GLOBAL CENTER ON ADAPTATION

State and Trends in Adaptation Report 2021

How Adaptation Can Make Africa Safer, Greener and More Prosperous in a Warming World

Conference edition

GLOBAL CENTER ON ADAPTATION

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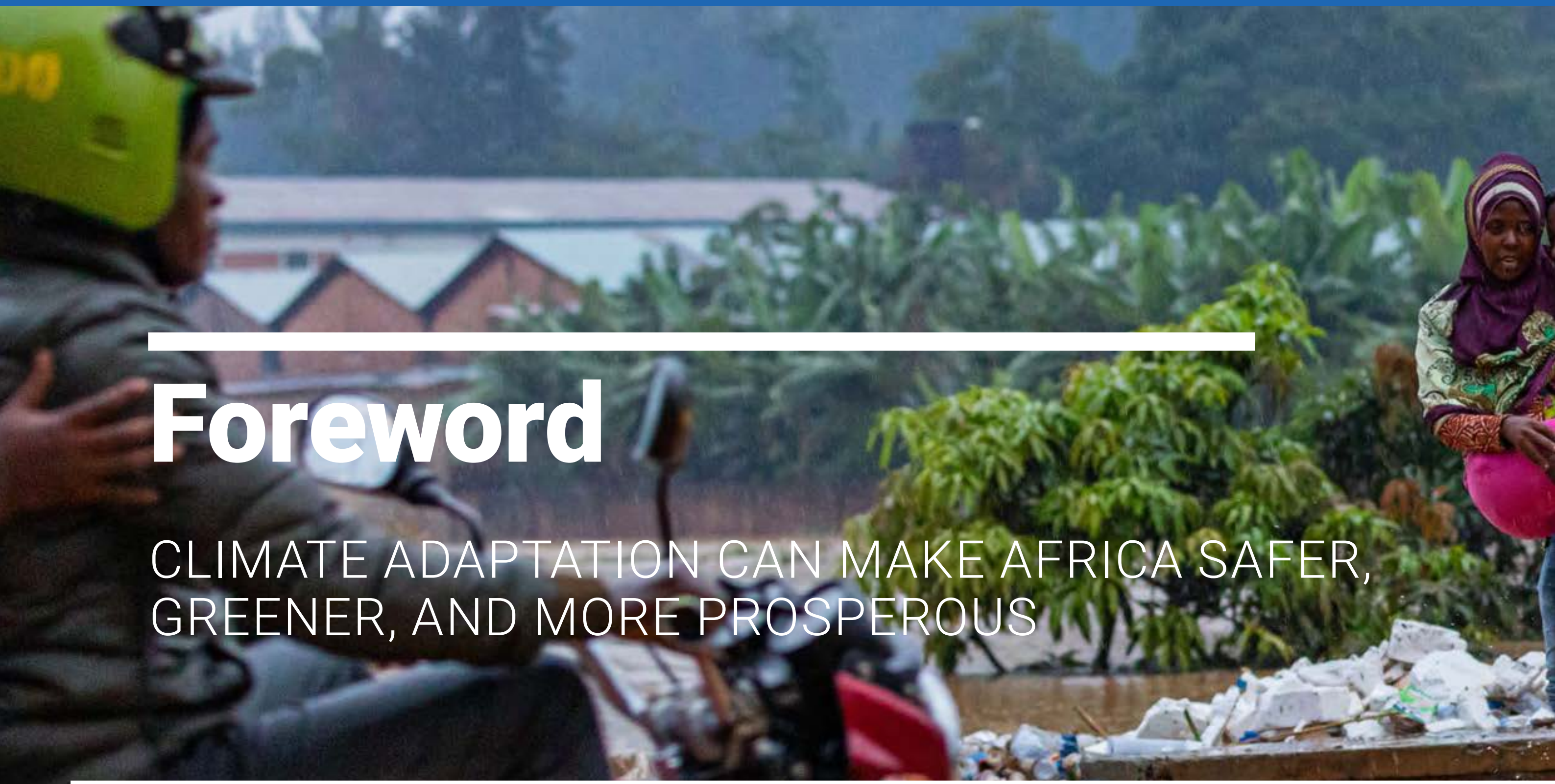

Foreword

CLIMATE ADAPTATION CAN MAKE AFRICA SAFER, GREENER, AND MORE PROSPEROUS

ADAPTATION IS CRUCIAL FOR THE CONTINENT THAT IS THE MOST VULNERABLE TO CLIMATE CHANGE, BUT ADAPTING SUCCESSFULLY WILL BRING ENORMOUS BENEFITS.

The early impacts of climate change are upon us. Scientific assessments detail what millions of people are already seeing with their own eyes. More extreme storms, record floods, searing heatwaves, more powerful cyclones, rising sea levels, and more severe droughts. Accelerated efforts to combat the causes of climate change must be matched by efforts to deal with its consequences, as these impacts will only grow more intense as the planet continues to warm.

Our climate emergency affects us all, but the warning light is flashing most urgently for Africa. Even before the social and economic trauma inflicted by the COVID-19 pandemic, African nations have already faced a long list of challenges from high rates of poverty and rising food insecurity to unplanned rapid urbanization, increasing water scarcity, ecosystem loss and desertification, and a lack of decent jobs to meet a growing population.

Despite contributing the least to global warming, Africa finds itself on the frontline of this climate emergency. Highly dependent on rainfed agriculture, hundreds of millions of smallholder farmers are affected by changes in the monsoons they rely on. Indeed, large portions of Africa—in particular, the drylands areas that cover three-fifths of the continent—are warming at a rate twice the global average, putting half a billion people at risk.

Africa has no choice but to adapt now to the present and future impacts of climate change. Yet while adaptation is a critical need, when done right it also presents major opportunities. With swift and effective action across all sectors, Africa can achieve a larger development agenda and move forward rapidly on a new "green" and resilient pathway to growth, harnessing the powerful synergies between adaptation, growth and development. Given the right conditions, Africa has some special advantages that make this green growth path more achievable, such as a rapidly growing labor force and rich reserves of natural resources.

This new report from the Global Center on Adaptation, *State and Trends in Adaptation 2021*, combines in-depth analyses, case studies, and viewpoints from those on the frontlines of climate change impacts in Africa. It presents a detailed blueprint for action by offering innovative adaptation and resilience ideas, solutions, and policy recommendations. The results are clear and compelling. Adaptation measures can be enormously cost-effective and have the potential to start a positively reinforcing cycle of benefits. As these measures protect people and communities from floods, droughts, and others impacts, they also help lift people out of poverty, reduce hunger and undernourishment, raise incomes and living standards, fight diseases, create jobs, reduce inequality, mitigate the risk of conflicts, and give voice to the most vulnerable. These realizable results, in turn, further increase resilience to climate impacts.

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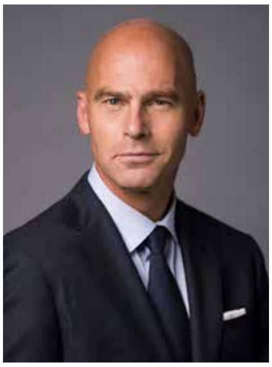
Of course, successful adaptation will not be easy. It requires major increases in adaptation finance and mainstreaming adaptation into all policies and budgets across the public and private sector. New partnerships will need to be forged to embrace both new technologies and traditional adaptive farming practices, empowering women and youth, and transforming key sectors, including agriculture, transportation, energy, trade, and water management.

Yet as, this report also details, African countries and communities have already taken numerous steps forward to adapt and to build resilience. This leadership shows a more prosperous, more sustainable, and safer future is achievable. We hope that this comprehensive report will be an inspiration and a guide to build upon and accelerate those efforts, bring them to scale, and seize the enormous opportunity that lies within our grasp.



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Greening slums with vertical farms: Olumuyiwa Bayode Adegun (Federal University of Technology, Akure, Nigeria)

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Executive Summary

TOWARD A MORE RESILIENT AFRICA

THE URGENT NEED TO ADAPT TO CLIMATE CHANGE

The average global temperature is on track to rise to 1.5°C above pre-industrial levels within the next decade or so and 2°C or more by mid-century. These warmer temperatures are already transforming the planet, causing more extreme storms and floods, rising sea levels, more intense heatwaves, and longer and more severe droughts. As global temperatures continue to climb, those impacts will inevitably intensify.

Africa is particularly vulnerable to these extreme impacts of climate change. It faces exponential collateral damage, posing systemic risks to its economies, infrastructure investments, water and food systems, public health, agriculture, and livelihoods, threatening to undo its hard-fought development and reverse decades of economic progress. Rates of poverty are high, both among the millions of smallholder farmers and the large numbers of people who live in informal settlements with low access to basic services in cities. In addition, large portions of Africa—in particular, the drylands areas that cover three-fifths of the continent—are warming at a rate twice the global average, putting half a billion people at risk.

Projections estimate that climate change will cause a 2 percent to 4 percent annual loss in GDP in the region by 2040. The brunt of the impact will be borne by the poor, women, and currently marginalized or excluded populations. Even if international mitigation efforts keep global warming below 2°C, the continent is expected to face climate change adaptation costs of US$ 50 billion per year by 2050. Meanwhile, the continuing COVID-19 pandemic has been a severe disruption, straining resources in many countries.

Africa thus has no choice but to adapt now to the present and future impacts of climate change. At the same time, rapid and decisive action to cut greenhouse gas emissions and mitigate climate change is crucial for reducing those future impacts; without at least some mitigation, adapting to climate change may be impossible for Africa.

The GCA's *State and Trends in Adaptation 2021* report presents the most comprehensive overview of the present and future prospects for the African continent in the light of climate change. It offers a blueprint for how individuals and institutions in the African and international policy space can finance, design, and implement adaptation plans to best protect the lives and livelihoods of millions of African people from such disruptive change.


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The macroeconomics of adaptation: The potential for large benefits

The analyses in this report document the high costs of climate change impacts in Africa. Because of better hazard reduction measures, improved social safety nets, humanitarian support, and other measures, African nations have significantly reduced the number of deaths from floods, droughts, and other weather events. But the economic toll, which includes reduced crop yields, business losses from disruptions to supply chains and power outages, damage to housing stock and infrastructure, people displaced from their homes and farms, and livelihoods harmed, is enormous—billions of dollars a year. If Africa had not experienced numerous damaging weather events over the last decade, the strong growth rates countries have achieved would have been even higher.

Adaptation measures are essential to decreasing those large economic damages and further decreasing the loss of life. Yet adaptation can accomplish much more than simply preventing future damages; it also presents major opportunities to achieve a larger development agenda and put Africa on a new "green" and resilient pathway to growth. Adaptation and development work hand in hand, creating powerful synergies that can increase the chances of meeting global Sustainable Development Goals and additional goals that African nations have set for improving agricultural productivity. Moreover, Africa has some special advantages that make the green growth path more achievable, such as a rapidly increasing labor force and vast available resources.

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Adaptation measures have the potential to create a virtuous circle. Even as they protect people and communities from the impacts of climate change, they can also help lift people out of poverty, reduce hunger and undernourishment, raise incomes and living standards, fight diseases like cholera and dysentery, create jobs, reduce inequities, reduce the tensions that lead to conflicts, and empower women. Those gains, in turn, will further increase resilience, enabling communities to better cope with future extreme storms, droughts, or other climate change impacts. In addition, many of these actions will help mitigate climate change as well by cutting emissions or pulling carbon from the atmosphere.

The macroeconomic analysis in this report shows that the economic case for adaptation is strong. Adapting now is much more cost-effective that continuing to finance increasingly frequent and severe crisis responses, disaster relief measures, and recovery efforts. Studies focusing on Africa show that the benefits of adaptation measures are almost always more than twice the costs, and often are more than five times higher. In addition, moving quickly to adapt is especially beneficial, with a benefit-cost ratio for early action of at least 12 to 1.

A comprehensive plan of action

This report uses in-depth analyses, case studies, and viewpoints from those on the frontlines of climate change impacts in Africa to present a detailed blueprint for action, offering innovative adaptation and resilience ideas, solutions, and policy recommendations. It calls for a combination of coordinated and supportive bottom-up and top-down solutions. Adaptation is everybody's business.

The report documents and builds upon numerous examples that already exist today in Africa of successful adaptation strategies. An initiative called the Great Green Wall has evolved from the idea of a 7,000 km belt of trees planted across the width of Africa to a comprehensive vision for restoring 100 million hectares of degraded land, demonstrating that African nations can work together to set ambitious targets and make progress. In addition, several countries have released national green growth strategies that include a strong focus on adaptation, such as Ethiopia's Climate-Resilient Green Economy Strategy, Rwanda's Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development, and South Africa's Green Economy Accord. Equally important, these countries have ensured that consideration of adaptation is part of their planning processes and budget allocations.

Other nations are implementing specific adaptation measures, such as the modernized climate information and early warning system in Malawi. That system delivers improved forecasts and weather advisories to farmers, fishers, and disaster response organizations over mobile phones and other platforms, helping people prepare for coming weather events. One study showed that by 2019, the system had directly improved the resilience of 420,000 people and indirectly helped 1.2 million more people.

Many other efforts are growing up from the grassroots, such as farmer-led agroforestry restoration efforts that have increased crop yields in Niger and community-led efforts in urban informal settlements to build stormwater drains and improve access to clean water and electricity, increasing resilience to floods.

These examples, and many more, have laid a strong foundation for a more resilient Africa. But given the size of the climate threat, the pace of adaptation must be dramatically increased. As the report's chapters describe in detail, adaptation must be "mainstreamed" into decision-making at all levels of government, in all economic thinking and planning, and in every ministry, with high level adaptation champions in each country. Adaptation measures also must be implemented in every sector—agriculture, transportation, energy, trade, water resources, and urban development. Particularly important are nature-based solutions, such as restoring mangroves to protect coastal communities or creating urban parks that absorb stormwater and moderate heat waves in cities.

To support these efforts, adaptation finance must be accelerated using a wider variety of finance sources, from commercial banks and venture capital to insurance and foundations, and innovative ideas like debt for climate swaps.

Given the African continent's enormous human and natural resources, Africa has the potential to move forward rapidly in labor-intensive modern industries such as eco-tourism services, climate-smart agriculture, renewable energy, and green building and infrastructure. It thus has an opportunity to adapt to the impacts of climate change while simultaneously reaching sustainable development goals. This report is both a call to action and a comprehensive guide to the climate-adapted and resilient growth path that can move Africa towards a more resilient, healthier, and more prosperous future.

THE CHALLENGE: THE PRESENT AND FUTURE IMPACTS OF CLIMATE CHANGE

Africa's climate and weather are largely controlled by the El Niño Southern Oscillation (ENSO), a weather system driven by changes in atmospheric and ocean circulation across the equatorial Pacific Ocean, and by two monsoons. The West African monsoon brings rain to the western Sahel from June to September, and the East African monsoon drops precipitation in East and Central Africa from March to May and October to December. In addition, Africa's East Coast is regularly struck by strong cyclones.

Variations in these large-scale climate phenomena have huge implications for the amounts and patterns of rainfall and storms in individual African countries, and have historically caused numerous natural disasters like floods and droughts.

A major challenge in the planning for climate change is the deep uncertainty at small geographical scales (like a city) and over longer timeframes (the decades of useful life of infrastructure assets). This calls for a strong emphasis on no-regret robust solutions able to handle that uncertainty.

Now, however, climate change is increasing the frequency and intensity of those extreme weather events. The number of floods in Africa has jumped five-fold since the 1990s, and many floods are more extreme. Sudan experienced its most severe flood in 60 years in 2020, for example, with more than 500,000 people displaced and 5.5 million areas of farmland destroyed.

In 2019, two of the strongest storms ever recorded hit East Africa. Cyclone Idai destroyed 90 percent of the homes in the city of Beira in Mozambique and damaged 1.4 million hectares of arable land in Zimbabwe. A few weeks later, Cyclone Kenneth struck a little to the north. Together, the storms killed 1300 people and affected 3.5 million more.

Droughts are becoming more intense as well. A 2016-17 drought in Somalia caused US $1.5 billion in losses to agriculture, along with widespread malnutrition, and a 2019 drought lowered water levels behind the Kariba Dam, leading to US $200 million in lost production in Zimbabwe from power shortages.

In addition, the intensification of the Asian monsoon lows, which draw warm dry air from the Arabian Peninsula to North Africa, caused temperatures to rise up to 47°C in Egypt in August 2021, making it unsafe to work outdoors and forcing the Metro in Cairo to close. Such dangerous heatwaves are becoming more frequent.

The increase in extreme climate events is having serious consequences. Productivity growth for the continent's number one staple, maize, has stalled, and the likelihood of conflict has increased. Data for the period 1980-2016 show that one-third of conflicts have been preceded by a natural disaster within seven days. After the 2009 drought in Mali, for example, Al Qaeda militants based in southern Algeria recruited fighters and extended their operations into Mali.

Studies show that each 1°C rise in temperature increases the risk of intergroup conflict by more than 10 percent. That can start a vicious cycle, where higher levels of conflict triggered by climate change further undermine communities' abilities to cope with and adapt to more extreme weather events, making additional conflicts more likely.

These growing climate threats come at a time when Africa already faces significant economic and social challenges. More than one in five people across the continent experience hunger in their daily lives, and 282 million people are undernourished. The numbers of stunted children are rising, exacerbating cycles of poverty that can continue from generation to generation. And 94 percent of the world's cases of malaria—215 million in 2019—occur in Africa, with 386,000 deaths in 2019.

Climate change impacts will become more severe

There are large uncertainties about Africa's climate future. Whether or not certain regions will experience greater rainfall or suffer from more droughts is highly dependent on small changes in ENSO and the monsoons, which today's climate models cannot yet accurately predict.

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But many of the general trends are clear. By mid-century, average temperatures will be 2°C higher, or more, compared to pre-industrial levels. Life-threatening temperatures above 41°C are projected to increase by 50 to 200 additional days, depending on the region and the world's pace of cutting greenhouse gas emissions. For countries like Chad, Burkina Faso, and Togo, more than seven percent of all working hours will be lost because of heat stress.

The climate models do project that parts of North Africa, western Southern Africa, and Central Africa will continue to experience a drying trend—and that almost all regions of the continent will be struck by more frequent and more intense rainstorms, causing greater numbers of potentially devastating floods. At the same time, higher temperatures, enhanced evaporation, and more erratic monsoons are expected to increase the number and severity of droughts.

Meanwhile, sea levels are virtually certain to climb by half a meter by the end of the century and could rise nearly a meter unless greenhouse emissions

are quickly curbed, while cyclones are expected to become more powerful. The combination of higher seas and stronger storms will mean that today's 1-in-100-year coastal flooding events will happen once every 10 to 20 years by mid-century, threatening millions of people in coastal communities.

Failure to curb global greenhouse gas emissions would put the world on a trajectory towards planetary warming of 3°C, which would cause catastrophic disruptions of the whole African food system. Under the 3°C scenario, Africa would lose 30 percent of its current growing areas for maize and banana, and 60 percent for beans, by 2050.

Climate tipping points are also possible. If the ocean currents known as the Atlantic Meridional Overturning Circulation collapse, for example, deserts would spread across large areas of Africa south of the Sahara, with calamitous impacts on food production and agricultural livelihoods.

THE PATH FORWARD

Climate change presents a huge threat to Africa's economic development and social progress. Adaptation is thus a necessity, not a choice. But it can put Africa on the path to a more resilient and prosperous future. This report lays out a detailed blueprint for successful adaptation. The key enabling foundations include:

- *Mainstreaming adaptation.* This means creating national adaptation strategies and viewing every decision and every plan through the lens of how those actions can improve long-term resilience. In both government and the private sector, a focus on adaptation would lead to a revolution in the planning, design, financing, and delivery of infrastructure, including a heavy emphasis on renewable energy and nature-based solutions like the restoration of drylands and forests. A number of countries have taken important steps in this direction, such as South Africa, Rwanda, Ethiopia, and Kenya, among others
- *Dramatically increasing financial support for adaptation.* In their Nationally Determined Contributions (NDCs) under the Paris Agreement, 40 African nations have estimated their investment needs for adaptation at roughly $331 billion by 2030. The amount of money available for adaptation actions, however, is far less, leaving a $265 billion gap. There is an urgent need, therefore, to increase support from developed nations, sovereign wealth funds, pension funds, development banks, philanthropies, foundations, non-profits, and other sources, as well as integrating adaptation into national budgets. There are also opportunities for innovative financing models. The African Adaptation Acceleration Program will invest in climate-smart agriculture to increase yields and improve resilience, along with empowering youth through incubator and training programs, for example. The African Conservancies Fund offers loans to boost sustainable agriculture and eco-tourism in the Maasai Mara in Kenya. And some of the Seychelles national debt was acquired by the Nature Conservancy in return for creating the Seychelles Conservation and Climate Adaptation Trust, which has used $1.5 million in funding for such projects as restoring mangroves

and employing disadvantaged women to harvest seaweed for fertilizer. A related crucial step is requiring disclosure of climate risks. Combined with measures like *"green"* and resilient building codes and other regulations that support adaptation, that will steer both public and private investment dollars towards projects, products, and services that build resilience to floods, droughts, and other climate change impacts.

- *Harnessing the power of the private sector.* Ninety percent of the jobs in Africa and 75 percent of the continent's economic output come from the private sector. Adaptation is thus crucial for the private sector to survive and thrive. At the same time, a strong effort to adapt will create important new business opportunities. In one example, the OCP Group, a global fertilizer producer based in Morocco, has worked with public authorities to build desalination and wastewater recycling plants to reduce water shortages, and has also partnered with research centers to introduce new higher-yielding varieties of quinoa to farmers, helping to reduce food insecurities.
- *Improving hydrological and meteorological (hydromet) services.* Reducing the human and economic toll from disasters like floods or droughts is impossible without high-quality data on weather, climate, and key parameters like river flows and soil moisture—or without a system for warning those in danger. Just 24 hours of advanced notice of a coming storm or heatwave can cut damages by 30 percent, and accurate longer-range weather and climate forecasts can enable herders to move their livestock or farmers to change what and when they plant to maximize productivity. The World Bank estimates that deaths could be cut in half and $2 billion annual losses could be avoided if early warning systems in Africa were upgraded to European standards. In implementing such early warning systems, it's essential to engage local communities, taking advantage of their knowledge about vulnerable crops and livestock, the strength of the housing stock, the locations of shelters, and other key characteristics. It's also vital to devise methods for reaching people with forecasts and warnings. In one example, the national meteorological service in Senegal works with 83 community-based radio stations, plus text message servers, to reach 740,000 rural households with seasonal forecasts that can guide planting choices and other decisions.

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- *Creating more opportunities for young people.* With 43 percent of its population under the age of 15, Africa has the largest youth population in the world. Young people are particularly vulnerable to the impacts of climate change, with most employment being informal on farms or in urban households. They are also not yet significantly engaged with the climate crisis, and are often excluded from community-level political activities and leadership roles on a continent where countries are governed by the world's oldest leadership. But the youth "bulge" also offers important opportunities. Africa's young people today have more education than their parents do. With policies and investments aimed specially at accelerating "green" and resilient growth, therefore, youth can provide the workforce needed to expand the manufacturing sector, to improve agricultural productivity through climate-smart practices, and to increase formal employment in cities.
- *Empowering women.* Women also are especially vulnerable to climate change. Because they typically lack property and land tenure rights, they are often forced to work on the least productive land, while also taking on laborious tasks like collecting water and fuelwood. They are much less likely than men to use fertilizers and improved seeds or to make use of mechanical tools and equipment. And they are usually excluded from

decision-making. As a result, African countries are failing to take advantage of the unique knowledge, skills, and perspectives that women have—such as local knowledge about sowing seasons, traditional multi-cropping practices, wild edible plants, and livestock management. They also play major roles in disaster recovery and resilience. As a result, there is a critical need to develop gender-responsive policies that both remove barriers to women's advancement and utilize their unique skills. One promising path to those policies is giving more power to women's associations. In the Kenitra province of Morocco, for example, the Soulaliyat women started an initiative to claim land access rights. The Ministry of the Interior responded by urging provincial authorities to ensure that the principles of gender equality are upheld in the transfer of communal land.

The steps described above lay the crucial groundwork for successful adaptation. It is then essential to build on those foundations by targeting adaptation efforts in key sectors. This report examines six sectors that are important for Africa's future, offering in-depth analyses and recommendations for effective action.

Agriculture

Given the huge role of the agricultural sector in the African economy, the millions of smallholder farmers whose livelihoods depend on it, and the growing challenges of hunger and food insecurity, agriculture needs serious and urgent attention—and the economic case for adaptation is particularly strong. The cost of taking effective action (particularly in priority areas like research and extension, water management, infrastructure, land restoration, and climate information services) is estimated at US $15 billion per year, less than a tenth of the estimated US $201 billion annual cost of inaction, which includes paying for disaster relief and recovery after floods and droughts.

Numerous proven strategies can make African agriculture more resilient. Some involve providing farmers and herders with more information and resources, such as early disaster warnings, weather advisories, remote sensing of vegetation to pinpoint the best grazing areas, and innovative insurance products, such as payouts pegged to insufficient rainfall. In the Sahel, for example, such payouts have assisted 1.3 million drought-affected people. Expanding mobile internet coverage, which now reaches only 24 percent of the population, is important for both delivering information and enabling farmers to connect with buyers and access new markets.

Other approaches, especially those led by local farmers and communities, can boost yields and incomes. In Niger, smallholder farmers have allowed versatile nitrogen-fixing Faidherbia albida acacia trees and other valuable species to naturally regenerate from seeds and rootstocks. The new trees have "regreened" more than five million hectares of degraded drylands, improving the soil, suppling food and fuel, and recreating a traditional form of resilient agroforestry that has dramatically raised yields and incomes. Local knowledge can also be tapped to grow and market neglected local species that are climate tolerant, such as cassava bread in West Africa, teff in Ethiopian cuisine, rooibos tea in southern Africa, or the faba bean in northern Morocco.

More gains can come from better water management, such as more efficient irrigation and water storage in small farm ponds. Cold storage for fresh produce like fruit, eggs, dairy, meat, and fish, along with better storage for grains, could significantly reduce food spoilage, which now wastes 36 percent of all the food produced in Africa. And pastoralists can switch from cattle to sheep and goats, which require less feed during droughts, or to livestock bred to be more drought- or disease-resistant.


Photo: Jen Watson/Shutterstock

Adapting the agricultural sector to climate change bring benefits beyond higher crop yields and increased farm incomes. Those benefits include greater resilience to pandemics, lower inequities, more opportunities for women and youth, greater political stability, and billions of dollars' worth of ecosystem services like cleaner water as landscapes are restored.

Trade

When climate events destroy crops and cause food shortages, trade can cushion the volatility of food markets and reduce the harm to people and communities, while also creating jobs and raising incomes. The classic historical example is the arrival of the railroad in colonial India in the early 1900s. The resulting ability to transport food and supplies almost completely ended large numbers of deaths from regional droughts and food shortages. More recently, South Africa lowered barriers to imports of maize and other foods in response to a 2015-2016 drought, limiting shortages and price spikes.

Africa now should take greater advantage of the opportunities trade offers to open up markets, boost productivity, and improve resilience. Studies show that simply phasing out agricultural tariffs could cut undernourishment caused by the impacts of climate change by 64 percent, with 35 million fewer people suffering from hunger.

This report recommends that governments reduce trade barriers, especially for food, goods, and services that can directly increase resilience. Those can include new stress-tolerant varieties of crops, technology for early warning systems, renewable off-grid electricity generation, and innovative irrigation systems. Countries should also improve transportation networks throughout the continent, reducing their vulnerability to floods and other impacts, and ensuring that natural disasters don't curtail trade.

Drylands

Two-thirds of the total area of Africa is comprised of arid and semi-arid regions defined by a scarcity of water. These so-called drylands are home to two-fifths of the continent's population and contain three-fifths of the total farming land. In addition to cropland, they range from woodlands and savannas to Mediterranean shrublands and the hyper-arid


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Sahara. Unfortunately, many of these dryland areas have suffered from decades of land degradation. Now, the drylands are warming at a rate twice the global average, putting half a billion people at risk.

There is an urgent need therefore to restore degraded drylands, to build greater resilience to future climate impacts, and to scale up climate-adapted development.

In the past, top-down interventions by government agencies, such as national efforts to plant millions of trees, have often been ineffective. In contrast, however, many community-led efforts that draw on local knowledge have been successful. In Burkina Faso, a farmer named Yacouba Sawadogo revived an ancient technique called zaï, in which people dig deep planting pits and stuff them with manure and other organic matter to trap water, making it possible to grow crops again and restore the tree canopy—and Sawadogo became known as "the man who stopped the desert."

On a much larger scale, the Great Green Wall Initiative aims to use zaï and other techniques like stone bunds (embankments to minimize erosion) and farmer-managed natural regeneration to regreen scores of millions of hectares. These approaches are already improving productivity and livelihoods and restoring ecosystems in countries like Mali, Niger, and Senegal, and can be encouraged by institutional, regulatory and land tenure reforms that give local communities more control over their resources.

The drylands also offer great potential for diversifying well beyond smallholder farming. With abundant solar resources, minerals, and biodiversity, and with spectacular landscapes and amazing cultures, they can support or expand many other forms of economic and social development. Cheap, renewable solar electricity can power value-added grain mills and cold storage for farmers, new factories, hotels, and other small business, or rural health clinics. Restored forests and thriving tribal communities can make it possible to expand eco- and cultural tourism, while also generating new revenues from increased carbon storage capacity.

This report encourages African nations to embrace a vision for the large-scale transformation of the drylands, simultaneously meeting the existing challenges of poverty, undernourishment, and lack of opportunity while creating more economic opportunities in these important regions as the climate changes. In regions facing the worst impacts of climate change, the emphasis should be on people-based policies (like health, education and social protection) and not only on place-based policies (like infrastructure and urban development).

Urban development

Africa has the highest rates of urbanization in the world. About half of Africans now live in cities, and the urban population is expected to nearly triple by 2050, driven by high population growth rates and increasing migration from rural areas to cities.

Africa already is home to seven "mega-cities" (those with populations over 10 million people), including Lagos, Johannesburg-Pretoria, and Nairobi, with others soon to cross the threshold. Many of these cities have large and expanding footprints, with the increase in urban area growing faster than population.

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Like many other urban environments around the world, Africa's cities face a long list of challenges: lack of basic housing and infrastructure, overcrowding, congestion, unemployment, large inequities, disease, crime and violence, and low standards of living. Some of the challenges are especially acute in Africa, including inadequate transportation, insufficient urban planning, and lack of employment—with 90 percent of urban jobs being informal. And in sub-Saharan Africa, an estimated 60 percent of the population lives in informal settlements that typically spring up without planning or basic services. With little air conditioning and vulnerable power grids, heatwaves threaten lives and cripple businesses. And because many informal settlements are located on floodplains or hillsides, they are especially vulnerable to floodwaters or landslides. After three days of intense rainfall in 2017 in Sierra Leone, for instance, a massive landslide in the Babadorie River Valley resulted in more than 1000 people being dead or missing.

Solving these problems and building resilience is a difficult and complex challenge, requiring actions at many levels. But African cities do have unique opportunities to adapt to climate impacts, given their relatively low current population density and the fact that many cities are still in the early stages of urbanization. This report's recommendations include strengthening early warning systems, providing affordable safe housing, creating urban parks and better drainage systems to soak up stormwater and reduce urban heat, promoting innovative urban agriculture (such as vertical farms on the walls of homes), strengthening and decarbonizing power grids, generating energy from wastes, moving communities from vulnerable floodplains and hillsides, and restoring natural features like riverbank mangroves and wetlands. In coastal Beira in Mozambique, one of the cities most threatened by climate change, restoring the natural drainage capacity of the Chiveve River and creating urban parks along the riverbanks has reduced the risk of future flooding. In other cases, local communities can lead the way. In Murkuru, a large slum in east Nairobi, local people have led an effort to build roads, add stormwater drains, and connect each household with electricity, clean water, and sewers, reducing flooding and the incidence of waterborne diseases.

Transport and energy

Many of the roads, bridges, power grids, and other key infrastructure elements in Africa are decades old and are unable to withstand the impacts of climate change. In Tanzania, businesses lose millions of dollars a year because of power outages and transport disruptions caused by flooding. In Mozambique, a 2000 flood destroyed road links between the capital of Maputo and the rest of the country, as well as the rail line to Zimbabwe, for almost a year, leading to the lowest level of economic growth in two decades.

The combination of vulnerable infrastructure and increasing climate shocks can create an "infrastructure trap" in which governments spend most of their limited funds repeatedly rebuilding the same failed structures and systems, leaving few resources to make progress towards a more resilient future.

The way out of this trap is switching from reacting only after disasters strike to "proactive" adaptation: considering climate risks at the beginning of every project, and incorporating resilience in planning, design, construction, operation, and maintenance. The upfront costs of building in resilience from the start are estimated to be only about three percent higher than normal construction, but the payoff is much larger—at least four times the additional investment in reduced rebuilding and maintenance costs. There are many other benefits as well. More resilient solar power plants not only provide electricity when droughts curtail hydropower, for instance, they also mitigate climate change, reduce air pollution, and lower fuel costs compared to alternative diesel generators.

Another part of the solution is making better use of natural systems. Green roofs, urban parks, wetlands, forests, and other nature-based approaches can significantly improve stormwater management and reduce flooding, while also reducing the costs of engineered solutions like more massive stormwater drains. Similarly, restoring salt marshes, coral reefs,


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and mangrove forests to protect coastal roads, rail lines, ports, and airports is highly cost-effective.

There are also countless opportunities for clever ideas. In Ghana, the Bamboo Bike Initiative trains rural women and youth to build bicycles for those who can't afford commercial ones. Farmers report that the bicycles enable them to spend more time growing crops, and students who used to walk up to 10 km to classes say their school performance is improving because they can arrive earlier and more quickly.

Water resources, floods, and disaster risk management

A key principle of adaptation is that you cannot prepare for future climate disasters if you are not ready for current disasters. That's why it is encouraging that all 55 countries in Africa have signed onto the Sendai Framework for Disaster Risk Reduction, which sets ambitious goals for reducing the number of people killed or affected by disasters, along with economic losses, damage to infrastructure, and disruptions of basic services. In addition, 18 countries have strategies or policies in place to work towards those goals, and seven more are developing such policies.

This is just a beginning, though. This executive summary has already offered many recommendations, from improving early warning systems to harnessing nature-based solutions like ecosystem restoration, for reducing the toll from floods, droughts, and storms.

Additional recommendations include boosting the financial resources for disaster relief and recovery—and using those resources to provide nearly instantaneous relief support. A case study in Malawi shows that a four-month delay in disaster support can increase the cost per household from a few dollars to US $50. And a nine-month delay sends costs soaring to US $1,300 household, primarily because people are forced to sell assets like livestock at distressed prices and children's development is set back.

Given that most disasters are caused by too much or too little water, better water management is also crucial. That means integrating policies across a range of sectors and activities—forestry, agriculture, municipal water supplies, hydropower and river management, to name a few. It also requires more international coordination, since many large watersheds cross borders. A good example of such basin-wide collaboration is the Niger Basin Agreement, in which nine countries have come together to develop both a sustainable development action plan and a climate resilience investment plan.

CONCLUSION: TURNING THE BLUEPRINT INTO ACTION

A consistent theme runs through the sections of this report: Adaptation is not just a vital imperative; it also represents a major opportunity to solve previously intractable problems and put Africa on a more resilient path.

The same adaptation measures that can prevent devastating floods will reduce outbreaks of waterborne diseases like diarrhea, now the leading cause of death in Africa in children under five. Regreening the drylands and boosting crop yields will help stamp out malnutrition and child stunting, beginning a positive cycle that can improve families' prospects and well-being over generations.

Or consider the challenges of gender equity. Women in Africa now have less access to productive land than men do. They get only seven percent of all agriculture extension services and less than 10 percent of the credit offered to smallholder farmers. They are less likely to have mobile phones to connect them to markets or warn of threatening weather events, and they tend to shoulder laborious tasks like fetching water and collecting fuelwood.

Adaptation done right not only corrects these inequalities, it also offers benefits from tapping into the often unique and invaluable knowledge and expertise of women in such areas as traditional crops, agricultural practices, and edible wild plants. This report thus strongly recommends giving women greater roles in politics and decision making.

Adaptation is not easy. The pursuit of other important objectives, like the 169 targets in the Sustainable Development Goals, can even result in actions that are maladaptive. For example, efforts to reduce hunger by increasing irrigation could end up depleting aquifers, with severe long-term consequences. It is encouraging, therefore, that this particular risk was recognized in the Sebou-Saïss basin in northern Morocco, and the Saïss Water Conservation Project was launched to both cut hunger through more efficient irrigation and boost long-term resilience by preserving the aquifer.

Successful adaptation will take countless efforts like this one—and a resolve and commitment that most countries have yet to fully embrace. Africa needs more international cooperation and South-South exchanges of practical adaptation solutions with demonstrated results at scale. The hope is this comprehensive blueprint report can help African countries make that commitment and provide a guide to the way forward, helping to put Africa on the path to a more resilient future.

Synthesis

INTRODUCTION

The *GCA's State and Trends of Adaptation in Africa* report presents a comprehensive overview of the present and future prospects of the African continent in the light of climate change. It is also a blueprint for how individuals and institutions in the African and international policy space can finance, design and implement adaptation plans to best protect the lives and livelihoods of millions of African people from such disruptive change.

For many reasons surveyed in depth in this report—including its large youth population, large proportion of the workforce in informal employment and in agriculture, historical and current development trajectories, distinctive geographical features and climatic characteristics, decreased fiscal space after the COVID-19 pandemic, and the continent's pressing challenges in the realms of food security, urban infrastructure and energy—Africa faces a stark threat from the present and potential effects of climate change. It has no choice therefore but to adapt.

In this context, the *State and Trends of Adaptation in Africa* report is especially timely. As the recently released first volume of the IPCC Sixth Assessment Report (AR6) in August 2021 suggests, it now appears that critical warming levels for the world are likely to be reached earlier in the century than previously projected. Given the time-lag between the strong mitigation measures recommended by the report to prevent average global temperature rising by 1.5°C is the ipcc recommendation or more by mid-century, and such measures taking effect, both the need and the urgency to adapt are stronger than ever in Africa. Research presented in this report shows that the relative economic impacts of climate

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change on Africa are projected to be greater than in the developed world, meaning a potential reversal of decades of hard-won economic progress. Adaptation can also be a wellspring of future development, generating hundreds of thousands of green jobs, ensuring stability and food security for the vulnerable, forestalling conflicts over key resources like water and energy, and having positive impacts on many other human development indicators. This report is published before COP26 and we hope it will support the design of adaptation programs and actions, linking to the race to resilience as it sets out to catalyze a transformational change in climate resilience globally and, in particular, for Africa and its most vulnerable populations.

What are the most optimal pathways that an integrated program of climate adaptation for Africa might choose from the available options and resources at its disposal? And how can governments, regional bodies, and institutional actors work together to deliver a systematic and integrated program of adaptation to help secure the lives and livelihoods of the people of Africa? This Synthesis chapter presents an overview of the key findings and policy recommendations of the papers featured in the *State and Trends of Adaptation in Africa* report. It calls for a combination of coordinated and supportive bottom-up and top-down solutions. Adaptation is everybody's business.

PRESENT AND PROJECTED CLIMATES IN AFRICA

Africa is exposed to complex, interconnected climate systems, with three of the most important being El Niño Southern Oscillation (ENSO), the monsoons, and cyclones. Each is already affecting the lives and livelihoods of people across the continent. As anthropogenic climate change causes the planet to warm, each of these climate systems is likely to increase their influence on extreme weather outcomes and to become more erratic.

The recently released first volume of the IPCC Sixth Assessment Report (AR6) suggests that it is becoming increasingly difficult to avoid reaching a rise in average global temperature of 1.5°C within the next decade or so and 2°C or more by mid-century. Even if lower emissions pathways are to be achieved, African climates are likely to be more erratic, with most of Africa becoming more arid and much of it so hot that outdoor work and tourism will be life-threatening for much of the year. Droughts and floods already threaten livelihoods and trap people in poverty, and both are likely to increase in intensity and frequency in the future. Africa is particularly vulnerable to climate extremes, or even shifts in weather norms such as the start of the monsoon, as so much food production is dependent on rainfed cropping and pastoralism. Infrastructure that supports the wider economy is also highly exposed to extreme events. Therefore, adaptation is now more urgent and challenging than ever. The Present and Projected Climate Risks in Africa chapter sets the scene, showing us where we stand now and the increasing climate challenges that are imminent.

Key Findings

The African continent is often associated with disasters. Like most other parts of the world, Africa has shown a marked decline in the number of people reported as being killed in disasters. For example, in the 20 years from 1970 to 1989, 679,000 people were reported as being killed in African climate disasters, compared with only 44,000 fatalities over the most recent 20-year period. Most of this change represents real improvements from better hazard-reduction measures, social safety nets and humanitarian support to alleviate the worst of the impacts. But some of the decline is due to changes in the attribution of the cause of death, especially in relation to drought.

From 1991 to 2020 there were about 50 reported disasters per year across Africa, with floods contributing two out of three events. But droughts have the greatest impact on African lives and livelihoods, with five times more people affected by droughts than floods. Floods are recorded as causing greater financial damage, but as only 14 percent of disasters in Africa have an estimate of damages recorded, little can be made of the damage data. The number of flood events reported has increased about five-fold since the mid-1990s while the numbers of other types of disaster have changed much less. Some of the increase in floods could be due to a changing climate, but changing exposure patterns of populations along rivers and coasts and improved reporting almost certainly contribute as well.

In August 2021 the first volume of the AR6 Report was released with new insights and modelling. It is based on a major new modelling effort (CMIP6) that

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compares over 30 models of general circulation to include more detail within the models and greater spatial resolution. Analysis for Africa shows that changes in temperature drivers are already observed to be consistently higher across Africa. Annual precipitation is expected to decrease in North Africa and Southern Africa by 2050, even though such a trend is not yet clear in the observational data. Northern and Southern Africa are expected to become more arid throughout this century, but in some parts of Southern Africa aridity will be accompanied by an increase in heavy rainfall events, possibly leading to floods.

Confidence in the prediction of changed climate patterns and their attribution to human effects has increased, and it now appears that critical warming levels are likely to be reached earlier in the century than previously projected. This is the AR6 Report's strongest message for adaptation. Both the need and the urgency to adapt are stronger than ever.

A major challenge in the planning for climate change is the deep uncertainty at small geographical scales (like a city) and over longer timeframes (the decades of useful life of infrastructure assets). This calls for a strong emphasis on no-regret robust solutions able to handle that uncertainty.

Climate change attracts attention when some form of climate shock occurs. However, more subtle climate changes also threaten ecosystems and the people whose well-being depends on them. Small changes in weather patterns arising from climate change can gradually erode productivity of food systems and cause losses of assets through events too small to attract global or even national attention. These affect people's well-being and can counter efforts to rise

Table 1: Summary of effects of increasing emissions on African climates

Temperature	
	Observed mean annual temperatures are increasing at 0.2°C to 0.5°C per decade.
	Under each of the major emissions scenarios assessed, a global temperature increase of 1.5°C over pre-industrial levels is likely to be exceeded in the next decade or so, and by mid-century all but the lowest emissions scenarios suggest temperature increases of 2°C or more.
	High-emissions scenarios suggest it is very likely that warming will exceed 3°C by 2100 except in Central Africa, where the estimate is 2.5°C.
	Extreme heat-observations are limited so no evidence of a recent increase. Modelling suggests days above 35°C will increase by 20 to 160 days annually depending on scenario and region.
	Life-threatening temperatures above 40°C are projected to increase by 10 to 140 days depending on scenario and region.
	Cooling degree days will increase and heating degree days will decrease.
Summary: Heat waves and heat stress will increase and drastically so in the worst scenarios.	

Precipitation	
	The frequency and intensity of heavy precipitation events are projected to increase almost everywhere in Africa, leading to more flooding events.
	Observations are variable, but in many areas there is evidence of a drying trend, especially in parts of North Africa, West Southern Africa and Central Africa. Models project that this trend will continue.
	River floods-observations suggest there has been some increase in recent decades. Model results vary with scenario and region, but they suggest that present 1 in 100 year floods could become as frequent as 1 in 40 years under low-warming scenarios and 1 in 20 years under higher warming scenarios.
	The West African monsoon appears to arrive later in the year and rainfall is more intense and erratic.
	Life-threatening temperatures above 40°C are projected to increase by 10 to 140 days depending on scenario and region.
Drought	Droughts are expected to increase in all regions of Africa except the northern parts of East Africa and the Horn of Africa.
Aridity	Observation and modelling suggest increasing aridity in North Africa, West and East Southern Africa, and in Madagascar.
Summary: Changes in total precipitation are small, but more rain is likely to fall in heavy rainfall events in most regions. But the effect of increased precipitation must also be considered alongside the prospect of increasing temperatures and evaporative demand. Thus the overall picture is one of drier conditions over most of the continent with more droughts but also more flooding.	

Coastal & ocean	
Sea levels	African sea levels are currently rising slightly faster than the global average, although a little slower in parts of the Indian Ocean coast. They are virtually certain to continue rising by 0.4 m to 0.5 m by 2100 under low-warming scenarios, and 0.8 m to 0.9 m under high-warming scenarios.
Ocean temperatures	Marine heat waves are expected to continue to increase in frequency and intensity, especially around the Horn of Africa.
Cyclones	Cyclones are possibly decreasing in frequency, but high-intensity events will become more common, often associated with very heavy rainfall.
Coastal flooding	Projections suggest that a current 1 in 100 year flooding event will become events with a return period of 10 or 20 years by 2050, and of 5 years to annually by 2100, even under moderate warming.
Fire weather	Likely to increase throughout extratropical Africa.
Dust storms	Evidence is uncertain due to confounding factors, especially changes in land cover and general uncertainty in detailed wind modelling. The whole topic is impeded by lack of controlled observations.

out of, or can push people back into, poverty, leading to millions of people never being able to escape from the threat of poverty. Table 1 summarizes the AR6 climate trend observations and projections for Africa.

Effective action on climate adaptation and resilience is only possible with high-quality weather, climate, hydrological, and related environmental data ("hydromet" data). This data is collected in each country by national hydromet agencies. Data is, of course, not enough. In the end, what is required is for all stakeholders in society—governments, businesses, civil society, and citizens—to take appropriate action based on weather and climate information and projections. The meteorological value chain—from weather observations to local forecasts, warnings, seasonal outlooks, and other climate services—needs to work in a coordinated manner to be truly effective.

An essential product of this meteorological chain is multi-hazard early warning systems. According to an estimate by the World Bank, if early warning systems in low- and middle-income countries were upgraded to European standards, lives lost could be halved and annual losses to assets of between $300 million and $2 billion avoided. High-quality hydromet data has many other benefits, including economic productivity in key sectors, from agriculture to logistics. Better historical hydromet data and projected climate changes are becoming more critical to mobilizing climate finance. The collection of weather and climate observations in Africa is weak and deteriorating in recent years. For example, over the last five years (January 2015 to January 2020), the number of upper-air observations dropped by almost half in Africa. This foundational problem poses significant challenges for the ability of Africa to adapt to climate change.

SECTION 1 – ECONOMICS AND FINANCE

Macroeconomics of adaptation

While Africa has enjoyed high levels of economic growth over the last decade, it now experiences high economic losses from climate-related variability and extreme events, such as major floods, droughts and storms. In fact, it is the region with the highest vulnerability to such events globally. These events have major macroeconomic consequences. The strong growth rates experienced in Africa over the last decade would have been even higher if climate shocks had been better managed; a failure to prepare for these events has led to foregone growth.

Looking to the future, climate change will exacerbate these existing impacts, and create new risks even in the near term. In the long term, it will lead to potentially very high future economic costs, though the level of these impacts will depend on global mitigation agreements and their implementation. Africa already has a large existing adaptation deficit.

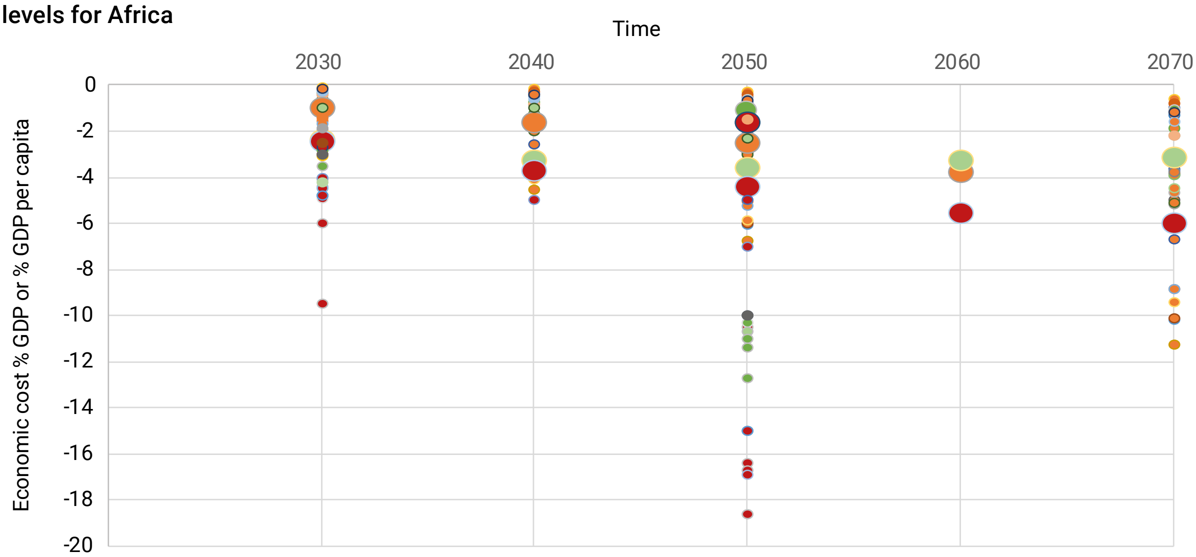
The Macroeconomics of Adaptation chapter provides a deep dive on the economics costs and macroeconomic risks of climate change impacts in Africa. It considers the potential economic benefits of adaptation, and the range of cost-benefit ratios of adaptation interventions in Africa.

Key Findings

There is an established literature on the economic costs of climate change, going back several decades. Despite the modelling challenges and uncertainties involved, there are many common insights across the various studies. Our analysis shows that:

- Even if the goals of the Paris Agreement are achieved, the economic costs of climate change in Africa are projected to be large. It is likely that Africa will experience higher relative impacts (as a percentage of GDP) than most other world regions, even though it is less responsible, both historically and in the present day, for global greenhouse gas (GHG) emissions than other major regions of the world. If the Paris goals are missed, the economic costs will be very significant in Africa, and potentially catastrophic.
- Climate change will affect near-term development and poverty reduction, as well as long-term growth for the continent. There is less agreement on the exact size of the economic costs of climate change in Africa and on which regions and specific countries in Africa will be most affected. Most studies report significant economic costs over the next few decades (i.e., several percent of GDP per year), rising significantly for high-warming scenarios in the longer term (to >5 percent and plausibly >10 percent for some countries), as shown in Figure 1. In addition, it is likely that these impacts will be unevenly distributed within countries, disproportionately affecting the most vulnerable.
- Only adaptation can reduce the economic costs of climate change in Africa over the next 20 years: Africa urgently needs to scale up adaptation now. Without a doubt, international mitigation policy is the only way to avoid the economic costs of high warming pathways, i.e., above 2°C relative to pre-industrial levels. However, while ambitious mitigation will provide huge benefits by avoiding these high-warming scenarios and the associated economic costs, the benefits of these policies have a relatively limited impact in the short term. Mitigation primarily has benefits after 2040, due to the inertia in the temperature response to greenhouse gas concentrations. To put this another way, the level of climate change in the next 20 years for Africa is already locked in, and these impacts can only be reduced by adaptation.

Figure 1: Selection of study findings of the economic cost of climate change over time for increasing temperature levels for Africa



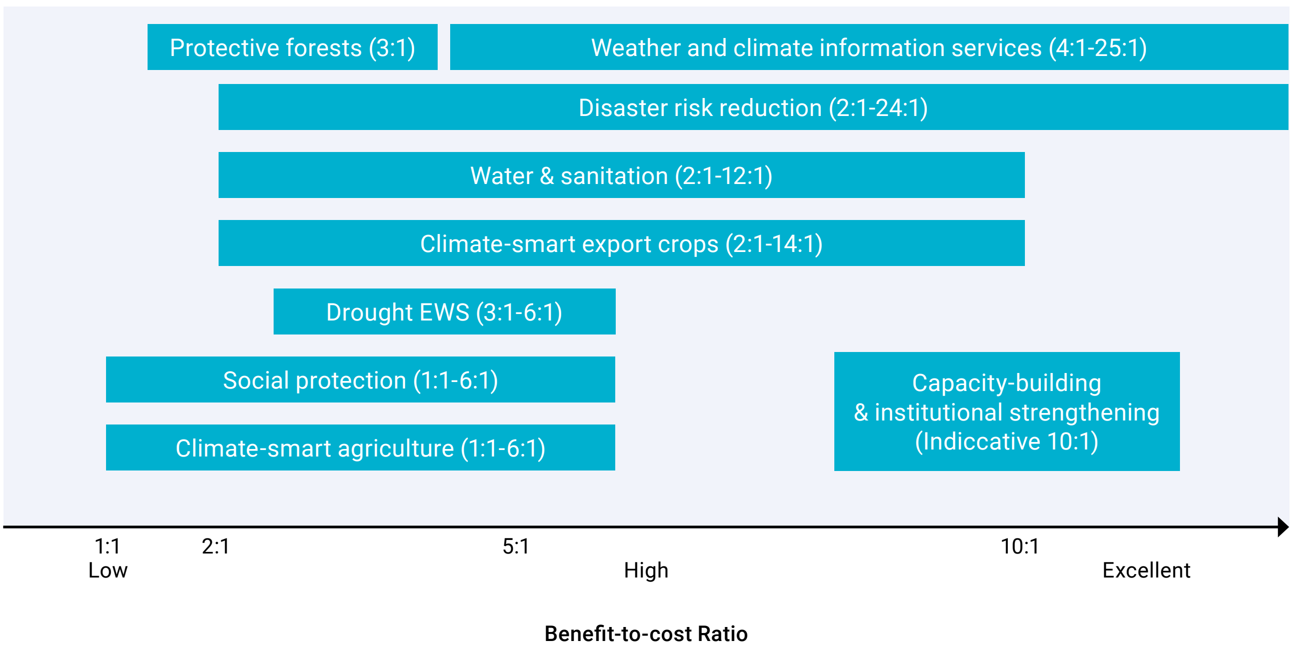
Source: Authors
Data shown are from a series of recent studies for low (green), medium (orange) and high (red) warming scenarios, including World Bank (2010), OECD (2015), Kompas et al. (2018), Baarsch et al. (2020), AfDB (2020), De Bruin et al. (2020), and Bosello (2021). They include regional studies for Africa and country studies: small circles represent country studies; large circles represent regional studies. Studies are plotted on the same scale, but they report slightly different metrics (e.g., percent of GDP, gross damages [including non-market impacts] as an equivalent percent of GDP, percent GDP per capita).

- There is a need to consider climate change in public financial management. The impacts of climate change on public finances, combined with the need to finance adaptation, could add pressure to debt levels in Africa. Financial market anticipation of these various impacts could hasten and exacerbate climate-related economic costs in Africa.
- Adaptation can reduce the economic costs of climate change in Africa very effectively. It should be seen as a complement to mitigation, not a substitute. While adaptation is found to be highly beneficial, the amount of adaptation (and the cost) depends on the decision framework used, as well as the level of warming.
- Early adaptation has high benefit-to-cost ratios. Our analysis focused on information for Africa specifically, to identify the potential benefit-to-cost ratios for adaptation. The findings are summarised in Figure 2. As shown in the figure, BCRs for a range of adaptation measures are mostly above 2:1, and often above 5:1, which is a sizable rate of return.

Policy Recommendations

A rapid scale-up of adaptation in the next 20 years is needed in Africa: doing nothing is not an option. It is important to strengthen the consideration of climate adaptation upstream (at a more strategic level in government policy and strategy), as well as to develop pipelines of bankable projects, considering both climate-proofing of planned development (e.g., resilient infrastructure) and also targeted adaptation projects (e.g., flood defences). Many countries will require external finance to deliver these scale-ups. There is an important role for government to identify the strategic economic case for action, and to consider where and how best to intervene to create the enabling environment for adaptation to ensure it is effective, efficient and equitable. There is a need to integrate economic thinking when designing adaptation strategies and policies, i.e., to consider market and policy failures, to identify where it is appropriate for government to act, and to design strategy and policy accordingly, as with other public policy areas. This will require analysis of these issues by governments and involve relevant ministries and expertise. It will also require external support.

Figure 2: Adaptation benefit-to-cost ratios for a selection of options from Africa-specific studies



Source: Authors
Note: The figure shows the indicative benefit-to-cost ratios and ranges for a number of adaptation measures. It is based on the evidence review undertaken for this study. It is stressed that BCRs of adaptation measures are highly site- and context-specific and there is future uncertainty about the scale of climate change. Actual BCRs will depend on all these factors.

COVID recovery

Globally, the unprecedented economic challenges of COVID-19 are being addressed by a combination of fiscal and monetary interventions. As some countries have begun to emerge from the depths of the health crisis, fiscal spending has again been the favored lever, this time to support long-term recovery by stimulating new jobs and enabling a return to pre-COVID-19 levels of economic growth. However, only a small share of the fiscal stimulus packages is explicitly green. Yet recent global economic studies suggest that green spending can secure both greater growth and a greener future. The COVID Recovery chapter reviews the COVID-19 recovery fiscal stimulus expenditures in selected African countries, analyzes their immediate benefits, and proposes ways to enable sustainable green economic growth. Selected countries include the Democratic Republic of the Congo, Egypt, Kenya and South Africa.

Key Findings

Before the COVID-19 pandemic, investment in adaptation to climate change was low when compared to investment in mitigation. Considering the economic crises and the disruption to livelihoods caused by the pandemic, it is important to stress on the idea of resilience and to contemplate new, green pathways to growth. This is especially so in the case of Africa, which has one of the largest populations of poor and vulnerable people in the world.

Agriculture is a dominant sector in the economies of most African countries. A focus on natural capital has the potential to bring economic, social, and environmental benefits, creating jobs rapidly and safeguarding communities against climate change. There is a clear and strong codependency between agriculture, natural capital, and climate change. Natural capital management provides a great variety of critical services to agriculture. Among them, for example, are ecosystem services (water, soil, nutrients, etc.) and regulating environmental conditions (physical protection against natural hazards like floods, tsunamis or wildfires, purifying water, etc.). On the other hand, poor agricultural practices and management reduce the availability and quality of natural capital, which in turn may

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create a spiral of degradation of both natural capital and agricultural activities. Both sectors are extremely vulnerable to climate change. Climate change accelerates the depletion of natural capital and ecosystem services by altering major geophysical conditions—average surface temperatures, ocean temperatures, precipitation patterns, the oxygen content and acidity of seawater—too quickly for natural systems to adapt. When these changes reach thresholds that ecosystems can no longer sustain, natural capital and ecosystem services often degrade along a nonlinear path.

The sustainable use of natural capital, particularly to address vast adaptation needs through nature-based solutions (NbS), and the adaptation of the agricultural sector to cope with current and future climate change impacts are vital for Africa's recovery and for resilient green economic growth.

Policy Recommendations

The examples of the four focus countries show that COVID-19 has caused a severe disruption to the countries of Africa, with huge consequences for both lives and livelihoods. Further, the absence of much fiscal space to generate remedial measures has meant that African countries have been able to spare only a fraction, when measured per person of the population, of the sums spent in the developed world and in low- and middle-income countries elsewhere in the world on relieving economic distress and providing safety nets.

But in the present crisis there is also a window of opportunity. As the nations of Africa seek to rebuild their economies, a new policy orientation emphasizing green and sustainable growth can not only boost the economy and create jobs on a large scale, it can also make the continent more resilient against the long-term challenges of climate change. Key principles that define and govern the "green growth" approach to development include sustainable economic growth; resource-use efficiency; climate change response through adaptation and mitigation; creation of decent green jobs; and human well-being and social inclusiveness.

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Many of the countries surveyed in this chapter, and more broadly in this report, have a significant percentage of their populations involved in, and a significant share of their GDP generated by, agriculture. As they seek to rebuild after the pandemic and to restructure their economies in the face of climate change, focusing on adaptation and natural-resource management can have many beneficial effects, among them the large-scale creation of sustainable green jobs for adaptation and resilience.

The needs and possibilities of each country are slightly different, and, as this chapter shows, under the broad orientation of green growth there is considerable room for the generation of portfolios of policy options tailored to each case. The provision of concessional finance by international partners, including foreign governments and multilateral organizations, is imperative for a successful COVID-19 recovery for Africa and to significantly reshape the economic, social, and environmental future of the continent.

Finance

Current adaptation finance flows to Africa are insufficient to meet growing adaptation needs on the continent. The Finance chapter provides an overview of existing adaptation finance flows in Africa and identifies opportunities to increase the volume and efficacy of that finance.

Key Findings

There is a pressing need to increase investment in climate change adaptation in Africa. While only six African countries have submitted National Adaptation Plans (NAPs) to date, all African countries, with the exception of Libya, have submitted Nationally Determined Contributions (NDCs), all of which include an adaptation component, as part of their

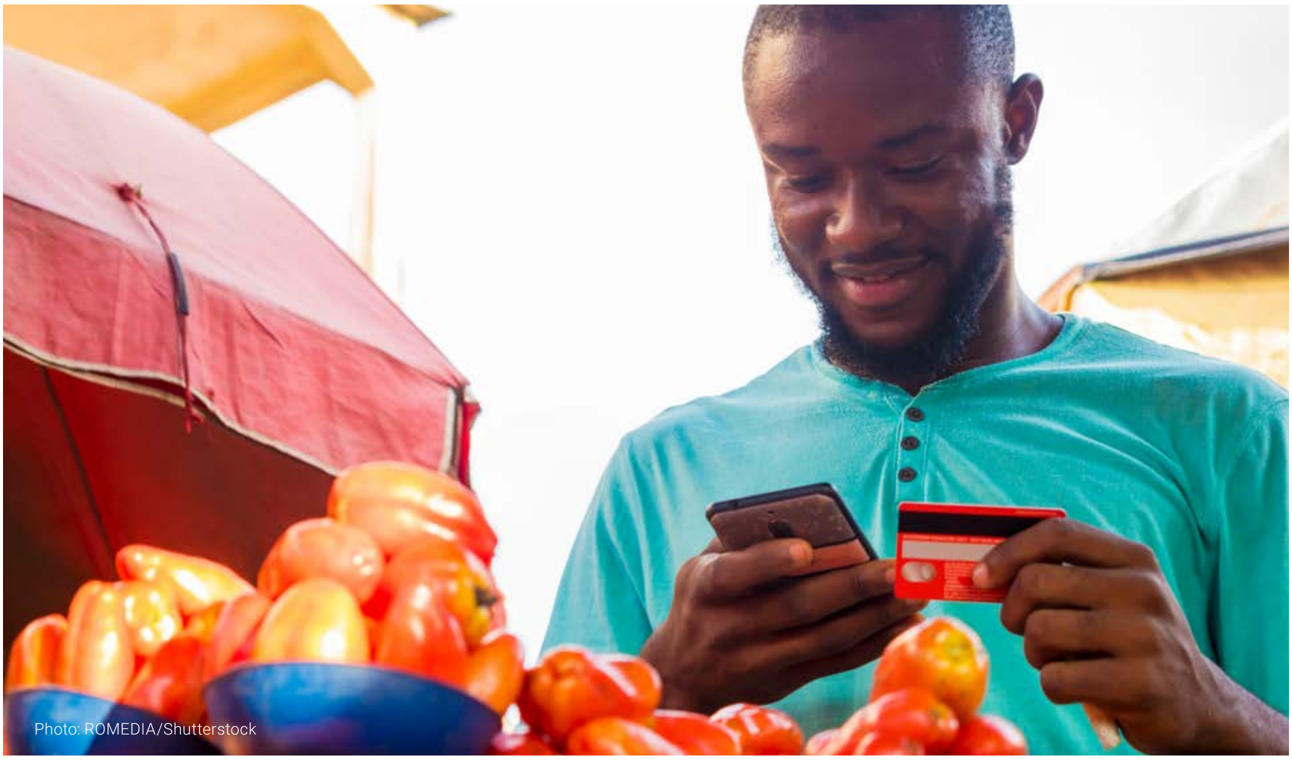


Photo: ROMEDIA/Shutterstock

commitment to the 2015 Paris Agreement. Based on these NDCs, all African regions prioritized at least three of these four sectors: 1) agriculture 2) water 3) health 4) forestry, land-use, and ecosystems. A total of 40 African countries provided estimated investment needs for adaptation, totaling roughly $331 billion through 2030. Fifteen countries provided a breakdown of conditional vs unconditional cost estimates, with an average ratio of 80:20. An average 80:20 ratio indicates that of the $331 billion estimated investment need (or $33 billion annually), countries expect to contribute around $66 billion (or $6.6 billion annually) from their national budgets, while the remaining investment gap of $265 billion (or $26.5 billion annually) must be met by international donors and domestic and international financiers.

Globally, an annual average of $46 billion in adaptation finance was tracked for 2019 and 2020, mostly provided by public actors (DFIs alone accounted for 80 percent of the total). Due to data limitations, nearly all flows tracked are from international public finance.5 Approximately $7.9 billion was tracked in adaptation finance to Africa in that period. If this trend continued through 2030, total finance from 2020-2030 would amount to $87 billion, far short of the $331 billion (or approximately $30 billion annually) in estimated needs per stated cost estimates in NDCs. Adaptation finance is therefore scaling too slowly to narrow the gap, even as the costs of climate impacts rise.

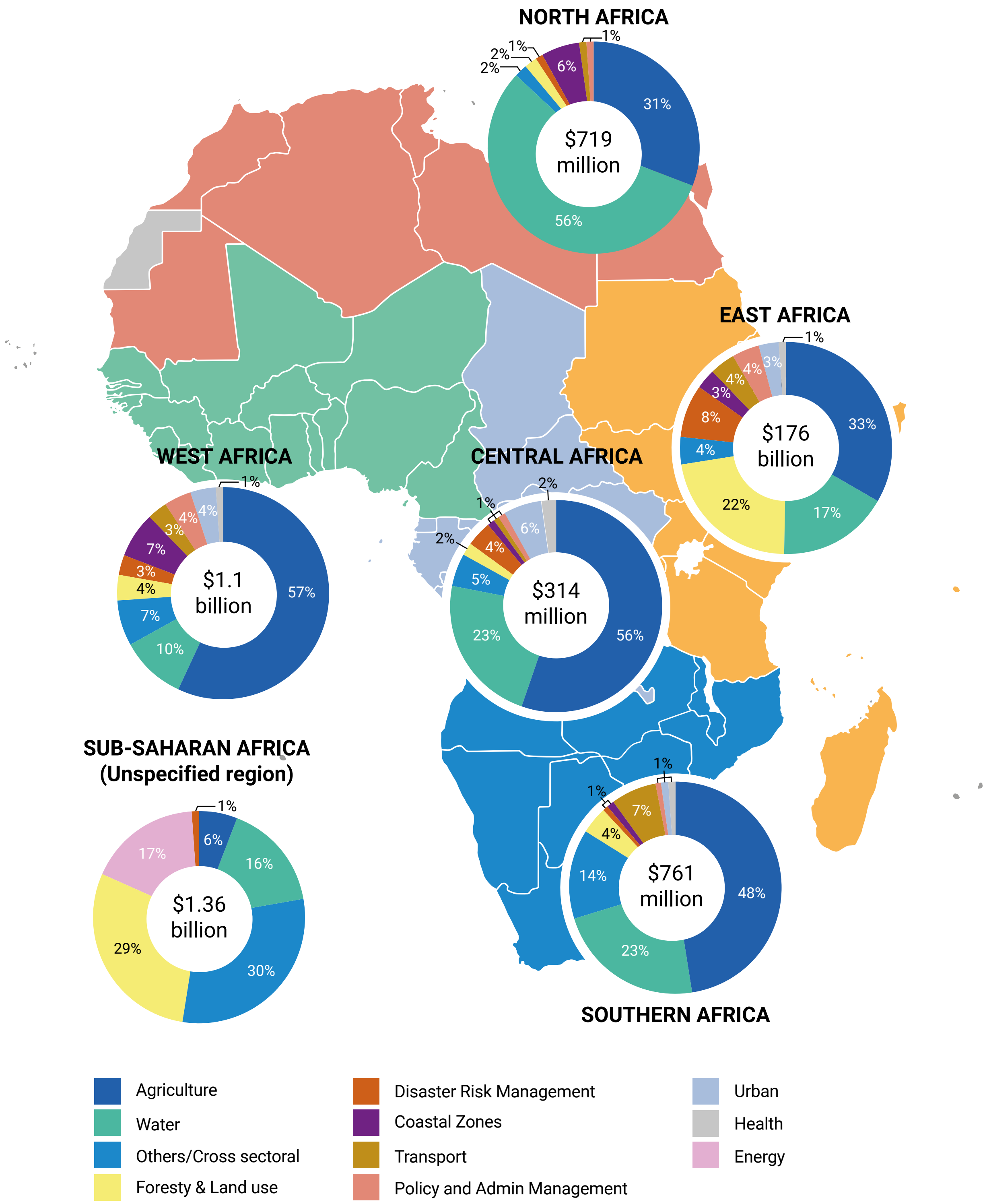
Of the $7.9 billion in adaptation finance tracked, grants and concessional debt accounted for approximately 68 percent of financial flows to adaptation in Africa. Two sectors - agriculture, forestry, land-use and natural resource management; and water and wastewater management - combined to receive the majority of sectorally identifiable adaptation finance in 2019-20. Regional analysis of adaptation finance by sector is available only through 2017-18, so Figure 1 represents tracked adaptation finance over that period.

The majority of finance flowed from Development Finance Institutions (DFIs) both from the region and external to Africa: multilateral, national, and bilateral DFIs contributed and managed 63 percent of total adaptation finance flows to the region, followed by bilateral government flows at 28 percent. The most vulnerable countries in Africa have not been recipients of proportionally high volumes of adaptation finance. There is limited to no correlation at the country level between climate vulnerability and adaptation finance overall or per capita.

Policy Recommendations

There is a pressing need to accelerate finance for climate adaptation in Africa over the coming decade. Adaptation investment needs to be mobilized from a wider variety of finance sources. Based on announced commitments, future adaptation finance for Africa is expected to more than double by 2025. However, even if many of the main DFI actors adopted best-practice commitments (similar to the World Bank's commitment to dedicate 35 percent to climate finance, of which 50 percent will go to adaptation) and if currently announced private sector mobilization efforts are successful (assuming at

Figure 3. Tracked adaptation finance by region and sector (USD, 2017–18 average)



least 20 percent of MDBs' $40 billion private sector mobilization target goes to adaptation in Africa), annual adaptation finance flows may still not meet minimum estimated investment needs by 2025.

There are many potential sources of adaptation finance for Africa, offering finance on a range of terms from highly commercial to highly concessional. Governments and stakeholders must mobilize different blends of these finances to ensure that adaptation efforts can be sustained on a consistent path, even as there is a greater effort made to generate high-quality, low-cost climate data and to translate climate science into policy. Figure 4 summarizes the financial actors which have a role to play in mobilizing finance for adaptation at scale in Africa. These actors offer financing along a spectrum of terms, ranging from highly concessional terms (lower return expectations and/or longer tenors) to commercial terms (market returns and tenors expected). Concessional capital is intended to fill a gap where the private sector (commercial capital) would not otherwise invest.

Yet there are numerous barriers to investment in adaptation that must be addressed. As discussed in the chapter, there are cross-sectoral barriers as well as sector-specific barriers hindering investment in adaptation activities, such as inadequate risk-adjusted returns, limited capacity to collect and analyze relevant climate data, policy and regulatory barriers in the agriculture sector, the need for regional coordination in the energy sector, lack of subnational fiscal autonomy for cities, and challenging economics for coastal ecosystems, among many others.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To mobilize these investors, a three-pronged strategy is needed.

1. Mainstream resilience into investment decision-making, through the following steps: (i) increase access to robust climate data; (ii) incubate technical expertise in financial structuring; (iii) engage pension funds through appropriate financial instruments; (iv) build capacity of African financial institutions and government entities to evaluate and act on climate risks; (v) require disclosure of climate risks—via national legislation and/or via DFI on-lending; and (vi) support small and medium-size enterprises (SMEs) that are offering adaptation-relevant products and services.
2. Build the enabling environment for adaptation investment, including the following: (i) articulate investment-ready NAPs and mainstream climate resilience in government procurement; (ii) build capacity to develop science-based policy and projects; and (iii) improve macroeconomic environments and adopt a multifaceted approach to address debt burdens faced by African countries.
3. Deploy innovative finance instruments, not only including grants and project finance, but also financing facilities, results-based finance, debt-for-climate swaps, liquidity instruments, and insurance.

Action taken now across the full range of potential adaptation finance sources will be critical to determining the course of Africa's capacity to respond to present and upcoming climate impacts and to building a more climate-resilient and livable future.

The private sector

The private sector generates two-thirds of the investments, 75 percent of the economic output, and 90 percent of the employment in Africa, through a diverse range of companies that include large multinationals on the one hand, and many micro, small, and medium-sized enterprises (MSMEs) on the other. The Private Sector chapter seeks to provide further insights on the role of the private sector in adaptation in Africa. It is based on a GCA analysis of the CDP's Corporate Climate Change Disclosure Questionnaire 2020; a survey of MSMEs in Africa by the GCA; and interviews with multinational

Figure 4: Potential Sources of Adaptation Finance in Africa

Offer Finance on Commercial Terms

- **Commercial Banks:** Commercial banks can raise their own funds through bank deposits and are governed by international standards set by Basel II and III regulations for capital adequacy. Commercial banks have networks that can be leveraged including relationships with farmers, co-operatives, and MSMEs and can build technical capacity to structure financial instruments in partnership with development banks and other concessional finance providers.
  - **Pan African Banks:** PABs can invest in MSMEs and mainstream resilience into their lending portfolios. PABs have been successful in increasing firms' access to finance and increasing competition and efficiency in the banking industry and can have a positive impact on micro-prudential stability with the least cyclical behavior in times of crisis.
- **Private Equity and Venture Capital:** Africa's PE industry was cultivated by DFIs that had a mandate to invest in private sector businesses in Africa to promote social and economic development. Gradually the industry expanded and by 2020, there are more than 150 active fund managers of different sizes spread across geographies and sectors in Africa. The nature of their investments is suitable for scaling up adaptation finance and has potential for investment in new and innovative adaptation technology and services.
- **African Institutional Investors:** African institutional investors have USD 1.8 trillion assets-under-management in 2020. Institutional investors' core goals are capital gains and stabilization of returns over the long term. They have very high ability to mobilize funds through pensions in the right regulatory environment and their prudential responsibilities require them to invest in assets with high credit ratings and assets that are listed.
  - **Sovereign Wealth Funds** invest in domestic markets and have potential to finance adaptation focused securities and government bonds.
  - **Pension Funds** are instrumental in mobilizing long-term saving and can support long-term adaptation investments.
- **Insurance:** Insurance penetration is concentrated in a few major markets like South Africa, Egypt, Morocco, Nigeria, and Kenya. Insurers have advanced technical capacity to evaluate climate risks and capacity for innovation in climate risk transfer mechanisms. Insurance companies must undertake qualitative and quantitative assessments of impact of physical and transition risks on their investment portfolio.
- **Large Corporations:** Sustainability and resilience in food production and supply chain are increasingly a focus for large multinational corporations especially those with global supply chains. Corporations have potential to deploy finance and technology at scale to undertake adaptation measures though will be largely focused on their own supply chains.
- **Multilateral & Bilateral DFIs:** DFIs play a critical role in mainstreaming adaptation in development finance by assessing climate risks and vulnerability, assisting country governments to build capacity for mainstreaming adaptation, and mobilizing private capital. DFIs can bridge knowledge gaps through tools such as feasibility studies, business risk assessments, technical assistance, and market studies.

- **Sub-Regional Development Banks:** SRDBs have a mandate to contribute to regional integration and regional infrastructure development projects. Four African SRDBs: Eastern and Southern African Trade Development Bank, East African Development Bank, West African Development Bank, and Ecowas Bank for Investment and Development are operational in Africa in three separate regional economic communities. 40 African countries are shareholders of the SRDBs and in 2013, the total assets of African SRDBs were USD 6.2 billion.
- **National Development Banks:** NDBs are state-owned or government-sponsored financial institutions with a primary mandate of providing long-term and concessional capital to high-risk sectors and industry which are underserved by private commercial banks and contribute to the country's development agenda. NDBs are important intermediaries for international climate finance and more than 10 currently have direct access to GCF funding.
- **Multilateral Climate Funds:** Multilateral Climate Funds established through international agreements or for a specific mandate provide financing for adaptation in Africa either through grants or market-linked instruments. They are catalytic in facilitating and accelerating financing in perceived high-risk adaptation projects by providing instruments like first-loss or junior equity, repayment guarantees, and grants to mobilize private investments.
- **National Climate Funds:** National, country-driven, dedicated, catalytic financial institutions designed to address domestic market gaps, take ownership of climate finance and crowd-in private investments in low carbon and resilient projects. NCFs have potential to provide integrated access to grants and finance to meet NDCs and have strong potential to mobilize private sector investments.
- **State-owned Enterprises & Financial Institutions (SOEs):** SOEs are public entities that are partly or wholly owned by government to deliver services in a particular sector or sectors. SOEs have not financed many climate adaptation activities to date but have substantial opportunity to lead in climate resilience given size of market share and public governance model.
- **African Governments:** African governments are already spending a considerable share of their budget on adaptation. For 42 African countries where data was available, the total weighted adaptation expenditure was around 0.18 percent of GDP, and the unweighted expenditure was around 3.4 percent of GDP, both higher than the share of adaptation finance received from international donors. African governments are instrumental in deploying capital to noncommercial adaptation activities and current levels of expenditure meet around 20 percent of the total adaptation need.
- **Official Development Assistance (ODA):** ODA is a critical component of adaptation finance in Africa to de-risk adaptation activities and support more commercial finance. Bilateral agencies have a relatively high risk appetite and strong climate mandates.
- **Philanthropies, Foundations, and Non-profits:** Like ODA, funding from these organizations can de-risk adaptation activities, draw in private finance, and support technical capacity building. Philanthropic funding is more nimble and flexible than ODA and can serve as catalytic capital for private sector investment.

Offer Finance on Highly Concessional Terms

companies, conducted jointly with the World Business Council for Sustainable Development.

The Private Sector chapter discusses key drivers, barriers, and motivations to enable adaptation by the private sector in Africa—including the role of policies and institutions; data and information; collaboration and capacity building; infrastructure and supply chains; and access to financial and economic instruments.

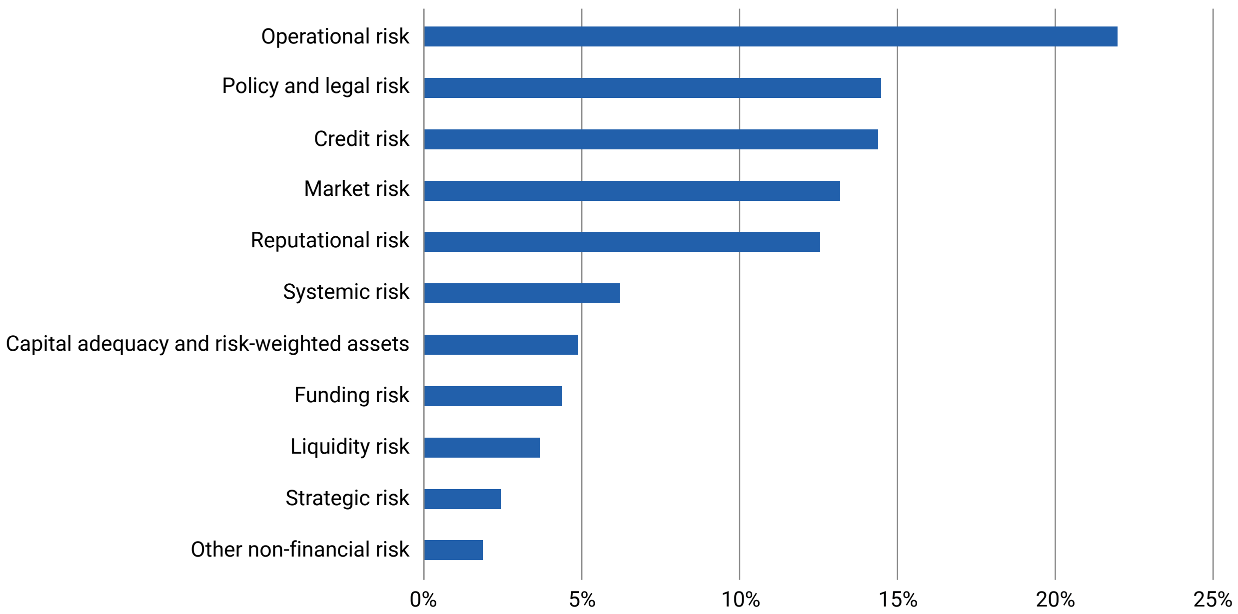
Key Findings

Our analysis of responses submitted to CDP by 515 companies working in Africa in services, manufacturing, agriculture, infrastructure, and hospitality, among others, shows that the climate risk assessments undertaken by companies consider risks that relate to current regulations, emerging regulations, reputation, markets, physical infrastructure, and technology. The climate-related risks that are identified most often are categorized under operational risks, policy and legal risks, credit risks, market risks, and reputational risks (Figure 5).

The companies surveyed identify droughts and flooding as the most urgent climate risks, followed by extreme weather events. Water scarcity is also of particular concern. For instance, South Africa has the largest number of businesses reporting detrimental water-related impacts globally, while businesses in Zambia, Malawi, Benin, Mozambique, and Kenya are also frequently affected. Stricter regulations and statutory water withdrawal limits are also cited as water-related impacts by companies in some countries.

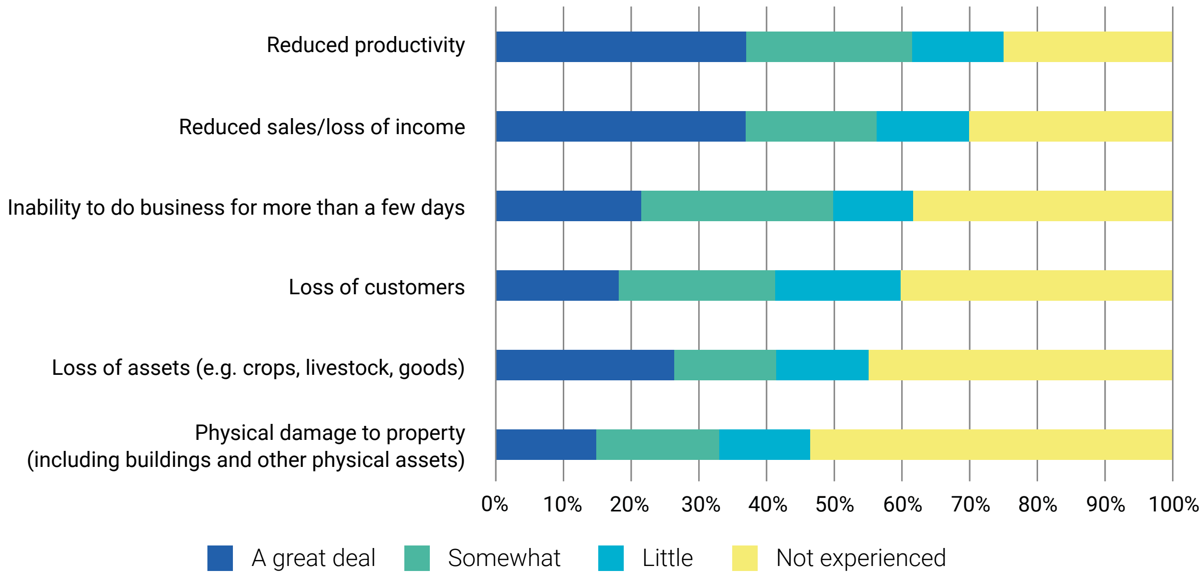
Our analysis indicates that the private sector in Africa already feels the impact of climate change, including droughts, floods, extreme heat and extreme rainfall, whether directly or indirectly, throughout their supply chains. In the interviews, the representatives of large corporations were more likely to be able to point to future climate risks and indirect impacts on their operations due to the instability of supply chains. By contrast, the MSMEs participating in the survey said they had less access to information on future impacts and were more likely to focus on current or recently experienced direct impacts of extreme

Figure 5: Most frequently identified climate-related risks by businesses in Africa



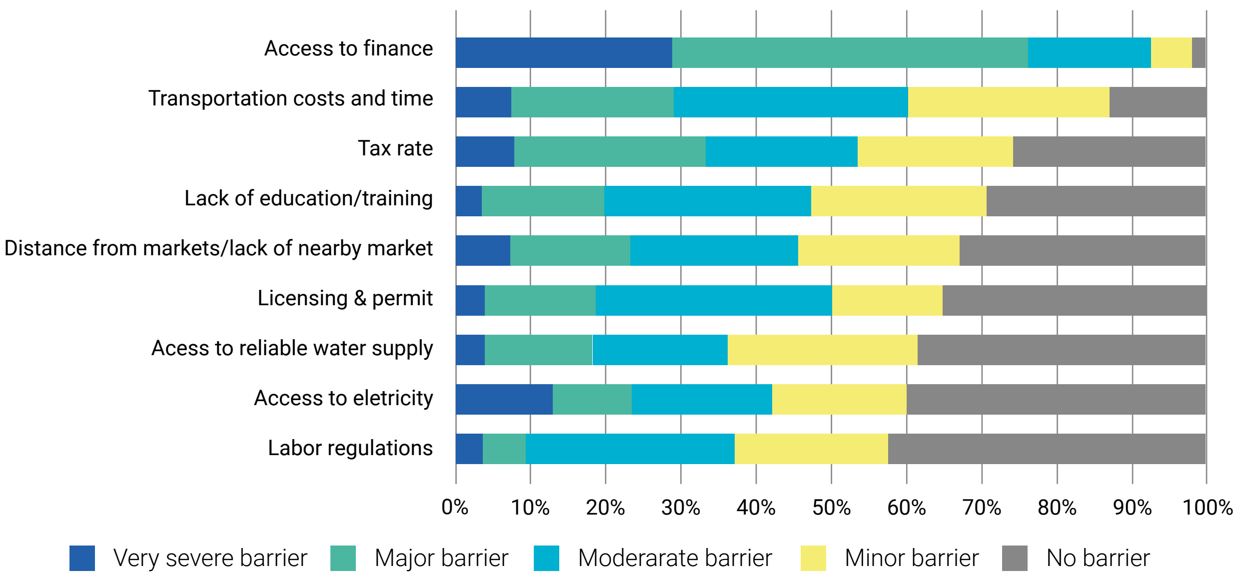
Source: Based on *CDP's Corporate Climate Change Disclosure Questionnaire 2020*

Figure 6: Direct impacts of extreme weather events on MSMEs in Africa



Source: authors

Figure 7: Climate adaptation barriers for MSMEs in Africa



Source: authors

climate events, including reduced productivity (75 percent); reduced sales and income (71 percent); loss of customers, for instance, due to displacement, resulting in loss of income (62 percent); and physical damage to property (47 percent) (Figure 6). The climate risks experienced by MSMEs also varied across regions. In West Africa, all surveyed companies were directly affected by climate change impacts, while in East Africa and Southern Africa, 70 percent and 47 percent respectively were directly affected.

Awareness of government policies that could support private sector adaptation is also low among MSMEs. Only 12 percent indicate that they received (mainly technical) support from national governments, while 10 percent indicate that they received support from local governments. MSMEs identified the following policy-related areas that pose barriers to their operations and subsequent adaptation actions: access to finance (93 percent); transportation costs and time (83 percent); high tax rates that impede action or additional investments in adaptation and resilience (69 percent); restrictive business operations licensing (60 percent); and lack of education or training (67 percent) (Figure 7).

Policy Recommendations

Adaptation is not a choice, but a requirement for the private sector to face worsening climate realities across Africa. Yet the African private sector remains underrepresented in discussions and in action due to a combination of factors, including lack of awareness, inadequate tracking mechanisms, and limited resources. Greater efforts to enhance awareness, mobilize private sector actors, and to provide visibility for their activities, along with accessible financial instruments, are therefore necessary. Frontrunners among Africa-based businesses capitalize on resilience and adaptation action, which not only helps them to manage climate risks but also positively impacts their productivity and profitability. A strong and supportive regulatory and policy environment can positively impact the scaling up of private sector climate adaptation efforts. Well-designed adaptation technology transfer programs for African SMEs must be part of the solution.

Large companies have the capacity to generate information on climate impacts on their operations through risk assessments, while MSMEs lack the same capacity and therefore the information. Sharing data and information with MSMEs, which are often an essential part of the value and supply chains of larger companies, will benefit larger companies in the long term.

Traditional project funding does not always work for private sector adaptation and resilience-building efforts, because investments can sometimes lead to a short-term loss of income or require investments in new skills or technologies. Appropriate support and financing mechanisms are necessary to help MSMEs switch to climate-resilient practices. Highlighting potential

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business opportunities, for instance in the form of new products and services that become necessary, can also enhance private sector engagement in adaptation and resilience-building efforts.

Youth

Africa's young population—often referred to as "the youth bulge"—has been a concern of African policymakers and stakeholders for some time and is characterized as both a crisis and an opportunity. Much of the discussion on youth-specific issues in Africa has focused on creating better employment opportunities, both for instrumental reasons—because this is necessary for economic transformation, poverty reduction, and possibly to realize a demographic dividend—and for intrinsic reasons—to help youth transition to economic independence from their parents, become empowered, and realize their full potential. The youth employment challenge will only worsen as climate change advances.

Key Findings

Overall, most employment opportunities in Africa are found in the informal sector—household farms and firms. This will only change as economies transform, a process which climate change will negatively affect without adaptation investments. Africa is the world's youngest region. 43 percent of the population is under the age of 15. Youth comprise 20 percent of the total population (compared with 16 percent for the world as a whole). Income is one of the key determinants of demographic transitions, so it is not surprising that as a lower-income region, Africa's demographic transition is at an early stage and its population is largely young. However, Africa's transition has been unusually slow owing to persistently high fertility.

Africa's demographic structure brings challenges for youth livelihood development and youth employment and earnings outcomes. The lowest-income countries are characterized by a lack of modern, formal private firms in non-agricultural sectors offering wage jobs. As a result, most people work informally with members of their family or household, on farms or in informal businesses. As the economy develops, it transforms, creating more formal firms that grow, increase productivity, contribute to GDP, and importantly, employ people. These employees usually receive higher wages on average than those working in household farms or businesses, because of opportunities to specialize, use skills more intensively, and work with more capital and technology. This employment transformation—an increase in the share of employment in formal wage work—is caused by an increase in labor demand relative to supply. High fertility creates a fast-growing labor force (a rapidly increasing labor supply), which delays the employment transformation. Africa's labor force is currently increasing at 3 percent per annum, and this pace is projected to slow very gradually.

Our analysis shows that the youth and climate change nexus cuts across a range of development issues not limited to employment. For example, the youth—especially young males—play a big role in urbanization trends, as they are most likely to migrate from rural areas or between urban areas. Climate change could accelerate this trend, even as urban areas suffer as well, trapping the youth in substandard living conditions (slums) and poverty. The youth are a vital part of the informal social safety net in Africa. Although the youth are only starting to develop their livelihood patterns, in the absence of any form of social safety net, many young people have to contribute financially to support younger siblings, and sometimes parents. Negative effects of climate change on their employment and earnings opportunities will have cross-generational implications. Young women in Africa devote many hours to unpaid work supporting families—their own nuclear family and their extended family—as caregivers and in charge of household maintenance.

We have also reviewed the key interactions between the youth demographics of Africa—in particular, Sub-Saharan Africa—and the region's economic development progress and prospects (especially the prospects for higher earnings and more secure employment for youth), youth engagement and empowerment, and the way climate change adaptation policies and investments interact with these trends. We find that the effects of climate change, which are already being felt as more extreme weather events, are likely to negatively affect the livelihoods and welfare of rural and urban youth in


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several ways.

In rural areas, declines in agricultural productivity and soil degradation will not only affect those engaged in agriculture, but they will also be felt all the way down the rural value chain. Meanwhile, the negative effects of climate change in rural areas could increase youth migration to larger urban areas, increasing the share of the urban population in slums. Urban youth will also be negatively affected, but the trajectory could be slower. For those youth who live in slums, the rainfall increases projected for the middle of Africa would soon negatively affect their living and working conditions, as both activities often use the same location. Youth in urban slums in drier areas will have to devote more time and money to procuring water, a burden which falls mostly on women. If adaptation measures are taken now, the projected negative effects on youth in 20–30 years could be reduced. This would benefit African youth during their peak earning years and beyond. However, changing the trajectory of public and private investment toward adaptation, while necessary, may have costs in the next 10–20 years, which will be felt by youth as well.

In sum, absorbing these youth into productive, remunerative employment opportunities has been and will continue to be a challenge for African countries.

Policy Recommendations

Multiple countries in Africa achieved broad-based growth and successfully improved employment opportunities through a combination of (i) supply-side policies (expansion of education), (ii) demand-side policies to encourage the entry and growth of firms and (iii) investments supporting productivity increases, especially in agriculture and digital services. Nonetheless, most youth and their parents continue to work in the informal sector. COVID-19 has interrupted this transformation process, frustrating the youth's ambitions. For the benefit of their youth as well as their older adult population, countries need to restart this process.

Africa's youth, including those not yet born, will bear the costs of climate change in the coming decades. Opportunities for Africa's youth depend on complex demographic and economic transitions, which now also face headwinds from climate change. Climate change could reverse progress made on improving employment opportunities for the youth and could also increase rural-urban inequality. The implications of climate change for other development processes like migration, gender roles and expectations, and education are all considerable.

African countries can avoid some of the worst effects of climate change by taking up adaptation measures now. But these will be costly investments, both in terms of funds spent, and in opportunity costs—the activities and investments which were not undertaken because funds and time were absorbed by adaptive investments. Yet not adapting is not an option.

Finally, although they are the most educated generation ever in Africa, there is not yet a significant level of engagement by the youth with the climate crisis, partly because of the pressing nature of their immediate needs and aspirations for education and employment. The youth in Africa are also often excluded from community political activities and national leadership roles—the youngest continent has the oldest political leadership. Given the importance to their future, youth should be consulted and actively and effectively engaged in both early-stage investment decisions and in monitoring outcomes at the local and national levels. A prerequisite appears to be a better understanding among youth of what is at stake for them, and what are the parameters for adaptive change to reduce the risks to their welfare ahead.

Jobs

Job creation and retention in Africa is central to building community resilience in the face of climate change. While Africa's labor force participation rate of 63 percent is higher than the global average of 61 percent, it is dominated by own-account workers. Furthermore, Africa also has the world's highest proportion of workers in informal employment, at around 86 percent. This combination of high levels of own-account work and informality has resulted in almost 250 million workers in Africa currently living in extreme or moderate poverty.


Photo: Riccardo Mayer/Shutterstock

The Jobs chapter presents the risks and challenges that climate change poses for jobs, the job creation opportunities that climate adaptation and resilience-building activities provide, and the policy responses needed to reduce the climate risks for jobs and enhance the creation of jobs for adaptation and resilience.

Key Findings

Between 2000 and 2015, 23 million working-life years were lost annually at the global level because of environment-related disasters caused or exacerbated by human activity. This is equivalent to 0.8 percent of a year's work globally. Africa suffered some of the greatest losses of working-life years, with an annual average of 376 working-life years per 100,000 people of working age lost between 2008 and 2015. At the same time, globally, some 1.2 billion jobs—particularly those dependent on farming, fishing, and forestry—currently rely directly on the effective management and sustainability of a healthy environment. In Africa, these sectors represent 58 percent of total employment.

Without adaptation measures, the combined effects of climate change and poor natural resource management will threaten these jobs, which could lead to devastating social and economic impacts. In addition to threatening the natural resource base, climate change exacerbates the stresses on jobs in several other ways. Negative impacts on employment include job losses through impacts on business assets and business interruptions, disruptions in transportation of market and essential goods, impacts on working conditions and occupational safety and health affecting labor productivity, forced migration, and reduced demand due to economic shocks and instability. Business assets and transport and industrial infrastructure, as well as the workforce, are increasingly concentrated in cities in Africa. All of these are at risk when disaster events hit urban areas.

Agriculture accounts for a high percentage of employment and a key source of livelihoods in many African countries and is particularly vulnerable to water scarcity. In 2019, more than 232 million workers in the region were employed in agriculture, accounting for over 50 percent of the continent's total employment. Many of Africa's farmers depend on rainfed agriculture, which will be particularly at risk. In addition, increases in labor migration are likely because of climate change and other factors.

Social protection represents a central lever of adaptation to climate change, but it is also necessary to acknowledge its current limits. Despite recent progress in Africa, 83 percent of the population is currently excluded from any form of social protection, which corresponds to a financing gap to achieve universal coverage estimated by the ILO (including the impact of COVID-19) of $136.9 billion for 2020. Collaborative approaches at the national, regional and international level to increase fiscal space for both social protection and climate policies are therefore necessary to fill this gap.

Policy Recommendations

While climate change is already having negative impacts on jobs in Africa, adaptation responses can reduce these impacts by protecting existing jobs, minimizing job losses, and providing opportunities for new economic activity, investments, and decent work. For this to occur, adaptation policies must be coordinated and coherent, human-centered and address key risks to workers, enterprises, and vulnerable sectors. They must also support a just transition to a resilient and greener development path and be equitable and socially inclusive, taking the concerns of women, youth, indigenous people, and other minorities into account.

These policy interventions will be critical, as Africa's rapidly growing population means that it is projected to have more than a third of the global workforce by 2040. The substantial share of its population in informal employment and without adequate social protection means that it already has a substantial deficit of decent work and of resilience to the potential effects of climate change on employment, particularly in the agriculture sector.

Green jobs—defined by the ILO as employment in the environmental sector that meets the requirements of decent work—and, in particular, jobs for adaptation

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and resilience, a sub-category of green jobs, need to be prioritized by African policymakers. There is also an urgent need for increasing adaptation finance to support and scale up interventions that increase resilience and generate income and employment. A stimulus in climate-resilient infrastructure is already necessary if Africa is to meet the Sustainable Development Goals, and will have to be a critical element of Africa's adaptation strategy. This will not only help protect and secure existing jobs but will also present an immense opportunity for direct and indirect job creation. Working more closely with nature though nature-based solutions and improved natural resources management also provides a key opportunity for Africa in this context. Its massive endowment of nature can be harnessed as both an engine for jobs and a pathway for cost effective adaptation, allowing Africa to embark on a more sustainable development pathway.

To build adaptation and resilience, skills are required to transition to green resilient jobs, nature-based solutions, and hybrid 'green-gray' approaches. Skills development should build on the capabilities of local institutions to ensure they anticipate climate risks and uncertainties, generate resilient solutions, and manage adaptation initiatives over the long term without being dependent on project-based donor funding.

Effective adaptation will also require the redesign and expansion of social protection systems in Africa to protect workers against the increased and new climate-related risks they will face. Finally, social dialogue and community participation in the design and implementation of adaptation policies and measures will be important to ensure more inclusive adaptation measures that support local development and employment creation.

SECTION 2 – FOCUS SECTORS

Agriculture and food systems

Food and nutrition security in Africa is off track. In 2020, more than one in five people in Africa faced hunger—more than double the proportion of hungry people in any other region. About 282 million of Africa's population are undernourished. While Africa's agricultural exports are rising, the continent remains a net food importer at an annual cost of $43 billion, and could top $110 billion by 2025 as demand for food is rising at more than 3 percent per year. The African Union's most recent Biennial Review shows that only 4 of 49 member states are on track to achieve the goals and targets of the Malabo Declaration on Accelerated Agricultural Growth by 2025. This means that Africa is also lagging on progress to achieve Sustainable Development Goal 2, which calls for ending hunger in all forms by 2030.

The Agriculture and Food Systems chapter reviews the current and projected impacts of climate change on the sector. It discusses the most important adaptation solutions, including in the areas of research and extension services, climate information and risk management services, climate-resilient infrastructure, sustainable water management, restoration of degraded landscapes, and sustainable land management. The chapter presents new analyses of incremental costs for adaptation of the agriculture and food systems in Africa, as also the cost of inaction. It reviews new approaches to more effectively channel larger financial resources to the sector.

Key Findings

Food security in Africa needs urgent and serious attention from policymakers. Climate change is already stalling progress towards food security in Africa, interacting with multiple other stresses and shocks, including inequality, conflict, and the COVID-19 pandemic. A 3°C warming trajectory will cause catastrophic disruption to African food systems within the next 30 years. A 1.5°C trajectory provides more options for adaptation of African food systems, but still demands urgent action. Agriculture and food are the leading sector for synergies across development and climate action, delivering simultaneously on Sustainable Development Goals, national growth and food security goals, and climate adaptation and mitigation.

Massive changes in agricultural suitability can be expected across the continent, with farming systems, food production, and import dependency changing beyond recognition. For example, under a 3°C (RCP8.5) scenario, Africa is expected to lose 30 percent of current growing areas for maize and banana and 60 percent for beans by 2050. Other crops will see smaller but significant effects, with up to 15 percent loss of production area for cassava, yams, millets and sorghum.

Large areas will need to shift out of crop production altogether. Over the 2050 to 2100 timeframe, Africa's typical mixed cropping-livestock systems will need to change to pure livestock systems across 3 percent of Africa's land area, directly supporting around 35 million people in agricultural livelihoods. At the same time, these pastoral systems will be under increasing threat in terms of forage quality, fire frequency, and water availability. Significant drops in the catches of African marine fisheries are also expected, putting further pressure on people's access to highly nutritious animal foods.

Leading adaptation options for food systems are well-defined and build on evidence and experience, including in Africa. They include public policy and incentive solutions, food value chain and livelihood solutions, and on-farm and productive landscapes solutions. Among these options, the priorities for public sector investment in Africa are fivefold: research and extension, water management, infrastructure, land restoration, and climate information services. Some of the adaptation practices have long-term African experience to build on (e.g., livestock management, agroforestry), while others are newer areas of endeavor on the continent or globally (e.g., fiscal measures, co-benefits of mitigation finance). Some are lower-hanging fruit (e.g., low-cost early warning systems) while others need more complex multi-sector reforms (e.g., affordable healthy diets).

These groups of solutions are not 'better' than others, not will they solve all adaptation problems in food systems on their own. They are highlighted because they are areas in which the case for public sector investment is high for the following reasons: strong public good benefits; the need for interventions at a large scale, such as the national level or whole landscapes or whole catchments (often cross-boundary or transnational); opportunities for progressive distributional outcomes, improving equality of access for women and poor people; initially high capital outlays that may be prohibitive for all but the largest private operators; and the associated need for policy incentives that provide signals to land and water managers and to food system participants.

A modern approach to climate adaptation moves beyond purely agricultural solutions into whole food system approaches. For example, problems with agricultural production can be addressed not through on-farm solutions alone but also through trade, social safety nets, and policy incentives for consumers and food businesses.

Given the pace and unpredictability of climate change, another principle is that building of ongoing adaptative capacity is more important than one-off investments; hence the importance attached to enhancing systems for rapid learning, foresight and lesson-sharing, through digital-based R&D and extension systems. This capacity will be critical as farmers, governments and businesses increasingly need to build proactive preparedness for the larger transitions required should the 3°C warming scenario become a reality—such as a country or region needing to move out of production of a major staple crop.


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Appropriate investments in the agriculture sector can help the food systems adapt by increasing productivity, resilience, and resource-use efficiency. All indications are that financing adaptation to climate change will be more cost-effective than financing increasingly frequent and severe crisis response, disaster relief, and recovery pathways. The adaptation costs for Sub-Saharan Africa include annual public investments that already address resilience needs:

that is, the reference scenario ($5.9 billion) and annual incremental investment costs ($9.6 billion) to offset climate change effects on hunger between 2015–2050 (Table 2).

The agricultural financing gap in many African countries surpasses government budgets and available donor funding. The financing gap for climate adaptation is at risk of widening in the future due to fiscal drain on resources from the coronavirus pandemic.

For more than a decade, Multilateral Development Banks have been tracking climate finance flows in their operations across sectors through an agreed joint methodology for adaptation and mitigation. Climate finance flows to the agriculture sector in Sub-Saharan Africa increased from $433 million in 2015 to $2 billion in 2018 and then declined to just over $1 billion in 2020. Adaptation flows are consistently higher than mitigation flows, ranging from 58 percent in 2019 to 69 percent in 2017. These levels are clearly insufficient.

Key opportunities to close the gap lie in developing the business case for climate finance and for blended private finance, based on the growing information base on costs of action and of inaction. Closing the finance gap will require a range of public policy actions including increasing the space for private sector activity, improving the policy and regulatory environment, and using public financing to help crowd-in private-sector investments to optimize the use of scarce public resources. In addition, it will be important to design new financing mechanisms and overcome longstanding technical and institutional barriers, such as the limited capacity to manage production, marketing and price risks, and the high transaction costs of lending to farmers.

The adaptation investments by small-scale producers

Table 2: Annual reference scenario and incremental investment costs for agricultural adaptation for sub-Saharan Africa by 2050 ($ billion)

Scenarios	Research and extension		Water management		Infrastructure and market access	Sustainable land management	Climate information services	Total
	International agricultural research	National agricultural research	Efficient irrigation and increased water use efficiency	Improved soil water holding capacity				
Reference scenario ($billion)	1.11	1.11	3.11	0.39	0.18	-	-	5.9
Incremental costs ($billion)	1.66	-	1.42	1.20	1.90	3.35	0.053	9.58
Total	2.77	1.11	4.53	1.59	2.08	3.35	0.053	15.48

Sources: Sulser et al. (2021); World Bank (2021), and others' calculations
Financing adaptation to climate change will be more cost-effective than frequent disaster relief. For sub-Saharan Africa, our estimates based on a synthesis of existing studies (Table 3) indicate that the annual agricultural adaptation cost is $15 billion (0.93% percent of regional GDP), but the cost of inaction could be more than $201 billion (12% of GDP).

Table 3: Annual agricultural adaptation costs and costs of inaction ($ billion)

	Research and extension	Water management	Infrastructure and market access	Sustainable land management	Climate information services	Total
Cost of action ($ billion)	3.88	6.12	2.08	3.35	0.053	15.48
Cost of inaction ($ billion)	71.21	90.67	12.56	26.76	0.488	201.69
Cost of action as proportion of cost of inaction (%)	5.44	6.75	16.56	12.51	10.86	7.67

Sources: Authors

will be a vital component of building the resilience of African farmers. Therefore, increasing and targeting flows of capital to these farmers, livestock keepers, fishers and small businesses is critical.

Policy Recommendations

Climate change adaptation in food systems can be enabled and driven through various policy instruments, not only in the environment and agriculture sectors but also in economic development, finance, health, infrastructure, gender equality, digital, trade and social safety net policies. The food system offers opportunities for win-win-win outcomes for food security, adaptation, and mitigation.

- **Ramp up support to research and extension services.** As climate change accelerates, real-time data collection, analysis and learning become increasingly important to manage emerging unpredicted climate risks. This is important on the 1.5°C trajectory where research and extension are critical to dealing with climate shocks, and even more important on the 3°C trajectory, under which climatic conditions will soon move beyond anything experienced by farmers since the introduction of agriculture.
- **Public spending programs would need to focus on innovation systems because a robust supply line of technologies is not enough.** It is critical that the knowledge on these technologies and innovations reaches farmers, especially small-scale producers, and that they adopt it.
- **Strengthen inclusive climate information and risk management services.** The provision of tailored information related to current and forecasted weather, on a timeframe ranging from daily to seasonal to multi-year, is vital to cost-effective planning by farmers, food businesses and governments. Key climate information services include seasonal weather forecasts for farmers, and early warning systems that can help anticipate and manage natural disasters, pest outbreaks and yield failures.
- **Implement insurance schemes against shocks and wider social safety nets to counter climate risks.** Designing climate-responsive social protection strategies can strongly support proactive measures to avoid, minimize and address the complex, long-term impacts of climate change on human health, livelihoods, poverty and inequality. For smaller climate events, revenue diversification and remittances are helpful; market insurance is best for more intense events. Financial inclusion is helpful against medium climate events.
- **Repurpose subsidies and eliminate policy distortions that increase climate vulnerabilities.** No country in sub-Saharan Africa is currently on track to meet its commitment of allocating at least 10 percent of total budget funding for agriculture in 2019. Yet, in many sub-Saharan African countries, a significant share of public spending goes to poorly targeted and distortionary market price supports and subsidies. This calls for adopting smarter public spending programs.
- **Deploy mitigation policy and finance in ways that support adaptation.** Agriculture is the largest source of GHG emissions in Africa, accounting for about 58 percent of emissions in the continent. Several adaptation and mitigation measures can help address climate change, but no single measure is sufficient by itself. Mitigation finance is an adaptation tool that will allow African regions to mitigate the adverse effects and reduce the impacts of climate change.
- **Reduce trade barriers, especially in times of crisis.** As discussed in the Trade chapter, international trade is an important adaptation mechanism to deal with the geographic variation in climate-related harvest failures. Climate change affects parts of the world differently, shifting crop suitability and regional comparative advantages and altering trade patterns.
- **Provide and maintain adaptative climate-resilient infrastructure.** In the food supply chain, practical logistics and infrastructure for food storage, such as the correct use of metal drums and hermetic bags, can drastically reduce grain losses. Other options include drying equipment (e.g. for grains, fish or vegetables) and enabling cold storage for fresh produce (where the highest losses typically occur).
- **Reduce and manage food loss and waste.** About 36% of the food produced in sub-Saharan Africa is lost or wasted, and the largest proportion of the losses occur at the production and handling stages. Helpful interventions to manage food loss


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and waste include biological controls, storage infrastructure management and information systems, and diversification of value addition and byproduct use.

- **Create demand for affordable healthy diets.** In general, solutions have framed adaptation and resilience for African food security in the light of supply and neglected the demand-pull aspect of the food system. For both nutrition and sustainability reasons, Africa needs to accelerate its transition towards diets that meet people's health and cultural needs, and are widely accessible and affordable.
- **Climate-smart agriculture (CSA) interventions increase productivity,** adjust farming systems to perceived or projected climate change impacts, and reduce or remove (where possible) GHG emissions.
- **Improve sustainable water management at both farm and catchment levels.** Agriculture accounts for the highest percentage of total water withdrawal in Africa, at up to 81 percent. Water management is a key priority for adapting to climate change and achieving sustainable food systems and zero hunger.
- **Nature-based solutions are fundamental to climate adaptation strategies in the agriculture sector, for purposes of water management as well as additional benefits such as biodiversity.** Mangroves protect shorelines from storms, lakes store large water supplies, and floodplains absorb excess water runoff. If combined, nature-based solutions and engineered options can maximize ecosystem services such as clean water supply, soil and slope stability, water storage, soil fertility, and nutrient recycling.
- **Restore degraded landscapes and practice sustainable land management.** Land management options for climate adaptation include increasing soil organic matter, no-till farming, perennial crops, erosion control, dietary change, forest protection, sustainable forest management, controlled grazing, rangeland management, clean cooking, fuel and fire management, peatland restoration. Other measures include regulating the management and conversion of peat soils, coastal restoration, mangrove conservation, long-term land use planning, vegetation management, afforestation and grazing-land management.
- **Scale up context-specific climate-smart soil management.** Sustainable land management (afforestation, reforestation, agroforestry, and rangeland management) can help reduce the negative impacts of multiple stressors, including climate change, on ecosystems and societies.
- **Improve livestock management.** Livestock systems are impacted by climate change, both through direct impacts related to heat and through an array of indirect impacts on forage quantity and quality, water availability, and disease spread. Climate adaptation of the livestock systems need technical, behavioral and policy actions.
- **Monitor and manage new trends in pests and diseases.** The range, intensity and frequency of pest and disease outbreaks are all likely to shift under climate change. Key adaptation options include climate and pest monitoring to predict and

respond rapidly to emerging and existing pests, and pest prevention measures to discourage the establishment and development of pest populations.

- **Promote diversification of crops and livestock.** On-farm diversification is a promising strategy for farmers to adapt to climate change. Diversification can enhance biodiversity, pollination, pest control, nutrient cycling, soil fertility, and water regulation without compromising crop yields.
- **Use climate-ready species, cultivars, and breeds.** Recent breeding work has enabled several crops and animals to become better adapted to African climate risks, such as Drought-Tolerant Maize for Africa (DTMA) varieties, heat-tolerant beans, and fat and thin-tailed ovines.
- **Incorporate perennial crops, including agroforestry.** Trees outside forests substantively contribute to livelihood improvement while also enhancing biomass and carbon stocks. Agroforestry's resource management is proven to enhance livelihood benefits in provisioning, regulating, and supporting ecosystem services. The objectives of the UN Decade on Ecosystem Restoration are particularly relevant in this area.

Trade

Trade can play two crucial roles in supporting Africa's efforts to adapt to a changing climate. Trade cushions the volatility of food markets by providing a vital flow of supplies to regions that may see a sudden reduction in domestic production of food crops due to a climate shock. Over time, trade enables producers and consumers to adapt to changes in comparative advantage, thereby helping the transformation of Africa's agricultural sector and the diversification of its broader economy. More broadly, international trade can also help create jobs and raise incomes, which strengthen households' resilience, not least by enhancing their ability to purchase food. The Trade chapter analyzes the climate change and trade nexus and how trade can play these roles in supporting Africa's efforts to adapt to a changing climate, with a focus on the agriculture sector.

Key Findings

Trade considerations have a role to play in the adaptation components of countries' NDCs as well as in National Adaptation Plans being produced. Africa is no exception and trade could support their climate adaptation policies and strategies. Many African countries may be foregoing significant opportunities to bolster their climate adaptation strategies through proactive, forward-looking trade policies. Five action areas offer opportunities to help integrate trade and climate adaptation policies in Africa and ensure that international trade can better support the continent's climate adaptation and economic diversification strategies: (i) improve the functioning of markets for food and agriculture; (ii) strengthen policies and institutions for sanitary and phytosanitary (SPS) measures; (iii) reduce barriers to trade in goods, services and technologies for adaptation; (iv) enhance the climate resilience of transport and other key trade-related infrastructure; and (v) use economic integration policies to promote trade and economic diversification.

Climate change is expected to have implications for both rural and urban populations and may have differing effects on the food security of different

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types of actors in rural areas, depending for example on the extent to which the source of their livelihoods is exposed to the impacts of climate change. Yet close to 60 percent of sub-Saharan Africa's population lives in rural areas, with many engaged in subsistence agriculture, while close to 10 percent of the rural population lives in remote less-favored agricultural land or on remote land with poor market access (lack of roads, railways, navigable waterways). These factors complicate any prospective role for trade in agricultural goods to alleviate the threat to food security in rural areas unless there is a substantial improvement in trade-related infrastructure.

Our analysis shows that the role of trade in adaptation to climate change is complicated by an additional factor. While Africa is endowed with abundant natural resources (renewable like forests, and non-renewable like subsoil), property rights for these resources tend to be poorly defined, making them vulnerable to 'tragedy of the commons' outcomes prone to be exacerbated by international trade. Threats to biodiversity, already present, will increase. Under weak environmental governance, increased international trade presents a challenge.

To play an essential role in supporting food security, trade must be underpinned by open, transparent, and predictable policies that improve how food markets function, not least by allocating resources more equitably and sustainably.

International trade in goods and services can help lower the cost of climate adaptation in the short term and promote economic and export diversification in the long term. In addition to helping countries adapt to the impacts of extreme climate events and changing climate conditions, trade also strengthens countries' resilience to climate change by fostering economic growth and reducing poverty. Yet, trade considerations have been largely absent from the adaptation components contained in countries' NDCs under the 2015 Paris Agreement, let alone the National Adaptation Plans produced to date.

Policy Recommendations

The following policy recommendations offer opportunities to help integrate trade and climate adaptation policies in Africa and ensure that

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international trade can support the continent's climate adaptation and economic diversification strategies. Integrating trade and climate adaptation policies calls for action by African countries, both at national and regional levels, along with action by all WTO members.

- **Improve the functioning of markets for food and agriculture:** In an interconnected global economy where global value chains span national boundaries, policy action, including in response to climate shocks, can affect producers and consumers in other countries. Governments should ensure that policies adopted in response to climate shocks do not undermine the competitiveness and resilience of food producers and consumers in other jurisdictions, while still achieving better climate and development outcomes. Many types of policies that boost productivity sustainably are allowed without limits under WTO rules, such as farmer extension and advisory services, research, rural infrastructure, or pest and disease control. Governments can use these programs to redress historic underinvestment in the farm sector and improve resilience to future shocks.
- **Strengthen policies and institutions for sanitary and phytosanitary (SPS) measures:** As intra- and extra-regional trade in agricultural commodities is likely to increase with climate change, regulatory

bodies that set SPS measures will have to be strengthened to deliver safe trade at least cost. Countries that are unable to provide traceability in the value chain and the necessary trading infrastructure such as certification and inspection services to ensure that their products meet SPS and other requirements may be excluded from markets overseas. The same challenges apply to trade in agricultural products within Africa.

- **Reduce barriers to trade on goods, services and technologies for adaptation:** Open and transparent trade policies are an integral part of a broader strategy to access high-quality and low-cost goods and services that are essential to help the agricultural and other economic sectors to adapt to climate change. Examples of such goods and services include stress-tolerant cultivars, pesticides for weed control, early warning systems, equipment for renewable off-grid power generation, irrigation technology and related engineering and technical services, as well as agricultural extension services. For Africa specifically, eliminating barriers to trade in adaptation goods and services would significantly reduce the cost of acquiring efficient, innovative, and competitive inputs that are critical to carry out countries' adaptation priorities.

Photo: Sunshine Seeds/Shutterstock

- **Enhance the climate resilience of transport and other key trade-related infrastructure:** The proliferation of regional and global value chains has important implications for African countries and their ability to diversify their economies. Value chains provide an opportunity for African countries to integrate into global and regional markets by exporting just one part or component of a product, instead of having to develop the industrial base required to manufacture the entire finished product from scratch.

Drylands

Drylands are regions where primary production is generally limited by water availability. Nearly a third of global drylands occur in Africa, where they cover 19.6 million km^2, and nearly two-thirds of Southern, Western, Eastern, and Northern Africa (see Figure 8). This area is home to over 525 million people in Africa (40 percent of the population), growing by about 3 percent per year (faster than the African average of around 2.5 percent), with a demography firmly skewed toward the young. The drylands of sub-Saharan Africa are the most vulnerable to food insecurity compared to other global drylands. There can be no climate-adapted Africa without its drylands being climate-adapted.

The Drylands chapter reviews the impacts of climate change in African drylands in the context of other major biophysical and social trends, proposes a positive vision for a future for drylands largely centered on climate-adapted development, and identifies key opportunities for successful adaptive actions.

Key Findings

The outcomes of climate change in African drylands are driven mainly by the vulnerabilities of

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its population that collectively lead to a low Human Development Index. After decades of improvement, food insecurity and undernourishment are on the rise in almost all subregions of sub-Saharan Africa. In drought-sensitive sub-Saharan African countries, the number of undernourished people has increased by 45.6 percent since 2012.

The year 2019 recorded a deteriorating food security situation in sub-Saharan Africa, as well as increased population displacement and the increased food insecurity of those displaced people. As a result, adaptation is essential but cannot and should not be addressed separately from Africa's development—the target must be climate-adapted development.

To unlock this potential to transform the resilience of drylands at sufficient scale to adapt to climate change, important challenges need to be acknowledged and addressed. Adapted drylands with resilient communities and livelihoods cannot be achieved piecemeal by sector or by individual projects.

Many of Africa's longest running conflicts are associated with drylands, arguably because drylands are often the hinterlands of nations, being remote with poor infrastructure, or in border areas where countries struggle most to maintain control over their territories and where arbitrarily drawn, post-colonial boundaries exacerbate this issue.

Large initiatives for African dryland resilience like The Great Green Wall Initiative (GGWI) and AFR100 currently tend to be founded around a notion of restoration, whereas climate-adapted development needs to capture transformative opportunities and value creation. Dryland regions are not places of endemic famine and shattered societies and policies, where deep transformation is impossible. In general, African drylands are well-endowed with space, solar energy, minerals, water resources in many areas, carbon storage capacity, with important climate mitigation opportunities, biodiversity, spectacular landscapes, rich cultural traditions, and abundant human capital, including women and youth, among many other potentially positive resources. They do face many challenges—population growth, competition for land, climate change, poor governance and conflict, among others. But this should not inhibit a vision for transformation at scale, as described in more detail in the Drylands chapter, informing realistic programs with the potential to trigger a virtuous cycle that can stabilize and improve the security, well-being, and prosperity of dryland inhabitants.

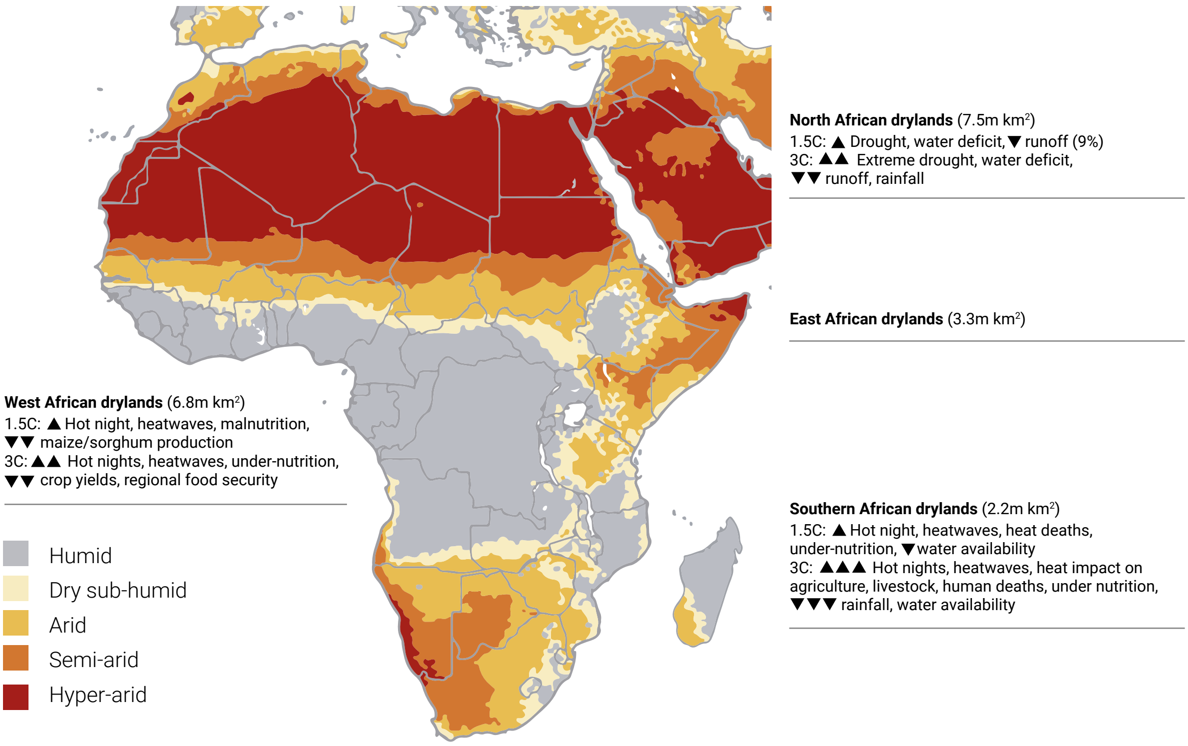
In regions facing the worst impacts of climate change, the emphasis should be on people-based policies (like health, education and social protection) and not only on place-based policies (like infrastructure and urban development).

Policy Recommendations

Several key underlying challenges, exacerbated in the drylands, also require addressing at a larger and more strategic scale to create an environment in which these elements of success can thrive and drive wider drylands resilience, and eventually reduce the pressures for conflict. To this end transformative interventions and targeted investment partnerships are needed to:

- **Support major initiatives that already exist,** as long-term vehicles to integrate and implement the elements of success in drylands at scale, improving the resilience of dryland environments and livelihoods to climate change around conventional dryland opportunities based on natural capital in pastoralism, farming, forestry, and land restoration.
- **Establish a series of ambitious, cross-border decadal initiatives in new domains** where drylands have a comparative advantage, to also act explicitly as integrating vehicles to develop additional climate-adapted livelihoods based on natural and other capitals (such as conservation and tourism, renewable energy, sustainable irrigation, food processing, carbon storage through sustainable land management). Support market links within regional economies and global value chains to this end.
- **Support the establishment and operations of an African drylands entity or initiative** to help ensure that policies are implemented in dryland-sensitive ways. Such an entity is essential to ensure a drylands voice over two-thirds of the continent, and should contain nested drylands commissions

Figure 8. Predicted changes in drylands of Africa, under 1.5°C and 3°C global average rise in temperature



Source: IPCC (2019). Climate Change and Land, Special Report; & IPCC (2018). Global Warming of 1.5°C, Special Report within countries.

- **Patiently support African drylands through strengthened regional and global partnerships** while they transition to greater resilience and contribute to the global economy. This support must act to reduce accidental and deliberate interference; help control capital export from drylands; ensure transparency in resource extraction; ensure transfer of appropriate technology and practices; and enable equitable participation in global trade. It must also help deliver humanitarian safety nets, and relief and recovery in the face of disasters and conflict.
- **A positive vision of adapted African drylands is essential.** Misleading negative imagery has obscured the potential for value creation based on the endowment of space, solar energy, minerals, water resources, biodiversity, and rich cultural heritages, as well as people, including women and youth, in drylands. Recent decades have shown that livelihoods based on natural capital can deliver significant economic returns and reduce poverty locally.

Transport and energy

Poor infrastructure continues to hinder economic growth in most African countries. To close the infrastructure gap, investments in infrastructure in Africa must go up to 4.5 percent of GDP from approximately 3.5 percent, where it has persisted since 2000. Moreover, climate risks are affecting infrastructure development strategies and investments. Rising temperatures, changes in rainfall patterns and intensity, and the increasing frequency of extreme weather events are leading to losses in asset values, higher operating costs, and reductions in the economic benefits that infrastructure generates.

Infrastructure spending and access to infrastructure services is a key contributor to development, economic growth, and poverty alleviation in Africa. It is crucial that investments in infrastructure in Africa are sustainable and resilient. This requires a fundamental systemic transformation. A revolution in the planning, design, financing, and delivery of infrastructure is urgently needed to meet the acute needs of warming Africa.

The Transport and Energy chapter analyzes how climate change impacts infrastructure in Africa, with a focus on the energy and transport sectors, with sobering implications across social, economic, environmental, and development outcomes.

Key Findings

While African governments need to integrate adaptation and resilience into infrastructure investments to minimize the harm caused by climate impacts and maximize development opportunities, they face significant challenges:

- The impacts of climate change on infrastructure can be acute or chronic. Acute climate impacts cause a sudden shock to the system, often from an extreme event such as a flood. The event may have widespread impacts (like coastal flooding) or may be very localized (as in a landslide). Climate-related damage to infrastructure disrupts social services and exacts a significant short and long-term human and economic toll in Africa.
- Closing the infrastructure gap and enhancing climate resilience is critically important for economic development, improving the quality of life, and the growth of the private sector in Africa. The good news is that infrastructure investments in Africa have risen increasingly over the past 15 years, and international and national investors have both the desire and the funds to spend much more across the continent. However, while investments in adaptation and resilience for energy and transport infrastructure are rising (from $19 million to $252 million between 2010 and 2019 for the energy sector; and from $11 million to $128 million in the same period for transport), they are still well below actual needs.
- Making infrastructure more climate-resilient will have additional upfront costs of 3 percent, but returns can be four times the initial investment, in addition to important social returns.

Climate-resilient infrastructure planning needs to begin ‘upstream’ in the early planning stages; be integrated across sectors and activities at a strategic level; make use of better analytical tools to understand climate risk at a systems level; and prioritize resources for building resilience. Proactive adaptation—modification of designs and incorporation of resilient construction norms at the very outset of infrastructure projects—is a no-regret option in the energy and transport sectors, including for instance for hydropower and paved roads.

There is momentum building for national governments, development partners, and the private sector to integrate climate change into asset design. Development partners such as the World Bank and African Development Bank, for example, already screen projects for adaptation. However, there needs to be a fundamental shift further upstream to integrate climate resilience into how country and sector projects pipelines are planned, financed, and developed.

Once these 'upstream' decisions on the location, nature, and design of infrastructure are made, the options for climate risk management narrow. Such proactive 'upstream' adaptation and resilience measures can increase up-front investment costs, but reduce 'downstream' operations and maintenance costs.

Despite evidence of these benefits, investments in improving the climate resilience of infrastructure in Africa are well below the needs. Only 2.3 percent of total official development assistance (ODA) for Africa was allocated for investments in infrastructure adaptation between 2010 to 2019. Of this, 6.3 percent, or $831 million, was allocated for the transport sector, and 12.9 percent, or $1,694 million, for the energy sector. Domestic resource commitments form a large proportion of infrastructure investments in Africa, totaling $37.5 billion, or 37 percent of total infrastructure investments in 2018. While these investments are not screened for adaptation and resilience, ODA sponsors are increasingly calling for such screening, supporting a positive trend where total adaptation investments in energy increased from $19 million to $252 million between 2010 and 2019, while transport sector investments increased from $11 million to $128 million in the same period (Figure 9).

Policy Recommendations

The following recommendations help chart the way forward:

- **A transformational shift is necessary in how infrastructure is planned and designed, with systemic climate risks and resilience integrated upstream.** While infrastructure development in the energy and transport sector is vital to Africa's growth, there is a high potential that climate change will offset or reduce the benefits of such infrastructure. Adaptation has great potential to reduce the negative impacts of climate change, but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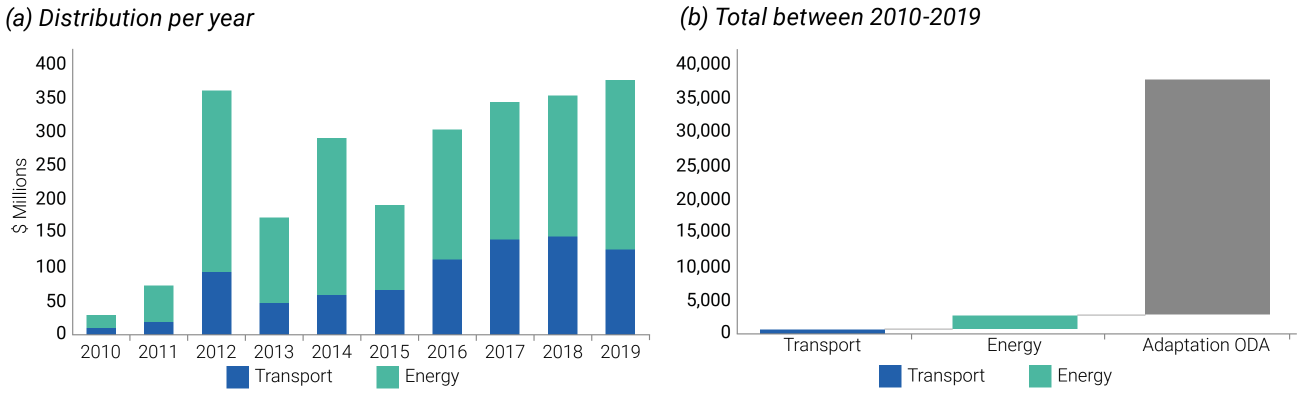
the planning and design of infrastructure in Africa is still conducted largely without taking climate change into account. Proactive adaptation in the energy and transport sectors, meanwhile, is a no-regret option.

- **Adaptation of rural infrastructure** needs special approaches and cannot be left behind urban infrastructure.
- **Invest in integrated systems to generate data for investment planning.** To bring down the cost of the analysis needed to integrate climate considerations into energy and transport development, and to mainstream systemic risk and resilience, significant amounts of data on climate, infrastructure assets, supply chains, the environment, economic activities, and other socioeconomic aspects is needed. Most African countries and their development partners already have existing systems and projects that generate the required data, but these systems are siloed and mostly disconnected from decision-making processes. While data alone will not increase infrastructure adaptation and resilience, it is a vital entry point for putting in place the building blocks for climate-smart investments in infrastructure. African countries should focus on two priorities: Climate data and infrastructure asset data. This will also improve assessments of key vulnerabilities of infrastructure when used with the climate data and will help to prioritize investments.
- **Invest in tools and methodologies to quantify energy, transport, and infrastructure-related ecosystem services provided through natural assets.** NbS, implemented on a large scale, could reduce costs by 90 percent for the same level of adaptation benefits. There is a need to ensure sharing of research within and across sectors, and to standardize methodologies and approaches for integrating NbS in infrastructure planning and implementation where appropriate, while recognizing the context-specificity of NbS projects.
- **Leverage PPP frameworks that promote incentives for climate resilience and adaptation of infrastructure projects.** While PPPs represent a relatively small proportion of infrastructure investments in Africa, they provide a clear entry point for integrating adaptation and resilience into infrastructure design and asset management. A robust PPP framework is imperative to attract private capital for infrastructure, particularly in Africa where market conditions are more sensitive, given the complexity of PPP projects, contract size, and risk exposure.
- **Governments must drive reforms for improved operations and maintenance asset management.** Planning, designing, and financing climate-smart infrastructure represents only one portion of the infrastructure lifecycle. Asset management is often ignored or de-prioritized in the drive to finance and increase infrastructure capacity in Africa. Countries must enhance fundamentals of climate-smart infrastructure governance by reflecting climate change in asset management practices through clearly defined system performance metrics and levels of service. Specific recommendations to integrate climate change into asset management

Figure 9: Adaptation official development assistance for transport and energy



Source: Authors, with data from OECD (2021). OECD.Stat database

practices include: defining requirements; assessing climate impacts on the asset base; developing climate-smart capital works strategies; integrating climate risk in financial plans; and integrating climate change and hazard data in management information systems (MIS).

Urban Development

The Urban Development chapter reviews the current state, past trends, and projections of urbanization in Africa. It analyzes present and project climate risks in urban areas, focusing on floods, specific risks for low-lying urban centers, the impacts of droughts on water supply services, coastal erosion and its linkage to sea level rise, and heatwaves. The chapter then reviews adaptation options for African cities in three groups: (i) untapped opportunities and early wins; (ii) urgent adaptation actions in the post-COVID recovery; and (iii) medium- to long-term measures after the economic recession caused by the pandemic.

Key Findings

At 4.4 percent, Sub-Saharan Africa is the region with the fastest urbanization rate globally, with about 40 percent of its population living in urban areas, up from 22 percent in 1980. With close to one billion urban residents, the growth will continue and double in number by 2050. On average, 60 percent of Africa's urban residents live in slums.

Urbanization in Sub-Saharan Africa is taking place at lower levels of income. In 2005, the GDP per capita of Sub-Saharan Africa at close to 40 percent urbanization was about $1,000. At that same rate of urbanization, the GDP per capita for the Middle East and North Africa was $1,800, and for East Asia and Pacific was $3,600.

The COVID-19 pandemic is having severe economic impacts in Africa and its cities. Economic activity in Sub-Saharan Africa is estimated to have contracted by 2.0 percent in 2020. The region has seen its first recession in over 25 years, with activity contracting by nearly 5.0 percent on a per capita basis. Local governments could experience a drop in local finances of 30–65 percent, on average.

African cities face rapidly growing climate risks but with large variations across the continent that need targeted responses. Climate risks in urban areas of Sub-Saharan Africa include floods, droughts, sea-level rise, heat waves, and increased risks to diseases like malaria, cholera, and rodent-borne diseases. The urban poor are suffering the worst impacts of the climate crisis due to their lower resilience capacity.

Low-lying coastal areas have specific climate risks due to sea level rise and, in many areas, increased flood frequency. Climate risks are compounded by demographic trends in coastal areas. About half of the African settlements with 1-5 million inhabitants are located in low-elevation coastal zones. By some estimates, Africa's populations in low-elevation coastal zones (LECZ) will rise at more than double the world's average.

One of the urban services that will be most affected by climate change is water supply. Access to piped water supply has progressively increased in Africa (from 82 million urban dwellers with piped water in 2000 to 124 million in 2015). However, given the rapid urban population growth, the percentage actually declined from 40 percent in 2000 to 33 percent in 2015. Most of the increase came from increased access to piped water off premises and self-supply. As informal settlements have grown quickly, informally, and without adequate urban planning or space, the provision of water infrastructure is complex. Droughts are expected to become stronger in many parts of Africa, as discussed in the Present and Projected Climates in Africa chapter. They will have significant impact on water utility services.

The impact data of heatwaves is limited in Africa, but trends are worrisome. Combining temperature and population growth projections for 150 large African cities, a recent study showed that the number of people that will be subject to dangerous and lethal heat conditions will be 20 to 52 times higher at the end of the century compared to current conditions.

The rapid population growth of African cities and the current and projected climate risks compound economic risks. A combined analysis of population growth projections and climate vulnerability in cities worldwide, shows that cities in Africa are growing the fastest (86 of the 100 fastest growing cities), and 79 of these cities fall in the "extreme risk" category of their climate index.

The early stages of urbanization in most Sub-Saharan African cities provide a unique opportunity. The low levels (40 percent) of urbanization of the region and the low-density of its large cities offer opportunities for low-cost actions that can prevent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locking-in errors of other highly urbanized regions of the world.

Policy Recommendations

Given the limited financial resources African cities currently have, it is important to prioritize the adaptation actions that are feasible and have the greatest impact. Our GCA analysis has grouped these possible avenues in two groups: (i) the untapped opportunities and early wins; and (ii) the urgent options in the recovery.

African cities can undertake a range of opportunities that require fewer financial resources and can generate immediate and significant adaptation benefits or set up the planning basis for enhanced adaptation measures as part of the post-COVID recovery. The first group of measures includes:

- **Rapid climate risk assessments** that gather recent disaster information, infrastructure bottlenecks, and information gaps for a rapid evaluation of critical weaknesses of the city.
- **Community engagement,** including the youth and women, for resilient action in the low-cost measures identified in the rapid climate risk assessments.
- **Basic urban planning** to reduce uncontrolled sprawl in areas of high climate risk.
- **Early warning systems** by connecting the city to the national warning systems and hydrometeorological agencies to ensure that the information on upcoming climate disasters is received by the municipality, transmitted to the communities, and acted upon.
- **Individual and community resilience,** including behavior change, climate risk communications, childrens' education, and women and youth empowerment for resilience and disaster preparedness.
- **Maintenance of existing infrastructure** and enhanced safety measures for non-networked water and informal waste solutions.
- **Land and property rights** and urban planning are indispensable elements of a resilient city. The first basic steps of mapping and data collection can be done at low cost and serve as the basis for a long-term transformation process.
- **Leverage the resilient power of nature** by protecting existing buffers like mangroves, wetlands, and floodplains. These green spaces are rapidly disappearing in African cities and the cost of building gray infrastructure in future years to compensate for the disappearance of the natural buffers will be expensive.

A second group of adaptation and resilience measures requires more financial resources, but their urgency resides on the avoidance of growth patterns that will lead to the need for retrofits, or in the high benefit to cost ratios in terms of lives saved or assets protected. These measures include:


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- **A comprehensive urban resilience and adaptation master plan** that considers the various climate risks of the city, combines them with the urban growth needs, and provides a climate-smart development path in the medium-term.
- **Prioritized infrastructure retrofits and enhancements** that solve the critical bottlenecks and priority risks for the city for the more recurrent climate shocks, such as floods and related landslides.
- **Resilience business market opportunities** associated with the infrastructure actions above, designed to support the creation and growth of SMEs that would generate new jobs for adaptation and resilience.
- **Continuous capacity strengthening of city officials,** both municipal staff and delegated staff of national agencies, in the areas of climate adaptation and resilience.
- **Climate adaptation project preparation,** to ensure engineering designs and bidding documents for the most critical medium- and large-size projects are ready when the economic conditions recover after the COVID pandemic.

In the medium- to long-term, our GCA research indicates that African cities need to undertake a more comprehensive adaptation and resilience strategy based on the following nine areas:

- **Strengthen the capacity of all city stakeholders to minimize the economic impact of disasters** through early planning, preparedness programs, community engagement, and rapid reconstruction using "build-back-better" principles.
- **Deepening the resilience of the private sector,** as discussed in the Private Sector chapter. The municipality can take an active role to encourage and support the building of that capacity through information and capacity building.
- **Explore new financial mechanisms for enhanced resilience,** beginning with simple ones such as insurance for the most critical municipal assets, PPPs for resilient infrastructure, land-value capture to finance flood control infrastructure, and others described in the Finance chapter of the report.
- **Scenario planning,** based on continuous data collection and partnership with scientific bodies and network of cities with more experience in robust planning and climate projections at the local level.
- **Multi-level government coordination,** as many of the climate risks of the city require coordination and action with other jurisdictions such as neighboring municipalities in metropolitan areas, or river basins for watersheds providing water to the city or flood protection.
- **Progressive institutional reform** and continuous capacity building that approaches adaptation and resilience as a cross-departmental platform.
- **Leverage new technologies** and bring the best

elements of smart cities and disruptive digital technologies.

- **New alliances** to ensure adaptation and resilience are seen as everybody's job and not only a responsibility of the municipal government.
- **Inclusive approaches to adaptation** to ensure that socially vulnerable groups, from persons with disabilities to unemployed youth, women, migrants, and internally displaced populations, are all part of the resilience plans and programs of the city.

Water resources management, floods and disaster risk management

The Water Resources Management, Floods and Disaster Risk Management chapter brings together two areas that connect several previous chapters. These areas are, first, disaster risk management (and the closely associated issue of flood risks) and, second, integrated water resources management. The most important manifestation of climate change in Africa is through water. This chapter reviews the state of flood risks in Africa, the implication of floods on poverty, current projections of climate change and their impact on poverty, and policy recommendations on flood risk management for the continent. Finally, it discusses how three major international agreements reached in 2015 connect to climate adaptation and resilience: the Sendai Framework for Disaster Risk Reduction (SFDRR), the Sustainable Development Goals (in particular, Goal 6.5 on integrated water resources management), and the Paris Agreement.

Key Findings

Disaster Risk Reduction (DDR) and the Sendai Framework: In 2015, the Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR) was endorsed by the UN General Assembly. All 55 African countries signed up for the Sendai Framework. The African Union and its member countries identified five additional targets specific to the region. A key target of the SFDRR is the development of national and local disaster risk reduction strategies with a deadline of 2020. In Africa, 18 countries have validated strategies or policies aligned to the SFDRR, and seven more countries are developing or validating their strategies. 101 countries worldwide have reported the existence of national DRR strategies in the SFDRR framework monitor used to measure progress. Africa is not too far behind the global average of developing regions.

Two other major international agreements were reached also in 2015: the SDGs and the Paris Agreement. Since then, there have been concerted efforts to coordinate these agreements at the country level. Climate adaptation and resilience are at the center of these agreements. However, the different institutional arrangements for DRR and CCA lead to mismatches in governance, data and information, and funding streams.

Our review of the various assessments of the state of DRR in Africa shows that financial resources are still insufficient to develop DRR and resilience programs. In addition, the national planning and development processes have not yet fully mainstreamed DRR. The level of domestic financial resources dedicated to DRR activities is insufficient in most African countries. On average, 4 percent of national budgets, at the planning stage, are related to DRR, but only 1 percent is directly dedicated to DRR interventions. A wide range of instruments can be combined and leveraged in a multi-layer financial architecture for DRR and climate-related disasters together (Figure 10). A key objective of this architecture is to mobilize as fast as possible the resources needed for post-disaster reconstruction and recovery.

Floods: In Africa, over the period 2008–2018, floods accounted for 65 percent of events and caused 24 percent of deaths. The 2018–2019 cyclone season caused the most considerable flood damage seen in the region. The leading cause was Cyclone Idai, which primarily affected Mozambique and Zimbabwe with at least 900 deaths and infrastructure damage estimated at more than $1 billion.

The rainfall and river basin flows in the continent have a wide range of variability, which poses significant challenges for managing floods. These challenges range from managing floods in large transboundary river basins, understanding the extreme floods in ungauged catchments with minimal information, and reducing the vulnerability of low-income informal settlements in African cities.

Partly driven by population increase, the number of people exposed to river flooding in Africa is predicted to rise to 23.4 million by 2050, with a projected 57 percent increase in fatalities if global average temperatures increase by 1.5°C. Without additional flood protection, and following the projected substantial increase in economic value in flood-prone areas, the projected economic damage in the region could reach $266 billion per year by 2050.

Populations living in poverty are particularly vulnerable to climate shocks such as floods. This means that the poor lose proportionally more when such shocks hit them due to factors that are particularly relevant for Africa, such as: (i) lower-quality housing that is more vulnerable to damage and loss; (ii) greater income dependence on climate-dependent agricultural and ecosystems; and (iii) less resilient infrastructure services.

Integrated water resources management (IWRM) is a holistic framework used to address the diverse demands and pressures on water resources across sectors and at different scales—from the local to the transnational—in an equitable, sustainable manner. Even though IWRM has traditionally included flood and drought risk management through water storage infrastructure solutions, the IWRM and DRR programs and policies have not been well coordinated. A rapidly changing climate requires a change of this situation.

Policy Recommendations

Current and projected flood risks in Africa are significant and growing. Our analysis suggests that the following policy recommendations bring together regional and international good practices applicable to Africa: (i) Flood risk management requires not only understanding the types, causes, and likelihood of flood events but also the population and assets in potentially affected areas and their vulnerability and understanding of floods; (ii) traditional structural flood reduction infrastructure is expensive and needs careful targeting; (iii) the most essential and cost-effective non-structural flood risk management measures are planning and preparedness; (iv) land use planning and management, and nature-based solutions, are as important as non-structural measures; and (v) rapid changes in Africa (from urbanization to land use change and development of floodplain areas) combined with climate change make flood prediction in the short- and medium-term challenging.

IWRM has traditionally included flood and drought risk management through a combination of water storage solutions and water availability information for decision-making under stress conditions. Generally, IWRM and DRR have not coordinated actions and

Figure 10. Multi-layer financial architecture for DRR and climate disasters

Source: GCA (2020), *State and Trends in Adaptation*, adapted from World Bank (2016), Colombia: *Policy strategy for public financial management of natural disaster risk.*

programs under different institutions with different approaches and areas of focus. Our analysis shows that the growing urgency of climate adaptation actions makes this coordination even more critical.

SECTION 3 – CROSS-CUTTING THEMES

Health

Health indicators and services in Africa have made substantial progress in recent years before the COVID-19 pandemic, but still lag behind the rest of the world. Approximately 615 million people do not receive the health care services that they need.

Photo: Beate Wolter/Shutterstock

When the quality of services is considered, the coverage scores are even lower. Every year, 15 million people (1.4 percent of the region's population) are pushed into poverty due to out-of-pocket health care expenses. The Health chapter reviews the impacts of climate change on various health factors in Africa, projected trends, and possible climate adaptation solutions. It also examines progress towards mainstreaming adaptation in health systems.

Key Findings

Climate change is a modest factor today in the overall burden of disease and health indicators in Africa. However, the trends are of concern, and decisive action is needed to mainstream practical adaptation strategies in health services and sectoral factors that impact health outcomes. Population health is impacted by climate change through multiple exposure pathways including heatwaves; infectious diseases; hunger and malnutrition, particularly due to the impact of climate shocks on agricultural production; water- and food-borne diseases linked to climate shocks; long-term health and developmental challenges on children; injuries, disabilities and deaths resulting from floods; damage to health facilities and access disruptions caused by floods; and inequality and vulnerability as amplifying factors.

The risks are unevenly distributed, with poor and marginalized communities at higher risk, and the health services they can access are of poorer quality. This combination already results in higher health impacts of climate shocks today to climate shocks and, if no adaptation actions are taken, worse health outcomes in the future.

Improved health outcomes for the population of Africa will not depend only on health systems, but also on investments to make progress on the SDGs in ways that are adapted to a changing climate. These investments range from safe water and sanitation to food security, and from basic services in low-income urban communities to early warning systems.

An analysis of the NDC's to evaluate how public health was incorporated, including impacts, adaptation, and co-benefits, concluded that most

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countries in Africa referred to health in their NDC. Nearly 100 percent of countries in the African region had a mention of health in theirs, and more than 40 percent had a section on health.

Policy Recommendations

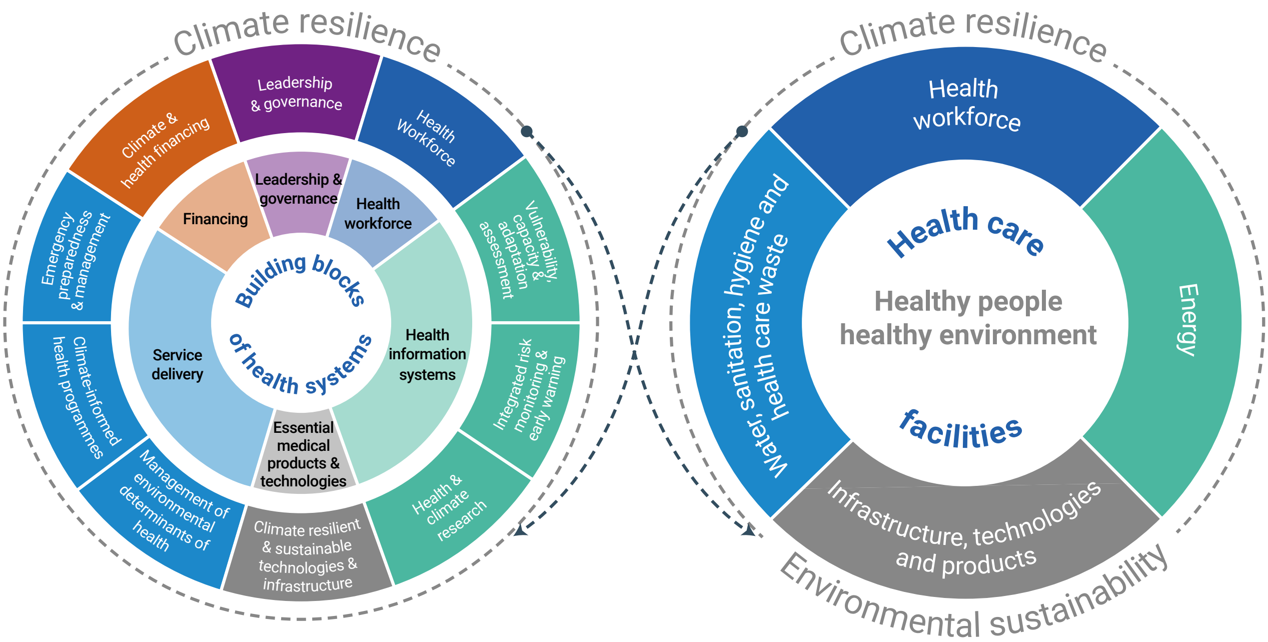
A first policy recommendation is to ensure health systems are resilient to climate shocks. Figure 11 shows, on the left, the components of climate resilient health systems, and on the right, the components of climate-resilient and environmentally sustainable healthcare facilities.

Becoming resilient to today's disasters is a step towards making health systems better adapted to climate change. The interlinkages with emergency response systems and infrastructure planning are equally important. These principles are designed not only for climate disasters, but also to support health systems respond better to a wide range of shocks and stresses. Table 4 summarizes these pillars and recommendations for government action.

Gender

Climate change and gender inequalities are linked in complex ways. On the one hand, climate change can be a barrier to progress towards gender equality. But equally, gender inequality can exacerbate the effects of climate change. Women and men are not only affected differently by climate change, they

Figure 11. WHO guidance for climate-resilient and environmentally sustainable healthcare facilities



Source: World Health Organization (2020)

Table 4: Five pillars of resilient health systems and associated priority actions

Resilience in health systems	Objectives	Examples of policy actions
Resilient health facilities	Enhanced capacity and resilience of facilities by:	• Understanding climate risks today and in the future • Upgrading structures to withstand climate shocks • Enhancing staff capacity to deal with climate shocks and emergencies • Preparing crisis protocols, business contingency plans, and emergency stocks of essential supplies
Resilient health systems	Integrate individual health facilities into a coordinated network by:	• Using data-driven decision-making process to optimize resources during climate shocks • Improving communication and cooperation between diverse entities of health system • Leveraging facilities outside the health system to delivery emergency services • Deploying mobile clinics to underserved and disaster-hit areas to boost capacity during crisis
Integrated emergency response	Integrate health care into climate shock response systems by:	• Coordinating closely with search and rescue agencies to manage health needs • Establishing inter-agency communication channels and coordination before climate shocks • Clearly defining roles and mandates for crisis response • Enhancing early warning systems and disseminating information to the health system • Integrating health system needs in climate risk finance strategies
Resilient infrastructure	Ensure resilience of critical infrastructure systems on which health facilities depend by:	• Upgrading transport, water, electricity and telecommunications assets vulnerable to climate shocks, especially those needed for health systems operations • Identifying redundancy in infrastructure assets • Leveraging new technologies for service and supply delivery

Source: Adapted from World Bank (2021), *Frontlines* also contribute differently to climate action. Women and men experience different levels of exposure, vulnerability and resilience to climate risk and climate change impacts as a result of gender differences in rights, responsibilities and opportunities. They experience differing vulnerabilities because of differences in workloads, in access to and control over productive assets and resources, and in participation in household decision-making and access to information and technology. Their vulnerability varies not only because of gender, but also disability, sexual orientation, ethnicity, religion, class, location and age. Rural women in particular are at high risk of being negatively affected by climate change, due to household responsibilities, increased agricultural work resulting from climate impacts, and male out-migration—with consequences on family nutrition, childcare, and education. The feminization of marginal agriculture, given the migration of young men to cities, is a problem that requires particular attention and solutions. The gender chapter analyses these issues.

Key Findings

Barriers to resolving gender inequalities in climate change mitigation and adaptation processes continue to persist and still need to be addressed. Many climate change interventions prioritize productivity at the expense of issues such as gender, social inclusion, and equity. This trend must be checked. Further, for effective assessment of progress towards gender equality in climate action and to adequately report on instruments, well-structured and robust monitoring and evaluation (M&E) systems, with sex-disaggregated data and sufficient funding support, are a must.

Women remain largely absent from climate change politics and policymaking. This is because climate change debates have been shaped by stereotypically masculine discourses that work to exclude or alienate women and their concerns in climate change issues. Further, climate change is widely represented as a techno-scientific problem requiring technical solutions, yet women with expertise continue to be sidelined from participating in the development of such solutions. Without women's inputs on climate change policy, climate change could itself become another barrier to gender equality.

Women's awareness and agency should be harnessed for gender-responsive and sustainable climate action. Their unique knowledge, skillsets and perspectives, borne out of how they interact with food systems, technology, and institutions, can improve the effectiveness of climate action.

There are many groups and institutions doing significant work at the intersection of gender and climate change in Africa, and a range of proven and potential adaptation actions and strategies suitable for the continent that focus on bringing women into the mainstream of climate action.

Policy Recommendations

Promoting women's voice in policy, planning and implementation needs to be supported by funding. Further work is needed to prioritise funding for grassroots and women's organisations to empower local civil society and to complement the large financing mechanisms. The implementation of gender actions in projects requires dedicated funding; hence it is a good practice to allocate a sufficient budget for the project to support activities promoting gender equality. If the funds are not allocated or the implementing project does not have funds to implement specific actions, the gender mainstreaming process will be adversely impacted and delayed. This is the case in most African countries.

Most NDCs do not address structural causes of gender inequalities and mentions of gender in many tend to be brief. Only 10 countries have developed gender and climate change plans (GCAPs) in the last few years, half of which are in Africa: Kenya, Mozambique, Nigeria, Tanzania, and Zambia.

It is crucial to have women represented in decision-making at all levels to be able to influence innovative, sustainable solutions to climatic challenges. Gender balance in national delegations to the UNFCCC should be encouraged and women supported to maximize their voice, confidence, and negotiation skills while 'at the table'. Where women are excluded from governance, decision-making processes are more likely to result in policies that ignore the unique needs, knowledge, and contributions of women. In addition to strengthening women's skills and decision-making ability, it is important to promote women's access to knowledge related to climate change across all the relevant sectors.

It is essential to develop tools, methodologies, guidelines and indicators for the monitoring, reporting and verification of the development and implementation of gender-responsive climate policies and strategies in Africa to facilitate tracking of progress in this area. Data collection tools such as the Women's Empowerment in Agriculture Index (WEAI) and the Gender Empowerment Index for Climate-Smart Agriculture (GEI-CSA) provide a good starting point to measure the impact of climate interventions on women and men and address areas of disempowerment.

Governments need support to build their capacity to integrate gender into national adaptation and mitigation plans and Present and Projected Climates in Africa, and into sectoral plans and programs through training in gender-responsive policy analysis, policy development, planning, budgeting, implementation, monitoring and evaluation. In addition, there is need to strengthen the capacity of farmers' groups for gender-responsive service delivery in the face of climate change, for example through access to resources and services such as land, fertilizers, seeds, and markets.

Conflict and migration

Globally, the link between climate change, conflict and migration is gaining academic and policy salience. In 2007, the United Nations Security Council first established the link between climate change and security across policy arenas, recognizing it as a 'risk multiplier' which exacerbates existing vulnerabilities. However, the evidence attesting to the causal link, and to the mechanisms through which climate change may affect conflict and/or migration, remains weak and often contradictory. Whilst our analysis indicates that climate change is not the sole cause of violent conflict or migration, a growing evidence base supports the 'threat multiplier' discourse. The Conflict and Migration chapter aims to unpack the climate-conflict-migration nexus in Africa and the nuanced pathways in which they interact, to better understand the role of climate adaptation and resilience in addressing these risks.

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Photo: Stanley Dullea/Shutterstock

Key Findings

Africa is the only continent that witnessed an increase in political violence by state and non-state actors in 2020, even as the pandemic contributed to a slight decrease of conflict in the rest of the world. Increasing inequalities laid bare by COVID-19 appear to have contributed to drivers of conflict, further deepening the 'conflict trap'. Currently, 26 out of the 54 African countries which are highly vulnerable to climate change are considered fragile or extremely fragile. Out of the ten most vulnerable countries to climate change, eight are in Africa, and six are currently facing armed conflict. The year 2020 also marked the highest number of internal displacements recorded, the majority of which were in North and Sub-Saharan Africa. New and repeated displacements were also recorded when conflict overlapped with extreme weather events, triggering an estimated 4.3 million new displacements in Sub-Saharan Africa alone.

Our analysis shows that climate and environmental change are never the sole causes of conflict and migration. Instead, they interact in highly complex and context-dependent ways. There is a variable relationship between disasters and conflict. While some countries did record conflict events following the onset of a disaster, others reported increased cooperation and trust as a post-disaster outcome. Some countries appear to be more vulnerable to climate-related conflict than others if they experience (i) ethnic fragmentation; (ii) high dependence on rainfed agriculture; (iii) low human development; and (iv) political and economic marginalization. Mediating factors such governance and institutions, adaptive capacity, and existing vulnerabilities also play an important role in shaping conflict outcomes. Despite the abundance of climate-conflict studies one main concern highlighted frequently across the literature is the lack of robust analysis of climate variables.

We also found that there is limited evidence about the viable role of adaptation and disaster risk reduction (DRR) in conflict settings. However, there is a consensus that poorly designed adaptation and DRR interventions can compound existing inequalities and exacerbate the risk of conflicts. Moreover, people living in conflict-prone settings are highly vulnerable to climate change.

Policy Recommendations

There are important opportunities to tackle the challenges of climate change, conflict, and migration in a coordinated manner through investments, governance and institutional capacity-building, and national and regional plans.

In the area of investments, it is important to: (i)

Promote holistic and multi-sectoral investments in adaptation and resilience, which integrate climate hazards and pre-existing vulnerabilities; (ii) invest in robust databases with more consistent monitoring of climate variables, as well as migration and conflict triggers and trends; (iii) invest in key areas of research such as localized and context-specific research on the climate-conflict-migration nexus; and (iv) invest in early warning systems, preparedness, and combined management systems for climate change, conflict, and migration.

In the area of governance and institutional capacity, it is recommended to: (i) build the capacity of institutions to create an enabling environment for peace and sustainability while promoting inclusive and participatory governance, with a specific lens towards climate change; (ii) promote climate resilience solutions which foster social dialogue and cohesion by recognizing existing social, political and economic inequalities in communities; and (iii) build the capacity of national statistical systems to collect better quality data on climate-related conflict and migration.

Finally, **in the area of national and regional plans,** it is key to: (i) conduct localized climate-conflict assessments and include them in countries' NDCs and NAPs as well as regional cooperation agreements; (ii) consider planned migration as an adaptation strategy, especially when it aims to alleviate poverty and reduce vulnerability to climate change; and (iii) embed migration (in its three phases: before, during, and after movements) into regional, national and local development planning, as well as into NAPs and NDCs.

Sustainable development goals

In 2015, two major international agendas were agreed: the Paris Agreement and the 2030 Agenda for Sustainable Development. The adaptation component of the Paris Agreement focuses on building adaptive capacity, reducing vulnerability to climate change, and enhancing resilience. The 2030 Agenda seeks to progress social, economic, and environmental dimensions of development through 17 Sustainable Development Goals (SDGs). Despite apparent differences in primary objectives, the two agendas overlap considerably. There are significant opportunities for catalytic synergies and linkages between the two—along with the significant danger that lack of progress in one could heavily compromise progress in the other. The SDGs chapter explores these synergies and linkages; identifies opportunities to strengthen links between SDG strategies, plans, and actions and the NDCs; and explores the multiple negative impacts of climate disasters on SDGs.

Key Findings

Sustainable development and climate change adaptation are inextricably intertwined. Climate change can undermine sustainable development efforts without adequate adaptation responses to support food security, poverty alleviation, human health, and other determinants of sustainable development for Africa. Adaptation and resilience actions, meanwhile, can lower the risks of climate change and variability, and help deliver sustainable development. Similarly, robust sustainable development measures can help build adaptive capacity and reduce vulnerabilities.

The sustainable development, adaptation, and resilience-building agendas are mutually reinforcing, and their convergence presents a significant opportunity to deliver mutual benefits. Despite this opportunity for alignment, only 13 SDG targets and 21 indicators (8 percent) of the 169 targets and 232 indicators include an explicit reference to adaptation and resilience (mentioning adaptive capacity, vulnerability, hazards, exposure, and/or resilience). A further 27 SDG targets that contribute to resilience and adaptive capacity for disaster risks, and enable inclusion and accessibility through good governance, have been identified by the UN Office for Disaster Risk Reduction (UNDRR). Other SDG targets may also be relevant to climate change adaptation, depending on the underlying vulnerability contexts.

Our analysis shows that failure to integrate the adaptation and resilience agenda into sustainable development action will therefore substantially hinder progress towards the SDGs, especially for developing countries. Parallel agendas can increase the risks of negative outcomes (maladaptation) to additional target groups and actors (rebounding vulnerability); compromise the ability of other groups to respond to climate change (shifting vulnerability); and result in constraints on or failure of sustainable development.

Climate disasters like drought, floods, hurricanes, and cyclones have multi-dimensional impacts, affecting several SDG indicators at the same time. The SDG chapter presents the analysis of seven recent climate-related disasters in Africa related to water scarcity (drought), and excess water (floods and cyclones). The analysis shows how these disasters have slowed progress toward achieving SDGs, and the multi-dimensional impacts they cause. Climate disasters can reverse the progress achieved in SDG indicators at the sub-national level, and even at the national level for small countries. Mainstreaming adaptation and enhancing the resilience of SDG investments can reduce the impact and avoid such reversals. There is an opportunity to better integrate the SDG framework in post-disaster assessments to map impacts across different socioeconomic systems.

Policy Recommendations

A climate risk-blind pursuit of the SDGs can exacerbate climate-related impacts in Africa, whereas an integrated approach to achieve the SDGs and build climate resilience at the same time can significantly reduce systemic vulnerability, optimize the use of resources, and enable transformational adaptation.

The current adaptation ambition of NDCs in Africa may not be sufficient. African NDCs should strengthen SDG-related adaptation action, related to SDG 3 (health); SDG 4 (quality education); SDG 5 (gender equality); SDG 9 (infrastructure); SDG 10 (reducing inequalities); and SDG 11 (sustainable cities). Measures that target national vulnerabilities, build the resilience of human systems, and deliver multiple SDGs should be prioritized to optimize the use of resources and synergize efforts.

Single climate disasters can negatively impact multiple SDGs through, for instance, loss of life; an increase in malnutrition and disease; and the destruction of water sources, arable land, infrastructure, and the natural environment. The only way to stop this cycle of negative synergies is to accelerate effective action to achieve the SDGs and adapt to climate change.

Unlike adaptation, the SDGs are supported by a robust set of indicators and targets to measure progress. Identifying the links between the SDGs and adaptation can therefore help track progress on adaptation, and to identify gaps.

Africa needs more international cooperation and South-South exchanges of practical adaptation solutions with demonstrated results at scale.

Future topics for research

This report has analyzed in detail six focus sectors that are fundamental for African economies and communities, and four cross-cutting themes. We recognize there are many other important adaptation topics for the African continent. Some examples include education and training, research and development, locally-led adaptation, governance, coastal erosion, and blue economy. These topics require further analysis and will be part of the future analytical work for the Global Center on Adaptation in coming years.

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Present and Projected Climate Risks in Africa

► KEY MESSAGES

- **Africa is particularly vulnerable to climate extremes, or even shifts in weather norms such as the start of the monsoon, as so much food production is dependent on rain-fed agriculture and pastoralism.** Infrastructure that supports the wider economy is also highly exposed to extreme events.
- **Surface temperatures are increasing across all African regions.** Africa is warming faster than the global average over both land and oceans. The latest IPCC report (AR6) now predicts that globally, critical warming levels are likely to be reached earlier in the century than previously projected. Both the need and the urgency to adapt are stronger than ever.
- **Adaptation is even more essential than generally acknowledged because, although there is now wide awareness of the scale and scope of climate change, small changes in weather patterns arising from climate change can also gradually erode the productivity of food systems and cause losses of assets through events too small to attract global or even national attention.** These changes affect people's well-being and can counter efforts to rise out of, or can push people back into, poverty, leading to millions of people never being able to escape poverty.
- **The collection of weather and climate observations in Africa is weak and deteriorating in recent years.** The Global Framework for Climate Services (GFCS) State of Climate Services reports

Photo: Oluwafemi Dawodu /Shutterstock

prepared by WMO and partner organizations have identified needs for significant additional investment to improve systematic weather and climate observations; operational exchange of data and products between the national, regional and global levels; interaction with stakeholders in climate sensitive sectors to co-design, develop and deliver tailored hydromet products and services; "last mile" service delivery; use of the best available science for climate action and associated investments; data on country capacities and on financial allocations for hydro-met systems and services, to enable tracking of financing in relation to assessed gaps and needs; and documentation of socio-economic and environmental benefits of adaptation action.

"(we need to)...revisit our climate ambitions and accelerate the implementation of our actions planned under our national priorities. To do this we will need to focus on actions to adapt to the impacts of climate change, these include nature-based solutions, energy transition, enhanced transparency framework, technology transfer and climate finance."

H.E. President Félix-Antoine Tshisekedi Tshilombo of the Democratic Republic of Congo, and African Union Chairperson
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Introduction: A picture of intensifying climate change in Africa

"In Somalia they called the drought Sima, meaning equal, because it hammered everyone equally hard."[1]

Sima is one of the most recent and largest droughts to strike Africa, but it is just one of a series of droughts, floods, and heat waves that even in the current climate have devastated the livelihoods of so many Africans in the past few years. Such events are associated with major suffering when they occur, and such impacts will likely be exacerbated by further warming.

The east coast of Africa has faced a period of droughts that began in 2008 and have extended, without much relief, except for occasional floods, until recently. In 2019 strong cyclones and heavy rains along the Arabian Peninsula, resulted in higher-than-normal vegetation growth, which provided ideal conditions for desert locusts. The result was the largest desert locust outbreak in 25 years in the Greater Horn of Africa and Yemen, which exacerbated existing conditions of undernourishment. In Ethiopia alone, 200,000 hectares of cropland were damaged, and over 356,000 tons of cereals were lost, leaving almost one million people food insecure.[2] By September 2020, the number of Somalis facing acute malnutrition and marginally able to meet minimum food needs tripled to 3.5 million compared to early 2020.

Droughts in southern Africa brought Cape Town face to face with its Day Zero on 22 April 2018, which was the day the city was projected to run out of water. Only the most stringent water restrictions and cooperation from citizens saw the city through the crisis until it was relieved by winter rains.

But drought is common across much of Africa. The Sahel, that strip of land between the Sahara to the north and tropical rain forests to the south, faced a drought extending through much of the 1970s. It was so extreme that the idea of establishing a green wall of trees to hold back the advancing Saharan sands was formed (see Great Green Wall insert). Since the 1980s conditions have moderated, but have become even more variable, making the life of smallholder farmers and pastoralists more difficult.

These changes are driven by the West African monsoon, which in turn is affected by cycles of warming and cooling in the Pacific, Indian and surrounding oceans.

During August and early September 2021, Egypt experienced some the hottest weather in the past 50 years. For several weeks temperatures were up to 7°C above average, along with high humidity. Temperatures exceeded 40°C in many areas and sometimes reached 47°C. When combined with humidity of 50 percent or higher, such conditions exceed the limits for safe work outdoors, especially in the sun. In Cairo there were power outages and the metro transport system was closed several times. The deaths of "dozens of people" have been directly attributed to heat stroke, but it is likely the extreme heat has caused many more to succumb to existing illness such as heart disease.[3] This brings home the impact that further global warming will have on people who already live at the limits of human tolerance. The anomalous warm events over Egypt are directly related to an intensification of the Asian monsoon lows which draw warm, dry air from the Arabian Peninsula and the Iranian Plateau across north Africa. Modelling shows that these conditions are expected to increase with climate change.

The east coast of Africa falls within a cyclone zone. In March 2019 Cyclone Idai struck Mozambique near Beira City, to be followed a few weeks later by Cyclone Kenneth, which struck a little to the north. Both were among the strongest cyclones recorded in Africa; they led to havoc from high winds, storm surges and flooding in Mozambique and the rain-induced floods extended inland into Malawi and Zimbabwe. Together they left 1,300 dead and 3.5 million people affected through the loss of livelihoods and of 100,000 homes. The majority of those affected were poor people living in substandard housing in informal settlements that were unable to withstand the high winds, torrential rain and floodwaters. Around 90 percent of Beira's homes were affected.[4] The cyclones coincided with the annual harvest, prolonging the losses through the subsequent food shortages, and then in some areas the recovery was further hampered by a cholera outbreak that affected at least 4,000 people.[5]

Disasters in Africa

The African continent is often associated with disasters. Its countries have little resilience to hazards, and they are often forced into years of suffering and many of their citizens fall back into poverty following a disaster. The great droughts in Ethiopia and Somalia in 1973 claimed 120,000 lives and damaged the livelihoods of over three million people. A decade later, another drought affecting Ethiopia and Sudan was estimated to claim 450,000 lives and affected 16 million people. Floods usually claim far fewer lives, but they are more numerous, as so many Africans live along the many great African rivers. Nigeria suffered floods in 2010 and 2012 that killed 400 but affected 8.5 million people, and floods in Mozambique in 2000 killed 800 and affected 4.5 million[6].

The EM-DAT database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) is a global, comprehensive and readily accessible record of disasters (Box 1). Their data is often used to make the case that the number and impact of disasters has been increasing rapidly, but these claims must be treated with caution.

The capturing and reporting of events were irregular across the globe for most of the last century, with major droughts and flooding events being captured but many smaller events likely missed. It was in the late 1990s that the number of recorded disasters rose rapidly (Figure 1). This increase is as much due to better reporting and increasing exposure of people and economic assets as it is to climate change. In the past decade the number of recorded disaster events has dropped compared to the previous decade. More time is needed to see if this is a temporary dip or a true trend in a positive direction.

The number of flood events reported has increased about five-fold since the mid-1990s, while the numbers of other types of disaster have changed much less. Some of the increase in floods could be due to a changing climate but changing exposure patterns of populations along rivers and coasts and improved reporting almost certainly contribute as well.

Box 1: The Centre for Research and Epidemiology of Disasters (CRED)


Photo: istock

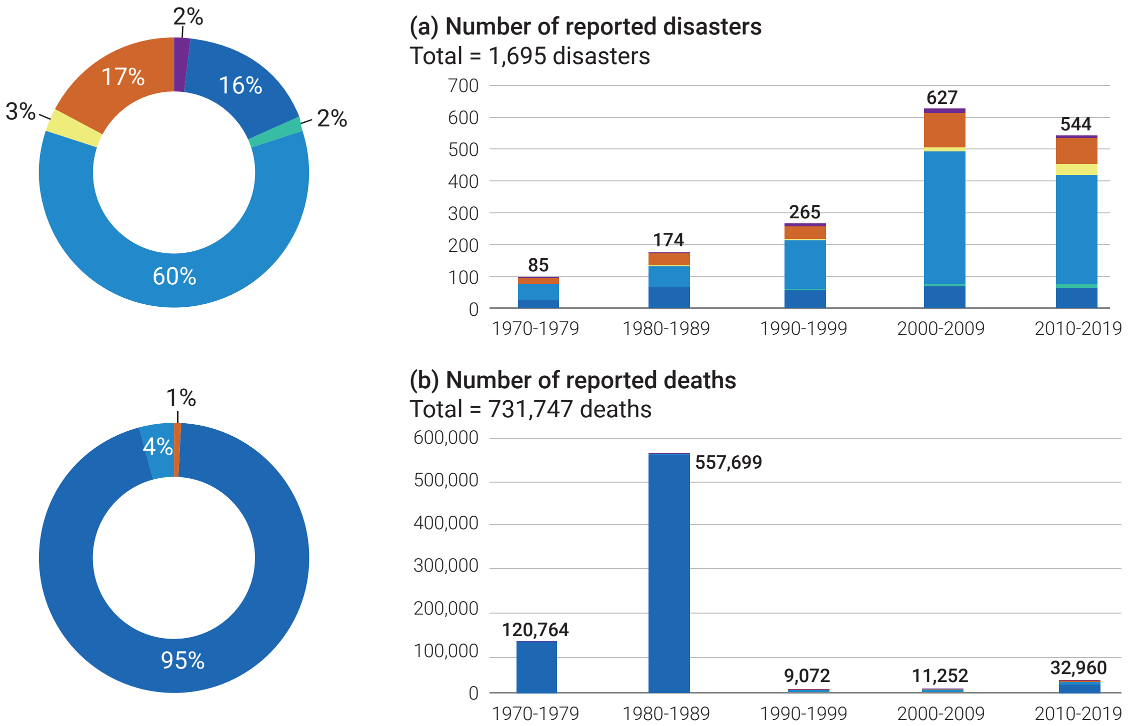
The Centre for Research on the Epidemiology of Disasters (CRED) was established in 1973, and is a World Health Organization Collaborating Centre with links to various UN and NGO humanitarian institutions. It maintains a database on all forms of disaster including climate-related, geophysical (e.g., earthquakes), technological (e.g., industrial and transport accidents), and extra-terrestrial (e.g., geomagnetic storms). Disasters are defined as events that cause at least 10 deaths, or affect, injure or make homeless 100 or more people, or are declared a state of emergency by the affected country. The data base includes estimated loss and damage in monetary terms, but these estimates are available for less than one in six of reported African disasters.

The CRED EM-DAT database is readily accessible at https://www.emdat.be/. This chapter focuses on climate-related disasters which corresponds to their categories of Climatological, Meteorological or Hydrological disasters.

Africa, like most other parts of the world, has shown a marked decline in the number of people reported as being killed in disasters. For example, in the 20 years from 1970 to 1989, 679,000 people were reported as being killed in African climate-related disasters, compared with only 44,000 people killed over the most recent 20-year period. Most of this change represents real improvements stemming from better early warning systems, social safety nets and humanitarian support to alleviate the worst of the impacts. But some of the decline is due to changes in the attribution of the cause of death, especially in relation to drought. During the 20th century four droughts were recorded as leading to over 100,000 deaths, whereas the largest loss of life in the 21st century is a single case of 20,000 deaths attributed to the drought in Somalia in 2010.[7] Deaths associated with recent droughts are likely to be higher than recorded in the EM-DAT database, but now many are attributed more direct causes of death such as infectious and nutrition-related diseases, and not to the drought disaster per se.

Recorded economic losses from 1970-2019 are approximately evenly distributed across drought, floods and storms but, as only 14 percent of disasters in Africa have an estimate of damages recorded, more data is needed on economic damages and losses.

Figure 1: Recorded disasters by event type, 1970–2019



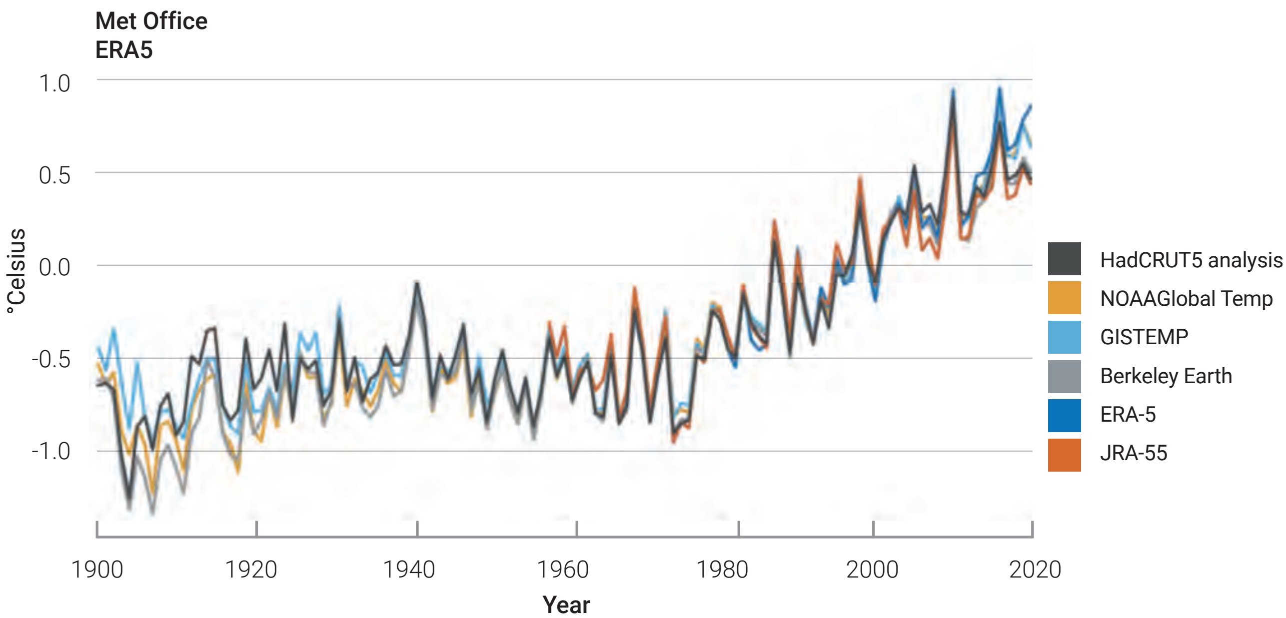
Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)

Recent trends in African climate

Near-surface (2 m) air temperature averaged across Africa in 2020 was between 0.45°C and 0.86°C above the 1981–2010 average (Figure 2), based on six data sets.

Depending on the data set used, 2020 was between the third and eighth warmest year on record. Africa has warmed faster than the global average temperature over land and ocean combined.

Figure 2: Area average land air temperature anomalies in °C relative to the 1981-2010 long-term average for Africa



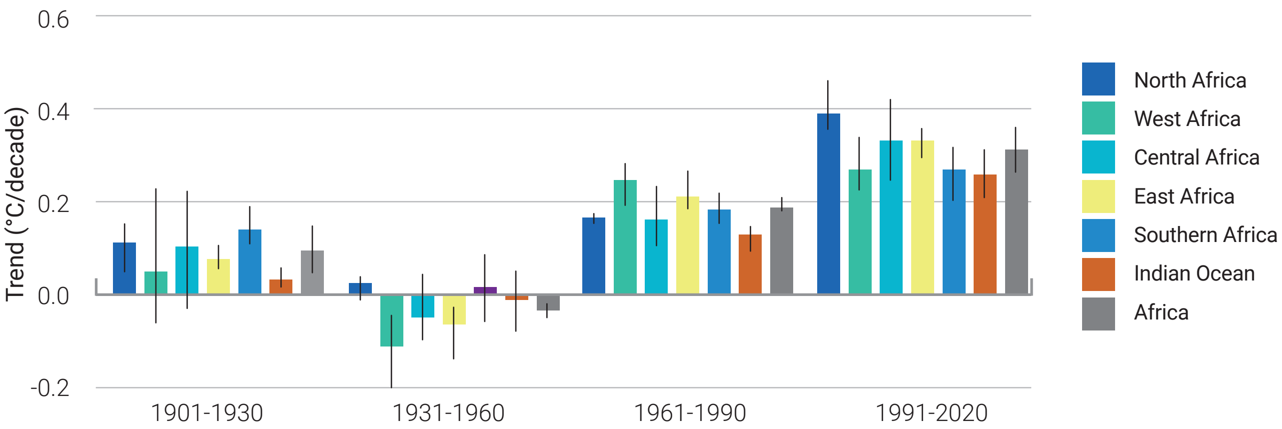
Crown Copyright. Source: Met Office, United Kingdom
Note: This is based on six data sets: HadCRUT5, NOAAGlobalTemp, GISTEMP, Berkeley Earth, JRA-55 and ERA5 – validated in some cases with in-situ observations. Africa is the WMO Regional Association I.

At subregional scales, analysis using the six temperature data sets shows that the warming trend in the 1991–2020 period was higher than in the 1961–1990 period in all African subregions and significantly higher than in the 1931–1960 period (Figure 3). Uncertainty in the trends of the earlier two periods is larger than for the latter two periods, which is not necessarily well described by the spread of the available data sets.

Sea levels are also rising around the African continent, threatening low-lying coastal areas and small island states, and increasing risks of coastal riverine flooding (Figure 4). Analysis based on the Copernicus Climate Change Service (C3S) gridded sea-level data set shows that the sea-level change rates on the Atlantic side of Africa were rather uniform and close to the global mean, while the rates were slightly higher on the Indian Ocean side (Figure 4).

The Mediterranean coasts display the lowest sea-level rise, at approximately 2.9 mm/yr lower than the global mean. Sea-level rise along the tropical and South Atlantic coasts is higher than the global mean, at approximately 3.6 mm/yr.

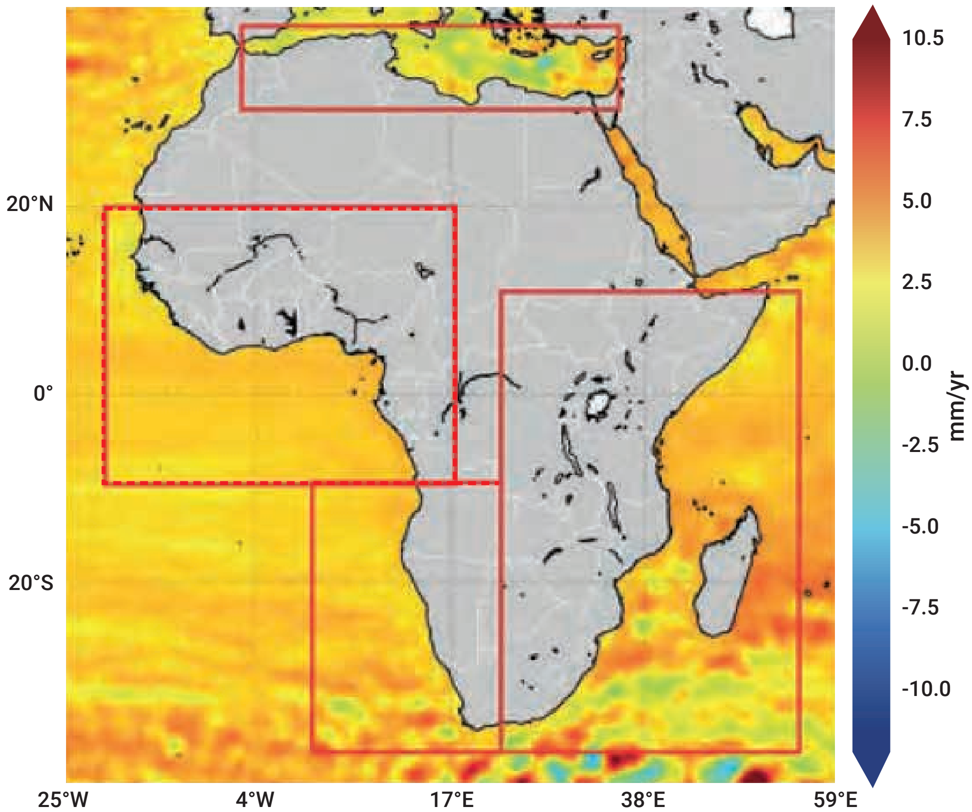
Figure 3: Trends in the area average temperature anomaly time series for the subregions of Africa and for the whole region over four sub-periods



Source: WMO State of Climate in Africa 2020
Note: The black lines at the top of each bar indicate the range of the trends calculated from the six data sets.

Photo: Toa55/Shutterstock

Figure 4: Sea-level trends from January 1993 to June 2020 (mm/yr)



Source: WMO State of Climate in Africa 2020
Note: The red boxes indicate the areas for the analysis of coastal sea-level trends: the Mediterranean Sea, the tropical Atlantic, the South Atlantic and the Indian Ocean. Source: C3S

Projections of African climates

This STA21 Report was drafted largely in the first half of 2021 mostly based on climate change insights and modelling derived from the 2013 Fifth IPCC Assessment Report (here abbreviated to AR5). In August 2021 the first volume of the Sixth Assessment Report (AR6) was released with significant new insights and modelling.[8]

This section briefly describes the new findings and tools provided by AR6, with a focus on the interplay between some of the main components of the African climate, climate change, and the people who must seek their livelihoods while negotiating the consequent erratic weather patterns. The first volume of AR6 on the *Physical Science Basis* of climate change will be elaborated by two further volumes due for delivery in February/March 2022. One will deal with *Impacts, Adaptation and Vulnerability* in social and biophysical systems under the different scenarios of climate change, and the other on the *Mitigation of Climate Change*, which will explore many mitigation-adaptation interactions.

Recent IPCC Assessment Reports have been supported by major modelling efforts (Coupled Model Intercomparison Projects or CMIPs). The AR6 report is based on a major new modelling effort (CMIP6), that compares over 30 models of global circulation that include more detail within the models and greater spatial resolution. Since AR5, high-resolution downscaling for regional projections have improved and their results coordinated through international initiatives such as CORDEX. These efforts have advanced the understanding of regional climate variability, adding value to CMIP global models, particularly in areas of complex topography, coastal areas and small islands, and in the representation of extremes.[9] Africa was selected as a focus in developing CORDEX with many African scientists engaged in the initiative.

The AR6 has focused on reporting information relevant to major regions of the globe and for the first time has provided a readily accessible Interactive Atlas for flexible spatial and temporal analyses of much of the observed and projected climate change information.[10]

The technical advances of CMIP6 act to reinforce the messages that were already emerging from previous assessments (Box 2). Confidence in the prediction of changed climate patterns and the attribution to human effects have increased, and it now appears that critical warming levels are likely to be reached earlier in the century than previously projected. **This is the AR6 Report's strongest message for adaptation. Both the need and the urgency to adapt are stronger than ever.**

Box 2: IPCC AR6 headlines statements

- Human influence on climate is now unequivocally established. Humans are the main drivers of climate change.
- Observation and modelling support each other very strongly.
- As global temperatures increase, so too will many other weather extremes.
- Global warming projections are a little higher than previously anticipated. From an adaptation planning point of view these changes are too small to matter much.
- The global temperature projections show that stabilisation or peaking at around 1.5°C can be achieved with a few scenarios, but these scenarios are at odds with the current emissions effort. More likely scenarios show that we must prepare for global warming approaching, or exceeding, 1.5°C by the 2030s, 2°C by 2050 and 3°C to 4°C by 2100 unless decisive global action is taken.[11]


Photo: Istock

Africa in the IPCC AR6 Report

Developing climate models for Africa has been difficult, partly because of its complex set of drivers, but also because past and recent meteorological observations are sparse throughout many parts of the continent.[12] However, since the previous IPCC Report (AR5) research based on and in Africa, the use of remotely sensed meteorological data to back up the sparse observational network has increased, allowing better modelling of Africa in AR6. An example of these new skills is the ability to clarify and attribute the direct human role in the Sahel drought of the 1970s and 1980s and the wetter period that followed. Since the 1950s, increasing aerosols emissions from Europe and North America cooled the North Atlantic, which suppressed Sahel rainfall for decades. The subsequent reduction in aerosol emissions through clean air policies then contributed to North Atlantic warming and recovery of Sahel rainfall.[13]

Africa's changing climate: observed trends and modelled projections

The bulk of the IPCC AR6 WGI report deals with the physical processes that determine changes in the climate system. Chapter 12 of the AR6 report makes the next step towards providing information for evaluating regional impacts and risk assessment. The IPCC AR6 WGII report, *Impacts, Adaptation and Vulnerability* due in February 2022, will take this much further by considering the interactions between the hazards identified in WGI and the wider set of factors, such as exposure, vulnerability, adaptive capacity, etc. Chapter 12 of the AR6 provides a global overview of 33 Climate Impact Drivers (e.g., extreme heat, river floods, aridity, sand & dust storms), and their effects by region.

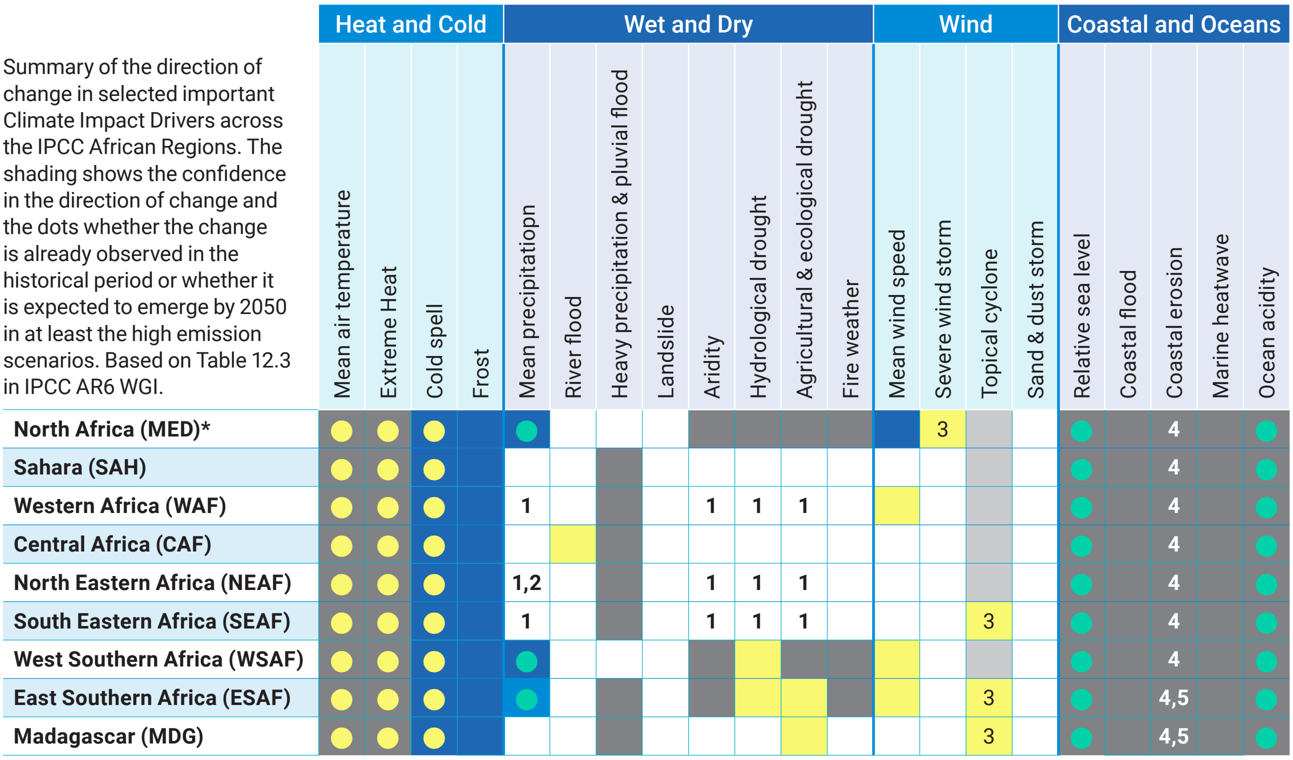
In keeping with the goal of AR6 to provide a greater regional focus there is a summary of the specific projections for nine regions covering the African continent and surrounding islands. The IPCC regions differ from the African Union's regions that are used throughout most of this report.

In the AR6 report each continent has a two-page fact sheet and concise summary graphic as presented here for Africa in Figure 5. This figure summarises for each Climate Impact Driver and by each subregion whether a change in the driver can be seen against the background variability, and whether it can be seen in observation data or whether it appears in modelling before or after 2050 (dot color). It also shows whether the associated hazard is increasing or decreasing (red or blue background shading) and the confidence in the conclusion (depth of shading). Figure 5 shows high confidence that changes in temperature drivers (grouped as Heat and Cold) are already observed to be consistently warmer across the continent, while moisture (wet and dry) and wind-related drivers are more varied by subregion, with many not yet showing a clear signal above the background variation. Annual precipitation is expected to decrease in North Africa and Southern Africa by 2050 even though such a trend is not yet clear in the observational data. Northern and southern Africa are expected to become more arid throughout this century, but in some parts of southern Africa aridity will be accompanied by an increase in heavy rainfall events possibly leading to floods.

Africa and its subregions are also covered in about eight pages of text (AR6 12.4.1), which is briefly and selectively summarised in Table 1.

Photo: Tonis Valing/Shutterstock

Figure 5: Climatic impact-drivers for different African regions



Already emerged in the historical period

Emerging by 2050 at least in Scenarios RCP8.5/SSP5-8.5

Both medium to high confidence

Key

High confidence of decrease

Medium confidence of decrease

Low confidence in direction of change

Medium confidence of increase

High confidence of increase

Not broadly relevant

1. Contrasted signal within region: drying in western portions and wetting in eastern
2. Likely increase over Ethiopian Highlands
3. Medium confidence of decrease in frequency but increase in intensity
4. Along sandy coasts and in the absence of additional sediment sink/sources or any physical barriers to shoreline retreat
5. Substantial parts of ESAF and MDG coasts are projected to prograde if rates of change of present-day ambient shorelines continue

* North Africa assessment is based upon the African portions of the Mediterranean Region
North Africa is not an official region of IPCC AR6, but the assessment here is based upon the African portions of the Mediterranean Region

Source: AR6 WGI (2021), Table 12.3

> **If we are to achieve this ambitious climate adaptation agenda, it is only through partnerships that we can strengthen and accelerate resilience across our continent."**

H.E. President Uhuru Kenyatta of Kenya
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Table 1: Summary of effects of increasing emissions on African climates

Temperature	
	Observed mean annual temperatures are increasing at 0.2°C to 0.5°C per decade.
	Under each of the major emissions scenarios assessed, a global temperature increase of 1.5°C over pre-industrial levels is likely to be exceeded in the next decade or so, and by mid-century all but the lowest emissions scenarios suggest temperature increases of 2°C or more.
	High-emissions scenarios suggest it is very likely that warming will exceed 3°C by 2100 except in Central Africa where the estimate is 2.5°C.
	Extreme heat—observations are limited, so no evidence of a recent increase. Modelling suggests days above 35°C will increase by 20 to 160 days depending on scenario and region.
	Life-threatening temperatures above 41°C are projected to increase by 10 to 140 days depending on scenario and region.
	Cooling degree days will increase and heating degree days will decrease.
Summary: Heat waves and heat stress to increase and drastically so in the worst scenarios	

Precipitation	
	The frequency and intensity of heavy precipitation events are projected to increase almost everywhere in Africa, leading to more flooding events.
	Observations are variable, but in many areas there is evidence of a drying trend especially in parts of North Africa, West Southern Africa and Central Africa. Models project that this trend will continue.
	River floods—observations suggest there has been some increase in recent decades. Model results vary with scenario and region, but they suggest that present 1 in 100-year floods could become as frequent as 1 in 40 years under low warming scenarios and 1 in 20 under higher warming.
	The West African Monsoon appears to shift later in season and rainfalls more intense and erratic.
Drought	Droughts are expected to increase in all regions of Africa except the northern parts of East Africa and the Horn of Africa.
Aridity	Observation and modelling suggest increasing aridity in North Africa, West and East Southern Africa, and in Madagascar.
Summary: Changes in total precipitation are small, but more rain is likely to fall in heavy rainfall events in most regions. But the effect of increased precipitation must also be considered alongside the prospect of increasing temperatures and evaporative demand. Thus, the overall picture is of drier conditions over most of the continent with more droughts but also more flooding.	

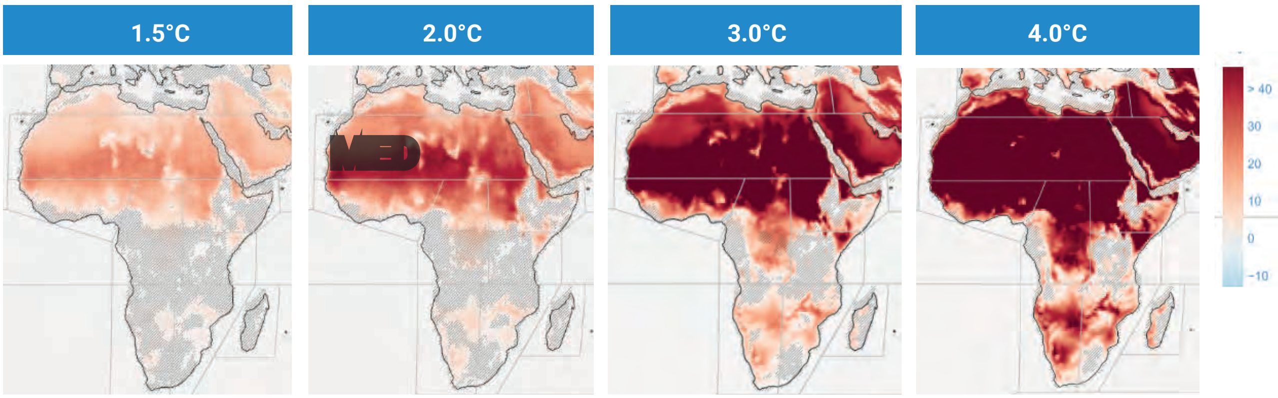
Coastal & Ocean	
	African sea levels are currently rising slightly faster than global average, although a little slower in parts of the Indian Ocean coast. They are virtually certain to continue rising by 0.4m to 0.5m by 2100 under low-warming scenarios and 0.8m to 0.9m under high-warming scenarios.
	Marine heat waves are expected to continue to increase in frequency and intensity, especially around the Horn of Africa.
Cyclones	Cyclones are possibly decreasing in frequency, but high-intensity events will become more common, often associated with very heavy rainfall.
Coastal flooding	Projections suggest that a current 1 in 100 year flooding event will become flooding events with a return period of 10 or 20 years by 2050, and a return period of 5 years to annually by 2100, even under moderate warming.
Fire weather	Likely to increase throughout extratropical Africa.
Dust storms	Evidence is uncertain due to confounding factors, especially changes in land cover and general uncertainty in detailed wind modelling. The whole topic impeded by lack of controlled observations.

Impacts by degrees

The Paris Agreement seeks to limit the global temperature increase in this century to 2°C above pre-industrial levels, while pursuing the means to limit the increase to 1.5°C. This agreement is core to the international mitigation and adaptation negotiations. Summaries such as Figure 5 and Table 1 are useful, but many will seek higher resolution and more nuanced projections of the impacts that may emerge from different global temperature increases. Projections of the impacts on human and natural systems will come mostly from AR6 WGII's report due in February 2022, and subsequent work. However, the WGI report provides a valuable tool to simplify access to the climate projections via its interactive Atlas.

This is demonstrated in Figure 6, which shows the occurrence of extremely hot days (temperatures exceeding 40°C) across Africa for different global warming levels (GWLs). Currently the hottest regions of Africa in the Sahara and north Africa average about 10 to 20 days per year of conditions approaching the safe limits to human activity outdoors. At GWLs of 2°C this will increase by 30 days in some areas. At 3°C parts of western Sahara will endure about 80 additional days per year; at 4°C this rises to 120 days per year in the worst-affected regions. These temperatures will limit the amount and efficiency of work outdoors not just in agriculture but also in construction, transport and tourism.

Figure 6: Increase in the number of days exceeding 4°C under increasing global warming levels



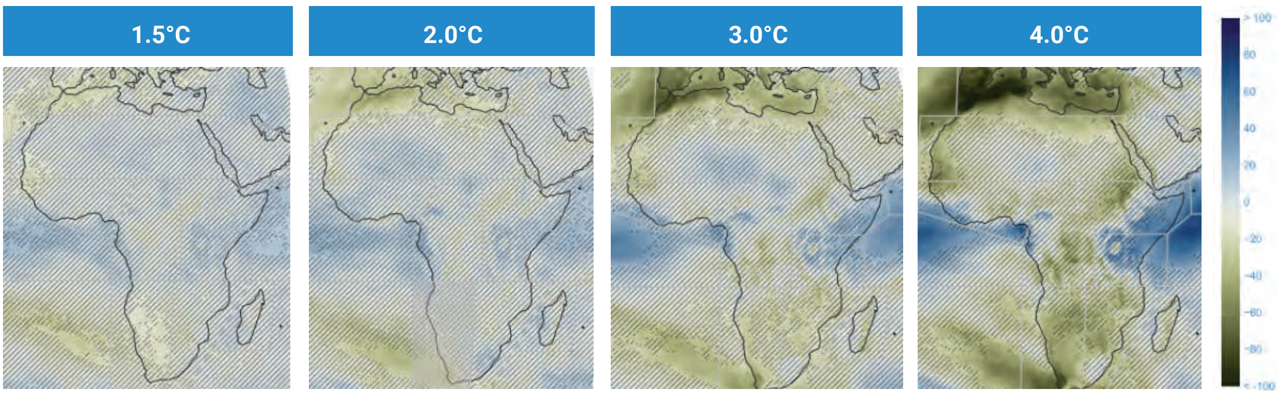
Source: IPCC AR6 WGI Atlas (2021) CORDEX Africa - Days with TX above 40°C (TX40) Change days - Warming 1.5 to 4.0°C RCP 8.5 (rel. to 1995–2014) - Annual (31 models)

Photo: Vadim Petrakov/Shutterstock

Figure 7 shows the long-term trend towards further aridity across much of Africa and the few areas that may become wetter. The Standardized Precipitation Index (SPI) is an index used globally for quantifying and reporting meteorological drought. Essentially it measures the deviation in precipitation from the long-term distribution of rainfall. It is an effective measure of precipitation excess or deficit and thus of meteorological drought. The continental scale projection of the percentage change in SPI can be used as a broad indicator of increasing dryness (brown in Figure 7a) or wetness (blue). Despite some disagreements between the models shown by the shading, as GWL increases areas of increased drought in North Africa, Western Sahara and South-western Africa emerge, as do areas of wetter conditions in northern East Africa and the Horn of Africa. The SPI is most likely an underestimation of increased aridity, as it does not consider the increasing effects of high temperatures on increased evapotranspiration, so agricultural and ecological droughts may be even more pronounced. Figure 7b highlights that even in regions of increasing dryness such as across Madagascar, Central and South-eastern Africa, heavy rainfall events, calculated as the maximum 5-day precipitation events, are also expected to increase, showing that these regions are likely to be subject to both increasing droughts and intermittent floods.

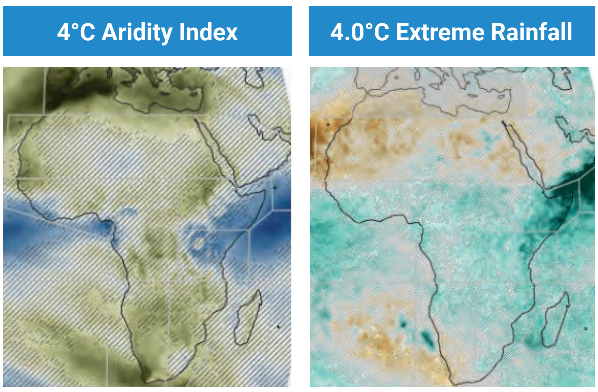
Figure 7a: Percentage change in the Standardized Precipitation Index (SPI-6).

Darker shading shows a shift towards drier conditions and blue to wetter conditions. The hatching shows that over most of the continent there is disagreement between the models.



Source: IPCC AR6 WGI Atlas (2021). CORDEX Africa - Standardized Precipitation Index (SPI-6) Change % - Warming 1.5 to 4.0°C RCP 8.5 (rel. to 1995–2014) - Annual (21 models)

Figure 7b: Some areas with increasing aridity will also be subject to increasing extreme rainfall events.



Source: IPCC AR6 WGI Atlas (2021). CORDEX Africa – Left, Standardized Precipitation Index (SPI-6) Change %; right Maximum 5-day precipitation (Rx5day) Change %. - Warming 4.0°C RCP 8.5 (rel. to 1995-2014) - Annual (20+ models)

Climate change attracts attention when some form of climate shock occurs, and the above figures show the projected trends towards extreme conditions. However, more subtle climate changes also threaten ecosystems and the people whose well-being depends on them. Small changes in weather patterns arising from climate change can gradually erode the productivity of food systems and cause losses of assets through events too small to attract global or even national attention. These changes affect people's well-being and can counter efforts to rise out of, or can push people back into, poverty, leading to millions of people never being able to escape from the threat of poverty.[14]

This report makes the case for supporting climate-informed development that increases poor peoples' resilience to a wide range of threats, as climate change so often acts as a magnifier of impacts. Thus, there is a need for social safety nets, risk-spreading mechanisms including subsidized insurance, and resilient infrastructure ranging from cyclone- or flood-resistant housing to resilient road systems. And there is a need for novel financial mechanisms to sustain these interventions (see Finance chapter for more details).

There is also a role for better information about climate. This includes not just changes in the medium (decadal) to long-term climate as is the focus of IPCC, but also risk information and early warning systems of imminent threats that do not just provide an alarm but facilitate risk-reducing behaviours.

Hydromet services

Effective action on climate adaptation and resilience is only possible with high-quality weather, climate, hydrological, and related environmental data ("hydromet" data). This data is collected in each country by national hydromet agencies. Data is, of course, not enough. In the end, what is required is for all stakeholders in society—governments, businesses, and citizens—to take appropriate action based on weather and climate information. For this to happen, the meteorological value chain shown in Figure 8[15] needs to have all components working effectively in a coordinated manner.

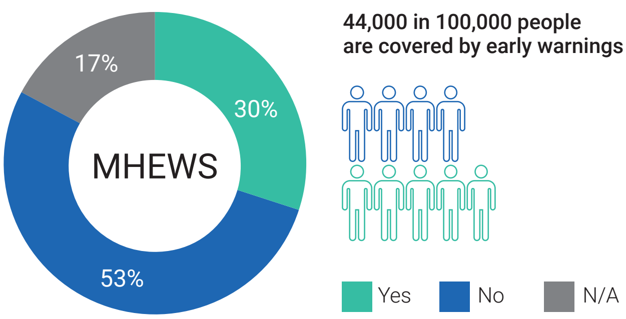
Figure 8: The Meteorological Value Chain

Source: WMO (2021) Hydromet Gap Report

Weather, water and climate observations are collected and exchanged internationally through the WMO Global Data Processing and Forecasting System. This information is used by national meteorological services and the private sector to generate local forecasts, warnings, seasonal outlooks, and other hydromet services. These products can then be used by different stakeholders to act, including on climate adaptation.

One essential product of this value chain is multi-hazard early warning systems. In Africa, the WMO collects data from its Members to evaluate gaps in these systems. Based on data submitted by 46 African countries (87 percent of the region), only 30 percent report having a fully-functioning, end-to-end, Multi-Hazard Early Warning System in place (Figure 9). In addition, only 11 percent of African countries are using the Common Alerting Protocol (CAP) which provides a single system to alert the public of any hazard using all available media. Without strong early warning systems, the ability of communities and societies to be prepared for climate shocks is limited.

Figure 9: Distribution of African countries that reported having a multi-hazard early warning system in place



Source: WMO (2020). 2020 State of Climate Services
Note: as a percentage of the total number of WMO Members in the region (53)

According to an estimate by the World Bank, if early warning systems in low- and middle-income countries were upgraded to European standards, lives lost could be halved and annual losses to assets of between US$ 300 million and US$ 2 billion avoided.[16] The Global Commission on Adaptation reports that a 24-hour advance warning of a coming storm or heatwave can reduce damages by 30 percent.[17] High-quality hydromet data has many other benefits, including economic productivity in key sectors from agriculture to logistics. Better historical hydromet data and projected climate changes are becoming more critical to mobilizing climate finance.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Strengthening the hydromet value chain

Finally, better hydromet data is essential for the insurance and finance sectors, as discussed in the Finance chapter. The Task Force on Climate-Related Financial Disclosures (TFCD) climate risk disclosure standards call for better hydromet data.

The collection of weather and climate observations in Africa is weak and deteriorating in recent years. The WMO estimates that in Small Island Developing States (SIDS) and Least Developed Countries (LDCs), only 300 stations achieve the international standard for data collection and sharing. About 2,000 new and/or rehabilitated stations (surface and upper air) would be needed to have adequate weather data collection.[18] Furthermore, over the last five years (January 2015 to January 2020), the number of upper-air observations dropped by almost half in Africa.[19] This foundational problem poses significant challenges for the rest of the hydromet chain.

The WMO and the Alliance for Hydromet Development have begun working on the above issues through the establishment of a Systematic Observation Financing Facility (SOFF).[20] SOFF aims to support all 67 LDCs and SIDS to achieve sustained compliance with the international standard to collect and share internationally surface weather observations. This target would result in a 28-fold increase of surface data and a 16-fold increase of upper-air data. The World Bank has estimated the benefits of this program to be US$ 5 billion per year, or a US$ 25 return for every dollar invested.[21]

In 2018, the Conference of the Parties called on WMO through its Global Framework for Climate Services (GFCS) to regularly report on the state of climate services with a view to *"facilitating the development and application of methodologies for assessing adaptation needs"*. The GFCS was established by the international community at the World Climate Conference-3 in 2009 to improve climate-related outcomes through the development and incorporation of science-based climate information into planning, policy and practice (see Box 3).

Several reports have been produced by WMO and a consortium of climate finance and United Nations organizations and other partners, focused on the top three adaptation priorities identified by Parties in their Nationally Determined Contributions to the Paris Agreement. [22, 23, 24]

A synthesis of the recommendations areas to be addressed for strengthening these systems and services, and for guiding investments, prepared for a forthcoming WMO contribution by the systematic observation community to the Paris Agreement Global Stocktake, includes the following:

- Systematic observation – The systematic observations that underpin climate services needed to support priority areas identified in Parties' NDCs remain inadequate.
- Systems integration – Operational exchange of data and products between the national, regional and global levels is essential for improving service delivery for country-level adaptation. Fit for purpose-financing is needed to enable data and

products to flow from countries to advanced data processing and forecasting centres and vice versa.

- Co-development of decision-support products and services – Increased interaction with stakeholders in climate sensitive sectors is needed to co-design, develop and deliver the tailored products and services that support improved user decisions leading to improved adaptation outcomes.
- Access to services – Data consistently show that "last mile" service delivery is insufficient to ensure widespread access to climate services, particularly in developing countries.
- Climate science basis – Climate action and associated investments should be based on the best available science. Methods and tools now available for this purpose should be upscaled on a widespread basis to promote adaptation effectiveness.
- Capacity data – Data on adaptive capacities in climate services is incomplete and the data that are available need to be quality assured as a basis for certification of climate services capacities.
- Overall investment levels and associated data – Adaptation finance for climate services remain inadequate, especially for meeting needs in LDCs and SIDS. More detailed data on financial allocations for hydro-met systems and services is needed to enable tracking of financing in relation to assessed gaps and needs.
- Documentation of socio-economic and environmental benefits of adaptation action – Although case studies suggest high returns on investments in climate services for adaptation, more systematic documentation of the benefits of adaptation actions and the resulting improvements in adaptation outcomes is needed to ensure that the measures being financed are cost-effective and that progress towards the global adaptation goal is being achieved.

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Box 3: The Global Framework for Climate Services (GFCS)

The GFCS was established by the international community at the World Climate Conference-3 in 2009. The GFCS seeks to accelerate and coordinate the implementation of technically and scientifically sound measures to improve climate-related outcomes through the development and incorporation of science-based climate information into planning, policy and practice. As a framework with broad participation and reach, GFCS enables the development and application of climate services to assist decision-making at all levels in support of addressing climate-related risks. The GFCS has five components, which span the value chain for weather, water and climate: (i) observations and monitoring; (ii) climate services information system; (iii) research, modelling and prediction; (iv) user interface platform; and (v) capacity development.

The GFCS currently focuses on developing and delivering services in five priority areas identified in the NDCs: agriculture and food security, disaster risk reduction, energy, health, and water.

At country level, GFCS implementation is guided by National Frameworks for Climate Services (NFCS)[22]. An NFCS is a multi-stakeholder stakeholder interface platform that enables the development and delivery of climate services at country level. NFCSs focus on improving co-production, tailoring, delivery and use of science-based climate predictions and services, focused on the five GFCS priority areas. NFCSs support NDCs and NAPs by providing climate services that help assess climate vulnerabilities, improve the understanding of climate and its impacts, identify adaptation options, and providing operational products that support decision-making in climate-sensitive sectors. NFCSs also provide a mechanism for the systematic monitoring and documentation of socio-economic benefits associated with the services provided.

The GFCS is now nearing the end of its initial 10-year implementation phase. The next phase of implementation will build on the foundation from the first phase, which has assisted 70 percent of countries for which data are available to provide climate services for adaptation at an essential, full, or advanced level according to WMO criteria. The next phase of the GFCS is expected to emphasize improved articulation of end-use demand, co-development of tailored products, and documentation of the socio-economic benefits of adaptation action, on the one hand, and strengthened operational systems on sub-regional scales to increase country access -- and capacity to add value -- to global and regional data and products needed to provide such services on the other.

Some of the foundational elements in this regard for the next phase include a country-driven focus on identification of national adaptation priorities based on NAPs and NDCs; identification of effective adaptation actions based on scientific evidence of past, present and projected future climate conditions; technical advisory services to ensure that investments in hydro-met systems and services are designed and implemented to international standards; quality management processes to certify specific services and capacity data and improvements; and continuous reporting to the international community on status, gaps and needs in the State of Climate Services reports.

The 'last mile'

All the above efforts will amount to little if the 'last mile' of communication of an early warning system (EWS) fails. Experience has led to the tenet that to be effective an EWS must be embedded in the local social processes. This leads to tensions between the essentially top-down, technologically driven approach described in the Meteorological Value Chain (Figure 8) and those responsible for bringing the efforts along the chain to fruition. The delivery of an early warning needs to consider who is the target of the communication, what options they have once they receive the warning (e.g., remove assets from a potential flood zone versus fleeing), the sequence of warnings that best enable and encourage people to act, and what sort of ongoing communication is necessary. Preparation at this level is as important as the other steps in the Meteorological Value Chain.

Some have suggested that the focus should not be on the last mile, but the 'first' mile, meaning that local communities need to be engaged from the beginning of the design of an EWS.[23] This requires that the circumstances of the target communities needs to be known (e.g., the strength of their housing in high winds; vulnerable crops and livestock; cultural norms that may affect responses, etc.) as well as their options such as access to shelter, whether stock can be moved to safer areas, etc. The Red Cross and Red Crescent is increasingly looking to link impact-based forecasting with early warning systems. Impact-based forecasting provides the information in terms meaningful to the recipient and designed to facilitate early action to reduce risks. For example, rather than stating that "a tropical cyclone of category 4 with winds of 170 km/hr is expected to strike within the region within the next 6 to 8 hours", the warning will also state "the winds are likely to be strong enough to de-roof all but the most compliant cyclone-resistant structures; and storm surges and river flooding will damage roads and bridges connecting X and Y, making transport between them impossible for several days." Impact-based forecasts and warnings should communicate a sequence of information that allows those at risk to make timely decisions to safeguard against the impact of forecasted extreme weather or climate events.

The challenge ahead

Climate variability and change are already affecting the lives and livelihoods of people across Africa, and as the planet warms, extreme weather will become increasingly likely across the continent. The recently released first volume of the IPCC Sixth Assessment suggests that it is becoming increasingly difficult to avoid reaching a global warming of 1.5°C above pre-industrial levels within the next decade or so and 2oC or more by mid-century. Even with the lower-emissions pathways, African climates are likely to be more erratic, with much of Africa becoming so hot that outdoor work and tourism will be threatened for some of the year. Droughts and floods already threaten livelihoods and trap people in poverty. Both are likely to increase in intensity and frequency in the future. Africa is particularly vulnerable to climate extremes, or even shifts in weather norms such as the start of the monsoon, as so much food production is dependent on rain-fed cropping and pastoralism. Infrastructure that supports the wider economy is also highly exposed to extreme events.

Adaptation is now more urgent and challenging than ever. This chapter has simply set the scene—where we stand now and the increasing climate challenges that are coming. The rest of this report begins to outline solutions to how we might effectively achieve continued climate-informed development for all of Africa.

"We have to insist that equal attention be paid to climate adaptation and mitigation in climate finance. Africa calls on the developed nations to shoulder the historic responsibility and to join the program to accelerate the adaptation in Africa."

H.E. President Ali Bongo Ondimba of Gabon, and Chair of the African Union-led Africa Adaptation Initiative
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021


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Photo: Anna Dunlop/Shutterstock

Scaling up the use of Modernized Climate Information and Early Warning Systems in Malawi

Geography: Malawi

Adaptation measures: This project worked to strengthen early warning and climate forecasting infrastructure and to build the capacity of Malawi's Department of Climate Change and Meteorological Services (DCCMS) to provide climate services (weather forecasts and local climate advisories) and disaster management training. It also implemented participatory planning processes among farmers to increase the reach of climate services.

Key outcomes: As of 2019, the project had improved the climate resilience of more than 420,000 people directly and 1.2 million people indirectly[24] through raising awareness, improved weather forecasts and access to information and trainings to integrate climate services into farm management, fishing and disaster response operations.

Partners and funding: UNDP in partnership with the Department of Disaster Management Affairs of Malawi (DoDMA), government line ministries, climate centers, the National Smallholder Farmers' Association of Malawi (NASFAM) and other CSOs and community level actors. 2017-2023. Green Climate Fund (US$12.2 million), Government of Malawi (co-financing US$ 2.1 million) and UNDP (co-financing US$ 1.8 million).

PROJECT SUMMARY

Malawi is a densely populated, landlocked country in southern Africa with one of the world's poorest economies (it came in 174th out of 189 countries on the Human Development Index for 2020),[25] and the vulnerability of the population has been further exacerbated by climate change. Floods and droughts pose a significant and recurring threat, with over 100,000 and 1.5 million (10 percent of the population) people affected on average every year, respectively.[26] Malawi has seen eight major droughts, affecting over 24 million people, in the last 36 years.[27]

Major flooding in the southern districts, driven by a one-in-500-year rainfall event, killed nearly 200 people, displaced more than 200,000 and caused more than US$400 million in damages in 2015. Compounding this, a drought in 2016/2017 in the southern and parts of the central region left more than 6 million people in need of food assistance, with damages over US$ 365 million and recovery costs of about US$ 500 million.[28] These recurrent climate disasters are particularly detrimental because agriculture—primarily smallholder subsistence farming—accounts for 40 percent of the country's GDP and makes up more than 85 percent of its total export earnings; and the threats are likely to increase in the coming years.

Mean temperatures in the region are expected to increase by 1-3°C by 2050, and although future overall rainfall trends are uncertain, the amount of rainfall during extreme events is expected to increase by 19 percent by 2090.[29] The success of efforts to alleviate food insecurity and poverty will be contingent upon the country's ability to address climate impacts and disasters through early warning systems (EWS) and strengthened disaster risk reduction (DRR) coordination mechanisms.

UNDP's M-CLIMES project was designed to provide tailored and context specific (demand-driven) climate services for vulnerable communities, including smallholder farmers, fishers and flood-prone communities. The project scales up climate information and EWS through the establishment of weather observation infrastructure (33 weather stations, eight lightning sensors, two lake-based water buoys and a data processing system). It also focused on capacity development, training seven Department of Climate Change and Meteorological Services (DCCMs) staff on installation and maintenance of infrastructure and data integration for improved forecasts and storm advisories, locally tailored advisories, a dissemination strategy based on complementary and tailored channels (mass media, SMS, extension services and lead farmers).[30] Finally, it aimed to improve last-mile access[31] and use of information through farm-level participatory management approaches.[32]

The scaling strategy for providing access to information was based on a training of trainers approach, building the capacity of lead farmers who, in turn, shared the information and skills they gained with other farmers. Lead farmers disseminated information about seasonal and short-term forecasts to more than 162,000 smallholder farmers to improve seasonal planning. A cadre of trainers was empowered to provide courses to 208 frontline disaster managers and 20 school staff in collaboration with the Malawi University of Science and Technology (MUST). Tailored climate information products and decision-support platforms for end-users were developed based on facilitated planning sessions between extension workers and farmers to identify the most needed responses which resulted in local advisories, including seasonal forecasts. Flood forecasts and water catchment information were provided in 13 districts; the project also strengthened the district climate information centers as hubs to promote learning, knowledge sharing and community-based early warning systems.

The project has improved the national coverage of weather-stations by 17.5 percent, capacities of NHMS to downscale seasonal forecasts at a resolution useful at district and sub-district levels and on translation of weather information into advisories and their dissemination at district and sub-district levels.

Participatory planning processes were scaled across ten districts by training 60 expert trainers and 264 extension workers (28 percent of them women) who, in turn, trained more than 16,000 lead farmers (53 percent of them women). Scaling was also achieved by translating capacity-building materials into local languages and through outreach and awareness campaigns using digital media resources like SMS, radio and television programs. More than 17,000 farmers received short-term forecasts through different SMS platforms. Tailored and cost-effective advisories (i.e. storm early warnings) were also issued to fish processors and fisheries. Overall, as of 2019, the project had increased the resilience and enhanced the livelihoods of more than 1.6 million[33] people.

The project also improved the enabling environment for climate services in several ways. Extension services' capacity to support communities and livelihoods was improved, increasing their social standing; coordination between institutions in translating weather information into local advisories for agriculture and fisheries was enhanced; and the efficiency of service delivery was improved through extension services and through the training of trainers and lead farmers. The integration of information communication technologies such as digital based advisories and smartphone apps, has been identified as an area for improvement.

Adaptation – What is it and how to measure it?

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A simple dictionary definition of adaptation is "the process of changing to fit some purpose or situation." After several decades of debate by researchers, practitioners and governments, the IPCC definition (Box 1) still reflects that dictionary definition. The IPCC definition is specific to climate change, it recognises that the driver of adaptation can come from experienced or anticipated climates, and that the process of adaptation must be deliberate in that it specifically seeks to moderate harm or exploit opportunities. The deliberateness was a recent addition to make it clearer that actions that do not specifically take climate change scenarios into account, such as generic efforts to promote good development or more productive agriculture, should not be claimed as adaptation activities, especially when accounting for money spent on adaptation.

Despite the relative clarity of what is meant by adaptation, it has taken decades for adaptation to become a fully integrated part of our approach to reducing the impacts of climate change. There are several reasons for this, but one that is often overlooked is that for a long period the scientific community misunderstood to need for adaptation.

Box 1: Definitions from IPCC AR5 WGII Glossary 2015

Adaptation - The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Vulnerability - The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Adaptive capacity - The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Resilience - The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Vulnerability index - A metric characterizing the vulnerability of a system to a change in climate. A vulnerability index is typically derived by combining, with or without weighting, several indicators assumed to represent hazards or physical impacts, exposure, sensitivity, resilience, or adaptive capacity.

In the early years of the twentieth century the Swedish scientist, Arrhenius,[34] was one of the first to conclude that continued emissions of carbon dioxide (CO2) would mean that in the centuries to come we would be living in a very different environment But he hoped to enjoy a future with *"more equitable and better climates … when the earth will bring forth much more abundant crops than at present"*.

This optimistic view of the impact of climate change persisted throughout much of the 20th century, gradually morphing in the latter half to recognising that more pleasant climes may not always await us, but still retaining the hope that natural and human systems could adapt sufficiently and largely autonomously, i.e. with minimal human action, as the climate changed. This was the basis for the Convention on Climate Change at the close of the century (UNFCCC 1992) that set mitigation targets to *"prevent dangerous anthropogenic interference with the climate system" and to be reached "within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner"*.

But views on adaptation were changing rapidly, partly driven by a better understanding summarised in the early IPCC Assessment Reports that adaptation needed to be proactive, and partly by pressure from developing countries for substantial support for the adaptation challenges that were being left to them to deal with. But in the pressures of the climate negotiations, some still feared that a discussion of adaptation was an implicit admission that mitigation efforts might fail, or that adaptation might for some countries provide a potential disincentive, or even a pretext for inaction, in pursuing mitigation.[35] Progress on implementing adaptation was also mired by the complexity of the technical discussions of how to describe the process of adaptation, and the lack of clear measures of effectiveness of actions and of progress in adaptation.

Depending on the debates of the time many different forms of adaptation have been described, such as pro-active and re-active adaptation depending on whether adaptation actions were stimulated by anticipation of a changing climate or by the experience of the unanticipated impacts of a climate event. Currently there is a focus on the need for more adaptation that goes beyond being simply incremental adjustments to better cope with climate change, but instead seeks transformations in our perception and paradigms about adaptation and profound changes in the structure of our institutions and livelihoods that will be necessary if we are to thrive in a radically changed world.

Much of the recent debate about adaptation has related to how to place adaptation within the well-established risk management framework and this has led to a confusing, and often confused, debate over terms and their meaning.

Climate change is one of many *hazards* faced by human communities; other hazards include natural events such as earthquakes and human actions such as conflict and malpractice. The challenge is to manage the consequences of a hazard to reduce the *risk* of damage and losses. Some of the consequences of climate change will come in the form of sudden onset shocks or disasters and others through slower, chronic changes in conditions that bring negative outcomes, and sometimes opportunities, to those exposed to them.

There are a series of concepts and terms used to describe the link from the occurrence of an hazardous event to the experiences of consequences. The risk of consequences is governed by the *likelihood* of a hazardous event occurring, the degree of *exposure* of people, their means of livelihood, assets and other objects of value (e.g. ancestral graves) to the hazard, and their vulnerability to negative consequences. Some items can be exposed but not sensitive to damage, such as a well-constructed dwelling in a cyclone, and some assets can be readily replaced (e.g. chickens more readily than a cow) or insured by some means depending on the *adaptive capacity* of those experiencing the hazard. Adaptive capacity is the ability to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

So there is a sequence of concepts leading from the likelihood of a hazard, through the exposure to that hazard, the sensitivity to damage and the adaptive capacity to prevent that damage becoming a loss with long term consequences. These concepts are grouped in various ways and sometimes new concepts introduced.

A core concept is *vulnerability*, which is the susceptibility to being adversely affected by a changing climate. Vulnerability was initially described as encompassing exposure, sensitivity and adaptive capacity, although now most prefer a formulation of adaptation based on risk management where exposure is a separate component of the risk function described above.[36] The term *resilience* is often treated as the obverse of vulnerability in the sense that it is the capacity to cope with, rather than be susceptible to, current and future hazardous events. However, there has been a long and continuing debate over the meaning of resilience in the wider context of complex systems.[37]

The concept of resilience usually includes the rider that resilience involves responding to hazards or shocks in a way that maintains the essential identity, structure and function of the original system. This is an apt goal in the original context of resilience in describing ecosystem stability, but is somewhat discordant when used in the context of now common goal of transformative adaptation which seeks more to disrupt than return to the status quo.

A goal of adaptation is to seek that the losses from the occurrence of an hazardous event are reduced to a tolerable level. But here two different schools of thought come into play. Initially most adaptation thinking was dominated by the impact-response model described above. It focusses on estimating the likelihood and intensity of an hazardous event (e.g. extreme heat), and the impact on assets (e.g. the reduction in crop yield) leading to the view that adaptation meant finding less vulnerable crops (i.e. more heat resistant crops). This is essentially a biophysical approach to vulnerability.

Another school of thought focusses more on the complex underlying causes of the vulnerability of individuals, households and communities. In the above example they start with the question did the farmers have access to resources to better protect their crops, such as emergency irrigation during the heatwave, and if not why not? Did those affected have access to different livelihoods and food sources? There is a greater focus on the social, economic, political and institutional factors that affect societies' sensitivity to climate impacts and their capacity to adapt. This reflects the increasing recognition of the importance of considering social vulnerability alongside biophysical vulnerability.

The challenge for the two schools is not to seek dominance over the other, because both approaches are needed to bring about an effective transition to societies that are adapted to changed climates. Social vulnerability is seeking to tackle the root causes of inadequate adaptation, including inequality, inclusion and voice, while biophysical vulnerability is more amenable with current governance and business norms. And that brings us to another challenge to progressing adaptation; namely the need for ways to measure adaptation effectiveness and progress.

The need for adaptation metrics

It has been often observed that adaptation has no baseline metric such as tonnes of green-house gas emissions as used for mitigation measurement and tracking. Nor is it likely that adaptation will ever have the equivalent of the flawed but much used proxy of GDP as a measure of economic and larger social advancement.[38]

Photo: Monkey Business Images/Shutterstock

However, modern management practices and international agreements require that we have some agreed upon measures to track performance and progress. Performance at adaptation project and program levels can be tracked within management-relevant time frames by reporting against inputs and outputs, especially if there is a strong Theory of Change that links inputs and outputs to adaptation outcomes.

Tracking progress in adaptation outcomes is more difficult as the process of adjustment leading to adaptation usually plays out over longer periods than are relevant to management feedback. They also take place against a highly variable background of a changing climate and ultimately face questions of counterfactuals and attribution.

The technical literature is replete with material discussing this problem. This literature includes frameworks for elaborate, and yet to be agreed upon, measurement systems. Others focus on who should choose the most appropriate measures. Should they be determined top-down to meet national and international monitoring requirements, or should they be chosen by those most affected by climate change.[39]

Leiter et al (2019)[40] provided some pragmatic advice to the Global Commission on Adaptation that included: start with the purpose of the measurement and not the metric; draw upon the experience from development indicators; and be prepared to use qualitative measures when necessary. Their paper, and others,[41] go on to identify the purposes for which metrics might be needed and the characteristics of a useful metric.

This State and Trends Report appears only a year before the first stocktake of mitigation and adaptation under the Paris Agreement. The goal is to assess every five years the overall progress towards the Paris goals; not necessarily by country in 2023 but by a system that can aggregate results across scales and contexts, assess collective progress and inform, update and enhance of national level actions.

The 2023 stocktake for adaptation will be very unlikely to use an agreed set of metrics. Most likely the UNFCCC will eventually adopt a mix of tracking outputs (such as NAPs and NDCs, among others). It could also could take an SDG approach by assessing how many countries reached defined goals in adaptation relevant metrics.[42,43]

Developing metrics will be a long journey and such journeys can only begin by taking some brave first steps. Here we take one such step by asking whether two often cited measures of progress in adaptation, one, a measure of impacts of climate change and, the other, a measure of vulnerability, have any capacity in measuring progress in adaptation. The first is a measure of the direct impacts on people from climate related disasters records[44] and the second is an often cited and used index of vulnerability. Data for each is available at national and often sub-national levels and annually for many decades in the past.

Despite the frequent citing of extreme disaster statistics as evidence of the need for adaptation a focus on extremes is not particularly informative for tracking progress (see Present and Projected Climate Risks chapter). Disasters are fortunately relatively rare and they are difficult to classify in terms of their intensity; for example not all category 4 cyclones are the same. Also, the reporting of the impact of a disaster is problematic. The number of deaths is even more stochastic than the occurrence of a particular hazard itself and fortunately the number of deaths is declining partly due to efforts to minimise them and partly due to changes in reporting. For example, very few people are now described as dying from a drought but instead deaths are attributed to more direct medical causes such as disease or malnutrition.

An alternative measure is the number of people affected by a disaster as within Africa 8,000 people are affected for every death by a disaster. This measure is also subject to variability in what is identified as affected. In a developing country 'affected' may mean the number of people injured or displaced from their damaged homes, while a developed country may report as affected the number of people without electricity for more than 24 hours after a wind storm.

Here it is important to ask whether sets of African countries grouped by income or by region show any potentially meaningful change in the impact of disasters (Fig 1 a&b). The results suggest that by pooling information over 5-year periods and averaging across all the countries within a group may offer some value as a metric. Pooling countries across cross all of Africa suggest that the impacts of climate related disasters has been falling for at least the past two decades. This may also be true across the 23 low income countries (LICs). The 22 lower middle income countries (LMICs) have a smaller portion of their population affected by disasters, but there is no apparent trend over the past two decades. There are only a few upper middle and high income countries (6 and 1 respectively) and they show very variable results.

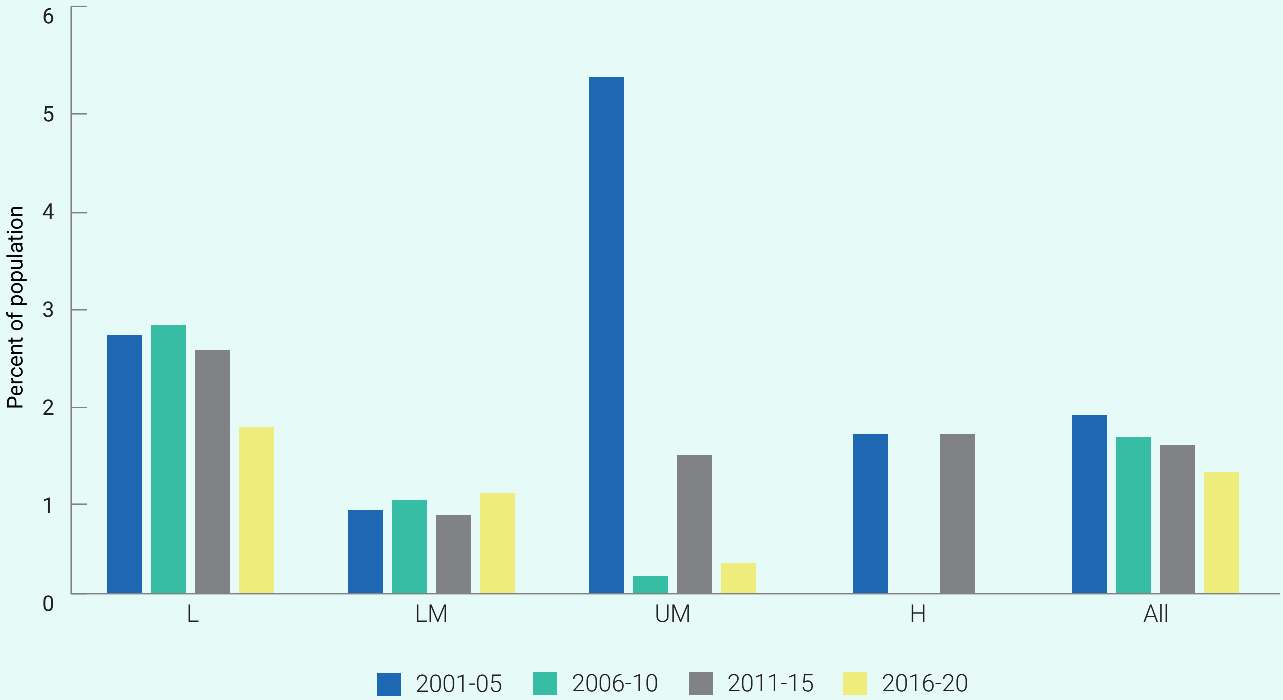
When grouped by regions the results are less clear, possibly because some climate disaster events have a wide spatial spread and affect multiple countries within a region leading to high stochasticity.

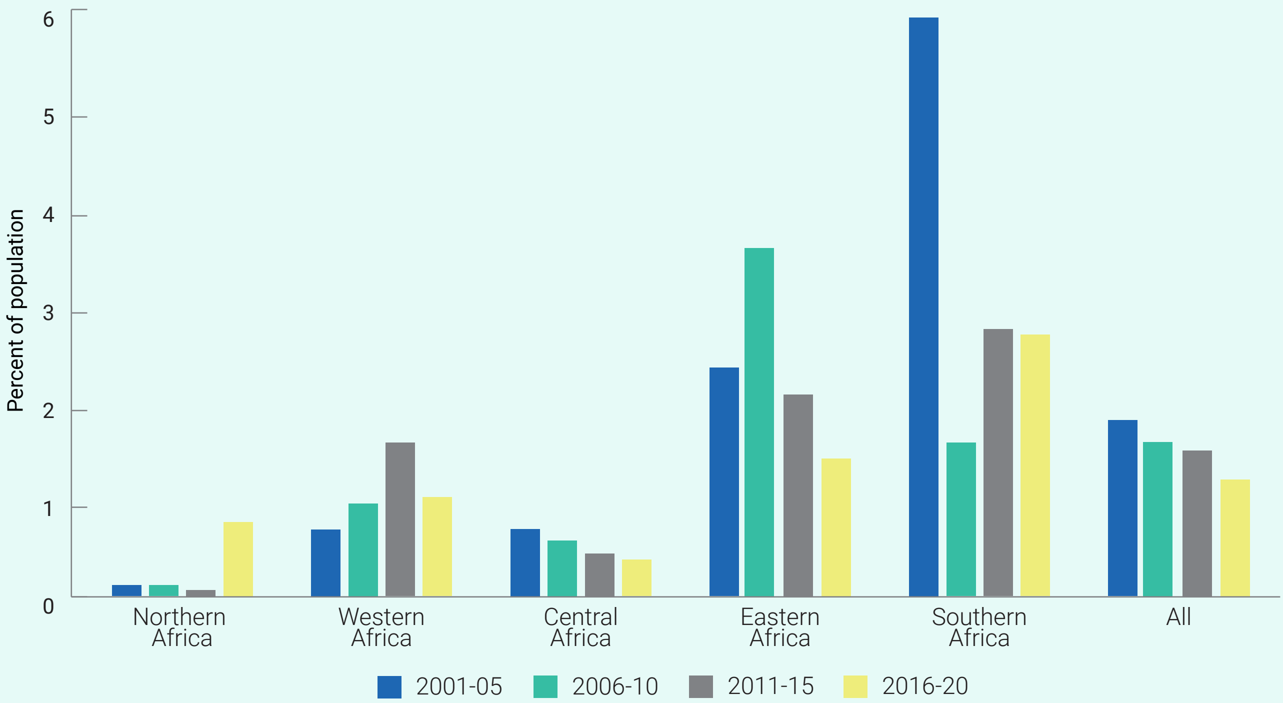
It is not suggested here that this type of disaster-related metric should be used for monitoring, but this first step does raise some interesting questions. Does the difference between LIC and LMIC countries reflect the observation that LICs attract more support for disaster management and hence their improvement, while LMICs find it more difficult to attract support and do not show improvement? Does the approach provide similar interesting information in other regions?

An even more important criticism is that climate hazards are only partially experienced as disasters. To many people, it is the increasingly erratic seasons, or the hotter summer days making work in a field or a factory ever more exhausting etc. that make livelihoods unproductive or even unsustainable. We

Photo: Vadim Petrakov/Shutterstock

Figure 1a & b: Percentage of people affected by disasters averaged per group over 5-year periods based on the CRED EM-DAT database. In the upper graph the income groups are L = Low Income Countries (23 countries); LM = Lower Middle Income (22); UM = Upper Middle Income (6) and H = High Income countries (1) all based on current income rankings. 'All' refers to all 52 African countries for which data are available.





can capture statistics on these types of impacts through household and business surveys, and even track households being pushed back into poverty.[45] This is a promising line of research, but it is resources-intensive and much of the effort is piecemeal.

The second faltering step we take is to perform a similar analyses with the ND-GAIN index.[46] It brings together 45 different indicators, similar to the SDG indicators, to represent two components; a measure of a country's vulnerability to climate change and a measure of a country's readiness to absorb funding and resources to reduce its vulnerability. The index has been used in many reports, especially as a measure of vulnerability of countries. It has also found use in the business community as a measure of readiness.

The ND-GAIN analysis finds that vulnerability is falling across the continent as a whole and in most income and regional groups. This is good news for Africa and also surprising as one of the criticisms of the vulnerability component during the development of the ND-GAIN index was that it was relatively unresponsive.

The analysis also confirms the well-known finding that readiness increases with income level, but the LICs and LMICs are declining in readiness as are all regions except Western Africa (Fig 1c). Maybe this is a shortcoming of the index or it may reflect part of the decline of several important developmental measures within Africa as reported elsewhere in this Report. It begs further analysis.

The purpose of these analyses is not to suggest that these metrics are the best we can find for assessing progress in the stocktake. Further analysis of their detail or their application to other regions of the globe may uncover more insights or greater inadequacies. Instead, the analyses are presented as a challenge to all within this field to move on from debating the ideal solution to taking those first steps on the path to solutions.

Figure 1c: Changes in the ND-GAIN Readiness metric averaged across countries within each of the African Union's regions.

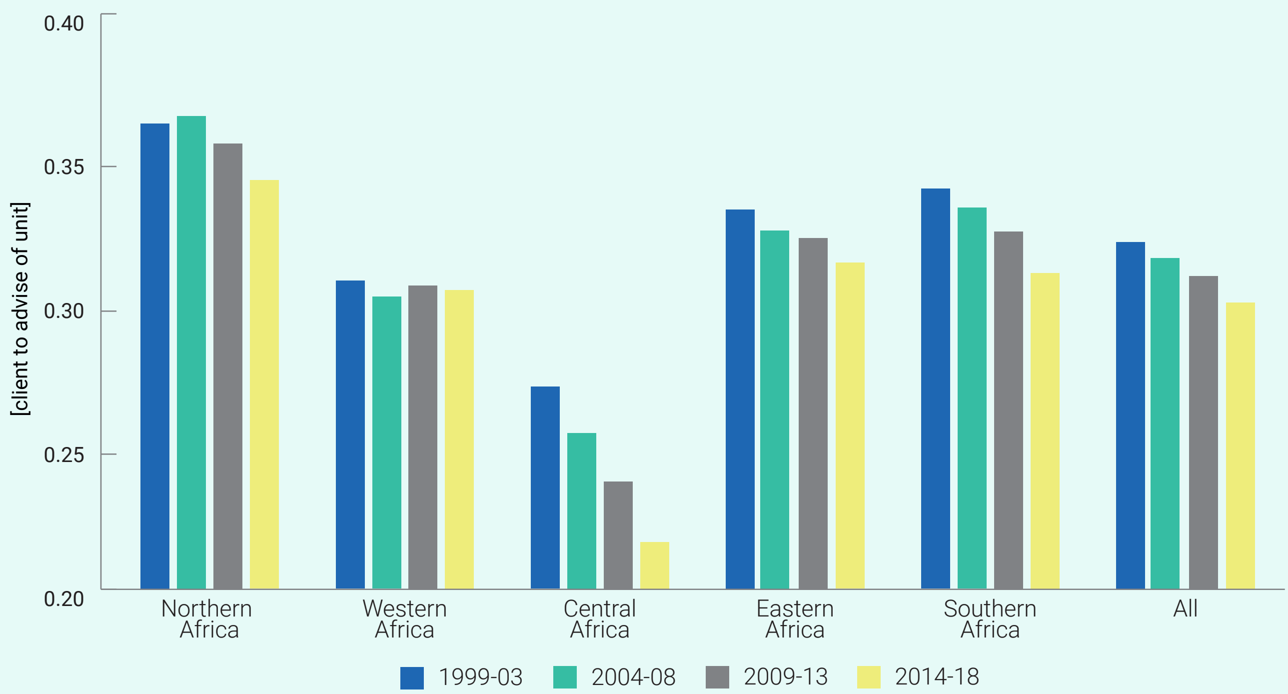



Photo: Piyaset/Shutterstock

Reaching the most vulnerable through weather advisories in Tanzania

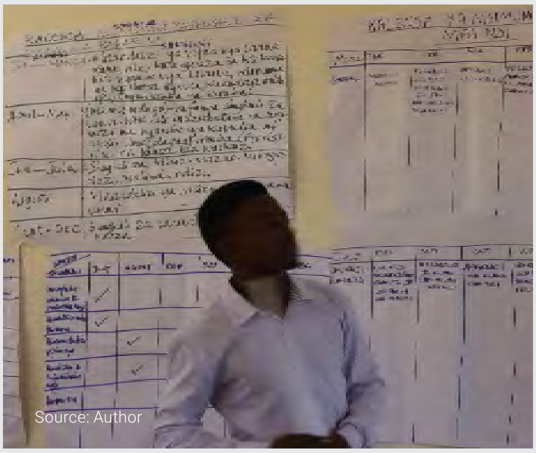
Climate Action Network Tanzania

Year after year, season after season, smallholder farmers, pastoralists, and fisherfolks in Tanzania work hard to increase productivity in livelihoods that are extremely climate-vulnerable, with no significant improvements. Their efforts are stymied by extreme weather events – especially prolonged droughts and severe floods – in addition to poor soil fertility, limited markets, poor access to technologies, and limited farm extension services. The result is increased vulnerability, poverty, and food insecurity.

In 2017, Climate Action Network Tanzania (CANTZ), a network of 50 non-government organizations (NGOs) working on climate change and renewable energy, initiated a project funded by Bread for the World to support communities in Chalinze, Lushoto, and Pangani districts through the provision of weather and climate advisories, to enable them to make informed decisions and improve their livelihoods.

The project aims to ensure access, integration, and utilization of downscaled and locally-relevant weather and climate services, including seasonal forecasts and advisories, by farmers, pastoralists, and fisherfolk, to help them adapt to climate change. Training is provided to intermediaries and extension agents, including local NGOs; farmer, pastoralist, and fisherfolk associations; and village leaders on the importance of integrating weather and climate information into livelihood decisions. The phone numbers of trainees are shared with the Tanzania Meteorological Authority (TMA), which uses them to send out weather forecasts and advisories. The intermediaries, in turn, train more farmers, pastoralists and fisherfolk, increasing the reach of the services.

Trainings of trainers


Source: Author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Information is disseminated through SMS, WhatsApp groups, radio, local governments, community-based organizations, farmer groups, village assemblies, and, to a limited extent, with direct contact with CANTZ and TMA. The project has also motivated end users without access to electricity, such as Maasai pastoralists and fisherfolk, to get access to renewable energy to charge their phones and radios, so they can receive the advisories. This has helped the project reach remote communities and sparsely populated areas who have no access to the grid. Over 2,000 stakeholders were trained as of September 2021, and registered to receive the advisories.

Once the information is received, intermediaries and end users work together to interpret it, and facilitate decisions on what type of crops to grow and when; how many cattle to keep and where to go for pasture and water; and when and where to

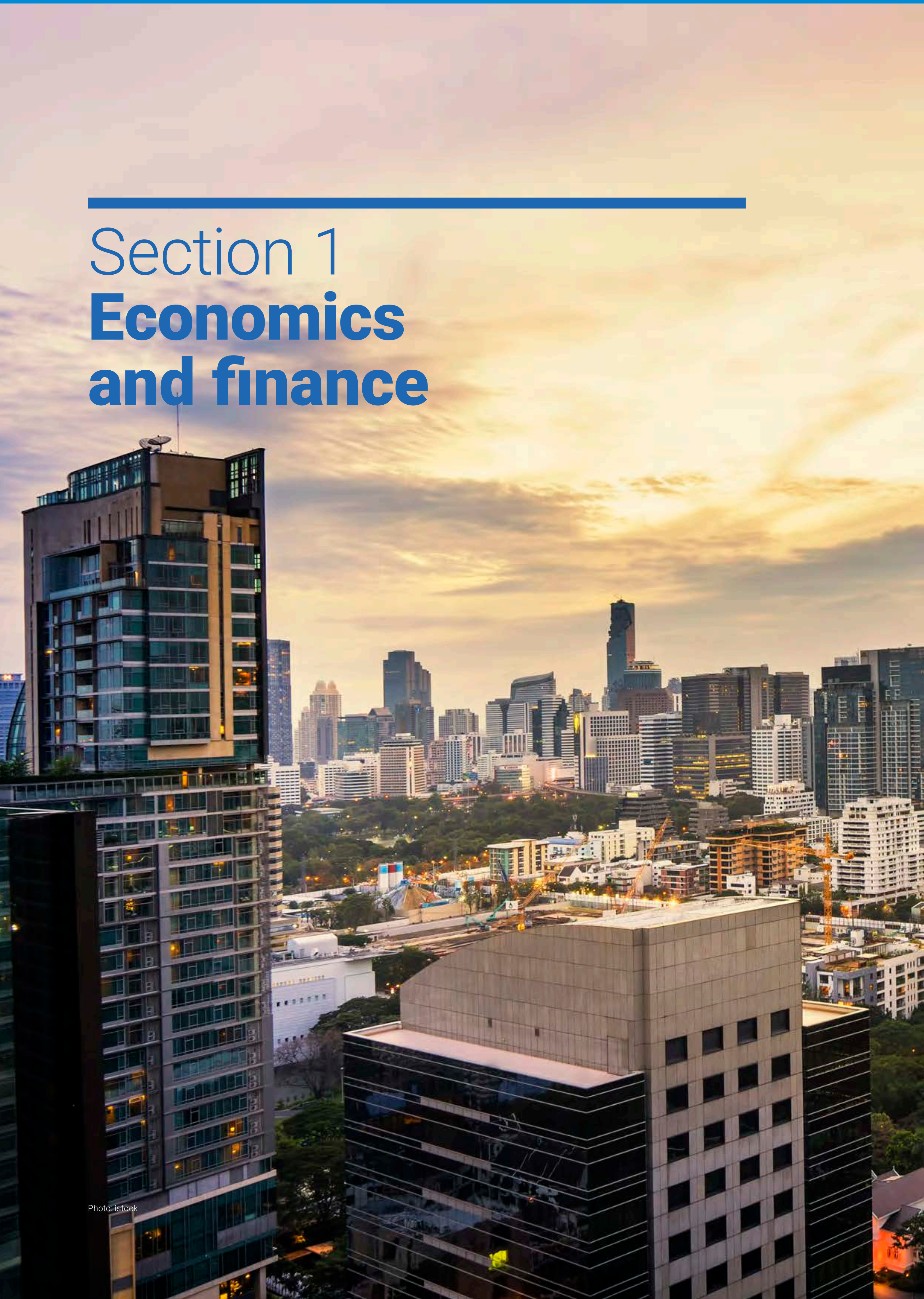
A fisherman enjoying a fish catch at Ushongo village in Pangani district

go for fishing, to avoid strong wind and storms. The fishing community in Pangani, for instance, combines the information they receive with indigenous knowledge to decide where to go for certain types of fish. In Kihangaiko village, in Chalinze district, the information service has helped reduce long-standing conflicts between pastoralists and farmers during the dry season, and reduce the losses suffered by pastoralists. The project also trains farmers and pastoralists on how to select drought resistance breeds; implement soil and water management practices; manage livestock; diversify livelihoods; and make budgets and keep records.[47]

The success of the interventions is due to the trust built over time between the providers and recipients of information, the timely delivery of information, just before the start of the growing season, when it is most needed; and the close collaboration with local knowledge providers. Meetings between TMA and CANTZ staff, local NGOs, local media, district, ward and village extension workers, village leaders, and women groups are held before the start of the growing season, to discuss and interpret seasonal forecasts. These meetings, which allow room for discussion and mutual learning between forecasters, intermediaries, and end users, are followed by smaller group meetings to tailor the information further to local needs, and to decide the dissemination strategy.

The project demonstrates the close collaboration and trust that is necessary between researchers, meteorologists, extension agents, farmers, pastoralists, fisherfolks and other end users to deliver meaningful weather and climate advisories to the most vulnerable. To sustain such efforts, institutional frameworks, from the national to community levels, are necessary. Future plans aim to target the delivery of advisories for the harvest and post-harvest seasons.

Section 1
Economics and finance



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Macroeconomics and Climate Adaptation

KEY MESSAGES

- **Even if the Paris Climate Agreement goals are achieved, the economic costs of climate change in Africa are projected to be large. It is likely that Africa will experience higher relative impacts (as a percentage of GDP) than most other world regions,** even though it is less responsible (whether historically or in the present day) for global greenhouse gas emissions than other major regions of the world. If the Paris Climate Agreement goals are missed, the economic costs will be very significant in Africa, and potentially catastrophic in some sub-regions. It is likely that these impacts will be unevenly distributed within countries, affecting the vulnerable the most.
- **Climate change will affect near-term development and poverty reduction, as well as long-term growth for the continent.** Most analyses show significant economic costs over the next few decades (i.e., several percent of GDP per year), rising significantly for high-warming scenarios in the longer term (to more than 5 percent and plausibly more than 10 percent for some countries).
- **Climate change is a major macroeconomic risk and is likely to affect the public finances of most African countries.** Recent findings indicate that climate change could reduce the sovereign

credit ratings of African countries, increasing the cost of borrowing/cost of capital. It could also increase the level of uninsured assets and contingent liabilities, and negatively affect foreign investment. The impacts of climate change on public finances, combined with the need to finance adaptation, could add pressure to debt levels in Africa. Financial market anticipation of these various impacts could bring forward climate-related economic costs in Africa.

- **The level of climate change in Africa in the next 20 years is already locked in, and these impacts can only be reduced with adaptation. Africa needs to scale up adaptation now.**

More positively, adaptation can reduce the near-term economic costs of climate change very cost-effectively, and many early interventions have high benefit-to-cost (BCR) ratios. The existing estimate shows that BCRs are mostly above 2:1 (i.e., a dollar invested generates double this in terms of economic benefits), and often above 5:1. Furthermore, many adaptation measures have important environmental co-benefits, and some can address other drivers of vulnerability in terms of poverty reduction, especially in low-income countries.

INTRODUCTION

While Africa has enjoyed high levels of economic growth over the last decade, it still experiences high economic losses from climate-related variability and extreme events, such as major floods, droughts and storms.[1] In fact, it is the region with the highest vulnerability to such events globally.[2] These events have major macroeconomic consequences. Several studies have found that climate shocks reduce economic (GDP) growth,[3,4,5] especially for low-income countries. To put this another way, the strong growth rates experienced in Africa over the last decade would have been even higher if climate shocks had been better managed; a failure to manage these events has led to foregone growth. While current climate-related extremes are often the result of natural climate variability, there is strong evidence that these events are increasing,[6,7] and that climate change is playing an increasing role in extreme event frequency and/or intensity, as reported in recent attribution analyses in Africa for major droughts.[8,9]Africa already has a large existing adaptation deficit.[10]

Looking to the future, climate change will exacerbate these existing impacts, and create new risks even in the near term. In the long term, it will lead to potentially very high future economic costs, though the level of these impacts will depend on global mitigation agreements and their implementation. The Paris Agreement of 2015[11] set the goal of limiting average global temperature rise to well below 2°C above pre-industrial levels and of pursuing efforts to limit it to 1.5°C. However, greenhouse gas emissions (GHG) are still increasing globally, and recent analysis indicates the world is not on track to achieve the Paris goals.[12,13,14] More positively, international action on climate mitigation is gathering pace. A series of recent announcements indicate greater global ambition on mitigation, with countries committing to achieving net-zero emissions goals by mid-century. This will help limit future warming, though net-zero goals have not yet been translated into announced policy action internationally.

This chapter provides a deep dive into the economics of climate change impacts in Africa. It presents the findings of recent analyses on the potential economic costs of climate change in Africa, as well as recent evidence on the potential macroeconomic risks of climate change. The chapter then considers the potential economic benefits of adaptation, and summarises the potential costs and benefits of adaptation interventions in Africa. Based on this analysis, it provides a number of key messages and policy recommendations.

The Economic Costs of Climate Change in Africa

There is a small but established literature on the economic costs of climate change, going back several decades. This uses models to estimate the potential economic costs of climate change, either as aggregate values (an equivalent percentage of GDP) or as a social cost of carbon (the marginal cost of a tonne of additional carbon emitted, i.e., $/tCO2). The earlier analyses[15] used a small subset of models to generate these estimates. In recent years, the number of models and approaches has expanded (see Box 1). This provides a larger evidence base to sample, but it has also increased the range of values reported.

This chapter reviews the latest analytical estimates in the academic and grey literature on the aggregate economic costs of climate change in Africa, covering global, regional and country studies.[16] It is stressed that assessing the impacts of climate change on societal welfare (the economic cost[17]) is extremely challenging, as discussed in Box 1. Any estimates can only be considered indicative and should be treated with caution.

"The dangerous divergence in economic fortunes between the rich and the poor, in countries and across the globe ... is the most important race to win because only when we come together as people we can fight the climate crisis. This requires the wealthy countries to fulfil their pledge of $100 billion per year, it requires adaptation to be put on equal footing with mitigation as we fund action, and it requires all of us to do our part."

Kristalina Georgieva, Managing Director, International Monetary Fund
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

The challenges involved, and the wide range of reported values, make it very difficult to report central estimates of the future economic costs in Africa with confidence. However, there are many common insights that these various studies provide, and our analysis based on an extensive literature review identifies **robust findings from the evidence.** These findings are presented on page 37.

Box 1: Modelling the Economic Costs of Climate Change

Photo: fivepointsix/iStock

Estimating the economic costs of climate change is difficult. This is because of the complexity of trying to assess and monetize the impacts of climate change for multiple hazards (both slow-onset factors and changes in the frequency and intensity of extreme events), for all sectors (market and non-market), and for all countries globally, over long timespans. These challenges are compounded by high uncertainty, firstly over future emission scenarios and mitigation levels, and secondly from the climate modeling projections, as the climate response to any given emission scenario varies significantly across different models. Beyond this, there are challenges and uncertainties in estimating the physical impacts (including damage functions) of climate change, and in the valuation of these changes, as well as the impacts on the economy including feedbacks. This is compounded by other changing factors (notably socioeconomic change) which affect vulnerability and adaptive capacity, and can increase (or decrease) climate impacts.

Most of the earlier literature on the economic costs of climate change was produced by a small number of Integrated Assessment Models (IAMs). More recently, additional approaches have been developed, which include the use of computable general equilibrium (CGE) models and econometric (statistical) studies. This has led to more studies, but it has also increased the range of published estimates. The reasons for the large differences are partly due to the methods used. They also vary due to the inputs used (e.g., scenarios and climate model projections) and the coverage of impacts.

It is emphasized that all studies are partial, in that they include only a subset of the economic costs of climate change. There are also differences in the model outputs, because of the nature of the models used. For example, some studies (econometric and CGE models) only include market damages, while others, such as IAMs, include some non-market impacts (health, ecosystems). A further issue is the lack of empirical evidence on climate change impacts and economic costs at higher temperatures, and thus whether there will be a step-change in impacts. There is also a further set of potential risks from the risk of large-scale, non-linear global discontinuities, often called tipping points.[18] The inclusion of these events gives greater weight to ambitious mitigation scenarios.

Finally, the results of any study are affected by the assumptions made. This includes aggregating assumptions, notably on whether and how to add up or adjust effects in different regions and time periods, including positive and negative values, and for risk and equity/inequality aversion. When expressing economic costs as a social cost of carbon or in present value terms, there is a further issue around the appropriate discount rate to use.

Photo: Fearless on Four Wheels/iStock

Even if the Paris Agreement Goals are achieved, the economic costs of climate change in Africa are likely to be very high, and impacts in Africa are projected to be greater (as a percentage of GDP) than in other world regions.

We find that recent modeling studies generally report higher economic costs from climate change than earlier studies, including for the impacts in Africa. The early literature, as summarised in several reviews,[19,20,21] generally reports low economic costs from climate change, with a 1 to 2 percent welfare-equivalent income loss globally, expressed as a percentage of income, for 2–3°C of warming. These estimates were primarily based on IAM results.

Studies undertaken since the IPCC AR5 (2014) generally report much higher estimates of the economic costs of climate change at the global level, particularly in Africa. This reflects more negative findings in the climate science (e.g., higher levels of sea-level rise as projected in the IPCC SROCC[22]), as well as the greater coverage of climate impacts, including extreme events. These higher values are seen in updates to existing IAMs,[23,24] as well as studies that update the functions in Integrated Assessment Models.[25] Higher costs are also often reported by alternative modelling approaches, with generally higher values from computable general equilibrium (CGE) models[26] and from econometric studies that consider the effects of climate change impacts on growth rates as well as output, noting that these studies can lead to higher long-term impacts because of compounding effects over time.[27,28,29]

A second robust finding that emerges from our work is that the relative distribution of climate change impacts will not occur evenly across the world. The absolute costs of climate change are influenced by the size of regional and national economies, and thus the proportion of global total damages in Africa is low. However, the relative cost of climate change reveals a different picture. All studies project much higher relative economic impacts in Africa and Asia, as a percentage of GDP, than in other world regions. For example, the OECD analysis reports that the relative economic costs of climate change in sub-Saharan Africa could be double the global average. Other studies find even higher ratios than this for Africa.[30,31] The reason for this is that Africa, and especially the Least Developed Countries in the continent, are particularly affected by climate change in relative terms[32] as they have climate-sensitive economies (with agriculture being a more important sector), they are often close to climate thresholds (e.g., for outdoor labor productivity efficiency or crop tolerance levels), and they have lower adaptive capacity.[33]

This means that even if the Paris Goals are achieved, the economic costs of climate change in Africa are projected to be large, and it is likely that **Africa will experience higher relative impacts than most other world regions, even though it is the least responsible for global GHG emissions.** If the Paris goals are not met, then the economic costs in Africa could be extremely large and climate change will fundamentally affect development and growth objectives for the African continent.

Our GCA analysis finds that there is less consensus on the exact size of the economic costs of climate change in Africa and on which regions and specific countries in Africa will be most affected, though most studies report significant economic costs over the next few decades (at several percent of GDP per year), rising significantly (to more than 5 percent and plausibly more than 10 percent for some countries) for high-warming scenarios in the longer term.

There are now a reasonable number of global, regional and national studies that present results for the economic costs of climate change in Africa. Our review finds that they report a very wide range of results. This range is influenced by the future scenarios, i.e., whether the world is on a 2°C or 4°C pathway by the end of the century relative to pre-industrial temperature levels (captured by consideration of different Representative Concentration Pathways or RCPs). They also vary with the climate model projections for a given scenario, i.e., across the ensemble of climate model projections. There are also major differences in which sectors and impacts are included, including market and non-market sectors, and whether wider economic effects (e.g. trade) are included. Because of this wide variation in results and the parameters of coverage of different studies, it is not possible to present definitive results, at least with confidence (see Box 2). Nonetheless, useful insights do emerge from our review.

Box 2. Estimates of the Economic Costs of Climate Change in Africa from the Literature

Photo: mtcurado/istock

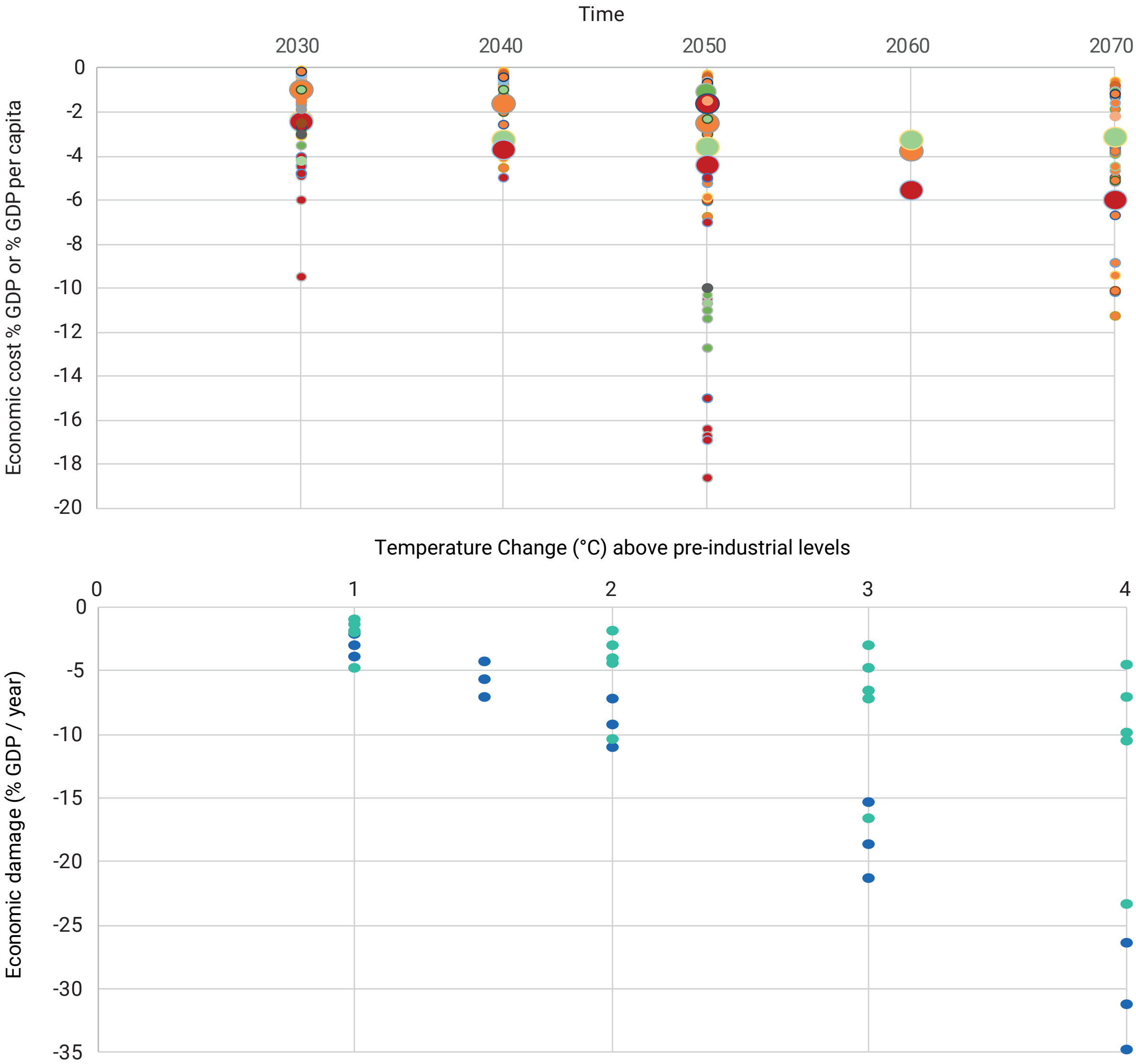
As highlighted in the main text, there is a wide range of reported values in the literature on the economic costs of climate change globally and in Africa. These are reported in a forthcoming Supplementary Research Paper. These reflect the scenarios considered, i.e., low- or high-emission pathways, the sectors and impacts considered, and the type of study or model used (for example, integrated assessment, CGEs, or econometric studies). There is also a wide range of values from the consideration of uncertainty, whether from climate model projections, impact assumptions, or monetary valuation. Summary values can be presented in terms of the impact over time (for different scenarios, e.g., RCP2.6, RCP4.5) or for different global warming levels (e.g., 2°C, 3°C) though as results are normally the sum of climate and socioeconomic change, it is stressed that time matters.

A consideration of different studies provides an illustration of the size of reported estimates. Many integrated assessment models estimate lower values. For example, De Bruin and Ayuba (2020)[34] report damages in Africa of 1.1% to 1.6% of GDP per year by 2050, and 0.6% to 2.8% by 2100, for RCP2.6 and RCP8.5 scenarios respectively. Many CGE studies report higher values than these. For example, the Bosello et al., (2021) estimates GDP losses for Africa of 3%, 4.5% and 6% per year for RCPs 2.6, 4.5 and 6.0 respectively by 2060. Kompas et al. (2018)[35] report values for a selection of African countries at between 0.3% and 6.7% by 2050 for a 3°C scenario per year, rising to 0.6% to 11% of GDP by 2070, but also report much higher damages for 4°C outcomes, especially for African LDCs (up to 27% of GDP). Many econometric studies present high estimates. AfDB (2019)[36] and Baarsch et al. (2020)[37] estimate losses at 0.6% to 3.6% of per capita GDP even by 2030, rising to 5% to 10% by 2050 for low- and high-warming scenarios, and report that some of the most affected countries in Africa could lose up to 15% of GDP by 2050. However, Kahn et al. (2019)[38] report lower values, with estimates of 0.1% to 4.2 % loss of GDP per capita for individual African countries in an RCP8.5 scenario in 2050, rising to 0.2% to 12.6 % by 2100, but lower and even positive values for RCP2.6.

A selection of recent results are presented in the figure below. Mostly, they indicate important economic costs in Africa in the short term (e.g. 1–5 percent of GDP per year), but rising significantly over later decades, especially for high-warming scenarios[39] (to more than 5 percent and in some studies and countries to more than 10 percent per year). Under the latter high-warming pathways, the economic costs projected from many studies would have extremely severe consequences in Africa.

There are also large differences in the relative impacts projected in different regions and countries in Africa, which means it is unclear where economic costs will be greatest. For example, Kompas et al. (2018)[40] identify highest economic costs as a percentage of GDP in western Africa; Baasch et al. (2020) identify the highest impacts in western and eastern African countries; ADAPTCost (2010)[41] in northern Africa; and Kahn et al. (2019)[42] in southern Africa. These differences often emerge from different methods (e.g., econometric versus IAMs), and depend in part on the sectors covered (e.g., econometric studies omit sea-level rise). The studies also show different relative impacts by sector. Some studies show highest impacts for the coastal impacts, others for health, and others for agriculture. It is also worth noting that study results also vary with the consideration of socioeconomic scenarios,

Figures 1 and 2: Selection of economic study findings over time for increasing temperature levels for regions and countries in Africa



Source: Authors

Data shown are from a series of recent studies, for low (green), medium (orange) and high (red) warming scenarios, including World Bank (2010),[43] OECD (2015),[44] Kompas et al. (2018),[45] Baarsch et al. (2020),[46] AfDB (2020),[47] Bosello et al., (2021),[48] De Bruin et al. (2020),[49] and include regional studies for Africa and country studies. Small circles represent country studies, large circles represent regional studies. Studies are plotted on the same scale, but they report slightly different metrics (e.g., % of GDP, gross damages [including non-market impacts] as an equivalent % of GDP, % GDP per capita).

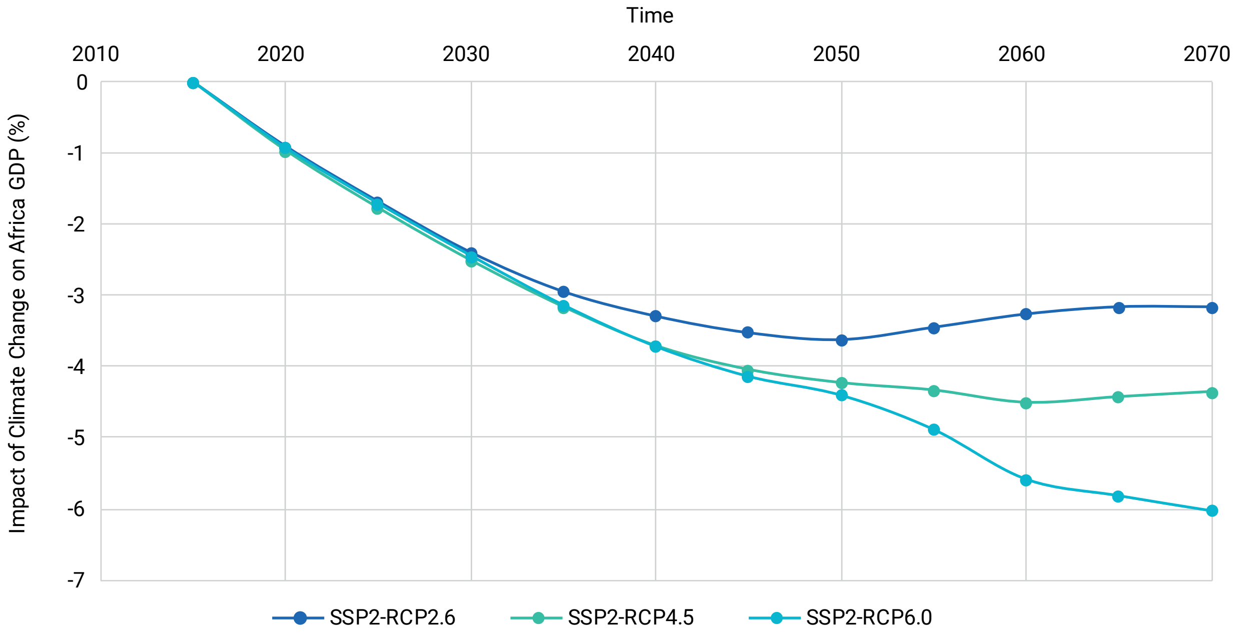
and which scenarios are included, as well as the assumptions on development trends and vulnerability over time. That is, factoring in development trends can reduce the climate impact in some sectors or regions.[50]

Our GCA analysis of the results also provides another key insight. **Only adaptation can reduce the economic costs of climate change in Africa over the next 20 years. Africa needs to scale up adaptation now.**

International mitigation policy is the only way to avoid the economic costs of high warming pathways, i.e., above 2°C relative to pre-industrial levels. Given the extremely high impacts in Africa from such scenarios (see Figure 2), the need for early and ambitious global mitigation action is paramount. Without this, Africa will suffer extremely high impacts, as seen in the figure above, that would be likely to reverse recent economic and development gains. In such a case, climate change will mean it will take longer for the LDCs and LICs in Africa to achieve middle-income status. The impact of climate change on growth by mid-century could be equivalent to almost a lost decade of economic growth.[51]

However, while ambitious mitigation will provide huge benefits by avoiding these high warming scenarios and the associated economic costs, the benefits of these policies have a relatively limited impact in the short term. Mitigation primarily has benefits after 2040, due to the inertia in the temperature response to GHG concentrations.[52] Even under ambitious mitigation scenarios, therefore, there will be high economic costs for Africa. This can be seen in Figure 3. This presents the projected changes in economic costs for Africa for a number of different scenarios (RCPs) and shows that they only diverge significantly after 2040,[53,54] because the economic costs follow the temperature (and wider climate change) projections. Economic costs diverge strongly after 2040, but this means there are still significant economic costs for Africa in the next 20 years. This finding is critical. To put this another way, **the level of climate change in the next 20 years for Africa is already locked in, and these impacts can only be reduced by adaptation.**

Figure 3. Estimates of the economic cost of climate change for Africa for different climate scenarios over time



Source: Bosello et al., (2021)[48]

Photo: subman/iStock

Climate change will affect public finances: it is now considered a financial and a macroeconomic risk. There is a need to consider climate change in public financial management.

Our GCA analysis shows that climate change is now recognized as a financial risk,[62,63] including by many of the world's central banks, including in Africa,[64] and by International Finance Institutions.[65] These financial risks include physical climate risks from the changing climate, i.e., the climate risks outlined by the models above.[66] In line with the economic cost estimates above, these physical climate risks have the potential to be large in Africa, especially as they compound other issues of lower economic diversification, less climate-resilient public infrastructure, and lower capital market flexibility compared to other world regions.

Severe weather and climate shocks (natural disasters) are already the second-most frequent source of contingent liabilities in emerging markets, and they can be a direct cause of sovereign defaults from their impact on government finances and economic growth.[67] For example, Hurricane Ivan in 2004, which resulted in damages of over 200 percent of GDP, was the direct cause of Grenada's subsequent debt restructuring. Further hurricanes in 2003 and 2004, which damaged the agricultural sector, were contributing factors in the Dominican Republic's debt restructuring in 2005.

The vulnerability of countries worldwide to existing climate shocks is already correlated with sovereign credit ratings.[68,69] These issues are more important for developing countries, including in Africa and especially sub-Saharan Africa, as they are driven by the greater importance of agricultural GDP (a climate-sensitive sector), the quality of infrastructure, and the level of institutional strength. Indeed, one study,[70] albeit somewhat controversial, reports that climate risks are already reflected in ratings for the vulnerable countries, and have led to an increase of approximately 10 percent on interest costs on government debt, in turn putting upward pressure on interest rates.

As highlighted in the Finance chapter of this report, African nations already face low sovereign credit ratings from the three major credit rating agencies or CRAs (Moody's, Standard & Poor's, and Fitch). Looking forward, rating agencies,[71, 72] expect climate change to be a global mega-trend impacting sovereign creditworthiness. For example, these look at the impact that climate change could feed through to sovereign creditworthiness on economic performance (e.g., growth prospects), fiscal performance (public finances as tax revenues, additional government budget for disaster recovery, reconstruction), and external performance (e.g., exports of agricultural products for foreign currency). The higher projected economic costs of climate change in Africa than in other world regions, therefore poses a disproportionate financial risk to the region. However, the size of these climate risks is uncertain (see earlier discussion on economic costs, (Figures 1 & 2), and thus the potential impacts on public finances are subject to the same caveats as identified in the economic section above.

A number of studies have investigated these issues and assessed the potential impact of climate change on sovereign ratings globally, including Moody's (2016),[73] ICBS and SOAS (2018);[74] Volz et al. (2020),[75] IMF (2020),[76] CFA (2020),[77] Klusak et al. (2021).[78] The detailed review is presented in the forthcoming Supplementary Research Paper.

In summary, we conclude that climate change is likely to affect sovereign ratings globally and in Africa. This is due to the potentially negative effects of climate change on the criteria that are used by rating agencies, which center on economic, fiscal and institutional strength, as well as other factors such as monetary flexibility, international investment position, event risk and others, noting that the exact factors vary with each agency.

The analyses of climate change and sovereign ratings identify multiple transmission channels through which physical climate risks could affect these criteria, and thereby the ratings. These include direct effects from rising hazards (event risk), but just as importantly, a broader set of pathways. These include the potential for climate change to reduce government revenues and increase government expenditure, reduce external performance (exports), increase contingent liabilities, increase external vulnerability, damage infrastructure assets and services, increase social costs, increase government debt levels, and reduce economic growth. This combination will lead to elevated macro-financial risks and Africa has been identified as one of the potentially most vulnerable regions.[79]

Analyzing these pathways is challenging, not least because of the wide range of reported impacts (as illustrated by Box 2 and Figure 2). There is high confidence that countries in Africa could face potential risks, but the exact size of the impacts remains difficult to predict with confidence.

The limited studies to date that look at sovereign risk have used a simpler approach where susceptibility is assessed in terms of exposure and resilience, rather than from analysis of economic impacts, with many existing studies using the ND-GAINS index[80] to assess these two components. These studies show relatively large impacts in vulnerable countries internationally, in terms of basis points or rating notch downgrades, and all show disproportionately high impacts on sovereign ratings in Africa.[81] As a result, climate change is anticipated to increase the cost of government borrowing and the cost of capital of climate-vulnerable countries in Africa, though these findings should be interpreted with caution with regard to the size of the effects.

A further insight of our analysis is that climate change could affect the public finances of countries by increasing government expenditure and public debt, as well as by reducing government revenues, all of which affect fiscal stability. Again, the size of these impacts will be influenced by the level of economic impacts that occur. Climate change[82] will also affect the affordability of insurance in higher-risk countries, not least because there is strong evidence of rising hazard levels from climate change. This could therefore increase the level of uninsured assets. Climate change is also projected to influence the private sector, from potential risks to assets and higher operating costs (by raising insurance costs, increasing supply chain disruption, increasing operating costs/ losses), and potentially lower revenues, affecting cash flow and subsequent company performance (profit and loss, balance sheet values).[83,84] This will influence expected rates of return for investors, and could affect international investment attractiveness and thus flows into perceived high-risk countries.

Our GCA analysis looked at some early assessments that examine the risks to the financial sector and equities. For instance, one study,[85,86] estimated very large climate impacts in terms of the 'expected value at risk' of global financial assets, albeit in the long term. Another report assessed the potential impacts on financial markets and equities,[87] considering the potential effects on asset classes and return expectations, and concluded that climate change risks could impact investment returns for emerging market equities, especially in the most affected sectors, such as agriculture. Another study[88] estimates that that under more extreme climate scenarios, short-term shifts in market sentiment could lead to economic shocks and losses in equity investment portfolio value, with some areas such as real estate and infrastructure assets identified as key concerns due to the high physical climate risks. Overall, these studies highlight the potential risks. Given the size of the economic costs projected for Africa (Figures 1 and 2), these are anticipated to be important for the continent, but the size and speed of these risks remains uncertain.

Interestingly, and worryingly, awareness of these financial impacts could circulate through markets before the actual climate change of impacts occur, because of market anticipation of future impacts.[89] Climate-related financial disclosure, as encouraged by the Task Force on Climate-Related Financial Disclosures (TCFD), could therefore be detrimental for high-risk areas, including Africa. As markets start to price in climate risks, commercial banks, insurers and investors might be more cautious, or even withdraw from particularly vulnerable regions or countries.

Climate change will have disproportionally more impact on the poorest and most vulnerable in Africa, and could increase the number of people in poverty.

As well as differences between regions, the impacts of climate change will have marked distributional variations within groups in society. Climate change is projected to affect the poorest and most vulnerable most in relative terms (as a percentage of income) as those with lowest incomes have higher vulnerability and lower adaptive capacity.[90] There is also likely to be a strong distributional contrast between urban and rural areas, with a general expectation that larger relative impacts will occur for rural agricultural livelihoods. Climate-related shocks already keep people in, or drag them back into, poverty; they affect the poorest the most due to their greater exposure and vulnerability, but also because they have fewer resources. Climate change is also projected to increase these impacts globally, affecting economic growth and poverty reduction targets. This could result in an increase of 122 million people globally living in extreme poverty by 2030[91] of which the highest relative proportion, up to 43 million by 2030, are in sub-Saharan Africa.[92] Even if development is rapid, inclusive and climate-informed, up to 12 million people could be pushed into poverty in this region. Considering the economic consequences, climate change can increase inequalities between countries in Africa (delaying convergence by approximately 10 years in terms of the Gini index). It could widen the inequality gap within countries.

THE ECONOMIC BENEFITS OF ADAPTATION

Because it is challenging to estimate the economic costs of climate change, it follows that it is also challenging to estimate the economic benefits of adaptation in reducing these costs. Therefore, many of the same challenges that were highlighted in Box 1 apply for our analysis on the economic benefits of adaptation. However, there are also additional challenges in estimating the effectiveness of adaptation as well as its costs.

Proactive planned adaptation is difficult to do in practice, because of the uncertainty around future warming scenarios and climate model projections. Long-term modeling studies therefore do not reflect the reality of early adaptation decision-making. A further issue is whether the adaptation deficit is included in the estimated design and costs of adaptation. This deficit relates to the adverse impacts of current climate variability and extremes. Many African countries have a considerable adaptation deficit today, above the level that might be considered economically efficient. While this adaptation deficit is not caused primarily by climate change, future adaptation will be less effective (and/or will involve higher costs) if it is not first addressed.

As a consequence, any aggregate estimates of the economic benefits or costs of adaptation, at the African or national level, need to be treated with caution. Nevertheless, as with the discussion above, there are many insights that the studies from the literature provide. In this analysis, we have conducted a detailed literature review to identify robust findings from the evidence. These are presented below.

Adaptation can reduce the economic costs of climate change in Africa very effectively. A number of the economic studies of climate change assessed for this report (described in the section above) also include analysis of adaptation. Indeed, there are a growing number of global, regional and country studies that consider evidence evidence for Africa. These find that adaptation can reduce the economic costs of climate change very significantly and cost-effectively for both low- and high-warming pathways. It is noted, however, that adaptation will cost more under high-warming scenarios and there

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> **There has been a very considering strengthening of ambition in adaptation. Adaptation really is coming of age. Countries are ready for new ambitions on adaptation, and they are ready for much scaled up financing on adaptation, too."**

Ban Ki-moon, GCA Board Chair & 8th UN Secretary-General
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

may be significant limits to adaptation for high-warming pathways. It is also highlighted that Africa will still face high residual costs after adaptation, and that these levels will be greater under high-warming scenarios. Adaptation should therefore be seen as a complement to mitigation, not a substitute.[93]

For example, the African Development Bank reports high economic benefits from adaptation, as well as potential benefits for macroeconomic stability.[94] This study draws on an African-specific IAM to look at the economic benefits (and costs) of adaptation, and it indicates the relatively high levels of damage that can be reduced by adaptation in Africa (26–63 percent) under an optimal framework, though this still involves considerable investment, reported at 0.3 to 0.6 percent of GDP by 2050.[95] The effectiveness of adaptation is confirmed by country studies of impacts and adaptation in Africa, including Uganda,[96] Ethiopia, Ghana, Mozambique and others.[97]

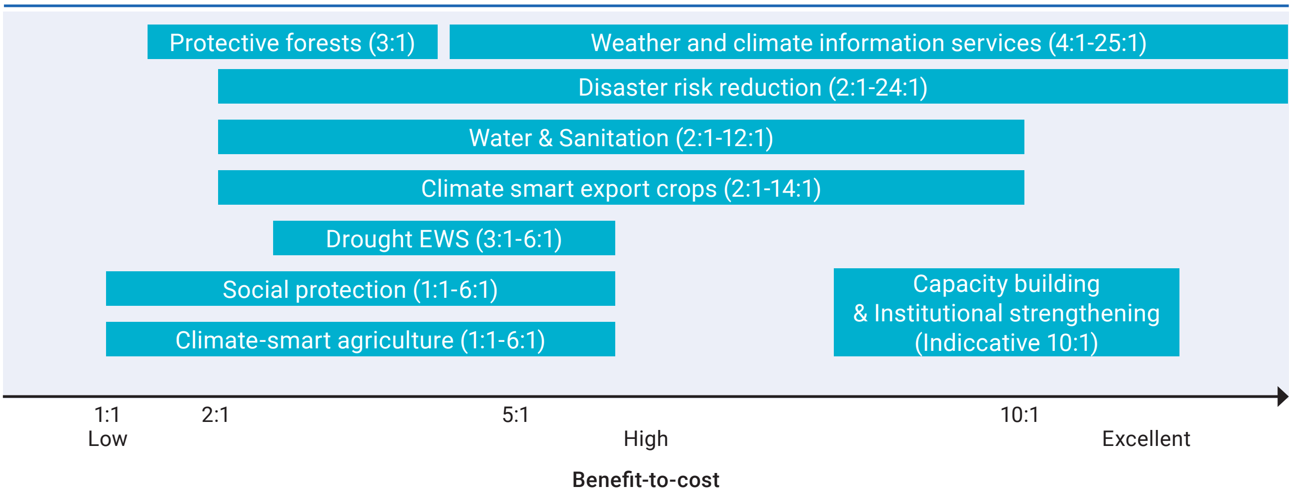
Dropping down to the sector level, adaptation is very effective in reducing the economic costs of climate change in Africa. There are several findings that consider coastal regions and sea-level rise for Africa or African countries and report on the very high benefits of adaptation, and low residual damage after adaptation.[98,99,100] These indicate climate impacts could be reduced by more than an order of magnitude with adaptation, and that such investment is relatively modest (though it will be more important in GDP terms in low-income countries). In many cases, coastal adaptation has high benefit-to-cost ratios[101] but not in all cases. Similar findings are found for river flood adaptation,[102] and these report that adaptation will lead to large decreases in future damages (as a percentage of GDP) in Africa (as well as other world regions), and with positive net present values in many parts of the continent. Recent studies also report similar positive findings on reducing the water gap (the gap between demand and supply), including for Africa,[103] and for adaptation for the main agricultural crops.[104]

Based on this review, we conclude that while adaptation is found to be highly beneficial, the amount of adaptation (and the cost) depends on the decision framework used, as well as the level of warming. The decision on how much adaptation to undertake involves trade-offs, because reducing residual damages to very low levels involves more adaptation and higher costs, and is therefore not optimal from an economic perspective (noting countries do not reduce current weather and climate-related impacts down to zero today). These are policy decisions, and will depend on the approach taken to setting policy (economic efficiency, acceptable levels of risk) as well as risk tolerance/preferences and even ethical choices, especially where the decisions involve risks of fatalities.

Early adaptation has high benefit-to-cost ratios In economic appraisal, options are usually considered using cost-benefit analysis. This assesses a policy, program, or project by estimating the economic benefits it produces over time, and compares these to the costs (capital, operating and maintenance costs) over time from a societal perspective, adjusting values in different time periods using discount rates. The results are usually expressed as the Net Present Value (NPV) or the benefit-to-cost ratio (BCR). An option that generates a BCR greater than one has a net positive economic effect.

While adaptation is context- and site-specific, there is growing evidence, including from GCA, that shows that early adaptation delivers high BCR ratios.[105,106,107,108] We have reviewed the information on adaptation economic studies in the academic and grey literature, **focusing on information for Africa specifically**, to identify the potential benefit-to-cost ratios for adaptation. This has focused in particular on short-term interventions, i.e., no- and low-regret

Figure 4. Adaptation benefit-to-cost ratios for a selection of options from africa-specific studies



Source: Authors

Note: The figure shows the indicative benefit-to-cost ratios and ranges for several adaptation measures. It is based on the evidence review undertaken for this report. It is stressed that BCRs of adaptation measures are highly site- and context-specific and there is future uncertainty about the scale of climate change. Actual BCRs will depend on all these factors.

interventions. The findings of the BCRs reported are summarised in Figure 4. The detailed review is presented in the Supplementary Research Paper.

This demonstrates that investing in adaptation generally leads to positive economic benefits. As shown in the figure, BCRs are mostly above 2:1 (i.e., a dollar invested generates double this in terms of economic benefits), and often above 5:1, which is high. Furthermore, many adaptation measures have important environmental co-benefits, and some, such as adaptive social protection, can address other drivers of vulnerability in terms of poverty reduction, especially in low-income countries.

Our review identifies several interventions that generate large, positive returns for a range of different climate hazards, across multiple sectors. These high returns are due, in part, to the existing adaptation deficit in Africa. Adaptation can deliver high economic benefits immediately by reducing losses or enhancing gains associated with the current climate (and extremes), as well as enhancing resilience to future climate change. However, as well as options that deliver adaptation, there is a need for capacity building. Capacity building has a high BCR (as shown in Figure 4) as it improves the efficiency and effectiveness of adaptation delivery.[109] Adaptation is also a core part of the COVID green recovery. The literature reports that a "good" green recovery has several key characteristics, including that investments can be made quickly ("shovel-ready"); that they are labor-intensive in the short-term and have high economic multipliers; and that they can contribute to the productive asset base.[110,111] Many adaptation measures perform well on these criteria. They include measures that target climate and disaster resilience (including nature-based solutions). There is an opportunity to include these adaptation investment opportunities in post-COVID-19 stimulus packages, as discussed in the COVID Recovery chapter of this report.

We conclude that there is a strong case to act now in a number of key areas. Delaying adaptation will increase costs.

Given the long timescales involved in climate change, it is not necessary to do everything now. However, in some areas it is important to act early. Delaying adaptation in these cases will make it much harder to tackle future climate risks and may make large future costs inevitable, as opportunities for building resilience could decline with time.[112] At the same time, there are some decisions and actions that can be delayed. A key issue is to distinguish what action is urgent, and what can be done later as part of an adaptive management approach. There are three areas where early action is needed and can be justified in economic terms.[113]

- First, Africa already experiences large economic costs from climate extremes today, and these are growing. There are therefore large net **economic benefits today** from reducing these with low- and no-regret actions such as weather and climate information services and climate-smart agriculture. These have high benefit-to-cost ratios, as shown in the figure above. While there is growing recognition of these options, there is a need to promote and share experience on the most promising ones to help scale up these early interventions.
- Second, in some areas there is a potentially large economic cost from delaying action. This involves decisions or investments (or a lack of decisions) that involve lock-in risks or path dependency, i.e., which could lead to very large future costs that will be costly to address later or are irreversible. There is often a one-off opportunity to avoid these risks now. A good example is with infrastructure or urban development, because of the long timespans involved. Infrastructure built over the next five years in Africa will operate under a very different climate to today. If future climate risks are not considered in infrastructure design, climate change could cause asset damage or failure, and affect operating costs and/or revenues.[114] Integrating climate resilience into infrastructure when it is designed and built therefore makes sense, and should have positive benefit-to-cost ratios (potentially of 4:1[115]). However, due to climate uncertainty, it is challenging to design climate-resilient infrastructure (and address other lock-in risks), and more support is needed for countries in Africa. The Transport and Energy chapter and the Urban Development chapter review in further detail this challenge.
- Finally, there are some extremely low-cost preparatory actions that can be taken to improve future decisions, effectively providing option values.[116] This involves developing adaptive management plans, especially for decisions that have long lead times or involve major but uncertain future change. Again, while these approaches have significant benefits, they can be challenging to deliver in practice.[117] So there is a need to build awareness and capacity for such adaptive management in Africa.

It is stressed that at the country level, all three of these priorities are needed, and this requires portfolios of interventions, since there is some emerging evidence that portfolios can deliver higher economic benefits than individual options alone.

We also found that while adaptation is beneficial, there are barriers and constraints that stop it from happening. There is a role for government and economic decision-makers to consider these and create the enabling environment for adaptation.

While Figure 4 shows the potential benefits of adaptive action, there are a range of barriers and constraints that make adaptation difficult in practice.[118] These various barriers can make it difficult to take action, even when it is clear that action is needed, and it would lead to economic benefits.

These constraints can include physical and ecological limits, technological limits, financial barriers, information and cognitive barriers, and social and cultural barriers. However, it is also important to consider these barriers from an economic perspective. The barriers to adaptation include market and policy failures, and there is a role for government (and economic and planning ministries) to consider these.[119]

One of the most common barriers to adaptation identified in this report is the issue of uncertainty.[120] The presence of uncertainty around future climate change translates into imperfect information, which is a market failure,[121] or information asymmetry, which acts as a barrier to adaptation by both public authorities and the private sector (individuals and firms). When public or private actors have inaccurate, incomplete or uncertain information they are unable to make the most appropriate adaptation decisions, or in some cases any decision at all.

There are also a range of other economic barriers to adaptation which include a range of market failures, or factors that prevent the private sector from delivering socially efficient adaptation and therefore justify government intervention.[122] A major economic barrier for adaptation concerns public goods and externalities. Many adaptation actions have public-goods or non-market dimensions that the private sector is unlikely to invest in (e.g., large-scale flood defenses). To put it another way, by acting rationally in their own interest, private companies will base their adaptation decisions on private costs and benefits, not those that are best from a societal perspective. It is a generally accepted role of government to address externalities, and thus there is a role to help deliver adaptation with a focus on public goods.

There are also potential barriers around misaligned incentives, where the costs of adaptation fall on certain individuals while the benefits accrue to others.

The market structures in place, whether monopoly, oligopoly or perfect competition, shape the incentives and affect the investment decisions on climate change adaptation, and may incentivize adaptation, and/or lead to over- or under-adaptation due to distortions.[123] The availability of finance is also an obvious and important constraint to adaptation, though this is discussed in greater detail in the Finance chapter.

Our GCA analysis also identified a set of policy, institutional and governance barriers to adaptation.[124] Policy constraints may arise when a regulation or a policy creates a barrier to effective adaptation. Policy barriers can also arise when there are conflicting or competing policy objectives, or a lack of clarity.

"With our partners, we intend to mobilize $25 billion in financing for the success of the Africa Adaptation Acceleration Program. It is time for developed countries to meet their promise of providing $100 billion annually for climate finance. And a greater share of this should go to climate adaptation."

Dr. Akinwumi A. Adesina, President of the African Development Bank
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021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As adaptation is a fairly new theme in policy and development decision-making, the existing structures and/or the regulatory policy framework are often poorly aligned to its objectives. As an example, development objectives may not take into account the vulnerability of assets and people to climatic risks. Governance barriers occur when there is ineffective institutional decision-making and/or implementation of adaptation. These can constrain action, creating challenges or slow planning and implementation. There are often institutional barriers: for example the lack of a clear mandate and responsibility, or of coordination and resources. This is a particular problem for adaptation, which frequently involves cross-cutting themes, and thus multiple actors and institutions with different objectives, jurisdictional authority and levels of power and resources. There is often a lack of coordination (or clear leadership or mandate), as well as (internal) competition for resources and policy control, that can all act to make adaptation harder to deliver. These institutional aspects may be compounded by the problem of competing priorities, and the need to address short-term priorities (rather than long-term climate risks), inherent in political and medium-term (5-year) planning cycles which are commonly used in Africa.


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What is clear is that effective adaptation will require a clear consideration of the role for government intervention—as in all areas of public policy—and that there is a need to integrate economic thinking and relevant line ministries in these decisions. This also requires consideration of the appropriate case for government intervention to address the barriers above, i.e., to establish what the case for government intervention is, as well as to design appropriate action to address these barriers and create the enabling environment for adaptation.[125]

Adaptation needs to be designed to reach the most vulnerable As highlighted above, the impacts of climate change are likely to have strong distributional variations, with particularly high relative impacts for low-income groups and those with the most vulnerability. Accordingly, adaptation interventions may reduce or reinforce these inequalities, because they may redistribute or create new vulnerability.[126] For example, adaptation may be undertaken by some households and private sector actors, notably those who have access to resources. However, such action is unlikely to benefit (or be taken up by) the poorest. As highlighted above, without appropriate signals, the private sector might not undertake the most appropriate level of adaptation, and might even increase the vulnerability of others or the system as a whole. Furthermore, there are additional challenges for implementing adaptation for the most vulnerable that makes it more challenging for public and private actors. For example, it is simpler to work on adaptation for a single major infrastructure project than it is to target tens of thousands of individual farm smallholders, even if the latter are highly vulnerable.

We found that there is therefore a danger that adaptation could increase inequality. Following from the section above, there is a role for government to put in place the right signals or conditions to ensure adaptation is fair and equitable, and that it also benefits the most vulnerable. This requires distributional considerations (and targeting) when planning and implementing adaptation. It may also include specific targeting of adaptation to the most vulnerable, e.g., with targeted policies such as adaptive social protection, noting these have been shown to have high economic benefits.[127]

Several key messages emerge from our analysis:

- Even if the Paris Goals are achieved of limiting temperature rise to well below 2°C above pre-industrial levels, it is likely that Africa will experience higher relative economic costs (as a percentage of GDP) from climate change than most other world regions, even though it is less responsible, both historically and in the present day, than other major world regions for global GHG emissions.
- If the Paris Goals are missed, these economic costs will be very significant in Africa, and potentially catastrophic for development and poverty reduction, as well as long-term growth for the African continent.
- There is less agreement on the exact size of the economic costs of climate change in Africa, and on which regions and specific countries in Africa will be most affected in economic terms. Most studies report significant economic costs over the next few decades (several % of GDP per year), rising significantly for high-warming scenarios in the longer term (to more than 5 percent and plausibly more than 10 percent for some countries).
- A further insight is that impacts will also be unevenly distributed within countries, and climate change is likely (in relative terms) to affect the vulnerable the most.
- Climate change is a major macroeconomic risk and is projected to affect governments and public finances.
- Recent studies indicate that climate change could reduce the sovereign credit ratings of African countries, increase the cost of borrowing/cost of capital, and increase the level of uninsured assets and contingent liabilities. The impacts of climate change on public finances, combined with the need to finance adaptation, could add pressure to debt levels in Africa.
- These same trends could affect the profitability of companies in Africa, and could affect their attractiveness for foreign investment.
- Financial market anticipation of these various impacts on the public and private sector could exacerbate and bring forward climate-related economic costs in Africa.


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- The level of climate change in the next 20 years is already largely locked in, and the potential impacts of these changes can only be reduced with adaptation. Global mitigation action is critical, but it will primarily reduce impacts from mid-century onwards. Thus Africa needs to scale up adaptation now.
- More positively, adaptation can reduce the near-term economic costs of climate change very cost-effectively. A literature review undertaken for this report finds many early adaptation options have high benefit-to-cost ratios. This includes investing in capacity building, as this improves the effectiveness of delivery.
- It is also important to prioritize early adaptation, and there is growing evidence that portfolios of interventions can deliver higher economic benefits than individual options alone.
- However, important barriers to adaptation exist, and these require targeted interventions by governments for effective adaptation, and the management of distributional considerations to ensure benefits reach the most vulnerable.

In response to these challenges, our analysis identifies several policy recommendations and potential solutions.

POLICY RECOMMENDATIONS

There is a need to integrate climate change in public financial management, as well as more fully into development policy and budgetary cycles. This involves moving beyond national adaptation plans to integrate climate change in national and sector development planning. This needs a stronger lead from economic and financial ministries (in coordination with sector ministries), combined with greater understanding, coordination and management of climate risks across sectors. Countries will increasingly need to demonstrate they are managing climate risks to reassure financial markets and investors, but they will need support to do this. IFIs and bilateral donors can help governments improve climate risk financial management.

Delivering this will mean more direct integration of climate change risks and adaptation budgeting in public financial management, and into development planning and budgeting cycles. Clearly, this starts with countries assessing the risks of climate change to the economy and on public finances. This information then needs to cascade into the integration (mainstreaming) of climate change adaptation in long-term country visions (e.g., for 2040 or 2050) and medium-term (5-year) plans, as well as more generally in macroeconomic forecasts and planning. This needs to happen in the relevant ministries, notably finance ministries. For example, the Helsinki Principles,[128] from the Coalition of Finance Ministers for Climate Action, includes six common principles, including the need to take climate change and the need for Paris alignment into account in macroeconomic policy, fiscal planning, budgeting, public investment management, and procurement practices.

There have been positive examples of such action internationally, though there is a need to scale up. This includes Climate Public Finance Tracking (Climate Budget Tagging),[129] which allows countries to identify how much of the government budget is currently being spent on adaptation (and mitigation) activities and creates a climate mainstreaming cascade across subsequent development planning and budgeting processes. Several countries have undertaken such exercises, including in Africa (e.g., in Tanzania, Uganda and Ethiopia – see insert on this topic). It also includes initiatives such as the UNDP Poverty-Environment Action for Sustainable Development Goals initiative, which has sought to integrate climate into development planning, with pilots conducted in Malawi, Mozambique and Rwanda. These approaches have important advantages, as they can leverage funding of underlying development budgets, and can nudge national and sector development plans along climate-smart pathways. However, there is still work to do to translate these approaches into systematic input to inform future plans and budgets.[130] These issues also need to be integrated in national development support and financing from development partners and International Finance Institutions, for example in country partnership programs.

More broadly, there is an opportunity for greater participation of African central banks in the network for greening financial systems.[131] This could extend to integrate climate-related financial risks in macro-and micro-prudential supervision and even to integrate climate risk/resilience into developing-country financial policy and regulation.[132]

There also needs to be more action to reduce climate risks. While this will require investing in adaptation (see next point), there is also a need to improve structural and financial resilience more generally. This might include enhancing economic diversification and policy management, fiscal buffers, insurance schemes, etc., to help the public finances with the challenge of climate change in particular and economic development in general.[133] It might also include innovative financing instruments linked to climate change to reduce the debt burdens in the case of catastrophic events.[134]

Given the impacts of climate change will be uneven, there will be a need to support more vulnerable regions and countries in particular. Across all of these areas, there will be a need to communicate that action is being taken and that risks are being addressed with credit agencies, financial markets and investors. Communication with these stakeholders would benefit from support from development partners, multilateral development banks, and International Finance Institutions.

Underpinning all of this is the need for better access to high-quality historic, current and projected future climate data—and investment in the training and support needed to interpret this data and include it in public financial management and development planning. There is some evidence on the success factors for such adaptation mainstreaming.[135,136] These include the presence of a high-level champion, the involvement of strong ministries (notably Finance), and the availability of climate finance and technical assistance. Supportive policy frameworks (and commitments) can also help push forward the


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process of mainstreaming, as can the presence of coordination mechanisms across government that support mainstreaming goals, and information and tools. Such activities could be supported by DPs and IFIs through technical assistance and funding (e.g., policy-based lending), as well as from country-to-country sharing of practice. There is also likely to be a role for such partners to help provide macroeconomic support and innovative solutions to help particularly vulnerable countries directly.

Given the potentially large impact of climate change on countries' public finances and macroeconomic implications, there will need to be a rapid scale-up of adaptation in the next 20 years in Africa. It is important to strengthen the consideration of climate adaptation upstream (at a more strategic level in government policy and strategy, as well as MDBs), as well as to develop pipelines of bankable projects, considering both climate-proofing of planned development (e.g., resilient infrastructure), but also targeted adaptation projects (e.g., flood defenses).

This chapter shows the strong economic case for adaptation-positive benefit-to-cost ratios. However, a core challenge now is to scale up adaptation. To date, much of the focus has been downstream, at the level of individual projects, and there is a need to move the debate and analysis upstream—for example, to incorporate climate risks in early-stage planning of national infrastructure, rather than when it is being built. There are good examples of such action internationally and in Africa. For example, in Ghana, the GCA catalyzed a joint initiative between the Ministry of Environment, Science, Technology and Innovation, UNOPS, UN Environment and the University of Oxford's Environmental Change Institute to explore the performance of Ghana's energy, water and transportation system under climate change, and to identify actions at both the system-level and asset level that can help improve the resilience of national infrastructure.

There is also a need to develop investable project pipelines and facilitate the integration into the mainstream planning and investment pipelines of the country, for example by climate-proofing infrastructure. This may be supported by other activities, for example developing standards and codes that embed climate resilience at national level, or providing guidance for the integration of climate risks into public-private partnerships.

Clearly, this will require an increase in the financing of adaptation, which will in turn lead to issues for public finances, e.g., on debt levels and sustainability. These are discussed in the Finance chapter of this report, including external finance for many LDCs. However, delivering this in practice will also require institutional support and capacity building, and technical assistance, information and guidance.

There is an important role for governments to identify the strategic economic case for action, and to consider where and how best to intervene to create the enabling environment for adaptation, as well as to ensure it is effective, efficient and equitable. There is a need to integrate economic thinking when designing adaptation strategies and policies, i.e., to consider market and policy failures and where it is appropriate for government to act, and to design strategy and policy accordingly. This will require analysis of these issues by governments, and involve relevant ministries and expertise, and the translation of these into strategy, policy and development. As well as efficiency and effectiveness, there will be a need to design interventions to ensure the most vulnerable are not left behind, and to ensure there is the capacity to deliver. Many countries will require support to do this.

Looking forward, it will be useful to identify some metrics to measure the issues above, so as to allow changes in these metrics to be considered in subsequent versions of this report. This might center on the number of medium-term national development plans in Africa that have integrated climate adaptation, as well as the status of climate risks on credit risks of African countries. It might also assess the progress on addressing distributional issues in adaptation policy and programming.

Mainstreaming adaptation in national planning and finance

Photo: Dennis Diatel/Shutterstock

With African economies projected to lose an average of 3.2 percent of annual GDP between 2021-2050 due to climate change, adaptation and climate resilience has to become an integral part of national planning and budgeting. This insert highlights efforts to mainstream climate change in national planning and finance in five countries in Africa.

Ethiopia

Ethiopia launched the Climate Resilient Green Economy (CRGE) Initiative in 2011 to pursue the triple goals of economic growth, net-zero emissions, and resilience. Its five main elements include:

1. The CRGE Strategy
2. iPlan, an integrated planning process for CRGE sector investment plans
3. CRGE units in line ministries and in regional states
4. A national monitoring, reporting, and verification (MRV) system
5. A CRGE Facility to mobilise, access, and blend climate finance

Ethiopia estimates that an investment of US$ 150 billion will be needed over 2010-2030 to implement the Strategy, which the Planning and Development Commission has integrated into the country's second Growth and Transformation Plan and Ten-Year Development Plan. Climate change is a central pillar of the Ten-Year Development Plan, which reflects the submissions of different sectors. Ethiopia has also taken steps to mainstream climate change in subsequent three-year plans and in planning at the '*woreda*' or district level.[137]

In 2013, the Ministry of Finance established a dedicated CRGE Unit and Secretariat to drive the climate change integration agenda, with technical guidance from the Environment, Forest, and Climate Change Commission (EFCCC).

Each ministry now has an independent climate finance unit that reports through the CRGE Unit to the CRGE Secretariat.[138]

The Ministry of Finance introduced a Fiscal Risk Statement in 2019, and is currently working on quantifying the risks associated with droughts and floods, two key climate-related hazards in the country. The Ministry of Finance is also in the process of strengthening public investment management (PIM) from a climate and environment perspective; and developing a consolidated climate budget tagging and tracking system, with a pilot expected to be ready in late 2021.

Finally, Ethiopia plans to be the first country in Africa to pilot the Public Expenditure and Financial Accountability (PEFA) climate module, with an assessment of its performance planned for 2021. There are also ongoing discussions to establish a domestically financed climate fund proposed by the Ministry of Finance, which is expected to get 0.5 percent of the annual budget to restore degraded land and fund afforestation and reforestation.[139]

Uganda

The priority of Uganda's Nationally Determined Contribution (NDC), which is based on a 2015 National Climate Change Policy, is to reduce the climate-change vulnerability of its population, environment, and economy by promoting adaptation in agriculture, livestock, forestry, and infrastructure. The NDC emphasizes human settlements, social infrastructure, transport, water, energy, health, and disaster risk management. Sustainable land management and climate-smart agriculture will be scaled up to increase resilience at the grassroots level.[140]

The Ministry of Finance, Planning and Economic Development (MOFPED), the National Planning Authority (NPA), and the Ministry of Water and Environment's Climate Change Department are currently spearheading the NDC implementation and revision. This arrangement has encouraged the revision process to span across sectors and include multiple stakeholders that include national, sub-national, and non-government entities.

The tripartite group has also led efforts to mainstream climate change into national planning and budgetary processes.[141]

Uganda has mainstreamed climate change in Uganda Vision 2040,[142] and climate change is one of the strategic programs in the Third National Development Plan (NDP III) 2021-2025.[143]

Climate change has also been identified in Budget Call Circulars as a key crosscutting issue since the 2017-2018 financial year. MOFPED's first fiscal risk statement for 2019-2020 featured climate change as a driver of extreme weather that endangers economic growth and social welfare, with potentially significant consequences for the national budget through unplanned or emergency spending. Since then, climate change has been qualitatively featured in annual fiscal risk statements.[144]

In 2018, MOFPED and the NPA partnered with the World Bank to develop a paper on natural capital accounting and a country-adjusted macroeconomic report. This provided quantitative estimates for NDP III to consider the contribution of natural assets to the economy, and incorporate risks to natural resources from climate change.[145] In the same year, MOFPED introduced climate budget tagging, with support from the World Bank for a climate budget tagging manual. It was piloted in four ministries and four local governments, but its implementation was delayed, partly due to the COVID-19 pandemic and limited dedicated administrative capacity.

Uganda has mainstreamed climate change in its well-established performance-based budgeting system. In the last three years, PIM has become a focal point of public financial management reform in the country, leading to the creation of a draft national PIM policy. Finally, Uganda is in the process of drafting a National Climate Change Bill to support implementation of the National Climate Change Policy. The passage of the Bill will ensure that procurement standards include climate change factors, and will roll out the budget tagging methodology.[146]

Kenya

Kenya's NDC aims to ensure a climate-resilient society by mainstreaming adaptation into its medium-term plans and Country Integrated Development Plans (CIDP); and by implementing adaptation measures. The Climate Change Act of 2016 mandated the establishment of Climate Change Units in all counties and ministries to mainstream climate change activities within planning and budgeting.[147] A National Climate Change Fund was launched in the 2018-2019 financial year, and County Climate Change Funds (CCCF) have been piloted in five counties.[148] Kenya has also recognized climate change as a risk to the country's development in Kenya Vision 2030, launched in 2008.

The National Action Plan (NAP) for 2015-2030 and the National Climate Change Action Plan (2018-2022) further detail the government's climate change ambitions, while the National Climate Change Framework Policy (2018) provides an explicit commitment to integrate climate change considerations into planning, budgeting, implementation, and decision-making at the national and county levels, and across all economic sectors. Finally, the National Climate Finance Policy (2018) promotes the establishment of legal, institutional, and reporting frameworks to access and manage climate finance.[149]

Photo: Jen Watson/Shutterstock

The CIDP embraced decentralization and enlisted the Council of Governors and county governments to establish the CCCF. The CCCFs are managed by county authorities, and receive funds from the national budget, donors, and international climate funds. They provide financial support to counties to propose, prioritize, and implement adaptation measures, including for local efforts to mainstream climate adaptation, and gather data on local risks, hazards, vulnerabilities, and adaptation measures.[150]

Kenya has also introduced various plans, policies, and interventions to integrate climate change into the national budgetary system. For example, the 2020 Budget Call Circular outlines priority mitigation and adaptation interventions and details Kenya's system of climate budget tagging. The country also has a separate system for reporting disaster-related expenditures by ministries, departments, and agencies. The national Budget Policy Statement (equivalent to a budget speech) recognizes the need to reduce exposure to climate-related risks and disasters, and consequent impacts on the budget and economy. Over time, this has led to the establishment of the Disaster Risk Financing Strategy, which proposes financing options to reduce the impact of primary disaster risks. Kenya had sovereign insurance for drought but ended it because of its cost, reflecting the inability of governments in Africa to overcome the barrier of high upfront costs for climate risk insurance. The country was also a member of the African Risk Capacity's risk insurance pool until 2017.

Kenya's PIM program incorporates climate risk, and in 2015, all ministries, departments, and agencies were required by law to evaluate the effects of climate change on programs and activities. Finally, Kenya is considering issuing a green bond. Despite Kenya's efforts to mainstream climate adaptation, inadequate social inclusion has limited the impact of its resilience-building efforts.[151]

Rwanda

Rwanda's Ministry of Agriculture has placed adaptation at the center of its plans to boost the productivity of coffee and tea production — the country's primary export industries — as global temperatures rise.[152] In 2011, Rwanda launched a Green Growth and Climate Resilience Strategy (GGCRS) that set out actions and priorities on climate change adaptation and mitigation, including how these would be mainstreamed into economic planning.

GGCRS is now being revised to include a carbon neutral target by 2050. The strategy has 14 programs of action as a basis for strategic and sectoral programs. These include the NDC, *Vision 2050*, the National Strategy for Transformation, sectoral policies, sectoral strategic plans, the Strategic Programme for Climate Resilience (SPCR), and Sustainable Energy for All (2015-2030).[153] A National Environment and Climate Change Policy that aims to achieve a climate-resilient nation with a clean and healthy environment was enacted in 2019.

Most of Rwanda's interventions in climate budgeting and finance have focused on budget preparation processes. For example, Rwanda starts its budget process with a review of fiscal risks, as required under the East African Community Monetary Union. This is a new process, launched in 2020-2021, and led by the Ministry of Finance and Economic Planning's Macroeconomic Department. Climate change has featured in Rwanda's budget guidelines since 2011, championed by the Ministry of Environment, along with climate budget tagging. The tagging process is not built into the Integrated Financial Management Information System, but is a standalone exercise conducted annually by the Ministry of Finance and Economic Planning and the Ministry of Environment. Climate change is also usually featured in the Minister of Finance's annual budget presentation.[154]

Rwanda has a National Fund for Environment – FONERWA – financed entirely from national budgetary sources and managed by the Ministry of Finance and Economic Planning. FONERWA finances elements that are not normally covered by the budget, including unforeseen climate-related emergencies like floods and drought.

Finally, Rwanda is in the process of developing green procurement guidelines, and introducing environmental standards into PIM. It is also considering revenue measures, developing a post-COVID-19 green economic recovery plan, and the introduction of a climate change budget statement from 2021-2022. The country has expressed interest in receiving support from the Collaborative Instruments for Ambitious Climate Action workstream of the UN Framework Convention on Climate Change, to explore the adoption of carbon pricing instruments.[155]

Kenya has also introduced various plans, policies, and interventions to integrate climate change into the national budgetary system. For example, the 2020 Budget Call Circular outlines priority mitigation and adaptation interventions and details Kenya's system of climate budget tagging.

South Africa

South Africa's NDC includes plans to develop an integrated National Climate Change Adaptation Strategy and Plan and operationalize it as part of implementing the National Climate Change Response Policy (NCCRP); and to integrate climate change in national development, subnational, and sector policy frameworks for 2020-2030, including the National Development Plan Vision 2030. The NCCRP highlights the government's commitment *"to mainstream climate change response into the fiscal budgetary process and so integrate the climate change response programs at national, provincial and local government levels"*.[156]

Most of South Africa's interventions on climate budgeting and finance have been initiated at the local government level. For example, local governments are required by the Built Environment Performance Plans to consider climate risks in investment planning. Johannesburg and Cape Town have also issued green bonds.

In 2010, South Africa introduced the Renewable Energy Independent Power Producer procurement program to address regular power shortages, and over-reliance on a single state-owned electricity provider, Eskom

In September 2020, the National Treasury partnered with World Bank to develop a climate budget tagging system. As a result, the 2020-2021 Medium-Term Expenditure Framework submission guidelines mentioned climate change for the first time, requiring provinces to consider climate risks in their budgets.

In October 2020, South Africa's post-COVID-19 economic recovery plan committed to various green stimulus measures, such as re-prioritizing planned investments in renewable energy, increasing investments to energy and water efficiency of buildings, and developing the forestry sector.

South Africa is also in the process of developing various plans to extend climate-related public finance management reforms, introducing climate-relevant fiscal instruments through an Environmental Fiscal Policy Paper, and tabling a climate change Bill in the national legislature.[157]

Conclusions

While significant strides have been made in integrating climate adaptation and resilience into long-term planning, standard macroeconomic 'fixes' may not ensure stability in an era of climate shocks. Systematic climate risk management for policies and projects is essential, for which better climate data, tools and resilience planning efforts are necessary.

Efficient and prepared government institutions matter, as do sectoral and cross-sectoral climate-centered policies and investment. Governments must continue to enable and reinforce climate-informed macro-level analysis through research on whole-of-economy modeling of climate impacts, debt sustainability analysis, public expenditure reviews, and poverty diagnostics.

Greater internal coherence is key to stronger climate action, with a clear recognition that development outcomes hinge on the management of climate risk across sectors and levels of government. Robust ownership of climate action (rather than simply a compliance response) follows more easily from greater internal coherence, and can speed up adaptation and resilience efforts.

Photo: Sunshine Seeds/Shutterstock

Viewpoint:
Reshaping the relationship between science and policy for informed adaptation action

Lessons from the Future Climate for Africa program

SouthSouthNorth

Future Climate for Africa (FCFA) is a research and development program in which more than 200 researchers worked to improve the global understanding of Africa's climate and to bring climate information into the policy-making process. Through targeted engagements with key institutions and decision makers on specific adaptation problems in 16 pilot studies across 13 countries in Sub-Saharan Africa, the program has supported the integration of climate information into 13 national and local policies, plans and investments and delivered 14 tools to support the uptake and use of climate information.

FCFA consisted of one pan-Africa research consortium, Improving Model Processes For African Climate (IMPALA), and four regional research consortia.[158] In order to influence policy, planning and investments within the context of each pilot study, co-production was used as a guiding principle for engagement. Co-production refers to the process of "bringing together different knowledge sources and experiences to jointly develop new and combined knowledge [that] is better able to support specific decision-making contexts."[159] In the case of FCFA, co-production led to researchers tailoring climate information to decision makers' needs to be better fit to inform adaptation planning, policy and investments.

Within FCFA, co-production was not only important to delivering relevant and useful climate information, but was crucial to bridging the divide between researchers, practitioners and decision makers. Each pilot project had its own co-production process, but they all utilized six common building blocks: (1) identify key actors, (2) build common ground, (3) co-explore need, (4) co-design solutions, (5)


Source: Authors


Source: Authors

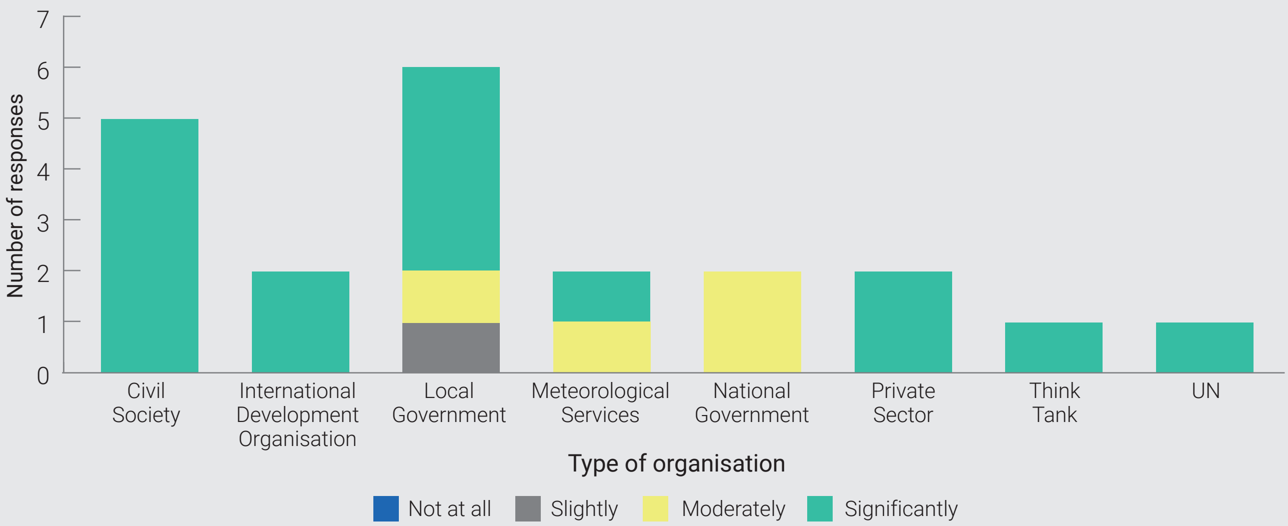
co-deliver solutions and (6) evaluate. This process helped to facilitate shared learning between all groups involved and strengthened relationships by building trust, creating shared goals and generating co-ownership of research. In-person meetings and regular virtual check-ins played a key role in maintaining these relationships while helping decision makers to engage in the research process, thus improving their receptivity to climate information. When key decision makers and stakeholders were asked in annual surveys[160] whether their engagement with FCFA had improved their appreciation of climate information and risks in decision-making, 100 percent of respondents stated they had an improved appreciation, with 75 percent of respondents noting significant improvements in their appreciation for information on climate risks (Figure 1).

Co-production was also beneficial in building the capacity of all involved. The interdisciplinary and co-production approaches employed by FCFA, in some cases, were the first instance in which climate scientists were able to directly interact with decision makers regarding climate research. Interviews with 12 partner researchers within the AMMA-2050 showed that 11 of these researchers felt their capacity to deliver climate information for decision-making had been partially or completely improved during the program.[161]

Bridging the gap between academia and policy and planning spaces was particularly important in helping these different actors to understand decision-making and bureaucratic processes and in shaping research outputs. For example, the embedded research approach adopted by FRACTAL placed researchers from local universities within local councils in southern Africa so they could develop a deep understanding of local government processes to tailor research towards their needs while strengthening relationships and institutional networks between local councils, universities and civil society. One example of these strengthened networks is the multi-stakeholder Lusaka Water Security Initiative (LuWSI), wherein the University of Zambia and the Lusaka City Council entered into an agreement to work together on water insecurity issues within the city.[162]

In other cases, co-production helped to build the capacity of climate scientists to co-explore user needs and develop information that was relevant to the decision-making context. For example the Ci4Tea project co-produced a range of climate metrics (i.e. climate variables specific to tea plants) that were particularly relevant for tea growers in Kenya and Malawi. Research results showed that tea farmers experienced regional differences in the climate sensitivities of crops (including heat wave frequencies, number of cold nights, number of rainy days and duration of dry spells) and that increasing temperature and rainfall variability requires prioritization of adaptations such as irrigation and climate-smart agriculture practices.[163]

Figure 1: Improved appreciation of climate risks



Working closely with decision-makers to understand their climate information needs also led to new knowledge on how climate information is packaged and communicated. While climate scientists and researchers often present decision-makers with complex data that has various levels of uncertainty, decision makers often only require high-level messaging. This realization led to the production of climate risk narratives. These narratives combine climate information with other data on the local socio-economic and environmental context to provide decision makers with a range of potential future scenarios. These narratives were found to be beneficial to both helping scientists to understand decision makers' needs and providing decision makers with a starting point to plan for the impacts of climate change.[164] For example, in Windhoek, Namibia, the climate risk narratives developed by the FRACTAL project were used as a reference point in the development of the Integrated Climate Change Strategy and Action Plan.

While FCFA's approach has helped to improve the capacity of researchers to produce user-relevant information, including decision makers and key stakeholders in the process also improved their capacity to use climate information. Key informant interviews with stakeholders that engaged with the AMMA-2050 indicated that 79 percent of decision makers felt the project supported the integration of climate information into decision making and planning.[165] One respondent highlighted the significant achievements made through co-production, saying, "[AMMA-2050] managed to achieve more understanding in one workshop than I have managed to achieve in the 20 years I've been doing this job."[166] This engagement not only improved decision makers' understanding of climate information but also increased demand for climate information.[167] For example, in the City of Ouagadougou, Burkina Faso, consultants working for the public sector in the city (Agence d'Etudes d'Ingénierie et de Maîtise d'oeuvre (AEIM) and Agence Municipale des Grands Travaux) requested intensity-duration-frequency (IDF) information from the project to inform road and drainage plans being developed for the city.

FCFA's collaborative and interdisciplinary approach was able to make significant headway in both the scientific understanding of Africa's climate and in approaches to support the integration of climate information into decision-making. While the full impact of the program will only be evident in years to come, it was able to create valuable networks and approaches that can be applied to future projects and programs to continue to support adaptation across the continent.

Source: Authors

Source: Authors

COVID-19 recovery

KEY MESSAGES

- **Before the COVID-19 pandemic, investment in adaptation to climate change was low compared to investment in mitigation.** In light of the economic crises and the disruption to livelihoods caused by the pandemic, it is important to emphasize the idea of resilience and to contemplate new, “green” pathways to growth.
- **Key common principles that define and govern the “green growth” approach to development include:** sustained economic growth; resource-use efficiency; climate change response through adaptation and mitigation; creation of decent green jobs; and human well-being and social inclusiveness.
- **In this chapter, the use of an Intervention & Investment Impact Model (I3M)** developed by the economics consultancy Vivid Economics and the Oxford University Economic Recovery Project models and analyses the prospects for several kinds of green economic activity and job creation in four African countries (the Democratic Republic of the Congo, the Arab Republic of Egypt, the Republic of Kenya, and South Africa).
- **Amongst economic activities that OUERP and partners indicated as presenting a high potential for levering green economic growth, two were prominent in all country case studies: agriculture, and natural capital services.**

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Agriculture is a dominant sector in the economies of most African countries, accounting for 30–40 percent of GDP and providing jobs for over two-thirds of Africa's population. A focus on natural capital has the potential to bring economic, social and environmental benefits, creating jobs rapidly and safeguarding communities against climate change.

- **Investing stimulus packages wisely in sustainable growth, supported by finance from foreign governments and international organizations, could deliver the triple dividend** of economic, social, and environmental gains needed to lay the base for a successful and resilient economic recovery for the economies of Africa.

"The time to move forward on adaptation is now. In the run up to COP26, we need to translate our ambitions into firm action, planning, financing and implementation."

H.E. Mark Rutte, Prime Minister of the Kingdom of the Netherlands
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

GREEN ECONOMIC RECOVERY AND GROWTH IN AFRICA

Globally, the unprecedented economic challenges of COVID-19 are being addressed by a combination of fiscal and monetary interventions as indicated in the macroeconomics chapter. As countries have begun to emerge from the depths of the health crisis, fiscal spending has again been the favored economic policy lever, this time to support long-term recovery by stimulating new jobs and enabling a return to pre-COVID-19 levels of economic growth. Only a small share of the fiscal stimulus packages is explicitly green. Yet recent global economic analyses show that green spending can secure both greater growth and a greener future. These estimates on whether recovery packages will accelerate or retard progress on climate change, also emphasize the importance of front-loading resource mobilization to be able to invest in these sectors .[1] The availability of fiscal resources to invest in a green recovery remains a critical limitation for African countries, with recovery spending lagging compared to OECD countries. Additional resources, either through grants and concessional funding, or through market-based mechanisms, have been limited.

Key common principles that define and govern the "green growth" approach to development include: sustained economic growth; resource-use efficiency; climate change response through adaptation and mitigation; the creation of decent green jobs; and human well-being and social inclusiveness.[2]

Before the pandemic, investment in climate adaptation was still low compared to mitigation as indicated in the Finance chapter. It should now be prioritized. Climate-proofing developmental gains is crucial for economic growth and the eradication of poverty, as discussed in the following GCA recent reports:

- ***The report Adaptation Finance in the Context of COVID-19,*** developed in partnership with Climate Policy Initiative (CPI), had two objectives: first, to understand how adaptation finance flows could be affected by the pandemic and beyond; and second, to outline opportunities for stakeholders to identify and implement interventions that support a resilient recovery. The report highlights opportunities for increasing adaptation investment in the period of COVID-19 recovery, and proposes strategies for development finance institutions (DFIs) and governments to promote climate resilience. It also describes financial instruments that can be leveraged for recovery and resilience, and highlights the critical role of overseas development assistance (ODA) in financing climate adaptation, particularly for highly climate-vulnerable developing countries.[3]
- ***The report A Green and Resilient Recovery for Latin America,*** developed in partnership with the Government of Mexico and CELAC *(Comunidad de Estados Latinoamericanos y Caribeños),* analyzed COVID-19 recovery packages and climate regulations in the Latin American region, providing a pathway for their sustainable and resilient recovery.[4]

In an effort to inform government policy and strategies on how green investments can bolster a short-term economic recovery from the pandemic in Africa while also catalyzing long-term economic prosperity and advancing progress towards key climate commitments and the SDGs, the United Nations Economic Commission for Africa (UNECA), in partnership with Oxford University Economic Recovery Project (OUERP), Smith School of Enterprise and the Environment (SSEE) and the economics consultancy Vivid Economics, reviewed the COVID-19 recovery fiscal stimulus expenditures in selected African countries, analyzed their immediate benefits, and proposed ways to enable their sustainable green economic growth. Selected countries include the Democratic Republic of the Congo, Egypt, Kenya and South Africa.

The measures for green economic growth include energy, transport, and other sectors where greenhouse emissions can be reduced. Other measures would support the adaptation and resilience of African economies to climate change. Amongst economic activities that OUERP and partners indicated as presenting a high potential for levering green economic growth, two were prominent in all country case studies: agriculture, and natural capital services. Agriculture is a dominant sector in the economies of most African countries, accounting for 30–40 percent of GDP and providing jobs for over two-thirds of Africa's population. A focus on natural capital has the potential to bring economic, social and environmental benefits, creating jobs rapidly and safeguarding communities against climate change.[5,6,7] In addition, the energy sector is also a critical platform for investment. Even when its contribution in terms of jobs or value addition directly from energy may be less, it is a key mobilising factor in developing all sectors.

Our analyses show that there is a clear and strong co-dependency between agriculture, natural capital and climate change. Natural capital management provides a great variety of critical services to agriculture. Among them, for example, are ecosystem services (i.e., water, soil, nutrients, etc.) and regulating environmental conditions (i.e., physical protection against natural hazards like floods, tsunamis or wild fires, purifying water, etc.). On the other hand, we found that poor agricultural practices and management reduce the availability and quality of natural capital, which in turn may create a spiral of degradation of both natural capital and agricultural activities. Both sectors are extremely vulnerable to climate change. Climate change accelerates the depletion of natural capital and ecosystem services by altering major geophysical conditions—average surface temperatures, ocean temperatures, precipitation patterns, the oxygen content and acidity of seawater—too quickly for natural systems to adapt. When these changes reach thresholds that ecosystems can no longer sustain, natural capital and ecosystem services often degrade along a nonlinear path.[8]

The sustainable use of natural capital, particularly to address vast adaptation needs through nature-based solutions (NbS), and the adaptation of the agricultural sector to cope with current and future climate change impacts are vital for Africa's recovery and for resilient green economic growth.

This chapter reviews the opportunities and recommendations developed by OUERP and partners, for green economic growth particularly in the natural capital and agriculture sectors, which may benefit immensely from climate adaptation initiatives and yield the triple dividends of economic, social and environmental benefits much needed by the continent. It summarizes the analysis from 4 original papers with a focus on the modeling approach used; the impacts of the pandemic and the policy responses it elicited; the expected benefits from green growth spending; and recommendations for agriculture and natural-capital related sectors as well as priorities in the four selected countries. The full papers can be found on the OUERP website.[9]

Photo: Magnifical Productions/iStock

MODELING APPROACH

Aiming to estimate the direct and indirect economic impacts of different stimulus packages, the analysis used the economic model *Intervention & Investment Impact Model (I3M)*, The modeling approach is composed of four steps:

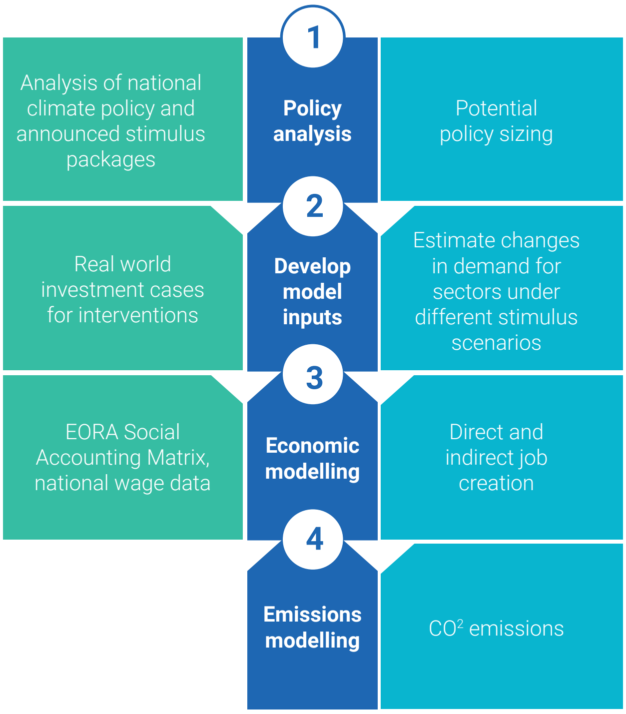
1. **Coordinate background policy analysis:** mapping of existing COVID-19-related spending policies for years 2020 and 2021, the policies included rescue-type spending such as household and job support programmes, as well as non-targeted business support. To consider recovery-type investment policies, a set of reference investments across core sectors was established. Vivid Economics designed a series of indicative green recovery policies to form a potential green recovery package. This package is tailored to the national context, while drawing on international best practice for designing green stimulus policies. These policies are categorized as recovery policies (incentive measures and investment measures) and rescue measures (temporary liquidity measures, temporary life and livelihood measures, and temporary tax and payment relief measures). They are analysed with regard to their:
    - potential environmental impact: GHG emissions and air pollution reduction, and conservation and sustainable use of natural capital;
    - potential social impact: wealth-inequality mitigation, quality of life increase, rural livelihood improvement; and
    - potential economic impact

2. **Develop model inputs:** translating interventions into 'shocks' for use in the I3M model and changing model shocks in sectoral final demand.

3. **Conduct economic modelling:** estimation of the direct and indirect economic impacts of the different stimulus scenarios. The shocks are applied to the model to estimate the direct and indirect economic impacts of the different stimulus scenarios. The direct economic impacts are those within the sector where demand has changed. For example, an increase in demand for solar power will directly increase jobs in the renewable energy sector, and indirectly bring upstream supply chain impacts.

4. **Conduct emissions modelling:** demonstration of the CO^2 emissions mitigation benefits of a green recovery.

Figure 1: Overview of modelling approach



Dark blue boxes summarize the steps in the analysis, green boxes indicate inputs at each stage, and light blue boxes indicate outputs.

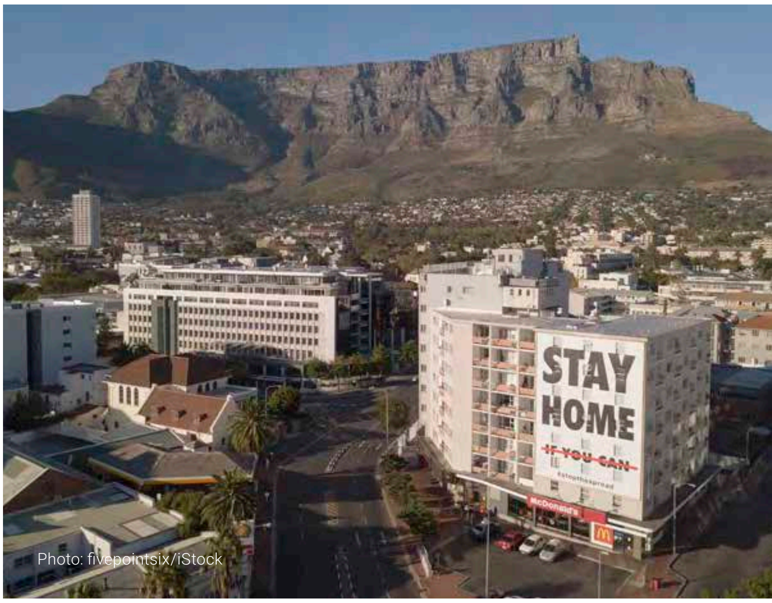


Photo: fivepointsix/iStock

COVID-19, FISCAL STIMULUS AND GREEN ECONOMIC GROWTH IN SELECTED AFRICAN COUNTRIES

Democratic Republic of the Congo

COVID-19 impacts and policy responses

The economy of the Democratic Republic of the Congo (DRC) is heavily reliant on metal and mineral exports. With the volatility in commodity prices as well as mobility restrictions imposed by the pandemic, the country's exports were deeply impacted, reducing taxation revenue by 46% in 2020. Pre-pandemic, the country's economy was forecast to grow 5.4% in 2020; instead, its GDP contracted by 2.2% (or 1.7% according to domestic estimates).[10] Before the pandemic, the DRC already faced one of the highest poverty rates and lowest energy access rates in the world. Due to the disruptions of COVID-19, poverty increased appreciably: 6.2 million new people (7% of the population) now face acute food insecurity.[11]

DRC has only 0.1 physicians per 1,000 people (compared to the global average of 1.6 physicians per 1,000 people), with health expenditure of just $30.72 per capita. Hence, the country was unprepared to deal with the magnitude of the pandemic's health impacts, which were further worsened by a new Ebola outbreak in April 2020 and a second wave of COVID-19 in late 2020.[12] Limited fiscal space and strong reliance on international support resulted in a constrained response to the pandemic. As of March 2021, the DRC had spent only $11 per person to contain the crisis, compared to an average in advanced economies of ~$11,000 per person and ~$640 per person in emerging market and developing economies.

International assistance has been crucial in the DRC's response to the pandemic, which has benefited significantly from concessional finance given by institutions such as the IMF and the AfDB among others. The country devoted CDF 1.9 trillion (USD $928 million) to short-term rescue measures and CDF 93 billion (USD $47 million) to longer-term recovery measures.[13] Although these figures are small by value, the government has responded to the crisis with new spending priorities. Most spending has been oriented to reinforce the healthcare system for handling COVID-19, to support macro-economic stability and economic recovery, and to reinforce social security, particularly for vulnerable populations. The environmental characteristics of the initiatives covered by the stimulus package are unclear and, to date, green recovery spending has been almost zero.

Moving towards green and resilient economic growth

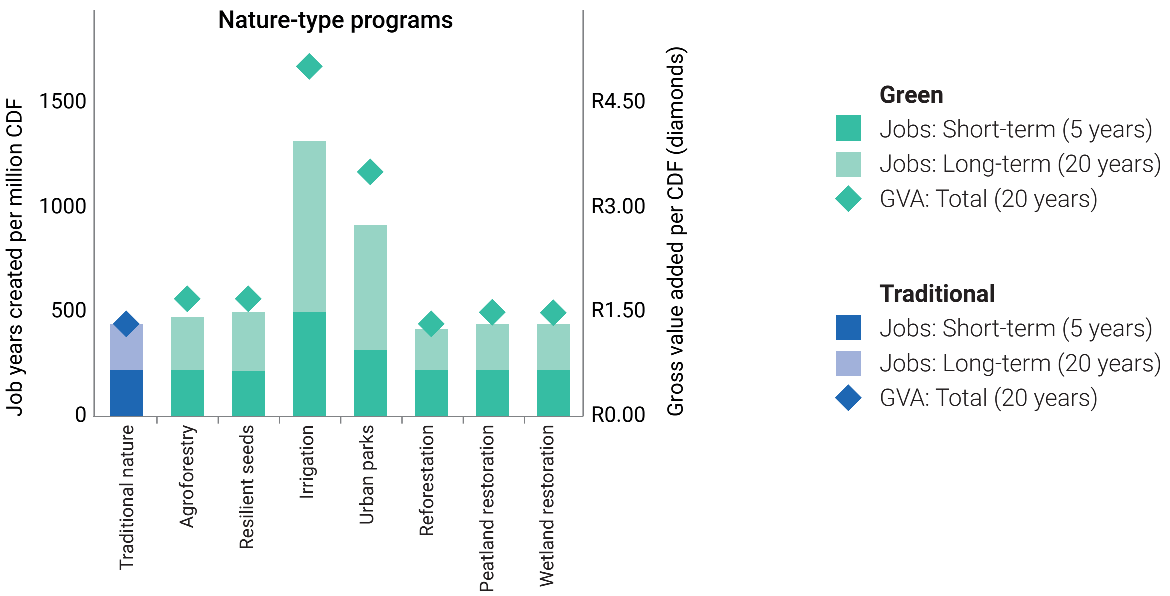
The DRC holds the African Union presidency, and is well positioned to establish itself as a global leader on climate and environmental sustainability. Alongside benefits to the country's reputation in the international sphere, green stimulus measures are a promising option for short-term job creation and the economic recovery of the DRC.

Green and resilient stimulus measures can be one of the DRC's strongest spending options in support of economic recovery in the coming years, boosting both short-term job creation and growth and laying the foundation for future prosperity. The DRC must ensure that domestic institutions are capable of dispersing increased volumes of aid equitably, transparently and diligently. The provision of concessional finance by international partners, particularly through green and resilient assistance, is imperative to significantly uplift the economic, social, and environmental future of the DRC. Natural capital stands out as a potential sector with strong potential to yield triple dividends to the country. Figure 2 shows a subset of potential job creation through green and resilient spending in selected sectors compared to traditional spending.[14]

"Africa needs and defines adaptation as prosperity. 250 million people will go to bed hungry tonight. 400 million people have no energy. That is what adaptation means for Africa."

Vera Songwe, Executive Secretary, UNECA

Figure 2: Job and Gross Value Added (GVA) impacts of a subset of green spending focused on adaptation and resilience, compared to traditional spending in the Democratic Republic of the Congo. All modelled policies.



Source: modelling output from Vivid Economics

Natural capital

DRC is home to some of the most impressive and abundant natural resources on the African continent, and is one of the richest sites of biodiversity in the world.[15] The country's natural capital is a major asset and agriculture is a key driver of the economy, with almost two-thirds of the total working population employed in the sector.[16]

Natural capital investment supported by international partners is likely to bring large benefits for DRC on economic, environmental and social levels. Alongside a swift expansion of jobs, a rise in economic activities and enhanced living conditions, NbS can generate improvements in air quality and agricultural yields and safeguard communities against climate change, making the DRC more resilient to future shocks.[17] The country should capitalize on its natural resources through programs such as agroforestry, resilient seeds and irrigation, urban park development, peatland restoration, and reforestation.

OUERP's analysis suggests that natural-capital related investments could be among the top green-related investments that the government could make, with particularly strong impacts for the DRC. Nature-based interventions include restoration of habitats, agricultural interventions that sustainably boost productivity and protect livelihoods, and urban greening. Provided there is appropriate and consultative design, these can be implemented quickly, create low-skilled jobs, and can be one-off investments. They are not susceptible to investment leakage outside of the country, ensuring that stimulus is focused on the domestic economy. These opportunities could act as climate adaptation safeguards, protecting against the impacts of climate change. In doing so, they can also increase the resilience of the economy.

- **Agroforestry:** agroforestry and habitat restoration can decrease the likelihood and severity of droughts by improving soil water retention, slowing water loss, and regulating water flow. Agroforestry practices can also decrease livestock loss due to heat stress, thanks to improved shading.

- **Resilient seeds and irrigation:** DRC's agriculture sector is particularly vulnerable to the changing global weather patterns and climate shocks. Policies which build a resilient agriculture can both support jobs today and enable the DRC to better adapt to changing climatic conditions. This includes investments in irrigation and drought-resistant seed technologies that enable farmers and their cultures to withstand droughts. Investments in resilience-focused projects could lead to high economic returns, with CDF1.7 to CDF2 in revenue for every CDF1 spent. These economic benefits would increase farming revenues, enabling farmers to then reinvest into these practices.
- **Urban parks:** Kinshasa is the second largest city in Africa and is projected to have a population of at least 20 million by 2030. Urban parks support recreation, health, and well-being, translating into a healthier population, improved human capital, and lower pressure on health services.
- **Restoring peatlands:** the process of restoring and conserving peatlands aims to cover bare peat areas with vegetation, blocking drains to raise the water table, and reintroducing mosses and other plants into areas where they have been lost.
- **Reforestation:** reestablishing natural forests, planting more native species, or increasing the density or extent of an existing forest. Well-managed, consultative, and participatory reforestation can enhance wildlife habitats, support biodiversity, protect water supplies, develop recreational opportunities, and address numerous issues associated with climate change, including through carbon sequestration.

Photo: Petri Oeschger/iStock

Arab Republic of Egypt

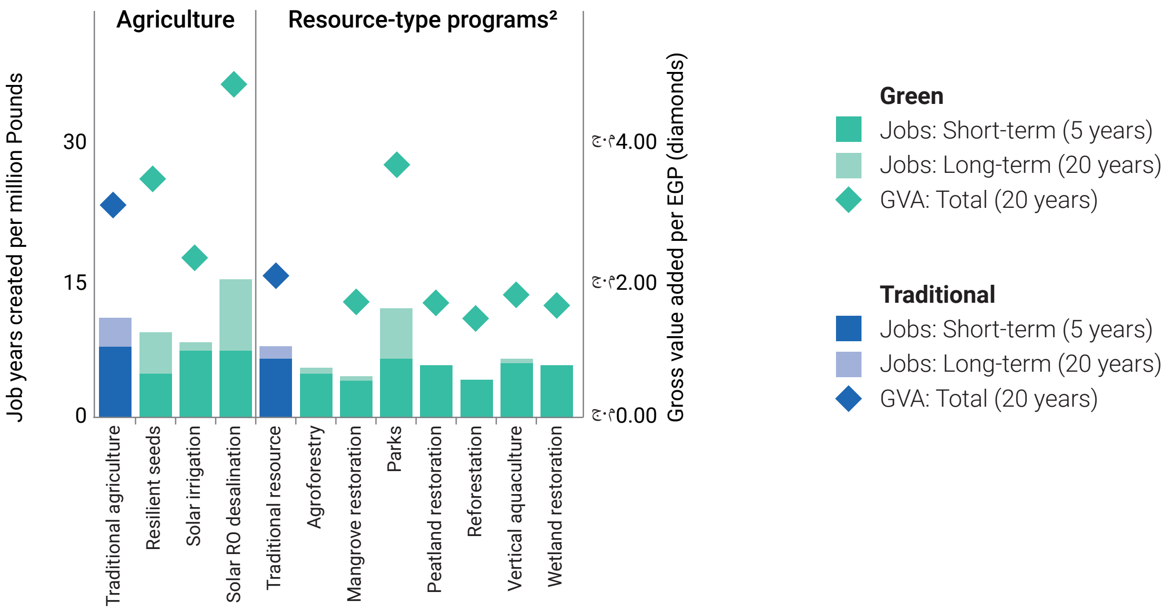
COVID-19 Impacts and policy responses

Once known as one of the fastest growing economies in Africa and the Middle East, Egypt has seen its economy hit by COVID-19 impacts just as the reforms of the two previous decades were set to begin paying off.[18] The combination of the partial lockdown and the collapse of the tourism sector caused a contraction in GDP of 1.7% in the second quarter of 2020.[19] The slowdown in economic activities triggered an increase in unemployment, which went from 7.7% to 9.6% between the first and second quarters of 2020—2.7 million jobs were lost during the second quarter of 2020 alone.[20]

In order to reverse this slide, the Government of Egypt has put in place measures to attract investments that encourage job creation and improve the living standards of the country's large and growing population. To that end, policymakers are working to cut red tape, reduce debt, leverage investments in the infrastructure sector and develop human capital and social protections.[21] In 2020 Egypt allocated 3.8% of GDP to COVID-19-related spending, with 0.4% of GDP for long-term recovery spending, compared to the G20 (excluding the EU) average of 18.5% of GDP for COVID spending and 2.3% for recovery, and, in low- and middle-income countries (LMICs), 10.6% of GDP spent on the pandemic and 1.6% for recovery. The major share of this spending is a fiscal stimulus package of EGP 110 billion to support the healthcare system, as well as social programs, announced in March 2020.[22] Although this fiscal stimulus package provided the immediate support needed to control socioeconomic shocks, little or no spending covered by this initiative was explicitly green. On the contrary, from this package, EGP 3.5 billion was allocated to extend natural gas pipelines and EGP 5 million was used to support the aviation and tourism industries.

Notwithstanding this, in September 2020 Egypt issued $750 million in green bonds, of which $500 million was used for funding five key green projects: one desalination plant, three wastewater treatment facilities, and one monorail project.[23] Preventing a water crisis is a top priority for the government and funding new desalination plants and wastewater treatment facilities will support Egypt become more resilient to climate change impacts and ensure the availability of water resources to people and for economic activities.

Figure 3: Job and Gross Value Added (GVA) impacts of a subset of green spending focused on adaptation and resilience, compared to traditional spending in the Arab Republic of Egypt. All modelled policies.



Source: Modelling output from Vivid Economics

Moving towards green and resilient economic growth

The rise in unemployment, combined with school closures, is likely to increase underemployment and force people into working in 'the wrong' jobs.[24] These impacts are likely to disproportionately affect young people[25] and, without a more skilled labor force, the country is at risk of facing a severe social and economic crisis in the long term. Recovery policies in Egypt should prioritize the creation of jobs, particularly for the youth and in the formal sector. Along with job creation, Egypt must provide support for the education and training of young adults, with a specific focus on preparing them for the green jobs of the future. Furthermore, it is vital to enable access to finance for green start-ups and Micro, Small, and Medium enterprises (MSMEs) to create more opportunities for young Egyptians, as well as to sustainably boost the country's economy. The figure below shows a subset[26] of potential job creation through green and resilient spending in selected sectors compared to traditional spending.

Agriculture and water

Agriculture accounts for 11% of national GDP and 29% of jobs. It is concentrated largely in the Nile basin area, which is highly vulnerable to the negative impacts of climate change.[27] Investments in sustainable large-scale projects to bolster water supply, including desalination plants and wastewater treatment plants for water reuse, increase the circularity of water in intensely farmed areas, providing resilience to climate shocks and enabling the continuity of the activities of the sector in adverse scenarios.These capital-heavy efforts should be complemented with incentives to improve micro-level irrigation efficiency and solar-powered irrigation.[28]

As an emerging agro-industry, biofertilizers can also deepen the circular economy, limit waste generation, and catalyze enterprise in the local community, with significant job creation. The viability of biofertilizer investment is showcased by the success of Baramoda, an Egyptian company transforming agricultural waste into biofertilizers.[29]

Photo: Aleksandar Todorovic/Shutterstock

Republic of Kenya

COVID-19 Impacts and policy responses

The Kenyan economy was hit hard in 2020 by the COVID-19 pandemic. On a macroeconomic level, the mobility restrictions imposed by COVID-19 impacted the country's export, tourism and remittance inflows.[30] GDP decreased by 5.5% in the second quarter of the year—the first quarter of negative growth in 8 years,[31,32] —and the second wave of the pandemic in December 2020 induced even deeper economic distress. A national survey revealed that 22% of households (10.7 million Kenyans) reported increased food insecurity during the lockdown.[33] The World Bank estimates that additional two million people have fallen into poverty.[34]

In response to COVID-19, in 2020, Kenya spent ~$10 per person, compared to an average in advanced economies of ~$11,000 per person and ~$640 per person in emerging market and developing economies. The bulk of announced spending in Kenya is contained in a KES 38 billion package released in May 2020,[35] which targeted direct cash transfers to the vulnerable, liquidity support measures for businesses and major industries, and healthcare spending.

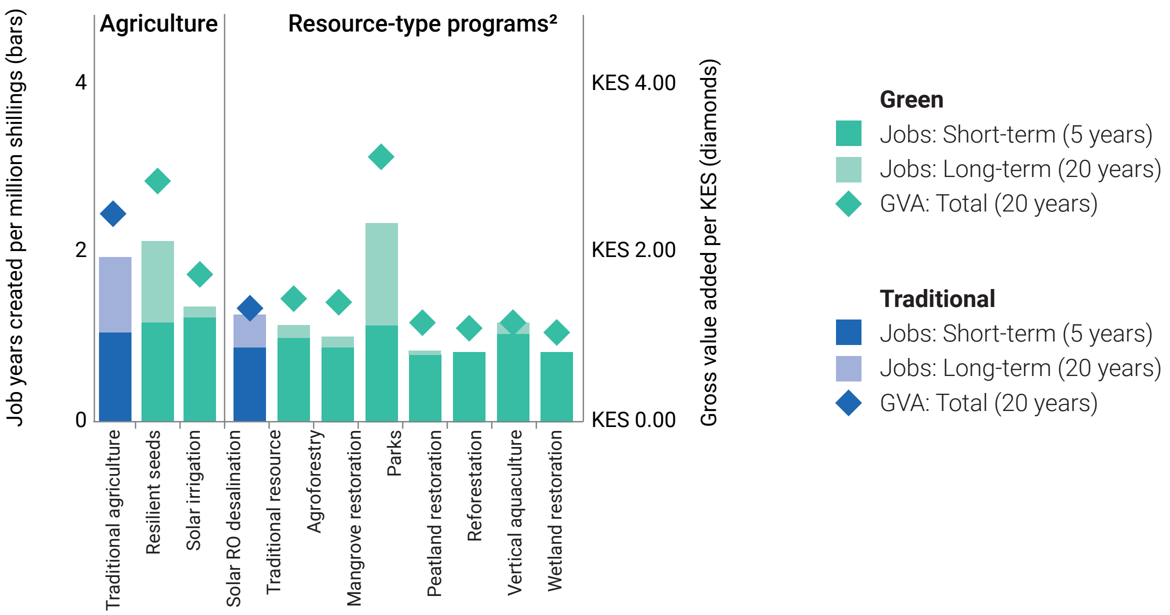
Kenya spent a higher proportion of recovery funds on green initiatives than most nations, with more than KES 4 billion of its recovery package being directed to explicitly green initiatives, including funding for wildlife conservation, reforestation, and flood control. Nevertheless, significant green opportunities still remain uncaptured.[36]

Moving towards green and resilient economic growth

Debt constraints, low credit ratings and limited fiscal space have restricted Kenya's ability to fund sufficient levels of rescue or recovery spending. The provision of concessional finance by international partners, including foreign governments and multilateral organizations, is imperative to significantly reshape the economic, social and environmental future of the Kenyan population. In response, Kenya must ensure that domestic institutions are capable of dispersing increased volumes of aid equitably, transparently and diligently.

Kenya should urgently invest in a sustainable economic recovery plan that prioritizes natural capital solutions. This plan should be based on the existing national green framework for growth and development, and should be capable of strengthening the country's directives for green economic growth.

Figure 4: Job and Gross Value Added (GVA) impacts of a subset of green spending policies focused on adaptation and resilience, compared to traditional spending measures in the Republic of Kenya. All modelled policies.



Source: modelling output from Vivid Economics

Figure 4 shows a subset[37] of potential job creation through green and resilient spending in selected sectors compared to traditional spending.

Natural capital

Kenya relies heavily on natural resources, including for the agricultural sector, which contributes to roughly 33% of GDP and more than 40% of employment;[38] as well as the drastically hit travel and tourism sector, which contributes to 8.8% of GDP and 8.3% of employment.[39] Investments in nature-based solutions have the potential to reinvigorate the tourism and travel industry. They can bring economic, social, and environmental benefits, creating jobs rapidly and safeguarding communities against climate change.[40] Kenya should capitalize on NbS through programs such as agroforestry, reforestation, resilient seed and irrigation programs, and the development of urban parks.

- **Agroforestry:** agroforestry and habitat restoration can decrease the likelihood and severity of droughts by improving soil water retention, slowing water loss, and regulating water flows. Through improved shading, agroforestry efforts can also decrease livestock loss due to heat stress.
- **Reforestation:** well-managed, consultative and participatory reforestation can enhance wildlife habitats, support biodiversity, protect water supplies, develop recreational opportunities, and thereby address multiple climate hazards.
- **Resilient Seeds and Irrigation:** investments in irrigation and drought-resistant seed programs enable farmers to better withstand droughts and could lead to high economic returns, with KES1.7 to KES2.8 in revenue for every KES spent. These economic benefits would increase farming revenues, enabling farmers to then reinvest into these practices, further enhancing their benefits.
- **Urban parks:** Green spaces support recreation, health and wellbeing, translating into a healthier population, improved human capital, and lower pressures on health services. They can also make cities more attractive to tourists and business travellers, enhancing Nairobi's position as an international business centre.

South Africa

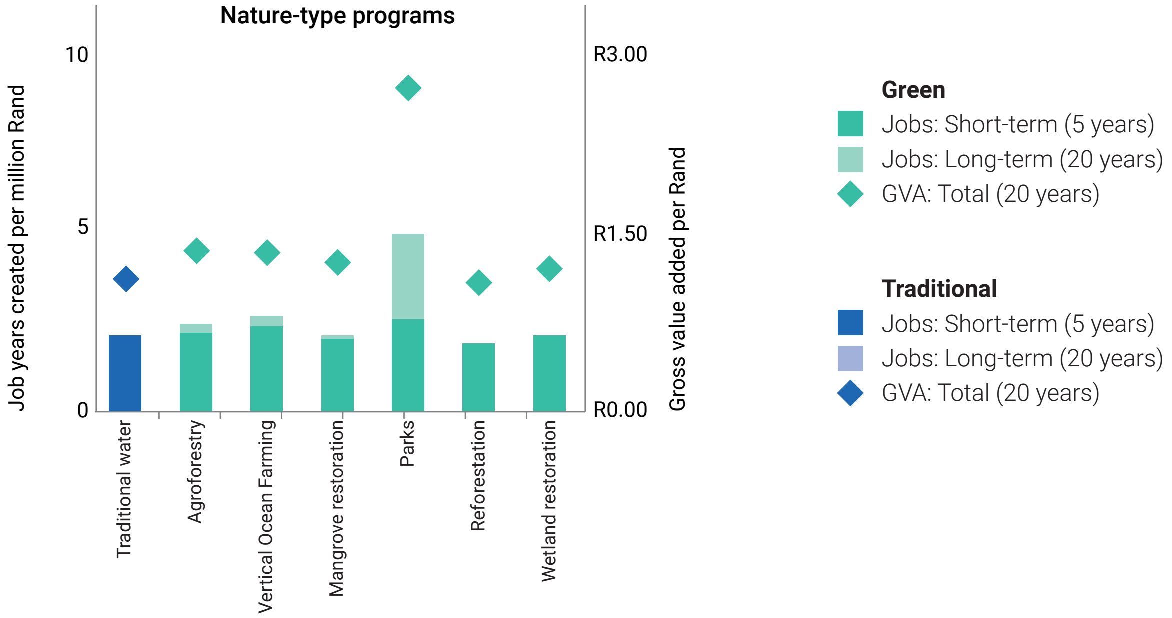
COVID-19 impacts and policy responses

Preexisting economic fragility and persistent inequality intensified the impacts of COVID-19 in South Africa. The country recorded an economic contraction of 8.0% in 2020 and an unemployment rate ballooning to 37%.[41] The pandemic has pushed thousands of families below the poverty line, particularly households headed by women, black households, and those with lower levels of education.[42] The second wave in December 2020 created even stronger socio-economic adversity. Economists predict that the country may not fully recover until 2025.[43]

Rescue spending has totaled 11.5% of GDP in 2020, compared to an average of 14.2% of GDP across the G20 countries. During the same period, 0.3% of GDP was earmarked for recovery, compared to the average of 2.1% among G20 countries (excluding the EU) and 1.6% in low- and middle-income countries (LMICs). It is likely that low recovery spending has so far been driven partly by the continuing prevalence of the virus, as well as by a lack of affordable borrowing options. In 2020, South Africa announced spending of more than ZAR 630 billion ($44 billion) to alleviate socioeconomic disruptions caused by the pandemic. The country used ZAR 612 billion ($42 billion) to bolster the healthcare system and prevent virus transmission, as well as to provide tax deferrals and loan guarantees to businesses, and direct payments and unemployment insurance to individuals. Also among these measures was a deferral of carbon tax payments. Only ZAR 18 billion ($1 billion) was directed to economic recovery measures.

An Economic Reconstruction and Recovery Plan, aiming to achieve economic recovery largely through infrastructure investment, was announced in October 2020.[44] Details on the implementation of the plan are still scarce. However, it clearly entails a greener approach to forthcoming investments in the transportation, energy, sanitation and agriculture sectors.

Figure 5: Job and Gross Value Added (GVA) impacts of a subset of green spending, focused on adaptation and resilience, compared to traditional spending in South Africa. All modelled policies.



Source: modelling output from Vivid Economics

Moving towards green and resilient economic growth

Pairing green and resilient investments with health and education infrastructure programs, as well as with initiatives that support the agriculture sector to become more sustainable and resilient to shocks, will increase the effectiveness and sustainability of these investments. Alongside these, extensive skills training programs in green business and services could reduce unemployment by empowering the local labor force to meet the needs of large-scale green investment programs. Figure 5 shows a subset[45] of potential job creation through green and resilient spending in selected sectors compared to traditional spending.

Natural capital

NbS can sustainably boost agricultural productivity, protect assets and livelihoods, enable urban greening and support the conservation of the environment and biodiversity in South Africa. Alongside adaptation and resilience benefits, the implementation of NbS can create quick-entry jobs and bring returns for the badly hit travel and tourism sector, increasing the resilience of the economy to future shocks. Investment in natural capital and green spaces could therefore yield significant economic, environmental and social benefits for South Africa. The country should capitalize on NbS through programs such as agroforestry, wetland and mangrove restoration, reforestation and vertical ocean farming.

- **Agroforestry:** agroforestry and habitat restoration can decrease the likelihood and severity of droughts by improving soil water retention, slowing water loss, and regulating water flow. Agroforestry efforts can also decrease livestock loss due to heat stress, through improved shading.
- **Wetland restoration and mangrove restoration:** rehabilitation of mangroves and wetlands stabilizes coastlines, buffers against extreme weather events, and reduces the risk of soil erosion.
- **Reforestation:** well-managed, consultative, and participatory reforestation can enhance wildlife habitats, support biodiversity, protect water supplies, develop recreational opportunities, and address numerous issues associated with climate change.
- **Vertical ocean farming:** supply chain interventions combining plants (seaweed and sea vegetables), fish, and mollusks into the same farming system can improve food security and resilience to food shortages and disruptions. They diversify production and can shorten the length of supply chains.

> **There are fantastic initiatives across the [African] continent to enable communities to adapt in the face of climate change.”**
>
> **Alok Sharma, President of COP26**
> Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

Photo: Adeyinka Yusuf/iStock

CONCLUSION

As the examples of the four focus countries in this chapter show, COVID-19 has caused a severe disruption to the countries of Africa, with huge consequences for both lives and livelihoods. Further, the absence of much fiscal space to generate remedial measures has meant that African countries have been able to spare only a small fraction, when measured per person of the population, of the sums spent in the developed world and in low- and middle-income countries elsewhere in the world on relieving economic distress and providing safety nets.

But in the present crisis there is also a window of opportunity. As the nations of Africa seek to rebuild their economies, a new policy orientation emphasizing green and sustainable growth can not only boost the economy and create jobs on a large scale, it can also make the continent more resilient against the long-term challenges of climate change. Key common principles that define and govern the “green growth” approach to development include: sustained economic growth; resource-use efficiency; climate change response through adaptation and mitigation; creation of decent green jobs; and human well-being and social inclusiveness.

These country case studies have a significant percentage of their populations involved in and a significant share of their GDP generated by agriculture and related activities, which are themselves greatly dependent on a stable environment and healthy and sustainable ecosystems. As they seek to rebuild after the pandemic and also to restructure their economies in the face of climate change, focusing on adaptation and natural-resource management can have many beneficial effects, among them the large-scale creation of sustainable “green jobs” and the climate-proofing of past, present and future gains from development.

The needs and possibilities of each country are slightly different, and a key finding is that under the broad rubric of green growth there is considerable room for the generation of particular portfolios of policy options tailored to each case. The provision of concessional finance by international partners, including foreign governments and multilateral organizations, is imperative for a successful COVID-19 recovery for Africa and also to significantly reshape the economic, social and environmental future of the continent.

Finance

KEY MESSAGES

There is a pressing need to accelerate finance for climate adaptation in Africa over the coming decade. The NDCs of 40 African countries cumulatively show a need for an estimated $331 billion in investment for adaptation through 2030, with about 20 per cent of this sum coming from their annual budgets.

That would create an adaptation investment shortfall of approximately $265 billion through 2030, which needs to be met by international donors and domestic and international financiers. In the wake of the COVID-19 shock to the global economy, robust flows of foreign direct investment and domestic private investment are critical to maintain a high baseline for potential adaptation mainstreaming.

Adaptation and resilience spending have not had a prominent role to date in the economic recovery packages adopted by most African countries in the wake of the COVID-19 pandemic. But major Development Finance Institutions (DFIs) around the world have committed an appreciable portion of their budgets to adaptation and to Africa, and are also devising innovative models for the deployment of these funds.

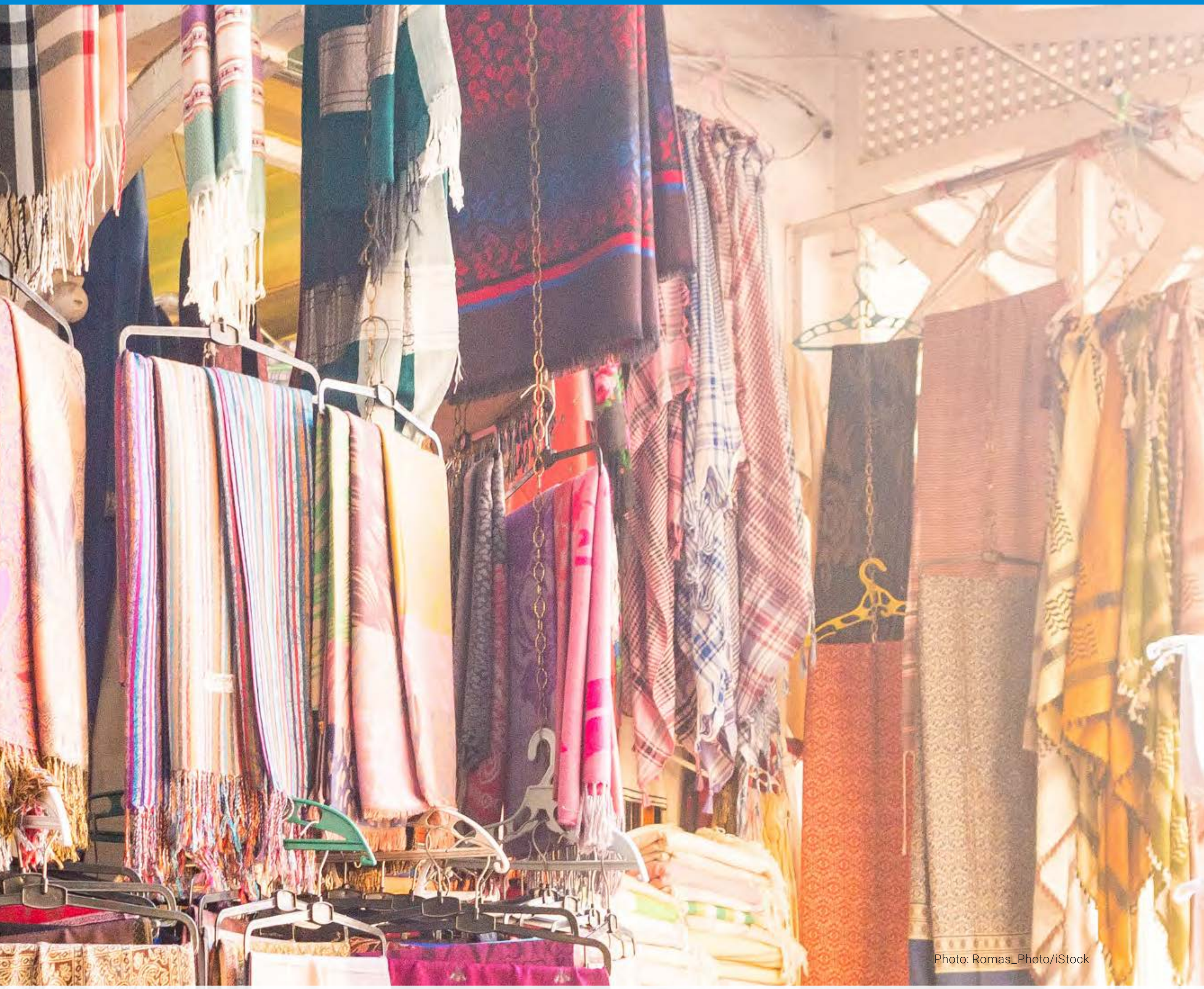


Photo: Romas_Photo/iStock

There are many potential sources of adaptation finance for Africa, offering finance on a range of terms from highly commercial to highly concessional. Governments and stakeholders must mobilize different blends of these finances to ensure that adaptation efforts can be sustained on a consistent path, even as there is a greater effort made to generate high-quality, low-cost climate data and to translate climate science into policy.

African countries and governments must also focus on creating an enabling policy and regulatory environment for climate adaptation, and on building institutional capacity and mainstreaming resilience into their economic policy.

“We must help people cope with the impacts of a climate that is already changing, thinking more innovatively about adaptation and adaptation finance is key to this.”

Secretary Janet Yellen, US Secretary of the Treasury
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

Current adaptation finance flows to Africa are insufficient to meet growing adaptation needs on the continent.[1] This chapter provides an overview of existing adaptation finance flows in Africa and identifies opportunities to increase the volume and efficacy of that finance. The core objectives of this chapter are to:

- **Assess the state of adaptation finance and risk-finance mechanisms** already available and in use in Africa.
- **Analyze African financial market readiness** for climate adaptation finance and risk-finance mechanisms.
- **Identify gaps where climate risk exists yet there is insufficient finance** to address it, as well as the barriers to implementation.
- **Propose solutions to increase the volume and variety of capital** available for adaptation finance and risk-transfer mechanisms in Africa and to enable pipelines for adaptation and dual-benefits projects in the region.

Financial flows to adaptation in Africa fall far short of the needs

There is a pressing need to increase investment in climate change adaptation in Africa. While only six African countries have submitted National Adaptation Plans (NAPs) to date, all African countries, with the exception of Libya, have submitted Nationally Determined Contributions (NDCs), all of which include an adaptation component, as part of their commitment to the 2015 Paris Agreement. Based on these NDCs, all African regions prioritized at least three of these four sectors: 1) agriculture 2) water 3) health 4) forestry, land-use, and ecosystems. 40 African countries provided estimated investment needs for adaptation, totaling roughly US$331 billion through 2030.[2] Fifteen countries[3] provided a breakdown of conditional vs unconditional cost estimates,[4] with an average ratio of 80:20.

An average 80:20 ratio indicates that of the $331 billion estimated investment need (or $33 billion annually), countries expect to contribute around $66 billion (or $6.6 billion annually) from their national budgets, while the remaining investment gap of $265 billion or $26.5 billion annually) must be met by international donors and domestic and international financiers.

Globally, an annual average of $46 billion in adaptation finance was tracked for 2019 and 2020, mostly provided by public actors (DFIs alone accounted for 80 percent of the total). Due to data limitations, nearly all flows tracked are from international public finance.[5] Approximately $7.9 billion was tracked in adaptation finance to Africa in that period.[6] If this trend continued through 2030, total finance from 2020-2030 would amount to $87 billion, far short of the $331 billion (or approximately $30 billion annually) in estimated needs per stated cost estimates in NDCs. Adaptation finance is therefore scaling too slowly to narrow the gap, even as the costs of climate impacts rise.

Of the $7.9 billion in adaptation finance tracked, grants and concessional debt accounted for approximately 68 percent of financial flows to adaptation in Africa. Two sectors - agriculture, forestry, land-use and natural resource management; and water and wastewater management - combined to receive the majority of sectorally identifiable adaptation finance in 2019-20. Regional analysis of adaptation finance by sector is available only through 2017-18, so Figure 1 represents tracked adaptation finance over that period.

The majority of finance flowed from Development Finance Institutions (DFIs) both from the region and external to Africa: multilateral, national, and bilateral DFIs contributed and managed 63 percent of total adaptation finance[7] flows to the region, followed by bilateral government flows at 28 percent. The most vulnerable countries in Africa have not been recipients of proportionally high volumes of adaptation finance. There is limited to no correlation at the country level between climate vulnerability and adaptation finance overall or per capita.

Figure 1: Tracked adaptation finance by region and sector (USD, 2017–18 average)

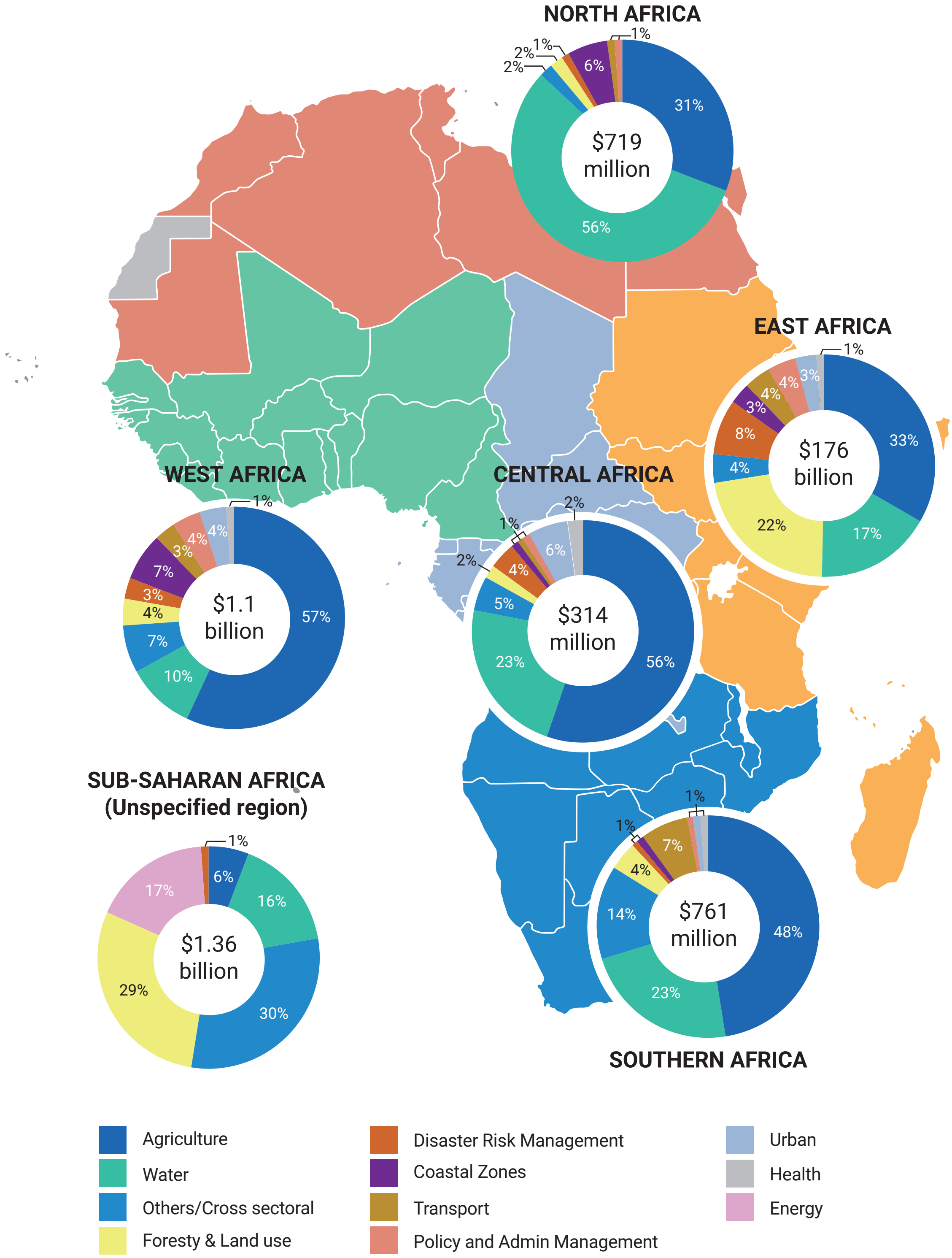


Photo: Africanway/iStock

The COVID-19 pandemic creates significant uncertainty in future adaptation flows, as well as the opportunity to catalyze a resilient recovery

Key factors that are likely to have impacted the volume of adaptation finance in 2020 and will continue to affect future adaptation finance flows are as follows.[8]

Negative factors:

- **Inclusion of resilience in stimulus packages is limited.** In an upcoming study, the World Resources Institute reviewed the 2020 fiscal stimulus packages of 66 countries—including all G20 and V20 countries—for whether and how they included climate resilience. Less than one-third (18) of the responses were found to integrate physical climate-risk awareness and resilience components, including just two African countries: Niger and Kenya. This limited inclusion of resilience in stimulus packages suggest that there is a potential missed opportunity to ensure that climate risks are considered in new funding allocations. Beyond the limited inclusion of climate resilience, the size of stimulus packages in developing economies has been much smaller than those in developed economies, with middle-income countries spending 6% of GDP and low-income countries spending 2%, compared to 24% of GDP spent in high income countries, in 2020.[9]
- **Private sector investment has declined in the short term**. Although capital outflows stabilized relatively soon after hitting record lows in March 2020, foreign direct investment (FDI) declined 16% in 2020 in Africa to $40 billion, a decline to 2005 levels of investment.[10] Liquidity support for firms was also largely not conditional on adopting any climate resilience measures. Given the potential for private sector investment in adaptation activities, robust flows of foreign direct investment and domestic private investment are critical to maintain a high baseline for potential adaptation mainstreaming.
- **The COVID-19 pandemic continues to severely impact developing economies.** Just over 50 million doses[11] of COVID-19 vaccines have been administered across a continent with a population

of 1.3 billion. As of October 2021, just 6 percent of Africa's population had been fully vaccinated.[12] Adaptation finance flows in future years will depend heavily on vaccine distribution speed and equitability to enable recovery of sectors critical to Africa's macroeconomic prospects, including international trade and tourism.

Positive factors:

- **Multilateral Development Bank (MDB) adaptation finance commitments to Africa increased substantially in 2020 from 2019 levels.** The group of MDBs reported $4.7 billion in adaptation finance committed to sub-Saharan Africa in 2020, vs $3.6 billion in 2019.[13] For Middle East-North Africa, $1.4 billion was committed in 2020, vs $1.0 billion in 2019. It is not clear if this increase is sustainable without re-capitalization or replenishments of MDB funding, which was spent quickly to counter the effects of the pandemic. For example, the 32% increase in adaptation finance commitments across the two regions is roughly proportional to the total increase in MDB commitments in 2020, estimated at 39%.[14]
- **MDB climate finance targets are increasingly targeting adaptation.** In 2019, nine MDBs announced a collective commitment to double their total levels of adaptation finance provided to clients by 2025, to $18 billion annually.[15] Towards that end, the World Bank announced a 35% target for climate finance as a proportion of total finance from 2021–2025, of which at least 50% will support adaptation. The African Development Bank (AFDB) has committed to a target of at least 40% for climate finance by 2025, to a doubling of climate finance to $25 billion between 2020 and 2025, and to prioritizing adaptation finance.
- **The IMF is firmly committed to deal with climate risks by** integrating climate in its economic and financial services. In addition, a proposed allocation of Strategic Drawing Rights (SDRs) of $650 billion would benefit all IMF members, including in Africa, and could support a global green and resilient recovery.
- **A group of Development Finance Institutions is collectively advancing adaptation finance efforts.** Under the DFIs+ Adaptation and Resilience Collaborative, members are advancing a set of actions to accelerate finance to adaptation and resilience. The group has made several commitments, including to pursue a substantial increase in investments in adaptation and resilience, to move towards ensuring all investments made have been assessed for and are resilient to climate risks, and to increase support and collaboration to shape markets and build pipelines of bankable investments in climate adaptation.[16]
- **New innovative models are being launched to address the gap.** For example, the GCA and the AfDB have jointly developed the African Adaptation Acceleration Program (AAAP). The AAAP was launched at the Climate Adaptation Summit in January 2021 and aims to mobilize $25 billion towards adaptation activities in Africa by 2025. AfDB has committed $12.5 billion to the AAAP. The remaining $12.5 billion is to be mobilized through partnerships and domestic resource mobilization through national governments and the private sector and will be centered on four action areas:
  - Innovative financial initiatives to enhance access to finance and mobilize new investment in adaptation activities (potential innovative finance mechanisms are highlighted further in Table 3), through support to the development of debt instruments in viable markets and training programs to increase technical capacity in climate risk assessment and financial structuring.
  - Climate-smart digital technology for agriculture and food security to help smallholder farmers increase yields and drive climate resilience in the agriculture sector.
  - An African Infrastructure Resilience accelerator to mobilize investment in climate resilience infrastructure through project preparation initiatives and innovative finance mechanisms including debt-for-resilience swaps.
  - Youth empowerment in entrepreneurship in climate adaptation and resilience with the aim to generate climate-resilient jobs for youth and to strengthen youth entrepreneurship via an incubator program and training programs.

- **With appropriate policy approaches, there is substantial potential for a green and resilient recovery.** There are efforts underway to drive a resilient recovery to COVID-19 in Africa, including through the Debt Service Suspension Initiative, through the Access to COVID-19 Tools Accelerator, and through moves to issue and allocate new Special Drawing Rights. These efforts all have the potential to help facilitate a resilient recovery and additional investment in climate adaptation.[17] A resilient recovery also has the potential to address challenges Africa faced prior to COVID-19, including youth unemployment, high climate risks, poor infrastructure, and weak governance. Investment in climate-resilient infrastructure, nature-based solutions, technology, and other sectors has significant potential to address underlying climate risks and respond to pre-COVID-19 challenges.

Adaptation investment needs to be mobilized from a wider variety of finance sources

Future adaptation finance for Africa is expected to more than double by 2025 based on announced commitments discussed above. However, even if many of the main DFI actors adopted best practice commitments (similar to World Bank's commitment to dedicate 35% to climate finance, of which 50% will be for adaptation), and even if currently announced private sector mobilization efforts are successful (assuming at least 20% of MDBs' $40 billion private sector mobilization target goes to adaptation in Africa), annual adaptation finance flows may still not meet minimum estimated investment needs by 2025.

"Let us come together as it is our mission to protect the planet for today's and for future generations, let us do the absolute best through global solidarity. It is no longer about me, myself, and I – but it is about us as a global community."

H.E. President Wavel Ramkalawan of Seychelles, Chair of the AU commission on the Island States
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

To mobilize further investments and to increase the impact of investments in terms of building resilience, a wider variety of sources of finance need to be tapped. Public spending alone cannot meet the adaptation finance gap, so private sector investment must scale alongside public investment to supplement limited public resources.[18] Figure 2 summarizes the financial actors which have a role to play in mobilizing finance for adaptation at scale in Africa. These actors offer financing along a spectrum of terms, ranging from highly concessional terms (lower return expectations and/or longer tenors) to commercial terms (market returns and tenors expected). Concessional capital is intended to fill a gap where the private sector (commercial capital) would not otherwise invest.

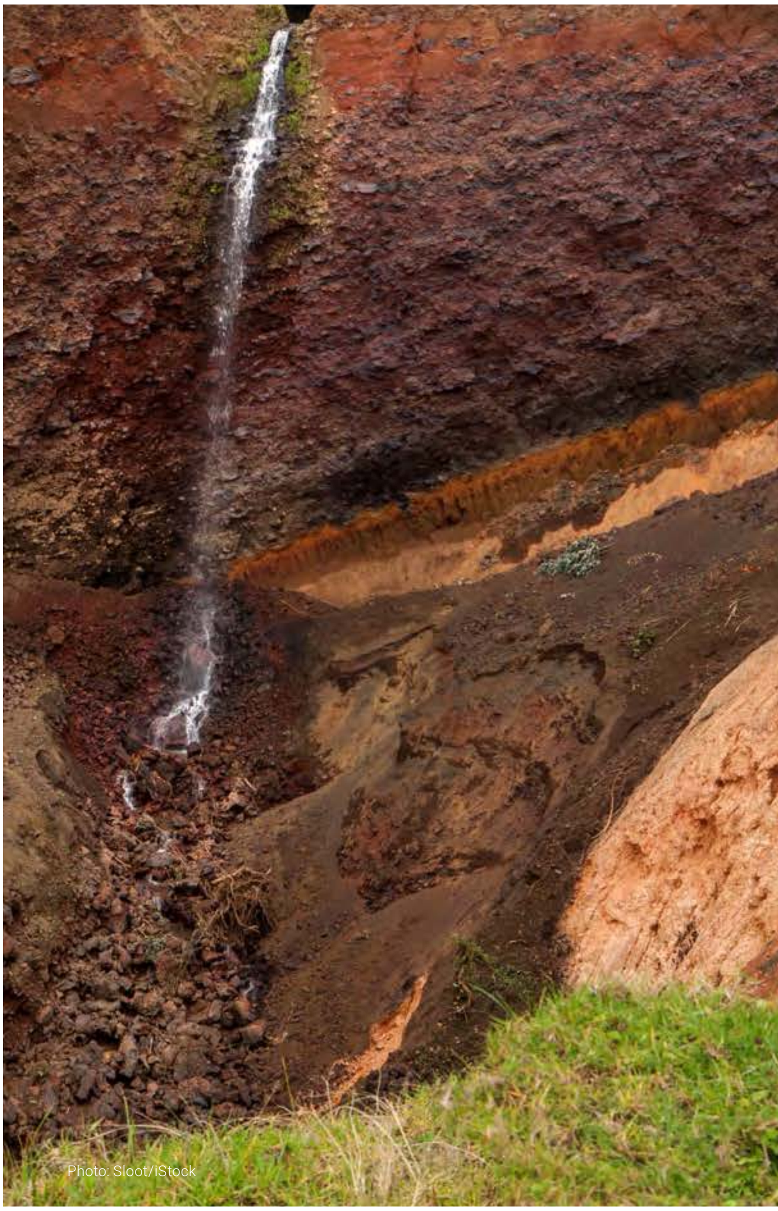


Photo: Sloot/iStock

Figure 2. Potential sources of adaptation finance in Africa

Offer Finance on Commercial Terms

- **Commercial banks:** Commercial banks can raise their own funds through bank deposits and are governed by international standards set by Basel II and III regulations for capital adequacy. Commercial banks have networks that can be leveraged including relationships with farmers, co-operatives, and MSMEs and can build technical capacity to structure financial instruments in partnership with development banks and other concessional finance providers.
    - **Pan African banks:** PABs can invest in MSMEs and mainstream resilience into their lending portfolios. PABs have been successful in increasing firms' access to finance and increasing competition and efficiency in the banking industry and can have a positive impact on micro-prudential stability with the least cyclical behavior in times of crisis.
- **Private equity and venture capital:** Africa's PE industry was cultivated by DFIs that had a mandate to invest in private sector businesses in Africa to promote social and economic development. Gradually the industry expanded and by 2020, there are more than 150 active fund managers of different sizes spread across geographies and sectors in Africa. The nature of their investments is suitable for scaling up adaptation finance and has potential for investment in new and innovative adaptation technology and services.
- **African institutional investors:** African institutional investors have USD 1.8 trillion assets-under-management in 2020. Institutional investors' core goals are capital gains and stabilization of returns over the long term. They have very high ability to mobilize funds through pensions in the right regulatory environment and their prudential responsibilities require them to invest in assets with high credit ratings and assets that are listed.
    - **Sovereign wealth funds:** Invest in domestic markets and have potential to finance adaptation focused securities and government bonds.
    - **Pension funds:** Are instrumental in mobilizing long-term saving and can support long-term adaptation investments.
- **Insurance:** Insurance penetration is concentrated in a few major markets like South Africa, Egypt, Morocco, Nigeria, and Kenya. Insurers have advanced technical capacity to evaluate climate risks and capacity for innovation in climate risk transfer mechanisms. Insurance companies must undertake qualitative and quantitative assessments of impact of physical and transition risks on their investment portfolio.
- **Large corporations:** Sustainability and resilience in food production and supply chain are increasingly a focus for large multinational corporations especially those with global supply chains. Corporations have potential to deploy finance and technology at scale to undertake adaptation measures though will be largely focused on their own supply chains.
- **Multilateral & bilateral DFIs:** DFIs play a critical role in mainstreaming adaptation in development finance by assessing climate risks and vulnerability, assisting country governments to build capacity for mainstreaming adaptation, and mobilizing private capital. DFIs can bridge knowledge gaps through tools such as feasibility studies, business risk assessments, technical assistance, and market studies.

- **Sub-regional development banks:** SRDBs have a mandate to contribute to regional integration and regional infrastructure development projects. Four African SRDBs: Eastern and Southern African Trade Development Bank, East African Development Bank, West African Development Bank, and Ecowas Bank for Investment and Development are operational in Africa in three separate Regional Economic Communities. 40 African countries are shareholders of the SRDBs and in 2013, the total assets of African SRDBs were USD 6.2 billion.
- **National development banks:** NDBs are state-owned or government-sponsored financial institutions with a primary mandate of providing long-term and concessional capital to high-risk sectors and industry which are underserved by private commercial banks and contribute to the country's development agenda. NDBs are important intermediaries for international climate finance and more than 10 currently have direct access to GCF funding.
- **Multilateral climate funds:** Multilateral Climate Funds established through international agreements or for a specific mandate provide financing for adaptation in Africa either through grants or market-linked instruments. They are catalytic in facilitating and accelerating financing in perceived high-risk adaptation projects by providing instruments like first-loss or junior equity, repayment guarantees, and grants to mobilize private investments.
- **National climate funds:** National, country-driven, dedicated, catalytic financial institutions designed to address domestic market gaps, take ownership of climate finance and crowd-in private investments in low carbon and resilient projects. NCFs have potential to provide integrated access to grants and finance to meet NDCs and have strong potential to mobilize private sector investments.
- **State-owned enterprises & financial institutions (SOEs):** SOEs are public entities that are partly or wholly owned by government to deliver services in a particular sector or sectors. SOEs have not financed many climate adaptation activities to date but have substantial opportunity to lead in climate resilience given size of market share and public governance model.
- **African governments:** African governments are already spending a considerable share of their budget on adaptation. For 42 African countries where data was available, the total weighted adaptation expenditure was around 0.18% of GDP, and the unweighted expenditure was around 3.4% of GDP, both higher than the share of adaptation finance received from international donors. African governments are instrumental in deploying capital to noncommercial adaptation activities and current levels of expenditure meet around 20% of the total adaptation need.
- **Foreign government agencies (ODA):** ODA is a critical component of adaptation finance in Africa to de-risk adaptation activities and support more commercial finance. Bilateral agencies have a relatively high risk appetite and strong climate mandates.
- **Philanthropies, foundations, and non-profits:** Like ODA, funding from these organizations can de-risk adaptation activities, draw in private finance, and support technical capacity building. Philanthropic funding is more nimble and flexible than ODA and can serve as catalytic capital for private sector investment.

Offer Finance on Highly Concessional Terms

Yet there are numerous barriers to investment in adaptation that must be addressed

There are cross-sectoral barriers as well as sector-specific barriers hindering investment in adaptation activities. Table 1 summarizes key barriers to investment across seven key sectors assessed in this analysis alongside cross-cutting barriers which affect investment potential across sectors.

Table 1: Barriers to mobilizing adaptation finance by sector and cross-cutting

Sector	Barriers
Cross-cutting	**Inadequate risk-adjusted returns:** Returns do not compensate investors in developing countries for the additional risk associated with unfavorable regulations and policies, such as foreign investment restrictions. **Complexity of project due diligence:** Many private sector actors, including institutional investors, have largely avoided financing infrastructure projects across sectors in the region due to cost recovery challenges and the complexity of the technical due diligence. **Limited capacity to collect and analyze relevant climate data:** The lack of reliable and accessible information about climate risks and impacts, combined with limited capacity to process available climate data in infrastructure modeling and translate findings into the necessary resilience measures, makes it difficult to adapt proactively.
Water	**Lack of municipal/subnational implementation capacity:** Water projects often involve municipal or other subnational implementers with limited implementation capacity (to pursue finance, structure an adaptation project, or access climate analytics).
Agriculture	**Policy and regulatory barriers:** Lack of regulatory incentives for climate-smart agriculture in terms of priority lending and mal-incentives in regulatory environments with subsidies for non-adaptive crops. **Limitations in aggregation:** Difficulty in aggregating or securitizing many small-scale projects due to local contexts and disparate level of development
Transport	**Variability of climatic conditions within a single project:** Transport projects are often cross-jurisdictional in nature and therefore face a complex range of climate risks. **Public sector nature of the sector:** Even more than for other infrastructure projects, some elements of the transport sector including roads, railways, and ports are often publicly owned and operated and private sector investment involvement may not be feasible.
Energy	**Need for regional coordination:** As countries are tackling domestic energy security challenges separately, this is creating build-up of overcapacity in some countries and deficiencies in others. **Risk attitudes of decision-makers:** Given the long lifespan of energy infrastructure, ranging from 50 to 100 years for hydropower assets, it is critical to base expansions and new infrastructure investments on future climate projections. However, uncertainties around climate projections and the magnitude of associated revenue losses contribute to the lower risk perception of decision-makers.
Urban infrastructure	**Lack of subnational fiscal autonomy:** Subnational borrowing capacities for infrastructure and other capital needs are severely constrained, making long-term planning for climate resilience challenging and creating delays in responding and recovering promptly from disasters.
Coastal Ecosystems	**Challenging economics:** Adaptation in coastal ecosystems zone is often overlapping with flood-risk management and land-use planning which have significant public good characteristics, making it difficult to build an economic case.[19]
Land Use and Forestry	**Multi-stakeholder solutions can create complexity for channeling funding:** Developing and implementing solutions in land use and forestry involves numerous actors and flows across sectors and jurisdictions. Coordination across these sectors and jurisdictions can make the design and implementation of funding solutions complex.

TO MOBILIZE THESE INVESTORS, A THREE-PRONGED STRATEGY IS NEEDED

1. Mainstream resilience into investment decision-making

Many investors are already engaged in investment that has significant relevance to adaptation goals—but their investments are not yet climate resilient. For example, a multinational corporation investing along an agricultural supply chain or an infrastructure investor building a water treatment facility will be operating in a sector with substantial climate risk, but may not be screening for climate risk nor mitigating that risk. For instance, the Infrastructure Consortium for Africa (ICA) finds that water infrastructure sector commitments totaled $13.3 billion in 2018 in Africa. This compares to the $1.2 billion tracked in adaptation finance to the water sector in the same year—suggesting that a significant proportion of finance to the sector is not climate resilient, or at least has not been rigorously assessed for physical climate risks.

To enable financial institutions to mainstream resilience into the investments they are making, the following steps are critical:

- Increase access to robust climate data: There is a critical lack of climate data in many parts of Africa, which limits adaptation projects and leads to uncertainty about the optimal approach. The poorest countries have the most significant lack of climate data: either they are post-conflict or fragile states, or simply do not have the funding and technical resources to develop climate data such as groundwater baseline data, 24–48-hour precipitation data, and forward-looking climate projections. Lack of past and current hydromet data particularly hinders design of some types of adaptation activities and finance instruments. Resilience bonds or results-based performance instruments, for example, require disaggregated data across hazards, exposures, and vulnerabilities to accurately inform risk assessments and track impact.
- Concessional funding and grants are needed to increase climate information collection, accessibility, and technical capacity to utilize the information. The ability to access and use climate information is critical for project implementers seeking funding for climate adaptation projects. Without robust climate information on hazards, exposures, and vulnerabilities, implementers in Africa are stuck in a vicious cycle where they cannot prove the adaptation relevance of a project—and are also unable to access finance that would help them collect and utilize that climate information.
- More targeted concessional finance and grants, from DFIs, donor governments, and foundations are needed to support policy makers and other implementers in collecting and providing access to sufficient data, as well as to support collaboration and training on open-source models that can utilize the data. Across the board, there should be an emphasis on increasing access to high-resolution climate data at low cost so that implementers may undertake climate risk assessments as a basis for future adaptation planning.
- Incubate technical expertise in financial structuring: Adaptation work requires the blending of public, private, domestic, and international finance and therefore calls for substantial financial engineering expertise. Donors are also increasingly requesting quantitative adaptation metrics, including data on physical infrastructure. It is very difficult to assess what volume of adaptation finance is needed and where it should be directed, due to the shortcomings of our current approach to aggregating adaptation finance flows. Policymakers should prioritize development of frameworks for measuring adaptation progress at the global level. This step will be especially critical to drawing in the private sector and to developing a more robust analysis of investment gaps in terms of direct impact on resilience outcomes.
- Pension funds should be engaged through appropriate financial instruments: Pension funds are instrumental in mobilizing long-term saving and can support long-term investments.

However, traditionally they have low risk appetite due to liquidity requirements. The percentage of people covered by pension schemes has reached about 80% in some North African countries, while it is still as low as 10% in sub-Saharan Africa. Pension funds are especially strong in South Africa, Botswana and Namibia per their assets-to-GDP ratio. Total assets under management in 12 emerging markets in Africa are close to $400 billion. Reports suggest that the assets-under-management of African pension funds were expected to rise to $1.1 trillion by 2020.

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- Build capacity of African financial institutions and government entities to evaluate and act on climate risks: A concerted effort should be made to increase membership of Pan-African Banks, locally based pension funds, and national development banks in international financial initiatives such as the UN Principles for Responsible Investment and Banking, and the International Development Finance Club—and to provide these institutions with the resources to participate actively. Capacity building is also crucial to strengthen African financial institutions' capacity to access finance from Climate Funds through pre- and post-accreditation support.
- National Designated Authorities (NDA), Direct Access Entities (DAEs) and the other Accredited Entities (AEs) also require technical and institutional capacity building to build project pipelines and proposals to the Green Climate Fund (GCF). These needs are especially acute in the most vulnerable countries where access to international climate finance is also difficult. The support of International Accredited Entities and readiness programming is crucial in strengthening the DAEs and NDAs to achieve the goal of a bottom-up, country-driven approach of mobilizing adaptation finance.
- Require disclosure of climate risks, via national legislation and/or via DFI on-lending. Domestic financial regulators in Africa should consider requiring financial institutions to disclose climate-related risks in line with the Task Force for Climate-related Financial Disclosures recommendations. Moody's has found that the 49 banks it rates across Africa have more than $200 billion in lending across sectors with high potential climate risk, so disclosure of climate risks is critical.[20]
- Support small and medium-size enterprises (SMEs) that are offering adaptation-relevant products and services. There should be increased attention on the considerable potential value that SMEs hold in unlocking climate adaptation solutions and engaging the private sector. There are 100s of SMEs across Africa that have valuable adaptation solutions and have developed viable business models to implement those solutions. Significantly more focus and finance are needed in this space to support the number of SMEs with potential to deliver adaptation solutions.

2. Build the enabling environment for adaptation investment

The enabling environment in a country will help determine the viability of certain types of instruments. In some cases, lack of financial sector development or lack of commitment to a particular climate adaptation priority will make certain investments difficult to implement. In these instances, there may be a stronger role for concessional capital from DFIs or foundations to facilitate the effective deployment of an investment.

Countries' readiness for adaptation finance may be assessed via several factors across categories of policy environment, market environment, and stakeholder environment, which are further detailed in Table 3 to indicate which specific factors enable the successful implementation of different instruments. Some instruments and sectors require clear policy support from government in order to be effectively implemented. Table 1 summarizes key factors across these categories.


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Table 2: Key factors in the enabling environment

Policy environment	Market environment	Institutional/stakeholder environment
• National adaptation plans/strategy in place • Regulations enforcing adaptation measures (i.e., building codes) • Availability and capacity to analyze climate data and modeling	• Access to international markets • Developed insurance market • PE/VC availability • Subnational borrowing capacity	• Availability of accredited entities for accessing climate finance • Engagement of NDBs, regional development banks, and other regional institutions

- Articulate investment-ready National Adaptation Plans (NAPs) and mainstream climate resilience in government procurement: Having a nationally articulated strategy for adaptation is critical for establishing long-term expectations, identifying priority actions across sectors, and indicating areas for private sector participation. Only six countries in Africa have submitted NAPs to date, while 34 other countries have received funding or have submitted proposals to access funding from the Green Climate Fund (GCF) and the Least Developed Countries Fund (LDCF) for NAP development. Policymakers should ensure that adaptation planning is incorporated and mainstreamed into all relevant policy and procurements plans. An increased focus on climate adaptation mainstreaming within procurement plans in particular is critical to ensure that international infrastructure investment must screen for and build in resilience.
- Build capacity to develop science-based policy and projects: For much international public climate finance, there is a need to establish attribution between a climate impact and the corresponding action/measure that aims to mitigate that impact. This attribution is challenging, requires substantial quantitative and science capacity, and is often a critical factor for mobilizing adaptation finance. There is a substantial need to increase capacity to translate science into policy, and to translate policy into investment needs, for instance by utilizing climate resilience indicators to prioritize budget allocations. Resilience outcomes are also difficult to track against a moving baseline—for example, other development projects may have also contributed to improved social outcomes in a given region.
- Improve macro-economic environments and adopt a multi-faceted approach to address debt burdens faced by African countries: Even before the pandemic, external debt averaged 40% of GDP across the African continent. Gross debt-to-GDP ratios across Africa are projected to have increased by around 8 percentage points in 2020, and by over 20 percentage points in the Republic of Congo, Seychelles, Sudan, and Zambia.[21] Four countries (Mozambique, Democratic Republic of the Congo, São Tomé and Príncipe, and Somalia) are already in debt distress,[22] while 15 other countries are at high risk of external debt distress. Absent substantial global efforts to help reduce the debt burden, many countries are not able to take on additional debt to address climate risk.

- Overall, African countries have low sovereign credit ratings from the three major credit rating agencies (CRA): Moody's, Standard & Poor's (S&P), and Fitch. Just two countries—Botswana and Mauritius—have investment grade ratings from Moody's while all other countries are either sub-investment grade (19 countries) or do not have a rating (26 countries). A low sovereign credit rating or lack of a rating raises the cost of debt and makes attracting foreign direct investment more challenging. Already low sovereign credit ratings are put further at risk by increasing climate-related risks as CRAs begin to incorporate such risks into their ratings. Moreover, increasing climate impacts and a lack of adaptation action pose significant risk to sovereign credit ratings across the region.[23]
- African finance ministers have called for external assistance of $100 billion annually over the next three years to close a financing gap of $345 billion to achieve a sustainable recovery.[24] The participation of private creditors will be critical to relieve existing debt burdens, requiring innovative financing models that set clear incentives. Additional actions that should be considered to address debt challenges in African countries include:
    - Advance efforts to link credit ratings with reductions in climate risk to incentivize resilience and lower the cost of debt.
    - Continue implementation of the Debt Service Suspension Initiative (DSSI) program and seek as many avenues as possible for alleviating debt strain on African countries as a key strategy to increase domestic adaptation finance.
    - Develop sovereign bonds with an adaptation component (e.g., Ghana's 2030 bond with an IDA guarantee of 40 percent) and scale up sovereign debt-for-adaptation swaps to countries where conditions are viable.[25]

3. Deploy innovative finance instruments

There is a wide array of available investment instruments, risk finance mechanisms, and broader finance-relevant solutions that financial actors are already mobilizing in support of climate resilience across Africa. The universe of financial instruments captured in this analysis is represented in Table 2. The level of "concessionality" required for certain instruments will vary by market or policy environment. Financial instruments can be used to finance activities that build physical resilience to climate change impacts (reducing physical risk) and are also useful in responding to risks where physical climate impacts cannot or have not been eliminated (through risk transfer and risk reduction instruments).

It is critical to carefully select a financial instrument or structure that meets the conditions and activities targeted. Selection of appropriate financial instruments must be informed by the sectoral focus of the adaptation activity, underlying country-level policy and market conditions, and the stakeholders and actors engaged. Instruments will only function successfully when they target an appropriate context. Key factors that must be considered when designing an instrument include currency stability, strength of project pipeline, strength of debt capital markets, presence of strong policy environment, existence of a sovereign credit rating, existence of corporate bond market, robustness of climate information, and engagement/existence of a domestic private sector.

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Table 3: Financial instrument types

Instrument typology	Example
Grants: Funding (non-repayable or reimbursable) typically used for technical assistance, early-stage project development, and capacity building.	**Example (application in the agriculture sector):** The Ethiopian government launched the Productive Safety Net Program (PSNP) in 2005 in partnership with international and aid organizations. The program finances conditional or unconditional cash or food transfers for undertaking public works or social infrastructure in response to chronic food insecurity or short-term shocks like droughts targeting the highly-climate vulnerable population. **Stage of implementation:** In November 2020, Phase V of PSNP began through Strengthen Ethiopia's Adaptive Safety Net Project (SEASN) project. This financing includes a $200 million credit and a $312.5 million grant, with additional support from USAID ($430 million), UK FCDO ($281 million) and Government of Ethiopia ($600 million). The project aims to expand geographic coverage and enhance service delivery of PSNP and effectively respond to disasters. **Country context:** Countries with relatively challenging underlying market and policy conditions are well suited to this instrument because it is largely concessional in nature. This could include countries with low sovereign credit ratings, high sovereign debt, and limited capital markets. The implementing environment does require at least some monitoring and evaluation capacity, in the form of at least a sufficiently stable political environment to allow for the evaluation of progress to take place.
Project finance: Typically involves direct debt or equity investments into a single project; can be fully commercial, or forms of concessional finance could include loan guarantees, first loss debt, and off-taker guarantees	**Example (application in the agriculture & urban infrastructure sector):** Cooling as a Service (CaaS) aims to deploy efficient cooling technology at scale through a pay-per-service model that enables customers to pay per unit of cooling consumed and eliminates upfront investment in cooling technology. CaaS supports dual benefits projects across mitigation and adaptation, reducing emissions through cleaner cooling technology deployed and addressing underlying climate risks associated with increased heat. One current application of the CaaS model is in Nigeria where increased temperatures associated with climate change affect food storage capacity and will lead to increased harvest losses, increased food waste, and adverse health outcomes. The social enterprise ColdHubs designs, installs, commissions and operates solar-powered walk-in cold rooms in produce aggregation centers and outdoor markets that can help address those climate risks and support agriculture sector adaptation. Farmers and retailers pay a fixed price per 20kg crate per day to store their goods inside the cold room. **Country context:** Servitization instruments work well in country contexts with relatively strong country-level market and policy enabling environments, basic legal and regulatory frameworks in place for contract enforcement, and availability of local commercial banks. 21 countries indicated urban planning and infrastructure as a priority sector in their NDCs.[26] The SADC Center for Renewable Energy and Energy Efficiency (SACREEE), a member of the CaaS Alliance, recently launched an Industrial Energy Efficiency Program (SIEEP) which will run through 2018–2023 and will involve providing training for bankers, creation of project pipelines, and seed funding. Participating countries in this program may be good candidates for CaaS.
Financing facilities: Involve debt or equity funding for a pool of projects, companies, or individuals (as opposed to single projects); can offer varying levels of concessionality including subordinate debt or equity, longer debt tenors or fund horizons, or supplemental grant capital.	**Example (application in the water sector):** Climate Investor Two is a fund structured to finance projects across three stages: 1) a development fund, 2) a construction fund, and 3) a re-financing fund. Climate Investor Two will focus on water, oceans, and sanitation subsectors, including: municipal and industrial water and wastewater supply, desalination, bulk water supply, waste and wastewater to energy, and riverine and coastal ecosystem management and protection. **Country context:** Climate Investor Two requires a strong project pipeline in the water sector in target countries. A strong ecosystem of project developers is critical to this criterion. The project pipeline can be supported by a favorable policy environment where it is feasible to engage private capital in water infrastructure projects and where there is sufficient climate risk information available to ensure the projects meet set climate adaptation criteria. In addition, the Fund makes investments in non-local currency, so a relatively stable currency environment is needed to avoid significant foreign exchange losses or hedging costs that would erode investor return. The ability to move capital in and out of the country without significant penalty or delay is also critical.

Instrument typology	Example
Results-based finance: Involves debt or grant capital for a project or portfolio of projects that is contingent on the achievement of a certain climate adaptation outcome.	**Example (application to land use and forestry):** The African Conservancies Fund (ACF) was established by Conservation International (CI) with the objective to align economic and conservation objectives in the communities in and around the Maasai Mara in Kenya. The ACF provides debt capital to a trust to develop sustainable revenue generating activities such as eco-tourism, sustainable agriculture, and carbon credit generation. The loans are to be repaid from this revenue. To-date, CI and its affiliates have provided $500,000 in loan capital to the Trust and aim to increase this to $5 million over two years. **Country context:** The Trust model relies on the authority of local communities to make decisions around how their land is managed, and to be able to earn income from activities carried out (or avoided) on the land. Areas under national government control are less likely to be able to benefit from this highly local, highly participatory structure. In addition, trusts need a legal framework to be able to incorporate and have authority to take investments, borrow money, distribute funds, and oversee and implement conservation and income-generating activities.
Debt-for-climate swaps: Debt-for-climate swaps are a type of debt swap in which the debtor nation, instead of continuing to make external debt payments in a foreign currency, makes payments in local currency to finance climate projects domestically on agreed upon terms.	**Example (application to coastal ecosystems):** In 2017, the Seychelles became the first country to successfully undertake a debt-for-climate swap aimed specifically at protecting the world's oceans. The Nature Conservancy (TNC) acquired Seychelles' foreign external debt at a discounted price and raised additional funding worth $5 million from private donors. In return, the government of Seychelles promised to repay the loans to TNC to a specially created the Seychelles Conservation and Climate Adaptation Trust (SeyCCAT). Since 2017, SeyCCAT has issued over $1.5 million in grants to more than 25 grantees implementing a total of 33 projects. More than half of the funds have gone towards projects led by or benefitting women and a third towards youth-led or projects where youth are the primary beneficiary. 23 projects have benefited small-scale artisanal fisheries. **Country context:** Countries with sovereign debt held bilaterally and not at imminent risk of default are likely the most conducive to debt for climate swaps, to ease negotiations and as they still require repayment into a trust. In addition, high-level political support and whole-of-government support from the debtor's government is needed.
Liquidity instruments: Grant or debt facilities designed to provide immediate access to capital; typically established to help governments, businesses, or individuals cover their immediate needs in the wake of a major event.	**Example (application in the agriculture sector):** Cash transfer programs provide unconditional cash transfers to poor and vulnerable households. Research suggests that these programs have significant climate resilience benefits and that households receiving cash transfers suffered much less from weather shocks, their food security increased, and poorest households saw the biggest gains.[27] These programs are especially critical in countries with a high proportion of the labor force in the agriculture sector. For example, Mozambique suffered from severe droughts in 2015–16, which negatively impacted agricultural yields in 2017–18. Cyclones Idai and Kenneth in 2019 exacerbated the crisis faced by farmers, leaving nearly 3% of the population at risk of severe food insecurity. In response to these crises, the World Food Programme, with funding from DFID, developed a program to supply the affected population with either cash or food vouchers to allow them to obtain food for themselves and their households. **Country context:** Access to climate data relevant to vulnerable populations and geographic areas in order to target assistance most effectively is needed. In the case of Mozambique this was done by using other indicators of social and economic vulnerability as proxies for food insecurity. In addition, a reliable mechanism for distributing funds, either through physical networks (such as local banks or community organizations), or mobile payments systems, is needed.
Insurance: Most common form of risk transfer and captures catastrophe bonds, parametric insurance, index insurance, and risk pooling.	**Example (application in the agriculture sector):** The African Risk Capacity (ARC) is a sovereign risk pool and early response mechanism designed to provide insurance to countries in the event of a contingency. ARC's mission is to help members of the African Union to protect the food security of their vulnerable populations. As an insurance risk pool, ARC's objective is to capitalize on the natural diversification of weather risk across Africa, allowing countries to manage their risk as a group in a financially efficient manner to respond to probable but uncertain risks. **Country context:** To participate in ARC, countries must undertake several processes, including customizing the Africa RiskView (ARV) software, signing MOUs for in-country capacity building, defining a contingency plan for ARC payouts, and determining risk transfer parameters. ARC currently offers maximum coverage of $30 million per country per season for drought events that occur with a frequency of 1 in 5 years or less. 34 African Union member states are a part of ARC in 2020, 24 have active MOUs, 13 are Class A Members who have purchased the policy, and 7 countries have received payouts. Since 2014, ARC Ltd has collected over $100 million in premiums, provided $720 million of insurance coverage, and paid a total of $65 million in payouts, mainly in the agriculture sector that has financed efforts including scale-up on cash transfers and replenishment of strategic grain reserves in Malawi in 2017 and response to severe drought in Mauritania in 2018 and in Madagascar in 2020.

In sum, African countries are among the most at risk of increasing frequency and severity of climate-related shocks and stressors. There is a pressing need to invest in climate change adaptation to support individuals, SMEs, municipalities, corporations, financial actors, and governments in building resilience to climate impacts.

To date, climate adaptation finance is scaling far too slowly to build climate resilience, even as the costs of climate impacts rise.

To mobilize the levels of investment needed and to increase the resilience impact of these investments, a wider variety of sources of finance must be tapped. A three-pronged strategy is needed to tap the wide range of potential actors: 1) mainstream resilience in investment decision-making, 2) build the enabling environment for adaptation investment, and 3) aggressively deploy innovative finance instruments at scale towards adaptation activities. Action taken now across the full range of potential adaptation finance sources will be critical to determining the course of Africa's capacity to respond to present and oncoming climate impacts and to building a more climate-resilient and livable future.

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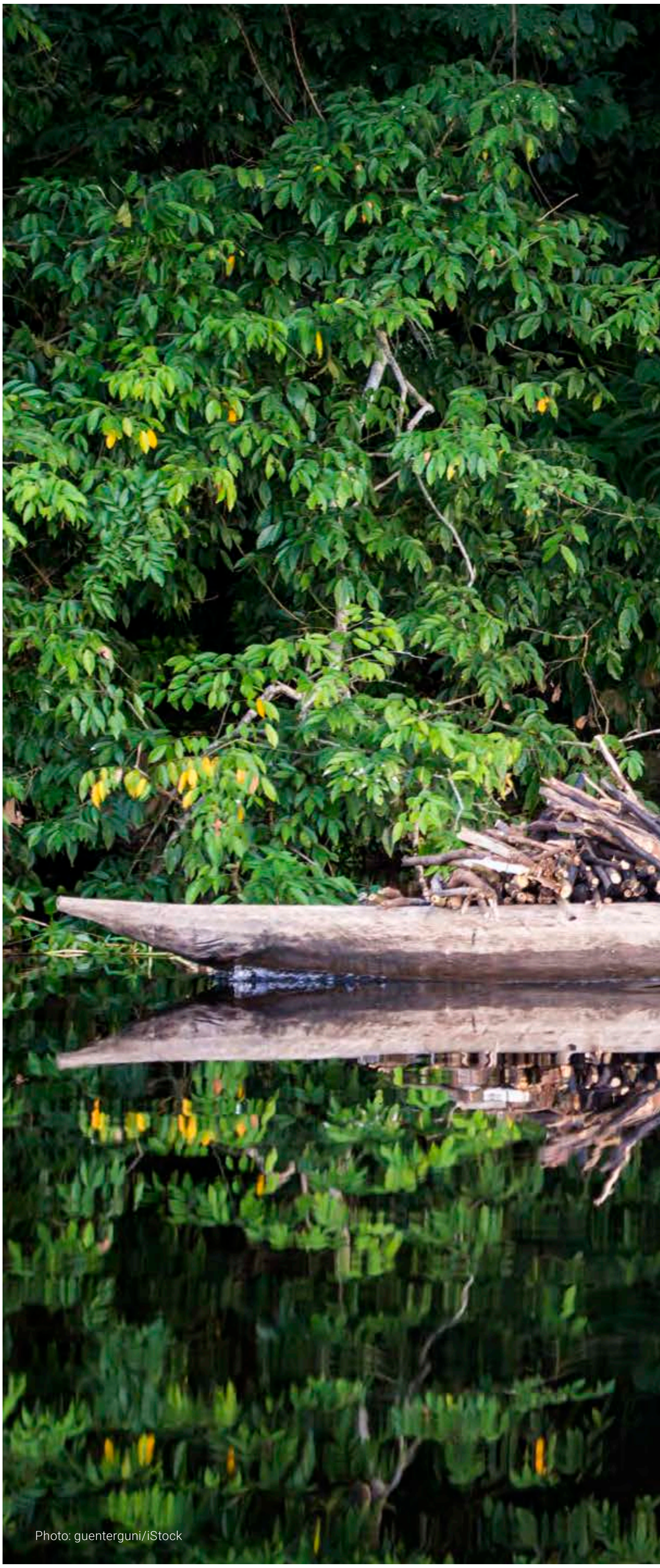
There are two things that motivate business: risks or opportunities. A mandatory Task Force on Climate-Related Financial Disclosures (TCFD) with a focus on adaptation as well as an opportunity agenda will mobilize business."

Peter Bakker, President and Chief Executive Officer, WBCSD



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Africa Adaptation Acceleration Program

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The Africa Adaptation Acceleration Program (AAAP) was jointly launched by the GCA and the African Development Bank (AfDB) at the Climate Adaptation Summit in January 2021. AAAP is aligned with the vision of the Africa Adaptation Initiative (AAI), which was initiated by African Heads of State in 2015 to ensure that the continent urgently adapts to the adverse effects of climate change. AAAP will contribute to this goal of scaling up and accelerating adaptation in Africa and aims to leverage US$ 25 billion by 2025.

Pillars of the AAAP

A broad range of stakeholders – including African leaders, institutions, and multiple development partners – were consulted on the design of AAAP. Based on their inputs, and on the priorities and needs identified in Nationally Determined Contributions, National Adaptation Plans, the Africa Adaptation Initiative (AAI), and the Initiative for the Adaptation of African Agriculture, four key pillars were identified: climate smart digital technologies for agriculture and food security; Africa Infrastructure Resilience Accelerator; empowering youth for entrepreneurship and job creation in climate adaptation and resilience; and innovative finance initiatives. A brief description of the four pillars of the AAAP follows.

Climate smart digital technologies for agriculture and food security

More than 60 percent of the population of Sub-Saharan Africa is employed in smallholder farming.[28] At the same time, 51 percent of the population is food insecure, and over 256 million people are malnourished.[29] Agriculture and food security are therefore critical sectors in Africa, with considerable potential to contribute to the achievement of several Sustainable Development Goals (SDGs). However, agriculture is also one of Africa's most vulnerable sectors when it comes to climate change, with agricultural yield reductions of over 50 percent predicted in some regions by 2050.[30]

Digital technologies can help smallholder farmers to adapt better and contribute to overall food security by increasing yields by 40-70 percent. This pillar of AAAP therefore seeks to scale up the uptake of climate-smart digital technologies and associated data-driven agricultural and financial services for at least 30 million farmers in Africa, particularly women, by 2025. This is expected to:

- Increase food security in 26 least developed countries
- Reduce malnutrition for ten million people
- Increase the agricultural yield of farmers participating in the activities under this pillar by about 40 percent
- Significantly increase smallholder incomes

A microinsurance blueprint and a digital platform for adaptation in agriculture will also be developed.

Africa Infrastructure Resilience Accelerator

The Africa Infrastructure Resilience Accelerator (AIRA) aims to scale up investment for climate-resilient infrastructure and close the infrastructure gap in Africa, to help achieve the SDGs despite climate change. Under AIRA:

- The National Resilient Infrastructure Program will help 16 countries in Africa to strengthen their enabling environment and increase financial flows to make infrastructure investments
- The City Climate Adaptation Accelerator will assist 32 cities in 16 countries in Africa to develop sectoral infrastructure adaptation plans, to guide future investments
- The Build Smart Project Preparation Facility for Water will mobilize about US$ 7 billion worth of investments
- Influence at least US$ 30 billion worth of infrastructure investments in the water sector for adaptation and resilience
- Nature-based Solutions will be promoted for new and existing infrastructure, to promote resilience, socioeconomic growth and green jobs

Empowering Youth for Entrepreneurship and Job Creation in Climate Adaptation and Resilience

Africa's burgeoning youth population, the youngest in the world with an average age of 19.7, is expected to double by 2050. It is predicted, however, that 50 percent will unemployed, discouraged, or economically inactive by 2025.[31] This pillar aims to unlock the untapped potential of youth in Africa to drive resilience through their innovativeness, energy, and entrepreneurship. It aims to promote sustainable job creation at scale by 2025, by promoting youth entrepreneurship and innovation for action on climate adaptation and resilience in Africa. Specifically, the pillar will support:

- Legal, policy, and regulatory reforms to remove structural barriers that prevent youth participation in businesses and jobs related to adaptation
- 10,000 youth-led micro, small, and medium-sized enterprises on adaptation
- Enhanced skills for one million youth in jobs related to adaptation and resilience
- Unlocking of US$ 3 billion in business opportunities for adaptation action by innovative youth-owned enterprises, 50 percent of which will be led by women

Innovative Finance Initiatives

Africa received 17 percent of global climate adaptation finance tracked in 2019-2020, or $7.9 billion annually. This compares with the estimated needs represented in the NDCs of 40 African countries which cumulatively indicate a need for an estimated $331 billion in investment in adaptation through 2030, or approximately $33 billion annually.[32] This pillar aims to increase financial flows for adaptation to Africa by US$ 12.5 billion by 2025, to complement the US$ 12.5 billion commitment of the AfDB. Specific activities will include:

- A Technical Assistance Program (TAP) to help eight countries access adaptation funds for projects related to the other AAAP pillars.
- Support to three countries in Africa to develop new tools such as green bonds and debt for resilience swaps.
- Support to strengthen the capacity of national finance ministries, central banks, and financial institutions in eight countries to identify, manage, and disclose climate-related risk, and to integrate climate risks in macroeconomic and risk modelling.

An AAAP Investment Facility is also being established to mobilize resources from innovative public and private sources to finance the AAAP.

The private sector

KEY MESSAGES

- **Adaptation is not a choice but a necessity for the private sector to manage worsening climate realities across Africa.** This chapter reveals that while there is more private sector adaptation action on the continent than is currently recorded, it is still low compared to other regions of the world and is mostly focused on mitigation.
- **Frontrunners among Africa-based businesses capitalize on resilience and adaptation action, which not only helps them to manage climate risks but also positively impacts their productivity and profitability.** Almost all the large companies that were interviewed identified potential business opportunities in managing climate risks.
- **Large companies have the capacity to generate information on climate impacts on their operations through risk assessments, while micro, small, and medium-sized enterprises (MSMEs) lack the capacity and therefore the information.** Sharing climate data and adaptation knowledge with MSMEs, which are often an essential part of the value and supply chains, will benefit larger companies in the long term.

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- **Traditional project funding does not always work for private sector adaptation and resilience-building efforts, because investments can sometimes lead to a short-term loss of income or require investments in new skills or technologies.** Appropriate support and financing mechanisms are necessary to help MSMEs switch to climate-resilient practices.

“

Climate action is a $3 trillion investment opportunity in Africa by 2030 ... The Africa Adaptation Acceleration Program, and many other ambitious African initiatives, must be empowered to fully deliver on their goals.”

António Guterres, Secretary-General of the United Nations
Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

The private sector generates two-thirds of the investments, 75 percent of the economic output, and 90 percent of the employment in Africa, through a diverse range of companies that include large multinationals on the one hand, and many micro, small, and medium-sized enterprises (MSMEs) on the other.[1] Its importance is therefore hard to dispute. However, little is known about its role in climate adaptation and resilience-building efforts, or about how it can help to scale up and strengthen adaptation efforts across the continent.

The information that does exist indicates that there is currently limited private sector engagement in climate change in Africa compared to other regions of the world, and most of it is focused on mitigation rather than adaptation.[2] It would also appear that governments are not always fully aware of how to engage the private sector on climate change, as only five countries in Africa have systematically integrated private sector involvement in their Nationally Determined Contributions (NDCs).[3]

This chapter seeks to provide further insights on the role of the private sector in adaptation in Africa. It is based on a GCA analysis of the CDP's *Corporate Climate Change Disclosure Questionnaire 2020;* a survey of MSMEs in Africa by the GCA; and interviews with representatives of companies that are either based in Africa or have assets or branches in Africa, conducted jointly with the World Business Council for Sustainable Development.[4] It finds that while the private sector is doing more than is currently recorded, much more needs to be done to adapt and climate-proof operations, as delaying adaptation action will put the viability of entire businesses at risk.[5]

Following a brief overview of private sector action and reporting on climate change in the next section, the chapter highlights key drivers, barriers, and motivations to enable adaptation by the private sector in Africa—including the role of policies and institutions; data and information; collaboration and capacity building; infrastructure and supply chains; and access to financial and economic instruments.[6] Finally, it finds that adaptation and resilience efforts also present opportunities for the African private sector, for instance in the form of new products and services that become necessary.[7]

Private sector climate action and reporting in Africa

Around the world, climate action by large enterprises has increased rapidly over the last decade, with an unprecedented number of companies adopting climate targets despite the COVID-19 pandemic.[8] Driven partly by a heightened demand from clients, investors, and shareholders, large businesses are increasingly committing to climate action, demonstrating that ambitious climate action can go hand-in-hand with market outperformance.[9]

Investors are more likely to provide capital to firms that disclose information on climate- and sustainability-related parameters, through various tools such as those provided by CDP, the Task Force on Climate-related Financial Disclosures, Businesses for Sustainability Reporting, and the Global Reporting Initiative.[10] As businesses reckon with the impact of climate change on their own activities, it is also not uncommon for business leaders to urge politicians to show greater climate ambition at climate summits and conferences.[11] However, most private sector action is currently focused mainly on mitigation.

Photo: Claudiovidri/Shutterstock

In our GCA analysis, we find that information disclosure on climate change by large businesses in Africa is still limited.[12] Of the 3000 companies that responded to CDP's *Corporate Climate Change Disclosure Questionnaire 2020*, only 17 percent (or 515 companies) disclosed data on climate activities in Africa.[13] Of the 515 companies, 31 (approximately 6 percent) have their headquarters in Africa, while the rest are multinationals with operations in Africa. The disclosure of data is unequally distributed across Africa, with most reporting from South Africa, Algeria, Egypt, Morocco, Angola, Kenya, and Botswana. The most prominent sectors that disclose climate information in Africa include services, manufacturing, materials, food and beverages, agriculture, biotech, health care, pharma, infrastructure, retail, and hospitality.

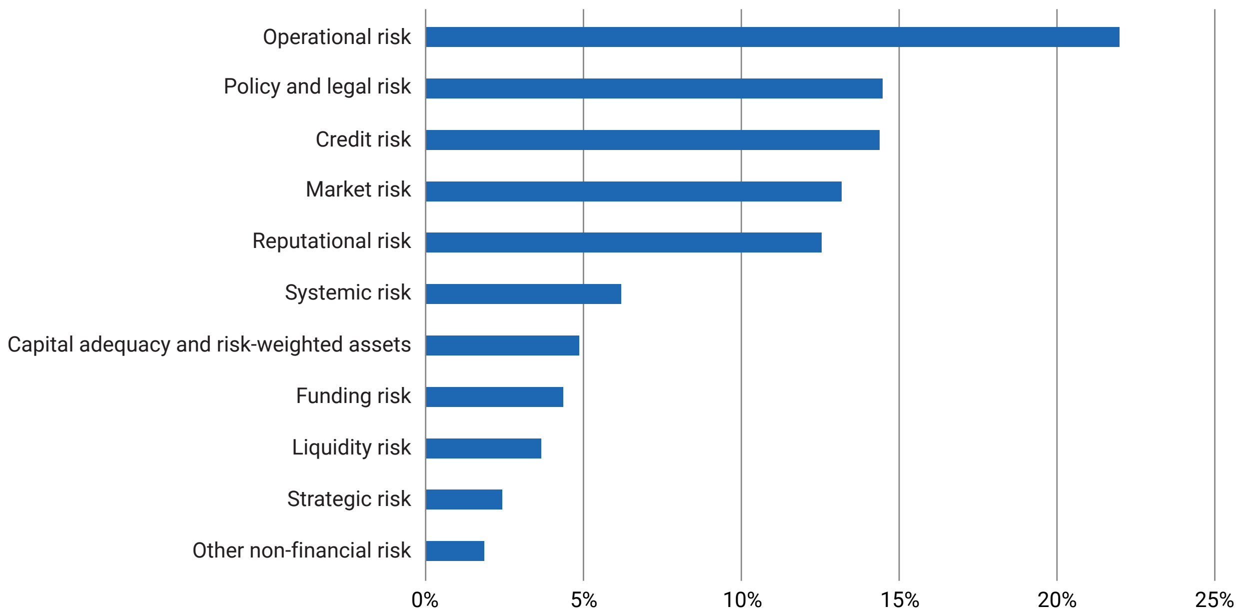
An overwhelming majority of companies that disclose data on climate-related activities in Africa identified potential financial or strategic impacts due to climate risks (88 percent), as well as climate-related business opportunities (94 percent). Almost all of them (97 percent) report that climate-related risks and opportunities have influenced their strategy and/or financial planning, and more than half (59 percent) have developed low-carbon transition plans.[14] They identify adaptation and resilience as the fourth most important topic for corporate engagement with policymakers, behind clean energy generation, energy efficiency, and climate finance.

Many of these companies (65 percent) identify climate risks that could have significant strategic and financial implications. Possible negative financial impacts include decreased revenues due to reduced demand for products and services; decreased revenues due to reduced production capacity; increased direct costs; and increased capital expenditures. Approximately half the companies provided a specific figure for estimates of the financial impacts of climate risks, while others provide a range.

The climate risk assessments undertaken by these companies consider risks that relate to current regulations, emerging regulations, reputation, markets, physical infrastructure, and technology. The climate-related risks that are identified most often are categorized under operational risks, policy and legal risks, credit risks, market risks, and reputational risks (Figure 1). The climate-related opportunities for business expansion identified most often, meanwhile, relate to products and services and resource efficiency.

Using a range of climate scenarios to conduct climate risks assessments, the companies identify droughts and flooding as the most urgent climate risks, followed by extreme weather events.[15] Water scarcity is also of particular concern. South Africa has the largest number of businesses reporting detrimental water-related impacts globally, while

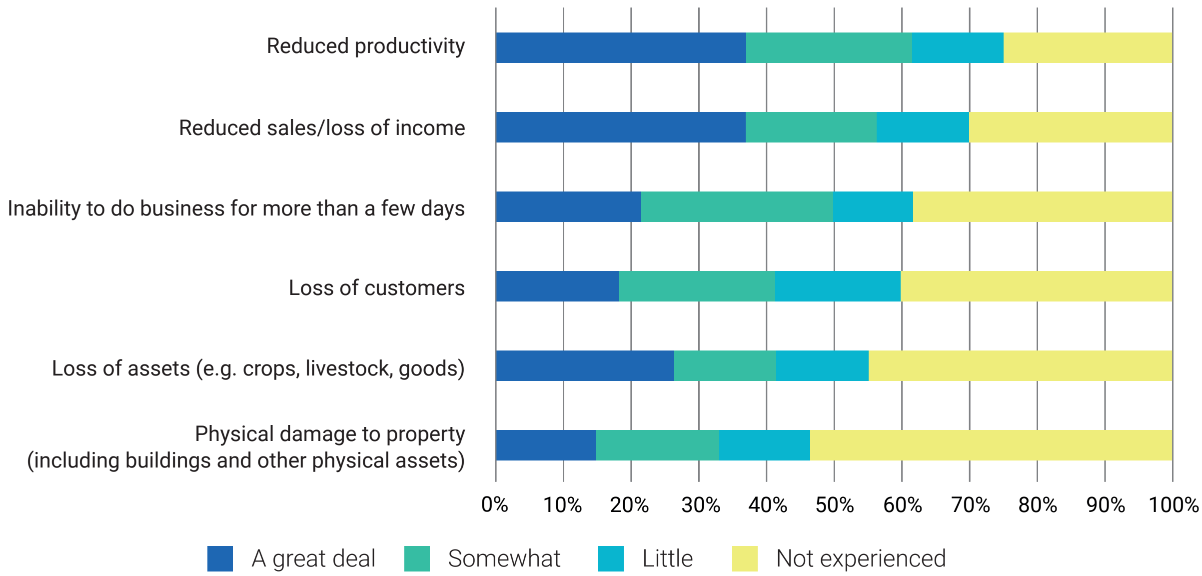
Figure 1: Most frequently identified climate-related risks by businesses in Africa



Source: Based on CDP's *Corporate Climate Change Disclosure Questionnaire 2020* businesses in Zambia, Malawi, Benin, Mozambique, and Kenya are also frequently affected. Stricter regulations and statutory water withdrawal limits are also cited as water-related impacts by companies in some countries.

The private sector in Africa already feels the impact of climate change, including droughts, floods, extreme heat, and extreme rainfall, whether directly or indirectly, throughout their supply chains. In the interviews, the representatives of large corporations were more likely to be able to point to future climate risks and indirect impacts on their operations due to the instability of supply chains. By contrast, the MSMEs participating in the survey said they had less access to information on future impacts and were more likely to focus on current or recently experienced direct impacts of extreme climate events. Some of these impacts include reduced productivity (75 percent); reduced sales and income (71 percent); loss of customers due, for instance, to displacement, resulting in loss of income (62 percent); and physical damage to property (47 percent) (Figure 2). The climate risks experienced by MSMEs did not vary across regions. In west Africa, 67 percent of companies were directly affected by climate change impacts, while in east Africa and southern Africa, 70 percent were directly affected.

Figure 2: Direct impacts of extreme weather events on MSMEs in Africa



Source: authors

ENABLING ADAPTATION AND RESILIENCE ACTION BY THE PRIVATE SECTOR

In the recent survey and interviews conducted by GCA and the World Business Council for Sustainable Development that inform this chapter, private sector representatives identify several elements that can foster adaptation action and resilience building within the private sector in Africa. These elements can also encourage a constructive role for the private sector in supporting adaptation efforts by governments and non-government actors.

These include:

- **Policies and regulations** to incentivize innovation.[16]
- **Information and data** to reduce uncertainty, and to guide planning and decision-making by businesses.
- **Collaboration and capacity building** to support those within the private sector with limited capacities, and to coordinate responses, arrange partnerships, encourage formal and informal networks, and formulate strategies.[17]
- **Accessible financial and economic instruments,** such as insurance schemes to enable adaptation and resilience building, particularly for MSMEs.

- **Resilient infrastructure** for essential services such as water, electricity, transportation, and access to markets, along with **resilient supply chains.**[18]
- The identification of potential **business opportunities,** including the promotion of local entrepreneurship, through which the private sector can play a constructive role.

While referring to climate risks, private sector actors often employ different terminologies such as "volatility management," "risk response," or "resilience building". For instance, Rabobank, a Netherlands-based cooperative bank with a strong focus on the food and agriculture sector, finds it more effective to refer to risks that could affect the businesses of its clients instead of "climate change adaptation." Similarly, IBM Research, the research and development division of multinational technology corporation IBM, employs terminology that relates to the risk management processes of firms, such as supply chain disruption, agricultural production losses, water scarcity, maintenance disruptions, and civil infrastructure damages.

Related to the issue of terminology and definitions, companies sometimes struggle to indicate progress in adaptation and resilience efforts which, unlike mitigation, lack straightforward measures of progress. This subsequently complicates measuring, pricing, and reporting adaptation action, with businesses having to stitch together a range of benefits to make a business case for adaptation, such as livelihood benefits, job creation, and farm productivity.

Policies and regulations

Appropriate policies and regulations at the national and local levels can create an enabling environment for adaptation and provide positive incentives for the private sector to innovate. Conversely, poorly designed regulations can inhibit innovation. For example, Holcim, a Swiss-based global building materials and aggregates producer with assets in Africa, developed a "green concrete" called ECOPact+ by upcycling construction and demolition materials, to encourage circularity and resource efficiency. While the use of such innovative products could

Photo: THEGIFT777/iStock

be scaled up if governments introduce supportive regulations, a representative from Holcim notes that norms currently do not evolve at the speed of innovation.

Norms can be designed to benefit both communities and companies, notes a representative from Enel, a multinational energy producer with a presence in South Africa. For instance, South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) supports renewable energy producers, and at the same time requires power producers to support local enterprises and participate in socioeconomic development activities.[19]

Climate information and data

Information and data on potential climate risks, and the possible adaptation measures that can be taken to mitigate these risks, is a fundamental requirement for the private sector to act. But while large companies like Holcim and Enel have in-house capacity, or the capacity to engage experts, to generate data and information through risk assessments that use multiple climate models, others, particularly MSMEs, lack the capacity and therefore the information. Even the risk assessments conducted by large multinationals do not always include assessments for their limited Africa-based assets.

The assessments conducted by large companies inform decisions on locations, production, and climate-proofing efforts. Companies also recognize that the resilience of entire value chains, not only of their own operations, is important. DSM, for instance, recognizes the importance of stable incomes and sustainable business operations among its suppliers, while noting that the risk of suppliers in the value chain becoming financially unsustainable is still higher in Africa than in most other parts of the world. Improving the resilience of MSMEs along the value chain is therefore beneficial for all businesses, from multinational to micro. Sharing information from value chain risk analyses, often conducted by large companies, can help MSMEs understand and quantify their risks, and to inform their decisions on elements such as insurance and infrastructure. This will benefit large companies in the long term.

More information may not, however, always mean more adaptation action. When risks are high, banks may either choose not to invest at all; or to invest along with adaptation measures.

Climate data was cited as an important constraint to adaptation action by MSMEs that responded to the survey. In the survey, 29 percent of the MSMEs indicated that they lack climate data, and 17 percent said they lack knowledge of climate impacts. Survey respondents said they need more technical support (31 percent) and knowledge (19 percent) to respond to climate change impacts, access solutions, use weather forecasts, and exchange information. Most MSMEs learn about climate measures through online research (10 percent), or through knowledge sharing, for instance with clients, business partners, and universities. Some also attended online courses, conferences, and workshops.

> “The danger which is already at our doorstep shows that we need to take strong, integrated and sustained adaptation measures. The climate won’t wait until we have ended the Covid pandemic”
>
> H.E. President Faure Gnassingbe of Togo
> Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

Awareness of government policies that could support private sector adaptation is also low among MSMEs. Only 12 percent indicate that they received (mainly technical) support from national governments, while 10 percent indicate that they received support from local governments. MSMEs identified the following policy-related areas that pose barriers to their operations and subsequent adaptation actions: access to finance (93 percent); transportation costs and time (83 percent); high tax rates that impede action or additional investments in adaptation and resilience (69 percent); restrictive business operations licensing (60 percent); and lack of education or training (67 percent) (Figure 3).

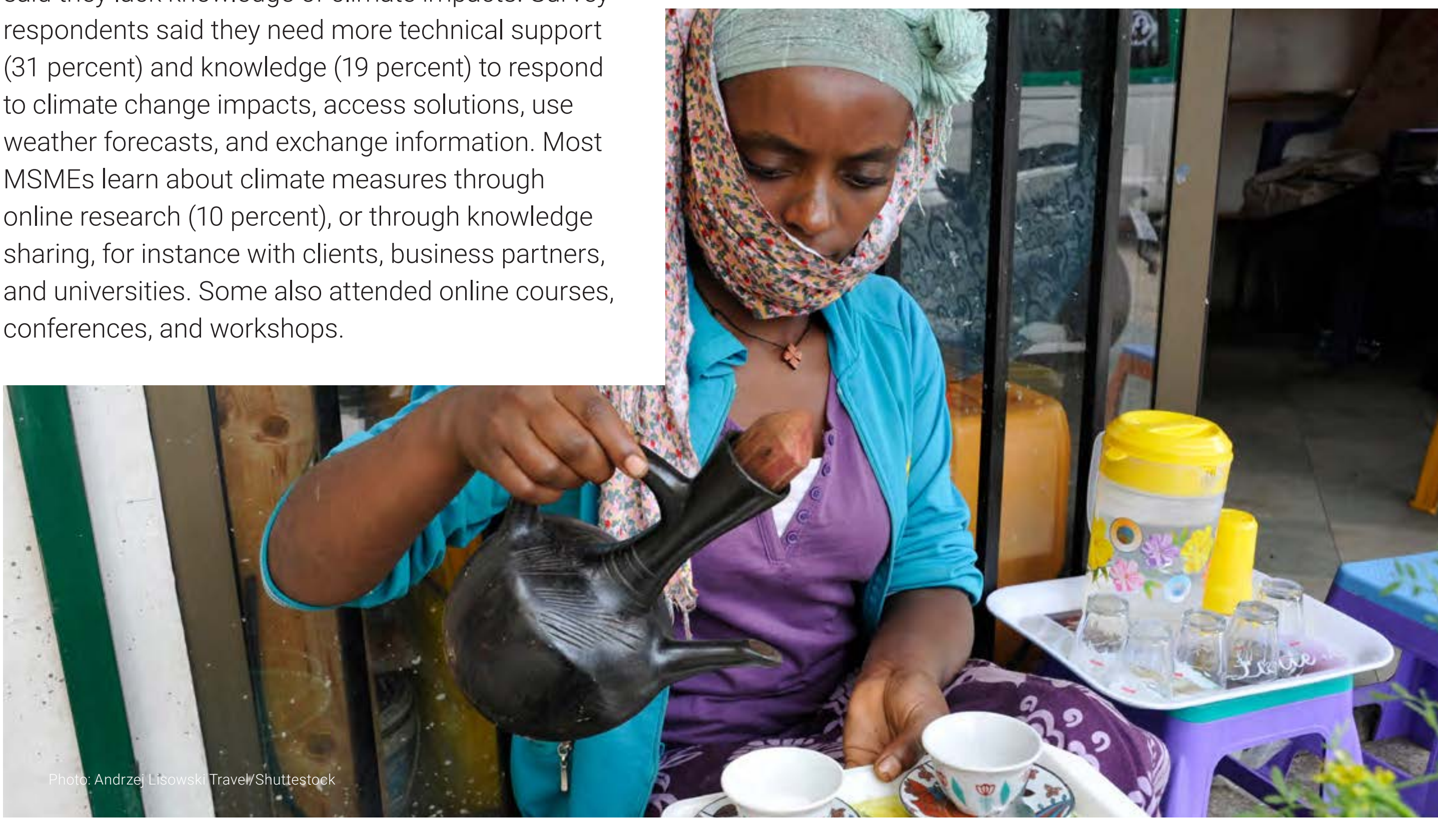
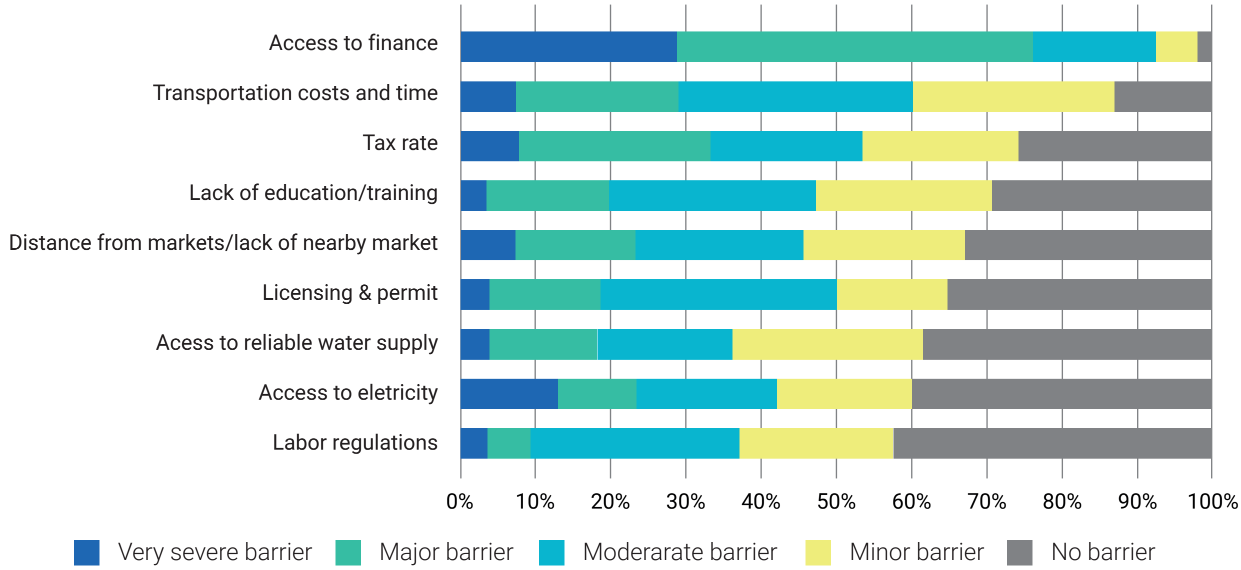


Photo: Andrzej Lisowski Travel/Shuttestock

Figure 3: Climate adaptation barriers for MSMEs in Africa



Source: authors

Collaboration and capacity building

Companies large and small highlight the importance of collaboration, cooperation, and partnerships among stakeholders to advance adaptation. Collaborations and linkages between institutions can significantly increase the ability of businesses to adapt, and, with networks, provide mutual support and access to capital, markets, and technologies that cannot be accessed by individual MSMEs.[20]

Larger corporations often forge information and knowledge networks with academia, scientists, and government research institutions. For instance, OCP Group, a global fertilizer producer based in Morocco, has partnered with the Mohammed VI Polytechnic University, the International Center of Biosaline Agriculture, and the International Development Research Centre in Rehamna province in Morocco to introduce high-yielding quinoa varieties to farmers, and contribute to food and nutrition security. Similarly, 24 percent of the MSMEs surveyed report collaboration with others to broaden their knowledge and skill sets, raise awareness, share guidelines, disseminate information on disasters, participate in capacity building programs, and coordinate cooperation with other private sector actors.

Our analysis indicates that large companies with substantial operations in Africa often engage in capacity building to support the adaptation efforts of their clients and of other stakeholders.

For instance, the OCP Group provides farmers with training on sustainable farming practices, resulting in improved land management, and increased yields and incomes. The power company Enel provides risk forecasts and assessments prepared by in-house experts to adapt its activities to heatwaves, floods, sea level rise, and strong winds, all of which present risks to its assets and operations across Africa. With the non-profit Res4Africa Foundation, Enel has also created the Microgrid Academy in Nairobi to train young Africans to plan, manage, and maintain mini-electric grids, and support stable access to renewable energy for rural communities.

Sharing climate and weather data through innovative technologies such as cloud computing is another means of collaboration. For instance, IBM's Environmental Intelligence Suite provides generic accelerators for environmental and climate impact modeling at scale via its Climate Impact Modelling Framework (CIMF). CIMF provides analytics-ready data and pre-build models for climate-related extremes such as floods, wildfires, and droughts, and a library of Artificial Intelligence algorithms for better calibration, quantification, and predictions.

Business networks can also play a vital role in building capacity and raising awareness, particularly among MSMEs. For instance, NBI, a group of national and multinational companies in South Africa

Photo: Lucian Coman/Shutterstock

cooperating on sustainable development efforts, provides MSMEs with resources on adaptation and climate finance.

Accessible financial and economic instruments

Short-term investments in adaptation, even when they are high, can ensure long-term benefits for both companies and their clients, and the continued sustainability of business operations. Although some MSMEs receive financial support to respond to climate impacts from international initiatives (10 percent) or family and friends (14 percent), finance remains a key barrier for adaptation action for almost all the companies surveyed.

Traditional project funding does not always work for private sector adaptation and resilience-building efforts, because the uncertainty around climate risks makes a difficult case for investments, and adaptation benefits are insufficiently understood.

For instance, investing in climate-resilient crops can sometimes lead to a short-term loss of income, or require investments in new skills, technologies, and crop varieties, notes a representative from Olam International, a food and agri-business company. Farmers need support and financing mechanisms to make these choices and switch to climate-smart practices, as private sector operators cannot bridge this gap at scale.

Initiatives like NBI are looking for alternative and experimental ways to fund private sector adaptation, such as alternative currencies, ecosystem services payments, and blended financing. Rabobank collaborated with Mastercard to create a digital platform to connect small-holder farmers with buyers, payment tools, and digital transaction records. Such services are also increasingly sought by clients, according to international banking group BNP Paribas, which is responding to the rise in demand by developing blended finance and alternate financing mechanisms to address adaptation needs.

Large companies have a significant role to play in supporting suppliers and smaller companies deal with climate impacts, including by managing value chains and providing risk data to reduce uncertainties. Better risk data can help lower the cost of insurance premiums for smaller companies, by lowering uncertainty and providing insight into residual risk exposure.

> “Funding mitigation is easier because it fits into a generally understood model of how finance works... For adaptation, you're essentially funding deferred costs, which does not always sit well with traditional project financing.”

Representative of NBI

Infrastructure and supply chains

Efforts to improve the resilience of infrastructure can benefit local communities in addition to company operations. For example, the OCP Group has collaborated with public authorities in Morocco to invest in desalination stations and wastewater recycling plants to reduce water pollution and address water stress. Enel has installed water storage and filtration systems in football fields in South Africa, where each system can filter up to 17 million liters of clean drinking water annually to supply neighboring households. NBI seeks to engage businesses and policy makers to identify opportunities for adaptation projects and to address possible barriers.

Large companies are aware that climate extremes can result in volatility of supply chains and create a sub-optimal investment climate that could obstruct business expansion. Some companies, such as the OCP Group, indicate that their operations in Africa are more vertically integrated than elsewhere to manage supply and logistics chains. A pro-adaptation regulatory environment could protect smallholder suppliers in such contexts. Others, like Royal DSM and Holcim, ensure that they can alternate suppliers and producers when certain locations are affected by extreme events, to ensure operational continuity in the short term.

Such alternative arrangements may not be possible for MSMEs when they are affected by transport, energy, and connectivity issues caused by climate extremes.

Almost all the large companies that were interviewed for this chapter identified potential business opportunities in managing climate risks. Many have introduced new climate-resilient products to cope with climate challenges such as increasing temperatures, water scarcity, and deteriorating coastal reefs. DSM, for instance, has introduced enzymes for the food and beverage industry that can potentially reduce water consumption. It has adjusted their own production methods for omega fatty acids in response to changing fish migration patterns and biodiversity concerns.

Occasionally, climate catastrophes result in innovations. In the aftermath of Cyclone Idai, 14Trees, a joint venture between Holcim and the UK’s development finance institution CDC, built the world’s first 3D-printed school in Malawi within 18 hours.

MSMEs also see opportunities for business expansion while managing climate risks (95 percent). New products were identified by 81 percent of MSMEs, while 22 percent found new markets for existing products, and 60 percent identified opportunities for new markets. MicroInsurance Services, for instance, is an MSME in Malawi that capitalized on the demand for information on adverse climate impacts, and now provides weather-related information in addition to risk insurance. Other MSMEs have found opportunities for expansion into new products such as organic fertilizers and renewable energy powered farm-machines.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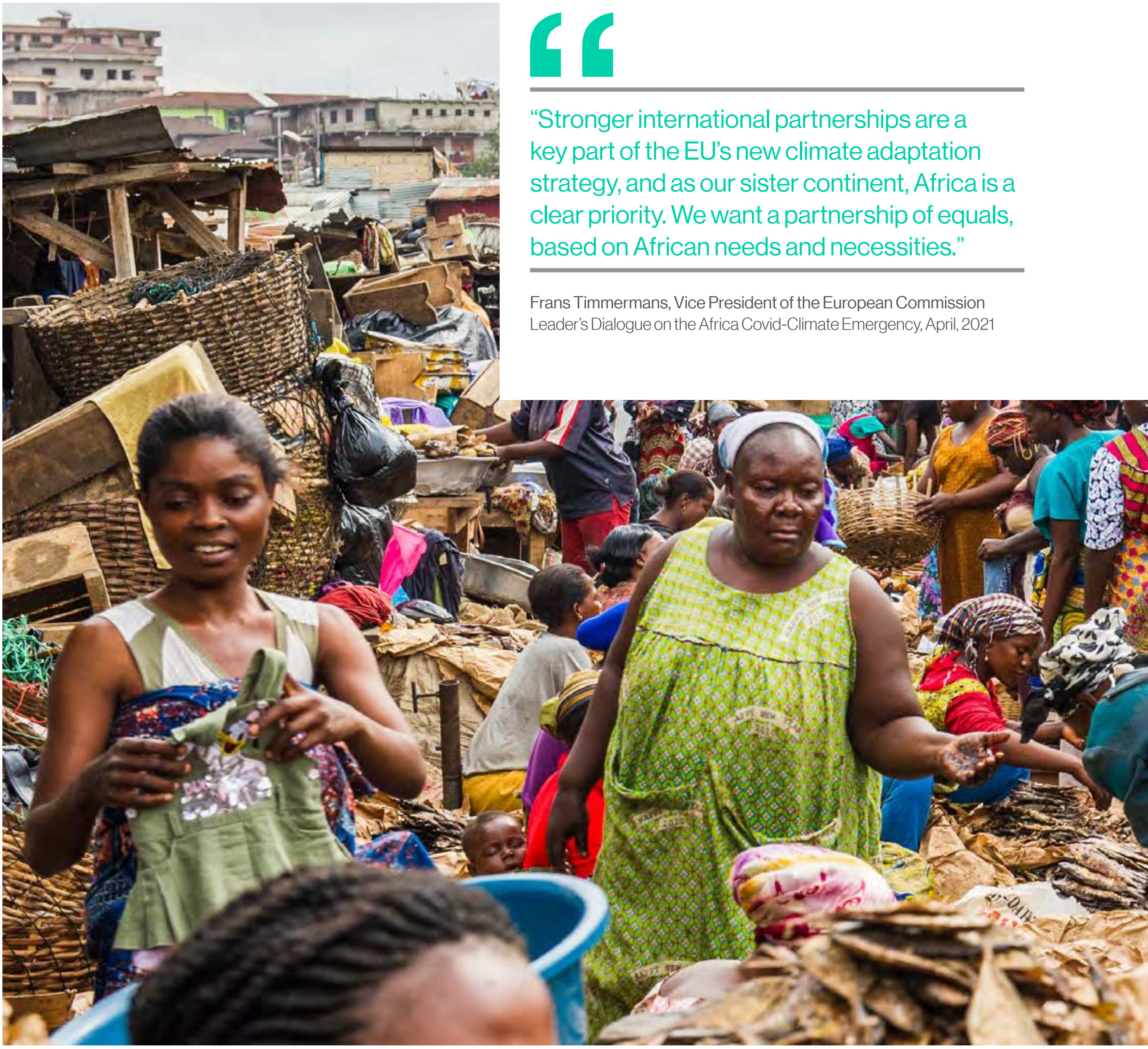
ADAPTATION AS A WIN-WIN FOR THE PRIVATE SECTOR

Adaptation is not a choice, but a requirement for the private sector to face worsening climate realities across Africa. Yet the African private sector remains underrepresented in discussions and in action due to a combination of factors, including lack of awareness, inadequate tracking mechanisms, and limited resources.[21] Greater efforts to enhance awareness, mobilize private sector actors, and to provide visibility for their activities, along with accessible financial instruments, are therefore necessary.

At the same time, government policies and enabling environments at all levels (including procurement policies and product standards) are key to incentivize both MSMEs and large enterprises, and to promote innovation. Collaborations and partnerships within the private sector, and with other stakeholders, can not only help build private sector resilience, but can also generate adaptation and resilience benefits for the communities that they operate in.

Finally, it is important to dislodge the notion that adaptation and resilience efforts are all costs without benefits.



> “Stronger international partnerships are a key part of the EU’s new climate adaptation strategy, and as our sister continent, Africa is a clear priority. We want a partnership of equals, based on African needs and necessities.”

Frans Timmermans, Vice President of the European Commission
Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

> "It is a misconception to view the implementation of sustainability project interventions and actions only as a cost… Being sustainable is a win-win approach and is positive not only for the local population or for the environment, but for the investment itself."

Representative of Enel

Photo: Anton_Ivanov/Shutterstock

Cooperative initiatives to engage the private sector in adaptation in Africa

Photo: Davide Bonaldo/Shutterstock

Cooperative initiatives — collaborations between state, non-state, and sub-national actors – have emerged as an important vehicle to engage businesses and investors in adaptation around the world.

Examples include 4 per 1000, an initiative with voluntary public and private sector stakeholders working on land and soil management; the InsuResilience Global Partnership, which facilitates dissemination of market-oriented and poverty-and gender-sensitive solutions for climate risk insurance in developing countries; the Business Alliance for Water and Climate, which works to improve water security and resilience; and the Value Chain Risk to Resilience initiative, which works with businesses to increase their ability to diagnose and understand physical climate risks, and to adopt and implement climate resilience measures.

According to the Climate Cooperative Initiatives Database (C-CID), a database of 300 international cooperative initiatives, approximately 27 percent of the adaptation initiatives are active in Africa – mostly in west Africa, with fewer initiatives in east Africa (Figure 1).[22]

While relatively few Africa-based private sector actors take part in these adaptation initiatives, many non-Africa-based private sector actors are involved in activities in Africa, fulfilling different roles as funders, participants, or lead partners (Figure 2).

Figure 1: Cooperative adaptation initiatives in Africa

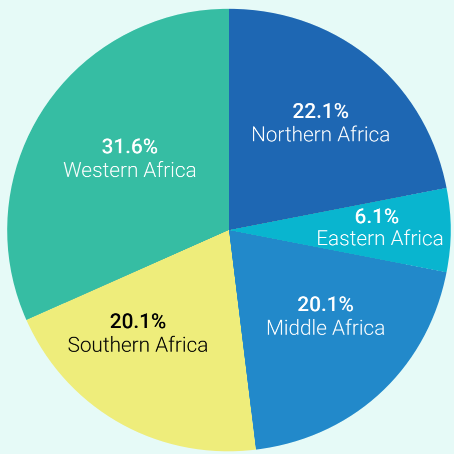


Figure 2: Businesses and investors based outside Africa that participate in resilience and adaptation initiatives on the continent

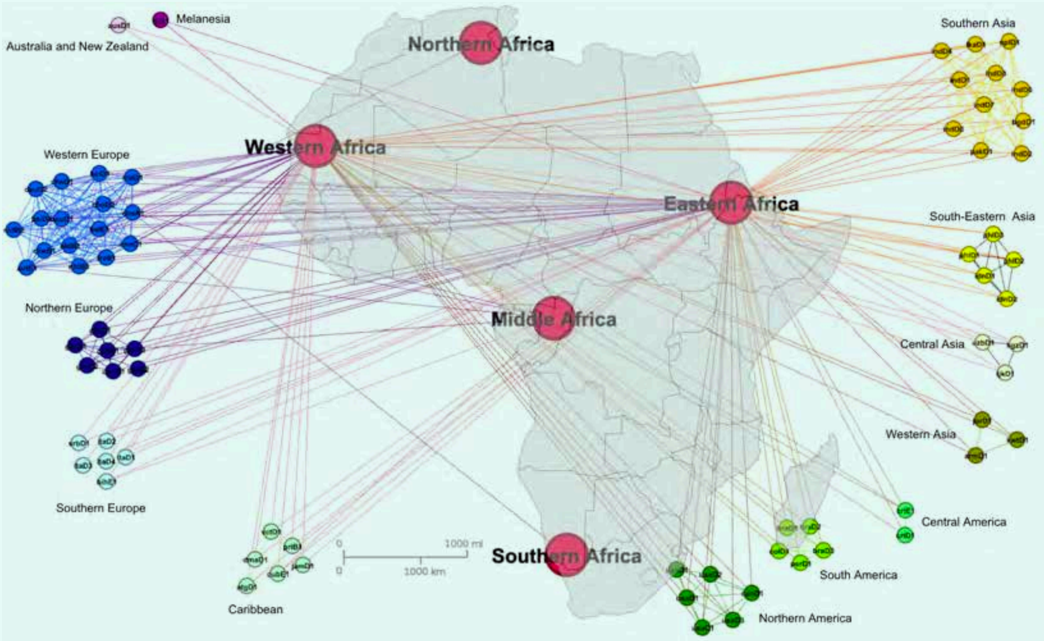
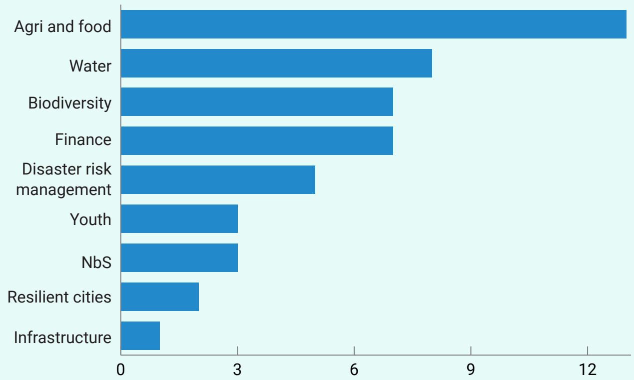


Figure 3: Adaptation-related action areas of international cooperative initiatives in Africa

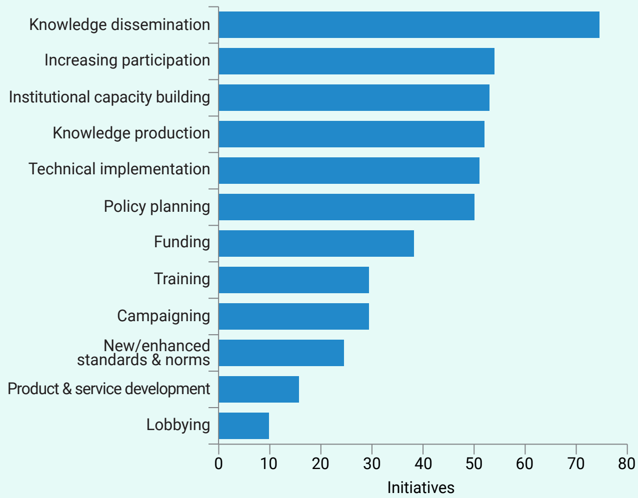


Action areas in Africa

A closer look at cooperative initiatives that primarily implement in Africa (with at least 50 percent of the countries they are implemented in based in Africa) shows that they most often focus on agriculture and food security, followed by water, biodiversity and finance (Figure 3). There is less focus on resilient cities and infrastructure. Water and nature-based solutions feature as crosscutting themes across multiple action areas – for instance, many youth-oriented initiatives address water issues, and nature-based solutions feature in initiatives on resilient cities, infrastructure, youth, biodiversity, and finance.

These action areas are addressed through a wide range of activities that include knowledge dissemination, enhancing participation (to get more peers to support a standard or to make individual commitments), and institutional capacity building (building new institutions or partnerships, or expanding existing organizational capacity). There is less of a focus on lobbying activities, and product and service development (Figure 4).

Figure 4: Activities under cooperative adaptation initiatives in Africa



Africa-based private sector participation

Although African private sector actors make up a relatively small proportion of overall participants, there are still 275 Africa-based businesses and investors that participate in one or more cooperative initiatives. They are mostly very large companies (with more than 1000 employees) or large companies (100-999 employees). Small and micro enterprises (SMEs, with 1-9 employees) are much less engaged (Figure 5), despite their importance to productivity and employment across Africa. This could be due, in part, to the international attention on initiatives that involve large enterprises.

Moreover, SMEs are typically not publicly listed and do not experience the same demands for transparency on environmental and social governance (ESG) as publicly listed companies do. Many of the private companies that participate in cooperative adaptation initiatives, for instance, do not have published ESG plans (Figure 6).

Africa-based businesses and investors engage mostly in the finance and insurance sector. Other sectors that are particularly exposed to climate change impacts, such as agriculture, forestry, and fishing, are under-represented.

Figure 5: African businesses in climate adaptation: Top 10 sectors

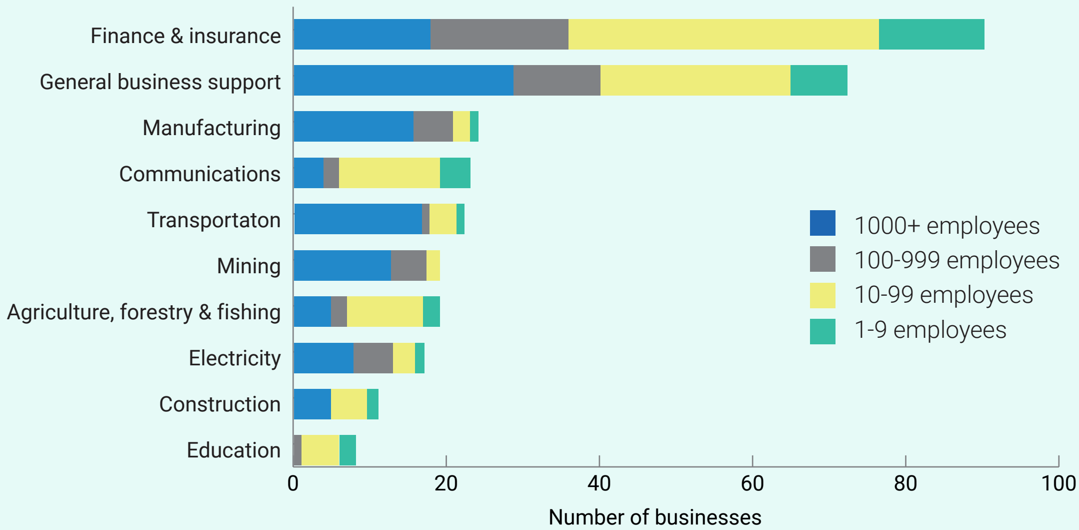
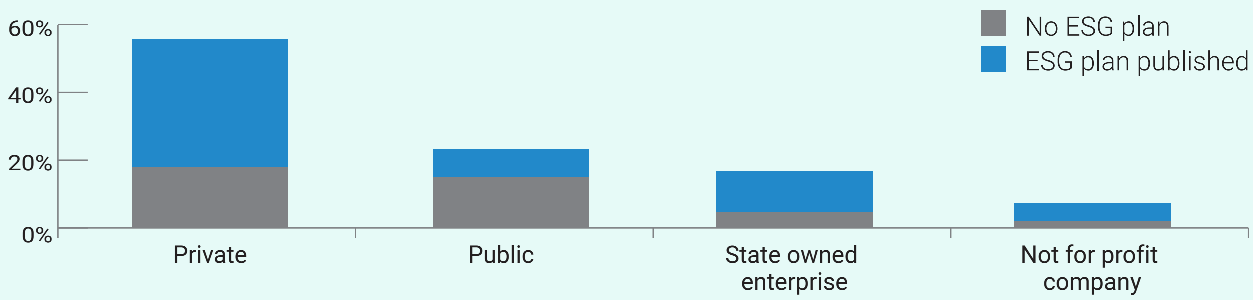


Figure 6: Africa-based businesses participating in cooperative adaptation initiatives, with ESG plans



International cooperative initiatives can therefore make important contributions to adaptation and resilience-building in Africa, but the number of Africa-based businesses and investors participating in such initiatives remain relatively low. Efforts to engage private sector actors across Africa, particularly SMEs which make up a large part of employment and economic output across Africa, are necessary. The invisibility of SMEs could be due to the international focus on larger businesses and investors, and due to fewer incentives – and possibly capacity – for SMEs to report on ESG policies.[23] Fortunately, recent years have seen growing efforts to stimulate national and regional action – for instance, Kenya, Uganda, Tanzania, and Rwanda have launched the East African Climate Change Technical Working Group to foster cooperation and engage non-state actors; and Africa Climate Week is organized annually to bring together private and public stakeholders.


Photo: iStock/Igor-Kardasov

Youth

KEY MESSAGES

- **Africa's youth, including those yet to be born, will bear the costs of climate change in the coming decades,** since the worst effects are expected mostly in the second half of this century.
- **Although they are the most educated generation ever in Africa, there is not yet a significant level of engagement by the youth with the climate crisis,** partly because of the pressing nature of their immediate needs and aspirations for education and employment. Further, the youth in Africa are often excluded from community political activities and national leadership roles—the youngest continent has the oldest political leadership.
- **The youth in Africa are undergoing complex demographic and economic transitions, which now face headwinds from climate change.** Climate change could reverse progress made on improving employment for the youth and could also increase inequality by affecting agriculture in rural areas. The implications of climate change for other development processes like migration, education, and gender roles are all considerable.
- **Climate change is not only a threat to youth livelihoods and welfare 20+ years hence, but also a threat now,** owing to the investments needed in Africa to avoid the weather effects that are starting to creep in. Not adapting could lead to major welfare declines down the road.

Photo: hadynyah/iStock

- **African countries can avoid some of the worst effects of climate change on the youth by taking adaptation measures now.** But these will be costly investments, both in terms of funds spent and opportunity costs. Yet not adapting is not an option. It is for the political leadership to set the right priorities in this process with youth engagement.
- **The youth need to engage politically and socially around them within national policy processes to a much greater degree, for it is they who have the greatest stake in the outcomes.** Including and encouraging youth participation in decision-making related to climate change is critical to making sure that choices, investments, and interventions have their support and are responsive to needs.

"My country is one of those heavily affected by climate change, as it is an arid country with low and erratic rainfall, high temperatures, very limited surface water, and an increased frequency of extreme weather conditions such as droughts and floods (...) it is an an area where our entrepreneurial, tech-savvy youth can contribute by developing innovative solutions."

H.E. President Masisi of Botswana
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

As global youth protests over the last five years denouncing the lack of preventative action by the largest greenhouse gas emitters have shown, climate change is fundamentally a youth issue. Nowhere is this truer than in Africa, which is now and for the foreseeable future the region with the largest youth population in the world, and simultaneously the region expected to suffer the most from climate change impacts despite being the lowest emitter of greenhouse gases. Africa's youth, including those not yet born, will bear the costs of the emissions of previous generations in countries that now enjoy an exponentially higher standard of living. This global income and welfare gap is expected to persist throughout the 21st century, raising issues of both cross-country and intergenerational economic justice.

The economic effects of climate change in Africa are expected to be substantial. Without actions to reduce emissions in rich countries and to adapt development infrastructure and policies in Africa, declines in GDP over baseline of up to 30 percent are predicted (see Macroeconomics and Climate Adaptation chapter). The worst effects are expected mostly in the second half of this century. Some of these effects can, and should, be mitigated through adaptive investments commencing now and continuing through the century. However, these investments have their own costs, including opportunity costs in terms of alternative growth and development-inducing investments. This prioritization problem raises the stakes for Africa's development policy choices over the next decade.

Africa's young population—often referred to as "the youth bulge"—has been a concern of African policymakers and stakeholders for some time, and is characterized as both a crisis and an opportunity.[1] Much of the discussion on youth-specific issues in Africa has focused on creating better employment opportunities, both for instrumental reasons—because this is necessary for economic transformation, poverty reduction, and possibly to realize a demographic dividend—and for intrinsic reasons—to help youth transition to economic independence from their parents, become empowered, and realize their full potential. Partly because they are the most educated generation ever in Africa, youth have high aspirations for economic empowerment and employment. However, African economies have been unable to fully deliver on these aspirations, leading to a major aspirations-attainment gap.[2] The aspirations gap seems to explain the positive correlation between education and employment in Africa today. Many politicians worry that this aspirations gap could lead to political instability, although thus far the correlation between youth unemployment and conflict is very low.[3]

The youth employment challenge will only worsen as climate change advances. Overall, most employment opportunities in Africa are found in the informal sector—household farms and firms. This will only change as economies transform, a process which climate change will negatively affect without adaptation investments. The majority of Africa's youth today live in rural areas and engage part- or full-time in agriculture, a sector that will be hit particularly hard by the effects of climate change. There will be less rainfall in many areas that currently rely on rainfed agriculture and more rainfall leading to flooding in others (see Agriculture and Food Systems chapter); more weather variability impacting on-farm productivity and incomes; more heat stress affecting the whole agri-food system; and the need to constantly refresh technology to adapt to changing weather conditions. Africa is urbanizing because of natural population growth in urban areas as well as migration, and urban youth livelihoods will be affected as well through the effects of more extreme weather on their places of work (which are often their homes) and employment opportunities.

The youth and climate change nexus cuts across a range of development issues not limited to employment. For example, the youth—especially young males—play a big role in urbanization trends as they are most likely to migrate from rural areas or between urban areas. Climate change could accelerate this trend, even as urban areas suffer as well, trapping the youth in substandard living conditions (slums) and poverty. The youth are a vital part of the informal social safety net in Africa. Although the youth are only starting to develop their livelihood patterns, in the absence of any form of social safety net many youths have to contribute financially to support younger siblings, and sometimes parents. Negative effects of climate change on their employment and earnings opportunities will have cross-generational implications. Young women in Africa devote many hours to unpaid work supporting families—their own nuclear family and their extended family—as caregivers and through household maintenance. This pattern begins early. Teenaged girls report doing much more housework than men, and one in ten African women aged 20–24 had at least one child by age 18.[4] Climate change could increase this burden by reducing infrastructure services, including access to safe water—already a challenge in rural areas. The youth in Africa are also often excluded from community political activities and national leadership roles—the youngest continent has the oldest political leadership.[5] The potential for youth collective action, protest, and engagement in civil conflict is a threat that lurks underneath the surface of political discussions and has inspired authoritarian actions throughout the region, often snuffing out the potential for an increased voice for the youth in key decisions around climate change adaptation investments that will affect their future.

This chapter reviews the key interactions between the youth demographics of Africa with emphasis on sub-Saharan Africa (SSA), the region's economic development progress and prospects (especially the prospects for higher earnings and more secure employment for youth), youth engagement and empowerment, and how climate change adaptation policies and investments interact with these trends.

We find that the effects of climate change, which are already being felt as more extreme weather events, are likely to negatively affect the livelihoods and welfare of rural and urban youth in several ways. In rural areas, declines in agricultural productivity and soil degradation will not only affect those engaged in agriculture, but it will also be felt all the way down the rural value chain. Urban youth, whose share of the youth population is increasing owing to migration, will also be negatively affected, but the trajectory could be slower.

For those youth who live in slums (which may occur following migration), the rainfall increases projected for the middle of Africa would soon negatively affect their living and working conditions, as both activities often use the same location (see the Present and Projected Climate Risks chapter). Youth in urban slums in drier areas will have to devote more time and money to procuring water, a burden which falls mostly on women. Meanwhile, the negative effects of climate change in rural areas could increase youth migration to larger urban areas, increasing the share of the urban population in slums.

If adaptation measures are taken now, the projected negative effects on youth in 20–30 years could be reduced. This would benefit African youth during their peak earning years and beyond. However, changing the trajectory of public and private investment toward adaptation, while necessary, may have costs in the next 10–20 years, which will be felt by youth as well. Although these issues are complicated, youth need to engage politically and socially around them within national policy processes. In many countries, paths to impactful youth engagement are blocked by the gerontocracy which dominates governance and political processes. Given the centrality of key investment and policy decisions around adaptation to the youth's future welfare, young people should be supported and encouraged to engage further on these issues.

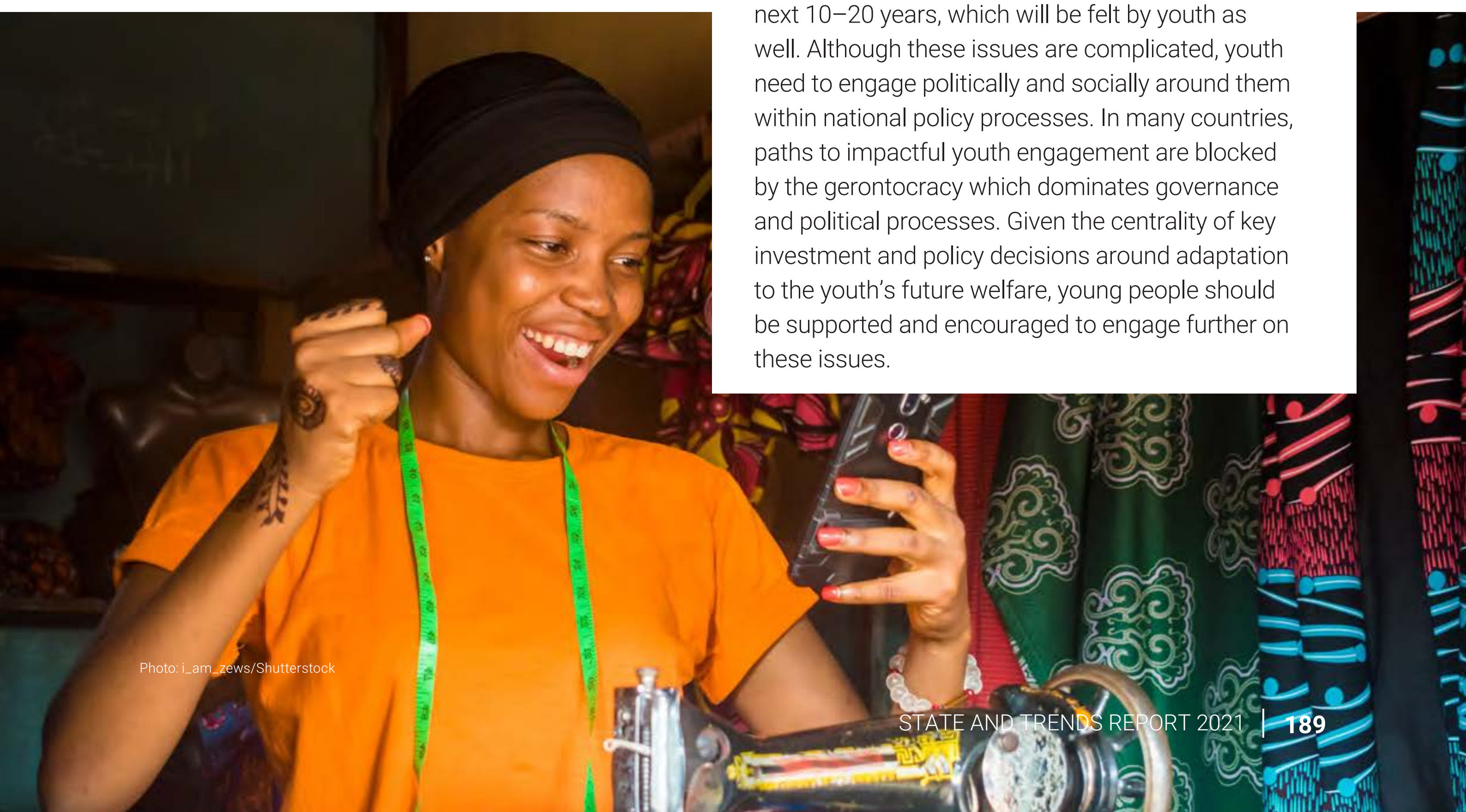


Photo: i_am_zews/Shutterstock

Box 1. What age group defines youth?

As a separate demographic group, youth are most commonly defined as those aged 15–24, a definition proposed by the UN Statistics Division (UNSD) and used by UN statistics-producing agencies such as the ILO, UNESCO, and the World Bank. But even among statisticians and UN agencies, different definitions prevail. Some distinguish between youth aged 15 to 18, as people in this age group are mostly expected to still be in school, living with their families or relatives, and not married or having children (UNICEF). Unfortunately, in a number of African countries, women under the age of 18, especially from lower-income families, are not able to meet this expectation, indicating important gender differences.

The African Union in 2006 enacted the African Youth Charter, labeling people aged 15–35 as youth. This was both a political statement—many countries have positions in Parliament or in government reserved for youth, and 35 seemed a more fitting age cutoff—and a cultural and economic one, expressing the frustration many young people, especially males, feel with the difficulties they face in achieving economic independence and assuming what are considered to be the social responsibilities of an adult male. While the frustration is clearly real, Africans develop along the same lifecycle as people in other parts of the world, and survey data from Africa do indicate that most youth are economically independent from their parents by age 25; some even support younger siblings during their youth (also see Figure 2).

In this chapter, we adopt the UNSD definition, as it is widely used. Data in public international statistics databases such as World Development Indicators and ILOSTAT offer data broken down by this definition of youth, but not by other definitions such as that by the AU Youth Charter's.

THE DEMOGRAPHICS OF YOUTH IN AFRICA, AND THE CONSEQUENCES FOR YOUTH EMPLOYMENT OPPORTUNITIES

Youth is a distinct human developmental stage, a time of transition from dependence to independence, marked by critical decisions that affect the future of the individual and the broader society (see Box 1 for the definition used for this chapter's analysis). A positive youth trajectory concludes with the development of a mature adult who has a positive sense of self, has developed agency and impulse control, and has a set of core competencies and skills for engaging effectively with the economy and society. A negative trajectory means a young person who does not develop self-esteem and agency, and concludes with risky and or destructive behavior such as teenage pregnancy, crime and violence, self-destructive health habits, and disengagement from society, all of which can lead to household poverty and lower economic growth.[6] Recent research demonstrates that while cognitive learning proceeds most rapidly until the age of 15, socio-emotional skills are learned up to the age of 25 or later, in part because the key parts of the brain (notably the prefrontal cortex) continue to develop through this period.[7] With so much at stake, it is clear why youth development is an important economic development issue.

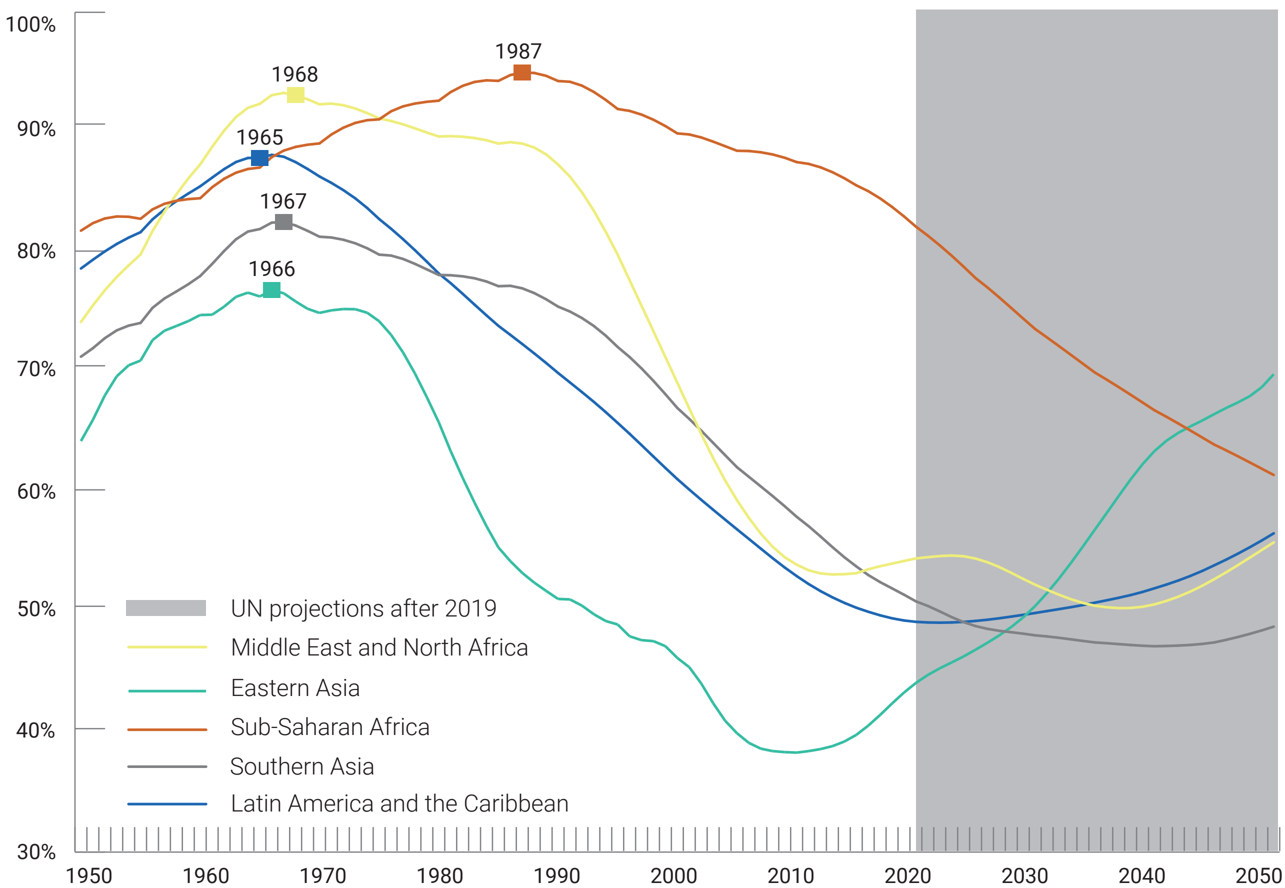
Youth constitute a high proportion of the population in low-income countries (LICs), and Africa, where 75 percent of the world's LICs are located, is the world's youngest region. 43 percent of the population is under the age of 15, owing to Africa's late and slow demographic transition.[8] Youth comprise 20 percent of the total population, compared with 16 percent for the world as a whole.[9] Income is one of the key determinants of demographic transitions, so it is not surprising that as a lower-income region, Africa's demographic transition is at early stage and its population is largely young.

One of the benefits of the demographic transition is a high share of working-age people in the population, implying a low share of dependents. This leads to more investments in human capital, a more productive labor force, higher public and private savings rates, all leading to an acceleration in economic growth called the demographic dividend.

However, Africa's transition has been unusually slow owing to persistently high fertility. This can be seen in Figure 1, which shows the ratio between the working-age population and those outside working age for Africa and other developing regions. The peak of the curve is somewhat higher, and the slope of the African curve less steep than in other regions, implying a later and slow transition and potentially little or no demographic dividend if the projections bear fruit.[10] However, noteworthy as well is that the dependency ratio (the proportion of dependents in the population relative to the number of people in the age group 15–64) for the continent as a whole peaked almost 40 years ago. The youth share of the working-age population has also peaked (in 2001[11]), so while the African population and labor force is young, it is getting older by the day; the youth bulge is gradually decreasing.

Figure 1: Africa's youth bulge is diminishing

Dependency ratio, actual and projected by region



Note: Working-age population is the estimated population aged 15–64; dependency ratio is the population outside working age ("dependents") divided by the working-age population.

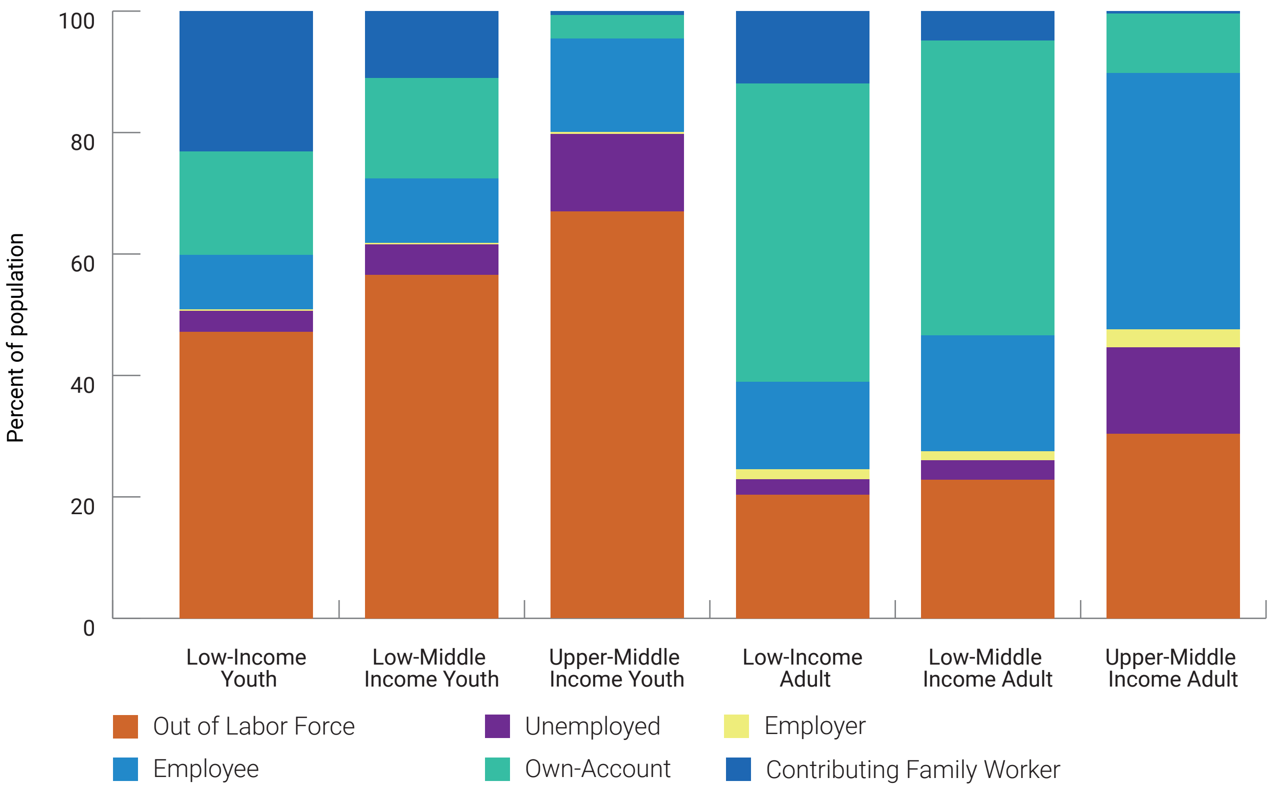
Source: United Nations World Population Prospects 2019 (Medium Variant)

Africa's demographic structure brings challenges for youth livelihood development and the employment and earnings outcomes. The lowest-income countries are characterized by a lack of modern, formal private firms in non-agricultural sectors offering wage jobs. As a result, most people work informally with members of their family or household, on farms or in informal businesses (the informal sector—see Figure 2). As the economy develops, it transforms, creating more formal firms that grow, increase productivity, contribute to GDP, and importantly, employ people. These employees usually receive higher wages on average than those working in household farms or businesses, because of opportunities to specialize, use skills more intensively, and work with more capital and technology. This employment transformation—an increase in the share of employment in formal wage work—is caused by an increase in labor demand relative to supply. High fertility creates a fast-growing labor force (a rapidly increasing labor supply), which delays the employment transformation. Africa's labor force is currently increasing at 3 percent per annum, and this pace is projected to slow very gradually.

In middle- and high-income countries, most youth are actually out of the labor force, in school or sometimes home with young children—they are neither unemployed nor looking for a job (Figure 2). In low-income countries, youth are likely to be contributing to household livelihoods—helping out on the family farm or in the family shop. As the role of household remunerative activities in the economy diminishes, participation as a contributing family member diminishes as well. And by the time they become adults at age 25, youth in countries at all income levels have mostly established their own livelihood, either as self-employed persons or as employees. It is hard for youth to operate a farm or business independently,[12] but easier for adults, as the data in Figure 2 reveal. However, it is only in the upper-income countries that the majority of employment is found in wage work. Partly as a result of the need to search for wage employment in upper-income countries, as well as the availability of more family resources and a broader social safety net, youth unemployment is high in upper-income countries and low in the lower-income countries.

Figure 2: Youth enter the labor force later, and receive better employment opportunities, as countries get richer

Employment status by age group



Source: ILOSTAT

Photo: borgogniels/iStock

Youth employment opportunities are directly related to their own education and skills, and the structure of employment at time of entry. Educational access has been growing in Africa, and as a result, youth have more education than their parents or any other previous generation. This helps improve youth job prospects, provided there is a corresponding expansion of employment opportunities with the potential to use this education. Formal wage jobs often require completed secondary education, and only about 30 percent of youth aged 20–24 reach this education level in Africa today.[13] Studies in Africa show a high return to secondary and post-secondary education, indicating a demand for education in the economy.[14] But in many countries, education is expanding faster than the growth of formal wage jobs, leading to frustration among youth with education. Youth with secondary or post-secondary education have higher unemployment than their less educated counterparts, even in low-income countries.[15] Also, African education is often low quality, and not developing the 21st-century skills African youth need, such as problem solving, teamwork, or digital skills,[16] which may be one reason that educated youth are not supported by labor demand. Youth that do not enter into a wage job after leaving school rarely get one later, as there is limited mobility between these types of employment.[17]

Countries can increase the pace of employment transformation, creating better employment opportunities for youth by increasing the growth of firms employing workers—in other words, achieving transformative economic growth. This requires public investment in enabling social and economic infrastructure (such as education, health, roads, ports, energy, ICT, etc.), policies which encourage private investment (macroeconomic stability, a good business environment), and sources of finance for private investors—either internal or external. Prior to the COVID-19 pandemic outbreak and the ensuing economic downturn, Africa had 18 years without a recession; 39 out 45 African countries had positive per capita GDP increases over this period.[18] Some countries in Africa managed to achieve a significant employment transformation during this period.[19] Many of these transforming countries also attained lower-middle income status (LMIC) or are very near that income level. During the same period, the poverty rate declined significantly.[20] But even in the most successful LIC and LMICs, over half of the labor force still works in the informal sector.

While output and productivity growth in the non-agricultural sectors (which is faster than the rate of output growth in the economy as a whole) is necessary to improve employment opportunities and outcomes for all, especially for the youth, output and productivity growth in the agricultural sector is necessary for poverty reduction and underpins development of non-agricultural sectors. Productivity-led growth in agriculture reduces rural poverty, frees up labor for the non-agricultural sectors, helps earn the foreign exchange needed to import technology for expansion of output in other sectors, provides raw materials for the development of an agro-processing sector, and helps feed a growing population.[21] A more productive agricultural sector also offers better employment opportunities and outcomes for the less educated rural youth who will enter this sector. Youth do enter into farming and stay in the sector in LMICs even as the share of employment in agriculture declines, either because higher incomes and better prospects pull youth into a sector currently regarded less favorably by many young people, or because the lack of options outside of agriculture for rural youth push them into farming. The average age of farmers in Africa today is under 40, reflecting the steady entrance of youth into the sector over the last 15 to 20 years.

Opportunities in wage-earning employment have increased faster for males than females in African LICs and LMICs.[22] Several reasons appear to explain this. First, in most LICs and LMICs, primary school enrollment and completion are about equal for boys and girls, but boys are more likely to be enrolled and complete secondary and post-secondary education, levels that are usually prerequisites for a non-farm wage job. African firms (often male-owned and managed) also cite a preference for men in many jobs.[23] Finally, women are traditionally required to assume many responsibilities around the household—unpaid household work—which limits their capacity to observe the rigid full-time schedules that often come with factory or office work. In richer countries, infrastructure and the purchase of processed foods reduces this burden somewhat, especially in urban areas, but this has not taken place in Africa.[24] As a result, women are more likely to be self-employed or work in household farms and businesses than to have wage employment.

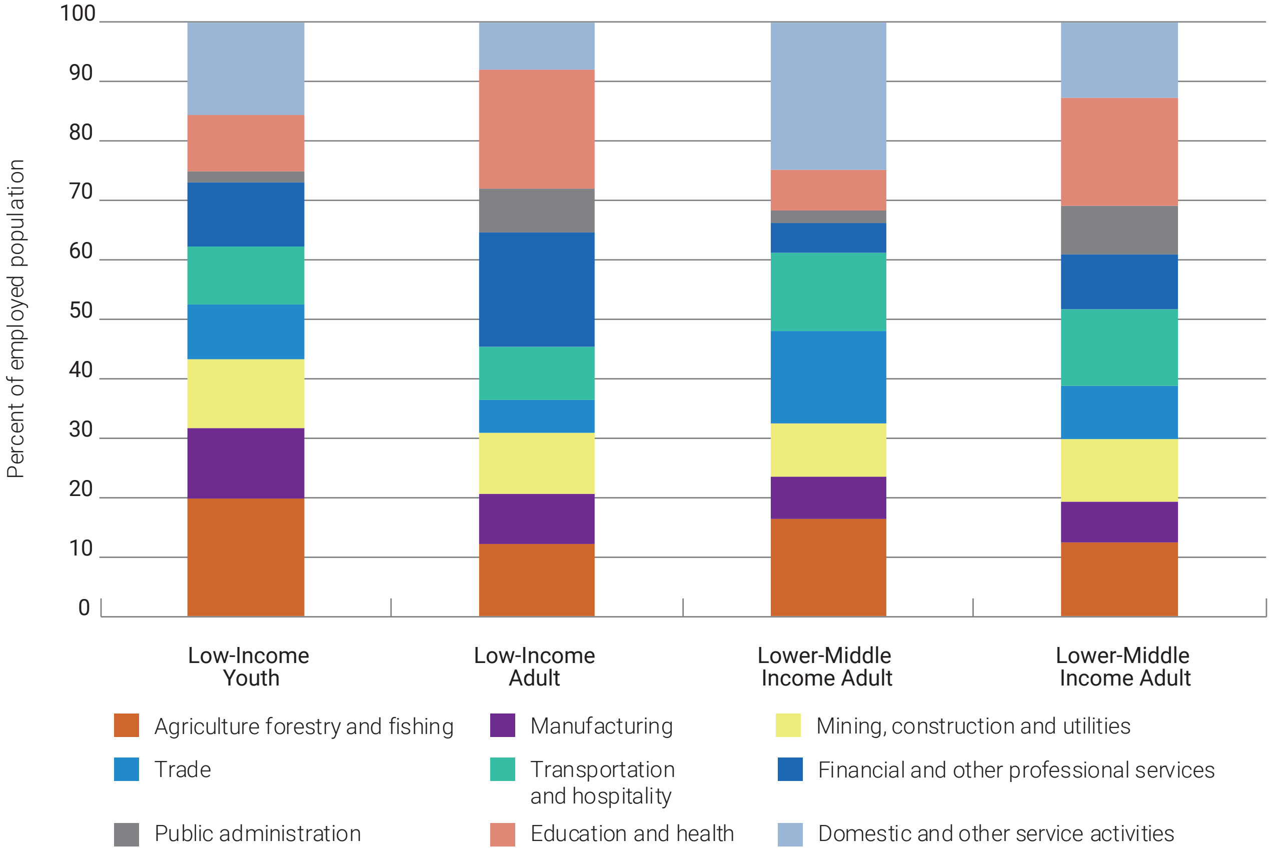
African youth seeking better-paying and more stable employment may undertake rural-urban migration. In Africa, rural-urban migration was high in the period after independence but settled down at a lower level in the 1980s–1990s in most countries. Rural-urban migration has distinct age and sex characteristics.[25] Overall, male youth are mostly likely to migrate out of rural areas, either for educational purposes or to seek employment. As a result, rural areas are becoming more feminized, with the opposite occurring in urban areas. Rural women aged 15–24 are about four times as likely to be heads of households in rural areas than men. This is possibly a concerning trend as female-headed farming households in Africa have lower productivity and earn less, in part owing to the burden of unpaid household chores, calculated to be over five hours per day in rural areas.[26,27] Meanwhile, evidence also shows that even controlling for human capital and other characteristics valued in the labor market, urban labor-force participants in Africa earn more than rural ones.[28]

Photo: Anton_Ivanov/Shutterstock

The result of the migration trends is that the youth share of the population in cities in SSA is about 28 percent while in rural areas it is about 19 percent. Faster fertility declines in urban areas (resulting in a smaller population age 0–15) explains part of the difference in the youth share, with migration accounting for the rest. The outcome of male-biased rural-urban migration is that the ratio of males to females aged 15–64 in urban areas is 1.05, while in rural areas it is 0.96. As discussed below, climate could accelerate youth rural-urban migration, but whether the male share would continue to be dominant, or fall is unclear.

In summary, while the share of youth in the working-age population is diminishing, the absolute number of youths in Africa is still increasing rapidly owing to slow fertility decline. Absorbing these youth into productive, remunerative employment opportunities has been and will continue to be a challenge for African countries. Multiple countries in Africa achieved broad-based growth and successfully improved employment opportunities from 2000–2018, through a combination of (i) supply-side policies (expansion of education), (ii) demand-side policies to encourage the entry and growth of firms and (iii) investments supporting productivity increases, especially in agriculture and digital services. Nonetheless, most youth and their parents continued to work in the informal sector. COVID-19 has interrupted this transformation process, frustrating the youth's ambitions. For the benefit of their youth as well as their older adult population, countries need to restart this process. Even when they can do so, most countries will face demographic headwinds, including spatial differences, which will slow down the process of transforming employment. They will increasingly face climate change headwinds as well, a topic to which we now turn.

Figure 3: Employment by sector by age group



PROSPECTS FOR IMPROVEMENT IN YOUTH EMPLOYMENT OUTCOMES—THE CLIMATE CHANGE THREAT

To improve employment opportunities, raise welfare and reduce poverty, Africa needs to continue to achieve broad-based and transformative growth. Current scenarios, which mostly do not incorporate climate change and adaptation effects and were prepared before the COVID-19 crisis, project that employment opportunities for the region as a whole will only transform slowly over the next 20 years.[29] For example, recent OECD projections suggest that the share of informal sector employment (household farms and firms) will only decline by three percentage points unless major shifts in policy and investments take place.[30] Most of this decline in informality is expected to take place in the agricultural sector, which has been losing its employment share for some time (see Figure 3), even as the absolute number of people working in the sector has continued to increase. Increased investments in productivity-led growth—a must for the development of climate-smart agriculture—to raise earnings in agriculture could significantly accelerate growth in the share of non-farm employment and wage employment through multiplier effects and by freeing up labor trapped in subsistence agriculture. This would substantially reduce the extreme poverty rate in Africa by 2030, with further improvements expected after 2030 if African economies continue to transform.[31]

Climate change effects, and the adaptation challenges associated with them, have the potential to stall this potential positive trajectory, or even reverse progress to date on improving employment opportunities for youth. It could also widen inequality in the population, including among youth, by eroding welfare faster and deeper in rural areas. Models suggest that the worst effects will not be felt until around 2045–2050 (see Macroeconomics and Climate Adaptation chapter), but as other chapters in this report indicate, these effects are expected to be severe. Today's youth would be 45–54 in 2050 and will have mostly passed their peak period of earnings growth at this point (if current age-earnings profiles hold). But the youth of 2030 will be in their peak period of earnings growth by 2045, and could suffer long-term income damage, affecting them and their dependents, if adaptation measures are not taken to counter the effects of extreme weather. Importantly, by age 40, in the absence of an effective social insurance program, people must start saving for old age if they wish to avoid burdening their children financially, meaning that today's youth could be disadvantaged in their older years owing to a worsening economy when they should be at peak savings. Africa's youth do not have to wait for 2050 for climate change to impact their livelihoods and income security, as countries are already experiencing the initial effects of more extreme weather patterns—both droughts and cyclones/flooding—with negative effects on youth employment and earnings opportunities.

The worst economic effects of climate change are expected to occur in the agricultural sector and in rural areas. Today's youth mostly see agriculture as the least desirable sector for employment. Yet youth, especially rural youth from poorer families, with few options to gain education, are entering the sector despite obstacles such as difficult access to land and credit.[32] Youth embarking on agricultural livelihoods today will suffer the effects of climate change; their livelihoods need adaptation support. Yield per acre declines in cash and food crops of up to 5 percent by 2030 are projected in the absence of measures to improve water management and develop and disseminate more climate-resistant varieties of plants and seeds. Youth in pastoral areas will suffer the most, as most of these areas are already facing declining pastureland and competition for land from crop farmers (see Drylands chapter). Projected trajectories differ by sub-region. For example, as indicated in the Present and Projected Climate Risks chapter, central Africa from west to east is expected to receive more rainfall, while the Sahel, the Horn of Africa, and most of southern Africa are expected to see dryland expansion as well as increase in severity of droughts—a very harmful scenario for agriculture. Increasing incomes in agriculture have positive multiplier effects on the rural non-farm economy, including the economies of towns and secondary cities, but decreasing agricultural incomes have the opposite effect, as the demand for non-farm goods and services declines. If this cycle of decline takes effect, progress in rural poverty reduction (where most of Africa's extreme poverty is located) can be expected to grind to a halt in some countries—for example, Ethiopia or Senegal, where significant progress has been made over the last 20 years, or Zimbabwe, where progress has not been made but could be realized with a different set of policies.

Non-agricultural sectors, which have been expanding employment and output, and mostly offer higher earnings potential, will also be threatened by climate change, as well as a host of other factors including technological change. Africa's manufacturing sector is small, and could possibly expand, especially in sectors such as food processing, textiles, footwear, furniture, building materials, and electronic assembly. However, this would not create sufficient wage employment opportunities for Africa's growing workforce, as manufacturing has become much more capital-intensive over the last 30 years, a trend that is expected to continue as technologies such as artificial intelligence (AI) and advanced robotics enters into widespread use in the developing world.[33] The service sectors in Africa are dualistic—supermarkets and sophisticated e-commerce exist alongside informal vendors selling their wares in market stalls and along the side of the road. Formal production of goods and services is more capital-intensive, which is one reason that employment in informal goods and service production has expanded faster when service sector output expands.

Both formal and informal businesses in non-farm sectors face two major constraints to expansion: infrastructure deficits and finance. The former is most likely to be affected by climate change. The infrastructure constraint—energy, trade and transportation, water supply and sanitation, and ICT services—will get worse as the world warms and the effects of extreme weather events are felt.

Expensive and unreliable electricity is the constraint most widely cited by formal employers as to why they do not expand their businesses. Africa's grid distribution system is fragile while its generation system is wholly inadequate relative to demand and is heavily dependent on hydro—itself very vulnerable to climate-change induced rainfall declines.

Most households do not have access to electricity for cooking, so they rely on a diminishing supply of wood from forests and homemade charcoal. Road and rail transport is likewise expensive and slow. Africa's coastal ports— lifelines for exports and imports—are slow and inadequate as well, except for the port of Durban in South Africa. Extreme weather events such as flooding and drought pose major risks to all these necessary services, making it harder to meet growing requirements from the private sector, government, and households. While all development strategies and public investment plans in African countries set targets for improving the quantity and quality of infrastructure services, these plans are massively underfunded. They mostly do not include plans for bolstering infrastructure to deal with climate threats.

Informal non-farm production of goods and services mostly takes place in urban homes, in marketplaces, or on urban or feeder roads. A majority of businesses are located in informal settlements (slums), which is a major risk factor to earnings, as informal settlements lack drainage systems as well as water supply and sanitation. Heavy rain can damage inventory or supplies and make it difficult for business owners to connect with clients for a sale or a haircut. Fire is an ever-present danger to both markets and homes, which increases when temperatures rise. African economic transformation and jobs development plans often neglect these risks to informal livelihoods. Youth entering this sector need solutions to reduce these vulnerabilities. Slum upgrading programs have had a mixed record with respect to this sector, as some programs have helped stabilize settlement infrastructure and improve security of tenure, while others have hurt businesses through relocation requirements (see Urban Development chapter).

National adaptation strategies generally call for action in two areas that are important to the economy's capacity to create new employment opportunities for youth:

- **To support rural youth,** plans call for agricultural research and development to find and disseminate seeds and inputs resistant to looming weather and water challenges, as well as increased investment in water management, including irrigation; and
- **To support transformation and increased connectivity,** plans call for strengthening energy, transportation, housing, commercial real estate, and water and sanitation infrastructure against extreme weather events.

Approaches to both are discussed elsewhere in this report (see chapters on Agriculture, Transport and Energy, and Urban Development). For youth and youth livelihoods, both are important, but prioritization is difficult. Maintaining and growing agricultural productivity underpins transformation in other sectors and is critical for future poverty reduction, even if the sector will only employ a minority of youth in the future. Very few countries have successfully reached middle- or upper middle-income status sustainably without continuous increases in agricultural output and major improvements in agricultural land and labor productivity.[34] However, agriculture grows within a thriving agri-food system of activities off the farm (including downstream value-addition activities such as marketing and storage, wholesale and retail trade, processing and manufacture, and food service; and upstream farm support systems such as input production and supply). This implies that investments in maintaining or increasing productivity on the farm need an increased focus on non-farm infrastructure—investments that would support production and employment in other non-farm sectors such as manufacturing, trade, transportation, and tourism.


Photo: dr322/iStock

To achieve transformative growth, investments in climate change adaptation need to be complemented by other investments needed to support improvements in employment opportunities and welfare for youth, including continual expansion and upgrading of the education system; financial-sector development to expand access to credit and reduce costs (e.g., lowering spreads through improved information to reduce transaction costs); ICT investments to improve digital connectivity and support the burgeoning new internet and computer-enabled production technologies; investments to improve child and adolescent health and nutrition; urban soft and hard infrastructure investments to allow cities to support increased productivity; as well as programs to reduce income risk, thus encouraging youth investments in their future livelihoods, such as social insurance and social protection. The prioritization of such investments, and the effective implementation of investment projects to realize expected rates of return, has already been a huge challenge for African governments.

Climate change is therefore not only a threat to youth livelihoods and welfare 20+ years hence, but also a threat now, owing to the investments needed in Africa to avoid the weather effects that are starting to creep in. These investments have an opportunity cost, in terms of other private and public investments that might have been made to support the entry and growth of firms needed to transform the economy and offer new job opportunities to the youth. It is often not obvious how to balance these needs and set priorities. The only obvious fact is that not adapting could lead to major welfare declines down the road. Setting priorities is the role of the political system. Including and encouraging youth participation in decision-making that affects their future is critical to making sure that choices, investments, and interventions have their support and are responsive to their needs.

Photo: AYA images/Shutterstock

YOUTH ENGAGEMENT AND EMPOWERMENT FOR MORE RESPONSIVE CLIMATE CHANGE ADAPTATION

While the case for climate change adaptation in Africa to help ensure a better future for Africa's youth is strong, the youth are today are mostly not able to push this agenda forward. While in other regions youth are on the frontlines, helping to mobilize coalitions for change, this is mostly not happening in Africa. One reason is the political and social forces that have accepted and ratified government by gerontocracy in much of Africa. A second reason is the lack of understanding of the issues and complex trade-offs in the population, including the youth, and youth's focus on the struggle to realize their economic ambitions in a challenging economic environment.

Observers inside and outside of Africa have often marveled at the African political paradox—the world's youngest region is governed by the world's oldest leadership. For the most part, this reflects the stranglehold that independence-era elites have maintained on political leadership and participation in decision-making.[35] Some of the longest-serving leaders are in effect autocrats; other are elected leaders in a state where one party controls and dominates the electoral process, while others were elected in highly contested elections. In many countries there is a lack of a generational change of guard.[36] The political process, controlled by the older elites, has effectively blocked youth from any meaningful participation in decision-making processes. While governments usually have a Ministry of Youth (often combined with Culture and Sport), this tends to be the weakest ministry, tasked mainly with carrying out patronage.[37] Most political parties do have youth divisions, but without any formal authority or effective collaboration mechanisms reflecting real intergenerational partnerships. More often, youth divisions are used as shock troops in political clashes, fomenting violence to undermine opposition.

In countries where contested elections take place, youth often join their parents in voting for the gerontocracy. Youth make up between 30 and 50 percent of voters (depending on the age definition, see Box 1). There are several reasons for this.[38] First, Africa traditionally venerates elders, especially in rural areas where traditional hierarchies dominate. This effectively denies the youth opportunities to ascend to leadership positions even at local levels—the proving ground for aspiring politicians. Second, elections are quite expensive in Africa. In countries such as Ghana and Kenya, where elections are contested between political parties, recent elections are estimated to have cost $12 and $25 per voter respectively. It is hard for youth, without deep connections to the economic elite or access to government-funded patronage networks, to even consider participating.

African youth are both optimistic and frustrated with their current situation.[39] Youth in Africa overall are less satisfied with their political system, and with democracy in general, than their parents were at their age.[40] In a survey conducted in 2017 among rural youth in 21 African countries, 93 percent of rural youth expected to see a big improvement in their lives in the next five years.[41] Most are surely disappointed now. Most youth leaving school want, and may even expect, to work in the public sector, owing to job stability and security.[42] Participants in Oxford University's "Young Lives" study in Ethiopia reported feeling "entitled" to government jobs if they completed secondary school. Others are willing to work in the private sector (10 percent of surveyed African youth), but as professionals or managers, not as laborers or on the factory floor.[43] These jobs are mostly not available. It is not surprising to find that almost two-thirds of young Africans surveyed in the School-to-Work Transition surveys (SWTS) performed between 2012 and 2015 wanted to change jobs if they could. Those working in the agricultural sector had the highest job dissatisfaction.

Yet, a key finding in this chapter is that despite deep dissatisfaction with their current employment and prospects, African youth are not focused on or likely to mobilize for policy change to avert the worst effects of climate change. According to the Afrobarometer survey,[44] the 18–25 age group has the highest percentage (26) of people agreeing that "no, climate change does not need to be stopped", compared with 21 percent for adults aged 56 and older, despite youth's higher education levels. Youth are also the least likely to say that climate change is making life somewhat or much worse. Youth reported low civic engagement, in part owing to time constraints, especially for young women. Youth are engaged in their communities, especially after a natural disaster. However, they are mostly engaged in low-cost, grassroots activities to help vulnerable community members or reconstruct damaged community infrastructure and housing.[45]

"We need to deliver on several fronts: Closing the gap between adaptation and mitigation financing, increasing support for adaptation action, including for the most vulnerable, as committed under the convention and the Paris Agreement, and specifically increasing support for adaptation financing."

Patricia Espinosa, Executive Secretary of UN Climate Change
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

In principle, coalitions for change, including coalitions promoting an increased focus of public policy on preparation for and adaptation to climate change, could be strengthened through youth participation. Youth should be involved in the framing and design of programs so central to their economic future, as part of a broader engagement on economic policy choices. Bilateral donors and international NGOs support many different youth-empowerment type activities, although most are more focused on either improving employment options (through, for example, post-school training); improving adolescent health, especially for young women; or reducing potential or actual civil conflict (peacebuilding). Few are actively engaged in climate change activism. This may reflect the youth's own choices and preferences. For example, the AU youth empowerment initiative—developed though a participatory process—proposes "seven game-changing interventions": (i) alternative pathways to education, (ii) young teachers' initiative, (iii) internships and apprenticeships, (iv) nurture youth-led start-ups, (v) leadership programs (focused on professional jobs), (vi) youth movement (regional consultations), and (vii) campaign on youth well-being and mental health. Climate change adaptation is not (yet) considered to be a game-changer for the youth.

POLICY RECOMMENDATIONS

Africa, the lowest greenhouse gas-emitting region, is expected to face the highest costs from impending climate change. This is very unfair, especially for Africa's youth, including those who are infants and children now but will be youths when the most extreme effects manifest themselves. African countries can avoid some of the worst effects by taking adaptation measures now. But these will be costly investments, both in terms of funds spent, and opportunity costs—the activities and investments which were not undertaken because funds and time were absorbed by adaptive investments. Africa has few other choices, however. While investments in adaptation will raise the cost of achieving the economic development Africa needs to provide better opportunities for its youth—those in this age cohort today and those expected to enter (and exit) the cohort over the next 30 years—the alternatives appear worse.

Beyond this overarching choice framework lies many context-specific choices around investment project selection and prioritization. Significant uncertainty surrounds these choices ex ante, as the rate of return depends in part on how an increasingly uncertain process unfolds.

For the benefit of the youth, countries need to undertake needed adaptation investments to ensure that economic transformation processes are sustainable, but not neglect the key human capital and other investments needed to help youth make the transition to adulthood and their own livelihoods. Investments need to be based on a realistic assessment of where most employment opportunities are likely to be in the future—in agriculture, and in informal household production of goods but mostly services, not in where youth might wish they would be (e.g., the public sector or high-tech start-ups).

Given the importance to their future, youth need to engage politically and socially around them within national policy processes to a much greater degree, for it is they who have the greatest stake in the outcomes. They should be consulted and actively and effectively engaged in both early-stage investment decisions and in monitoring outcomes at the local and national levels. A prerequisite appears to be a better understanding among youth of what is at stake for them, and what are the parameters for adaptive change to reduce the risks to their welfare ahead.

"

We need to be ambitious, in quantities and in qualities. It is really the cornerstone of our willingness and motivation.... We need to mobilize the public and private sector."

Remy Rioux, CEO, Agence Française de Développement, on behalf of H.E. President Emmanuel Macron of France
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Photo: Oluwafemi Dawodu/Shutterstock

Youth and Employment in North Africa

Photo: Adriana Mahdalova/Shutterstock

CHALLENGES

Unemployment among college-educated youth in North Africa remains high, especially among young women. Frustration over the lack of economic opportunities and access to basic services is evident in public demonstrations and calls for government change. The situation has also fueled the migration of youth from rural to urban centers, as well as formal and informal migration across the Mediterranean Sea northward towards Europe.

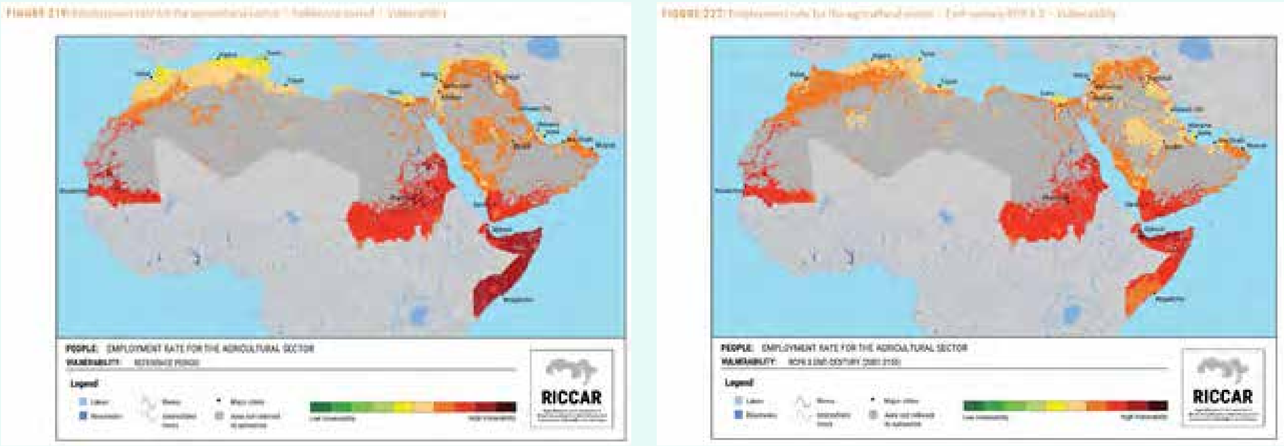
Climate security concerns associated with reduced water, food, and energy security and the damage caused by extreme climate events have also exacerbated unemployment and governance challenges in countries facing protracted conflicts. These conditions have contributed to internal displacement and increased the risk of radicalization of young cohorts. These impacts are stymying efforts to achieve peace and prosperity for all.[46]

The recent droughts experienced in parts of North Africa and the associated loss of income from agricultural value chains have contributed to socio-economic unrest. Agricultural employment vulnerability due to climate change in the Maghreb is projected to reach 77 percent by the end of the century if measures are not taken to increase adaptive capacity.[47] The western Tindouf basin, the western North Africa coastline, the upper Nile Basin, and the Horn of Africa face the highest vulnerability, as shown in Figure 1.[48]

Additionally, there is a lack of enabling environments for entrepreneurship in the region—particularly concerning access to services, infrastructure, and finance—and pathways to regularizing work from informal to formal structures. Small and medium-sized enterprises face the most significant restrictions regarding access to credit, which affects women entrepreneurs disproportionally, as women-owned businesses tend to be SMEs.[49]

Despite these challenges, opportunities are emerging to increase the adaptive capacity of youth and engage them in climate change advocacy and action.

Figure 1: Agricultural employment vulnerability at mid-century and end-century compared to the reference period



Source: ESCWA et al., Arab Climate Change Assessment Report: Main Report, E/ESCWA/SDPD/2017/RICCAR/Report, pp. 307-310.

Opportunities

Climate change considerations are being increasingly mainstreamed to enhance agricultural productivity and address water scarcity through remote sensing and regional climate modeling. These measures are helping to improve agricultural productivity and encourage more efficient water use in Algeria, Tunisia, and Morocco.[50] The efforts have been complemented by capacity building and institutional strengthening that have empowered young professionals to access new technologies and tools to enhance adaptation efforts. In tandem, more technology-savvy agricultural practices have been introduced through mobile applications. These tools lend themselves to young cohorts with smartphones and knowledge of social media, allowing them to access tools for information and innovation from production to marketing.[51] Transportation and logistics centers in Morocco and Tunisia are also becoming more efficient and responsive to extreme climate events with the support of Global Environment Facility projects.

Improved access to electricity can also strengthen adaptive capacity. Renewable energy projects are enabling the establishment of women-owned agro-businesses in rural areas in Morocco[52] and Tunisia.[53] These efforts are generating climate adaptation and mitigation co-benefits.

Targeting women and youth in Tunisia

In Tunisia, 47 percent of the population is under the age of 30. The agricultural sector, the primary source of income across much of the country, faces challenges associated with poor access to financial services, weak rural organizations, agricultural land fragmentation, and climate vulnerability. The sector's underdevelopment has pushed Tunisian youth to migrate from rural regions to urban areas looking for employment. Unemployment among young women aged between 15 and 24 years is particularly high, at 34.4 percent.

In 2017, the government adopted policies to promote a social and solidarity-based economy to develop the green economy and foster public-private partnerships for the professional training, employment, and economic inclusion of youth.

The Regional Initiative for Promoting Small-scale Renewable Energy Applications in Rural Areas of the Arab region (REGEND)[54] works to improve livelihoods through access to renewable energy technologies that can increase socio-economic inclusion and gender equality through integrated rural development focused on entrepreneurship and overcoming natural resource challenges. The initiatives have included training and investment in decentralized electrification projects and solar water pumping to support irrigation in rural areas of Tunisia. In addition, forty pro-poor microfinance investment projects prepared by local female entrepreneurs have been implemented in Chorbane, Tunisia alone.[55]

Technology and finance for green jobs and entrepreneurship

A growing number of youth innovators and entrepreneurs are ready to take a leap of faith to launch start-ups that revolve around green ideas and corporate social responsibility. These efforts are supported by incubators promoting entrepreneurship in water, energy, and food security, such as the MENA Innovation Hub.[56] As part of the efforts to prepare and mobilize the next generation of entrepreneurs, ESCWA and the International Chamber of Commerce (ICC) launched the joint Centre of Entrepreneurship in October 2020. The center pairs local entrepreneurs with experts from the United Nations and ICC to provide mentoring and coaching, thus establishing a community of innovative professionals with the potential to transform the future of business.

Initiatives to promote STEM in schools are implemented throughout the region to ready youth to be part of a greener workforce; for example, through the water innovations competition session conducted during Cairo Water Week 2021 and the through hackathons organized by the FAO and International Water Management Institute (IMWI).

These initiatives contribute to the development of green jobs; with digital online entrepreneurship expected to be the next frontier for accessing decent jobs during the economic recovery after the coronavirus pandemic, developing an incentive package for online entrepreneurship is a key to achieving success.[57]

REGEND Workshops in Chorbane, Tunisia

Capacity building

Joint action plans were developed through the Lima Adaptation Knowledge Initiative (LAKI) with lead organizations in climate-smart agriculture, drought monitoring, and nature-based solutions in North Africa and other regions. These action plans were designed to bridge critical knowledge gaps to facilitate adaptation. Several of these projects target youth who are more familiar than the older generation with smartphones and other digital technologies that can improve agricultural efficiency.

These efforts have empowered youth to take leadership roles in building back better by fostering opportunities to contribute to the regional knowledge base through digital technologies that engage them in data collection, research, and analysis on the ground, which can inform climate decision-making and empower climate action at the community level.

Youth engagement

The region is witnessing the emergence of a new generation of "young global citizens" who are more connected to a globalized world and well versed in the realm of technology and its potential to open new frontiers and create pathways to a cleaner, greener, and more sustainable world.

Climate and environmental movements and campaigns are growing across the Arab world, particularly among young people, who can articulate and understand the linkages between sustainable economic development, social wellbeing, and safeguarding the environment. Local engagement in national adaptation planning and community-based solutions also facilitates youth participation in decision-making processes.

Targeted interventions and inclusive engagement in a green recovery can thus help to unlock the potential of youth for a more sustainable future.


Photo: PeopleImages/istock

Youth and adaptation in Africa - Voices of resilience after Cyclone Idai

Photo: iStock/wilpunt

When Cyclone Idai swept across Malawi, Mozambique, Zimbabwe, and Madagascar in March 2019, Alinafe Nazombe, a young student and farmer in Mulanje, Malawi, lost her harvest after her farm was devastated by floods. "I was in school, so I could not go to the farm myself to try to limit the damage. I paid others to do it for me, but at the end of the day my crops were washed away, and I had nothing."

Lucia Gulugulu, a young community nurse from Chimanimani, Zimbabwe, was also caught off guard. What first appeared to be ordinary rain turned out to be the second most deadly tropical Cyclone on record in the Southern Hemisphere, causing immediate damage to life and property and pushing an already strained health system to the brink in its aftermath, as compromised water and sanitation systems led to the spread of cholera and typhoid.[58]

Fed by warm ocean temperatures, Idai affected over 2.2 million people, leaving an estimated 100,000 people displaced, more than 600 dead and an estimated 1,600 missing.[59,60] The Cyclone hit one of the youngest regions in the world – young people between the age of 15 and 24, representing more than 20 percent of the population in the four affected countries, were severely affected.[61] Such extreme weather events not only interrupt education for youth, but also result in the loss of caretakers, livelihoods, food security and other development opportunities and infrastructure, with deep impacts on their future.A recent report by the *Global Center* *on Adaptation, Young People and Drivers and Barriers to Climate Adaptation Action*, features interviews with the youth affected by Idai and other extreme weather events in Africa, to record their perspectives and responses to climate change.[62] It finds that the impacts of such events can be long-lasting. The flooding caused by Idai destroyed agricultural produce and stripped farmlands of nutrients, ultimately resulting in increased food prices. As a result, families in remote farming villages like Nazombe's are further driven to food insecurity and poverty.

The GCA report also finds that youth in Africa have demonstrated remarkable resilience and a commitment to protect their communities by organizing themselves, mobilizing resources, and leveraging the power of technology and social media. They are proactively engaged in disaster response, adaptation, resilience building, and promoting awareness about climate change.

Lucia Gulugulu, for instance, set up a 'youth corner' at her clinic to educate patients on the links between environmental change, extreme events, and health. In Maputo, Mozambique, 24-year-old Cidia Chiassungo established a youth movement called United for Beira to ship relief items to affected regions in the country after road connections were lost due to the Cyclone, and to help reunite families. Jossias Sixpence, a 35-year-old physical education instructor assembled a group to help displaced families resettle across Mozambique. His group now focuses on future disaster risk reduction by mobilizing youth to plant mangroves to protect coastal communities, and by working with architects to design resilient buildings. Wilker Dias, a 25-year-old political activist and journalist in Mozambique, distributed seeds in affected areas to support afforestation.

However, youth remain on the fringes of policymaking in Africa, with limited influence on policies. Recognizing this, Lucia Gulugulu's 30-year-old sister, Elizabeth Gulugulu, project manager at the African Youth Initiative on Climate Change, advocates inclusive climate policies in Zimbabwe. Young people in Africa are increasingly connected with peers around the world, advocating for global cooperation. They are repositioning themselves, reinforcing their own knowledge and capacity to adapt, and to mitigate the impacts of climate change on their lives.


Photo: Mukurukuru Media/iStock

Jobs

KEY MESSAGES

- **The labor market is a gateway to solving multi-faceted economic, social, environmental, and political problems.** Climate change is already having negative impacts on jobs in Africa. A vigorous and well-planned adaptation response can reduce these impacts while generating important opportunities for new economic activity, investments, and decent work.
- **These policy interventions will be critical, as Africa's rapidly growing population means that it is projected to have more than a third of the global workforce by 2040.** The substantial share of its population in informal employment and without adequate social protection means that it already has a deficit of decent work and of resilience to the potential effects of climate change on employment, particularly in the agriculture sector.
- **Green jobs— defined by the International Labour Organization (ILO) as employment in the environmental sector that meets the requirements of decent work, — and, in particular, jobs for adaptation and resilience, a sub-category of green jobs, need to be prioritized by African policymakers.** Africa's massive endowment of nature can be harnessed as both an engine for jobs and a pathway for cost-effective adaptation, allowing Africa to embark on a more sustainable development pathway.

Photo: Luca Prestia/Shutterstock

- **To build adaptation and resilience, skills are required to transition to green resilient jobs, nature-based solutions, and hybrid ‘green-gray’ approaches.** Skills development should build on the capabilities of local institutions to ensure they anticipate climate risks and uncertainties, generate solutions, and manage adaptation initiatives over the long term without being dependent on project-based donor funding.

- **With its rapidly increasing labor force and vast natural resources, Africa has the potential to take a growth path focused on labor-intensive modern industries in eco-tourism services, climate-smart agriculture, the ocean economy and green building and infrastructure.** The ILO has led the development of tools and methods to assess the employment impacts of a just transition and will continue this under its Climate Action for Jobs initiative (CA4J).

INTRODUCTION

Job creation and retention in Africa is central to building community resilience in the face of climate change. This is especially true if the jobs created meet the criteria of decent work, defined by the International Labour Organization (ILO) as work that is "productive and delivers a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration" and that offers "freedom for people to express their concerns, organize and participate in the decisions that affect their lives and equality of opportunity and treatment for all women and men."[1]

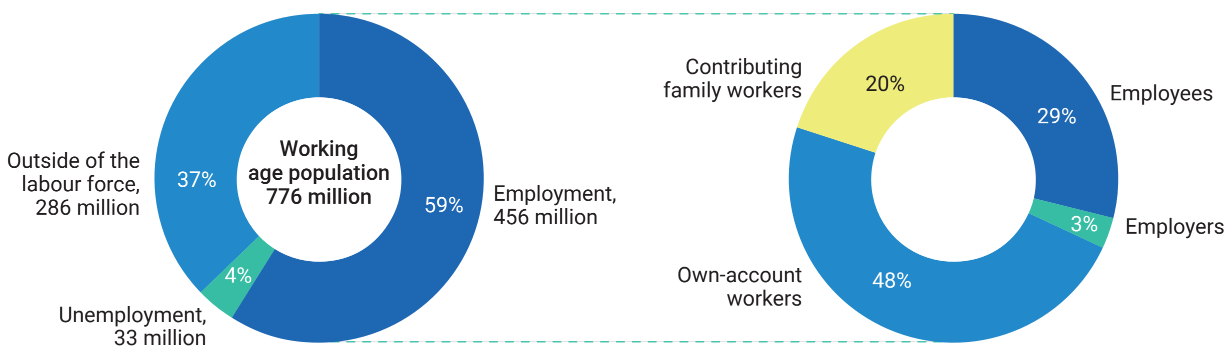
People with decent jobs in climate-smart sectors are likely to have better adaptive capacity and thus to be less impacted by the effects of climate change. Africa's population is growing quickly, with more than one billion workers projected by 2040—more than a third of the global workforce.[2] The continent's relatively young population provides a large and cost-competitive supply of labor. But there is currently a deficit of decent work for Africa's large and expanding workforce, which has impacts on the resilience of its communities.

While Africa's labor force participation rate[3] of 63 percent is higher than the global average of 61 percent, it is dominated by own-account workers (Figure 1).[4] Furthermore, Africa also has the world's highest proportion of workers in informal employment, at around 86 percent.[5] This combination of high levels of own-account work and informality has resulted in almost 250 million workers in Africa currently living in extreme or moderate poverty.[6]

Climate change is often associated with damage and loss. With the right approaches and coherent policies, however, the considerable resources likely to be invested in adaptation provide an opportunity to drive environmentally sustainable, socially just, and inclusive job-rich development. Good adaptation planning can prevent or minimize the loss of jobs, drive job creation, and support the provision of other employment-related benefits such as social protection and healthcare. Well-planned adaptation measures can help absorb anticipated job losses and protect vulnerable people and communities. To guide this process, the ILO has developed guidelines for a 'just transition' for policymakers to ensure that mitigation and adaptation measures are socially and economically sustainable and that no workers are left behind during the transition to a green economy.[7] Countries such as Chad, Burkina Faso, Burundi, Mali, Niger, and Senegal already consider labor in their development plans or national strategies on climate change. Niger's National Policy on Climate Change (2012) promotes the creation of 'green jobs' and the adoption of tax incentives for employers that create them.[8] Lesotho's National Adaptation Programme of Action considers employment creation as one of its six criteria for selecting priority adaptation measures.[9]

Sectors with notable potential—and indeed competitive advantages—for job-rich adaptation-related investments in Africa include climate-smart agriculture and processing (including crops, livestock, agroforestry, aquaculture and inland fisheries), the ocean economy, sustainable ecotourism, resilient

Figure 1: Employment status of working age population in Africa



Source: ILO, 2020b

energy systems, and climate-smart construction, housing and transportation systems. Investment in industries in these sectors, many of which are labor-intensive, can drive economic growth, protect, and create jobs, contribute to environmental sustainability, and ensure that Africa is competitive in a climate change constrained world.

Nature-based solutions (NbS) to climate change and greener approaches to building resilience have huge potential to deliver job-rich adaptation. Africa's vast and diverse landscapes are rich in natural resources, which already provide jobs and other sources of income and livelihood support for many of its people. With a population density of 45 people/km2 (lower than the global average of 58), sub-Saharan Africa also has relatively more available land and natural resources,[10] which can support greener approaches to resilience building. Careful stewardship of natural resources is also needed to ensure that the industries and jobs that depend on these resources are sustainable.

This chapter presents the risks and challenges that climate change poses for jobs, the job creation opportunities that climate adaptation and resilience-building activities provide, and the policy responses needed to reduce the climate risks on jobs and enhance the creation of jobs for adaptation and resilience. For the purposes of this chapter and analysis by ILO and GCA, we will focus on green jobs that support adaptation to the effects of climate change.

We would like to benefit from competencies transfers, technological transfers, capacity building (...) so that we can mitigate, adapt, and become resilient to climate change."

H.E. President Azali Assouman of Comoros
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

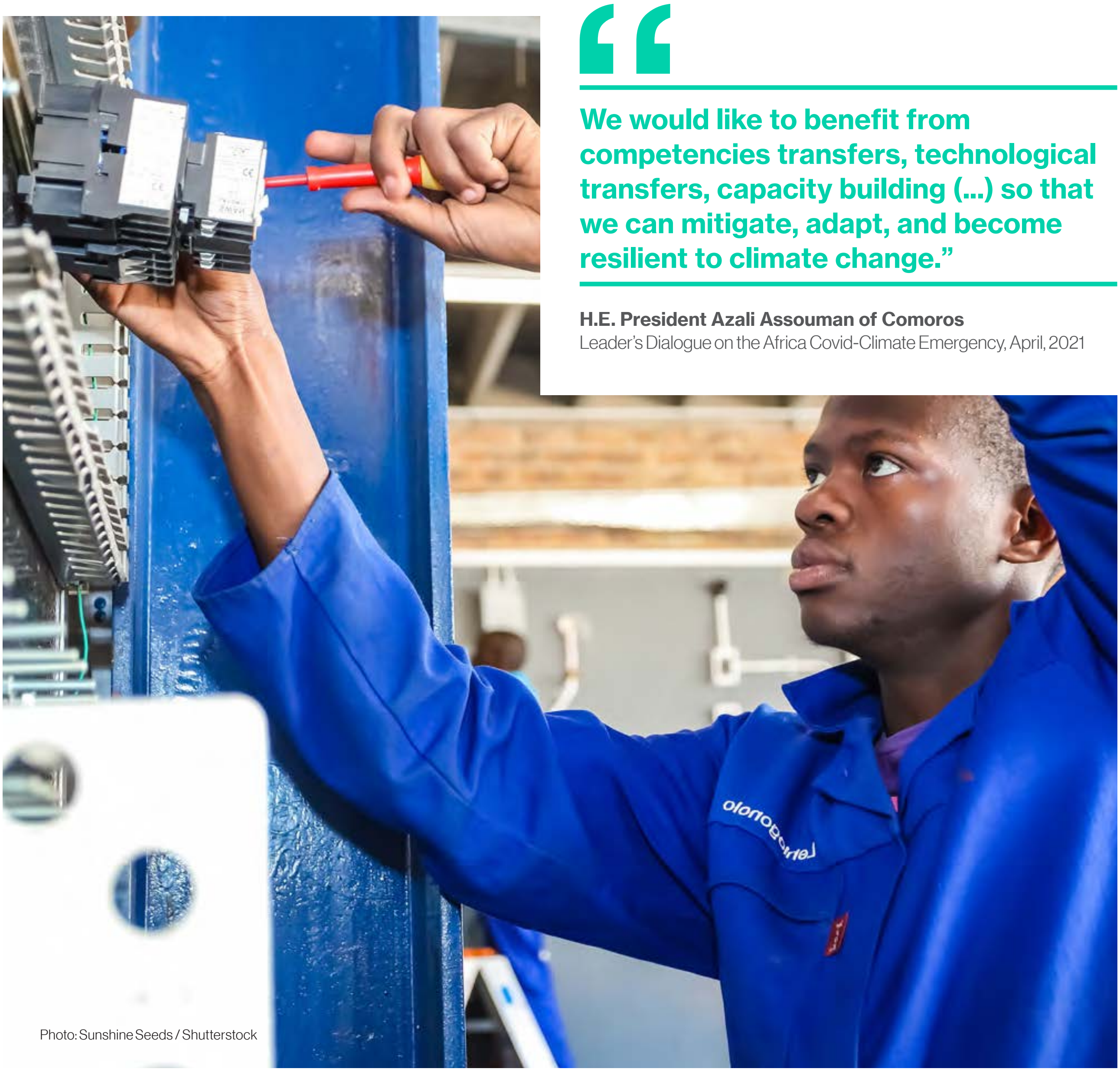


Photo: Sunshine Seeds / Shutterstock

CLIMATE IMPACTS: RISKS AND CHALLENGES FOR JOBS

Between 2000 and 2015, 23 million working-life years were lost annually at the global level because of environment-related disasters caused or exacerbated by human activity.[11] This is equivalent to 0.8 percent of a year's work globally.[12] These losses were particularly acute among low-income groups. Africa suffered some of the greatest losses of working-life years, with an annual average of 376 working-life years per 100,000 people of working age lost between 2008 and 2015.[13]

At the same time, globally, some 1.2 billion jobs—particularly those dependent on farming, fishing, and forestry—currently rely directly on the effective management and sustainability of a healthy environment. In Africa, these sectors represent 58 percent of total employment.[14] Without adaptation measures, the combined effects of climate change and poor natural resource management will threaten these jobs, which could lead to devastating social and economic impacts.

In addition to threatening the natural resource base, climate change exacerbates the stresses on jobs in several other ways. Negative impacts on employment include job losses through impacts on business assets and business interruptions, disruptions in transportation of market and essential goods, impacts on working conditions and occupational safety and health affecting labor productivity, forced migration and reduced demand due to economic shocks and instability. Business assets and transport and industrial infrastructure, as well as the workforce, are increasingly concentrated in cities in Africa, all of which are at risk when disaster events hit urban areas.[15]

Agriculture accounts for a high percentage of employment and a key source of livelihoods in many African countries. As discussed in the Agriculture and Food Systems chapter, the sector is particularly vulnerable to water scarcity. In 2019, more than 232 million workers in the region were employed in agriculture, accounting for over 50 percent of the continent's total employment.[16] Many of Africa's farmers depend on rainfed agriculture, which will be particularly at risk. In North Africa, for example, small-scale farmers in rainfed mixed farming systems are likely to be severely impacted by climate change.[17] Desertification, land degradation and disaster events such as floods, heavy precipitation, heatwaves and insect outbreaks also reduce productivity and

Photo: rvdw images/Shutterstock

destroy rural jobs in the agriculture sector. For example, the income of seven million people was put at risk in 2003 when severe droughts hit Ethiopia's primarily rainfed agricultural sector.[18] In Uganda, predicted temperature increases could devastate the coffee industry—on which over 12 million casual and permanent jobs depend—leading to massive loss of jobs in this sector.[19]

Increasing water scarcity also threatens employment and productivity in other sectors. For example, water shortages affect jobs in the hydropower sector, and, more importantly, jobs with enterprises that depend on energy from hydropower, as discussed in the Transport and Energy chapter.

Heat stress affects productivity and leads to negative occupational health effects and workplace injuries, especially in low-skilled labor-intensive sectors. Increasing temperatures mean that workers must spend more working hours resting and cooling down their bodies to keep core body temperatures below 38°C and avoid heat stroke. Africa is particularly vulnerable to heat stress because of its high heat exposure and low adaptive capacity. Temperatures in many parts of Africa are projected to rise faster than the global average during the 21st century. People working in factories and offices with poor cooling systems and those working outdoors—for example in agriculture, construction and forestry—will be particularly affected. While this will vary regionally, of the ten most affected countries in terms of percentage loss of GDP, eight are found in western Africa.[20]

Assuming a global temperature rise of 1.5°C by the end of the century, estimates suggest that by 2030 Chad, Burkina Faso and Togo will all lose more than 7 percent of working hours due to heat stress. In Western Africa, 4.6 percent of working hours are predicted to be lost under this warming scenario, which equates to around nine million fulltime jobs.[21] In terms of sectors, agriculture is expected to account for more than 90 percent of the working hours lost in central and eastern Africa in 2030 owing to heat stress.[22] More than 60 percent of all working women in sub-Saharan Africa are employed in agriculture, and these women will suffer disproportionately from heat stress as global temperatures rise.[23]

The impact of climate change-related extreme weather events and disasters on infrastructure will negatively impact overall productivity and employment. Disruptions and delays due to breakdowns in energy and transport infrastructure may have devastating impacts, in particular, on industries that produce perishable goods. Damages and climate risks may also increase the price of transport, reducing the competitiveness of industries on the continent. The Transport and Energy chapter presents further details. Furthermore, the costs of reconstructing housing and public and private infrastructure damaged due to an increase in the frequency and intensity of disasters could further crowd out other investment.

Coastal land is increasingly being lost and damaged due to sea level rise, erosion and extreme weather events such as hurricanes. This is destroying jobs in tourism, fishing and other sectors that rely on healthy coastal ecosystems. For example, a 50 percent decline in fisheries-related jobs is predicted for West Africa by the 2050s under a conservative warming scenario.[24] Ocean acidification resulting from increasing CO_2 absorption is also affecting ocean ecosystems and the jobs that rely on them.

Increases in labor migration are likely because of climate change and other factors. One 2007 study in Namibia concluded that even under the best-case climate change scenario at the time, a quarter of the population would need to leave vulnerable sectors such as agriculture, fisheries and tourism and find new livelihoods by 2050. The study predicted that displaced rural populations moving to cities would cause incomes for unskilled labor to fall by 12 to 24 percent to absorb the new workers.[25]

The impacts of climate change on jobs will be felt unequally, depending on socioeconomic status and location. Differences in social and economic roles and responsibilities exacerbate the vulnerability of women, migrants, youth, indigenous and tribal people, people in poverty and people with disabilities. These groups tend to have less access to resources for climate change adaptation, including land, credit, agricultural inputs, the support of decision-making bodies, technology, social insurance and training. Poor people also live and work in more vulnerable locations. For vulnerable individuals working in the informal economy and in small enterprises, it is especially difficult to recover from the effects of environmental disasters.[26]

JOB CREATION OPPORTUNITIES FROM RESILIENCE BUILDING ACTIVITIES

Even if Paris Agreement targets are met and global warming does not exceed 1.5°C, the implementation of a wide array of adaptation measures—from enhanced social protection programs to hillside reforestation to protect water sources and combat erosion—will be critical to help avoid climate change related damages and losses, create jobs and build resilience. In this ILO and GCA analysis, we review the opportunities that climate adaptation and resilience programs in key African economic sectors can have in terms of new decent jobs. For example, resilient infrastructure, climate-smart natural resources management and NbS, new adaptation technologies and climate information services can be key in the development of resilient economies and "green jobs for adaptation and resilience" (Box 1).

Box 1. Green jobs for Adaptation and Resilience

Green jobs are decent jobs that contribute to preserving or restoring the environment. They are often associated with emerging green sectors, such as renewable energy and energy efficiency, but can also be in traditional sectors such as agriculture and construction.

Green jobs help:

- Improve energy and raw materials efficiency
- Limit greenhouse gas emissions
- Minimize waste and pollution
- Support adaptation to the effects of climate change
- Protect and restore ecosystems

Green jobs that support the last two bullet items can be considered *"green jobs for adaptation and resilience"*. Green jobs related to adaptation can be found across different sectors. At the project or enterprise level, these jobs produce goods or provide services that are adaptation-related; for example, better-cooled buildings or more resilient roads. However, they can also relate to adopting new production practices: for example, adapting agricultural techniques to changes in climate.

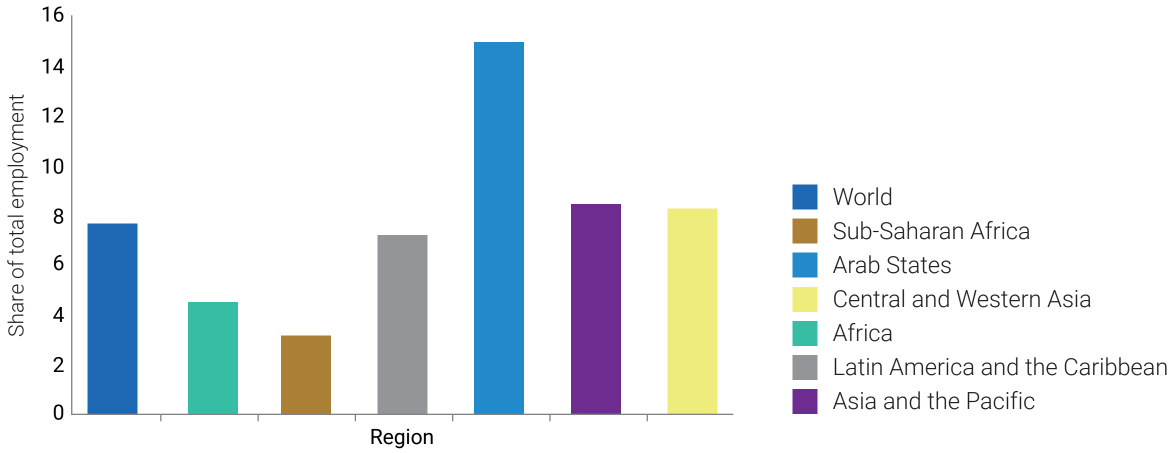
Many of the green jobs which help to protect and restore ecosystems are found in or are created through investments by the public sector, since in many countries ecosystems and the protection of nature are considered public goods and the responsibility of the state. Many of these jobs supported by public investment are created through what the ILO refers to as Green Works, defined as "the employment intensive development, restoration and maintenance of public infrastructure, community assets, natural areas and landscapes to contribute to environmental goals such as adaptation to climate change and natural disasters, environmental rehabilitation, ecosystem restoration and nature conservation." However, increasingly communities and enterprises whose livelihoods and productivity are influenced by the productivity of ecosystems are also investing in ecosystem restoration and protection.

Climate-resilient infrastructure

Investment in climate-proofing existing infrastructure and building new climate-resilient infrastructure can address Africa's infrastructure deficit, build societal resilience and create jobs in construction and related sectors. Infrastructure in Africa—including roads, ports, airports, railroads, water and sanitation, electricity and communications infrastructure—is already insufficient to enable it to achieve the Sustainable Development Goals (SDGs), and levels of investments remain below what is required. One indication of this is that employment in the construction sector—particularly in sub-Saharan Africa—is far lower than in other regions of the world and lower than the global average (Figure 2).

Our assessment is that bringing Africa up to par with other regions could easily double the number of people working in the sector. The construction sector already has a high employment multiplier in Africa, and resilient natural and built infrastructure, if designed properly, has the potential to generate employment opportunities far beyond the sector.[27] For example, increasing the resilience of transport infrastructure by raising road embankments and improving drainage can provide direct employment opportunities through construction work and indirect and induced employment opportunities in industries that supply the materials and equipment. Such investments would also protect the jobs and industries that rely on transport infrastructure.

Figure 2: Construction sector employment as a share of total employment (%) in 2019



Source: Compiled from ILO labor statistics database (ILOStat)

Photo: Nataly Reinch/Shutterstock

Investments in resilient infrastructure and housing are critical and can cost less than reconstruction and rehabilitation following disasters. Industries may need to be relocated, and projects related to irrigation, flood control, soil and water conservation and land management may be required. For Africa to reap the full job-related benefits of these investments, policymakers should consider adopting a sustainable infrastructure approach,[28] including local resource-based approaches (Box 2). These are based on the understanding that local participation in planning with the utilization of locally available skills, appropriate technology, materials and work methods has proven to be an effective and economically viable approach to infrastructure works and job creation in many countries.[29] Investments must also develop local skills and capabilities, maximize the use of local enterprises, value traditional knowledge and adopt gender-responsive approaches. Technology choices need careful consideration, with labor-intensive and environmentally friendly construction methods selected where possible.

Box 2: ILO's Local Resource-Based approaches and community contracting


Photo: Sunshine Seeds/iStock

In developing and maintaining community infrastructure, such as rural roads, footbridges, and irrigation canals, and in the implementation of Green Works, the ILO's Employment-Intensive Investment Programme (EIIP) promotes the use of Local Resource-Based (LRB) approaches. These approaches aim to optimize the use of local resources throughout the project cycle. Local resources include human resources, local enterprises, local materials (e.g., construction materials and tools) procured through local suppliers, as well as local knowledge and technologies, with the objective of generating incomes that circulate in the local economy and building local ownership and capacity to maintain these assets. Additionally, the LRB approach encourages the participation of women, youth, people with disabilities, indigenous and tribal people in the planning, implementation, monitoring and evaluation of the interventions, so that they actively participate in the development process.

The EIIP has extensive experience in adopting LRB approaches, including on projects promoting adaptation and resilience to climate change in Africa. In the Sahel countries of Mali and Niger, for example, the ILO is supporting programs against desertification by promoting the adoption of local knowledge and technology in areas around watershed and forest management, with planning, design and construction activities mostly implemented by local farmers.

Improved natural resource management and Nature-based Solutions

Nature-based solutions (NbS)[30] to societal problems such as climate change adaptation or disaster risk reduction offer significant potential for local employment creation and can provide cost-efficient ways to adapt or reduce disaster risk using local means, knowledge and practices.[31] The benefits can, however, take time to materialize.[32] Examples include reforestation and afforestation to regulate water flows and protect against landslides, large-scale watershed restoration to improve water quality and availability for entire regions, or coastal mangrove restoration to protect against storms, erosion and sea-level rise. ILO's Rebuilding the Forests project in Mali, for example, contributed to the preservation of forest resources and eliminated illegal land clearing. Through labor contracts between the forestry department and local villagers, it "returned the forest to the poor," thus strengthening local livelihoods and adaptive capacity.[33]

Nature-based solutions to climate change adaptation are effective and typically provide a multitude of co-benefits.[34] These include improvements in water security, human health, livelihoods, disaster risk reduction and climate change mitigation. The resulting increase in resilience and productivity in key sectors such as agriculture, fisheries, forestry and tourism create jobs, generates income and supports livelihoods, particularly for vulnerable groups. Indeed, the Global Commission on Adaptation promotes harnessing NbS as one of its key 'action tracks' for tackling both climate change adaptation and mitigation,[35] and many African nations countries already integrate NbS into their national climate strategies.[36] The Africa Adaptation Acceleration Program (AAAP) of the African Development Bank and GCA gives a key role to NbS mainstreaming in resilient infrastructure.

The traditional notion of what resilient infrastructure looks like may need widening to include 'green-gray' options, green/ecological infrastructure and 'building with nature' approaches.[37] For example, restored mangroves can protect coastal assets and communities, and in some circumstances replace or complement built sea walls or breakwaters. Similarly, riverbank re-greening provides an alternative to river training in the context of reducing disaster and downstream flood risks. Such adaptation and disaster risk reduction measures, if implemented well, can be effective and generate significant employment for local communities. Hybrid 'green-gray' approaches combine green (nature-based) with standard gray (engineered) solutions such as dams, water treatment plants and coastal defense structures.[38] Such hybrid approaches can be adopted in situations in which it is not practical to replace engineered approaches with NbS. These approaches, too, are associated with the accrual of multiple co-benefits. For example, local communities in Haiti continued to plant vetiver and benefit from associated commercial use, water retention services and a reduction in disaster risk, even after an ILO job creation project following Hurricane Jeanne in 2004 had ended.[39]

Implementing NbS and hybrid approaches can be labor-intensive and thus a first step towards creating decent jobs (Table 1). Significant job opportunities arise when such approaches are integrated into large-scale initiatives such as public employment schemes and regional interventions. The Great Green Wall for the Sahel and Sahara Initiative, an initiative of the African Union, has been cited as having the potential to create ten million environmentally-oriented jobs.[40] France, the World Bank and others have committed over $14 billion to this initiative, and this funding could fast-track efforts to restore degraded land, save biological diversity and build the resilience of the Sahelian people.[41] The insert on the Great Green Wall presents further details on this initiative.

Furthermore, labor-intensive approaches prioritizing local priorities, knowledge, skills and materials can strengthen local resilience when building climate-resilient infrastructure and implementing NbS (Box 2).

Incubating adaptation technologies and enterprises

In many contexts, effective adaptation will require appropriate new technologies adapted to the African context, the use and scaling up of existing local

Table 1: Employment returns and labor input of NbS, primarily in developing countries

Activities integral to NbS implementation	Employment returns: Total direct jobs (Full Time Equivalent/US$ million)	Labor inputs: Full Time Equivalent/hectare
Afforestation, reforestation, and desertification control	275 to 625	0.40 to 1.1
Watershed improvement	166 to 500	1 to 3
Indigenous forest management	200 to 400	0.25 to 0.5
Agroforestry including conversion of land	500 to 750	0.25 to 0.375
Fire management	200 to 250	0.1 to 0.125
Creation and management of urban green spaces	24 to 250	1 to 5
Removal and management of invasive alien species	unknown	0.05 to 0.14 FTE/ha for clearing of heavily infested areas. 0.002 to 0.014 for lightly infested areas
Management and conservation of protected areas and buffer zones	unknown	0.004 to 0.0002
Forest conservation	285 to 428	0.10 to 0.15
Coastal habitat protection	17	unknown
Vegetation planting to protect roads (including nursery work and plant maintenance)	unknown	1 to 2 (based on 250 to 500 workdays per hectare)

Source: Lieuw-Kie-Song and Pérez-Cirera 2020; ILO 2011; Payen and Lieuw-Kie-Song 2020 technologies, or a combination of both, particularly in agriculture and irrigation, infrastructure and construction, and eco-tourism, but also in other sectors. Existing local technologies can be cost-effective in this context. Local technologies can be developed by local workers and enterprises and by national research institutions and professionals such as soil scientists, plant breeders, irrigation specialists and livestock specialists. In Niger, for example, local people have developed soil and water conservation practices to ensure productivity in the face of climate change impacts and extend agricultural activities by growing vegetables outside the rainy season.[42]

Micro, small and medium-sized enterprises (MSMEs) are the main engines of job creation in most countries and are important partners for building resilience, because they are well placed to develop locally relevant effective adaptation solutions.[43] For example, increased investment in adaptation will allow business opportunities to emerge for engineers designing and developing hybrid 'green-gray' infrastructure or new irrigation technologies, contractors who can adapt housing, and manufacturers of agriculture equipment. Opportunities also exist in the finance and insurance services industry.

The ILO Zambia Green Jobs Programme aimed to demonstrate the key role played by MSMEs by creating at least 5,000 green jobs, particularly for young people, and improving the quality of at least 2,000 further jobs in MSMEs in Zambia's building construction sector. A mid-term program assessment in 2015 argued that it demonstrated a viable private sector development model delivering inclusive green growth, green job creation and climate change adaptation benefits.[44] The construction and infrastructure sector offers notable opportunities for job creation when compared to other sectors such as renewable energy. Support for the formation of cooperatives can also bring substantial benefits to many producers though increases in access to knowhow, inputs, finance and markets at fair prices. The Oromia Coffee Growers in Ethiopia and the cocoa farmer cooperative Kuapa Kokoo in Ghana are two examples of this.[45]

Climate information services

Climate information services providing information relevant to governments, employers and workers in the African context have been identified as a priority by the Africa Adaptation Initiative (AAI). Sub-Saharan Africa currently ranks last among all regions in terms of land-based observation networks, meeting only about one-eighth of the minimum requirements, as discussed in the Present and Projected Climates in Africa.[46] The design and development of these services will not only improve the ability of enterprises and workers to adapt, but should provide direct and indirect opportunities for new enterprises and a limited number of skilled jobs, for example, in innovative microinsurance product enterprises.

"To attract private sector investment we need to firstly have good projects, ... develop modules for private-public partnerships, and encourage all stakeholders to mainstream adaptation. Secondly, ... we must create a benchmark for green bonds for climate resilience."

Odile Renaud-Basso, President, European Bank for Reconstruction and Development
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021


Photo: Jean Francois/iStock

Photo: Pinar Alver/Shutterstock

POLICY RESPONSES FOR JOB-RICH ADAPTATION AND RESILIENCE AND TO REDUCE RISKS IN THE WORLD OF WORK

National climate change policies and programs must protect jobs and sectors that are critical for job creation and create opportunities for new decent jobs. This will, in turn, require considerable efforts in ensuring policy coherence and coordination. Nationally Determined Contributions and National Adaptation Plans will need to factor in employment, while sectoral policies—such as those relating to agriculture, forests, biodiversity, fisheries, marine issues, water regulation, tourism, energy and transport—must also provide opportunities for integrating job-rich adaptation strategies.

Policies are needed to promote investment in climate-resilient infrastructure, the development of adaptation technologies, climate information services and related enterprises, and improved natural resource management and NbS. A recent analysis of 16 countries in sub-Saharan Africa shows that legislation linking labor and the environment has been increasingly adopted since the early 2000s.[47] However, governments in Africa need to extend this further.[48] Investments need to be reallocated from sectors that deplete natural resources and damage the environment to more resource-efficient and environmentally sustainable sectors.[49] Green jobs for adaptation and resilience (Box 1) on land and in aquatic environments need to be prioritized Morocco, for example, launched its Plan Maroc Vert (PMV) in 2008. By helping smallholder farmers tackle drought by adopting efficient irrigation technologies and transitioning to drought-tolerant crops, the plan aimed to create 1.5 million jobs by 2020.[50] The PMV goals may not have been fully realized, but by the end of 2020, 350,000 jobs had been created for the kingdom's youth.[51] Madagascar has prioritized the blue economy, and investment in tourism on the island of Nosy Be has generated a diverse range of jobs.[52]

Skills development

Skills development policies and programs will be critical for meeting Africa's adaptation requirements and should anticipate likely climate change impacts and include adaptation-related skills and occupations. The Youth pillar of the Africa Adaptation Acceleration Program of the AfDB and GCA is designed to support such adaptation skills and jobs. The need for new skills is likely to increase in the agriculture, forestry, fisheries, construction, urban planning, manufacturing and transport sectors, among others.[53] Furthermore, new occupations in, for example, disaster risk reduction, coastal management and soil and water management will also require new skills. Education and training, including an emphasis on basic portable skills, will help workers adapt to changes in labor markets and move more easily into new jobs in other sectors, thus forming a key adaptation strategy.

To build resilience, skills are required to transition to green jobs, NbS and 'green-gray' approaches and to integrate these approaches into adaptation responses, policies and programs. Such skills development could address the lack of local and national government capacity to support NbS to climate change adaptation identified in Africa.[54] Agricultural extension workers, for example, could be trained in farming techniques such as soil and water conservation measures. In its analysis of skills for green jobs, the ILO has identified the need for informed, coherent and coordinated policies to support skills development. Central to this are strategic leadership and management skills, environmental awareness as an integral part of education and training at all levels, labor market information for anticipating and monitoring skill needs, effective coordination among line ministries and social partners, and decentralized approaches at sectoral and local levels.[55]

> **Preparedness reaps dividends: For every one dollar you spend on resilience, you see four dollars in benefits."**
>
> **Axel van Trotsenburg, Managing Director, World Bank**
> High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Countries such as Mali have committed to environmental sustainability but have a notable absence of institutional mechanisms to develop the skills required to achieve environmental policy goals. Agricultural enterprises involved in export and the domestic market in Mali lack training in sustainable agriculture and organic farming. In Uganda and Mauritius, by contrast, farmers have benefited from training in bio-farming and organic farming. Uganda now has the largest farm area under organic management in all of Africa, with employment estimates ranging from 200,000 to 400,000 farmers.[56]

Skills development should build on the capabilities of local institutions to ensure they anticipate climate risks and uncertainties, generate solutions and manage adaptation initiatives over the long term without being dependent on project-based donor funding.[57] Training can target disadvantaged and vulnerable groups, which will help address the inequity in who suffers most from climate change. In particular, the poor, illiterate and low-skilled, as well as those living in rural areas, women and the disabled are likely to require specific targeting efforts if they are going to participate in skills development to the level required for effective adaptation.[58]

Workplace risk reduction

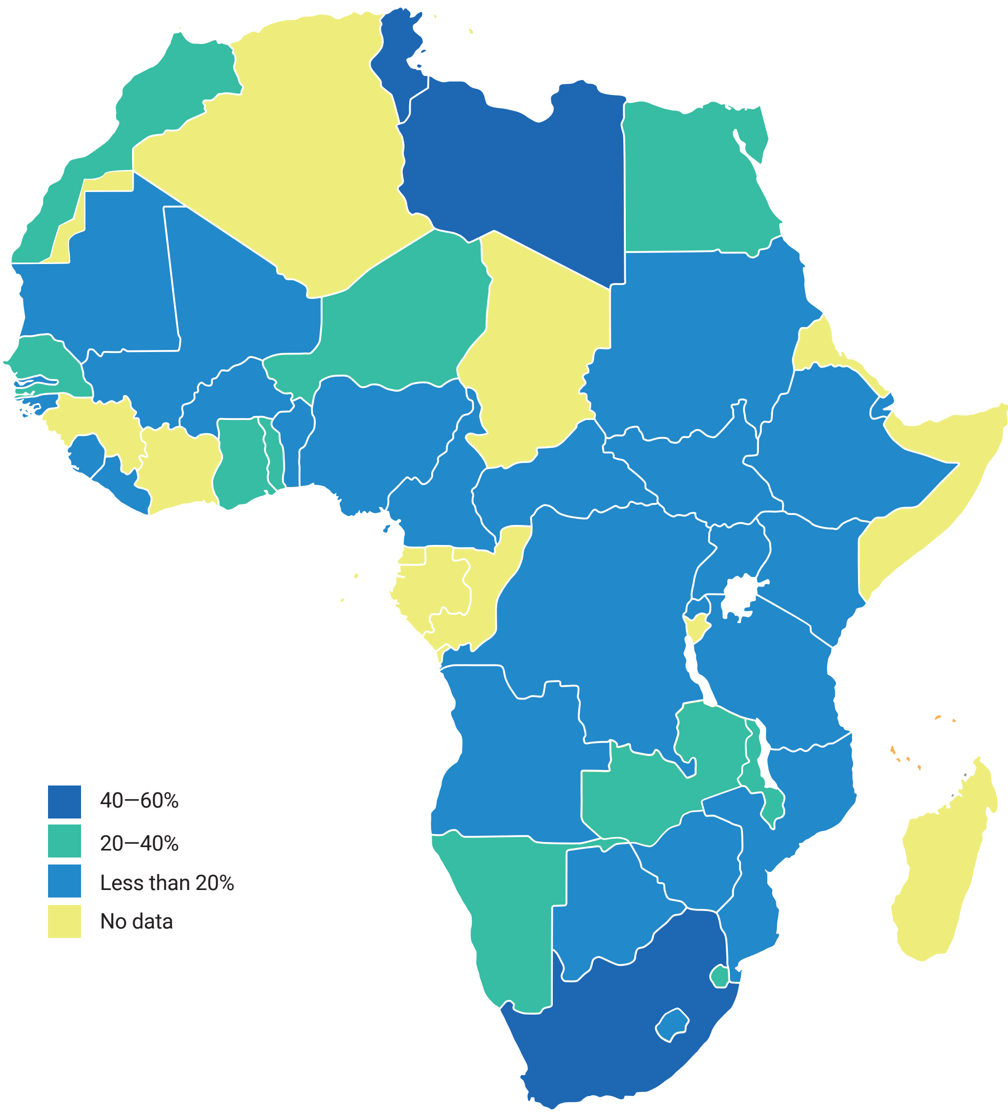
Reducing risk in the world of work is a priority for Africa. Workplaces may need physical modification as well as new occupational safety and health procedures to address climate change-related heat stress and stresses related to other extreme weather events, such as floods and hurricanes. The risk of deteriorating safety and conditions of work is especially significant in sectors vulnerable to climate change, such as agriculture, fisheries and tourism, not least because these sectors are already struggling to implement minimum standards and conditions of work.[59] Wider adoption of international labor standards, along with the development of appropriate national legislation can play a key role here, as can increased access to insurance covering these risks.

Social protection

The ILO considers access to social protection[60] to be not only a human right but also one of the four pillars of decent work (along with employment creation, rights at work and social dialogue).[61] It provides a strong opportunity to address both the causes and the effects of climate change, as discussed in greater detail in the Climate-adapted Social Protection insert. Indeed, through risk-pooling and redistribution mechanisms (including solidarity between those most impacted by climate change and those who are more insulated from its effects) social protection systems have the potential to guarantee protection for all members of society throughout their lives and to support people during shocks, displacements and transitions, including towards a greener economy.

If social protection represents a central lever of adaptation to climate change, it is also necessary to acknowledge its current limits. Despite recent progress in Africa, 83 percent of the population is currently excluded from any form of social protection (Figure 2),[62] which corresponds to a financing gap to achieve universal coverage estimated by the ILO (including the impact of COVID-19) of $136.9 billion for 2020. [63] Collaborative approaches at the national, regional and international level to increase fiscal space for both social protection and climate policies are therefore necessary to fill this gap.

Figure 2: Social protection in Africa: effective coverage (%)



Source: ILO World social protection data dashboard, https://www.social-protection.org/gimi/WSPDB.action?id=32

Another priority area that requires such effort in policy coordination, either within a country between provinces or between countries, is the issue of human migration, including people displaced by climate change. To enable migrants to enjoy the full scope of the social protection rights, it is essential that countries facilitate the portability of their rights within and across national borders.[64]

The coordination and integration by governments and social partners in disaster risk reduction, climate adaptation and social protection strategies is an essential step towards greater cross-sectoral coherence to approach climate change.[65] This is necessary not only to better manage disaster risks, but also to foster innovative practices based on evidence and lessons learned, while taking into account specific vulnerabilities to leave no one behind (e.g. workers in the informal economy, displaced persons and persons with disabilities).

Public employment programs (PEPs)

Public employment programs (PEPs) provide an important opportunity to combine economic, social, environmental and adaptation objectives. They can be used to implement adaptation actions on a large scale and also to target the rural poor and others most vulnerable to climate change, thus enhancing the income security and resilience of groups who are often difficult to reach with other measures.[66] Program activities can include afforestation and reforestation, improved soil and water management measures, raising road embankments, building dikes, climate-proofing buildings and upgrading low-income settlements, all of which can assist with adaptation and promote climate resilience through flood control and erosion reduction measures.[67] These programs are mostly public-sector driven and financed but can also provide opportunities to boost private-sector development. Such programs already support more than 100 million people in low and middle-income countries.[68] They provide significant potential for financing job-intensive environmental approaches such as green works,[69] NbS and 'green-gray' infrastructure implementation.[70] At the regional level, Africa had the highest incidence of programs with environmental components as of 2018, with 23 out of 36 including mitigation or adaptation activities.[71]

Photo: VILevi/Shutterstock

Flagship programs like the environmental sector of the Expanded Public Works Programme (EPWP) in South Africa and Ethiopia's Productive Safety Net Programme (PSNP) annually mobilize over a million person-years of labor to work on natural resource management activities. They have both been operating for at least 15 years (Table 2).[72] South Africa's Working for Water Programme supports more than 20,000 jobs by providing short-term contracts to local people to remove invasive species. It specifically targets vulnerable groups by seeking to employ 60 percent women, 20 percent youth and 5 percent persons with disabilities.[73] PSNP is Africa's largest climate resilience program by number of beneficiaries working on adaptation-enhancing activities.[74]

These programs combine environmental, employment and social protection objectives, which can make them challenging as the timeframes for these objectives are not always aligned. Improving income for vulnerable households may be an urgent need, but ecosystem restoration requires a longer-term perspective. It is therefore critical that a programmatic approach that includes ongoing investments and activities in landscape management is adopted, in turn creating sustained demand for labor. Different approaches may then allocate this labor demand to workers, depending on local needs and contexts. For example, ongoing part-time work may be more suitable in some cases, while rotating opportunities among community members may be preferred in other contexts.

Regional coordination and partnerships

Regional or continent-wide coordination on many of the above policy areas and approaches will be crucial going forward, particularly around sharing climate- and adaptation-related information technologies, collaborating on the restoration of shared ecosystems and disaster risk reduction and preparedness. Initiatives such as the Lake Chad Basin rehabilitation and the Great Green Wall for the Sahel and Sahara cross national boundaries underscore the need for strong regional coordination in planning for job-rich resilience-building.

Strong local, regional, national and international partnerships bringing together governments and their agencies, research organizations, the private sector, non-government organizations and local communities will be needed to help facilitate links between adaptation policies and decent job creation for successful outcomes. The AAI, Agenda 2063, and the African Union's Programme on Infrastructure Development in Africa—with its 279 stakeholders—provide good examples of these.[75]

Table 2: Public works programs and associated annual employment and natural resource management activities

Program	Annual employment	Natural resource management activities
Expanded Public Works Programme (Environmental Sector) South Africa	150,000 work opportunities	Invasive plant species removal, wetland rehabilitation, prevention and combatting of wildfires, restoration and cleaning of coastal areas, forest management, land restoration.
Productive Safety Net Programme (Ethiopia)	1.2 million working beneficiaries	Land rehabilitation through enclosure, soil embankment construction, stone embankment construction, seedling production and planting, development of nursery sites, pond construction or rehabilitation, water spring development, hand-dug wells, small-scale irrigation.

Source: Payen and Lieuw-Kie-Song, 2020

Photo: Sam DCruz/Shutterstock

Photo: Goddard_Photography/iStock

POLICY RECOMMENDATIONS

While the links between climate change and employment are becoming increasingly apparent, important knowledge and evidence gaps remain.[76] These include a better understanding of how climate change adaptation measures impact both the quality and quantity of employment.[77] For example, a better understanding of the employment returns of improved natural resource/landscape management and the use of NbS in Africa is needed to be able to assess the full socioeconomic benefits of such adaptation measures and support its much broader adoption. The ILO has led the development of tools and methods to assess the employment impacts of a just transition and will continue this under its Climate Action for Jobs initiative (CA4J).[78] The Africa Adaptation Acceleration Program of the AfDB and GCA will support the creation and growth of green jobs for adaptation and resilience. Resulting assessments are encouraging and show that net gains in employment following a transition to a green economy are possible but depend on the right policies and on the capability of the institutions implementing them.[79]

But this work has focused more on climate change mitigation measures, and further research is needed to better understand which adaptation measures can support better employment outcomes and vice versa.

The analysis reveals that there is also uncertainty about the changes in the trajectory of agricultural policies and practices that may occur and the resulting labor implications. This issue is highly relevant for Africa, given its dependence on agriculture for jobs and livelihoods. A development path with increased mechanization and industrialization of agriculture following the precedent set by high-income countries will have very different employment effects compared to one that includes more resilient practices such as regenerative farming and agroforestry practices, which tend to be more labor-intensive.[80] This presents an important choice for African policymakers and will require additional research into shifts in agricultural practices and how this will impact employment and in particular rural labor markets.[81]

Other areas for further research related to the world of work relate to skills for green jobs so that training systems and institutions can better plan and prepare the workforce to adopt more resilient practices across economic sectors.

While climate change is already having negative impacts on jobs in Africa, adaptation responses can reduce these impacts by protecting existing jobs, minimizing job losses and providing opportunities for new economic activity, investments and decent work. For this to occur, adaptation policies must be coordinated and coherent, human-centered and address key risks to workers, enterprises and vulnerable sectors. They must also support a just transition to a resilient and greener development path and be equitable and socially inclusive, taking the concerns of women, youth, indigenous people and other minorities into account.

There is also an urgent need for increasing adaptation finance to support and scale up interventions that increase resilience and generate income and employment. A stimulus in climate-resilient infrastructure is already necessary if Africa is to meet the SDGs and will have to be a critical element of Africa's adaptation strategy. This will not only help protect and secure existing jobs but will also present an immense opportunity for direct and indirect job creation. Working more closely with nature though NbS and improved natural resources management also provides a key opportunity for Africa in this context. Its massive endowment of nature can be harnessed as both an engine for jobs and a pathway for cost-effective adaptation, allowing Africa to embark on a more sustainable development pathway.[82]

Effective adaptation will also require the redesign and expansion of social protection systems in Africa to protect workers against the increased and new climate-related risks they will face. Finally, social dialogue and community participation in the design and implementation of adaptation policies and measures will be important to ensure more inclusive adaptation measures that support local development and employment creation.[83]

As the ILO's Director-General Guy Ryder stated at the opening of 2021 International Labour Conference, progress "depends on combining: the knowledge of the causes, mechanisms and consequences of climate change that comes from the scientific community; the financing of measures of mitigation and adaptation that must come from public and private, and national and international sources; and the labor market engineering required for just transition processes that realize the decent work potential of protection of the planet, and reconcile social and environmental objectives." [84]

With its rapidly increasing labor force and vast available resources, Africa has the potential to take a growth path focused on labor-intensive modern industries in eco-tourism services, climate-smart agriculture, ocean economy and green building and infrastructure. The world of work is a gateway to solving multi-faceted economic, social, environmental and political problems. However, for this growth and development path to be climate-resilient, effective adaptation of the world of work is required. This will, in turn, require coherence and coordination of climate, environmental, employment, macroeconomic and social policies.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Adaptive Social Protection

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Social protection refers to a broad set of policies and programs that aim to prevent, manage, and overcome poverty and vulnerability by diminishing people›s exposure to risks, and enhancing their capacity to manage economic and social risks, such as unemployment, exclusion, sickness, disability, and old age.

While some basic forms of social protection have been around for centuries, social protection policies and programs entered the mainstream as key components of poverty reduction strategies in the late 1990s.[84] Social protection is now one of the targets of Sustainable Development Goal 10 (reduced inequalities).

Adaptive Social Protection (ASP), a more recent concept, integrates the often-disconnected disciplines of social protection, disaster risk management, and climate change adaptation, and aims to build the resilience of poor and vulnerable households, while strengthening their capacities to prepare for, cope with, and adapt to climate impacts.[85]

Ideally, ASP programs use the full spectrum of social protection programs, which range from social assistance (such as non-contributory cash transfers, public works programs, fee waivers for basic health and education services; and subsidies for food, fuel, etc.); social insurance (contributory schemes providing compensatory support in the event of contingencies such as illness or shocks affecting crops or livestock); and labor market interventions (facilitating employment and an efficient labor market).[86] Existing social protection programs can be made adaptive and "shock-responsive" to climate change impacts by:

- Focusing on beneficiaries, areas, and households that are more vulnerable to climate shocks and risks.
- Temporarily increasing the value of benefits in the aftermath of climate shocks to support affected households.

- Introducing flexibility in program conditionalities during climate emergencies.
- Aligning humanitarian assistance with existing safety net programs.
- Supporting productive, diverse, and climate-resilient livelihoods that also contribute to community resilience where possible, for instance through landscape management, climate-smart agriculture, nature-based solutions, or mini-irrigation systems.
- Using weather forecasts and early warning systems to trigger early response, particularly for slow-onset climate shocks like droughts.
- Ensuring strong coordination across disaster response agencies through a multi-agency platform that includes the ministry responsible for climate action, and sub-national governments.[87]

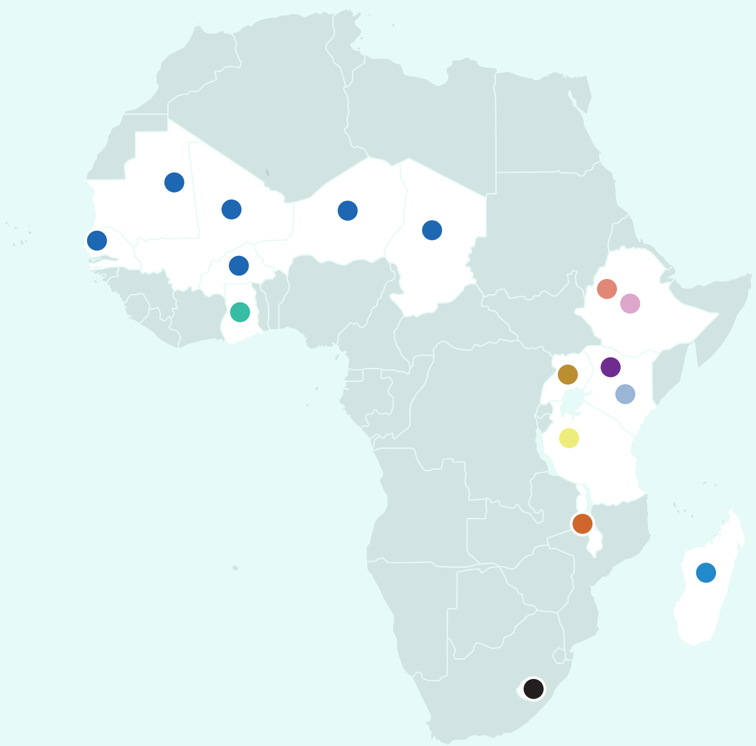
Social protection programs have a long history in Africa. The Jobs chapter presents statistics from the ILO database of social protection programs in the region. This GCA analysis looked at eleven ASPs in Africa (see Figure 1). It assessed them against a merged set of two design criteria: Tenzing's typology of social protection,[88] and the World Bank conceptual framework for adaptive social protection,[89] as presented in Table 1.

Table 1 – ASP assessment criteria

Tenzing's typology	World Bank criteria
1. Climate-informed planning, triggering action ex-ante	1. Link of ASP with financial mechanisms like financial inclusion (widening access to financial services) and mobile money (payments, finance, and banking provided through use of a mobile device)
2. Scalable and support coverage, scaling vertically (increasing length/level of support) and horizontally (expanding by absorbing non-typical beneficiaries, accounting for new shocks and stresses)	2. Conditionality of cash-transfer schemes (i.e., promoting positive behavioral change)
3. Reserve and forecast based finance: incorporating climate insurance, social safety nets, and contingency funds	3. Coordination of SPT from individual to community level
4. Strengthened institutional capacity and coordination: building on existing SPT infrastructure and enhancing capacity for beneficiaries through the upkeep of social registries	4. Innovations on climate and social protection in urban communities


Photo: Adam Jan Figel/Shutterstock

Figure 1: Select adaptive social protection programs in Africa



Note: The checkmarked boxes in the table indicate four categories considered important in the design of ASPs: climate-informed planning (CI); horizontal scalable support coverage (HSS); vertical scalable support coverage (VSS); reserve and forecast-based finance (RF); and strengthened institutional capacity and coordination (SI). The blue columns indicate elements that are key for building the resilience of vulnerable populations: behavioral change component (BH); financial mechanism (FM); scaling-up to community level (SU); and innovation in urban contexts (IU). The criteria in the table are underpinned by three functions of social protection: protection (providing ex post support against climate shocks); prevention (ex ante protection against climate shocks); and promotion (adapting livelihoods to enhance resilience). Protection and prevention relate to immediate relief through short-term, buffering 'coping' measures; while promotion relates to incremental, long-term changes to enhance adaptive capacity.

	Elements that might contribute to resilience				Adaptive Social Protection Design				
Project Name	BH	FM	SU	IU	CI	HSS	VSS	RF	SI
Hunger Safety Net Programme **Country:** Kenya **Type:** Safety-net		✓	✓		✓	✓		✓	✓
Tanzania Social Action Fund **Country:** Tanzania **Type:** Safety-net and Labor market interventions	✓	✓					✓		✓
Farm Input Support Programme **Country:** Malawi **Type:** Safety-net		✓							
The Sahel Adaptive Social Protection Program **Countries:** Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal **Type:** Safety-net and Labor market interventions	✓	✓	✓		✓	✓	✓	✓	✓
Northern Uganda Social Action Fund **Country:** Uganda **Type:** Safety-net	✓	✓			✓	✓		✓	✓
Livestock Insurance Programme **Country:** Kenya **Type:** Insurance		✓			✓	✓		✓	✓
Adaptation of Agricultural Value Chains to Climate Change **Country:** Madagascar **Type:** Safety-net		✓	✓		✓			✓	✓
Child Grant's Programme **Country:** Lesotho **Type:** Safety-net	✓					✓	✓		✓
Livelihood Empowerment Against Poverty **Country:** Ghana **Type:** Insurance and Safety-net	✓					✓	✓		
Urban Productive Safety Net Project **Country:** Ethiopia **Type:** Safety-net and Labor market interventions	✓	✓		✓					✓
Ethiopia's Productive Safety Net Programme **Country:** Ethiopia **Type:** Safety-net	✓		✓		✓	✓	✓	✓	✓

Source: Tenzing, J. D. (2020). Integrating social protection and climate change adaptation: A review. Wiley Interdisciplinary Reviews: Climate Change, 11(2), e626.

Social protection programs in Africa

The following social protection programs from across Africa demonstrate good practice for reducing vulnerability and increasing resilience of poor and vulnerable populations.

Kenya's **Hunger Safety Net Programme** (HSNP) is an unconditional cash transfer program implemented by Kenya's National Drought Management Authority, under the Ministry of Devolution and the Arid and Semi-Arid Lands. Currently in its third phase, HSNP delivers regular and emergency cash transfers through bank accounts that beneficiaries can access biometrically at pay agency outlets, by entering a PIN number at an ATM, or over the counter at a local bank branch. The program promotes financial inclusion by developing beneficiary trust in, and capacity for, using financial services; strengthens institutional capacity and coordination among stakeholders; and includes a monitoring and evaluation system that provides continuous feedback to improve the implementation of transfers. During droughts, cash transfers from the program are triggered by a Vegetation Condition Index, enabling households to meet their immediate needs, thus reducing their vulnerability.

Ethiopia's **Productive Safety Net Programme** (PSNP) was specifically designed as an ASP, to enable vulnerable rural households to deal with climate-induced food insecurity. PSNP has three components: safety net transfers for food insecure rural households; enhanced access to complementary livelihood services; and institutional support to strengthen safety net systems. With two main mechanisms for vertical and horizontal scaling, the PSNP has high anticipatory capacity at the systems level. Around 20 percent of the PSPN budget is earmarked for contingency funding through a Risk Financing Mechanism, which includes a suite of financing instruments and financial layering to ensure timely disbursement in the aftermath of a climate shock. Contingency planning relies on early warning information, hazard identification, response planning (including the targeting of transitory beneficiaries), public works activities and budgeting, operational support planning, and plans that are revised based on updated climate information. The cash payments from PSNP have had a modest positive effect on the absorptive capacity of household beneficiaries, with a reported reduction in the initial impact of drought and speedier recovery afterwards, compared to non-beneficiary households.[90] The evidence on the success of the PSNP as an ASP mechanism is, however, mixed – it has been linked to maladaptation in some cases, for instance by supporting an increase in non-farm income through the exploitation of natural resources.[91]

The **Third Northern Uganda Social Action Fund Project for Uganda** (NUSAF 3) aims to provide income support to build the resilience of vulnerable households in northern Uganda. The first component, labor-intensive public works (LIPW) and disaster risk financing, provides beneficiaries from poor and vulnerable households with a seasonal transfer for multiple years in return for their participation in LIPW; and includes a mechanism for providing ex ante finance in the aftermath of climate shocks. LIPW has supported 11,700 households with grants and 285,500 people through temporary employment wages.[92] The second component extends livelihood support to poor and vulnerable households to increase their productive assets and incomes. NUSAF 3 is an example of how behavioral components woven into the design of a project can blend with ex ante disaster risk financing and dependable livelihood support, to help build the resilience of vulnerable households in the face of disaster.

Social protection systems have been implemented in rural areas more than in urban settings. The **Urban Productive Safety Net Project** (UPSNP) is one of few urban social protection schemes in Sub-Saharan Africa, the first in Ethiopia. Although the scheme is not an ASP by design, it contains innovative approaches that can enhance the resilience of vulnerable communities. For instance, UPSNP includes a pilot program focused on youth employment to leverage the potential of young people and increase their income; and provides mobile childcare and early learning facilities in public works, to encourage the participation of women. The project also includes financial inclusion mechanisms, enabling many beneficiaries to open bank accounts for the first time. In the wake of the COVID-19 pandemic, UPSNP adapted its delivery systems to provide monthly cash transfers as a safety net. As of September 2020, UPSNP is reported to have reached over 600,000 beneficiaries, of which 60 percent are women; paid livelihood grants to up to 51,000 beneficiaries to start small businesses; and linked more than 60,000 people to social services.[93]

The **Sahel Adaptive Social Protection Program** (SASPP) is a multi-donor, US$ 75 million ASP managed by the World Bank,[94] which aims to address the high rates of poverty, displacement, and vulnerability to climate change in the Sahel region.[95] In its first phase (2014-2019), the program supported the inclusion of climate-related features into the design and implementation of existing social safety nets in six countries in the Sahel (Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal). Among other things, adaptation considerations were integrated into public works to build community assets that address disaster risks, ex ante risk financing mechanisms were established, and livelihood support was provided to enhance resilience.[96] Several innovative tools were piloted – including, for instance, a conditional cash transfer program in Tekavoul, Mauritania, to promote positive behavioral changes that support resilience, related to early childhood development, hygiene, and nutrition; the promotion of 'mobile money' in Burkina Faso to increase efficiency and security; and the use of satellite imagery to model food insecurity and improve drought prediction in Mauritania and Niger.

The first phase of SASPP directly supported nearly two million people,[97] and succeeded in its aim to respond rapidly to climate impacts, and to scale up horizontally to reach those in transitory poverty due to climate shocks.[98] The second phase (2020-2025) incorporates the lessons learned from the first phase and pilots innovations within the six countries. The SASPP provides an interesting example of how SPP can consider climate change into its design and build on its experience to further contribute to transforming livelihoods to address the structural causes of vulnerability to climate change, making them Adaptive Social Protection Programs.

Initial lessons learned with ASPs in Africa

The initial lessons of experience with ASP program implementation show that there are enormous benefits to leverage the potential of social protection programs. Some of the adjustments needed for social protection systems to cope with an increase in climate shocks include:

- Social protection (actors and institutions) must participate in planning and coordination processes relevant to climate change, such as national adaptation plans, NDC plans, just transition plans, national disaster risk reduction plans and any other plans or coordination mechanisms for addressing climate risks.
- Coordination of cross-sectoral policies related to climate change must be reflected in the design of climate-sensitive social protection systems (including active labor market policies, DRR, Disaster & Loss, portability of rights, etc.).
- Innovative and collaborative approaches based on lessons learned and evidence, as well as cross-sectoral collaborations, are necessary to improve every aspect of social protection systems with regard to their adaptation to the evolving needs of the population in a changing climate, assessing specific vulnerabilities to climate risks along the life-cycle, including persons with disabilities, women and children, indigenous people, etc.
- Adjust parameters to build a climate adaptation specificity to deliver pre-specified benefits to workers and their family affected by the occurrence of pre-identified climate risks, including sudden or slow onset disasters, possibly triggered by early warning mechanisms part of climate monitoring systems.
- Develop communication with rights-holders on climate risks and the benefits of climate-sensitive social protection schemes including social insurance.
- Systematize post disaster assessment to scale up and adapt social protection benefits to meet the specific needs of affected rights-holders.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Section 2
Focus sectors


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Agriculture and Food Systems

KEY MESSAGES

- **Food security in Africa needs urgent and serious attention from policymakers.** Rates of hunger are growing and progress towards the Malabo Declaration of 2014 is off-track. Climate change is already stalling progress towards food security in Africa, interacting with multiple other stresses and shocks, including inequality, conflict and the COVID-19 pandemic. A 3°C trajectory will cause catastrophic disruption to African food systems within the next 30 years. A 1.5°C trajectory provides more options for adaptation of African food systems, but still demands urgent action.
- **All indications are that financing adaptation to climate change will be more cost-effective than financing increasingly frequent and severe crisis response, disaster relief, and recovery pathways.** For Sub-Saharan Africa, the cost of action on climate adaptation of agriculture and food systems is less than a tenth of the cost of inaction: $15 billion compared to $201 billion per annum.
- **Leading adaptation options for food systems are well-defined and build on evidence and experience, including in Africa.** They include public policy and incentive solutions, food value chain and livelihood solutions, and on-farm and

productive landscapes solutions. Among these options, the priorities for public sector investment in Africa are fivefold: research and extension, water management, infrastructure, sustainable land management, and climate information services.

- **The adaptation investments by small-scale producers will be a vital component of building resilience of African farmers.** Therefore increasing and targeting flows of capital to these farmers, livestock keepers, fishers and small businesses is critical.

> **"My region East Africa has been battling swarms of desert locusts that have devastated thousands of hectares of cropland, the perennial droughts, and an encroaching desert that have laid bare the vulnerability of the entire horn of Africa."**
>
> **H.E. President Sahle-Work Zewde of Ethiopia**
> Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

CLIMATE CHANGE, FOOD SECURITY, AND THE RESILIENCE IMPERATIVE IN AFRICA

Status of food and nutrition security in Africa

Food and nutrition security in Africa is off track. In 2020, more than one in five people in Africa faced hunger—more than double the proportion of hungry people in any other region.[1] About 282 million of Africa's population are undernourished. In West Africa alone, nearly 17 million people needed immediate food assistance in 2020 due to a combination of drought, poverty, high food import prices, environmental degradation, displacement, poor trade integration, and conflict—a set of interlinked threats.

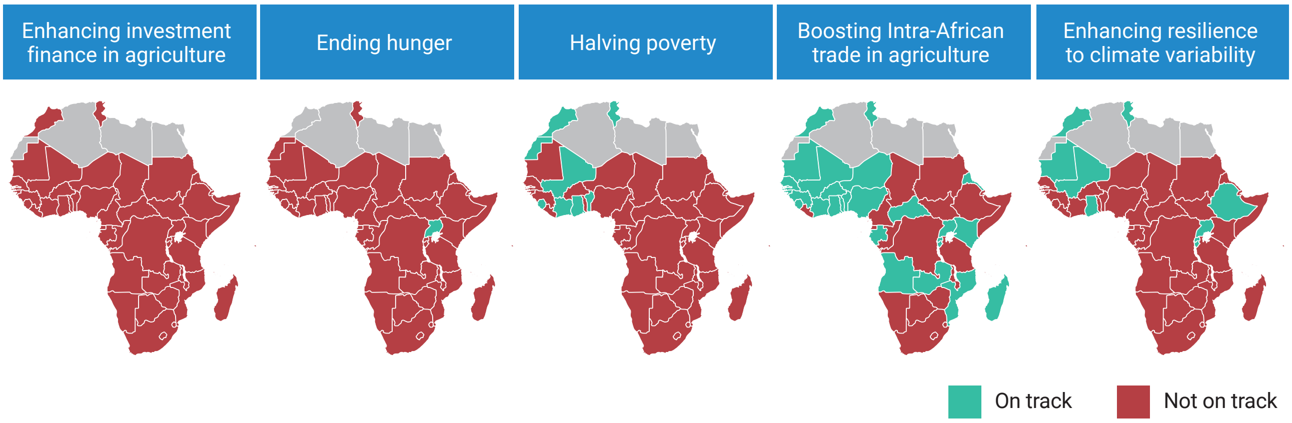
Africa's agricultural exports are rising, and many countries are net food exporters. However, largely driven by four countries (Nigeria, Angola, Democratic Republic of the Congo and Somalia), the continent remains a net food importer at an annual cost of $43 billion. Without action, the continent's food import bill could top $110 billion by 2025.[2] Demand for food is rising and will continue to do so, exceeding 3 percent per year through 2025. Population growth at the rate of about 3 percent per year, per capita income growth and urbanization, and changing consumer preferences—towards processed foods and agricultural products that are more nutritious and higher in calories—are the key drivers of demand. The continent's poorly integrated food markets cannot accommodate large yearly fluctuations in food crop production by directing surplus food to areas with shortages (for a more detailed analysis, see the Trade chapter). As a result, localized food shortages and price volatility are common, while farmgate prices remain low.[3]

The economic shocks arising from the COVID-19 pandemic are having deep impacts across Africa. Economic growth fell across the continent, most sharply in South Africa.[4] The recent locust outbreaks in East Africa, resulting in severe crop and livestock losses, have added additional pressure to food systems, with the burden falling heavily on low-income producers and consumers. While the pandemic has been one driver of increasing levels of food insecurity, the trend in numbers of hungry people was already on the rise since 2015, due to factors such as conflict, climatic shocks, food system inefficiencies, and increasing wealth and income disparities—all of which make healthy and sufficient diets less affordable.

The African Union's most recent Biennial Review shows that only 4 of 49 member states are on track to achieve the goals and targets of the Malabo Declaration on Accelerated Agricultural Growth by 2025.[5] This means that Africa is also lagging on progress to achieve Sustainable Development Goal (SDG) 2, which calls for ending hunger in all forms by 2030, and SDG 13, on taking action to combat climate change and its impacts. Looking at African countries' performance (summarized in Figure 1) the key takeaways from the African Union's Biennial Report scorecard are:

- On the Malabo commitment of 2014 to end hunger in Africa by 2025, African leaders resolved to accelerate agricultural growth, reduce post-harvest losses, increase agricultural productivity and improve nutritional status. Only Uganda is on track.
- Only seven member states are on track to reduce the prevalence of stunting among children to under 10 percent.
- On the commitment to invest 1 percent of agricultural GDP into research and development, only 12 countries did so between 2018 and 2020. In terms of access to agricultural advisory services, only seven countries are on-track.
- Performance on women's empowerment through agriculture has retreated, with only eight countries (out of 14 reporting) on track, compared with 16 on track in the last reporting period.
- On commitments to building climate resilience, only Morocco has a dedicated budget line at the national level. Less than a quarter of member states are on track towards the 2025 targets that encompass sustainable land management and support to farmers.
- In better news, 26 countries (65 percent) are on track to double the area under irrigation by 2025, and 16 are on track to double the current levels of quality agricultural inputs for crops, livestock and fisheries.
- Similarly, while most countries remain off track on increasing the value of trade of agricultural commodities and services within Africa, there has been a good deal of progress since the last reporting cycle, when only three countries were on track.

Figure 1: Performance by African member states on their commitments under the Malabo Declaration (2014) on food security



Source: African Union 2020

Impact of climate change on African food security

Climate change is already stalling progress towards food security in Africa. African agriculture and food systems are already suffering the impacts of climate change. Visible effects include changes to the start and end dates of growing seasons, and the frequency and intensity of dry spells and heavy rainfall events. Evidence shows that climate change has stalled productivity growth in the continent's foremost staple, maize.[6] Overall, Sub-Saharan Africa has experienced about a 1.4 percent reduction in food calories per year from key food security crops (maize, cassava, sugarcane, sorghum, rice) due to climate change.[7] Increasing climate variability exacerbates the climate challenge. From devastating droughts in North, West and Southern Africa to cyclones and intense flooding in East Africa, extreme weather is threatening crops, fisheries, and livestock and putting millions of Africans at risk of food insecurity. Food insecurity increases by 5–20 percent with each flood or drought.[8]

A trajectory of global temperature rise of 3°C will cause catastrophic disruption to African food systems within the next 30 years. In a 3°C scenario, by 2030 climate change is predicted to reduce the income of the poorest 40 percent of African people by more than 8 percent, further constraining their ability to respond to climate shocks and adapt to climate change.[9] Many more million Africans will suffer from hunger.[10] By 2050, the 282 million of Africa's population who are undernourished today is expected to rise to 350 million.[11] Climate change jeopardizes development gains by undermining food, environmental, water, and energy security. The impacts of climate change will deepen existing vulnerabilities and capacity gaps, leading to poverty, fragility, conflict, and violence.

Though human-induced warming is greater at high latitudes, climate impacts are emerging especially rapidly in the tropics, for both biophysical and socioeconomic reasons.[12] The most profound impacts will be on the production end of the food system—agriculture, wild foods, and the land and water systems that support them—though direct impacts on processing, distribution, storage, food environments and consumers' choices will also hit hard, particularly around food safety, seasonal food availability, and access to culturally preferred diets.[13] The level of upheaval to food systems under the 3°C scenario will require wholesale changes in what African people eat, where it is produced, and how supply is managed and governed.[14]

Massive changes in agricultural suitability can be expected across the continent, with farming systems, food production and import dependency changing beyond recognition. For example, under a 3°C (RCP8.5) scenario, Africa is expected to lose 30 percent of current growing areas for maize and banana and 60 percent for beans by 2050. By the end of the century, 1.85 million hectares of current bean cropping systems in Uganda and Tanzania, which grow 41 percent of the total Sub-Saharan African bean supply, will no longer be suitable. Other crops will see smaller but significant effects, with up to 15 percent loss of production area for cassava, yams, millets and sorghum.[15] High-nutrition and high-value-add fruits, vegetables and perennial crops also look set for major yield and quality declines.[16]

Large areas will need to shift out of crop production altogether. Over the 2050 to 2100 timeframe, Africa's typical mixed cropping-livestock systems will need to change to pure livestock systems across 3 percent of Africa's land area, directly supporting around 35 million people in agricultural livelihoods. At the same time, these pastoral systems will be under increasing threat in terms of forage quality, fire frequency and water availability.[17] Significant drops in African marine fisheries catches are also expected, putting further pressure on people's access to highly nutritious animal foods.[18] For example, under a 3°C trajectory, by 2050, West African marine fisheries are projected to experience a loss of a fifth of annual landed value, half of all fisheries-related jobs, and $311 million annually in foregone income across the food system.[19]

On the 3°C trajectory, climate change will be experienced primarily as increases in frequency and severity of climatic extremes, such as heatwaves, droughts, floods and storms. For example, heatwaves, defined as three or more days during which daily temperatures are in the top 5 percent of the 1971–2000 average for the region, currently occur 1–3 times per year in different African regions. Under a 3°C scenario, this is expected to increase five-fold by 2030, with Cameroon, Gabon, Somalia and Ethiopia particularly exposed.[20] These heatwaves will impact agriculture both by exceeding the temperature tolerance limits of key crops—cereals like maize and wheat are especially susceptible—and by reducing labor productivity.[21] Meta-analyses show that the heat and drought interact to bring about devastating impacts on crop harvests by shortening lifespan, interfering with reproduction and reducing the number, size and quality of grains, legumes and fruits).[22] For African people, the heat stress will be increasingly deadly; by the end of the century mortality-related heat stress levels are very likely to occur far more frequently—for example an additional 200 days per year in West and Central Africa.[23] As well as the direct threats to human health and lives, this heat is likely to drive labour, migration and patterns of settlement, with profound impacts on African food systems.

North Africa and southern Africa will face severe reductions in rainfall in the 3°C scenario, with more intense and frequent droughts, lower discharge in rivers, and higher likelihood of fires—with major impacts on crop productivity, irrigation potential, pasture quality and ecosystem services.[24] Other African regions will experience a smaller overall decline in rainfall, but highly impactful changes in rainfall patterns. Flood events, which can destroy production, particularly in low-lying irrigated zones, are likely to increase throughout Africa, including Madagascar.[25] Even more critically, a range of climatic tipping points are plausible in the 3°C scenario. For Africa, a critical potential future climate tipping point is a collapse of the Atlantic Meridional Overturning Circulation (AMOC), which would result in a southward shift in the Intertropical Convergence Zone, which would in turn drive drying and desertification across large areas of Africa south of the Sahara, with calamitous impacts on food production and agricultural livelihoods.[26]


Photo: Ozbalci/iStock

A 1.5°C trajectory provides greater options for the adaptation of African food systems but still demands urgent action. The world is already on the 1.5°C trajectory and is likely to exceed 1.5°C within the decade.[27] Even under this low-emissions scenario, more frequent region-wide food system shocks can be expected, with yield failures across multiple neighbouring countries, food safety breakdowns, food price spikes and social unrest . The likelihood of extreme droughts will double across North Africa and southern Africa[28] and heavy rainfall events and associated flooding are projected to be more frequent and more intense across most of the continent.[29] These rapid changes in both means and extremes will have unavoidable effects on the productivity, quality, safety and stability of cropping, livestock and fisheries systems, and on the health, productivity and mobility of the people who manage those systems.

Current actions to build resilience to climate change and related shocks across Africa's food systems are promising—but not nearly enough to meet the scale of the problem. Even on a 1.5°C trajectory, a more ambitious and urgent set of adaptation interventions are required. On a 3°C trajectory, which approximates more closely to current socioeconomic pathways and emissions trends, disruption to current systems will be profound everywhere and catastrophic for millions. Adaptation is an imperative, not a choice.

ACCELERATING ADAPTATION AND RESILIENCE FOR AFRICA'S FOOD SYSTEMS

This section provides an overview of the adaptation actions most relevant to African food systems. As a starting point, Table 1 gives a summary of the key solutions relevant to Africa, and these examples are then expanded on in the subsequent text. Three families of adaptation interventions are covered: public policy and incentive solutions, food value chain and livelihood solutions, and on-farm and productive landscapes solutions. Within these three families, all of the examples discussed have value, and many work in concert with each other. Moreover, the synergies with national and continental development agendas for jobs, productivity, nutrition and sustainability are very strong—delivering on climate adaptation will also deliver on the SDGs and Malabo goals. Some of the examples have long-term African experience to build on (e.g., livestock management, agroforestry), while others are newer areas of endeavor on the continent or globally (e.g., fiscal measures, co-benefits of mitigation finance). Some are lower hanging fruit (e.g., low-cost early warning systems) while others need more complex multi-sector reforms (e.g., affordable healthy diets).

Based on the leading reviews and modelling exercises of recent years (see the sources under Table 1), we identify five solutions within the three families for which public sector investment is most strongly needed in Africa. These are:

- Ramping up support to research and extension services
- Strengthening inclusive climate information & risk management services
- Provision and maintenance of adaptive climate-resilient infrastructure
- Improving sustainable water management at farm and catchment levels
- Restoration of degraded landscapes and practicing sustainable land management

These groups of solutions are not 'better' than others, nor will they solve all adaptation problems in food systems on their own. They are highlighted because they are areas in which the case for public sector investment is high for the following reasons: strong public good benefits; need for interventions at a large scale, such as the national level or whole landscapes or whole catchments (often cross-boundary or transnational); opportunities for progressive distributional outcomes, improving equality of access for women and poor people; initially high capital outlays that may be prohibitive for all but the largest of private operators; and associated need for policy incentives that provide signals to land and water managers and to food system participants.

A modern approach to climate adaptation moves beyond purely agricultural solutions into whole food system approaches. For example, problems with agricultural production can be addressed not through on-farm solutions alone but also through trade, social safety nets, and policy incentives for consumers and food businesses. The task is to provide suites of adaptation support, and to increase the set of choices available to farmers, consumers and businesses, rather than to identify a small number of the most promising 'silver bullet' types of solutions. Targeting to beneficiaries also matters greatly: public sector support should be actively designed and distributed to provide preferentially for low-income producers and consumers, with a focus on opportunities for women to participate on an equal footing.

Given the pace and unpredictability of climate change, another principle is that building of ongoing adaptative capacity is more important than one-off investments; hence the importance attached to enhancing systems for rapid learning, foresight and lesson-sharing, through digital-based R&D and extension systems. This capacity will be critical as farmers, governments and businesses increasingly need to build proactive preparedness for the larger transitions that the 3°C scenario will demand—such as a country or region needing to move out of production of a major staple crop, for example in Nigeria and South Africa.


Photo: Ozbalci/iStock

Table 1: Climate change adaptation solutions for African food, land, and water systems

Key: high, medium, low

Family of adaptation solutions		Adap-tation benefits	Food security co-benefits	Mitiga-tion co-benefits	Priority for public sector invest-ment	Early examples in Africa (expanded in text below)
Public policy and incentive solutions	**Ramp up support to research and extension services**	high	high	high	high	Mauritius, Namibia, Botswana
	Strengthen inclusive climate information & risk management services	high	high	low	high	Senegal, Rwanda, Angola
	Implement insurance schemes against shocks, and wider social safety nets to counter climate risks	medium	high	low	medium	Ethiopia, Mauritania, Niger
	Repurpose subsidies and eliminate policy distortions that increase climate vulnerabilities	high	high	low	low	Botswana, Senegal
	Deploy mitigation policy and finance in ways that support adaptation	medium	medium	high	low	Climate-Smart Agriculture Investment Plans, e.g. Mozambique, Mali
	Reduce barriers to trade in times of crisis	high	high	low	low	African Continental Free Trade Area
Food value chain and livelihood solutions	**Provide and maintain adaptive climate-resilient infrastructure**	high	high	low	high	Malawi, Zambia
	Reduce and manage food loss and waste	medium	high	high	medium	The Gambia, Malawi
	Create demand for affordable healthy low-carbon diets	high	high	high	low	South Africa, Egypt
	Link small-scale producers to value chains	medium	high	low	low	Nigeria, Rwanda
On-farm and productive landscapes solutions	**Improve sustainable water management at farm and catchment levels**	high	high	low	high	Burkina Faso, Madagascar
	Restore degraded landscapes and practice sustainable land management	high	medium	high	high	Ethiopia, Niger
	Scale up context-specific climate-smart soil management	high	high	high	medium	Zambia, Ethiopia
	Improve livestock management	medium	high	high	medium	Kenya, Nigeria
	Monitor and manage new trends in pests and diseases	medium	high	low	medium	International networks and services, e.g. FAO and CABI
	Promote diversification of crops and livestock	high	medium	medium	low	Morocco, Rwanda
	Use climate-ready species, cultivars, and breeds	medium	high	low	low	Pan-African—but adoption levels need to be raised
	Incorporate perennial crops, including agroforestry	medium	medium	high	low	Zambia, Côte d'Ivoire

Key sources for adaptation solutions: Niang et al., 2014; Mbow et al., 2019; Shukla et al., 2019; IMF 2020; Sulser et al., 2021 (country examples sourced more widely)[30]

WORLD BANK CLIMATE ACTION PLAN

Box 1: Africa World Bank Climate Business Plan and Climate Smart Agriculture

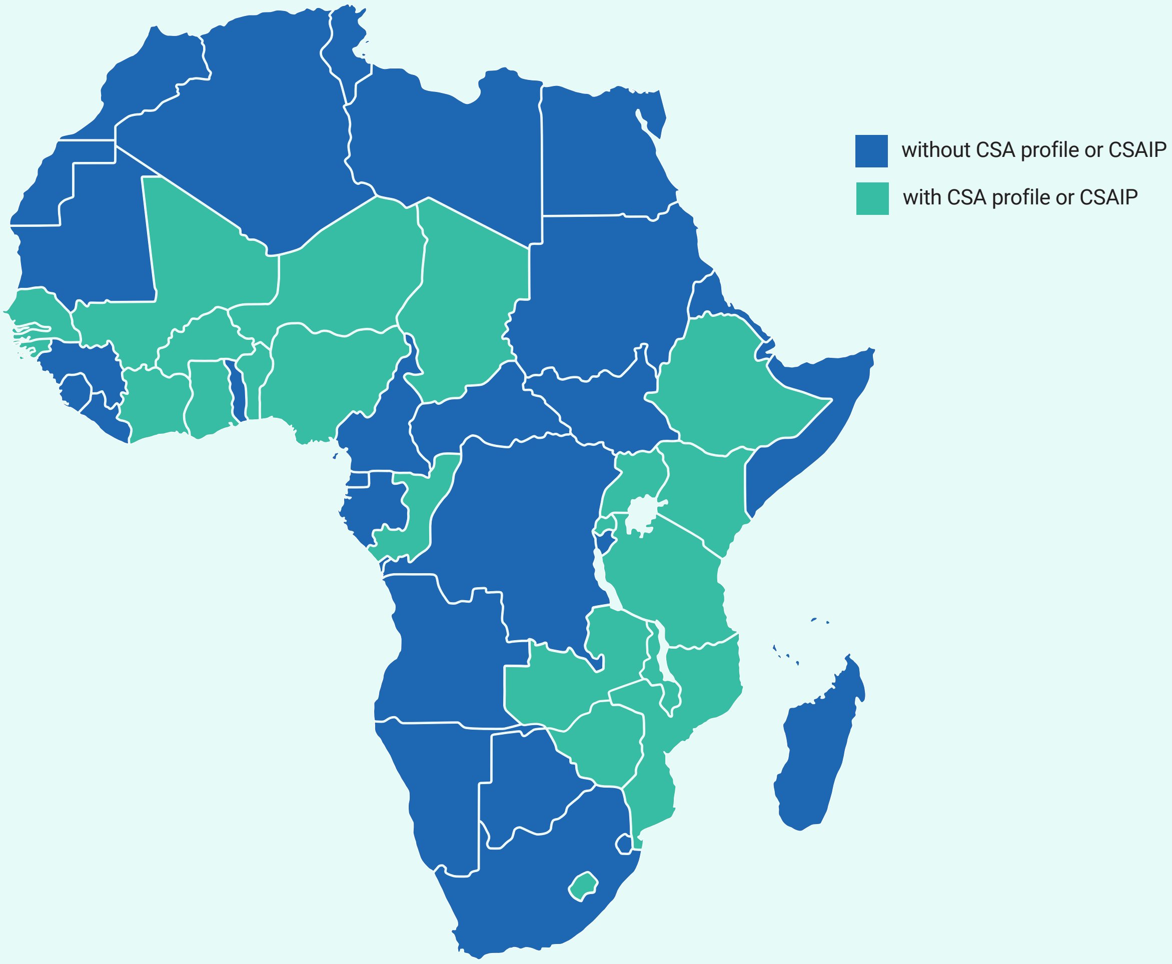

Photo: Andre Silva Pinto/Shutterstock

The Africa Climate Business Plan (ACBP) was launched by the World Bank at the 21st Session of the Conference of the Parties (COP 21) in Paris in 2015 to address Africa's intricately linked climate and development agendas. The ACBP calls for funding to help Africa adapt to climate change and build up the continent's resilience to climate shocks. The ACBP includes a focus on climate-smart agriculture (CSA). This integrated approach aims to address the interlinked challenges of food security and climate change by sustainably increasing agricultural productivity to support equitable increases in farm incomes, food security, and development; adapting and building the resilience of agricultural and food systems to climate change at multiple levels; and reducing greenhouse gas (GHG) emissions from agriculture.

Between January 2016 and June 2021, the World Bank invested over $11 billion in agriculture projects across 40 countries in Africa. The portfolio includes country-level projects and regional programs that aim to catalyze coordinated action to generate shared regional public goods and provide a platform for policy dialogue and reforms. For example, the World Bank is supporting CGIAR to implement the Climate Change, Agriculture and Food Security (CCAFS) initiative aimed at enhancing access to climate information services and validated climate-smart agriculture technologies across Africa. Climate finance (co-benefits) account for $6.8 billion or 60 percent of these investments, with 68 percent of the climate finance flowing into adaptation.[31] Higher finance flows to adaptation compared to mitigation reflect the priorities of African countries to address the agriculture sector's climate vulnerability and increase resilience. However, given the vast potential for African agriculture to reduce emissions through climate-smart practices, the mitigation flows should expand in the future, with co-benefits to adaptation. In response to diminishing conditions for food production, the World Bank plans to invest $5billion between 2020 and 2025 across 11 countries of the Sahel, Lake Chad, and Horn of Africa regions, stretching from Senegal to Djibouti. The funding will be used to restore degraded landscapes, improve agriculture productivity, increase climate-resilient infrastructure, and boost livelihoods and jobs, in line with the Great Green Wall Initiative.

To strengthen the evidence base for CSA implementation, a set of development partners (CGIAR, FAO, USAID, and the World Bank) actively support countries in the preparation of CSA country profiles and CSA investment plans (CSAIPs). The CSA profile provides baseline information for initiating discussion about entry points for investing in CSA at scale. It characterizes a country's climate vulnerability, specifies promising CSA technologies and level of adoption, and documents institutions and policies for CSA. The CSAIP takes the information provided by the profile further by identifying investments that offer the greatest potential to transform a country's agriculture into a more productive, climate-resilient, and low-emissions sector. It identifies potential pathways for scaling up CSA, the impact of several factors on adoption, and policy actions required to support effective scaling up. Currently, CSA profiles or investment plans have been prepared for 23 countries, with investment project financing initiated in 17 of these countries. The profiles and investment plans are major drivers of climate-smart agriculture and food system investments in Africa.

Figure 2: Countries with CSA profiles or investment plans



Source: World Bank

Photo: Travel Stock/Shutterstock

Public policy and incentive solutions

Climate change adaptation in food systems can be enabled and driven through various policy instruments, not only in the environment and agriculture sectors but also in economic development, finance, health, infrastructure, gender equality, digital, trade and social safety net policies. The food system offers opportunities for win-win-win outcomes for food security, adaptation and mitigation.

Several African countries have released national green growth strategies or roadmaps. Examples are Ethiopia's Climate-Resilient Green Economy Strategy, Rwanda's Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development, and South Africa's Green Economy Accord. These national strategies and roadmaps show green growth as an emerging agenda in policymaking across Africa.

The following public policy and incentive solutions are the most relevant for climate-adapted and resilient agriculture and food systems in Africa.

> **Importing staple foods into the continent when 60% of the population still lives on the land is madness by any measure. We can do better. It is time for a new approach, one that creates locally produced food for a local population. (...) The answer lies in initiatives such as Africa Improved Foods (AIF) (...) it is the first big public-private partnership in Africa to specifically address malnutrition and hidden hunger."**

Feike Sijbesma, Co-Chair of the GCA Board and Honorary Chairman of Royal DSM

Ramp up support to research and extension services. As climate change accelerates, real-time data collection, analysis and learning become increasingly important to manage emerging unpredicted climate risks. This is important on the 1.5°C trajectory where research and extension are critical to dealing with climate shocks, and even more important on the 3°C trajectory, under which climatic conditions will soon move beyond anything experienced by farmers since the introduction of agriculture. Investment in robust research functionalities has been identified as a key adaptation solution for food systems.[32] This is not just a matter of one-off filling of knowledge gaps; what is required is sustained investment in agile research services that are rapidly responsive to emerging risks, and also provide intelligent foresight into future risks and trends to enable proactive and systemic adaptation. Equally important, extension services that support innovation in both agriculture and food systems are critical to enabling rapid adaptive learning loops among farmers and other networks of food system participants.[33] Raising agricultural productivity requires the development of modern innovation systems for technology generation and diffusion.

Public spending programs would need to focus on innovation systems (the institutions and partnerships that link new ideas with impact at scale) because a robust supply line of technologies is not enough. It is critical that the knowledge on these technologies and innovations reach farmers, especially small-scale producers, and that they adopt them. However, the ability of farmers to adopt potentially transformative technologies is influenced by the policy incentives, market conditions and human capacity that affect the monetary and non-monetary costs of such technologies, including access to finance, land ownership, ICT connectivity, and the level of farmers' knowledge and skills. Thus the set of complementary areas of investments that will be critical for technology generation and adoption include:

- strengthening agricultural innovation systems;
- reorienting agricultural R&D to meet emerging climate challenges;
- modernizing agricultural extension services;
- building skills for technology innovation and adoption; and
- reducing policy barriers and maximizing enabling factors.

In Sub-Saharan Africa, agricultural research spending grew by about 50 percent between 2000 and 2014. However, this growth was concentrated in a small number of countries; expenditure actually fell in more than half the countries measured. Furthermore, the growth comes from a very low base, and still falls far short of what is needed. In 33 out of 40 countries for which data were available, less than one percent of agricultural GDP was spent on agricultural research).[34] For comparison, the intensity of agriculture R&D spending (total agricultural research spending as a share of agricultural GDP) in the Organization for Economic Co-operation and Development (OECD) countries is about 2.5 percent.[35] Key areas for ongoing research into climate adaptation in African food systems include a deeper understanding of the impact of (and response options to) climatic extremes; the deployment of cost-effective climate services; and farming inputs, including crop and livestock genetics; integrated land management and economic incentive schemes.[36] Systems-level analysis that can provide critical information for policy decisions also needs to be enhanced—for example, on synergies and trade-offs across adaptation, mitigation and food security options; or across water, energy and food supply; or across different groups of winners and losers in food.

Strengthen inclusive climate information and risk management services. Climate information services—the provision of tailored information related to current and forecasted weather, on a timeframe ranging from daily to seasonal to multi-year—is vital to cost-effective planning by farmers, food businesses and governments. Climate information services can be characterized as the set of institutions and processes that connect observers, modelers and forecasters (of both near-term weather and long-term climate) with interpreters of that information (e.g., agricultural advisories on planting dates or livestock care) and ultimately to users of that information: farmers, livestock keepers, fishers, agricultural service providers, governments and food businesses. The intent is to provide users with preparedness, to inform adaptation not only to seasonal variability in weather, but to longer-term trends in climate change itself. This can lead not only to better-informed decision making on the part of farmers, but to the creation of climate-smart agricultural value chains, in which agricultural investment up and down entire supply chains is able to manage climate risk over a period of several years.[37]

Key climate information services (CIS) include seasonal weather forecasts for farmers and early warning systems that can help anticipate and manage natural disasters, pest outbreaks and yield failures. CIS enables access to timely, cost-effective, and user-relevant information on weather and impending disasters, for improved agronomic decision-making. At the national level, climate advisories help countries to identify conditions that may endanger food security and inform farmers' decisions to adequately respond to, and when possible, capitalize on the changing conditions.

Much as climate information services are central to effective agriculture and food security risk management, the approach in Africa is still reactive rather than proactive. Inadequate early warning systems coupled with limited investment in climate information services and weak institutional and technical capacity, are implicated in contributing to food insecurity–related emergencies in the region. As discussed in the Present and Projected Climate Risks chapter, Africa needs to invest much more in technical and institutional capacity across the whole climate information value chain, including observations and monitoring, data processing, forecasting and modeling, coupled with agricultural advice, information delivery, and two-way communication channels. Early investments are underway, but much more needs to be done to scale up and to provide a more inclusive and higher quality level of service.

For example, African countries are leveraging the big data and geospatial capabilities of the Agricultural Intelligence Observatory (Ag Observatory) in targeting climate-smart interventions to improve their agricultural systems. Launched in 2018, the Ag Observatory is a climate-information services tool for near real-time detection of farming system shocks and initiate proactive response measures. The Ag Observatory integrates high-resolution private sector agrometeorological data (aWhere) with public domain meteorological and agricultural monitoring databases (e.g. crop calendars), linked to crop yield models and other forecasting tools.[38] aWhere is a subscription-based, artificial intelligence tool that collects and analyzes weather and agronomic data from 1.9 million virtual weather stations globally. Next challenges for the Ag Observatory are greater interlinkages across African countries, and the building of stronger and more inclusive links with end users, particularly small-scale farmers and their service providers (inputs, extension, and financial services).

Early warning systems are adaptive measures for climate change, using integrated communication systems to help regions, countries, or communities prepare for hazardous climate-related events. An ideal early warning system saves lives, jobs, and infrastructure and supports long-term sustainability. The Africa Road Map for Improving the Availability, Access and Use of Disaster Risk Information for Early Warning and Early Action identifies activities and practical recommendations aiming to improve the availability, accessibility and use of risk information at the continental, regional, national and local scales, for the African Union Commission, the Regional Economic Communities and four countries: Angola, Ethiopia, Tanzania and Zambia. Common priorities include improvement of monitoring and forecasting systems, development of inclusive communication systems, and implementation of preparedness plans.[39] A vital service in Africa is FEWSNET, the Famine Early Warning Systems Network created in 1985, which provides early warning and analysis on acute food insecurity worldwide. Examples at national level include the Strengthening Climate Information and Early Warning Systems project in Uganda, which has replaced outdated and inadequate meteorological stations with updated systems, improving disaster risk reduction with more effective means of generating and sharing information.

Reaching farmers with usable weather forecasts, preferably linked to agricultural advisory services, is another priority for climate information services. For example, the national meteorological service in Senegal works with an association of 83 community-based radio stations across the country, as well as text message services, to reach around 740,000 rural households with seasonal weather forecasts that inform planting dates and help farmers maximize effective use of inputs. In Rwanda there has been a focus on two-way communication with farmers, both through extension agents and the Radio Huguka community radio network that delivers bi-weekly climate information programming, with call-in shows and live debates with experts.[40]

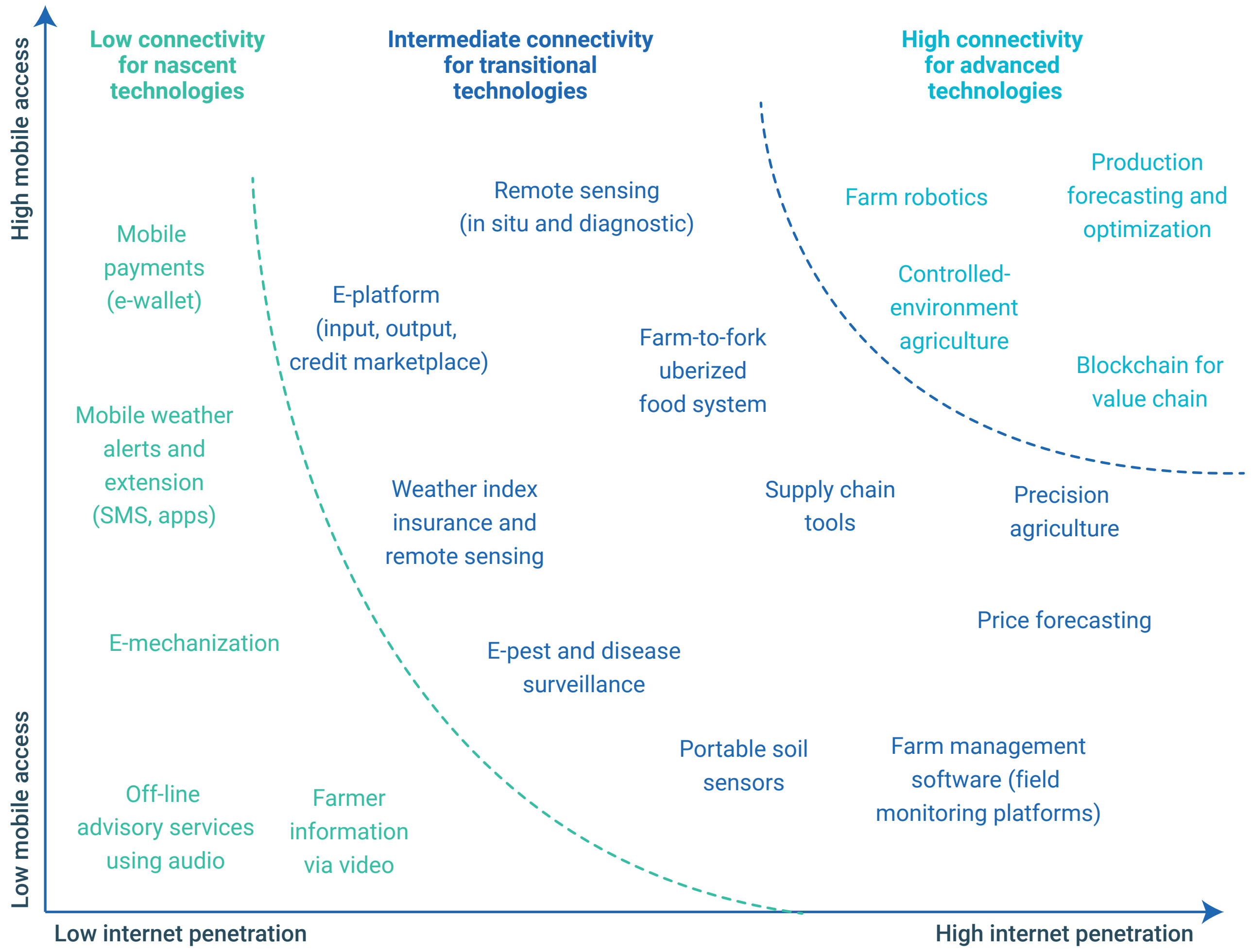
Box 2: Scaling up Digital Solutions in Africa

Photo: PeopleImages/iStock

Technologies for collecting, storing, analyzing, and sharing information digitally, including mobile phones and the internet, have great potential to solve several agricultural challenges, thereby improving the food system's efficiency, equity, and environmental sustainability. From video-based agricultural advice to the Internet of Things-enabled climate-smart irrigation tools to agroweather advisories that provide personally relevant information on weather and impending disasters and help farmers capitalize on changing conditions, digital solutions could be a game-changer in sustainably boosting agricultural productivity and resilience in Africa. The technologies enable actors within the food system to make informed decisions, improve productivity and incomes, and achieve better nutrition, health and resilience outcomes. To encourage adoption more broadly, digital technologies should be user-friendly and require low-level skills and literacy for its use, for example, with interactive voice response functionality.

Increasing the adoption of digital technologies in the food system will require expanding mobile internet coverage and promoting relevant digital applications tailored to different participants across the food system. As network coverage increases, so do potential users of digital solutions, which increases the incentives for digital solution providers to develop relevant applications. Digital technologies can also be applied to food e-commerce, thereby helping to match buyers with sellers, shortening agricultural value chains, providing access to new markets, reducing transaction costs, and creating new business opportunities for actors within the food system. E-commerce in Africa is growing rapidly each year.[41] In principle, digital agriculture also has the potential to help address Africa's youth bulge—the gap between job creation and the large number of young people entering the workforce each year—by leveraging the greater digital connectivity among younger age groups.

Figure 3: Digital agriculture technology continuum



Source: World Bank

Implement insurance schemes against shocks and wider social safety nets to counter climate risks. Designing climate-responsive social protection strategies can strongly support proactive measures to avoid, minimize and address the complex, long-term impacts of climate change on human health, livelihoods, poverty and inequality (See Climate-adapted Social Protection Systems insert). For smaller climate events, revenue diversification and remittances are helpful; market insurance is best for more intense events. Adaptative social protection mechanisms such as international aid, insurance and contingent finance and government reserve funds protect households from medium and large climate events; adaptive social protection programs combining multi-year cash transfers with direct efforts to promote productive employment have proven effective for improving food security and welfare of the poorest. Financial inclusion is helpful against medium climate events.

Weather insurance can be loosely grouped into micro (for individuals), meso (for businesses) and macro (for governments). An example at the macro level is the African Risk Capacity, which insured four governments and nine governments in its first and second year of operations respectively. In the first year, three of these four governments received payouts following insufficient rainfall in the Sahel, which was used to assist 1.3 million drought-affected people.[42] Currently, 24 countries have a memorandum of understanding with the ARC. At the micro level, Index-Based Livestock Insurance (IBLI) is a prototype commercial insurance product for small-scale livestock keepers in northern Kenya and southern Ethiopia. IBLI leverages the strong correlation between remotely sensed vegetation index and losses associated with forage shortages.[43]

Repurpose subsidies and eliminate policy distortions that increase climate vulnerabilities. No country in Sub-Saharan Africa is currently on track to meet its commitment of allocating at least 10 percent of total budget funding for agriculture in 2019. Yet, in many Sub-Saharan African countries, a significant share of public spending goes to poorly targeted and distortionary market price supports and subsidies. This calls for adopting smarter public spending programs. COVID-19-induced declining fiscal space and increasing government debt levels require repurposing public resources to support services and infrastructure in producing sustainable agri-food systems while addressing existing policy distortions. This provides opportunities for building more fiscal responsibility through repurposing public agriculture spending programs for longer-term productivity growth and climate adaption agenda (including infrastructure, early warning, R&D and extension, and skills development). This repurposing of public resources can also enhance resilience against short-term shocks by integrating budget lines for disaster preparedness and emergency response into medium-term expenditure frameworks for greater flexibility to manage shocks.

Ten African governments (Mali, Senegal, Burkina Faso, Ghana, Nigeria, Kenya, Tanzania, Zambia, Malawi and Ethiopia) spend roughly $1.2 billion annually on poorly targeted input subsidies.[44] Reallocation of expenditures from such programs to resilience-building investments, such as climate-smart technologies, research and development, and infrastructure, could bring major food security gains and promote the efficient use of scarce public resources. In addition, public support programs and policies can and need to focus on improving enabling environment and policy predictability to encourage private sector investments.

Repurposing agricultural policies and public spending does not only help to deliver more efficient and resilient food security outcomes, but it could also provide an opportunity to develop investment strategies aligned with the formulation of Nationally Determined Contributions under the Paris Agreement. Examples of opportunities for repurposing could include support to protecting forests, grasslands, peatlands and wetlands; direct conservation support and platforms toward integrated projects that bring together producers with scientists to develop needed innovations; and conditional funding on environmental practices, including use of graduated payments that reward farmers for better performance. Policies for financing land retirement (i.e., restoring agricultural land) on carbon-rich peatlands and lands with limited agricultural productivity and restoring them using native vegetation would also be beneficial.

Photo: Afrimages/iStock

Policy distortions also disadvantage women and their effective participation in food systems. Women are significantly more vulnerable to climatic risks than men, largely due to unequal access to governance systems, resources, services, and markets (see Gender chapter). Gender-responsive climate change policies, programs and planning are vital to effective adaptation and equal outcomes. Many tools and methodologies for gender mainstreaming into policy and programming are available, including CRiSTAL, Gender Impact Assessment, the Climate Vulnerability and Capacity Analysis methodology, and Participatory Vulnerability Analysis. Actions to eliminate discrimination against women in ownership of and access to productive resources, including land, are especially important. Mechanisms such as gender-responsive budgeting and auditing are also useful. In Uganda, gender budgeting in pilot sectors, including agriculture, yielded significant positive effects on social outcomes, such as reduced maternal mortality rates and improved primary school enrolment for girls—both of which build longer-term societal resilience as well as being of intrinsic value in themselves. In Rwanda, local-level gender budgeting has helped improve gender equality indices and inspired new land policies that require property registration in the name of both spouses, thus increasing women's ownership of productive resources.[45]

Deploy mitigation policy and finance in ways that support adaptation. Agriculture is the largest source of GHG emissions in Africa, accounting for about 58 percent of emissions in the continent.[46] Several adaptation and mitigation measures can help address climate change, but no single measure is sufficient by itself. Effective implementation of climate action in Africa depends on policies and cooperation at all scales and integrated responses that link mitigation and adaptation with other development goals. There has been increased national and subnational mitigation plans and strategies in recent years, though without robust financing propositions. Climate mitigation finance is critical as large-scale investments are required to reduce GHG. In addition, mitigation finance is an adaptation tool that will allow African regions to mitigate the adverse effects and reduce the impacts of climate change. The use of Climate-Smart Agriculture Investment Plans (Box 1) is an important step towards integrating mitigation and adaptation planning, and is expected to be reflected in African countries' revised submissions of Nationally Determined Contributions to the UNFCCC.

Reduce trade barriers, especially in times of crisis. As discussed in the Trade chapter, international trade is an important adaptation mechanism to deal with the geographic variation in climate-related harvest failures. Climate change affects parts of the world differently, shifting crop suitability and regional comparative advantages and altering trade patterns. Trade between African nations in agricultural products as a percentage of Africa's total agricultural trade has remained below 20 percent over the last few decades, one of the lowest in any region. Implementing the African Continental Free Trade Area (AfCTA) would enable trade to play its rightful role in improving food security and facilitating more efficient allocation of resources in agricultural production. For example, intra-regional trade within Africa on agriculture commodities and products could increase by an estimated 49 percent, while processed food trade could increase by 90 percent, and trade between Africa and the rest of the world could increase by 10 percent.[47] The increased movement of food commodities will increase food availability in deficit areas and help improve food security.

Furthermore, the AfCTA is projected to facilitate faster growth of the agriculture sector in all parts of Africa except for North Africa—as the sub-region would shift towards manufacturing and services. Real incomes would increase, and poverty will decline, enabling more people to access healthy diets. The impacts of AfCTA depend on the extent to which its agreements are implemented, including reduction of tariffs and technical barriers to trade among member countries, and the extent to which countries undertake trade facilitation measures. The AfCTA reforms would undoubtedly establish a regional policy and regulatory framework capable of mitigating against countries reverting to retrogressive trade policies such as export bans or rapid escalation of tariffs in times of crisis. There is evidence that such policies exacerbate the impacts of climate change on food security and hunger. In contrast, mechanisms to keep trade open will alleviate negative effects on the affordability of healthy and sufficient diets.[48]

This would, however, require establishing shared compliance standards as it relates to tariff and nontariff barriers, streamlining customs procedures and meeting environmental and climate requirements. AfCTA is supported by a fairly new regional institution, the Ecosystems Based Adaptation for Food Security Assembly (EBAFOSA), in developing Climate and Environment compliance standards along the entire food supply chain, along with the related Health and Quality and Safety Compliance standards. Together, these standards aim to ensure that processes along the food systems do not degrade ecosystems and enhance nature-based approaches in production while creating an open market for healthy, high-quality, environmentally friendly agro-produce—all of which are expected to contribute to agricultural transformation, which increases its climate resilience and reduces greenhouse gas emissions.

Photo: BOULENGER Xavier/Shutterstock

Food value chain and livelihood solutions

Many of the impacts of climate change on food production have adaptation solutions beyond agriculture. Just as there is climate-smart agriculture, there are also climate-smart food value chains and climate-smart food systems. All continents, including Africa, are still in the early days of exploring, testing and implementing value chain and livelihood-oriented mechanisms for building food system resilience in the face of climate change.

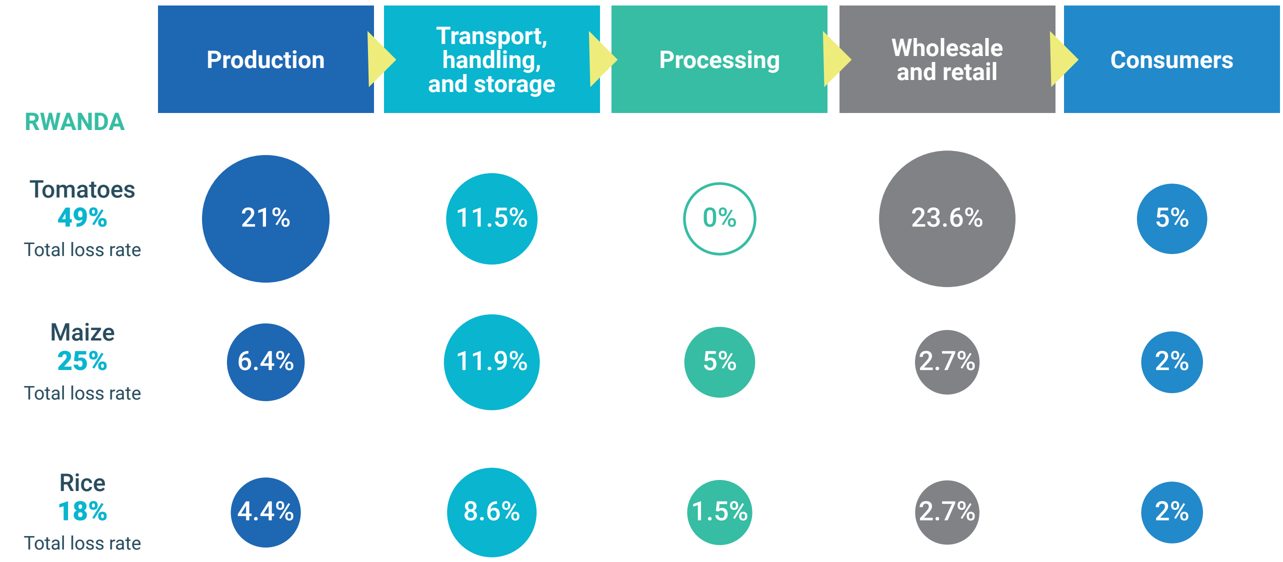
Provide and maintain adaptative climate-resilient infrastructure. In the food supply chain, practical logistics and infrastructure for food storage, such as the correct use of metal drums and hermetic bags, can drastically reduce grain losses. Other options include drying equipment (e.g., for grains, fish or vegetables) and enabling cold storage for fresh produce (where the highest losses typically occur). Commercial collective storage facilities with formal warehousing receipt mechanisms are viable solutions for farmers who cannot afford to build their own storage facilities. Roads and transport are also a primary enabler of rural connectivity and adaptation—and currently the leading sector for African infrastructural investments. The provision of transport routes facilitates market access, decreases transport time, reduces spoilage, and enables rural people's access to services and emergency relief, urban labor opportunities, and connectivity with family—all vital elements of resilience to climate change.

Two main strategies can be adopted regarding transport infrastructure development: either transport corridor development strategy or rural feeder strategy depending on intended impacts.[49] As a leading example, the AfDB has led the construction of 17 cross-border road corridors impacting agriculture in Africa from 2004 to 2018, such as the completed Nacala Road Corridor Phase I and II. These add up to to 12,700km of roads affecting 239 million people across the continent.[50] Transport corridors have more benefits for larger farms. When chosen as an adaptation strategy, road-building needs to be augmented with rural feeder roads and storage facilities to benefit small-scale farmers, fishers and livestock keepers.[51]

Reduce and manage food loss and waste. About 36 percent of the food produced in Sub-Saharan Africa is lost or wasted, and the largest proportion of the losses occur at the production and handling stages.[52] There is much variation across different food types (Figure 4), but in general the most nutrient-rich foods, such as fruits, vegetables, dairy, meats, fish and seafood are often highly perishable, making them disproportionately susceptible to food loss and waste.[53] Helpful interventions to manage food loss and waste include biological controls, storage infrastructure, management and information systems, and diversification of value addition and byproduct use. For example, Aflasafe® products, which are natural biocontrol agents, drastically reduce aflatoxins in crops, reduce post-harvest crop losses and, in turn raise farmers' incomes, delivering tangible and positive impacts for food security and livelihoods throughout Sub-Saharan Africa.[54] Strategies to reduce food loss and waste (FLW) need to be context-based for different countries and value chains, and to be clear on the different roles of public and private sectors. Working with the midstream of the food value chain—the processors, packers, transporters and wholesalers—to counter these losses and wastages is a valuable adaptation mechanism with potential in Africa.[55] Subsidies can be useful to support initial capital outlays.


Photo: africa924/Shutterstock

Figure 4: Food loss and waste hotspots along the value chain in Rwanda (loss percentages occur at each stage)



Source: World Bank Food Smart Country Diagnostic, Rwanda, 2020

Create demand for affordable healthy low-carbon diets. In general, solutions have framed adaptation and resilience for African food security in the light of supply and neglected the demand-pull aspect of the food system. For both nutrition and sustainability reasons, Africa needs to accelerate its transition towards diets that meet people's health and cultural needs, and are widely accessible and affordable, while also remaining within global environmental boundaries.[56] At present, the average African diet is low in emissions by global standards, but also falls short of national and global dietary guidelines for macro- and micro-nutrients.[57] Thus there is ecological space in Africa for more emissions-intense consumption patterns, for example greater consumption of animal products among low-income households and more diverse diets in all income brackets, but without overshooting dietary health recommendations, which are generally well aligned with environmental criteria.[58]

An increasing number of African countries, including Burundi, Central African Republic, Chad and Egypt, now have multi-sectoral strategies to decrease non-communicable diseases, which include action on healthy diets. There are many opportunities in African food environments to channel the demand that aids climate adaptation and resilience, beginning with building strong markets that deliver a diversity of more nutritious food products to local and urban markets. Components of successful demand creation include motivating consumers to take action, convening food businesses to be proactive ahead of regulation, and enacting enabling policies.[59] An array of regulatory options can help governments to drive demand for healthy food, including regulation of: trade in goods and services, Foreign Direct Investment, food health/nutrition claims, food composition standards for processed foods, food marketing, and procurement and provision in public institutions, particularly schools.[60] Consumer tax mechanisms are commonly thought to be appropriate only in high-income settings, but, in 2018, South Africa introduced Africa's first major tax on sugar-sweetened beverages based on grams of sugar. This health promotion levy coincided with large reductions in purchases of taxable beverages, in both volume and sugar quantities.[61]

Link small-scale producers to value chains. The midstream of the food value chain is the closest the market gets to the farmer—the traders, truckers and processors that connect farmers with retailers. There has been rapid growth and abundance of SMEs in the midstream of the output value chains, constituting a 'hidden middle'.[62] Wholesale, logistics, and processing SMEs in the aggregate are the most prominent investors (making up the lion's share of the private sector's volume) in creating markets for farmers in Africa today. About 80 percent of the midstream of the value chains are SMEs, and they are the motors of the value chain transformation and rural employment off-farm. For instance, input value chains, such as for improved seeds and fertilizers, have moved from being controlled by the public sector (and with private sector agents primarily involved in the 'last mile' of input delivery) to a supply system of both governmental and private sector providers. In Nigeria, the trader segment of the maize supply chain exemplifies the impact of the hidden middle. Though not yet modern with an extreme concentration of large firms, it is no longer traditional. The maize supply chain is run by dynamic small and medium-scale traders supported by a third-party logistics market for trucking and warehousing. This vibrant logistics market covers 85 percent of the maize volume sourced by traders from the northern maize basket, linking it to about 80 percent of the southern traders who buy maize from the north.[63]


Photo: Madalin Olariu/Shutterstock

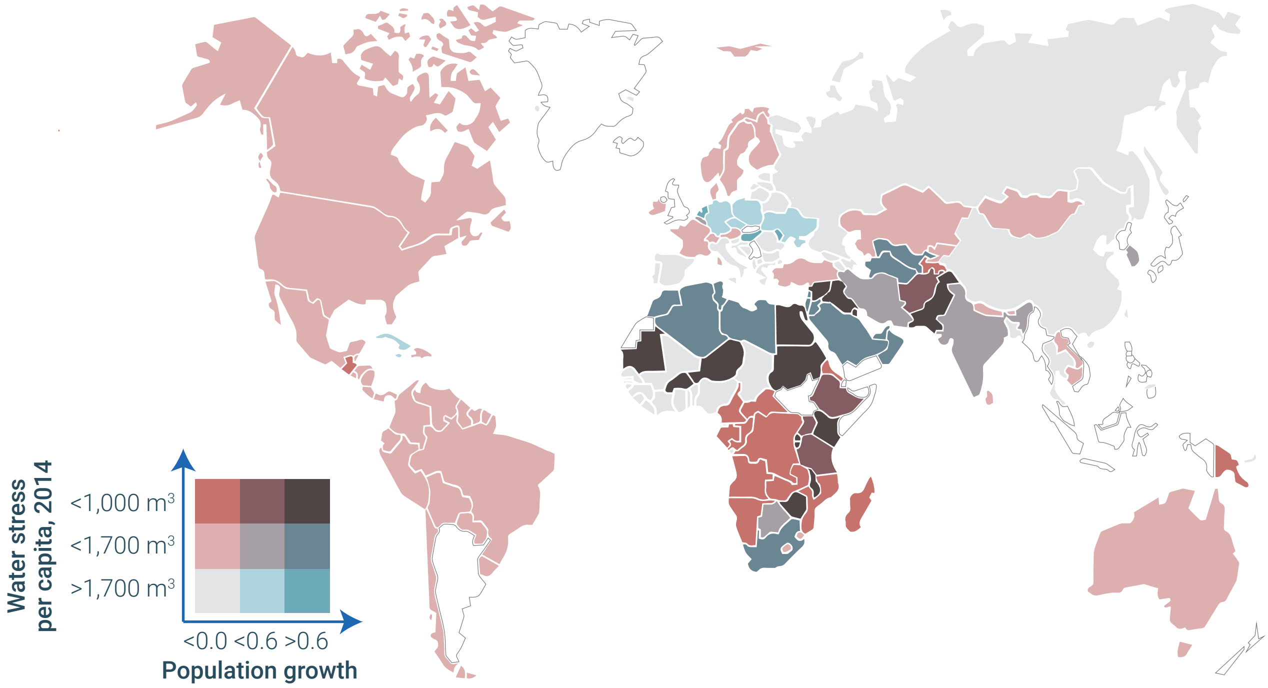
On-farm and productive landscape solutions

Climate-smart agriculture (CSA) interventions increase productivity, adjust farming systems to perceived or projected climate change impacts, and reduce or remove (where possible) GHG emissions. The climate-smart approach does not advocate specific measures or interventions for widespread application. Instead, it seeks packages of measures tailored to local conditions that improve the basket of choices for producers and consumers faced with increasing challenges to meet household and national food security needs under climate change. Climate-smart solutions can extend from the farm to the broader value chain and encompass productive land and water systems beyond the farm.

Improve sustainable water management at both farm and catchment levels. Agriculture accounts for the highest percentage of total water withdrawal in Africa, up to 81 percent. Water management is one of the key priorities for adaptation in Africa and a fundamental element in the goal of achieving sustainable food systems and zero hunger.[64] Persistent and severe droughts, aggravated by climate change, are causing increasingly severe water shortages in Africa's farming systems, which are predominantly rainfed and under small-scale management, threatening rural livelihoods. Water supply is also affected by poor water management, a growing population, and degradation of watersheds, among other factors, creating cascading effects on food and nutrition security and health. Across North Africa, economic losses of 6 percent to 14 percent of GDP are expected by 2050 due to climate-related water scarcity.[65] In Sub-Saharan Africa, where rainfed agriculture accounts for 95 percent of the region's farmed land, more than 1.1 billion people are at risk due to water constraints. With populations rising and climate change, water-related stresses will mount.

Many regions that are likely to see the highest rates of population growth by 2050—including Sub-Saharan Africa, with yearly population growth rates at 2.7 percent—are already the most water-stressed and impoverished and will endure even greater water deficits (Figure 5). Projections suggest that by 2050, global demand for water will increase by 30–50 percent, driven by population growth, rising consumption, urbanization, and energy needs. Even the most optimistic climate change trajectory (1.5°C) will put severe pressure on water resources for Africa's food system.

Figure 5: Per capita water availability and future population growth, 2050



Sources: Freshwater availability data: FAO AQUASTAT database. Population gowth estimates: United Nations Population Division, World Population Prospects, 2015 revision (moderate scenario), for the year 2050.

Measures to improve water security under climate change in Africa suitable for different spatial scales (farm, catchment, basin, see Table 2) and farming systems (from fully rainfed to fully irrigated) include water conservation, water harvesting, supplemental irrigation, ground water irrigation, surface water irrigation, and drainage, among others.

The Malabo Declaration of 2014 identifies irrigation as a priority investment to end hunger by 2025 in Africa. However, its potential for increasing farm yields and income and reducing risks from climate variability is currently untapped. Only three percent of the cropland in Sub-Saharan Africa is irrigated or equipped for irrigation, and many irrigation schemes suffer from water wastage.[66] Irrigation infrastructure could be expanded to up to 38 million hectares compared to the current 7.7 million.[67] Best practices for irrigated agriculture include increasing water-use efficiency in conveying and distributing irrigation water in the field; deficit irrigation, which involves optimal water use by spreading limited irrigation water over a larger area; supplemental irrigation to provide additional soil moisture during periods of water deficits and at critical plant growth stages; and water harvesting and improved water storage

Photo: boezie/iStock

for irrigation during times of surplus.[68] While there are many barriers to expanding irrigation across the continent—including investment costs for more sophisticated equipment, access to capital, and land tenure regimes—small-scale irrigation systems have expanded recently. Burkina Faso, Ghana, Tanzania, and Zambia provide notable examples of farmer-led initiatives that have helped increase yields and address risks at lower costs.[69]

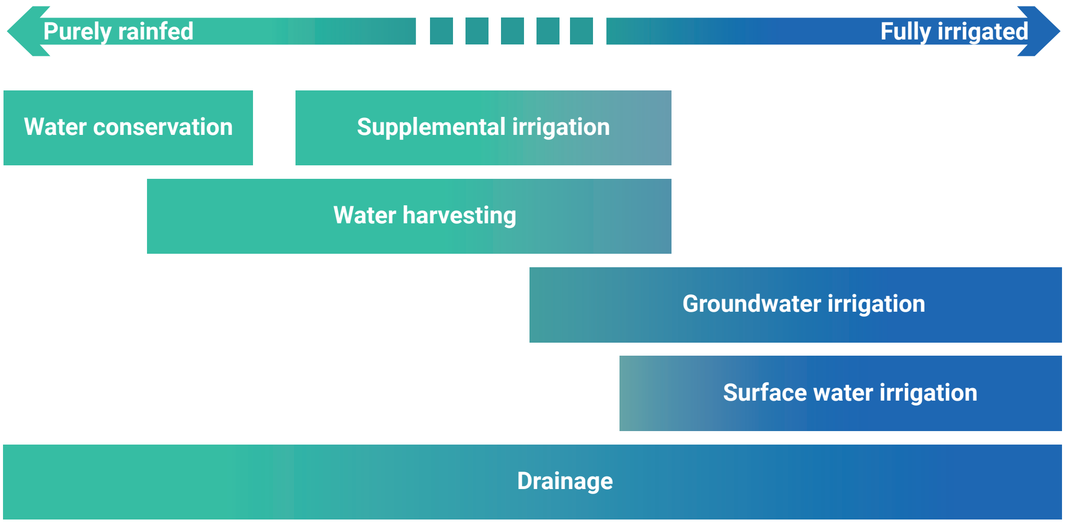
Table 2: Agricultural water management technologies at different spatial scales

Scale	Water source	Water control	Water lifting	Conveyance	Application	Drainage & reuse
Smallholder farm-level	**Rain water**	• In situ water • Farm ponds • Rain Column Green Wall • Cistern and underground ponds • Roof water harvesting • Recession agriculture	• Treadle pumps • Water cans	• Drum • Channels • Pipes	• Flooding • Direct application • Drip	• Drainage of water logging • Surface drainage channels • Recharge wells
	Surface water	• Spate and flooding • Diversion • Pumping	• Micro pumps (petrol, diesel) • Motorized pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Drainage of water logging
	Ground water	• Spring protection • Hand dug wells • Shallow wells	• Gravity • Treadle pumps • Micro pumps (petrol, diesel) • Hand pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Drainage of water logging • Recharge wells
Community or catchment	**Rain water**	• Soil water conservation • Communal ponds • Recession agriculture • Sub-surface dams	• Treadle pumps • Water cans	• Drum • Channels • Pipes	• Flooding • Direct application • Drip	• Drainage of water logging • Surface drainage channels
	Surface water	• Spate and flooding • Wetland • Diversion • Pumping • Micro dams	• Micro pumps (petrol, diesel) • Motorized pumps • Gravity	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels
	Ground water	• Spring protection • Hand dug wells • Shallow wells • Deep wells	• Gravity • Treadle pumps • Micro pumps (petrold, diesel) • Hand pumps • Motorized pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Recharge wells and galleries
Sub-basin, Basin	**Surface water**	• Large dams	• Gravity • Large scale motorized pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Drainage re-use

Source: UNECA (2011)


Photo: SilvaPinto1985/iStock

Figure 6: Agricultural water management along the spectrum from rainfed to irrigated



Source: FAO (2020)

Notes: Predominantly green boxes include water management practices by farmers reliant on rainfall but who may still apply some form of irrigation. Predominantly blue boxes refer to irrigation by farmers in purely irrigated settings, or farmers in rainfed areas with some access to irrigation.

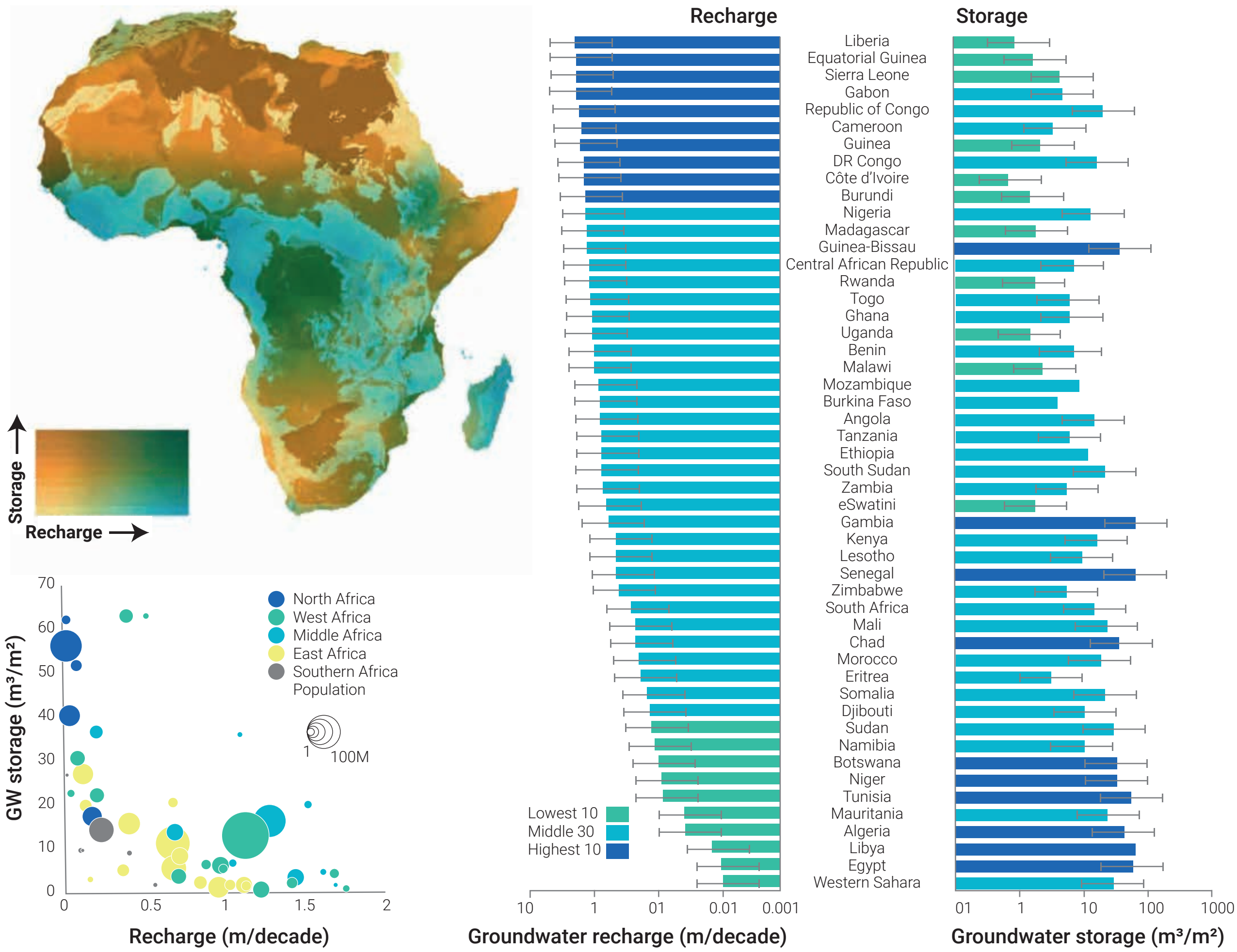
Africa's arid and semi-arid regions, as well as areas with limited water storage infrastructure, will benefit greatly from increased investment in water storage, which represents a key element for the continent's agenda on agriculture adaptation to climate change.[70] Techniques include storing groundwater during the rainy season, harvesting rainwater, and storing water in the ground through soil moisture conservation. These measures can be combined with more conventional surface storage systems for buffering variability, such as small farm ponds and large reservoirs. Effective agricultural adaptation also requires appropriate groundwater management measures in line with the storage versus recharge properties of aquifers.

At both 1.5°C and 3°C trajectories, impacts on net water availability will be concentrated in the northern and southern parts of Africa that are already the most arid: in the south, Botswana, Namibia, South Africa and Zimbabwe, and across the Mediterranean coast of Africa.[71] North African countries that receive little rainfall, including Algeria, Egypt, and Libya, have considerable groundwater storage but extremely low recharge rates, which makes them susceptible to long-term depletion of groundwater resources.

Countries with smaller groundwater storage capacity but heavier rainfall and a more reliable recharge rate such as Burundi, Côte d'Ivoire, and Liberia are more vulnerable to drought but more resilient to long-term depletion.[72]

Five countries in Africa are considered more water-secure than other countries on the continent, due to their groundwater storage and recharge rates that remain above the African average: Angola, the Democratic Republic of the Congo, Guinea-Bissau, Nigeria, and the Republic of the Congo. Net water availability in these countries is not expected to be heavily impacted by climate change, but heavy rainfall events and floods are likely to increase.[73] On the other end of the spectrum, countries like Eritrea, Eswatini, Lesotho, Zambia, and Zimbabwe are highly vulnerable to short-term climate hazards and long-term water resource depletion along both the 1.5°C and the 3°C scenarios, given their storage and recharge rates are below the African average. These countries require additional investments in monitoring and developing their groundwater resources (Figure 7).[74]

Figure 7: Storage and recharge rates of Africa's aquifers



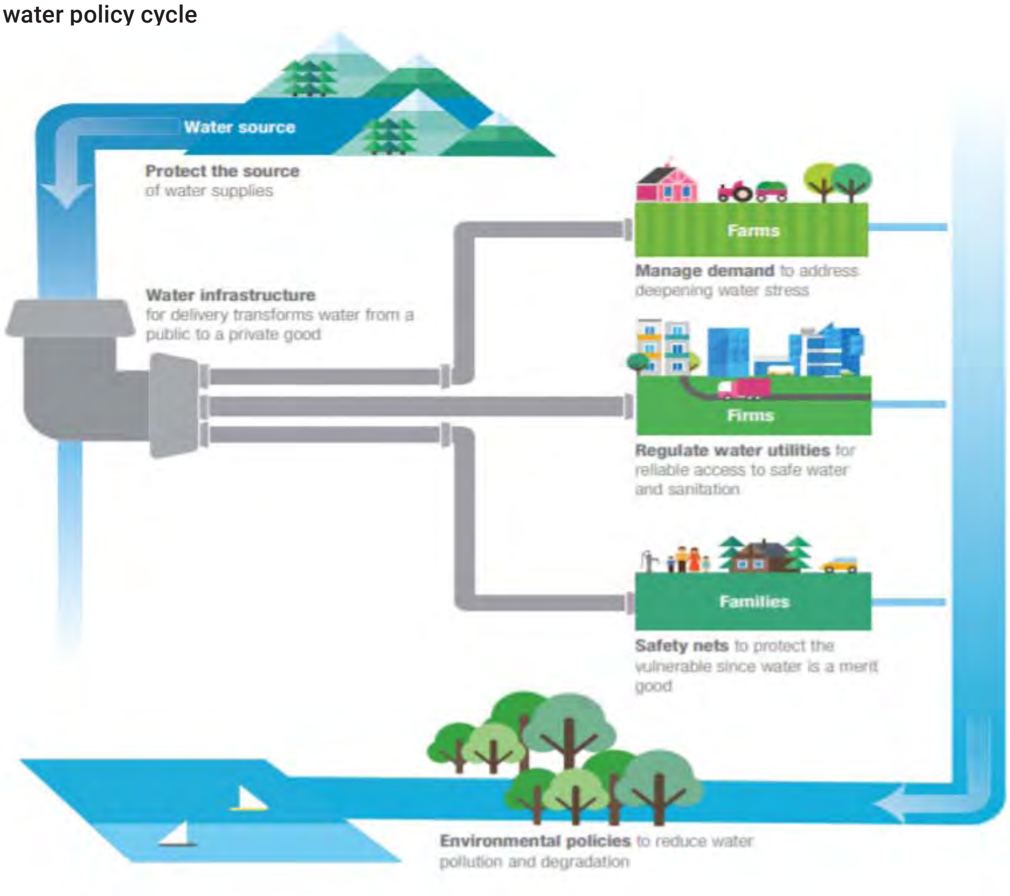
Source: MacDonald et al. (2021)

Nature-based solutions are fundamental to climate adaptation strategies in the agriculture sector, for purposes of water management as well as additional benefits such as biodiversity. Mangroves protect shorelines from storms, lakes store large water supplies, and floodplains absorb excess water runoff. While engineered innovative infrastructure and practices—such as precise application of irrigation water or measurement of plant moisture content using sensors—can contribute to water efficiency, working with natural infrastructure can optimize the performance and financial returns of engineered infrastructure.[75] If combined, nature-based solutions and engineered options can maximize ecosystem services such as clean water supply, soil and slope stability, air quality control, water storage, soil fertility and nutrient recycling, recreation and tourism, energy, biodiversity protection, water purification, food provision, groundwater recharge, flood control and disaster control. Mangrove restoration projects are ongoing in Kenya, Tanzania, Mozambique, Madagascar, Mauritius and Seychelles.[76]

Water security cannot be achieved by focusing on one single solution or by taking action in one sector only. Water is a fundamental input into all activities of the food system—from production, to processing, transportation, and distribution, to consumption—and engages different sectors across the chain: agriculture, energy, infrastructure, transport and trade. A warmer world, even under a 1.5°C scenario, calls for urgent collaboration and improved policy coherence and coordination across sectors, agriculture sub-sectors, and scales (Figure 8). Water management initiatives in one sector can have beneficial spillover effects on others by increasing the availability of water supply in the system. For example, wastewater recycling in urban areas or desalinization of water for the manufacturing sector may allow relocation of some of the water resources to other sectors of the economy, including agriculture. Sectoral collaboration also involves policy coherence, ensuring that initiatives in one sector do not create perverse effects on others, such as the case of subsidies or removal of trade barriers for water-intensive crops.

Similarly, policies and incentives need to complement investments in infrastructure and nature-based solutions to build long-term resilience, to ensure equitable access for the most vulnerable, and to address trade-offs in water system objectives. Water prices and quotas are essential for managing an increasing demand and for ensuring effective allocation of water resources across sectors. For vulnerable farming populations, weather risk insurance can provide a buffer against shocks and diminish long-term effects on livelihoods.[77] Policies that go beyond the agriculture sector, such as improving access to water for sanitation, are equally important.

Figure 8: The water policy cycle

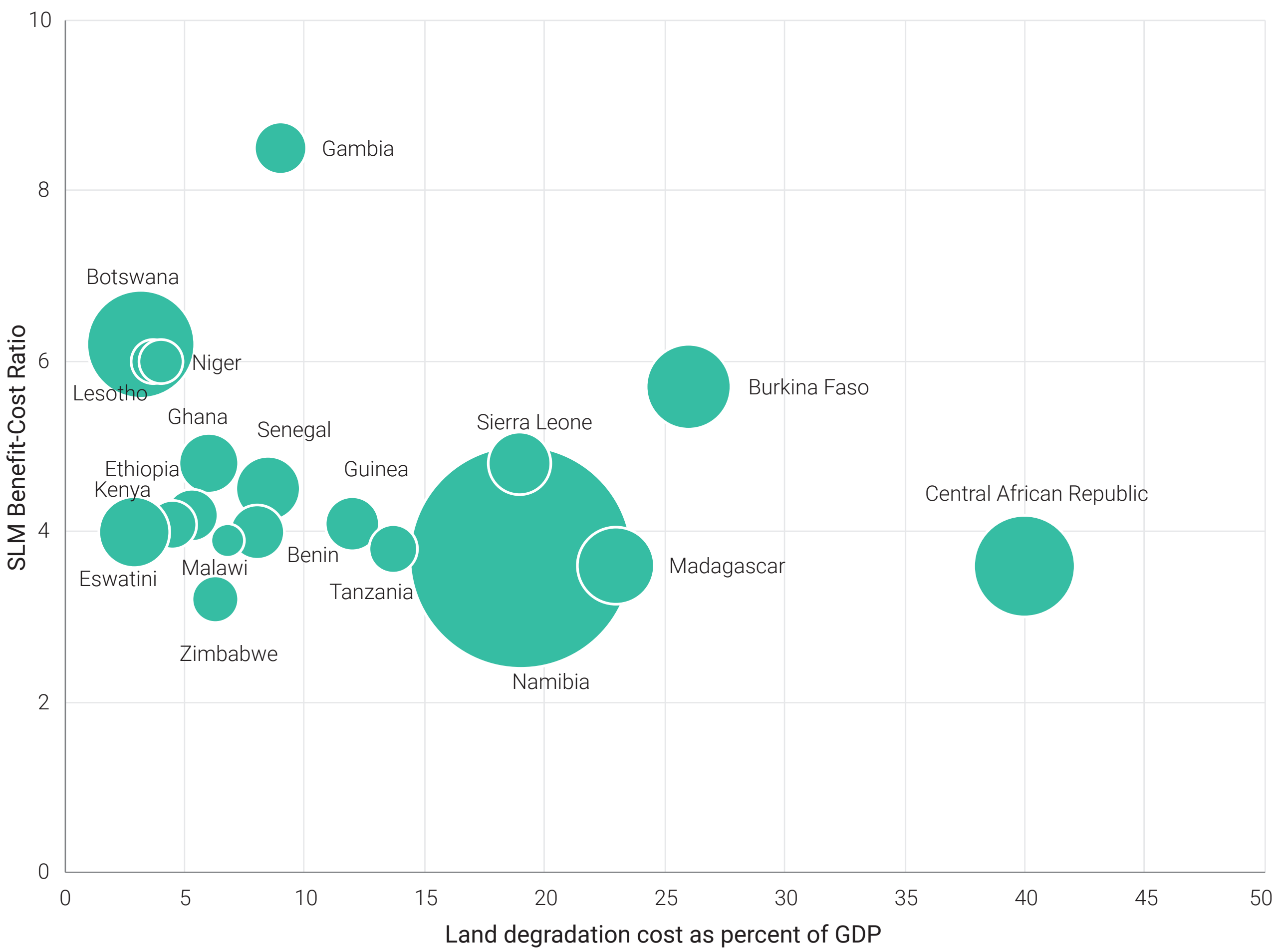


Source: World Bank (2017)

Restore degraded landscapes and practice sustainable land management. Land degradation interacting with climate change represents one of Africa's biggest and most urgent challenges. Land degradation costs about US$ 108 per person each year, or an average annual 12 percent GDP loss for 19 countries in Africa (Figure 9), through the loss of land's productive capacity due to a combination of human-induced factors such as soil erosion, acidification, nutrient leaching, and compaction. Land degradation reduces the effectiveness of adaptation options, yet these interactions have largely been omitted from adaptation planning.[78] Small-scale farmers suffer the most because poor soil conditions, climate and weather variability, land tenure insecurity, and limited access to markets pressure them to make short-term trade-offs that compromise long-term gains. Land degradation reduces options to meet both food demands and environmental needs sustainably. Agriculture is a dominant sector driving land degradation, forcing further global warming through the emission of greenhouse gases and reduced rates of carbon re-uptake and storage.

Land management options for climate adaptation include increasing soil organic matter, no-till farming, perennial crops, erosion control, dietary change, forest protection, sustainable forest management, controlled grazing, rangeland management, clean cooking, fuel and fire management, peatland restoration, regulating the management and conversion of peat soils, coastal restoration, mangrove conservation, long-term land use planning, vegetation management, afforestation and grazing land management.[79] For example, the African Forest Landscape Restoration Initiative (AFR100) is a global effort to restore 100 million hectares of degraded and deforested land in Africa by 2030. To date, 31 countries have made commitments to restoring country landscapes.

Figure 9: Relationship between land degradation cost as percent of GDP and benefit cost ratio of sustainable land management (SLM)



Source: Produced from data from Global Mechanism of the UNCCD (2018) and Nkonya et al. (2016)
Note: The width of the bubbles represents the annual cost of land degradation per capita

Scale up context-specific climate-smart soil management. Sustainable land management (afforestation, reforestation, agroforestry, and rangeland management) can help reduce the negative impacts of multiple stressors, including climate change, on ecosystems and societies. It can also contribute to mitigation and adaptation. Reducing and reversing land degradation, at scales from individual farms to entire watersheds, can provide cost-effective, immediate, and long-term benefits to communities and support several Sustainable Development Goals (SDGs) with co-benefits for adaptation and mitigation. Sustainable crop, grazing and forest systems can isolate substantial amounts of carbon from the atmosphere and store it in soils and vegetation. Sustainable soil and land management initiatives that build up soil organic matter can deliver co-benefits at all levels by contributing to climate change mitigation while maintaining soil-supported ecosystem services, thereby increasing agricultural ecosystems' resilience to climate change and other stressors. Specific technologies such as zaï, half-moons and stone bunds, when combined with an application of organic and inorganic nutrients, are promising climate-smart agricultural practices that small-scale farmers could practice widely.[80]

The Ethiopian government has spurred soil management with the extensive soil mapping under the EthioSIS[81] initiative. This has involved over 100,000 soil samples, machine learning to examine the full range of management options, and initiating public and private sector relationships to bring needed interventions to farmers. Other countries such as South Africa, Nigeria, Tanzania, and Ghana are also generating soil maps.

Improve livestock management. Livestock systems are impacted by climate change, both through direct impacts related to heat and through an array of indirect impacts on forage quantity and quality, water availability and disease spread. The main adaptation options available for different livestock systems are managerial, technical, behavioral and policy-related options. Managerial options include production adjustments and changes in labor allocation.[82] Examples of production adjustments include intensification, integration with crops, shifting from grazing to browsing species, multi-species herds, mobility, soil and nutrient management, water management, pasture management, corralling, feed and food storage, farm diversification and cooling systems. Examples of changes in labor allocation include diversifying livelihoods, shifting to irrigated farming, and labor flexibility. Technological options include breeding strategies and information technology research. Behavioral options include cultural patterns and encouraging social collaboration and reciprocity, such as livestock loans, communal planning, food exchanges, and information sharing.[83]

Locally adapted livestock species are an example of improving livestock for climate change, as disease risks, water availability and pasture quality change. For example, N'dama and West African Shorthorn goats have been bred to survive trypanosomiasis without drugs.[84] Samburu and Turkana Pastoralists in northern Kenya are increasing camel numbers to have more drought-resilient livestock. During drought periods, for example, pastoralists may shift from cattle to sheep and goat husbandry, as their feed requirements are lower, feeding habitats broader and reproduction rates higher. Taking up livestock production, usually poultry, or novel livestock such as cane rats and snails is an expanding adaptation practice in Africa.[85]

Monitor and manage new trends in pests and diseases. The ranges, intensity and frequency of pest and disease outbreaks are all likely to shift under climate change. Key adaptation options include climate and pest monitoring to predict and respond rapidly to emerging and existing pests, and pest prevention measures to discourage the establishment and development of pest populations. To support these direct measures, agroecosystem management can be applied to support ecosystem services and enhance the resilience of farms and landscapes to changes in climate and pest pressures.[86] Applying pest and disease models to analyze and predict yield losses is still challenging for the scientific community. The World Bank is funding the Regional Disease Surveillance Systems Enhancement (REDISSE) project to strengthen weak human health, animal health, and disaster response systems to improve the preparedness to handle future epidemics and minimize the national, regional, and potentially global effects of such disease outbreaks. It currently involves 16 West and Central African countries.[87] Another monitoring service is the Pest Risk Information Service (PRISE), currently being deployed in Ghana, Kenya and Zambia. The PRISE uses a novel combination of earth observation technology, real-time field observations, and plant-pest lifecycle to deliver a science-based pest risk information.

Promote diversification of crops and livestock. On-farm diversification is a promising strategy for farmers to adapt to climate change. Diversification can enhance biodiversity, pollination, pest control, nutrient cycling, soil fertility, and water regulation without compromising crop yields. Crop diversification may be spatial (simultaneous cultivation of species) and temporal (crop rotation).[88] Practices with proven adaptation functions include alternating cereal crops with legumes and broadleaf crops, introducing cover crops, and introducing poultry and small farm animals. Variability in responses and occurrence of trade-offs highlight the context-dependency of outcomes.[89]

Use climate-ready species, cultivars, and breeds. Recent breeding work has enabled several crops and animals to become better adapted to African climate risks, such as Drought Tolerant Maize for Africa (DTMA) varieties, heat-tolerant beans, and fat and thin-tailed ovines. Ten million small-scale farmers have benefitted from DTMA species resulting in increased yield and incomes. The use of adapted crops and varieties helps to reduce the negative impacts of climate change on agricultural systems while leading to stable agricultural production. Small-scale producers adopt climate-resilient crops and varieties to cope with abiotic stresses such as drought, heat, flooding and salinity. To maximize adoption, influencing factors such as availability and effectiveness of extension services, followed by education levels of heads of households, farmers' access to inputs and socioeconomic status of farming families, need to be dealt with.[90]

Incorporate perennial crops, including agroforestry. Trees outside forests substantively contribute to livelihood improvement while also enhancing biomass and carbon stocks. Agroforestry's resource management is proven to benefit livelihood benefits in provisioning, regulating, and supporting ecosystem services. Trees on arable land can support carbon sinks, contributing to adaptation and mitigation through carbon sequestration.[91] Agroforestry for climate adaptation at the farm level and enhanced resilience at the landscape level can take many forms. Agroforestry can reduce air pollution[92] and improve the atmosphere's warming and cooling, thus creating a more stable microclimate for crops and livestock. It also enhances water security through improved infiltration to soils and groundwater, protecting water catchments and watersheds.[93] The potential to improve soil properties and water availability to plants also make agroforestry practices suitable for landscape restoration. Moreover, trees provide several ecosystem services such as water regulation, climate buffering, soil fertility, erosion and flood control, food, fodder, medicine and wood. These are all important for resilience to climate change and reduced vulnerability of local people.[94] For instance, Côte d'Ivoire has committed to restoring forest cover to at least 20 percent of land area by 2030, and mixed cocoa agroforestry systems are a core component of the national strategy.


Photo: subman/iStock

FINANCING ADAPTATION OF AFRICA'S FOOD SYSTEMS TO CLIMATE CHANGE

Cost of action

Appropriate investments in the agriculture sector can help the food systems adapt by increasing productivity, resilience, and resource-use efficiency.

To generate the evidence base for policymakers, Sulser et al. (2021) assessed the cost of adaptation to climate change across a range of future climate scenarios and investment options (Table 3).

Table 3: Description of scenarios in the IMPACT model

Reference	With no climate change (NoCC; constant 2005 climate with various Shared Socioeconomic Pathways (SSPs))
	With climate change (CC; combinations of SSPs and Representative Concentration Pathways (RCPs) across a range of General Circulation Models (GCMs))
Agricultural R&D	Increased reserach and development (R&D) investment across the CGIAR portfolio plus faster and more eficient adoption of new technologies
Water Management	Expansion of irrigated area coupled with increased water use efficiency
	Improved soil water-holding capacity
Infrastructure	Infrastructure improvements to improve market efficiency through the reduction of transportation costs and marketing margins (rail, road, port, and electrification)

Source: Sulser et al. (2021).

Notes: The no climate change scenario is defined by Shared Socioeconomic Pathway 2 (SSP2), while the reference with climate change scenario is defined by the combination of SSP2 with RCP8.5 via the UK Met Office Hadley Centre Earth System Model (HGEM) General Circulation Model. Detailed descriptions of RCPs, GCMs, and SSPs are available from Moss et al. (2010), O'Neill et al. (2017), and Navarro-Racines et al. (2020)[95]

The assessment linking climate, crop, water, and economic models showed that climate change would slow progress toward eliminating hunger. An additional 78 million people are facing chronic hunger in 2050 relative to a no-climate-change future. More than half of the additional food-insecure people will be in Sub-Saharan Africa. The adaptation costs for Sub-Saharan Africa include annual public investments that already address resilience needs: that is, the reference scenario ($5.90 billion) and annual incremental investment costs ($9.58 billion) to offset climate change effects on hunger between 2015–2050 (Table 4).

The estimated cost of sustainable land management (Table 4) builds on an AFR100 initiative that seeks to restore 100 million of degraded land in Africa by 2030. For this report we raised the ambition to 175 million hectares of degraded land by 2050. At land restoration costs ranging from $500 per hectare for woodland to $5,000 per hectare for wetland, land restoration costs by 2050 were estimated at $187.21 billion or $6.24 billion per year for Sub-Saharan Africa. The estimated cost of Climate Information Services builds on a recent assessment on modernizing hydrometeorological services and early warning systems in Africa. Water investments (efficient irrigation systems, enhanced water use efficiency, and improved soil water holding capacity) dominate the reference scenario (59 percent) followed by agricultural research and extension to facilitate the adoption of climate-smart technologies (38 percent) and rural infrastructure to improve market access through the reduction of transportation costs and marketing margins such as rail, road, port, and electrification (3 percent). Additional investments to adapt to climate change impacts are dominated by sustainable land management (35 percent) followed by water (27 percent), infrastructure (20 percent), agricultural research (17 percent), and CIS (less than 1 percent). R&D-led adaptation is most effective in minimizing the impact of climate change on the food system,[96] delivering gains in food security by mitigating food price increases and enhancing environmental sustainability by slowing cropland expansion.

Table 4: Annual reference scenario and incremental investment costs for agricultural adaptation for Sub-Saharan Africa by 2050 ($ billion)

Scenarios	Research and extension		Water management		Infrastructure and market access	Sustainable land management	Climate information services	Total
	International agricultural research	National agricultural research	Efficient irrigation and increased water use efficiency	Improved soil water holding capacity				
Reference scenario ($billion)	1.11	1.11	3.11	0.39	0.18	-	-	5.90
Incremental costs ($billion)	1.66	-	1.42	1.20	1.90	3.35	0.053	9.58
Total	**2.77**	**1.11**	**4.53**	**1.59**	**2.08**	**3.35**	**0.053**	**15.48**

Sources: Sulser et al. (2021); World Bank (2021), and others' calculations

Notes: Sustainable land management includes vegetative measures such as agroforestry, tree planting, and natural tree regeneration, and structural measures such as terracing, flood control, cross slope barriers and other erosion control measures; CIS = Climate information services, including hydrometeorological observation and ICT equipment, Early Warning Systems and Services, Institutions, Regulatory Framework, and Training. Infrastructure includes road, rail, and electricity that help in linking rural communities to markets.

Cost of inaction

Financing adaptation to climate change will be more cost-effective than frequent disaster relief. For Sub-Saharan Africa, our estimates based on a synthesis of existing studies (Table 5) indicate that the annual agricultural adaptation cost is $15 billion (0.93 percent percent of regional GDP), but the cost of inaction could be more than $201 billion (12 percent of GDP). Note that there can be significant regional variations in the cost of inaction. For instance, West and East Africa could lose up to about 15 percent and Southern Africa up to about 10 percent of their GDP by 2050 if adaptation measures are not taken.[97] Also the five adaptation measures considered in this report will require different periods for their impacts to be felt. Public agricultural research undertaken today will begin to noticeably influence agricultural productivity and resilience in as little as three years and its impact could be felt for as long as 25–30 years. The report also assumes advances in international agricultural research to combine tolerances to drought and heat stresses in breeding programs for Sub-Saharan Africa and to rapidly scale up the adoption of these technologies.

With available financial resources and an adequate enabling environment, it can take between six to eight years to fully implement the 175 million ha target for land restoration targets. Different measures require different number of years to deliver adaptation benefits. For instance, structural erosion control measures can be completed within 18 months; grasslands require two years to reach maturity for natural regeneration or planting; natural tree regeneration at least three years; and planted trees about four to six years. On the other hand, once the necessary equipment and other infrastructure have been installed, CIS can provide real-time, personally relevant information that farmers can use to adapt to climate change. Furthermore, ecosystem services from sustainable land management deliver both private and public benefits. Our assessment indicates that provisioning ecosystem services account for only 33 percent of the ecosystem services, while the remaining 67 percent are mostly global environmental benefits. The public good nature of the ecosystem services from sustainable land management provides a compelling case to scale up payment for ecosystem services in Africa.

Adaptation to climate change would also benefit other development areas, such as resilience to pandemics, and boost growth, reduce inequalities, and sustain macroeconomic stability.[98]

Table 5: Annual agricultural adaptation costs and costs of inaction ($ billion)

	Research and extension	Water management	Infrastructure and market access	Sustainable Land Management	Climate information services	Total
Cost of action ($ billion)	3.88	6.12	2.08	3.35	0.053	**15.48**
Cost of inaction ($ billion)	71.21	90.67	12.56	26.76	0.488	**201.69**
Cost of action as proportion of cost of inaction (%)	5.44	6.75	16.56	12.51	10.86	**7.67**

Source: Based on Nkonya et al. (2016); Alene et al (2010); Fenta et al. (2020); Fuglie (2018); Nin Pratt (2021) Venton et al. (2019); Ludwig et al., (2016); and various calculations. See the Annexe on Methodology for more details.

As part of the analysis undertaken for this chapter, we find that deciduous forest is estimated to generate the largest ecosystem services value of $293 billion followed by wetland ($240 billion), while the least comes from woodland ($95 billion). Regulating services (e.g., carbon sequestration) account for 48 percent of ecosystem services provided by forests followed by provisioning services (food production, genetic resources, etc.). Regulating services (regulation of water flows, waste treatment, erosion prevention, etc.) also dominate the ecosystem services generated by wetland (68 percent), followed by cultural services such as recreation (16 percent). Habitat services dominate the ecosystem services provided by woodland (80 percent), while provisioning services dominate the ecosystem services provided by cropland. Provisioning services account for only 33 percent of the ecosystem services, while the remaining 67 percent are mostly global environmental benefits that beneficiaries other than local land managers enjoy. This provides justification for designing payment for ecosystem services schemes to encourage sustainable land management practices.

Economic activity in a month can shrink by one percent when the average temperature is 0.5°C above normal. This impact is 60 percent larger than the average for emerging market and developing economies in other regions, reflecting Sub-Saharan Africa's agricultural dependence and the temperature sensitivity of its agricultural sector. Climate-induced natural disasters, especially droughts, have a long-lasting impact on agroecosystems and people depending on them, reflecting the prolonged nature of the disasters. For example, medium-term annual economic growth in Africa can decline by one percentage point with one additional drought. This impact is about eight times that in emerging markets and developing economies in other regions.

Challenges to economic growth are compounded by widening fiscal and current account deficits and corresponding pressures on public debt and international reserves after a natural disaster. Reduced economic activity translates into lower tax revenues, while spending needs accelerate with the demands of post-disaster relief and humanitarian support and rebuilding damaged infrastructure. Post-disaster foreign financial assistance or remittances seldom fully offset strains on external positions from reduced agricultural exports and increased imports for reconstruction. Financial system stability can also be affected by rapid increases in non-performing loans and deposit withdrawals for banks and deteriorated balance sheets for insurance companies. More broadly, assets stranded because of weather-related disasters could lower collateral values and hurt the stability of financial institutions.

“

I call on all global leaders to ensure adaptation finance and technology reach the small-scale farmers and rural communities.”

Gilbert F. Houngbo, President, International Fund for Agricultural Development

Photo: pixdeluxe/iStock

Financing opportunities

The agricultural financing gap in many African countries surpasses government budgets and available donor funding. The financing gap for climate adaptation is at risk of widening in the future due to fiscal drain on resources from the coronavirus pandemic. Low-income countries are especially hard-hit as they bear a disproportionate weight of climate disasters. At the same time, their fiscal space is more limited, their credit ratings more at risk, and their borrowing capacity more constrained.

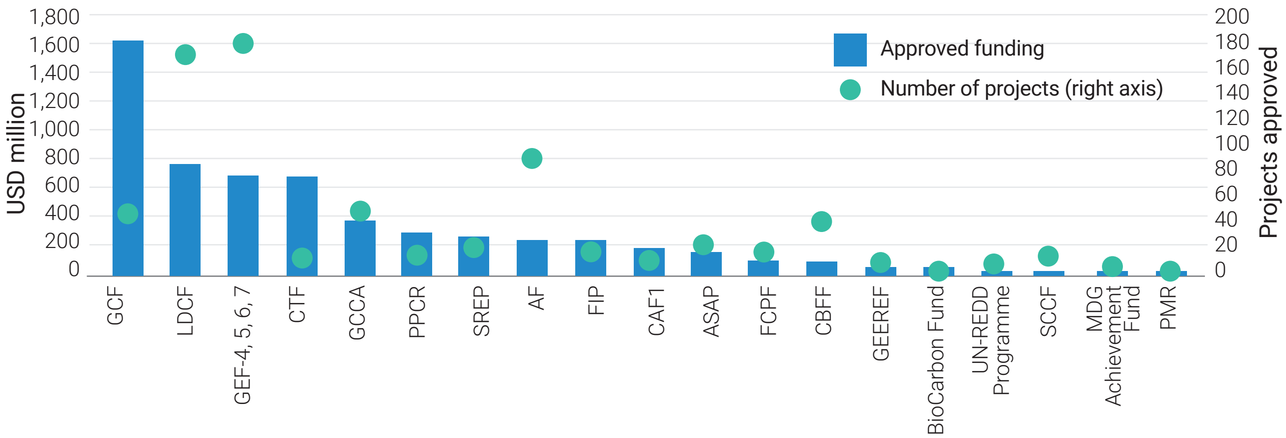
Globally, climate finance for agriculture, forestry, and land use totaled an average of $20 billion per year in 2017/2018, representing just 3 percent of the total global climate finance for the period.[99] On the other hand, climate finance targeting energy efficiency and renewable energy generation averaged $370 billion per year (about 64 percent), and low-emission transport received an average of $140 billion (24 percent) of the total climate finance tracked. Out of the total climate finance tracked, a total of $10 billion was channeled to bring benefits to small-scale agriculture actors, which is equivalent to only 1.7 percent of the total climate finance tracked.[100] Most commitments ($8.1 billion) consist of projects developed in the agricultural sector, forestry, land use, and other natural resource management.

Some 49 percent of the tracked small-scale agriculture climate finance was for climate adaptation projects, of which projects addressing both mitigation and adaptation objectives received 29 percent. In comparison, mitigation-only projects were targeted by 21 percent of the finance. The largest percentage directed towards adaptation is aligned with the increased vulnerability of small-scale agricultural actors to climate change. Low-carbon and climate-resilient infrastructure received the largest share of funding (36 percent), followed by investments to improve agricultural productivity and resilience at farm level and support for enhancing livelihood resilience of rural communities in general (each 14 percent).

Increasing financing for climate-smart agriculture requires addressing the set of market failures which hold back private investments. These include: (i) building technical and institutional capacity for the identification, appraisal and management of climate-smart agriculture investments; (ii) designing financing mechanisms which are operated on a commercial, transparent and sustainable basis and support the mobilization of additional commercial resources; and (iii) identifying and promoting climate-smart agricultural technologies that are commercially viable and deliver significant environmental benefits.

Between 2003 and 2020, multilateral climate funds investments to support low-carbon development and climate adaptation in Sub-Saharan Africa amounted to $5.9 billion. The largest sources of approved funding for adaptation projects are the Green Climate Fund (GCF), the Least Developed Countries Fund (LDCF) administered by the Global Environmental Facility (GEF), the Pilot Program for Climate Resilience (PPCR) of the World Bank's Climate Investment Funds (CIFs) and the Adaptation Fund (AF). Some 37 percent of the multilateral climate finance into Sub-Saharan Africa are adaptation flows, 33 percent support mitigation, 17 percent are multiple foci, and 13 percent support REDD+ [101] activities.[102]

Figure 10: Multilateral Climate Funds flow into Sub-Saharan Africa, 2003-2020

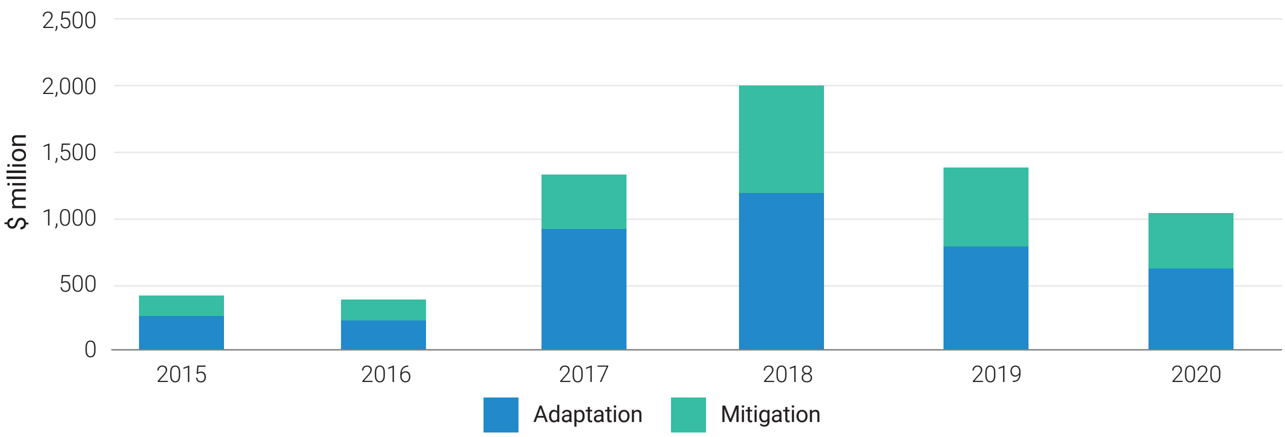


Source: Watson and Schalatek (2021)

For more than a decade, Multilateral Development Banks have been tracking climate finance flows in their operations across sectors through an agreed joint methodology for adaptation and mitigation. Figure 11 shows that climate finance flow to the agriculture sector in Sub-Saharan Africa increased from $433 million in 2015 to $2 billion in 2018 and then declined to just over $1 billion in 2020. Adaptation flows are consistently higher than mitigation flows, ranging from 58 percent in 2019 to 69 percent in 2017. This again reflects the priorities of African countries to address the agriculture sector's climate vulnerability and increase resilience. The increase in mitigation financing in the last four years suggest that countries are increasingly paying attention to the vast potential for African agriculture to reduce agricultural emissions through climate-smart practices. This is plausible as both adaptation and mitigation share the ultimate purpose of minimizing climate impacts.

Photo: Maria Schiffer/iStcck

Figure 11: Multilateral development banks' climate finance flow to agriculture and land use in Sub-Saharan Africa, 2015–2020 ($ million)



Source: Data compiled from the MDB joint reports on climate finance by African Development Bank (AfDB), the Asian Development Bank (ADB), the Asian Infrastructure Investment Bank (AIIB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank Group (IDBG), the Islamic Development Bank (IsDB) and the World Bank Group (WBG)

Maximizing finance will require a range of public policy actions including increasing the space for private sector activity, improving the policy and regulatory environment, and using public financing to help crowd-in private sector investments to optimize the use of scarce public resources.[103]

Significantly increasing the amount of capital available for climate-smart investments in agriculture is critical to achieving adaptation objectives. This will require designing new financing mechanisms and overcoming longstanding technical and institutional barriers. The critical barriers to closing the financing gap for agriculture include an inadequate enabling environment, limited capacity to manage production, marketing and price risks, and high transaction costs of lending to farmers.

Photo: Afrimages/iStock

Targeting finance to benefit small-scale producers

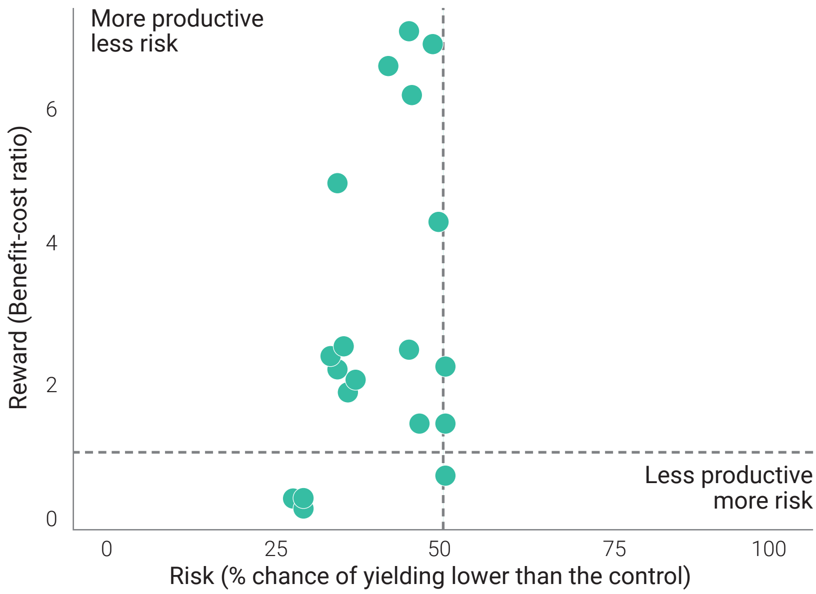
Small-scale producers—farmers, livestock keepers, fishers and small rural enterprises—are a key target for finance if Africa is to achieve sustained resilience to climate change. However, globally, small-scale agriculture continues to receive a low share (40 percent) of total climate finance for the Agriculture, Forestry and Other Land Use (AFOLU) sector. Between 2017 and 2018, Sub-Saharan Africa was the largest recipient of climate finance to small-scale producers, amounting to $3.6 billion, or 36 percent of the total climate finance committed worldwide to small-scale agricultural producers.[104]

The price tag for food system adaptation in Africa can make it easy to lose sight of the millions of financial decisions small-scale producers must make to transform agriculture. Evidence shows that adopting simple farming techniques—such as covering the soil with crop residues to conserve soil moisture,[105] planting trees to reduce ambient temperature,[106] among many others—may buffer against future climate hazards. But barriers to changing farming practices including costs and risks can be high, if not prohibitive, for many small-scale producers, as they need to invest new financial, knowledge, or human capital and the benefits are uncertain.[107]

Farmer investment in improved crop, soil, nutrient management, and agroforestry options reduce risk, helping farmers adapt. Yields are greater than business-as-usual for most options, though risks grow along with rewards (Figure 12). Nevertheless, the potential benefits typically far exceed costs, with expected returns up to seven times greater. Investments present an opportunity to capture benefits in relation to the level of risk incurred by the investment. Many resource-poor farmers may not be able to accept even the lowest level of risk, especially when the investment has an extended payback period or high upfront costs. Complementary strategies including insurance, credit, and access to weather information can further mitigate risk and catalyze changes in farming techniques, amplifying the adaptative capacity of small-scale producers.

Public sources of finance can be used to increase the flows of capital to small-scale food producers in Africa and de-risk investment in three main ways. The first is by developing an enabling environment that enhances farmers' access to tailored and demand-driven financial services. The second is by building the capacity of financial institutions to manage exposure to specific agricultural risks. The last is by supporting financial institutions in reducing transaction costs, for instance through branchless banking and mobile financial services. Better understanding of small-scale farmers' individual adaptation investment decisions, as described above, provides a critical foundation to increase and improve the flows of adaptation capital to them.

Figure 12: Potential trade-offs between rewards and risks for small-scale producers when investing in improved farming practices.



Note: Rewards were calculated as the benefit-cost ratio. Risk considers crop yields over time, given varying weather conditions, and represents the possibility of yielding lower than the average yield when not using the improved farming technique. Data were derived from farm budgets estimated during research trials in Kenya and Malawi and compiled as part of the Evidence for Resilient Agriculture (ERA) v1.0.[108]

POLICY RECOMMENDATIONS

To avert catastrophic impacts on food security, adaptation of agriculture and food systems is an imperative, not a choice, for African countries in this decade and in coming decades. All indications are that financing adaptation to climate change will be more cost-effective than financing increasingly frequent and severe crisis responses, disaster relief, and recovery pathways. For Sub-Saharan Africa, the cost of action works out to a tenth of the cost of inaction. Furthermore, there is tremendous synergy between adaptation actions and the development agendas enshrined in the Sustainable Development Goals and the Malabo Declaration of 2014.

Priority actions for African governments to enable adaptation of food systems encompass both policy interventions and public financial investments. For the policy interventions, the financial costs are relatively low, but political effort is needed. Key areas for attention are reduction in trade barriers, repurposing of existing agricultural subsidies, and addressing distortions that slow down adaptation, such as women's unequal legal access to productive assets. Other actions carry higher public sector investment costs, but deliver substantial benefits to adaptation, with compelling impacts on food security as well as co-benefits to climate mitigation.

"All the science is showing we are closer and closer and closer to a tipping point and so we have to find a way bring everybody together and agree to come on action. I am afraid I don't have a silver bullet idea for it. We just have to get it all done. We have to give equal weight to adaptation and mitigation, bring the developing and developed worldviews together to fight climate change. We have no choice."

Lee White, Minister of Forests, Oceans, Environment and Climate Change, Gabon
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Five key areas identified for such investment are: research and extension services, water management, climate-resilient infrastructure, sustainable land management, and climate information services. For all of these, there is a sound evidence base from which to build a business case for climate finance and private finance. There is also substantial practical experience to draw on for implementation, both from African contexts and globally.

In summary, climate adaptation of the agriculture and food systems is an urgent, impactful and achievable agenda for African countries.

Photo: Bartosz Hadyniak/iStock


Photo: WBG - Arbegona woreda land certification

Sustainable Land Management in Ethiopia

Geography: Ethiopia's highland regional states: Amhara, Oromia, Tigray, SNNP, Beneshangul/Gumuz, and Gambela.

Adaptation measures: This series of investment projects, and most recently, a results-based financing program, have been building resilience and addressing land degradation by establishing community and kebele[109]-level watershed management teams, developing and implementing participatory watershed management plans and building local capacity in sustainable land management (SLM). Investments to support the implementation of participatory watershed management plans include those for introducing and expanding climate-smart agriculture, grazing ex-closures to allow regeneration of vegetation on steep slopes, biophysical soil and water conservation measures – such as terracing, afforestation and participatory forest management, treatment of erosion gullies, small-scale irrigation and water harvesting systems. These investments are complemented by activities that help sustain these practices whilst also diversifying livelihoods, developing value chains for key crops and improving fodder supply and quality. The program also provides support for land titling and land registration in woredas to improve land tenure security and to incentivize farmer-level investment in sustainable land management practices. The CALM program takes these investments to transformative scale, by providing results-based financing in support of expanding the number of major watersheds under participatory watershed planning and management and for land certification and the establishment of woreda-level land registries.

Key outcomes: Targeting land degradation: Vegetation cover in the project area increased by 9 percent (as measured with remote sensing data) and soil carbon by 0.3 percent in the 2009–2013 period,[110] indicating a reduction in land degradation as a result of SLM practices. Although the extent of yield increases was not measured directly as part of the project, SLM has made measurable contributions with regards to reducing soil erosion and runoff, which has enabled farmers to get better return on their investments in productivity enhancements. (e.g., fertilizer and improved seeds).[111] Early results from support for land titling show that farmers are willing to use land certificates as collateral for microfinance loans, therefore increasing investment in SLM practices and business development.

Partners and funding: SLMP 1 and SLMP 2 (US$29 million and US$102 million, respectively from International Development Association, Government of Ethiopia and GEF 2008–2018); RLLP (US$129 million from IDA, GoE, Canada and Norway) 2018-2024; RLLP 2 (US$178 million from GCF and PROGREEN). 2018–2024; CALM (US$500m from IDA) 2019-2024.

PROJECT SUMMARY

Mean temperatures in Ethiopia have been increasing by an average of 0.25°C per decade, while the number of hot nights and days increased by 37.5 percent and 20 percent respectively between 1960 and 2003.[112] The trend is expected to continue up to a 3.7°C increase in mean temperature and a 26–69 percent increase in the number of hot days by the end of the century under a high-emission scenario, increasing the intensity of heat-waves and evapotranspiration demand and driving droughts.[113]

While the country's climate features a large amount of inter-annual variability, end-of-century trend data indicate a 20 percent rainfall reduction (baseline 1986) in spring and summer in the central, northern and southern regions, leading to increased water stress.[114] Drought impacts over the last century (from 1900 to 2020) have led to more than 400,000 deaths and nearly 80 million people affected,[115] with economic losses amounting to US$1.5 billion.[116,117]

About 79 percent of Ethiopians live in rural areas that largely depend on agriculture, a sector responsible for 48 percent of the country's GDP and 85 percent of export earnings.[118] Agricultural production is dominated by rainfed small-scale farms, which are highly dependent on healthy soils, water, forests and biodiversity. All of these are currently threatened by the impacts of land degradation, which is affecting some 80 percent of the country, with 27 million ha significantly eroded and two million ha beyond reclamation.[119] Losses from land degradation currently are estimated to cost 2–3 percent of GDP.

Community-based watershed management is a country priority for scaling SLM practices, and recent efforts have focused on integrating landscape approaches and climate adaptation needs. This approach has been used in the two phases of the Sustainable Land Management Project (SLMP) and its successors, the Resilient Landscapes and Livelihood Projects (RLLP 1 and 2) which are both ongoing, and most recently, the Climate Action through Landscape Management (CALM) Program for Results. In total, around 250 'major' watersheds are being supported by ongoing investment projects, an additional 5,000 microwatersheds by the CALM program; and around 380 districts are receiving land administration support.

Lessons learned from previous SLM interventions across other countries in the Sahel and West Africa region have informed the programmatic approach to supporting the GoE's SLM Program. For instance, previous projects often lacked ownership among communities or failed to create incentives through early benefit flows, rendering them unsustainable or quickly reversed. The SLMP and RLLP projects promoted SLM supported by the issuance of landholding certificates to smallholders and institutional capacity development to enhance communities' participation and investments. So far, the investment projects (SLMP 1, 2 and RLLP) have led to the establishment of 980 community-level watershed user associations with 125 multiyear management plans for major watersheds currently under implementation. CSA and conservation measures are now being implemented over 400,000 ha within these major watersheds. Bylaws were developed and applied across 500 micro-watersheds to improve the governance of communal lands and over 700,000 land certificates have been issued to households, of which over 500,000 have been issued to women, either individually or jointly with a man. Over 20,000 land certificates have been issued to previously landless youth. Whilst the RLLP and RLLP 2 projects are ongoing, and will continue under

Photo: WBG - Ethiopia, Tigray region, Kola District. As part of the World Bank funded SLMP, the community planting local species of trees.

implementation until 2024, the CALM Program is scaling this support still further, aiming to bring 2.5 million ha under watershed management plans and sustainable land management practices by 2024. It also aims to put in place modern land registration systems in 280 woredas and support issuance of nearly 19 million land certificates.

Typical SLM interventions under these projects and programs include the construction of physical soil and water conservation infrastructure (e.g. stone terraces, soil bunds, check-dams and trenches); tree planting and area closures to rehabilitate degraded communal lands (hillsides and pastures jointly held by the community for grazing and other needs); and soil and water conservation, water harvesting, agroforestry and improved seeds and agronomic practices on individual farmlands (land held and cultivated privately by smallholder farmers).

These projects and programs also benefit and enhance the inclusion of landless families, youth and women through the introduction of small ruminant livestock, poultry and bees. The building of livelihood resilience was supported through integrated fodder planting or poultry/sheep/goat and through infrastructure improvements like building of roads/feeder roads. Tens of thousands of farmers have been trained on income generating activities and nearly 100,000 people now take part in income generation activities under support from RLLP alone. Over 900 'common interest groups' have been established to support income generation and other livelihood activities under SLMPs 1 and 2 and the RLLP. In the long term, these interventions are expected to increase diversification of livelihoods, improve resilience, reduce vulnerability to climate shocks and reduce greenhouse gas emissions.[120]

Households' vulnerability to climate shocks was evaluated based on changes in food and water security and out-migration, with about that two thirds of the participating households showing reduced vulnerability to droughts after the SLMP 2 project was completed. Improved food security was highest in areas suffering from severe land degradation, which also saw reduced out-migration, and in drought-prone areas, where small-scale irrigation was the key enabler for increased yields and reduced exposure to droughts. Commercial agroforestry and sustainable charcoal production, which were promoted to help diversify communities' sources of income, also reduced vulnerability in some communities through

Photo: WBG - World Bank financed RLLP Farm land rehabilitation, Arbegona woreda, Sidama region, Ethiopia

income growth. However, the poorest and landless households and those without access to irrigation perceived relatively diminished benefits through activities like poultry, livestock production, beekeeping and harvesting of grass from communal lands.

The projects demonstrated greater success in abating land degradation than in improving livelihoods and reducing vulnerability, highlighting that addressing degradation alone is not sufficient to reduce vulnerability to climate shocks. For this reason, the RLLP projects have a stronger focus on improving livelihoods. The lessons learned from these projects also point to the importance of encouraging proactive local participation, having demonstrable and upfront economic benefits to incentivize smallholder farmers to maintain the SLM practices introduced as part of the projects and implementing market-oriented agroforestry interventions that can bring sustainable income for smallholder farmers.

Improvements in ongoing and future World Bank-financed projects (RLLP and RLLP II respectively) aim to strengthen the establishment of formal water organizations and the support revenue models through value chains, public-private partnerships or community linkages, enhanced capacity building and improved returns by increasing climate smart agriculture (CSA) and other practices to enhance productivity. The strong commitment of the Government of Ethiopia to the SLM agenda and the development of proven models for addressing land degradation have also enabled a transition from project to results-based financing and this now offers very promising prospects for achieving a transformational scale-up of support for SLM across Ethiopia's highlands.

Photo: AFD

Agroecology Program for West Africa – A solution for family farms of the Economic Community of West African States to climate change risks

Geography: Member states of the CEDEAO (Burkina Faso, Côte d'Ivoire, Mali, Senegal and Togo and to be expanded across 15 countries in West Africa).

Adaptation measures: The program aims to minimize projected climate change-related agricultural yield reductions and build resilience through an agroecological transition for sustainable intensification.

Key outcomes (expected): The project anticipates a 5 percent annual reduction in the number of people who are structurally vulnerable to climate risks, food and nutrition insecurity in the covered area.

Its goals include: 50 percent of agricultural family farms participating in collective organizations for agroecology; 10 percent of agricultural lands in project areas under agroecological practices; 15 mechanisms operational (three per country) to remove barriers to agroecology in the context of the National Plans for Agricultural Investment, Food Security and Nutrition (PNIASAN); a 5 percent annual increase in the number of people trained in agroecology (12,000 farmers, of whom 10 percent should be young people and 30 percent women); and at least 12 training centers with capacities in agroecology operating.

Partners and funding: European Union and French Development Agency (AFD). 2018-2024. 16.2 million euros.

PROJECT SUMMARY

West Africa is experiencing relatively rapid changes in climate, with warming across the region[121] and increased precipitation and climate extremes. Although future precipitation trends are uncertain, the western Sahel region (west of 0^{0}E) shows drier scenarios combined with a 2-4^{o}C warming in average temperatures by the end of the century.[122]

Despite uncertain future scenarios with regards to monsoon rainfall, projected crop yield losses have been identified as a common threat to livelihoods in rural West Africa. Studies show a consensus on expected yield reductions of 11 percent in West Africa, with corn being the crop most affected. Yield losses will be driven by the effects of higher temperatures on crop cycle duration and increased evapotranspiration demand, despite changes in rainfall.[123]

Scaling agroecological production is a crucial opportunity for sustainable development in West Africa. It will not only improve the productivity of agriculture but also its resilience to climate change, thus helping to contain food and nutritional insecurity in the region. Adequate public policy is needed to support the scaling of agroecological systems, backing agroecological intensification with complementary approaches (e.g. trainings, demonstration plots, expert consultation, alternative marketing systems) that promote the emergence, adoption and dissemination of environmentally intensive agricultural practices in family farming. This project has a double objective: to develop field projects to support groups of farmers and herdsmen who commit to changing their practices and to encourage experience sharing and contribute to the development of public policy.

The program is implemented by a commission of CEDEAO through the Regional Agency for Food and Agriculture (ARAA). Agroecological principles aim at promoting practices that are locally contextualized, add value to local resources, improve biodiversity and minimize dependence on external inputs. Within the context of African farming systems, practices that enhance soil quality, improve water management, adapt cropping systems (through modified sowing practices and crop/cultivar selection), and improve livestock management (mainly forage management, food supplements and grazing-free areas) are crucial to building resilience.[124] These practices contribute to livelihood adaptation by minimizing the impacts of reduced precipitation and increased rainfall variability and temperatures. They do so by improving the resilience of livestock and cropping systems, often using a combination of several practices.[125]

The project strategy is based on developing local participation and ownership, integration of communities and the agricultural industry, co-production of innovations, addressing adoption needs, strengthening of capacity building centers and diffusion of technological innovations, inclusion of women and youth, systematization of lessons learned (including applied research) and support of public policies towards agroecology.

Local implementation has been driven by 15 field projects, six of which had started by the end of 2020. Efforts in capacity building and dissemination of technologies are being rolled out based on diagnostic assessments of 12 training centers, agricultural schools and professional and research organizations. Farm level implementation of adaptation practices is framed under participatory landscape management plans that drive agroecological intensification at the farm level through community level processes supported by the training of technical staff and field schools for farmers. Finally, the projects will seek to add value and introduce agroecologically intensified products across the region.


Photo: Lance Hadley/Shutterstock

Better Beans for Africa

Geography: Pan-Africa

Adaptation measures: The project promotes resilience building across the value chain of bean production in Africa. It provides farmers with access to iron-biofortified beans, a climate-smart and resilient crop with enhanced nutritional content. To improve the uptake of the beans, the initiative works to develop the capacity of smallholder farmers and to improve nutrition education and awareness. It promotes diversification of meals among African households, with a focus on bean-based products, and fosters partnerships with the private sector to improve the market access of bean-based products.

Key outcomes: The program has developed more than 536 varieties of iron-biofortified beans and made them available to more than 300 million households. The bean crops produced are climate resilient, early maturing and have enhanced protection against pests and diseases. In Rwanda, iron bean yields were 20 percent higher than other available varieties, providing US$ 58-78 profit per hectare for smallholder farmers. In addition to improving nutrition security when introduced into the diets of local communities, beans help in alleviating iron deficiency among women and children.

Partners and funding: Consortium Group on International Agricultural Research, Alliance of Bioversity International, HarvestPlus, Agriculture for Nutrition and Health, International Center for Tropical Agriculture, Global Affairs Canada, Swiss Agency for Development and Cooperation (SDC), United States Agency for International Development (USAID), UK Foreign, Commonwealth and Development Office, The Rockefeller Foundation, Alliance for Green Revolution in Africa, KirkHouse Trust, Bill & Melinda Gates Foundation and other national and local-level stakeholders. 1996-present.

PROJECT SUMMARY

Despite growing efforts to fight hunger and malnutrition, the number of hunger-stricken people in Africa has increased by 47.9 million since 2014, reaching 250.3 million (or one fifth of the total population of the continent) in 2020. In West Africa, nearly 17 million people needed immediate food assistance in 2020 due to a combination of drought, poverty, high food import prices, environmental degradation, displacement, poor trade integration, and conflict–a set of interlinked threats. Almost 94 percent of the undernourished population resides in Sub-Saharan Africa.[126] Economic recession due to COVID-19 is expected to push additional 25 to 42 million to the brink of undernourishment.[127]

The African Union's most recent Biennial Review shows that only four of 49 member states are on track to achieve the goals and targets of the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods by 2025 (AU 2020). This means that Africa is lagging on progress to achieve Sustainable Development Goal 2, which calls for ending hunger in all forms by 2030, and Sustainable Development Goal 13 on taking action to combat climate change and its impacts.

African agriculture and food systems are already suffering from the impacts of climate change. Already, visible effects include changes to the start and end dates of growing seasons and the frequency and intensity of dry spells and heavy rainfall events. Evidence shows that climate change has stalled productivity growth in the continent's foremost staple crop, corn.[128] Overall, Sub-Saharan Africa has experienced about a 1.4 percent reduction in food calories per year from key food security crops (corn, cassava, sugarcane, sorghum, rice) due to climate change.[129] Precipitation is also likely to decrease over northern Africa and southwestern parts of South Africa by the end of the century, while the overall frequency and intensity of heavy precipitation events are projected to increase elsewhere on the continent.[130] These climatic changes are likely to have negative impact on agricultural production and food security. Food insecurity ncreases temporarily by 5-20 percent in the affected area after with each flood or drought.[131]

Studies have predicted that by 2050 calorie availability is likely to decline throughout the developing world, resulting in an additional 24 million undernourished children ages 0-5, almost half of whom will be living in Sub-Saharan Africa. This is 21 percent higher than the projection with no climate change.[132] This is particularly alarming since the adverse consequences of undernutrition in the first years of life are often irreversible.[133] The importance of improving diets, particularly for children, and having more complete nutrition in each meal has been recognized throughout the continent.

In light of this situation, beans have been identified as one key resource to combat undernutrition in Africa because of their high protein content, and generous amounts of fiber, complex carbohydrates and other dietary necessities. Beans also supply 25-30 percent of the recommended daily levels of iron and meet 25 percent of the daily requirement for magnesium and copper, as well as 15 percent of potassium and zinc.[134] Common beans are a staple across eastern, central and southern Africa, where about 6.3 Mha of land is used to grow beans every year. Per capita bean consumption in eastern Africa is the highest in the world–in western Kenya, Rwanda and Burundi, people eat around 50-60 kg of beans every year. Beans are also quickly gaining importance in countries such as Cameroon and Guinea in central and western Africa. However, the impacts of climate change are likely to negatively affect common bean production across Africa. Reduced precipitation will impact common bean production in southeastern Africa by 2050. The iron content in common beans is also expected to significantly decline under climate change-induced drought stress.[135]

The introduction of iron-biofortified beans in the African agricultural systems and diets offers an effective way to adapt the existing bean production and reduce food insecurity and undernutrition on the continent. The effort to mainstream these "better beans" was led by the Pan Africa Bean Research Alliance (PABRA), a collaborative, multi-stakeholder platform for research to facilitate rural transformation, which has worked to develop improved beans and complementary technologies. PABRA aims to enhance food and nutrition security, incomes, resilience to climate change and gender equality for improved rural and urban livelihoods in 32 African countries.

PABRA's resilience building interventions take place across the entire value chain from bean production to consumption. Specific areas of intervention include research development, wherein PABRA and its associated breeding program carry out biofortification of beans to increase their iron and zinc content, and working with communities to impart nutrition education and awareness. The project also works to improve the diets of smallholder farmers by encouraging them to consume their own crops; shares bean recipes and preparation skills with households to improve the quantity and frequency of bean consumption in household diets; and promotes dietary diversification through a food basket approach consisting of locally available fruits, vegetables, meats, roots and tubers, along with beans, to provide a well-rounded, diversified and nutritious diet. Additionally, it promotes the cultivation of community kitchen gardens and builds partnerships with the private sector to give an impetus to the commercialization of nutritious value-added bean products (e.g., bean-based porridge flour for use in school feeding programs), as well as working with cottage industry players like food vendors and local restaurants to develop bean-based snack foods. The iron-biofortification of beans is also carried out in response to farmer and market demands, with the improved varieties being early maturing, high in iron and zinc, drought and heat-resistant and protected against pests and diseases.

PABRA scales its efforts through multistakeholder partnerships in different countries. For example, in Burundi, PABRA partnered with the private sector and Institut des Sciences Agronomiques du Burundi to scale up the production of composite bean flour for infants and new mothers. In Rwanda, one of the early adopters of iron-biofortified beans, where about one in five women and four in 10 children suffer from anemia, PABRA–with support from CGIAR's HarvestPlus Program, Alliance of Biodiversity International, CIAT and the Rwandan Agriculture Board–has released ten iron-biofortified bean varieties to date. By 2018, an estimated 20 percent of the beans produced were high-iron varieties, consumed by 15 percent of the population (1.8 million people). Iron bean yields are about 20 percent higher than other available varieties, providing an additional US$ 57–78 in profit per hectare for smallholder farmers. To ensure sustained biofortification delivery, in 2019 the entire iron bean program was handed over to the Rwanda Bean Alliance, which includes representation from actors across the value chain and engages in activities from research to consumer education.[136]

To date, PABRA has released 536 varieties of beans, which have been distributed to more than 30 million households. Early evidence from Rwanda shows the increase in the physical work efficiency of women attributed to decreased iron deficiency through mainstreaming fortified beans in their diets.[137] Survey results from Tanzania also reveal the positive impact of fortified beans on the food security status of bean growers in the southern highland zone and reiterate the importance of policies that promote and facilitate access to fortified beans–such as education and programs to improve wealth status and market access–as central to alleviating food insecurity.[138]

MoA-INFO – Digital Solutions for Agriculture

Geography: Kenya

Adaptation Measures: The project delivers free digital agricultural extension and advisory services via SMS to smallholder farmers throughout Kenya. Topics include scientifically validated and reviewed agronomic practices to support the cultivation of 11 crops (corn, beans, Irish potatoes, sweet potatoes, mung beans, bulb onions, cabbage, sorghum, bananas, tomatoes and pigeon peas), agronomic information, climate-smart advisory, weather information, optimal input use, organic input use, monitoring of prices of agricultural inputs and extension services. MoA-INFO also designed and delivered "decision-support tools" to farmers via their mobile phones, which they can use to make better-informed decisions regarding monitoring for and managing fall armyworm infestations, selecting the most appropriate seeds based on local conditions, and fertilizer use.

Key outcomes: The project helps to boost agriculture yields by providing customized and farm-relevant advisory, the provision of timely and locally-relevant weather information to enable more informed cropping decisions, and optimal and informed use of agricultural inputs.

Partners and funding: Precision Development (PxD); Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MoALFC); the International Fund for Agricultural Development (IFAD); Center for Agriculture and Biosciences International (CABI).

PROJECT SUMMARY

Kenya has the largest economy in East Africa, and with a population of more than 52 million as of 2019, it serves as the region's financial, trade, and communications hub. Agriculture forms the backbone of the Kenyan economy, contributing more than 33 percent to the country's GDP. The majority of the agricultural production is rainfed (98 percent) and is led by smallholder enterprises, employing more than 40 percent of the total population and 70 percent of the rural population.[139] Agricultural productivity, however, has stagnated in recent years, despite continuous population growth. Only 20 percent of the land in Kenya is suitable for agriculture; however, maximum yields have yet to be achieved, leaving considerable potential for increases in productivity.[140] The current productivity losses arise from lack of access to basic agricultural inputs, updated technology and adequate finance and extension services. These issues will further be exacerbated by the growing impacts of climate change.[141]

Kenya not only faces increasing inter-seasonal variability in precipitation patterns but also a greater likelihood of extreme events like droughts and sea level rise along its coastline. Warming in Kenya is expected to be around 1.2–2.2°C by 2050, with the greatest temperature increases in the west. Projections also point to an increase in the duration (nine to 30 more days) of heatwaves. Precipitation patterns are expected to remain highly variable and uncertain; however, average rainfall is expected to increase by 2050, particularly during October and December.[142] Climate extremes, particularly floods and droughts, are also expected to become more frequent and severe. Climate disasters in the recent past have already caused severe economic losses. Droughts from 2008 to 2011, for instance, caused losses amounting to US$10.2 billion (compared to a loss of US$ 2.8 billion during the 1998-2000 drought) in livestock and crop production.[143,144]

Given the importance of agriculture to Kenyan economy and society, it is essential for adaptation options to help embed climate information better into cropping decisions to make the agricultural systems more resilient. Many disruptive agricultural technologies (DAT) are helping address not only threats posed by climate change but also several other challenges that impede agricultural growth, including: lack of market access for smallholder farmers; limited access to inputs like seeds, fertilizer and machinery; limited information about variables like weather patterns, soil characteristics, future market demand; inequalities among farmer groups and gender inequality.[145]

Precision Development (PxD) makes use of these disruptive technologies to alleviate challenges faced by smallholder farmers. The organization provides digital climate-informed advisory services, including decision-support tools, services, platforms and activities that can help disseminate climate information, enabling individuals and organizations to make climate-resilient decisions and adapt to climate variability. In Kenya, PxD started in 2016 with a pilot project that provided SMS-based advisory service to around 1,900 smallholder corn farmers, giving tailored recommendations based on local soil tests. Building on this approach, in 2017 PxD expanded the dissemination of its advisories through phone calls and e-extension systems in addition to SMS, reaching more than 5,900 farmers.[146] The advisories resulted in increasing the yields of sugarcane farmers by 11.5 percent.[147] Agricultural advisories also emboldened farmers and encouraged changes in behaviour and farming practices; e.g., making them 10-24 percent more likely to experiment with farm inputs to combat local soil acidity.[148] The initiative also strives for financial inclusivity by providing farmers with low-cost, accessible and relevant mobile agronomic advice that is customized to boost yields.

To bring the digital solutions to scale, PxD collaborated with Kenya's Ministry of Agriculture, Livestock, Fisheries and Co-operatives in 2018 to launch the MoA-INFO SMS platform to issue advisories to combat the spread of the fall armyworm. The advisories were co-produced with inputs from counterparts in the Ministry of Agriculture, CABI, and experts in the field, ultimately providing a decision-support tool for farmers to gain knowledge about armyworms, monitor the costs of pesticides and make informed and cost-effective decisions about their use.

The service, which provides free agricultural recommendations to farmers via SMS, can be accessed with any type of phone and currently has more than 650,000 registered users across Kenya. Initially, the platform was focused on advice around fall armyworms but has since expanded to include recommendations for growing 11 crops. The recommendations are customized based on the user's location, which is collected at the ward level, and are offered in either Swahili or English. The advisory messages are based on recommendations that were jointly developed with and approved by the MoALFC (including KALRO). The service allows farmers to pull up content when they are looking for information about crop production or pest control and to receive push messages with farming advisories that are timed to the crop calendars in different parts of the country. Lastly, the platform also includes multiple decision support tools (DSTs) that allow farmers to receive customized advice about seed varieties, fertilizer types, pests and diseases control measures.

PxD developed its own in-house platform (Paddy) to run MoA-INFO on behalf of the MoALFC. The platform allows for greater customization of advisories and can send content over SMS, voice messaging, WhatsApp and Telegram. Paddy is now being used in multiple countries where PxD works. Overall, PxD serves more than 5 million farmers in ten countries, five of which—Ethiopia, Kenya, Rwanda, Uganda, and Nigeria—are in Africa.

Supporting smallholder agriculture

Photo: IFAD

IFAD'S GROWING ROLE IN ADAPTATION

Smallholder and poor farmers in the developing world are heavily reliant on natural resources, which were already degrading before climate-related changes such as increasing temperatures, erratic rainfall, pest infestations, rising sea levels, and extreme events such as floods, droughts, landslides, and heatwaves presented further threats to smallholder habitats and livelihoods.

In response, the share of IFAD's resources allocated to climate change has been rising. During 2019-2021, 42 percent of IFAD's financing in eastern and southern Africa supported climate change actions. The equivalent figure for eastern and southern Africa was 34 percent. Up to 90 percent of IFAD's spending on climate change is for adaptation.[149]

IFAD's Adaptation for Smallholder Agriculture Programme (ASAP), first launched in 2012 with a second phase starting in 2018, is the world's largest climate adaptation program dedicated to supporting smallholder farmers.

ASAP aims to reach out to eight million people, including four million women and girls, to:

- Improve land management and gender-sensitive climate-resilient agricultural practices and technologies
- Increase availability of water and efficiency of water use for smallholder agriculture production and processing
- Increase human capacity to manage short- and long-term climate risks and reduce losses from weather-related disasters
- Make rural infrastructure climate-resilient
- Document and disseminate knowledge on climate-smart smallholder agriculture

An ASAP Trust Fund of US$ 316 million, supported by 11 donors, has so far committed US$ 292.6 million to 42 projects. Grants provided under the Programme are mainstreamed into larger IFAD projects, to increase the climate resilience of IFAD's approximately US$ 1 billion per year of new investments.

ASAP grants have supported adaptation tools; climate risk analyses; agroecological interventions that enhance resilience; food loss and waste reduction; climate-smart irrigation; climate information services; stakeholder engagement; and social protection. A brief snapshot of ASAP activities in Africa follows.

Adaptation toolbox

As part of ASAP, IFAD has developed a toolbox that includes the Climate Adaptation in Rural Development (CARD) Assessment Tool and the Adaptation Framework.

CARD enables the integration of climate-related risks into investments and strategies, food security studies, and rural development policies. Designed for non-expert public and private investors and decision-makers, it currently provides data for 17 major crops in nearly all African countries. CARD can be used to provide estimates of how climate variability and change will impact yields and value chains. It can also inform decisions to shift from one crop that may be more vulnerable to climate impacts, to another.

For example, Figure 1, generated by CARD, shows the impact of climate change on rainfed agricultural yields (without irrigation) in Mali. Cereals, tubers, and pulses, which are important crops for smallholder farmers in Sub-Saharan Africa, will be heavily impacted, with wheat yields in Mali, for instance, going down well below 40 percent by 2050.

The Adaptation Framework tool is a repository of adaptation actions for small-scale agriculture, including livestock, forestry, and fisheries, that can be used in project design.[150] Project design teams can consider cost-benefit, climate risk relevance, farmer capacities, mitigation co-benefits, and biodiversity support.

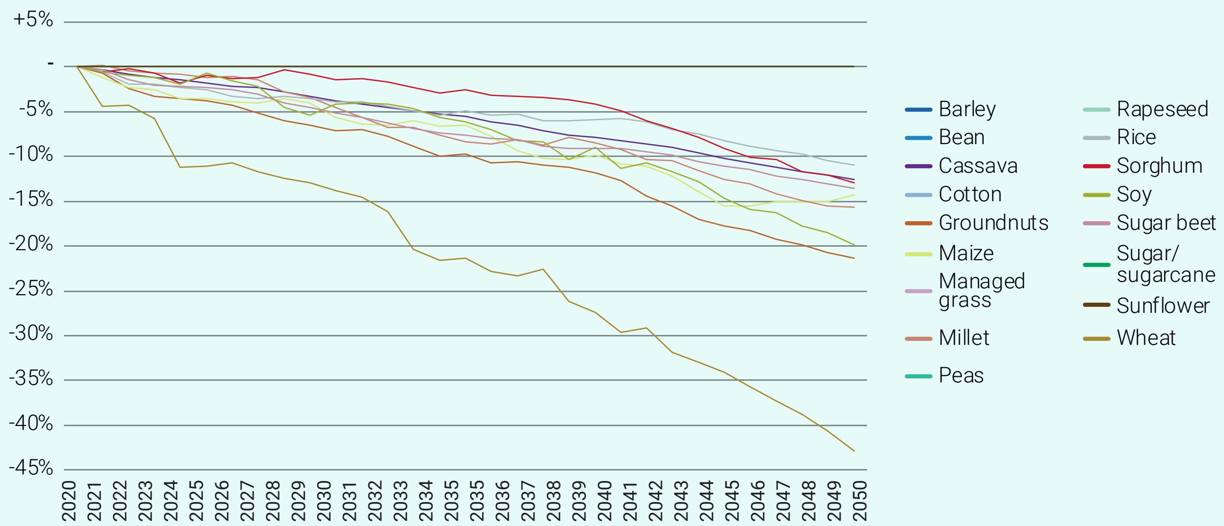
Climate risk analyses

ASAP also funds climate risk analyses (often conducted by regional and national institutions) to support the integration of climate information and improved knowledge of climate-related risks to smallholder farmers in country strategies and programming. For instance, a 2020 risk analysis by the University of Cape Town on the future suitability of crops in Zimbabwe found that increasing temperatures, increasing delays or inconsistencies in the onset of rainfall, and an overall decrease in annual and seasonal precipitation will result in negative impacts on all the crops assessed. Lost production of maize, one of the most climate-vulnerable of Zimbabwe's staples, is predicted to cost the country US$ 88.8 million per year.[151]

Agroecological interventions

Agroecology – the application of ecological principles to agriculture, where diversity, recycling, and effective use of resources in farming systems is central – has a strong potential contribution to farming system resilience against climate change impacts, to the conservation of biodiversity, and to reversing land degradation trends. IFAD defines agroecology not just as a set of agricultural practices, but also as changing social relations, empowering farmers, adding value locally, and privileging short value chains.

Figure 1: Impact of climate change on rainfed agricultural yields in Mali, without irrigation



An ASAP grant of US$ 4.9 million was integrated into the US$ 45 million Pro-poor Value Chain Project in the Maputo and Limpopo Corridors (PROSUL) project in Mozambique, implemented over 2012-2020. The ASAP grant amount financed smallholder adaptation to climate change in the three southern provinces of Gaza, Inhambane, and Maputo, where rural poverty is particularly high. The ASAP grant funded the installation of robust and efficient water management infrastructure; improvement of the weather stations network; and the introduction of sustainable agriculture techniques that are more resilient to climate shocks, such as intensified cassava production systems that integrate mixed cropping and improve household food security.

Drought tolerant varieties of casava were introduced, along with agroecological practices such as minimum tillage and mulching. Climate information services were delivered through mobile phones, and credit and saving groups were set up, where most of the members were women (80 percent). As a result, cassava yields went up from six tons per hectare to 20 tons per hectare, with positive impacts on income and food security (Figure 2).[152]

Reduction in food loss

Food loss in Sub-Saharan Africa is estimated to be 13.5 percent for grains, and as high as 50 percent for fruit and vegetables.[153] Over the 2014-2020 period, IFAD, partly through ASAP, funded the Climate-resilient Post-harvest and Agribusiness Support Project (PASP) in Rwanda, where average losses were estimated at 30 percent for key agricultural produce like maize, beans, potato, cassava, and dairy. The losses were found to be due to limited knowledge and skills in post-harvest handling and on-farm storage, and limited access to appropriate post-harvest equipment and drying, storage, and cooling infrastructure.

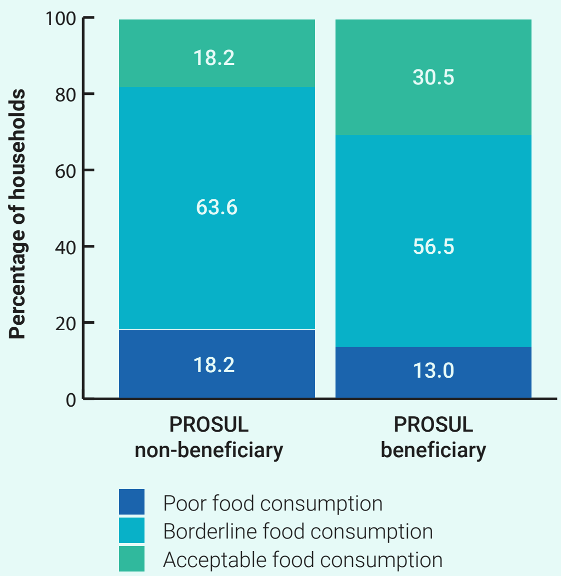
PASP focused on the creation and strengthening of hubs – multifunctional business centres where primary produce is aggregated. The hubs identified under the project (cooperatives, farmers' organizations, and small and medium-sized enterprises with a proven potential to develop inclusive business activities that benefit poor smallholder farmers) were assisted with investments in climate-smart technologies for drying, processing, value addition, packaging, storage, logistics, and distribution.

Around 44,000 smallholder households gained access to new climate-smart post-harvest technologies through PASP. In addition to a 20 percent reduction in the level of post-harvest losses over the baseline, the project contributed to improved food security, the creation of new employment opportunities, and an average income increase of at least 10 percent for project beneficiaries.[154]

Climate-smart irrigation

The frequency of severe droughts has increased in Sub-Saharan Africa in previous decades, particularly in the Sahel strip and the Horn of Africa. In the past, techniques such as small-scale irrigation and water harvesting have been used to counter the effect of droughts. While these techniques remain relevant, new solutions are needed to deal with the continuous change in climate. Moreover, measures promoted earlier to increase incomes during the dry season, such as horticulture using small irrigation systems, are now failing because of rising temperatures and unpredictable rains.[155]

Figure 2: Impact on household food consumption levels through the PROSUL project



Source: IFAD (2020). Pro-Poor Value Chain Development in the Maputo and Limpopo Corridors Project Completion Report.

In response, IFAD is promoting 'climate-smart irrigation' – a mix of hard and soft techniques that maximise water use efficiency for agriculture.[156] For instance, under Phase II of the Participatory Small-scale Irrigation Development Programme (PASIDP II, 2016-2021), ASAP grant funds sought, among other things, to protect US$ 80 million worth of infrastructure from extreme weather events; train 15,000 people in sustainable farming practices and technologies; help 80,000 households in vulnerable areas to receive increased water availability for agriculture; and improve water management over 60,000 hectares.[157]

In Madagascar and Burundi, IFAD promotes the System of Rice Intensification (SRI), where rice fields are kept alternately dry or wet instead of constantly flooded, and less water and fewer seeds are needed to produce the same quantity of rice.[158]

Climate information services

While the technical capacities for climate information services already exist in Africa, including frameworks to collect satellite-based and terrestrial data in regions such as the Sahel and the Horn of Africa, last mile information services lag behind.[159] IFAD supports tailored climate information services in various countries, by establishing networks (between, for instance, meteorological agencies, extension services providers, mobile phone companies, and farmer organizations), and creating links with weather insurance.

In Rwanda, Madagascar, Nigeria, Kenya and Mozambique, the focus is on sharing information on planting and irrigation dates with small-scale farmers. In Rwanda, for instance, more than 6,000 farmers receive advice on planting dates for maize.[160] In Kenya, weather advisory services are provided as part of an e-voucher based insurance scheme in eight arid and semi-arid counties (see below). The farmers that benefit from the scheme receive advice on planting dates and good practices to cope with dry spells.

Stakeholder engagement

The continuous engagement of not only primary beneficiaries (smallholder and poor farmers, including in particular women and youth), but also of local governments, research institutions, NGOs, and other actors is critical to keep adaptation interventions in the agriculture sector locally-relevant and effective.


Photo: IFAD

In Sudan, ASAP has supported the creation of inclusive local institutions to manage dry forests, rangeland, and water sources through the Butana Integrated Rural Development Project (BIRDP). The Natural Resource Governance Framework of Butana enabled communities to protect their customary rights on forests and rangeland, and has now been scaled up nationally to enable community dialogues between various groups of users, including the private sector, in a manner that avoid conflicts.[161]

Social protection

In contexts where poverty is high and natural resource depletion is extreme, social protection schemes are necessary to enhance resilience and adaptation capacities. IFAD has piloted a e-voucher system in Kenya, where smallholder farmers are provided with a debit card that comes with e-vouchers to access benefits such as agricultural inputs, insurance, and conservation agriculture services at a subsidized rate, with a decreasing level of subsidy over three planting seasons. The level of subsidy and lists of inputs are tailored to the county context in consultation with the Kenya Agricultural and Livestock Research Organization. Farmers must provide the rest of the cost as a deposit on their bank account. The e-voucher service is provided by two banks in Kenya, and also helps the farmers access formal banking systems. In total 114,000 farmers were supported by the e-voucher system, which has now been replicated beyond the IFAD-financed project.[162]

AfDB's work on agriculture and food security

Photo: AfDB

Transforming the agriculture sector in Africa can have a vital impact on inclusive growth on the continent. As of 2021, the AfDB's agriculture and food security portfolio included 170 active projects with an investment of approximately US$ 4.8 billion.

The AfDB is currently implementing its Feed Africa Strategy (2016-2025) which aims to develop the untapped potential of agriculture in Africa; drive inclusive gains to sustainably transform the lives of all, including the poorest and most vulnerable; and to empower smallholder farmers and youth.[163] The Strategy recognizes the crucial roles of the public and private sector in promoting sustainable agriculture, and the need for new technologies to modernize value chains and replicate success. Within the framework of the Strategy, AfDB has invested over US$ 40 million over the last three years towards productivity enhancement using best practice technologies. This has leveraged over US$ 450 million in terms of impact.

An additional US$ 245 million has been invested in ten projects to strengthen climate resilience of African food systems, complemented by an additional US$ 38 million for climate information services and agriculture disaster risk financing solutions.

Several innovative programs have been launched, including the Climate Smart Agriculture (CSA) Initiative and Technologies for African Agricultural Transformation (TAAT). Under CSA, which can contribute significant adaptation and mitigation co-benefits for Africa, AfDB is working with the GCA to provide at least 30 million farmers Climate Smart Digital Technologies for Agriculture and Food Security by 2025. This program will establish a dedicated Digital Agriculture Financing Facility to support public and private sector actors to work together, and put in place enablers to scale up the adoption of climate smart digital technologies for African food systems.

TAAT, meanwhile, aims to raise Africa's food output by 100 million tons and lift 40 million people out of poverty by 2025 by harnessing high-impact, proven technologies that boost agricultural productivity and mitigate climate risks to food security. TAAT's overall objective is to mitigate risks and promote diversification and processing in 18 agricultural value chains within eight priority intervention areas. The program deploys technologies at scale in nine commodity value chains: maize, rice, wheat, high-iron bean, cassava, orange-fleshed sweet potato, sorghum/millet, livestock, and aquaculture. Launched in 2018, the program has been successful in the deployment of drought-resistant maize, heat-resistant wheat, and pest-resistant crops, enabling farmers to increase yields and improve their livelihoods.

The US$ 257 million Programme to Build Resilience to Food and Nutrition Insecurity in the Sahel is an example of a multinational project being implemented by AfDB. The Sahel faces repeated food and nutrition crises due to a convergence of the impacts of climate change and variability, environmental degradation, weak governance, and limited infrastructure. The AfDB Programme is currently being implemented in Burkina Faso, Chad, The Gambia, Mali, Niger, Senegal, and Mauritania to target 180,000 farms and small and medium-sized enterprises; and to reach 1.43 million direct beneficiaries and 3.03 million indirect beneficiaries. It employs an integrated approach to build resilience, by optimizing available resources, mitigating the impact of shocks related to climate hazards, optimizing the agricultural calendar, and improving agricultural practices.


Photo: AfDB


Photo: AfDB


Photo: AfDB


Photo: AfDB

Digital Climate Advisory Services in Africa

Photo: iStock/guentergunt

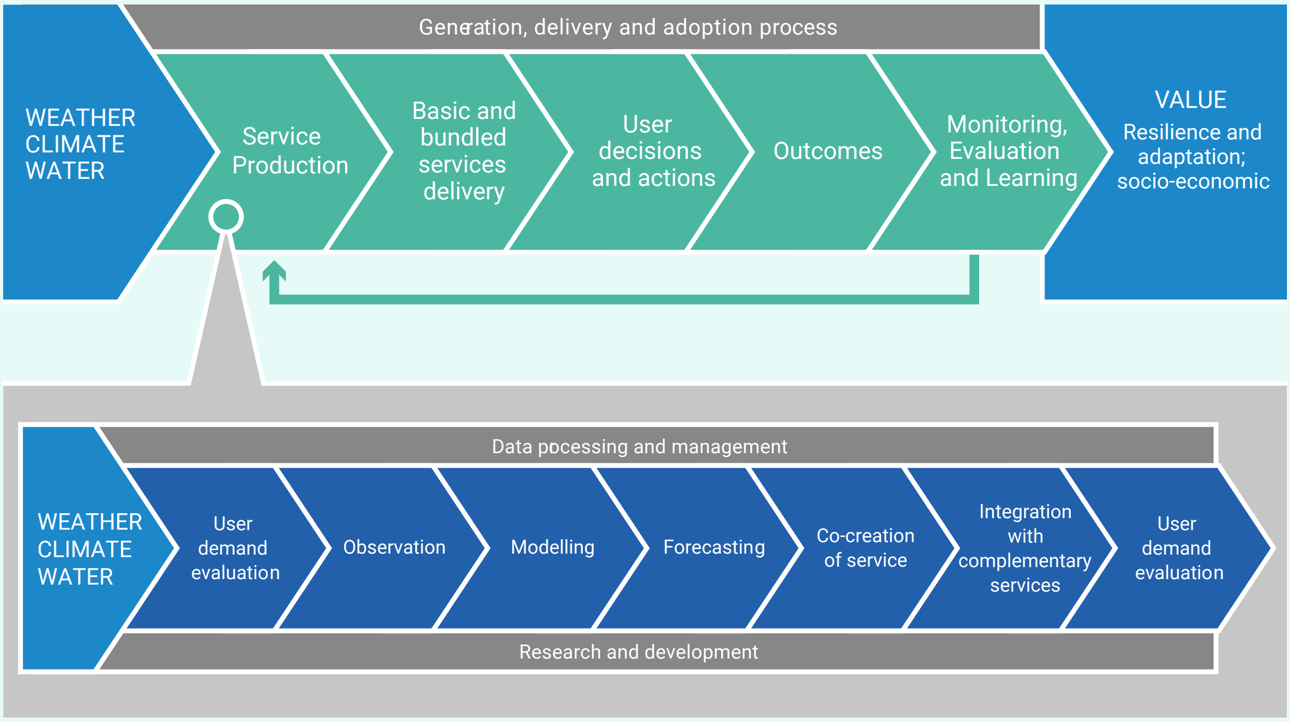
Digital climate-informed advisory services (DCAS) are tools, platforms or activities that disseminate climate information and help individuals or organizations make climate-resilient decisions and adapt to climate variability and change.

These services can be provided via mobile apps, radio and online platforms that disseminate advisories in different formats (e.g., bulletins) tailored to extension services, agri-business, and farmers, depending on the target audience's access to digital technologies and digital literacy. Moreover, these services are meant to support rather than replace person-to-person communication channels and strong agricultural extension services (Figure 1).

The growth of mobile technologies and internet access in Africa over the last two decades offers an opportunity to integrate farmers and Agri-SMEs into a digitally enabled agri-food system. More than 400 digital agriculture solutions provided by governments, the private sector and development organisations (including financial services, market linkages, supply-chain management, advisory and information services, and business intelligence) have helped an estimated 32 million African farmers increase their yields by 40-70 percent (Figure 2).[164]

Digital climate-informed advisory services offer a significant opportunity to build the resilience of farmers to the impacts of an increasingly variable climate. Effectively designed and timely transmitted advisory services—ranging from seasonal forecasts to pest advisories, planting calendars to early warning

Figure 1: Process of producing and delivering DCAS



Source: DCAS investment blueprint[165]

systems—can help farmers to adapt to climate shocks and plan for production in a changed climate. Decisions related to climate change adaptation may include switching to crops with greater tolerance for emerging climate change stressors and modifying land-use or cropping systems or supplementing rainfed production with irrigation as dry spells increase in frequency and length. Additionally, data and analytics can be used to improve pest and disease surveillance and the development of early warning systems. Digital soil maps are also critical for farmers to understand the local soil conditions and respond using locally specific advisories. Mobile platforms provide a digital identity and credit profile, making it easier for farmers to access markets and financial services, such as insurance, and thus to transfer or manage climate risks.

Figure 2: DCAS investment opportunities in Africa

Sub-Saharan Africa

90% of the market for digital services that support African smallholders remains untapped

400 different digital agriculture solutions with 33 million registered farmers

Growth of **40%** per year for the number of registered farmers and number of digital solutions

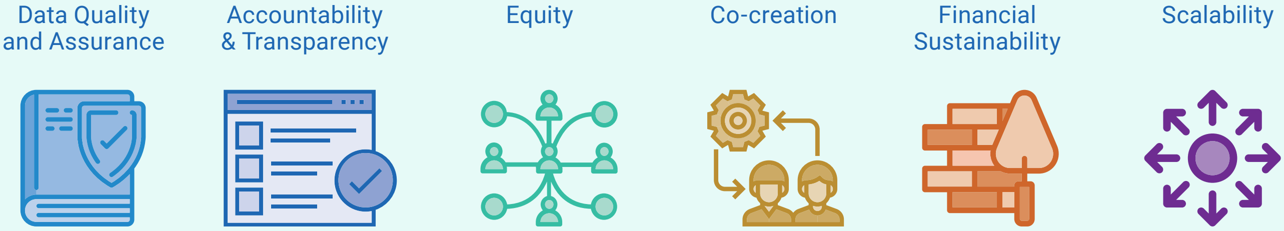
The Digitalisation for agriculture market likely to reach the majority of the region's farmers by **2030** (CTA & Dahlberg Advisors, 2019)

Photo: iStock/hadynyah

However, there are currently multiple gaps that need to be addressed in investments for digitally enabled value chains supporting the adaptation of smallholder farmers to climate challenges:

- Available digital solutions are currently outpacing the readiness to adopt them, and the agriculture sector lacks an important layer of enabling middleware infrastructure namely, agriculture specific data, hardware, and software infrastructure that digital agriculture solutions rely on to source information and deliver services to farmers and other agriculture intermediaries.
- There are gaps in the availability of and access to climate and weather data for the development of digital applications for advisory services.
- The majority of current digital solutions in the agriculture sector are used by commercial players, leaving smallholder farmers behind.
- Most of digital agriculture technologies used by farmers in Sub-Saharan Africa have been implemented at a small scale, dependent on donor funding, and remain at pilot stage.
- Agricultural technology companies—many of which are headed by young entrepreneurs—have yet to find a commercially viable business model to deliver digital solutions to smallholders and agri-SMEs at scale.

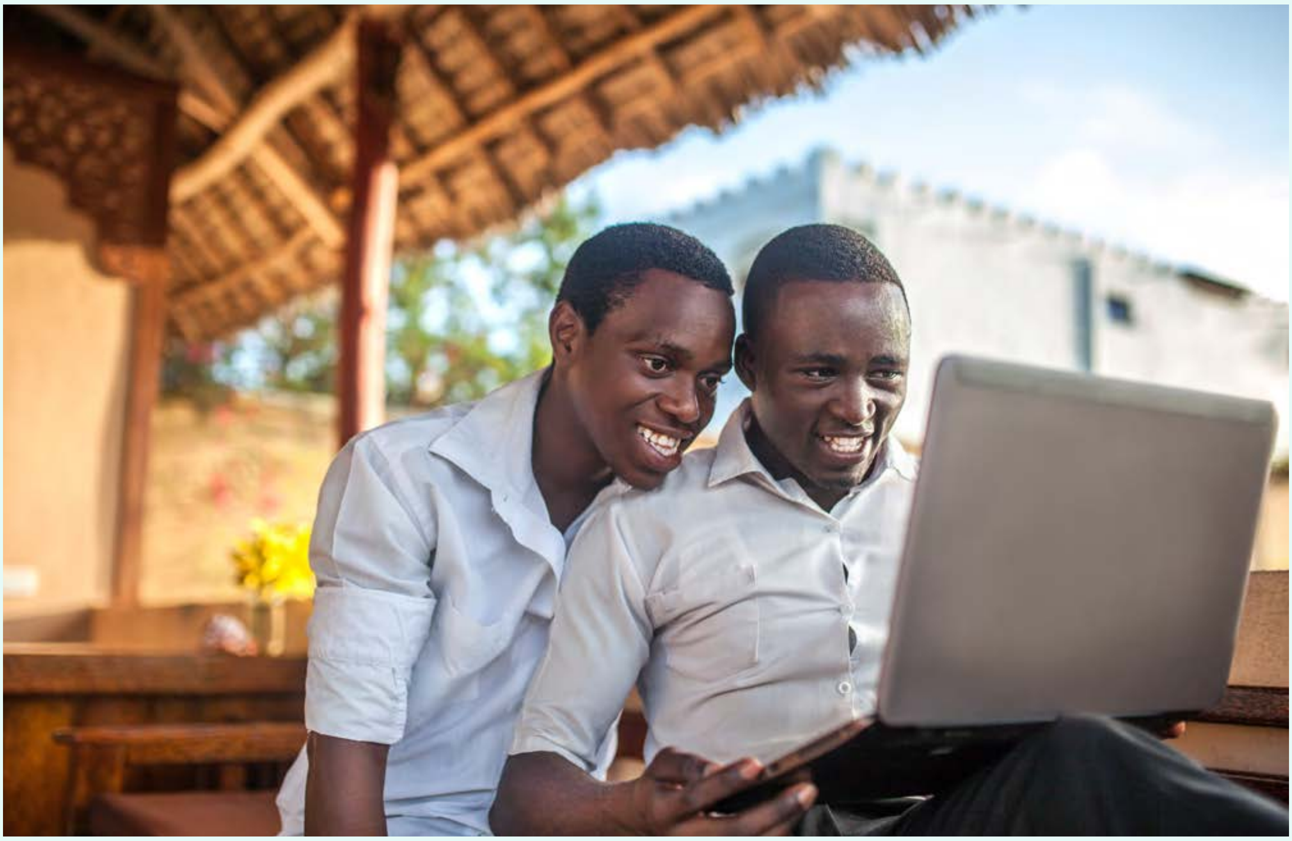
Figure 3: DCAS design principles



Source: DCAS investment blueprint

Moving forward, digital climate advisory services ought to enhance and facilitate farmers' adaptation through adoption and exchange of new technologies and adaptation practices and by promoting long-term, sustainable, equitable outcomes and design principles (Figure 3) to ensure impacts on the decision-making of farmers.

DCAS offer crucial opportunities to build the resilience of small-scale producers in the face of climate change, particularly when bundled with complementary services (e.g. financing, input supply, market access and insurance). Evidence indicates that appropriately designed and implemented DCAS—especially those that are bundled with financial and other services—can increase agricultural productivity and household income by as much as 57 percent.[166] The bundling of services has been found to be cost-effective and to foster uptake by farmers. Furthermore, it offers an opportunity to create unified and interoperable data platforms that permit the development of a wide range of services to respond to the interconnected challenges that farmers face. Governments have a central role to play in enabling conditions, for example, putting in place the middleware infrastructure. Private sector involvement in DCAS is essential to ensure innovation, scaling and sustained provision of services.



Trade

KEY MESSAGES

- **Trade can play two crucial roles in supporting Africa's efforts to adapt to a changing climate.** In the short term, trade cushions the volatility of food markets by providing a vital flow of supplies to regions that may see a sudden reduction in domestic production of food crops due to a climate shock. Over time, trade enables producers and consumers to adapt to changes in comparative advantage, thereby helping the transformation of Africa's agricultural sector and the diversification of its broader economy.
- **International trade can also help create jobs and raise incomes, which strengthen households' resilience, not least by enhancing their ability to purchase food.** As many African countries are expected to become more heavily food-import dependent, increased trade in other sectors (including services, manufacturing, and other primary sectors) can help finance these food imports.

- **Trade across African regions, underpinned by open and transparent trade policies as well as well-performing and climate-proof infrastructure (ports, roads, railroads), can contribute positively to Africa's efforts to build resilience to climate change.** The adaptation effect of trade is strongest for hunger-affected and import-dependent regions such as Sub-Saharan Africa, as trade reduces agricultural prices and increases food availability.

- **Africa is pursuing largely disjointed trade and climate adaptation policies and strategies.** One glaring example of this is the absence of any reference to climate change or the environment in the African Continental Free Trade Area (AfCFTA) agreement established in March 2018 and effective from 1 January 2021. Many African countries may be foregoing significant opportunities to bolster their climate adaptation strategies through proactive, forward-looking trade policies.

INTRODUCTION

Africa's trade in goods and services has gradually increased over the last 15 years. Nonetheless, its share in global trade has remained relatively constant at about three percent. Even in the absence of climate change, the challenge of enabling a growing population to escape poverty is a formidable task for the many countries across the continent, which continues to have close to zero adjusted net savings per capita.[1] Embarking on a sustainable development path remains a huge challenge.

Key drivers of this outcome are indicated in Figure 1. Trade is vital for many African countries with limited domestic markets. However, Africa's geography, characterized by long distances to markets, many landlocked economies, and low population densities across climate zones, constitutes a powerful barrier to trade. Furthermore, restrictive border measures, including informal ones like road checks, have contributed to high trade costs. Measures to protect the environment are largely absent in the Regional Economic Communities (RECs) along which continental integration is taking place.

Intra-African merchandise exports have grown over the last 15 years, but they still account for only 15 percent of total African exports. Goods export baskets remain highly concentrated in primary products. Over half of the region's merchandise exports are estimated to be fuel and mining products; about a quarter of them, manufactured goods; and 15 percent, agricultural products. Limited migration so far is another characteristic of Africa's current position in global trade.

Figure 1 also sketches the trade-related impacts resulting from selected slow and fast onset components of climate change.[2] Slow-onset events include a rise in average temperatures (and associated sea level rise) that will be accompanied by increased aridity. Notwithstanding this general trend, local variability implies that some regions may become wetter and cooler. A modification in local climate conditions will shift precipitation patterns, temperature, and the overall seasonality of weather events. Climate change is also expected to alter the natural ranges of pests and diseases, and to disrupt the "predator-prey" relationships that normally keep pest populations in check. In terms of fast-onset

Figure 1: The climate change challenge to African trade

Geography
- Artificial borders
- Several landlocked countries
- Crop disparities across climate zones
- Uneven distribution of natural capital
- Long distances, high trade costs

Current Trade
Movement of goods, capital, people
- Depletion of natural capital
- Low intra-African trade
- Export baskets concentrated on natural resources
- Africa's share of world trade reduced by half since 1960
- Limited migration (intra- and extra-regional)

Current trade policies
- High trade costs across Africa
- Extensive border measures (tariffs, NTBs)
- Few environmental provisions in RECs

Fast onset
- Floods
- Storms
- Droughts
- Pandemics

Climate Change
Trade-related Impacts
- Threat to food security
- Heterogenous impacts on agicultural productivity
- Threat to natural resources sustainability
- Stress on biodiversity/ecosystems
- Increased migratory pressures

Slow onset
- Rising temperature/sea level rise
- Increased aridity
- Increase in extreme weather patterns

Trade-related action areas for climate change adaptation
1. Improve the functioning of markets for food and agriculture
2. Strengthen policies and institutions for sanitary and phytosanitary (SPS) measures
3. Reduce barriers to trade in goods, services and technologies for adaptation
4. Enhance the climate resilience of transport and other key trade-related infrastructure
5. Use economic integration policies to promote trade and economic diversification

Source: Authors

events, the occurrence of extreme events such as heat waves and torrential rains is expected to continue to increase as it has in the recent past.[3] While slow and fast-onset shocks will have mostly negative impacts on Africa, they can be dampened by trade and by changes in trade policies, the focus of this chapter.

As discussed in the Agriculture and Food Systems chapter, for Africa, the threat to food security will be paramount.[4] Africa is the region with the largest share of hungry people among the population. About one in five people (21 percent of the population) was facing hunger in Africa in 2020, more than double the proportion of any other region.[5] Climate change is expected to have implications for both rural and urban populations and may have differing effects on the food security of different types of actors in rural areas, depending for example on the extent to which the source of their livelihoods is exposed to the impacts of climate change. Yet close to 60 percent of Sub-Saharan Africa's population lives in rural areas, with many engaged in subsistence agriculture, while close to 10 percent of the rural population lives in remote less-favored agricultural land or on remote land with poor market access (lack of roads, railways, navigable waterways). These factors complicate any prospective role for trade in agricultural goods to alleviate the threat to food security in rural areas unless there is a substantial improvement in trade-related infrastructure.

The role of trade in adaptation to climate change is complicated by an additional factor. While Africa is endowed with abundant natural resources (renewable like forests, and non-renewable like subsoil), property rights for these resources tend to be poorly defined, making them vulnerable to 'tragedy of the commons' outcomes prone to be exacerbated by international trade. Threats to biodiversity, already present, will increase. Here, under weak environmental governance, increased international trade presents a challenge.

Figure 1 also lists five trade-related action areas for climate change adaptation which are discussed in the fourth section. This chapter focuses on evidence about the role of trade policies to support climate adaptation efforts with a focus on the agricultural sector.

TRADE FOSTERS RESILIENCE BY LIMITING AFRICA'S SENSITIVITY TO GROWING EXTREME EVENTS

This section discusses the channels through which trade can attenuate the effects of fast-onset climate shocks (such as droughts and floods), whose frequency and intensity are expected to increase over time due to climate change (for more details, see the chapter on Present and Projected Climates in Africa. Past and current examples show how trade helped cushion the impact of extreme weather events (the arrival of the railroad in colonial India and the 2015–16 Southern African drought) and global crises (the 2008 food crisis and the COVID-19 pandemic) but also how uncoordinated policies amplified the shocks.

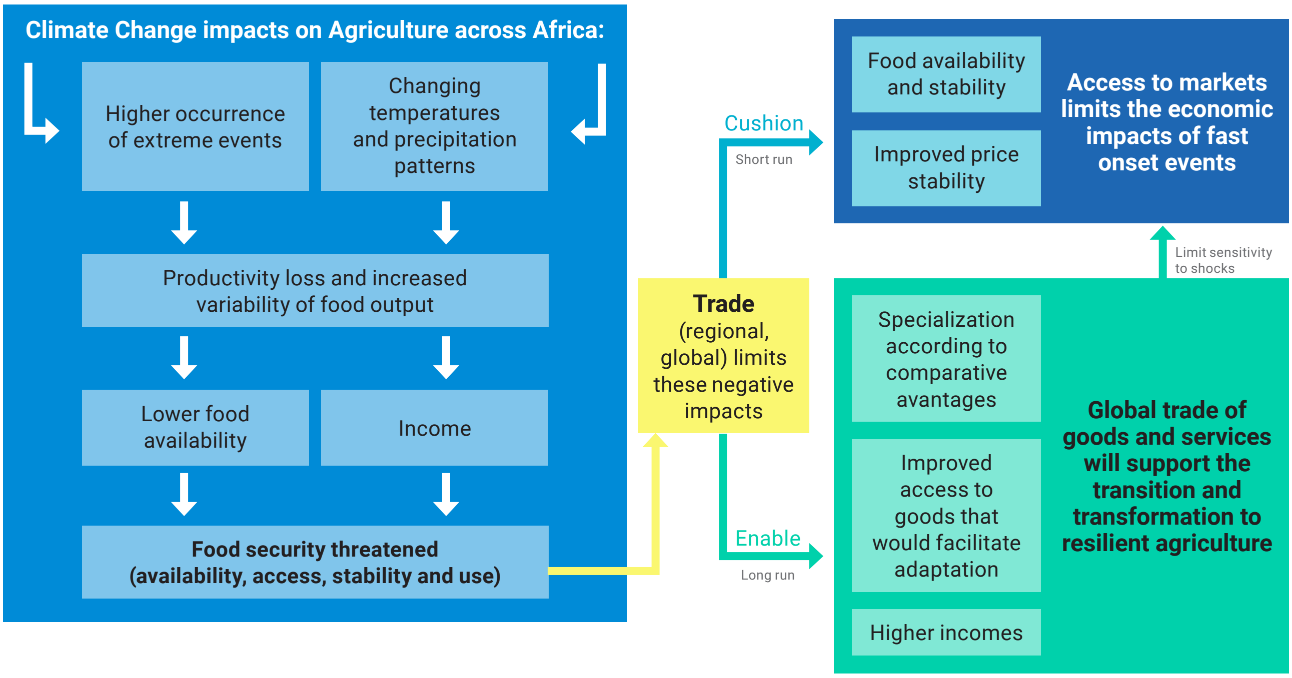
Climate change in Africa is a multi-sectoral threat: to agriculture, tourism, trade infrastructure (ports and other trade-related infrastructure) and coastal communities, especially urban ones. Here we focus on the impacts of climate shocks on the agricultural sector. The specific details of climate impacts on agricultural production and possible adaptation solutions are discussed in the Agriculture and Food Systems chapter.

As discussed in the Present and Projected Climates in Africa chapter, the distribution of hazards differs across regions and is expected to do so in the future. Trade across African regions, underpinned by open and transparent trade policies as well as well-performing and climate-proof infrastructure (ports, roads, railroads), can contribute positively to Africa's efforts to build resilience to climate change.

International trade and supply chains must be an integral part of our efforts to build climate resilience. Mainstreaming trade into climate adaptation strategies will lower the cost of adaptation while ensuring that countries can continue to use trade as a driver of development and poverty reduction."

Ngozi Okonjo-Iweala, Director-General, World Trade Organization
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Figure 2: Agriculture as cushion and enabler in developing resilience to climate change



Connections between climate change, food security, and trade

The adaptative capacity of populations in rural Africa, where poverty is greatest, is low. Extreme events will disproportionately affect poor populations in remote, arid and semi-arid areas.[6] For example, when a cyclone, flood, or drought hit Mozambique, per capita food consumption dropped by up to 30 percent—about 0.4 fewer meals per day per person.[7] In Zambia, the drought that accompanied the 2015–16 El Niño season decreased affected households' maize yields by about 20 percent and their income by up to 37 percent.[8] More broadly, the adverse impacts of natural disasters tend to disproportionately affect vulnerable groups of society: the poor and marginalized; women; and micro, small and medium-sized enterprises, many concentrated in rural areas.[9]

Climate change is projected to negatively impact the four pillars of food security—availability (e.g., through reduced yields on crop and livestock), access (e.g., through higher prices), utilization (e.g., through impacts on food safety due to increased prevalence of microorganisms and toxins) and stability (e.g., through increased frequency and severity of weather events).[10]

Figure 2 illustrates the channels through which climate change affects food security, and how trade contributes to adaptation. Specifically, trade can play two crucial roles in supporting Africa's food systems in the context of a changing climate. In the short run, trade cushions the volatility of food markets by providing a vital flow of supplies to regions that may see a sudden reduction in domestic production of food crops due to a climate shock. In the long run, the effects of a changing climate, along with ongoing urbanization, call for changes in crop and livestock patterns. Trade enables changes in comparative advantage, thereby helping the transformation of Africa's agricultural sector and broader economic diversification.

More broadly, international trade can also help create jobs and raise incomes, which strengthens individuals' resilience, not least by enhancing poor people's ability to purchase food. As many African countries are expected to become more heavily food-import dependent, increased trade in other sectors (including services, manufacturing, and other primary sectors) can help finance these food imports. The remainder of this section reviews evidence on trade and trade policy in fast-onset events from past and current episodes.

Evidence on food security under droughts and global crises: evidence from the past

A landmark historical example of the power of trade to alleviate food insecurity comes from the arrival of the railroad in colonial India. This example also serves to underscore the importance of hard infrastructure (ports, railroads, roads) to allow trade to cushion the effects of disaster events. Specifically, a study by Burgess and Donaldson (2010) showed that productivity shocks in the form of rainfall shortages—estimated to have caused between 15 and 30 million deaths during the period 1875–1919—almost entirely disappeared with the arrival of the railroad in colonial India.[11] The arrival of the railroad also significantly reduced the exposure of agricultural prices and real incomes to rainfall shocks.[12]

To play an essential role in supporting food security, trade must be underpinned by open, transparent and predictable policies that improve how food markets function, not least by allocating resources more equitably and sustainably. The role of trade policy in two recent examples of shocks to the food system is further discussed.

Photo: Kostenyukova Nataliya/Shutterstock

Food security under droughts: the Southern African drought of 2015–16

Box 1 illustrates the changes in trade patterns and policy reactions during the acute 2015–16 drought in Southern Africa. The region switched from being a net food exporter to being a net food importer. Policy responses to help consumers included the lowering of barriers on food imports. For cattle herders and farmers, policies included increases in support to key inputs and the temporary removal of the export ban on live cattle in Botswana, which aggravated the situation of cattle herders in other countries in the region.

The example in Box 1 shows how policy reactions to large shocks generate strong spillovers that require collective action to be controlled. This was also the case with the global crisis of 2008 and the COVID-19 pandemic.

Price hikes during global crises: the 2008 food crisis and the COVID-19 pandemic

During the 2006–08 food crisis, the major exporters of rice and wheat restricted exports. Export restrictions on medical equipment were enforced during the early phases of the COVID-19 crisis, and of vaccines more recently. Both episodes harmed African countries and illustrate the need for collective action to dampen global shocks. For example, the insulating behavior adopted by major exporters is estimated to have been responsible for 45 percent of the price increase of rice and 30 percent of the price increase of wheat contributing to the price hikes during 2006–08.[13]

Compared with the 2008 food crisis, export restrictions during the Covid-19 pandemic were short-lived and less pervasive. The affected goods only accounted for 5 percent of the world market of calories, down from 18 percent during the 2008 global food crisis. Critically, restrictions were short-lived, as most of them had been lifted or had expired by the end of April 2020. Major exporters of rice in ASEAN quickly removed restrictions on rice exports. These measures helped to prevent the pandemic from triggering a more far-reaching food crisis. Simulations show that an export ban on rice and wheat during 2020 (accompanied by relief in importing countries via a reduction in import tariffs of 25 percentage points) would have raised the average world price of these cereals by over 10 percent, resulting in an increase of 5 million at risk of hunger in Sub-Saharan Africa.[14]

The COVID-19 crisis also illustrates the importance of cooperation. Faced with a fall in the availability of essential goods (medical supplies, but also food) in international markets, some countries have tried to secure these goods by reducing import barriers while simultaneously restricting exports.[15] Global level estimates by Espitia et al. (2020) for food suggest that uncooperative trade policies could have multiplied the initial COVID-19 shock on trade by a factor of 3, with food-dependent low-income countries in Africa hit hardest.[16] Fortunately, many import-restrictive measures in the agricultural sector were short-lived.[17]

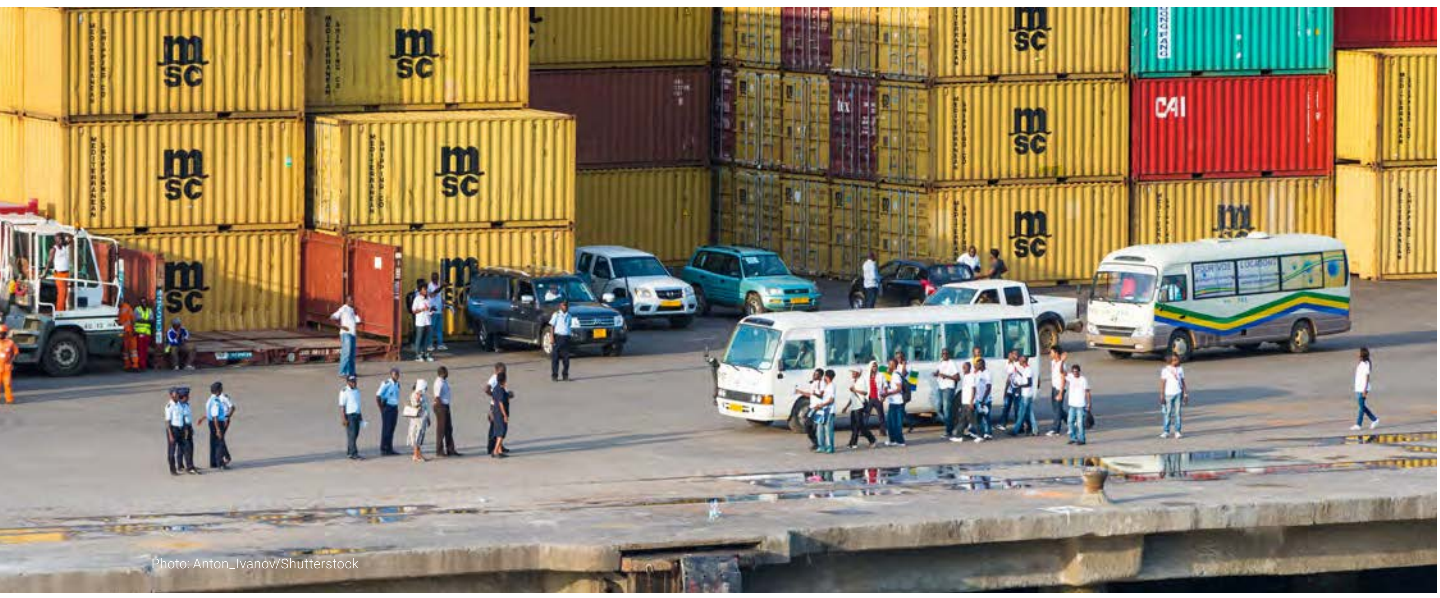
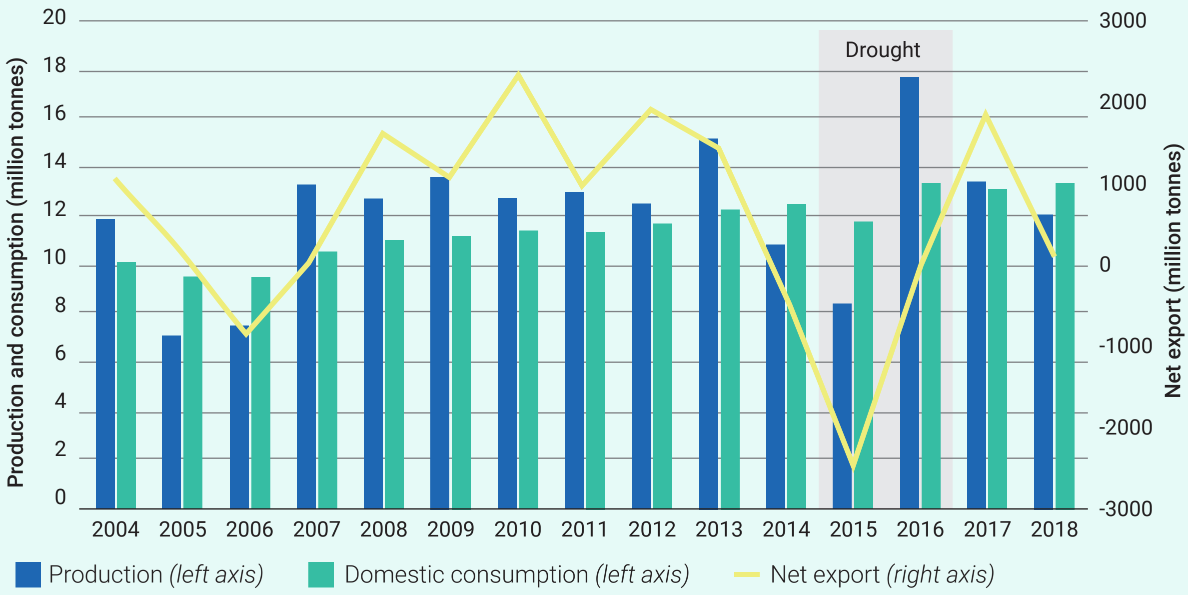


Photo: Anton_Ivanov/Shutterstock

Box 1: Agriculture during the Southern African Drought 2015–16

Southern Africa's maize imports rose as domestic output fell during the 2015-2016 drought



Source: Hepburn et al. (2021)
Note: Southern Africa includes Botswana, Eswatini, Lesotho, Namibia, and South Africa.

Droughts in Africa affect more people than any other natural hazard, especially the poor. With 43 percent of its area classified as arid, Southern Africa was particularly hard-hit by the 2015–16 El Niño-induced drought. At least 11 million people required urgent assistance as the decline in food production brought food insecurity, malnourishment, and stunting, affecting 30 percent of all children. Deficits in staple crops like maize (30 percent of caloric intake) forced poor pastoral households to purchase imported maize (see figure), the price of which had increased sharply because of the drought-induced currency depreciation. Nonetheless, sufficiently developed infrastructure allowed trade to help cushion the drought shock. Import restrictions on maize were lifted, improving food availability on domestic markets and attenuating price hikes.

The drought also sharply affected livestock, which is estimated to account for 35 percent of African agriculture. Government support relief packages included support for livestock feed and support for crop production inputs such as improved seeds, fertilizers, and farming implements. For example, in Botswana, the government doubled its subsidies to livestock feed to 50 percent and the export of live cattle was allowed to avoid cattle mortality. This put further pressure on struggling farmers in South Africa.

This episode shows that easing restrictions on food imports is an important policy response that governments can use to help consumers respond to sudden shortages by improving the availability of food on domestic markets and helping to attenuate sudden price spikes. Governments also need the flexibility to be able to temporarily increase support to producers when a shock occurs. In the longer run, governments need to support the provision of national and regional public goods like research for more resilient plant varieties to help boost yields sustainably, and early warning systems to better inform about extreme weather events (and other disasters like locust invasions).

Photo: gor Grochev/Shutterstock

Lessons from fast-onset events

Historical and contemporary evidence shows that in the short run, trade reduces the amplitude of a drought by moving food from places that have a food surplus to places that have a food deficit. In the case of the Southern African drought of 2015–16, the lifting of import restrictions led to an increase in maize imports, which helped poor consumers meet their food security needs. Historical evidence from colonial India also illustrates the key role of hard infrastructure in allowing trade to cushion the impact of rain shortfalls. However, policy responses to large contemporary shocks have sometimes increased the amplitude of a shock and undermined the role of international trade in matching supply and demand. During the Southern African drought of 2015–16, policies had spillover effects in neighboring countries. During the 2007–09 financial and economic crisis, export restrictions by major crop exporters amplified the shock. Similarly, during the COVID-19 pandemic, faced with a fall in the availability of essential goods (medical supplies, but also food) in international markets, some countries tried to secure these goods by reducing import barriers while simultaneously restricting exports. Collective action and policy coordination are essential to increase countries' resilience to shocks and avoid negative spillovers.

TRADE AS AN ADJUSTMENT MECHANISM TO CLIMATE-INDUCED REDUCTIONS IN CROP YIELDS

The slow onset of climate change is projected to harm agricultural production by reducing the yields of crops such as maize, rice, wheat, and others. Sub-Saharan Africa is expected to be the world's most severely affected region, with average crop yields estimated to decrease by 40 percent by 2080.[18]

Using spatial data on climate-induced reductions in crop yields, a number of recent studies have analyzed the related economic and social impacts, pointing to the importance of trade as an adaptation mechanism to climate change, alongside adjustments in production and urbanization.

As climate change has different impacts on crop yields within and across countries, this changes comparative advantage patterns in the production of crops. Related adjustments in production and trade can contribute to reducing welfare losses from climate change. A recent study shows that production adjustments in line with changed comparative advantage can substantially mitigate the negative effects of climate change.[19]

Gouel and Laborde (2021) estimate that climate-induced changes in crop yields could reduce welfare globally by one percent.[20] Adjustments in trade patterns and the choice of crop production contribute to reducing global welfare losses by 23 percent and 37 percent, respectively. In the case of trade, the ability to adjust import sources plays an important role in adapting to climate change. However, it is important to note that the impact of climate change differs substantially across countries. Net-food-importing tropical countries are severely harmed by negative productivity shocks and increased global food prices, while countries exporting agricultural products tend to gain thanks to improved terms of trade. Sub-Saharan Africa is estimated to experience an average welfare loss of around 6.5 percent, the largest among all regions, due to large decreases in potential yields on some key African crops such as cocoa and tropical roots, its dependence on food imports, as well as the high importance of agriculture for its economies.

Studies have also pointed to the important role played by trade in preventing hunger. One study estimates that under the current level of trade integration, climate change could add up to 55 million people globally who suffer from hunger by 2050.[21] The phasing out of agricultural tariffs, and other such trade-facilitating measures, could reduce the impact of climate change on undernourishment by 64 percent, which would correspond to around 35 million people not suffering from hunger because of climate change. The adaptation effect of trade is strongest for hunger-affected and import-dependent regions such as Sub-Saharan Africa as trade reduces agricultural prices and increases food availability. One study estimates that increases in global crop prices could raise malnutrition among households not employed in the farm sector by around 45 percent globally in a less integrated world economy, compared with a rise of less than 30 percent in a more integrated world where the most affected regions are able to import food from regions where climate change impacts are relatively less severe.[22]

Besides production and trade, labor mobility within and across countries is a third adjustment mechanism to climate change. A recent study estimates that climate-induced changes in crop yields could displace 12 percent of the population in Sub-Saharan Africa and reduce real GDP by 4 percent.[23] Lower trade frictions would strengthen agglomeration effects and lead to greater sectoral specialization between locations, reducing economic losses from climate change and fostering structural transformation in Africa through increased urbanization.

> **"Let's join hands in partnerships, in working together and addressing the calamities and challenges of the pandemic, but also the issue of adaptation to the changing climate."**
>
> **H.E. Prime Minister Abdalla Hamdok of Sudan**
> Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Photo: Fredy Thuerig/Shutterstock

POLICY RECOMMENDATIONS

International trade in goods and services can help lower the cost of climate adaptation in the short term and promote economic and export diversification in the long term. In addition to helping countries adapt to the impacts of extreme climate events and changing climate conditions, trade also strengthens countries' resilience to climate change by fostering economic growth and reducing poverty.[24] Yet, trade considerations have been largely absent from the adaptation components contained in countries' Nationally Determined Contributions (NDCs) under the 2015 Paris Agreement, let alone the National Adaptation Plans produced to date.

Africa is no exception in pursuing largely disjointed trade and climate adaptation policies and strategies. One glaring example of this is the absence of any reference to climate change or the environment in the African Continental Free Trade Area (AfCFTA) agreement established in March 2018 and effective from 1 January 2021. As a result, many African countries may be foregoing significant opportunities to bolster their climate adaptation strategies through proactive, forward-looking trade policies. In some cases, the pursuit of trade policies that are not aligned with the urgent need to adapt to a changing climate may even be undermining African countries' climate adaptation efforts.

The following action areas offer opportunities to help integrate trade and climate adaptation policies in Africa and ensure that international trade can support the continent's climate adaptation and economic diversification strategies. Integrating trade and climate adaptation policies calls for action by African countries, both at national and regional levels, along with action by all WTO members.

- **Improve the functioning of markets for food and agriculture:** In an interconnected global economy where global value chains span national boundaries, policy action, including in response to climate shocks, can affect producers and consumers in other countries. Governments should ensure that policies adopted in response to climate shocks do not undermine the competitiveness and resilience of food producers and consumers in other jurisdictions, while still achieving better climate and development outcomes. For example, governments that subsidize their farm sectors can seek to repurpose support in ways that improve delivery of public goods, and which minimize impacts on trade and markets. Major trading economies can usefully reform restrictions on food exports and imports to address objectives around food security and farm livelihoods both at home and abroad—for example, by ensuring that policies foster fair competition, help boost productivity and raise rural incomes, and contribute to climate mitigation and adaptation. Many types of policies that boost productivity sustainably are allowed without limits under WTO rules, such as farmer extension and advisory services, research, rural infrastructure, or pest and disease control. Governments can use these programs to redress historic underinvestment in the farm sector and improve resilience to future shocks.

- **Strengthen policies and institutions for sanitary and phytosanitary (SPS) measures:** As intra- and extra-regional trade in agricultural commodities is likely to increase with climate change, regulatory bodies that set SPS measures will have to be strengthened to deliver safe trade at least cost. This will be particularly critical in the face of new challenges brought about by climate change. Increasing temperatures, changing rainfall patterns and more frequent extreme weather events are expected to change the natural ranges of pests and diseases and disrupt the "predator-prey" relationships that normally keep pest populations in check. Sound SPS policies and institutions are a prerequisite for safe and efficient trade. Countries that are unable to provide traceability in the value chain and the necessary trading infrastructure such as certification and inspection services to ensure that their products meet SPS and other requirements may be excluded from markets overseas. The same challenges apply to trade in agricultural products within Africa. The Standards and Trade Development Facility (STDF) is a global partnership between the WTO and other international organizations that is helping African countries meet some of these challenges.

- **Reduce barriers to trade on goods, services, and technologies for adaptation:** Open and transparent trade policies are an integral part of a broader strategy to access high quality and low-cost goods and services that are essential to help the agricultural and other economic sectors to adapt to climate change. Examples of such goods and services include stress-tolerant cultivars, pesticides for weed control, early warning systems, equipment for renewable off-grid power generation, irrigation technology and related engineering and technical services, as well as agricultural extension services. Additional policy efforts—by African countries individually and by WTO members collectively—to reduce remaining tariffs and other trade barriers and facilitate trade could further enhance supply chains for climate adaptation goods and services, reduce costs, and accelerate the dissemination and deployment of climate adaptation technologies around the world.

  For Africa specifically, eliminating barriers to trade in adaptation goods and services would significantly reduce the cost of acquiring efficient, innovative, and competitive inputs that are critical to carry out countries' adaptation priorities.[25] Take import tariffs. In the case of lower and lower-middle income African countries, import tariffs on an illustrative list of 56 goods relevant to adaptation averaged close to 10 percent.[26] For specific goods, tariffs can be as high as 50 percent in some African countries. A group of WTO members is considering ways to advance work on liberalizing trade in environmental goods and services based on past efforts in this area, including the negotiations towards an Environmental Goods Agreement which were suspended in 2016.


Photo: SAPhotog/Shutterstock

- **Enhance the climate resilience of transport and other key trade-related infrastructure:** As discussed in the Transport and Energy chapter, climate change is projected to take a particularly heavy toll on the road system. To cope with heat and rainfall extremes, Africa will require substantial investment in transport as well as energy and communications infrastructure over the next few decades. To ensure spending on trade-related infrastructure delivers the best possible return and brings lasting development benefits, it is critical that investment plans consider the consequences of a changing climate. This calls for better understanding of risks and vulnerabilities, availability of more tailored data and information, as well as the development of guidance, standards, best practices, methodologies, and other tools in support of climate-proof infrastructure investment.

  The WTO-led Aid for Trade initiative, launched in 2005, can help mobilize investment in climate-resilient infrastructure. Aid for Trade aims to help developing countries, particularly LDCs, build the supply-side capacity and trade-related infrastructure that they need to implement and benefit from WTO agreements and more broadly to expand their trade. Since its launch in 2005, the Aid for Trade initiative has helped mobilize investments for building climate-resilient infrastructure. Aid for trade to build energy, transport and telecommunications infrastructure amounted to US$ 25 billion in 2019, representing 55 percent of overall aid for trade disbursements.[27]
- **Use economic integration policies to promote trade and economic diversification to reduce reliance on sectors that are highly exposed and vulnerable to climate change:** The proliferation of regional and global value chains has important implications for African countries and their ability to diversify their economies. Value chains provide an opportunity for African countries to integrate into global and regional markets by exporting just one part or component of a product, instead of having to develop the industrial base required to manufacture the entire finished product from scratch.

  Africa's participation in regional and global value chains is determined by factor endowments, geography, market size and institutions. But these fundamentals alone need not determine patterns of specialization across countries. To remedy the scarcity of capital, technology, and management skills needed to develop new economic activities, African countries should improve policies to attract foreign direct investment. To free domestic enterprises from the limits of domestic demand and local inputs and improve their access to new and expanding regional and global markets, governments should adopt trade facilitating and trade opening policies at home and negotiate better market access conditions abroad. Improving connectivity through transportation and communications infrastructure and introducing competition in these services can help African countries overcome remoteness or the disadvantage of being landlocked. Implementation of the AfCFTA offers opportunities to further develop regional value chains, including in more climate-resilient agricultural and manufacturing sectors. And participating in deep integration agreements can be a catalyst for institutional reform, especially when complemented by technical and financial assistance.[28]

  The Aid for Trade initiative focuses on economic diversification as being key to development and can therefore play a supportive role in helping African countries create an enabling environment to diversify their economies. In the context of the Aid for Trade monitoring exercise conducted in 2019, 97 percent of African respondents pointed to economic diversification as a priority.[29] African countries also recorded the highest share of responses saying they had seen progress in economic diversification since the launch of the Aid for Trade initiative.

In summary, African countries and their agricultural sectors are among the most at risk from the impacts of climate change. International trade in goods and services can help lower the cost of climate adaptation in the short term and promote economic and export diversification to reduce their reliance on vulnerable sectors in the long term.

To fully capture the potential benefits of international trade for climate adaptation, governments must work with individuals, SMEs, corporations, financial actors, and civil society to put in place trade policies that are fully aligned with, and supportive of, climate adaptation strategies and policies. Five action areas offer opportunities to do this: (i) improve the functioning of markets for food and agriculture; (ii) strengthen policies and institutions for sanitary and phytosanitary measures; (iii) reduce barriers to trade in adaptation goods and services; (iv) enhance the climate resilience of transport and other key trade-related infrastructure; and (v) use economic integration policies to promote economic diversification. Each area of opportunity can and should be tailored to the specific circumstances of African countries and to specific forms of participation in the regional and global economies.


Photo: Sunshine Seeds/Shutterstock

Drylands

▶ KEY MESSAGES

- **There can be no climate-adapted Africa without its drylands being climate-adapted.** Drylands cover two-thirds of Africa, with three-fifths of its farming lands, and are home to two-fifths of its population. They are warming at up to twice the global average rate, putting half a billion people at risk. Many of the most pressing challenges Africa will face this century will be disproportionately concentrated in the drylands and require nuanced climate-adapted development responses that are tailored to dryland characteristics. The gravity of the problem and the specificity of the possible solutions requires dedicated focus by a dryland-specific entity or initiative, instead of dispersed efforts.
- **A positive vision of adapted African drylands is essential.** Misleading negative imagery has obscured the potential for value creation based on the endowment of space, solar energy, minerals, water resources, biodiversity, and rich cultural heritages, as well as people, including women and youth, in drylands. Recent decades have shown that livelihoods based on natural capital can deliver significant economic returns and reduce poverty locally. The key elements for successful resilience building are now well-understood but need patient investment and equitable global policies on trade and capital movements.

Source: Authors

- **Large, coordinated initiatives are needed to take successful climate-adapted development to scale in drylands, modelled for example on the Great Green Wall initiative.** Transformational change will be achieved by applying these known approaches in new initiatives based more on labor and physical capitals (such as conservation and using tourism, renewable energy, and sustainable irrigation), and using technical and social innovation to leapfrog past development pathways, whilst remaining sensitive to local aspirations, knowledge, and values in the diverse drylands.

> **"The African continent is now the prey of droughts, of desertification, of flooding. We see our biodiversity being destroyed, we see deforestation progressing, and observe many factors harming our fragile ecosystems."**

H.E. President Macky Sall of Senegal
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

Drylands are regions where primary production is generally limited by water availability.[1] They cover 46 percent of the global land area and are home to three billion people.[2] Nearly a third of global drylands occur in Africa, where they cover 19.6 million square kilometers (km^2), and nearly two thirds of southern, western, eastern and northern Africa (Figure 1). This area is home to over 525 million people in Africa (40 percent of the population), growing by about 3 percent per year (faster than the African average of around 2.5 percent), with a demography firmly skewed toward the young.

Biophysically and socially, the drylands are diverse (Table 1). Biomes range from woodlands and savannas on either side of central Africa's equatorial forests, to Mediterranean shrublands in the north and south, and enclosing the hyper-arid Sahara in northern Africa and the smaller Namib in the south. This diversity means that the details of livelihoods are very context specific, but land use is broadly dominated by nomadic, transhumant or sedentary pastoralism, rainfed cropping and agroforestry, and localized areas of irrigated farming; the livelihoods of over 200 million people in Sub-Saharan drylands depend on cropping.[3] The range of crops has tended to narrow since the colonial period, but there are still diverse uses of local biodiversity for food and medicine that are important to local economies. Economically, in some regions, tourism (often associated with conservation reserves) and mining dominate the market economy, but only a small proportion of the capital from mining is captured locally.

Drylands are generally seen as marginal environments characterized by challenging agroclimatic conditions and endowed with limited resources to support primary production activities, resulting in hotspots of natural resource degradation.[4] The drylands of Sub-Saharan Africa are the most vulnerable to food insecurity compared to other global drylands.[5] The remoteness of many drylands puts them far from centers of governance, and the rule of law is often weak. The relative remoteness from political processes also pre-disposes them to loss of resources to powerful and often divisive groups, and compounds the fragility of livelihood strategies, due to the social and political marginalization of many dryland inhabitants.[6] Combined with the unpredictable supply of natural resources, this increases the risk of high levels of conflict that further exacerbates the vulnerability of local dryland populations. These are negative narratives which require balancing with opportunities, but there is no doubt that drylands in Africa are home to a large share of the region's poor, as well as many of those lacking access to basic services, such as health care, education, water, and sanitation.[7]

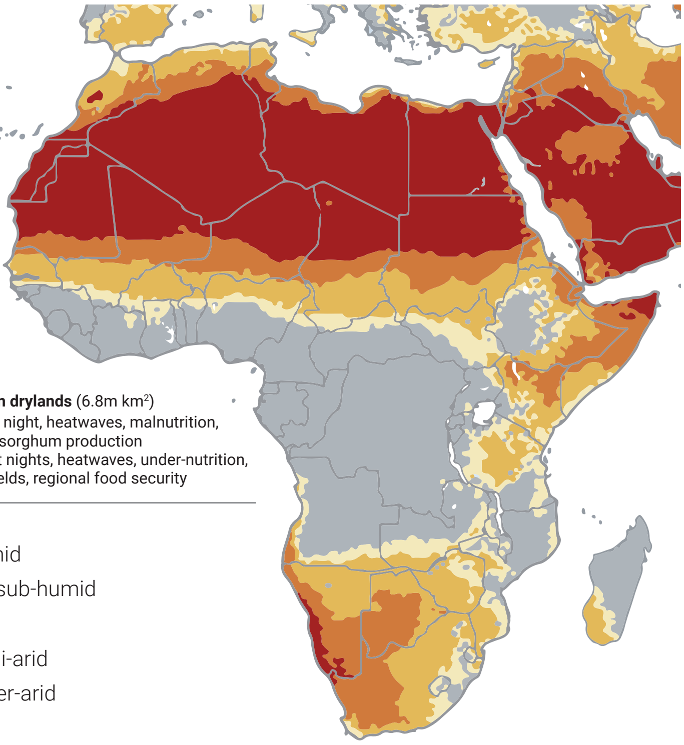
This chapter reviews the impacts of climate change in African drylands in the context of other major biophysical and social trends, proposes a positive vision for a future for drylands largely centered on climate-adapted development, and identifies key opportunities for successful adaptive actions.

Table 1: Key characteristics differentiating drylands in north, west, east, and southern Africa

North African drylands	
Area: 7.5 million km^2 (4.6 million hyper-arid), 99% of region	
Major land uses: Grassland 9%, Wooded 3%, Crops 7%, 'Barren land' 77%, Urban <1%	
Out migration 1970s/2000s: 140,000/319,000 people per year	
West African drylands	**East African drylands**
Area: 6.8 million km^2 (2.1 million arid), 53% of region	**Area:** 3.3 million km^2 (1.1 million dry sub-humid), 47% of region
Major land uses: Grassland 12%, Wooded 24%, Crops 8%, 'Barren land' 51%, Urban <1%	**Major land uses:** Grassland 25%, Wooded 44%, Crops 6%, 'Barren land' 12%, Urban 1%
Out migration 1970s/2000s: 224,000/508,000 people per year	**Out migration 1970s/2000s:** 152,000/241,000 people per year
Southern African drylands	
Area: 2.2 million km^2 (1.4 million semi-arid), 84% of region	
Major land uses: Grassland 28%, Wooded 59%, Crops 4%, 'Barren land' 7%, Urban 1%	
Out migration 1970s/2000s: 5,000/17,000 people per year	

Sources: FAO (2019). Trees, forests and land use in drylands: the first global assessment. Food and Agriculture Organization of the UN, Rome; & CIESIN (2011). Migration and Global Environmental Change. UK Government Office for Science, London.

Figure 1: Projected changes in drylands of Africa, under 1.5°C and 3°C global average rise in temperature



Source: IPCC (2019). Climate Change and Land. Special Report, Intergovernmental Panel on Climate Change, Geneva, Switzerland; & IPCC (2018). Global Warming of 1.5°C. Special Report, Intergovernmental Panel on Climate Change, Geneva, Switzerland.

CLIMATE CHANGE AND OTHER MAJOR BIOPHYSICAL AND SOCIAL TRENDS

In general, the risks of climate change to natural and managed ecosystems are expected to be higher in drylands than in humid lands.[8] Observations show that warming over drylands has already been 20-40 percent higher than in humid areas.[9] Heat waves and rainfall variability are increasing, both month to month and year to year, making cropping, pastoralism, and water management even more challenging.[10]

Looking forward, the Intergovernmental Panel on Climate Change (IPCC) projects that regional warming in African drylands may be up to twice the global average temperature rise (for instance, mean warming in southern African drylands is projected to be 3°C when global average temperature rises by 1.5°C, and 3.2-4°C if it rises by 2°C).[11] There are some differences among drylands regions (Figure 1), but in all regions the effects of a rise of 2°C or more are significantly worse than those of a 1.5°C rise. Key impacts of climate change will include reduced water availability, increased occurrence of vector and water-borne diseases, reduced crop and livestock productivity, and damage to transportation infrastructure and buildings.[12] Little overall change in the biophysical extent of drylands is expected with climate change, though they may expand in southern Africa and possibly retract a little in the Sahel.[13] However, the effects on land use and habitability for humans and livestock of rising heatwaves, extreme droughts, and water availability will change land use. In the absence of adaptation and despite urban migration, population growth means that the number of people dependent on agriculture and vulnerable to these effects is likely to increase by 40-80 percent from 2010-2030.[14]

The outcomes of climate change in African drylands are driven mainly by the vulnerabilities of its population that collectively lead to a low human development index.[15] After decades of improvement, food insecurity and undernourishment are on the rise in almost all subregions of Sub-Saharan Africa. In drought-sensitive Sub-Saharan African countries, the number of undernourished people has increased by 46 percent since 2012.[16] The year 2019 recorded a deteriorating food security situation in Sub-Saharan Africa, as well as increased population displacement and the increased food insecurity of those displaced people.[17] As a result, adaptation is essential but cannot and should not be addressed separately from Africa's development – the target must be climate-adapted development.[18]

BUILDING BLOCKS FOR A POSITIVE DRYLAND FUTURE

The African Union calls for a new African narrative, "inspired by the spirit of a vibrant Africa that drives and funds its own agenda in partnership with like-minded entities,"[19] which activates Africa's diverse options.[20] In the context of drylands, the first step towards this narrative is to envision what the African drylands and their communities could look like in a climate-adapted state (see Box 4 at the end of the chapter). An evolved version would have much greater community ownership and result from a nested process of co-creation across the diversity of African drylands and actors.

Much is understood about how to achieve sustainable land management and tree planting for land restoration, and these measures have been regarded as a surrogate for tackling many drylands resilience challenges, such as soil fertility, livestock feed, fuel wood, water recycling and biodiversity conservation. Since the 1970s, multiple agro-environmental, technical and institutional initiatives have been undertaken on this basis, but top-down interventions led and implemented by government agencies have often been ineffective,[21] undermining local equity.[22] Major UN reports show that community-based approaches drawing on local knowledge work better,[23] and use less resources, as long as local people obtain direct benefits. Many successful examples (such as the "man who stopped the desert" in Burkina Faso;[24] acacia gum plantations in the Ferlo-Sahel zone of Senegal; and the farmer-managed natural regeneration around Maradi in Niger of *Faidherbia albida*, a tree with multiple uses, especially as a food and fodder store in times of scarcity[25]) all deliver direct benefits that build the adaptive capacity of people. Key success factors synthesized by the World Bank and leading African research teams (Box 1) are now well understood, though by no means universally applied.

Improving the climate resilience of African dryland livelihoods depends on more than land management. There are well-established priorities for, and approaches to, improving the resilience of pastoral, agro-pastoral, and agroforestry productivity in the face of climate change, and the resilience of associated local livelihoods. Although much conventional development is focused on the narrow range of species exploited for industrial agriculture and its value chains, there are additional opportunities to apply local knowledge to grow neglected local species that are climate tolerant and get them to market, such as cassava bread in West Africa,[26] teff in Ethiopian cuisine,[27] rooibos tea in southern Africa, or the faba bean in northern Morocco. There are other livelihood opportunities based on biological resources, including payment for ecosystem services such as carbon sequestration and biodiversity protection, wild harvest of medicines, and tourism based on wildlife, culture, and landscapes.

However, real transformation for climate-adapted drylands requires a much larger shift, building on small-scale adaptation of local land-based livelihoods to create and link to new markets, engage other dryland assets at scale, and diversify into other forms of livelihood. Several key dryland opportunities need to be addressed.

All photos provided by the authors

The Covid-19 crisis unfortunately has cast a shadow on the climate crisis, and in the meantime the impact of climate change is growing"

H.E. President Mohamed Bazoum of Niger, Chair of the AU Climate Commission on the Sahel
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Box 1: Key lessons for improving the resilience of dryland livelihoods[28]

All photos provided by the authors

Supporting the adaptive capacity of dryland communities

- Institutional and regulatory reforms at national and regional levels often need support, such as tenure reform or devolved governance.
- Transformation in major initiatives require skills for strong participatory engagement of stakeholders by decision-makers, multi-stakeholder partnerships across sectors and levels, capacity mobilization, and engaged participatory action research to speed up learning.
- Support to bolster the capacity of local organizations, institutions, and governments is essential.
- Farmer and community-led approaches are more successful and cost less than large scale centrally managed schemes that have often failed, and they can often be better tailored to local changing environments.
- The role of youth, women, and other marginalized groups is important for equity.
- Communities must realize tangible local benefits in the short and long run.

Restoring and improving dryland resilience

- In addition to improving productivity and improving climate resilience, dryland restoration also delivers carbon sequestration and biodiversity benefits, although they are still hard to measure.
- Livestock pastoral systems can increase production and resilience through the integration of animal health, land use, and markets. There is a need to enhance the mobility of herds where feasible; develop livestock early warning systems; and to add alternative livelihoods including those based on payments for ecosystem services.
- Farming based on crop diversity can add varieties and hybrids, improve management of soil fertility and water, and promote sustainable irrigation, especially at small scale and with access to markets.
- Natural resource management should promote Farmer-Managed Natural Regeneration, especially the role of trees, and aim to add value to tree products locally to improve livelihood resilience.
- Native species are beneficial as adding species improves resilience; local knowledge and innovation can drive success in the face of local environmental changes.

Markets

To build better livelihoods, and to enhance African food security, local producers need to connect to markets in ways that retain significant benefits locally. While these can be local markets, greater benefits often come from connecting with value chains into African cities and globally. Data on the effects of food value chains in Africa is still limited and mixed,[28] but some global value chains that originate in drylands currently add very limited local value (only one percent, for instance, for cotton from Burkina Faso).[29] Other value chains are national (for instance, sorghum and millet), but profits are still essentially exported out of drylands.[30]

The case of the Ethiopian crop teff illustrates why African producers should ideally supply African urban markets (Box 2), although for new products, some of the problems can be mitigated through blended finance models that ensure significant local ownership of the profits, in production, aggregation and processing. Such models, recommended by the Organisation for Economic Co-operation and Development (OECD), are being tested by the Global Environment Facility (GEF) and other agencies and require that all lessons of Box 1 and supportive policies are implemented in a coordinated way.[31] The establishment of such value chains can create a diversity of ancillary livelihoods at all stages from land restoration through to processing, fulfilling the need for diversified new livelihoods that are less reliant on natural capital, and more on human and physical capital, in the face of rising populations and climate change.[32]

Box 2: Local crops, global markets - the case of teff

The case of the Ethiopian crop teff (*Eragrostis tef*) highlights the double-edged sword of global value chains. Teff is a non-conventional grain that is important for national food security in Ethiopia, but has reached global markets due to Africa's diaspora and its low gluten value.[34] Although domestic market can benefit poor producers,[35] the benefits of increased export revenue are captured largely by food distributors and storage operators.[36] Teff is now increasingly grown around the world (for instance in the US, Europe, and Australia), but patents on teff processing held in Europe have prevented Ethiopia from benefiting from product sales.[37] A focus on delivering climate-adapted, neglected local crops to African rather than global markets may be a more resilient strategy for new initiatives.


Photo: Dennis Wegewijs/Shutterstock

Water and irrigation

According to the World Bank, irrigation is technically feasible and financially viable on 5-9 million hectares of Sub-Saharan drylands.[38] This potential is not being used to boost agriculture and other economic sectors, whilst improving resilience to climate change and drought. These World Bank analyses show that small-scale irrigation offers the most important opportunities to improve agricultural water management in drylands, with four times the potential of large-scale irrigation. Well-managed, small-scale irrigation supported by off-grid solar energy could resolve many unused opportunities to grow food, extending growing seasons in places where dry seasons can last nine months of the year, as well as protecting against drought. Regionally coordinated small-scale irrigation schemes with distributed energy supplies, linked to grower cooperatives and market developments, will benefit many households and increase the resilience of a larger part of the population, compared to large-scale schemes based on building large dams.

Box 3: How energy access can enhance livelihoods

Using solar dryers to dehydrate cassava and increase its shelf-life enables producers to hold their harvest and sell only during peak demand to maximize earnings. This is an example of a mitigation investment in clean energy that can power adaptation through value-added agro-systems that unlock socioeconomic opportunities. Converting raw cassava to dry cassava and milling it to cassava flour (a finished product) using decentralized solar or micro-hydro-powered millers has been proven to increase incomes by 150 percent, compared to cassava that is sold raw after harvesting.[43]

Energy resources

Energy access is a key developmental challenge and opportunity for Africa, especially in its drylands (Box 3). Many African countries are still importers of energy. Rural areas have low access to electricity and a high reliance on biomass fuels, leading to wood extraction and charcoal use that exceeds tree production, especially in drylands.[39] This reduces the resilience of local communities and at the same time fails to capitalize on the energy transition. A coordinated effort to establish local grids can help dryland communities leapfrog the power supply challenges of low-density settlements. Innovative blended public-private financing, like the African Development Bank's Africa Renewable Energy Fund and the Development Bank of Southern Africa's Equity Fund for Small Projects Independent Power Producers, could be used to enable local ownership and local benefits.[40]

Potentially, these local grids could aggregate surplus production to supply the needs of African cities and (less likely) Europe. Early efforts in the form of DESERTEC, which sought to export solar and wind energy to Germany from North Africa, folded in 2014 due to a mixture of political risks and cheaper renewables in Europe (though these large-scale export ideas persist) indicating that markets within Africa are likely to be more secure.[41] In some areas, surplus energy could be aggregated to support green minerals processing from the many mines in drylands, enabling African industry to add value to its primary resources.[42]

“If we are to allow adaptation action to improve and really be successful, we need national, whole-of-government approaches where adaptation needs are duly considered from the outset in national priority setting”

Janine Alm Ericson, State Secretary for International Development Cooperation, Sweden
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021


All photos provided by the authors

Diversification and integration

To be adaptive and viable, the foregoing examples could benefit from multiple synergies among sectors and livelihood streams, with the potential to spin off many diversified livelihoods. Integrating livelihood systems across sectors or a truly integrated landscape management approach are not new ideas but are not widely pursued in development, which is too often sector-based.[44] Integrated landscape management can bring diverse landscape-based activities such as conservation, tourism, pastoralism, farming, water use, and energy production into regional approaches that create synergies among the land uses and help to resolve land use conflicts. With a population growing at a rate that will probably outstrip the ability of purely agricultural livelihoods to support all inhabitants, creating jobs is vital. Understanding the potential synergistic links among actions (for example, renewable energy for small-scale irrigation, as well as local energy access and telecommunications to enable marketing and early warning) can alter what may otherwise be unduly pessimistic appraisals of economic and social returns when assessed sectorally (for instance, for irrigation alone[45]).

OVERCOMING CHALLENGES

To unlock this potential to transform the resilience of drylands at sufficient scale to adapt to climate change, important challenges need to be acknowledged and addressed.

Fragmented efforts and partial solutions

Adapted drylands with resilient communities and livelihoods cannot be achieved piecemeal by sector or individual projects. The African Union highlights that fragmentation of effort is a key challenge for adaptation, especially for drylands with their limited resources, limited connectivity to agencies that might help coordination, and relatively low human capital to help network multiple initiatives.[46] There is a massive gap in adaptation finance,[47] and pan-African governance activities occur a long way from the drylands. Funding in three- or five-year project cycles damages continuity and acts against concerted scaling. Conceptualizing climate-adapted development options in silos means that synergies are missed, and financing may appear non-viable, as noted above.

Recent experience demonstrates that large initiatives such as the Great Green Wall Initiative (GGWI) provide a vehicle to bring multiple funding sources to bear in a framework that can allow the many elements of system success to be pursued together, and over longer time periods (see GGWI Insert). Despite a rocky, top-down start, the African Union today sees the GGWI as proof that Africans can set an ambitious target and progress towards achieving it, at the same time as showing the power of partnerships, local participation, and ownership.[48] Other large-scale restoration initiatives, such as AFR100, which targets US $1 billion in reforestation with support from EU countries, GEF, the World Bank, and private sector finance, could also serve as vehicles in which all of these elements are delivered as a coherent whole. Such approaches to adaptation should be extended to other opportunities in drylands at a system-wide scale, such as energy, irrigation, mining and processing, or major multi-use wildlife corridors and tourism.

Because drylands often have high costs to deliver products into more populated areas, it is important to choose initiatives that are in some way place-based. These could include, for instance, dryland tourism experiences that depend on landscapes or wild biota that only occur in drylands; irrigation possibilities that depend on water resources in drylands, that may be linked to benefits of isolation from pests and diseases; solar energy resources that can exploit space and solar intensities available in drylands; mineral resources that are physically located in drylands; or dryland cultivation of local neglected species, linked in a coordinated way to local, African urban, and global diaspora markets. These sorts of initiatives are usually developed and controlled by external sources of finance, so blended finance models need to be deployed to leverage significant local ownership of the profits, as emphasized by the OECD.[49] Supporting the capacity and engagement of youth and women is vital; this includes education of girls and recognizing that both youth and women may be disempowered without reliable access to land.[50]

All photos provided by the authors

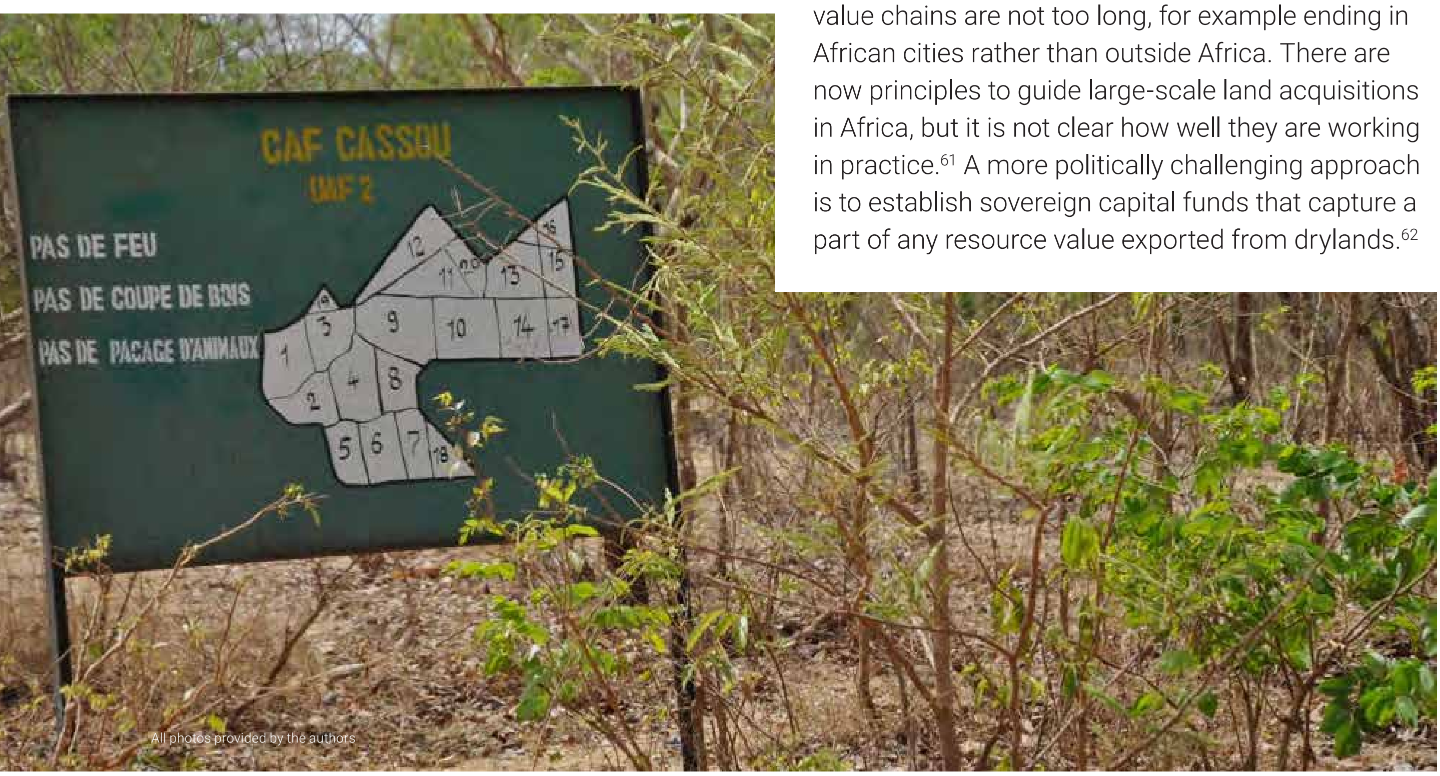
Conflict

Many of Africa's longest running conflicts are associated with drylands, arguably because drylands are often the hinterlands of nations, being remote with poor infrastructure or in border areas where countries struggle most to maintain control over their territories and where arbitrarily drawn, post-colonial boundaries exacerbate this issue. Many Africans despair of progress whilst conflicts keep recurring; they point to the reality that, at the same time as developed countries are providing valuable support for development, through complex supply chains some are trading in what become uncontrolled arms that fuel the conflicts.[51] Conflict may be exacerbated by climate change, as well as poverty, competition for limited resources such as water, and interactions with mining. Whether each of these is causal is contentious, but each plausibly and synergistically contributes to conflict in drylands.[52] The World Bank has shown how mining can have both positive and negative impacts on local communities[53] and on local conflicts, in ways that point to potential policy responses like enhanced corporate transparency that must be at least in part enacted and enforced by the global community.[54] There is no silver bullet for ameliorating conflict in drylands, but a series of coordinated actions within a long view, such as those listed in Box 4, can gradually enable greater security.

Capital leakage

There are many ways in which capital is exported from drylands, undermining adaptive capacity. Genetic resources are patented in, or trafficked to, rich countries. Industrial agricultural developments may be owned internationally (such as biofuels in Mozambique drylands[55]), and they may sell into global value chains with significant capital export.[56] Land acquisitions move control of natural resources offshore, with implications for energy use.[57] In the case of mining, most benefits from extractives, in an African context, are fiscal and national, and the World Bank showed that *"the size of resource-related intergovernmental transfers to local communities has been modest so far"*.[58] This is affirmed by a more extensive World Bank analysis that also points to policy responses.[59] Although the analysis is not dryland-specific, mines occur widely in the drylands where risk factors like weak governance are high and modest changes in capital retention have proportionally large effects for the marginalized poor.[60] In practice, not only do profits often go to overseas investors, but even what stays in Africa mostly leaves the drylands.

Whether national or global, all these processes export capital that is not re-invested in drylands. The creation of value chains that keep significant control locally can help; this is done more easily when value chains are not too long, for example ending in African cities rather than outside Africa. There are now principles to guide large-scale land acquisitions in Africa, but it is not clear how well they are working in practice.[61] A more politically challenging approach is to establish sovereign capital funds that capture a part of any resource value exported from drylands.[62]



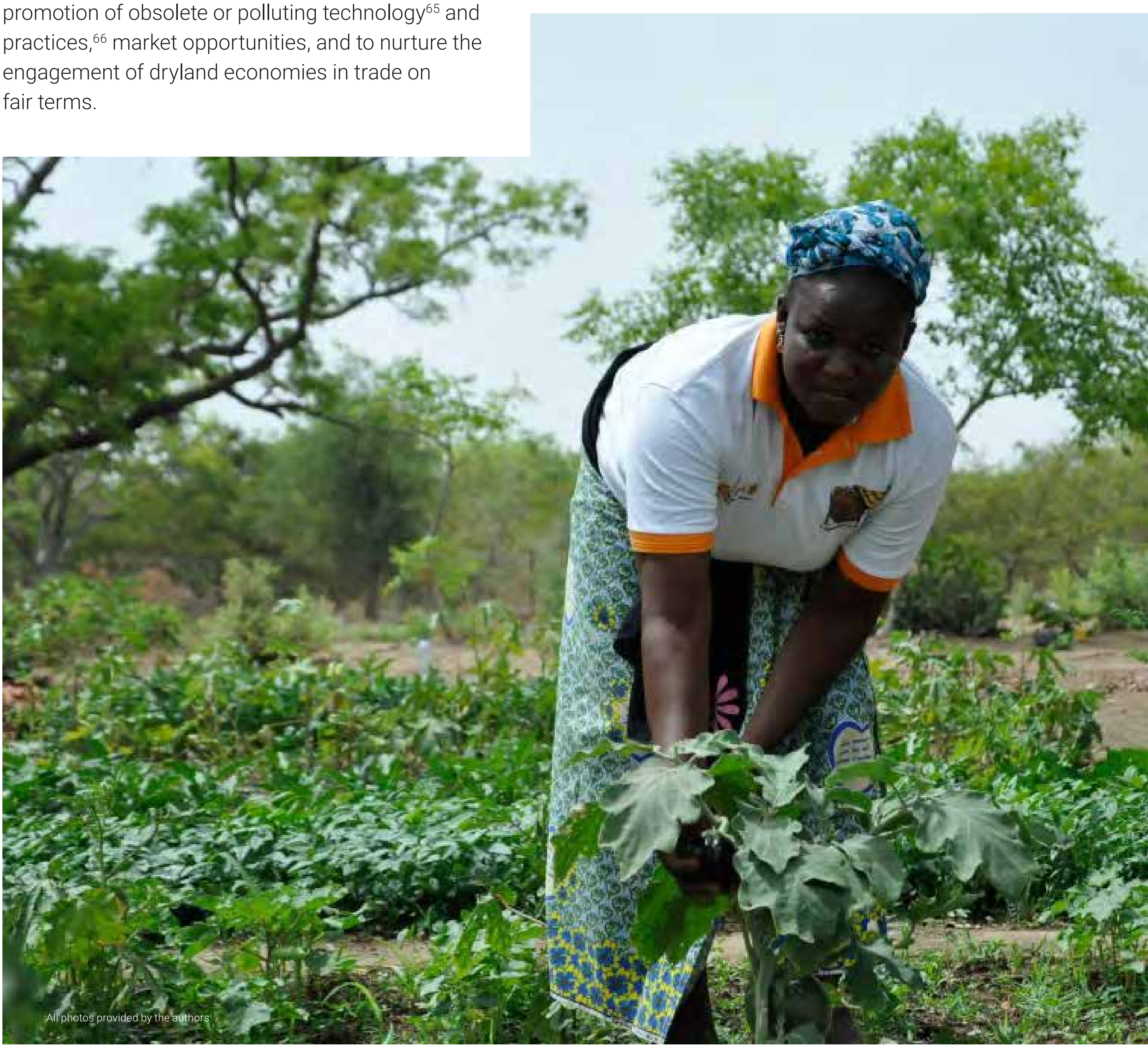
All photos provided by the authors

Global interactions

Whilst there are actions that African countries can take to build resilience in drylands, global support is necessary to reduce accidental and deliberate interference with local processes, and to enable equitable participation in global markets. Further work is necessary through international institutions such as the UN Convention on Biological Diversity (for fair patenting) and the World Trade Organization (for market access rules). New institutions may be necessary to oversee how multinational corporations and non-African governments affect African drylands futures, for instance through investments and related value chains,[63] transparency in resource extraction,[64] promotion of obsolete or polluting technology[65] and practices,[66] market opportunities, and to nurture the engagement of dryland economies in trade on fair terms.

Social protection

Global support will also be needed for humanitarian aid and disaster relief in the African drylands for some time.[67] Framed within support for the expansion of national adaptive safety nets, especially for lifting the poorest from poverty, contingent finance for short-run humanitarian assistance can be delivered with an eye to developing greater resilience and adaptive capacity, not merely on restoring the status quo. This requires patient investment, tailored for the diversity of circumstances, and a focus on the issues raised here that require particular responses in drylands.[68]



All photos provided by the authors

Box 4: A potential future for climate-adapted African drylands

What might the African drylands look like in 2040? This vision of the future draws on the scenarios of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.[70]

The African drylands provide all their inhabitants with key basic needs, including food, water, and energy security; shelter; access to health and education; and peace. Their environment is thriving despite climate change, with diverse, prosperous livelihoods for all community members, especially the youth and women.

Specifically, the African drylands have fully functional governance systems committed to creating unity of purpose and to developing physical and institutional infrastructure that efficiently services all citizens. A core population of farmers is producing a highly diverse, climate-adapted mix of crops, tree products, and livestock as suited to their context – in some areas, irrigated with cheap renewable energy and carefully managed water supplies. These are mostly small-holdings, with cooperatives to aggregate surplus production, and sell profitably and locally to the expanding African urban middle-class who are keen on African native products, as well as – on their own terms – to global markets.

These forms of agriculture are operating around many medium-sized dryland towns where most of the population is engaged in other livelihoods, including renewable energy, mining, tourism, manufacturing with a focus on local needs, food processing, and medicinal and textile industries, mostly locally owned but aggregated to scale. A significant service sector that ensures health and education is available within and outside the towns. It delivers use of geospatial science and technology and other digital services and supports strong peer-to-peer learning for resilient dryland systems in Africa and globally. Some dryland youth are returning to the land, many others are finding new livelihoods in the nearby towns and thus staying close to their families. Still others are linking into global markets, partly through the African drylands' diaspora. Net out-migration has stopped, with a stabilized ebb and flow of people moving between the drylands and Africa's great cities.

Countries have instituted devolved or decentralized governance arrangements that empower local decision-making within provincial, national, and pan-African objectives that are a co-creation of government policy and local input. Sovereign capital funds established outside short-term politics are reducing capital leakage from the drylands and re-investing in growing dryland environmental, social, and human capital.

A series of visionary initiatives exemplify and effect these arrangements, building on the GGWI in the 2020s that successfully delivered a regional vision of massive re-forestation, implemented under local control and supported by external capital that started as aid and loans, but became private capital for carbon and biodiversity. By the 2030s, other such flagship activities, supported by the sovereign capital funds, had been established. By 2040, these include widespread local renewable energy in lower productivity lands, locally owned but connected together through regional organizations; several significant regional irrigation districts use this energy to pump or desalinize water through cooperatively-owned infrastructure for production and marketing; a green minerals processing industry adds local value to what is mined in the drylands; and a continent-wide integrated corridor links conservation, wild harvest, culture and tourism livelihoods; all deliver core jobs and cultural confidence, as well as adaptive capacity for climate disasters.

Looking back, efforts to establish a positive future faltered through the 2020s as regional conflicts continued to flare in and around the drylands, often inflamed by financial or political interests driven by external actors taking advantage of poverty, as well as climate change. But a virtuous cycle from improving food security, declining inequality, more diverse livelihood options, as well as social safety nets that reduced the impacts of rising climate disasters, and governance systems that gave diverse dryland communities a genuine say in their own futures, meant that people felt more secure and in control, and less willing to be lured to be part of, or endure, disruptive insurgencies or petty dictatorships. As the African Union became a more effective projector of African priorities, countries globally helped by ensuring their companies and political interests did not undermine the improvements in Africa. The African Union's Drylands Assembly was established in the 2020s, drawing representatives from all African drylands; it now has a secretariat with significant analytical capability, and helps to ensure that pan-African policy is nuanced appropriately in the different drylands.

All this benefitted Africa as a whole, but its drylands particularly, as modern communications and energy lessened the effects of remoteness and lack of voice. And it benefitted the rest of the world as Africa took its place in the global economy, contributed to controlling climate change, and saw refugee flows cease.

Voice of drylands

Africa has developed a more coherent voice in the past two decades, with pan-African initiatives such as the African Union, the African Continental Free Trade Area, African Common Position in global negotiations, and the Africa Climate Change Strategy.[69] All of these have the potential to influence drylands positively, for example by opening up new markets. However, even where the challenges being faced are similar to other parts of Africa, the nature of drylands demands dryland-specific implementation. Specific institutional arrangements that provide drylands with a voice at the African level, as well as within nations, are therefore vital. This is an extension of the need for local empowerment in decision-making that has been shown to be a key success factor in restoration activities.

POLICY RECOMMENDATIONS

Large initiatives for African dryland resilience like GGWI and AFR100 currently tend to be founded around a notion of restoration, whereas climate-adapted development needs to capture transformative opportunities and value creation. Dryland regions are not places of endemic famine, shattered societies and policies, where deep transformation is impossible. In general, African drylands are well-endowed with space, solar energy, minerals, water resources in many areas, carbon storage capacity, biodiversity, spectacular landscapes, amazing cultures, and people among many other potentially positive resources. They do face many challenges – population growth, competition for land, climate change, poor governance and conflict, among others. But this should not inhibit a vision for transformation at scale (Box 4), informing realistic programs with the potential to trigger a virtuous cycle that can stabilize and improve the security, well-being, and prosperity of dryland inhabitants.

The necessary suite of interlinked actions can be summarized into a small set of elements of success (Table 2) that adaptation investment should immediately support in all interventions, including existing major initiatives. The diversity of African drylands means that all these actions require tailoring to local and national contexts, which is part of why local empowerment in the decision-making is so important. Particularly importantly, many of the key underlying challenges, such as effective local empowerment and the eventual reduction of the drivers of conflict, require that all these issues be addressed simultaneously at scale, to drive systems transformation towards improved resilience throughout the drylands.

All photos provided by the authors

Necessary as these immediate investments are, by themselves they are not sufficient, as the previous section showed. Several key underlying challenges, exacerbated in the drylands, also require addressing at a larger and more strategic scale to create an environment in which these elements of success can thrive and drive wider drylands resilience, and eventually reduce the pressures for conflict. To this end further key transformative interventions are needed:

- **Envision and invest in a suite of new initiatives** as additional vehicles for taking an integrated approach to development across sectors, regions, and scales. These could extend opportunities like energy, irrigation, conservation corridors and tourism, mining and processing to drylands, but must meet the principles of local empowerment within national support and environmental sustainability. They will emerge from a positive vision for African drylands as a whole (for instance, Box 4), replicated regionally.
- **Provide vital support from the global community** to achieve successful and durable adaptation in the drylands. Much of this depends on providing constructive investments and reducing the net export of capital from African drylands. Strong global partnerships must oversee how multinational corporations and non-African governments themselves affect African drylands futures through practices, investments, equitable management of intellectual property, resource extraction, promotion of technology, market opportunities, and engaging in trade on fair terms.
- **Within Africa, support the establishment and operations of an entity (perhaps as an assembly under the African Union) that can bring the voice of drylands together** to influence how pan-African policy is implemented in its drylands. This entity needs support to be replicated in each country with drylands to obtain the equivalent effect within their national policies.
- **Finally, the global community needs to be patient and humane,** continuing to invest in humanitarian and disaster assistance until the drylands obtain greater resilience, but doing so with these longer-term goals in mind. In the end this will create new, thriving markets for developed economies and lessen the migratory pressures from climate change. The adapted African drylands will be able to play their active role in an adapted global community.


Photo: client to advise dryland images source

Table 2: Immediate investment approaches for climate-adapted development in African drylands

Element	Rationale and investment
Empower the local	• Invest in the development of governance systems that empower locally-led adaptation and provide equitable tenure arrangements. • Invest in infrastructure (like communications and transport) that enables better connectivity between remote regions and political centers, reducing regional vulnerabilities, permitting adaptations, and accessing early warnings. • Prioritize vulnerable stakeholders, so as to provide the basis to address distributional outcomes and equity and improve community-level resilience.
Support and exchange local practices	• Invest in the demonstration of locally-led management practices that enable land restoration and sustainable production to be more resilient to climate change, using nature-based solutions, carbon and biodiversity credit markets, and local neglected species etc., as well as in horizontal knowledge exchange networks that speed up learning and empower peer-to-peer resilience building. • Apply participatory action research approaches to engage academic institutions in supporting local knowledge and innovation and speeding up local adaptive learning.
Create the links to markets	• Diversify adaptive livelihoods by supporting marketing of local products and innovations, especially into middle-class urban African markets, but within a balanced strategy that considers both local markets and global value chains. • Build local resilience by supporting the creation of cooperatives and other models for aggregating small-holder products and locally owned processing to add value to the products in the local economy and retain profits. This may be based on climate-adapted but currently neglected species, as well ecosystem services such as carbon sequestration and biodiversity credits, and livelihoods from other uses of local resources (such as tourism and energy systems).
Build social and human capacity	• Provide training in entrepreneurship and skills relevant to local livelihoods off the land, as well as the delivery of local services and innovations, which will provide the basis for adaptation to on-going future change. • Provide support for local champions and agents of change to drive transformation, as well as active capacity building and job opportunities for youth and women.
Take integrated and diversified approaches	• Invest directly to bring all the above elements together in an integrated way in major climate-adapted initiatives that run across sectors, peoples, and countries. • Coordinate investor partnerships to drive patient investments at large scale and over multiple funding cycles that accumulate to build resilience and reduce conflict.

In summary, transformative and targeted investment partnerships are needed to:

- **Support major initiatives that already exist,** as long-term vehicles to integrate and implement the elements of success in drylands (listed in Table 2) at scale, improving the resilience of dryland environments and livelihoods to climate change around conventional dryland opportunities based on natural capital in pastoralism, farming, forestry, and land restoration.
- **Establish a series of ambitious, cross-border decadal initiatives in new domains** where drylands have a comparative advantage, to also act explicitly as integrating vehicles to develop additional climate-adapted livelihoods based on natural and other capitals (such as conservation and tourism, renewable energy, sustainable irrigation, food processing). Support market links within regional economies and global value chains to this end.
- **Support the establishment and operations of an African drylands entity or initiative** to help ensure that policies are implemented in dryland-sensitive ways. The entity is essential to ensure a drylands voice over two-thirds of the continent; and should contain nested drylands commissions within countries.
- **Patiently support African drylands through strengthened regional and global partnerships** while they transition to greater resilience and contribute to the global economy. This support must act to reduce accidental and deliberate interference; help control capital export from drylands; ensure transparency in resource extraction; ensure transfer of appropriate technology and practices; and enable equitable participation in global trade. It must also help deliver humanitarian safety nets, and relief and recovery in the face of disasters and conflict.

An inspiring future vision for 2040 based on these major achievements, and a suite of smaller actions towards the elements of success (Table 2), will help deliver climate-adapted African drylands.

Photo: FAO - Fodder harvesting in year two of planting for land restoration (Soum province, Burkina Faso)

Action Against Desertification (AAD)

Geography: Burkina Faso, Djibouti, Eritrea, Ethiopia, The Gambia, Mali, Mauritania, Niger, Nigeria, Senegal, Sudan; currently expanding to dryland countries in southern and northern Africa.

Adaptation measures: The program implemented land restoration activities focused on communities' livelihood improvement and adaptation needs. It established income-generating enterprises that support economic growth, land productivity and environmental protection, including the development of non-timber forest products (NTFPs) with native species that were also planted.

Key outcomes: In five years, the programme restored 63,000 ha of degraded lands using 12 million seedlings and 120 tons of forest seeds from 110 locally prioritized species of trees, shrubs and grasses for food, animal feed, medicine, honey production and other purposes. Five hundred villages were involved in restoration activities with the participation of 100,000 households. Sustainable value chains were supported in restored areas through ten non-timber forest products. Some 40,000 people benefited from training activities, and about 8 million people were sensitized through capacity building and community mobilization to land degradation and restoration issues.

Partners and funding: FAO and Africa's Great Green Wall governments and country partners, African Union Commission (AUC), Pan Africa Agency of the Great Green Wall (PA-GGW), Africa, Caribbean and Pacific Group of States (ACP), The Global Mechanism of the UNCCD, Millennium Seed Bank Partnership of Royal Botanical Garden (RBG) Kew, Service Public de Wallonie, European Union (EU) and Turkey. 2014-2020. 34 million euros.

PROJECT SUMMARY[33]

Desertification threatens more than 45 percent of the land area on the African continent, of which 55 percent is at high or very high risk of further degradation.[34] Moderate to severe degradation has already been identified in several life-supporting river basins, including in Niger (50 percent degraded), Senegal (51 percent), Volta (67 percent), Limpopo (66 percent) and Lake Chad (26 percent).[35] In The Gambia, nearly 100,000 ha of forest land had already been lost to desertification between 1998 and 2009; while in Burkina Faso, from 1984 to 2013, bare soil and agricultural lands increased by 19 and 90 percent, respectively; while woodland decreased by 19 percent, gallery forest by 19 percent, tree savannahs by 5 percent, shrub savannahs by 45 percent and water bodies by 31 percent.[3637]

Studies forecast higher temperatures, increasing frequency of heatwaves and increased aridity for countries in Sub-Saharan Africa, which, in the absence of adaptation or other coping mechanisms, is projected to reduce the cropland by an average rate 4.1 percent by 2039, with 18.4 percent of the cropland likely to have disappeared by the end of the century.[38]

FAO has been supporting the on-the-ground implementation of Africa's Great Green Wall since July 2014, through the Action Against Desertification (AAD) programme. The programme initially involved six countries and supported rural communities, governments and civil society groups in restoring degraded land and sustainably managing agro-silvopastoral landscapes to enhance adaptation of local communities and their production systems. Building on the successful results, since 2018 AAD has been expanded to five other Great Green Wall countries: Djibouti, Eritrea, Mali, Mauritania and Sudan in the Sahel. It has also provided support to Southern African Development Community countries and to countries in northern Africa through a South-South cooperation approach. The large scale restoration model led by FAO in support of the Great Green Wall advances multiple sustainable development targets and addresses climate change adaptation and mitigation by integrating agriculture, forestry and other land uses, in alignment with the participating countries' climate strategies.

Since its launch, AAD has put biodiversity and local communities' interests and adaptation needs at the center of its innovative large-scale restoration approach. The local biodiversity of the Sahel is a key element for building communities and landscapes adapted to climate change, as the dryland dwellers rely on a wide range of plant and animal products for household consumption and sale, and such products often contribute significantly to household economies. Furthermore, FAO targets restoration[39] across the whole value chain, from seeds and land to end products and improvement of livelihoods.

The restoration approach entails, first and foremost, consulting communities to understand what they want to restore, where and which plants they consider important to replenish in their landscapes; then, planting the right species in the right places. The consultations make use of traditional knowledge of native species and ecological analyses of the area to determine which species are well adapted to the local conditions and therefore should be restored.

At the end of this process, communities had prioritized 110 plant native species of trees, shrubs and grasses that serve multiple purposes, including food, animal feed, medicine, veterinarian and honey production, among others. More than one million farmers in these communities were equipped with training in seed collection, handling and resource management, seedling production, establishment of village nurseries, planting and seeding, and managing and monitoring their restored land. Owing to the changing climate and variability in the region, the initiative has implemented a number of restoration techniques to build resilience, such as land ploughing for maximum rainwater harvesting before planting and direct seeding in order to help minimize drying of the soil, improve soil permeability and provide better chance for seedling growth; and planting only once the first rains have settled in, as opposed to immediately after the first rainfall.[40]

The restoration model combines plant science, local knowledge, community mobilization and mechanised technology. Communities were simultaneously supported to develop sustainable value chains for ten non-timber forest products (NTFPs), including gum arabic, Balanites oil, honey and fodder, generating income through diversification of their livelihoods and garnering direct restoration benefits. For instance, in Burkina Faso, Niger and Senegal, communities harvest planted grass fodder in restored areas as feed for their livestock and/or to sell for US$ 40/ha per season.

Based on partnerships developed through this programme, FAO and the AUC initiated the Africa Open Data for Environment, Agriculture and Land (Africa Open DEAL) to assess land use in Africa, establish biophysical baselines and define the potentials for land restoration at country and continental levels.[41] The analyses have revealed in Africa, more forests and more arable lands than were previously detected, and has revealed 7 billion trees outside forests for the first time. According to Africa Open DEAL analyses, potentially restorable lands in the continental Great Green Wall areas are estimated at 393 million ha, including 33 million ha restorable in northern Africa, 162 million ha in the Sahara-Sahel countries and 198 million ha in the Kalahari-Namib countries. Combined, that would be the equivalent size of India and represents a great opportunity for large-scale restoration interventions, bigger than anywhere else, in response to both climate change adaptation and mitigation needs.


Photo: FAO - Restored communities' plots with biodiverse native species (Burkina Faso)

Photo: WWF - Maasai cattle herders

WWF Africa Adaptation Initiative (AAI) - Supporting Climate Resilient Future for Protected Areas and Biodiversity in Africa

Geography: 13 African countries (Cameroon, Central African Republic, Democratic Republic of Congo, Gabon, Kenya, Madagascar, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe); 4 priority landscapes: Tri-National Dja-Odzala-Minkébé -TRIDOM); Southern Kenya and Northern Tanzania (SOKNOT); Greater Virunga Landscape (GVL); Kavango-Zambezi Trans-frontier Conservation Area (KAZA) and one priority seascape: South-West Indian Ocean (SWIO).

Adaptation measures: This initiative aims to support ecosystems and communities to adapt to climate change through enabling knowledge, research, policy and financial frameworks. It has done through building WWF and partners' capacity building (more than 700 people), conducting vulnerability assessments of 263 protected areas; implementing ecosystem based and community based adaptation solutions as well as other adaptation measures: building the resilience of coral reefs and communities, supporting integrated water resources and catchment management (river-bank stabilization, drip irrigation, tree planting, soil and water conservation structures), promoting climate-smart agriculture technologies, promoting water harvesting (infrastructure, drip irrigation and solar water pumps to support water access for farming); mainstreaming adaptation within regional and local strategy/policy processes and communicating adaptation best practices.

Key outcomes: WWF AAI goal is to implement with its partners climate smart conservation programmes that will support climate resilient ecosystems and community livelihoods by 2025. The phase II (2017-2020) outcomes were: Civil Society Organisations (CSOs) engagement has led to national stakeholders undertaking demonstrable Climate Change Adaptation (CCA) policy and practice change; four WWF focal countries (Mozambique, Kenya, Uganda and Zambia) and one priority landscape

(TRIDOM) have mainstreamed adaptation in their work and implemented climate-smart conservation projects; and at least 20 percent of households in the four focal country offices have benefitted from the adaptation activities supported by this programme.

Partners and funding: Local Ministries, Civil Society organisations and Community Based organisations: Kenya Climate Change Working Group (KCCWG); Associação Do Meio Ambiente (AMA); KULIMA; Environmental Management for Livelihood Improvement (EMLI); Conservation and Development Agency (CODEA); Zambia Climate Change Network (ZCCN). Norwegian Agency for Development Cooperation (NORAD), with support from WWF Norway and WWF Denmark, USD 897,000. 2017-2020 (Phase II).

Photo: WWF - Elephant herd in the Maasai Mara

PROJECT SUMMARY

African ecosystems are of great ecological, social, economic and cultural importance, providing resources that can support communities and enable pathways for adaptation to climate change. They also offer significant economic value. Fisheries, for instance, provide up to US$ 2.5 billion per year in economic benefits for Africa, while recreation, mangrove coastal protection and erosion protection can provide up to US$ 11,000 per km^2 per year, US$ 5,000 per km^2 per year and US$ 11,000 per km^2 per year in benefits, respectively.[42] The increasing change and variability in long-term patterns of temperature and precipitation induced by climate change will have a detrimental impact on the biodiversity and effectiveness of protected and conserved areas across the continent, with significant impacts on food, water, energy and health. These changes will also threaten the foundations of many rural and urban livelihoods. By 2100, climate change could result in the loss of more than 50 percent of African bird and mammal species, a 20-30 percent decline in the productivity of Africa's lakes and significant loss of African plant species.[43] For terrestrial systems, most studies indicate that Africa will be much more significantly affected than other regions.[44] The reality of climate change driven nature loss is critical for both people and biodiversity. In the absence of action, the world stands to see US$ 10 trillion wiped off the global economy over the next 30 years, with developing countries and regions like Eastern and Western Africa being particularly affected.[45]

Recognizing the alarming impacts that climate change poses the long term conservation and development goals in Africa, WWF has been supporting climate change adaptation in Africa since 2011 through its Africa Adaptation Initiative regional programme. The vision of the program is an "Africa where people and nature have enhanced capacity and resources to adapt to climate change."[46] Efforts have been focused on capacity building, vulnerability assessments, policy advocacy, resource mobilization and building resilience at ecosystem and community level across Eastern, Southern and Central Africa.

During its phase II (2017-2020), the WWF AAI has invested in better understanding how climate change is going to impact the future of Africa's protected areas (PAs) and associated species. Several studies were commissioned in collaboration with Anchor Environmental Consultants, to understand the level of vulnerability of 263 protected areas (PAs) across Sub-Saharan Africa to climate change and to develop strategic recommendations aimed at supporting these critical areas to adapt to climate change. This was done by assessing the potential impacts of climate change on these protected areas in terms of habitat change, species loss, increased resource pressure, and the adaptive capacity through their level of financing (in terms of loss of infrastructure and tourism demand) and the extent to which expansion of the protected areas is feasible.[47]


Photo: WWF - Maasai cattle herders

Of the 263 PAs assessed, only four protected areas (1.5 percent) are resilient to climate change (three in Central Africa and one in Southern Africa), 150 (57.0 percent) are highly vulnerable and 109 (41.5 percent) vulnerable. No habitat change is predicted for 109 protected areas while for seven PAs, more than 60 percent change in habitat is predicted by 2050 (one in Central Africa, three in Eastern Africa and three in Southern Africa). More than 50 percent of the 37 PAs' species are predicted to no longer find the PAs climatically suitable by 2050. The assessments have identified key adaptation responses for biodiversity to be implemented across WWF intervention areas. These include (i) creating and rehabilitating climate refugia for biodiversity (areas that remain relatively buffered from contemporary climate change) (ii) preserving the most resilient ecosystems, (iii) restoring, creating and facilitating wildlife dispersal area and movement corridors, within and outside protected, (iv) developing dynamic transboundary strategy and plans to ensure joint management of climate impacts on biodiversity and people, (v) strengthening local and transboundary monitoring of biodiversity responses to climate change and , species and ecosystem interactions and (vi) assisting communities' resilience building through nature-based livelihood activities.

One of the key areas where WWF has conducted this climate change vulnerability assessment is the Greater Mara Ecosystem (GME) within the Unganisha SOKNOT landscape. The GME covers an area of approximately 4,500–6,650 km^2 within the Mara River Basin, forming the Kenyan section of the Serengeti-Mara Ecosystem. The Masai Mara ecosystem has been regarded as one of the natural wonders of the world, as it supports the most diversity of migratory grazing mammals, including the great migration of more than one million wildebeests annually.[48] About one third of the GME is protected under the Masai Mara National Reserve (MMNR), managed by the government of Narok County, while the remainder falls within a number of smaller conservancies under the jurisdiction of members of the Kenyan Maasai community. The GME area, although it comprises only a quarter of the complete ecosystem area, is crucial to the entire system as it provides forage for wildlife during the dry season. Furthermore, GME is estimated to host around 25 percent of the wildlife in Kenya.[49] Tourism is vitally important to the region, but around 55 percent of its annual household income comes from livestock grazing. The conservancy land lease model introduced in 2006 has attempted to integrate these two activities by allowing landowners to partner with tourism operators, creating privatized Masai rangelands that have supported wildlife and tourism and provided landowners with a steady source of income through lease payments.[50]

Climate change projections for the region point to modest and seasonally variable increases in precipitation (5-10 percent), while temperature increase is likely to be between 2.5^0 and 3.5^0C by the end of the century.[51] Changes in precipitation, temperature and land use patterns (such as converting forests to agricultural or pasture lands) are likely to reduce dry season flows and increase peak flows. Studies have highlighted that the basin is highly vulnerable under high (+25 percent) and low (-3 percent) extremes of projected precipitation change.[52] Climate change is also likely to exacerbate many of the current pressures faced by the GME, including changes in wildlife migration patterns, water quality and flow changes, human-wildlife conflict (competition for scarcer resources) and tourist visits. Modelled species distributions indicated that 13 percent of species assessed in the MMNR will no longer find the MMNR climatically suitable by 2050, coupled with an increase in predicted habitat change of 25 percent.[53] Thus the MMNR is considered to be highly vulnerable to climate change with a vulnerability score of 25.5 percent.[54]

To counter these growing threats, conservation measures need to be strengthened and a holistic strategy to increase the resilience and effectiveness of the MMNR and conservancies must be implemented. Ecosystem-based adaptation provides a route through which conservation authorities can tap into international climate financing and implement strategies that provide several co-benefits for rural communities and also address non-climatic stressors. Strategies identified for increasing resilience of the Greater Mara Ecosystem are: extending the conservancy model to incorporate more land, including critical migratory corridors to the east of the MMNR; restoring degraded and more viable areas to climate change; securing environmental flows along the Mara River through better environmental protection of source and catchment areas, sustainable rangeland management and conservation farming methods, protection of buffer areas next to rivers, and adequate sanitation and treatment of waste water; strengthening management of species at high risk. Additional adaptation measures include promoting rainwater harvesting and diversifying the livelihoods of local communities through ecotourism, beekeeping, use of non-wood forest products and programs to improve market access as well as developing an overarching spatial management plan for GME that outlines the monitoring and protection of river systems and catchments and establishes riparian buffer zones to prevent flood damage. In the long term, efforts should be made to establish the Serengeti-Mara Ecosystem as a trans-frontier park.[55]

Going forward, the WWF will support translating the recommendations from the vulnerability assessments done for 263 PAs, into practical ground solutions to safeguard the functions of the most representative biodiversity areas in Africa and community dependent livelihoods and services. The regional programme will invest more in Nature-based Solutions work that leverage measurable and effective adaptation benefits for biodiversity and people in Africa. For the upcoming Africa Protected Area Congress (APAC), taking place in Kigali, Rwanda in March 2022,[56] WWF will push forward the development of a regional strategy on climate change and sustainable management of protected and conserved areas to drive transformational knowledge, solutions, effective policy and sustainable finance for the benefits of biodiversity and people in Africa.

Great Green Wall Initiative

Photo: Homo Cosmicos/Shutterstock

The Sahel forms the vast semi-arid belt that separates the Sahara Desert to the north and the tropical savannas to the south. Spanning an area of more than 3 million km^2, it stretches across 20 African countries, from Senegal in the west to Ethiopia in the east.

The region faces critical challenges: approximately 55 percent of fragile land is highly susceptible to degradation in the Sahel and other African regions; the Sahel has one of the fastest growing populations in the world, with a total population of more than 600 million that is growing at 3 percent per year; it includes countries with some of the lowest rankings on the Human Development Index (Burkina Faso, Chad, Mali and Niger are among the last 10 countries on the index); its subregions are riddled with internal conflict that has internally displaced nearly 1 million people in Burkina Faso, Chad, Mali and Niger[57]; and nearly 15.5 million people were on the brink of severe food insecurity as of 2020, a five-year high.[58] These challenges are further compounded by the growing impacts of climate change.

Studies in the recent years have identified the Sahel as the global hotspot for climate change. Climate models[59] point to a very likely increase in temperature of 3-6^{0}C by the end of the century, from a 1986-2005 baseline.[60,61] The Sahel has been identified as one of the regions where these unprecedented climates are projected to occur the earliest—by the late 2030s to early 2040s—even under a lower-emission scenario.[62] Furthermore, even at 1.5^{0}C warming, precipitation is expected to increase and associated flooding is projected to intensify for most regions in Africa apart from the far west Sahel.[63] Overall, models suggest an increase in precipitation over the central Sahel and a decrease over the western Sahel.[64] The combined effects of temperature and precipitation changes will also have impacts on surface water levels, with a 20-40 percent decline in river flows projected by 2050.[65]

Climate change impacts will also have a detrimental effect on the Sahelian livelihoods, particularly in agriculture, which will face significant reduction in crop yields, leading to further impoverishment in a region that is already grappling with one of the highest levels of multidimensional poverty in the world.[66] Dependence on livestock and agriculture renders approximately 50 million people in the Sahel highly vulnerable to the impacts of climate change.[67] Climate disasters in recent years have eroded resilience, exacerbating turmoil and conflict and the resulting displacement in the region. Flooding in Lake Chad in 2019, for instance, displaced 100,000 people in an active conflict zone.[68] In 2020, flooding in the Sahel region affected about 760,000 people in Burkina Faso, Cameroon, Chad, Ghana, Mali, Niger, Nigeria and Senegal.[69,70]

The Great Green Wall initiative (GGWI) is a large-scale restoration program to halt environmental degradation and desertification across the African continent. At the time of its conception in 2007, the African Union envisaged the GGW as a "wall of trees" stretching more than 7,000 km long and 15 km wide. However, at about the same time, studies pointed to a steady retreat of the southern border of the Sahara Desert and the greening of several parts of the Sahel.[71] The retreat was probably due to a decadal change to wetter weather patterns in the region and a reduction in aerosol emissions in the Northern Hemisphere that increased aridity during the 60s to 80s.[72] As a result, the efforts surrounding GGWI evolved from simply planting a "wall of trees" to a mosaic approach that builds resilient land use systems with the capacity to adapt to uncertainty and climatic extremes and to enhance the livelihoods of local people and provide long-term solutions for improving environmental and socio-economic conditions in the zone.[73] In its current configuration, the GGWI has become Africa's flagship initiative to combat land degradation, desertification and drought, with a vision of restoring 100 million ha of currently degraded land, sequestering 250 million tons of carbon and creating 10 million green jobs by 2030.[74,75]

In addition to the 21 countries engaged in the initiative, a number of governmental and non-governmental international implementation partners also support the GGWI, including the European Union, Government of France, African Union, FAO, GEF, IUCN, World Bank, United Nations Convention to Combat Desertification (UNCCD), UNEP, Permanent Interstate Committee for Drought Control in the Sahel (CLISS) and Sahara and Sahel Observatory (OSS), among others.

The activities undertaken under the GGWI are broadly clustered under five major strategic axes: sustainable land management and green economy; climate change, socio-economic development and governance in the localities; support for research and development; communication, marketing and advocacy; and information systems, observation, early warning and response. From the program's launch in 2011 through 2019, more than US$870 million had been mobilized in external funding, with GGWI programs covering a total area of 154 Mha, 10 times the size of the originally proposed belt.[76] The largest intervention zones are located in Niger (47.3 Mha), Mali (44.4 Mha), Ethiopia (13.2 Mha) and Eritrea (12.4 Mha).[77]

Figure 1: Funding for multi-country projects reported by international donors (in USD million)[78]

GGWI encompasses a variety of sustainable land management (SLM) activities, including forestry and agriculture initiatives like land restoration, agroforestry and assisted natural regeneration, and soil and water conservation measures like watershed management, construction of boreholes and irrigation systems and building terraces/soil measures. Several transboundary programs (see Figure 1) have been implemented to support the GGWI at the regional level, including the Sahel and West Africa Program (SAWAP) led by the World Bank and GEF, which follows a "mosaic approach" aimed at incremental improvements in oils, nutrient and water management and at reducing the risks of climate change and disasters across 12 African countries.[79] The interventions aim to build community resilience by tackling the root causes of land degradation and to alleviate land tenure insecurity in the region through the issuance of land certificates. Additionally, the program also receives complementary support from the Building Resilience through Information, Communication, and Knowledge Services (BRICKS) project, led by CLISS, OSS and IUCN, which was responsible for facilitating regional learning and monitoring and evaluation to support the SAWAP. These management approaches also address landscape perspectives (including watersheds), community planning, and conservation of biodiversity, including through biological corridors and protected areas Other large-scale interventions supporting GGWI include:

- The Front Local Environnemental pour une Union Verte (FLEUVE) project (2014-2018) developed by the UNCCD's Global Mechanism with funding from the European Union, which aims to improve the livelihoods of drylands populations and strengthen their resilience to land degradation, drought and climate variability through micro-projects and SLM interventions implemented in 23 communities across five countries.
- FAO's Action Against Desertification Program (AAD) (2014-2019), which aimed to build the capacity of rural communities, government and NGO partners to create an enabling environment for large-scale restoration, implement programs for creation of income-generating activities and employment opportunities in rural areas, and establish farmer field schools and knowledge exchanges to combat desertification.
- The Boosting Restoration, Income, Development, Generating Ecosystem Services (BRIDGES) program (2017-2020) led by the FAO-Turkish Forestry Partnership to promote south-south cooperation to combat land degradation and desertification through restoration, which has reinforced the value chains of non-wood forest products, along with building information and monitoring systems and knowledge sharing.
- GEF's Closing the Gaps in Great Green Wall: Linking Sectors and Stakeholders for Increased Synergy and Scaling Up project developed by UNEP and implemented by IUCN (2016-2019), which carried out its aims through enhanced investments, inter-sectoral coordination and engagement of marginalized groups.
- The Large-Scale Assessment of Land Degradation to Guide Future Investment in SLM in the GGWI Countries project (2019-2024) funded by GEF, NASA and USAID, which aims to strengthen science-based evidence. The program brings together several knowledge partners from the region as well as international institutions (e.g. the French National Research Institute for Sustainable Development, University of Lund/Sweden, and European Space Agency).

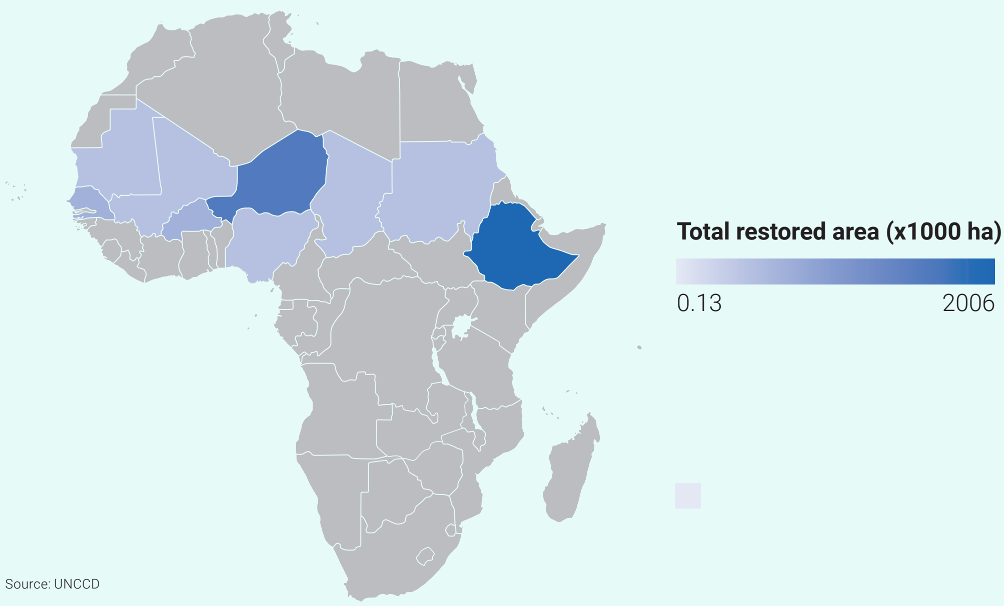

Photo: BOULENGER Xavier/Shutterstock

As of 2021, additional funds of around US$ 16.85 billion have been pledged as part of the GGW Accelerator initiative.[80] The GGW Accelerator aims to transform livelihoods through comprehensive rural development initiatives and by creating a mosaic of green and productive landscapes across 11 countries (Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, Ethiopia, Eritrea and Djibouti).[81] The Accelerator aims to build a GGW Online Platform by 2025 that will monitor, track and connect financing flows with project needs and implementation results; support countries in establishing related monitoring, reporting and verification systems; track implementation in beneficiary countries; and evaluate the impact of accelerator investments and progress made towards the 2030 GGW ambition.[82] The African Development Bank (AfDB) has also pledged to mobilize US$ 6.5 billion towards the GGWI over the next five years. The AfDB has made the Sahel a top priority for investment and for mobilizing new sources of financing to advance climate adaptation opportunities. It will also scale up the Technologies for African Agricultural Transformation (TAAT) program in support of the GGWI, providing access to improved and heat tolerant seeds.[83]

Even before the launch of the GGWI, farmers in the Sahel region were transforming their practices to minimize degradation; for instance, turning to a low-cost method of growing trees and shrubs, using root stock in their cleared fields and using these trees for fuel, fodder for livestock, food and soil improvement. Early evidence showed that nearly 5 Mha of land had already been restored in Niger as of 2011 and 0.5 Mha in Mali.[84] This success was mainly attributed to the adoption of farmer-managed natural regeneration (FMNR), with farmers ''changing the way they manage trees and their perception of the trees'' by going back to the agroforestry practices native to the region. Community ownership and co-creation are, therefore, essential for ensuring that the benefits of the restorative efforts are sustained. A sense of ownership is also key when creating and linking new markets, engaging other assets at scale or enabling diversification into other forms of livelihoods. Interventions need to build on grassroots efforts, while addressing legal issues like tree ownership and creating markets for the products of agroforestry. Projects must also consider local and traditional knowledge, especially when selecting tree species for restoration. Several key species, like Faidherbia albida, a nitrogen-fixing acacia species, have formed an integral part of the FMNR activities implemented by farmers in the Zinder region in Niger. More recently, projects like the Provision of Adequate Tree Seed Portfolio (PATSPO) in Ethiopia have allowed scientists to work with local institutions and communities to identify desirable tree species that are well adapted to local conditions.[85,86]

As of 2020, the GGWI had restored 4 Mha of land within the GGWI intervention zones (see Figure 2) and nearly 17.8 Mha when taking into account all lands restored in the wider GGWI region (between 2007-2019).

Figure 2: Total restored area as reported by 11 GGW member states as of 2019



Source: UNCCD

Current restoration activities have the potential to sequester up to 256 Mt carbon dioxide equivalent in woody biomass and up to 57 Mt of carbon dioxide through the soil by 2030. Agroforestry and SLM activities have also led to the creation of more than 335,000 job opportunities, as well as helping to reduce poverty through income generating activities such as the production and valorization of different fruit and non-timber forest products like honey, Arabic gum, baobab leaves, etc. The revenues from these activities since 2007 have amounted to approximately $90 million across 11 countries, with Niger alone having revenues of $81 million. Overall, nearly 500,000 people have benefited directly from the GGWI activities while another 10.2 million beneficiaries have been reached by the wider regional activities.[87]

To realize its vision of restoring a total area of 100 Mha by 2030, the pace of current restoration activities needs to be sped up to 8.2 Mha/year from the current 1.9 Mha/year. Comparing the average costs for land restoration across Africa ($440/ha) and within the Sahelian region (for instance, the average cost of $530/ha incurred by the SAWAP activities) points to a projected funding gap of approximately $3.6 billion to $4.3 billion per year through 2030.[88] These estimates, however, do not consider the resources needed for capacity building, training farmers or effecting changes in land use policies and governance structures.

To close the funding gap, there is a need to develop mechanisms through which funding and support is also mobilized from the private sector. The Inclusive Green Financing initiative (IGREENFIN) funded by GCF and implemented by IFAD is one such project under the GGWI. It aims to create an enabling environment for investments in adaptation, mitigation and climate technologies by removing the barriers faced by local public development banks, helping them to establish green lines of credit and building the capacity of both banks and smallholder farmers. The aim of the project is to scale its interventions to 12 African countries (Burkina Faso, Côte d'Ivoire, Ghana, Mali and Senegal in Phase 1 and Chad, Djibouti, Eritrea, Ethiopia, Mauritania, Nigeria and Sudan in Phase 2).[89]

Scaling up also requires projects to overcome several governance challenges. Previous experiences with GGWI projects have highlighted key challenges, including: lack of necessary institutional structures (e.g. establishment of national GGW agencies); lack of support from private, non-governmental and research sectors; lack of mainstreaming of environmental management practices into sector strategies, policies and action programmes; lack of coordination, exchange and flow of information and knowledge across the GGWI structures and at the regional and national levels; and the failure of GGWI national agencies to endorse an intersectoral "landscape approach" that goes beyond jurisdictional borders, mandates and the institutional power of the ministries of environment in each country.

Adopt a tree, record a tree

Tree Adoption Uganda

At Tree Adoption Uganda (TAU), we are powered by the vision of creating communities where both people and nature flourish. We build the resilience of smallholder farmers against climate change by restoring landscapes through tree planting and agroforestry; and train unemployed young people in rural communities to set up and manage indigenous tree nurseries and farms. By planting trees, we restore degraded landscapes and soil, combat desertification, and increase farmer resilience against climate change.

We have worked with TreeCorder in collaboration with our partners at Ecomatcher Ltd – a user-friendly technology platform and mobile phone application that records data on every tree planted, and saves it on the Cloud to be immediately accessible by anyone. With one click, TreeCorder records an image of the tree, its species, GPS position, name of the person who planted it, and the date it was planted. This eliminates any doubts on tree planting data, and promotes accountability for evidence-based adaptation action.

We have worked with over a thousand households to plant more than 300,000 indigenous trees, half of which are mapped on TreeCorder. In addition to training 3,000 young people on activities ranging from grafting, pruning and propagation to managing interactions between humans and nature, we have established 14 environment clubs in schools to stimulate stewardship of the environment through environmental education.

Communities in Uganda are already significantly affected by climate change impacts such as changing weather patterns, water stress, floods, prolonged droughts, landslides, and diseases. At the same time, the forest cover in the country has come down from over 4.5 million hectares in 1990, to less than two million hectares in 2015.[90] The combined impacts of deforestation and climate change has the biggest impact on the rural poor, who rely on subsistence agriculture and the environment for their needs. We believe a concerted and multi-partner approach is needed to adapt to climate change, so we are partnering with the Government of Uganda

Photo: Rachel Landman/Shutterstock

to plant and map 200 million trees over the next five years as part of the Running Out of Trees campaign. As part of the campaign, TAU will plant 200,000 indigenous trees in central and eastern Uganda over the next year, restoring 1000 hectares of land; and extend our environmental education activities.

TAU has also worked to reduce the causes of deforestation by training a thousand households in Bwaise, an urban slum in Kampala, in the conversion of organic waste into briquettes for cooking fuel instead of firewood. The households were taught skills in waste handling, sorting, and drying using low-cost and locally made technology, to provide them with livelihood skills at the same time. This project will be scaled up to the rest of the country starting with the Manafwa watershed. This watershed is part of Mount Elgon National Park, and one of the most highly populated areas in Uganda, with over 90 percent of the population dependent on biomass energy. This results in forest degradation and encroachment into the National Park. Community members will be trained to convert post-harvest agricultural waste and biomass, usually burnt by farmers, into briquettes for domestic use and income generation.

We believe that more corporate organizations and individuals will be willing to invest in the kind of work we do if we are transparent and accountable, and the impact on adaptation will be huge.

Transport and Energy

KEY MESSAGES

- **Climate-related damage to infrastructure disrupts social services and exacts a significant short and long-term human and economic toll in Africa.** Moreover, in the aftermath of the damage, governments are forced to divert limited public funding to rebuild or reconstruct, instead of investing in new infrastructure to make up for existing deficits. This creates an "infrastructure trap" – vicious cycles of repeated climate shocks that risk halting economic growth and disrupting or even reversing progress towards achieving the Sustainable Development Goals.

- **Closing the infrastructure gap and enhancing climate resilience is critically important for economic development, improving the quality of life, and the growth of the private sector in Africa.** The good news is that infrastructure investments in Africa have risen increasingly over the past 15 years, and international and national investors have both the desire and the funds to spend much more across the continent. However, while investments in adaptation and resilience for energy and transport infrastructure are rising (from US$ 19 million to US$ 252 million between 2010 and 2019 for the energy sector; and from US$ 11 million to US$ 128 million in the same period for transport), they are still well below actual needs.

Photo: MehmetO/Shutterstock

- **Making infrastructure more climate resilient will have additional upfront costs of 3 percent,** but returns can be four times the initial investment, in addition to important social returns.
- **Proactive adaptation – modification of designs and incorporation of resilient construction norms at the very outset of infrastructure projects** – is a no-regret option in the energy and transport sectors, including for instance for hydropower and paved roads. Once these 'upstream' decisions on the location, nature, and design of infrastructure are made, the options for climate risk management narrow. Such proactive 'upstream' adaptation and resilience measures can increase up-front investment costs but reduce 'downstream' operations and maintenance costs.
- **The integration of nature-based solutions (NbS) in infrastructure planning and decision-making** can make infrastructure more sustainable and resilient and offer other co-benefits.
- **Leveraging public-private partnerships (PPPs) for climate-resilient infrastructure** can help countries in Africa to mobilize funds to bridge the existing infrastructure gap, while ensuring climate resilience. Uncertainty and the lack of political commitment remain key barriers for infrastructure PPPs.
- **Going forward, integrating climate risk in infrastructure planning; building data systems for investment planning; quantifying the benefits of NbS; leveraging PPPs; and reforms** for improved operations and maintenance of assets in a climate-compromised world are necessary.

INTRODUCTION

Poor infrastructure continues to hinder economic growth in most African countries. To close the infrastructure gap, investments in infrastructure in Africa must go up to about $150 billion per year (or 4.5 percent of GDP) from the past actual investment levels of about $75 billion per year.[1] Moreover, climate risks are affecting infrastructure development strategies and investments. Rising temperatures, changes in rainfall patterns and intensity, and the increasing frequency of extreme weather events are leading to losses in asset values, higher operating costs, and reductions in the economic benefits that infrastructure generates.

Infrastructure systems and their component assets, some of which are decades old, are not planned and built to withstand the impacts of climate change and climate hazards. They are also often distributed over large spatial domains, and inevitably exposed to climate hazards such as droughts, flooding, storms, heatwaves, wildfires, landslides, and sea-level rise. Damage to these assets not only disrupts social services in the short-term, but also exact a significant long-term human and economic toll.


Photo: GUDKOV ANDREY/Shutterstock

Drought-induced power shortages in Zimbabwe and Zambia, for instance, have had cascading impacts on water, health, connectivity, and supply chains and businesses. In Tanzania, businesses lose US$ 101 million, or 0.3 percent of the national GDP, annually due to power outages caused by rain and floods; and US$ 150 million, or 0.4 percent of the GDP annually, due to transport disruptions caused by flooding.[2] In South Sudan, before the World Bank helped build rural roads, farmers could not think beyond subsistence farming because they had no means to bring their crops to market. New routes and development corridors can make a difference between isolation and access to the global economy and social development.

In the aftermath of climate-related damage, governments are forced to divert what limited public funding there is to rebuild, or in more extreme cases, reconstruct, instead of investing in new infrastructure to make up for existing deficits. This combination creates an "infrastructure trap" – vicious cycles of repeated acute and chronic climate shocks that risk halting economic growth and disrupting or even reversing progress towards achieving the Sustainable Development Goals (SDGs).[3]

Investing in climate-resilient infrastructure is critical to adapting to a warming world. Infrastructure spending and access to infrastructure services is a key contributor to development, economic growth, and poverty alleviation in Africa.[4] Investments in rural infrastructure, in particular, can lead to higher farm and non-farm productivity, employment and income opportunities, and increased availability of wage goods, thereby reducing poverty by raising income and consumption.[5]

However, with governments already under pressure, the ability to invest in new infrastructure in Africa is further strained by climate-related impacts and by the repercussions of COVID-19, which caused the continent's first recession in half a century.[6] At the same time, foreign direct investment in Africa decreased from US$ 47 billion in 2019 to US$ 40 billion in 2020,[7] and official development assistance (ODA) has been on the decline for several years.[8]

It is crucial that investments in infrastructure in Africa are sustainable and resilient. This requires a fundamental systemic transformation. A revolution in the planning, design, financing, and delivery of infrastructure is urgently needed to meet the acute needs of a warming Africa. Climate-resilient infrastructure planning needs to begin 'upstream' in the early planning stages; be integrated across sectors and activities at a strategic level; make use of better analytical tools to understand climate risk at a systems level; and prioritize resources for building resilience. In addition, nature-based solutions for adaptation should be promoted, and engineering standards improved to enhance resilience of individual assets.

This chapter analyzes how climate change impacts infrastructure in Africa, with a focus on the energy and transport sectors, with sobering implications across social, economic, environmental, and development outcomes. It finds that while African governments need to integrate adaptation and resilience into infrastructure investments to minimize the harm caused by climate impacts and maximize development opportunities, they face significant challenges.[9]

Understanding the impacts of climate change on infrastructure in Africa

The Zambezi is the "Great River" to the Tonga people of Zambia and Zimbabwe, the river of life. It is also a lifeline for both national economies. When the river's flow was affected by drought in 2014 and 2015, low water levels in Kariba Dam's reservoir resulted in a 50 percent drop in electricity generation in hydropower-dependent Zambia. GDP growth in Zambia dropped from 6 percent to 2.6 percent.[10] In Zimbabwe, similarly, the 2019 drought led to reduced capacity of the Kariba Dam, and to subsequent losses of US$ 200 million in just three months (June-August) through lost production due to power shortages.[11]

The impacts of climate change on infrastructure can be acute or chronic. Acute climate impacts cause a sudden shock to the system, often from an extreme event such as a flood. The event may have widespread impacts (like coastal flooding) or may be very localized (as in a landslide). Chronic impacts of climate change can build up over time. Higher temperatures, for instance, can lower the generation efficiency of power grids over the years, increase losses in transmission and distribution, and decrease the lifetime of key equipment. High temperatures can also shift demand for certain types of infrastructure, for instance by creating additional demand for energy for cooling and air conditioning. While the demand for such infrastructure and the value it generates will increase with climate change, investing in climate resilient infrastructure will bring economic benefits and a range of other socio-economic gains.


Photo: Adam Jan Figel/Shutterstock

> **"Failure to act now will be catastrophic in terms of the lives and livelihoods to billions of the world's people who are at risk."**
>
> **H.E. President Akufo-Addo of Ghana**
> Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Disruptions in critical services

The disruptions caused by climate-related damage to infrastructure can cascade into major societal and economic disruption. The Zambia and Zimbabwe case study highlighted in this chapter (Box 1) is illustrative of these wider impacts, but there are numerous other examples in Africa, sometimes of countries facing repeated crises before they have a chance to fully recover. In Kenya, a drought in 2000 led to a 25 percent reduction in hydropower capacity, resulting in losses of more than US$ 442 million representing 1.5 percent of GDP in 2000.[12]

Flooding of road networks has significant implications for access to healthcare infrastructure. In Uganda's capital city of Kampala, for instance, it is estimated that a third of the inhabitants of inner Kampala will not be able to reach health facilities within the 'golden hour' – the 60 minutes that maximize the chance of survival – in the event of a major flood, due to disrupted travel networks. Main roads, such as motorways and trunk roads, are disproportionately at risk of flooding compared to residential and other roads, not only in Kampala, but also in other African cities such as Bamako in Mali, Dar es Salaam in Tanzania, and Kigali in Rwanda.[13] According to the World Bank, the costs of road maintenance will rise by 270 percent due to precipitation, flooding, and temperature stress in central, east, south, and west Africa.[14]

Climate impacts on infrastructure also pose significant barriers to the connectivity of supply chains. In 2000, flooding in south Mozambique destroyed road links between the capital city, Maputo, and the rest of the country for almost one year, including the rail line to Zimbabwe. This reportedly led to Mozambique's per capita economic growth to decline to one percent in 2000 – the lowest level in two decades. Similarly, in Dar es Salaam, flooding poses a significant risk to the port access road even with regular low intensity rainfall events (4-6 mm per hour over a 24-hour period, occurring every 2-10 years).[15] Recent studies have found that seven airports in Africa are at risk from sea level rise even with under 1.5°C of warming, rising to 24 airports under a high baseline emission scenario in which emissions continue to rise through the 21st Century.[16]

Several coastal African countries rely almost exclusively on maritime transport for imports and exports, many from a single port, and could suffer crippling disruptions in trade due to sea level rise and flooding. Guinea, Liberia, Mauritania, and Sierra Leone, for example, transfer more than 97 percent of all imported goods through ports.[17]

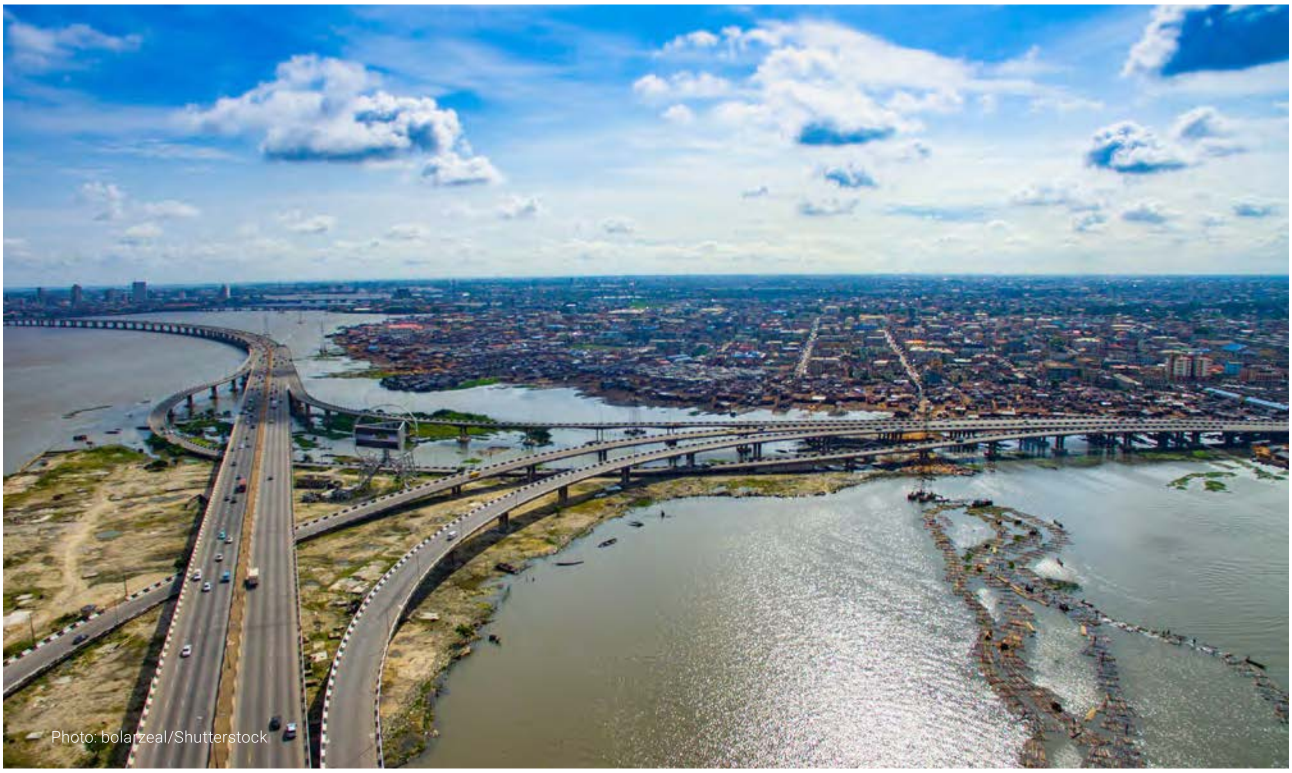


Photo: bolarzeal/Shutterstock

Box 1: Cascading impacts of climate change: The case of Zambia and Zimbabwe

Photo: Kariba Dam, Zambezi River

Zimbabwe and Zambia – two countries that rely on energy from the same hydroelectric power assets on the Zambezi River – suffered the impacts of drought on energy production at the same time but followed different trajectories. Zimbabwe was pushed further into the infrastructure-climate trap, while Zambia was able to strengthen its resilience by diversifying its energy mix.

The Kariba Dam is located along the Zambezi River, on the border of Zambia and Zimbabwe, and is the main source of electricity for both countries. In 2015, the Dam accounted for 97 percent of energy generated in Zambia, and more than 50 percent in Zimbabwe. When reservoir levels dropped to 12 percent due to low rainfall in 2014 and 2015; and again, to 9 percent in 2019, both countries faced extreme power shortages. Zambia experienced a deficit of between 20-40 percent of peak energy demand, while Zimbabwe's deficit was more than a quarter of peak demand.

Both countries initiated emergency measures to make up for the deficits. Zambia, normally an exporter, was forced to import electricity, including from diesel generators on a ship docked at Beira port in Mozambique. Zimbabwe spent US$ 200 million to set up the Dema Emergency Power Plant – consisting of 230 diesel generators producing 200 MW of electricity. Both countries also imported from South Africa's sole provider Eskom, although South Africa was also suffering power cuts. Despite this, drastic steps were needed to reduce demand, with up to 15 hours of load shedding per day in Zambia, and 18 hours in Zimbabwe. Zambia initially excluded copper mines (accounting for 77 percent of its exports) from load shedding, although they consume more than 60 percent of the nation's electricity but was eventually forced to reduce their supply by 30 percent.

Long-term impacts

While Zimbabwe has had trouble attracting investments in energy infrastructure in the aftermath of the energy shortages due to its fragile status, corruption levels, and poor credit rating, Zambia was able to diversify its energy sources and reduce its dependence on hydropower. Two solar power plants were launched in 2019 through the International Finance Corporation's (IFC) Scaling Solar program; and Maamba Collieries Ltd, its first coal-fired power plant, was set up to provide 10 percent of the country's electricity needs. Despite this, Zambia's GDP growth rates dropped to below 3 percent (from 10 percent earlier), and the national currency saw a depreciation of 47 percent against the dollar.

Both countries raised electricity tariffs to cover the costs of expensive alternatives – by as much as 200 percent in Zambia – with important implications for national economic growth and creditworthiness. Despite the higher tariffs, the Zambian utility ZESCO accumulated millions of dollars in debt and experienced a significant deterioration in financial performance (exacerbated by the fall in the currency) because tariffs were still lower than the costs of imports. ZESCO's uncertain financial performance was one factor that led to a suspension of the second phase of the Scaling Solar program.

In both countries, national efforts to expand energy access have been impacted. Zambia's Rural Electrification Fund needs US$ 50 million annually for its energy access targets but is severely underfunded, spending only US$ 15 million per year. The crisis has also diverted investments from the maintenance and expansion of existing assets.

Impacts have inevitably cascaded to other sectors. In Zambia, municipal water supply and boreholes reliant on electricity were affected, resulting in water supply shortages. In Zimbabwe, queues for water stretched more than 50 meters, creating an additional work burden for women. Zimbabwe's largest mobile operator, Econet Wireless, struggled to maintain its network, with 25 percent of its base stations forced to run on diesel generators for more than 18 hours a day. Healthcare facilities, especially in suburbs and rural areas, were affected. Workers were forced to work at night when electricity returned for a few hours. Supply chains and businesses were impacted, with reduced productivity, lost produce (particularly produce reliant on cold storage), and redundancies.

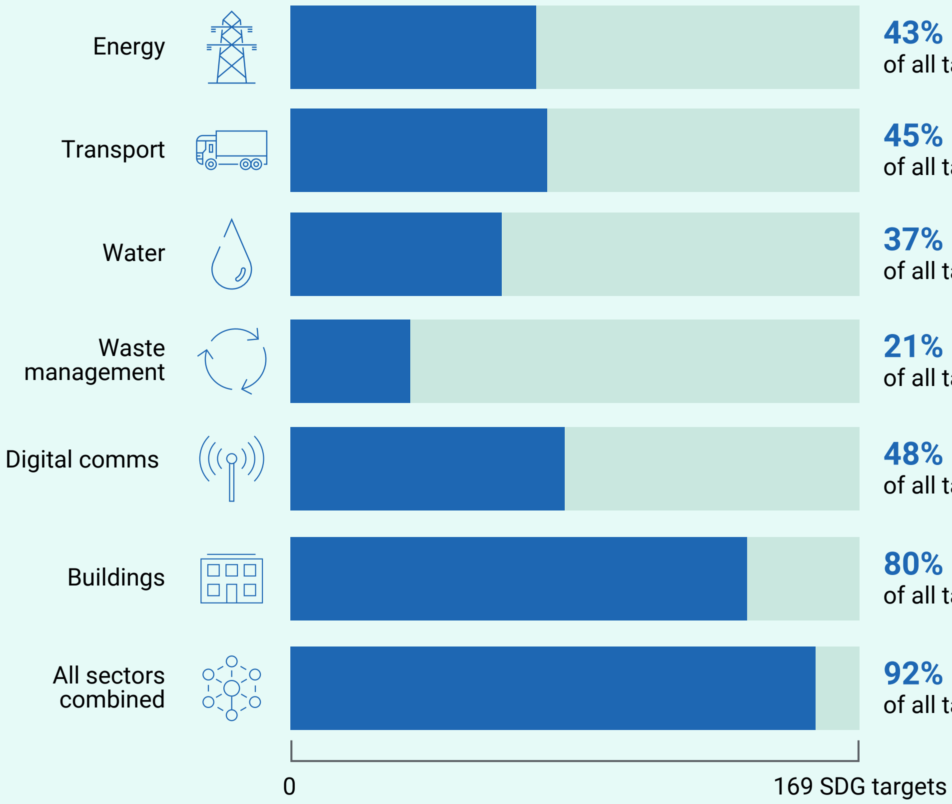
Although Zambia has managed to diversify its energy sources to some extent, both countries are likely to continue to face the consequences of the droughts for decades to come. Without urgent interventions and support from the global community to break the cycle of this climate infrastructure trap, it is unlikely that they will be able to meet either national or global goals for sustainable development.

Long-term socio-economic impacts

Disruptions in energy and transport infrastructure can quickly cascade into unforeseen disruptions on wider socio-economic development, including in key sectors like healthcare (SDG 3), education (SDG 4) and agriculture (SDG 2). They can exacerbate and further entrench existing barriers to Africa's integration and competitiveness in global markets. Seemingly minor disruptions can have significant repercussions on supply chains. One study in 23 African countries found that even a one percent increase in the frequency of power outages can reduce the sales shares of companies from exports by 0.12 percent; and reduce the likelihood of entrepreneurs starting their own business by almost 50 percent (excluding the farming sector).[18]

Photo: Felix Lipov/Shutterstock

Box 2: Infrastructure and the SDGs



Source: Adapted from Thacker et al.(2021)[19]

While infrastructure is addressed specifically in SDG 9, investments in infrastructure influence progress towards all 17 SDGs and 121 (72 percent) of the 169 SDG targets.[20]

SDG 9 recognizes that building resilient infrastructure, promoting sustainable industrialization, and fostering innovation unleashes dynamic and competitive economic forces that generate employment and income; play a key role in introducing and promoting new technologies; and facilitate international trade and enable the efficient use of resources.

In addition to SDG 9, infrastructure influences all the targets of four SDG goals – SDG 3 on good health and wellbeing; SDG 6 on clean water and sanitation; SDG 7 on affordable and clean energy; and SDG 11 on sustainable cities and communities. For 15 SDGs, more than 50 percent of targets are influenced by infrastructure.

Energy infrastructure has the largest direct influence on individual SDGs, notably SDG 7 (affordable and clean energy), while transport infrastructure has wide indirect benefits through its role in facilitating social and economic access and integration. The indirect benefits of transport infrastructure, for instance, impact on SDG 3 (health, for example through impacts on air quality), SDG 14 and 15 (natural environment, including marine and terrestrial ecosystems), SDG 11 (sustainable cities and communities), SDG 13 (climate change), SDG 10 (inequality), and SDG 5 (gender equality).

Infrastructure is fundamental to sustainable outcomes, particularly when interdependencies are considered. This points to the need for a planning approach which recognizes the synergies between infrastructure sectors and opportunities to contribute to sustainable development outcomes.

Critically, the cost of repairing and building back assets after they are hit by climate hazards diverts funding from building forward. In a world without climate change, Sub-Saharan Africa would need US$ 20 billion between 2015-2025 to address climate-induced damages to roads and bridges, according to estimates from the Programme for Infrastructure Development in Africa (PIDA), an initiative by the African Union to improve access to infrastructure networks and services in Africa. In a climate-compromised world, however, and in the absence of adaptative measures, this will cost US$ 74 billion. Malawi, Mozambique, and Zambia alone face a potential US$ 596 million price tag to maintain and repair roads under median climate scenarios until 2050, as a result of damages directly related to potential temperature and precipitation changes due to climate change.[21] These figures do not consider costs associated with expansion of new roads or improvement of existing roads to meet road standards. The opportunity cost of these expenditures is of particular concern in Africa because they will divert funding away from investment in new infrastructure development. If no proactive adaptation measures are implemented in Malawi, Mozambique, and Zambia, the opportunity costs will equate with the lost potential of expanding the existing paved road network (either with new roads or with upgrades to existing unpaved roads) in each of these countries respectively by 3,530, 3,213, and 8,760 km of paved road.[22]

Investments fall short of need

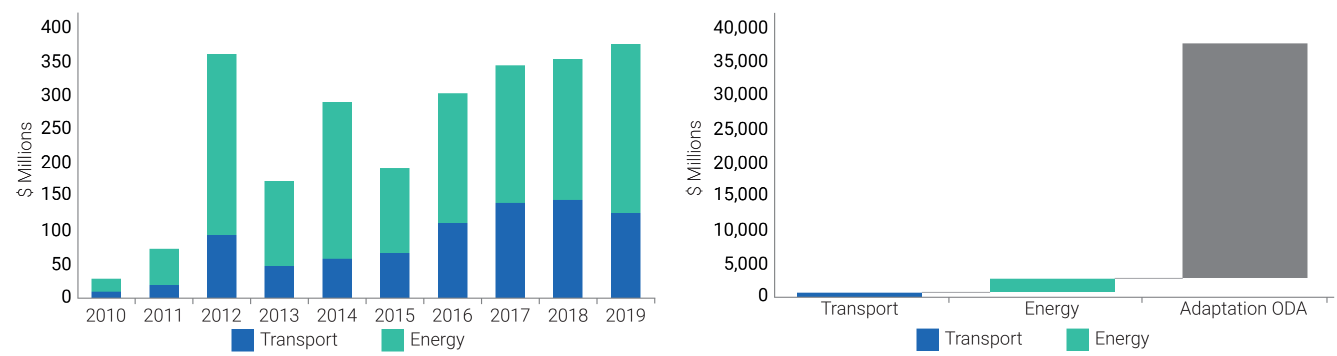
The benefits of investing in climate adaptation and resilience are increasingly becoming clear. Research from the GCA finds that making infrastructure more climate resilient will have additional upfront costs of three percent but returns can be four times the initial investment.[23] In addition to quantitative economic returns, these investments also have important social returns, influencing the attainment of most of the SDGs.

Despite evidence of these benefits, investments in improving the climate resilience of infrastructure in Africa are well below the needs. Only 2.3 percent of total ODA for Africa was allocated for investments in infrastructure adaptation between 2010 to 2019. Of this, 6.3 percent, or US$ 831 million, was allocated for the transport sector, and 12.9 percent, or US$ 1,694 million, for the energy sector. Domestic resource commitments form a large proportion of infrastructure investments in Africa, totaling US$ 37.5 billion, or 37 percent of total infrastructure investments in 2018.[24] While these investments are not screened for adaptation and resilience, ODA sponsors are increasingly calling for such screening, supporting a positive trend where total adaptation investments in energy increased from US$ 19 million to US$ 252 million between 2010 and 2019, while transport sector investments increased from US$ 11 million to US$ 128 million in the same period (Figure 1).[25]

Figure 1: Adaptation ODA for transport and energy

(a) Distribution per year

(b) Total between 2010-2019



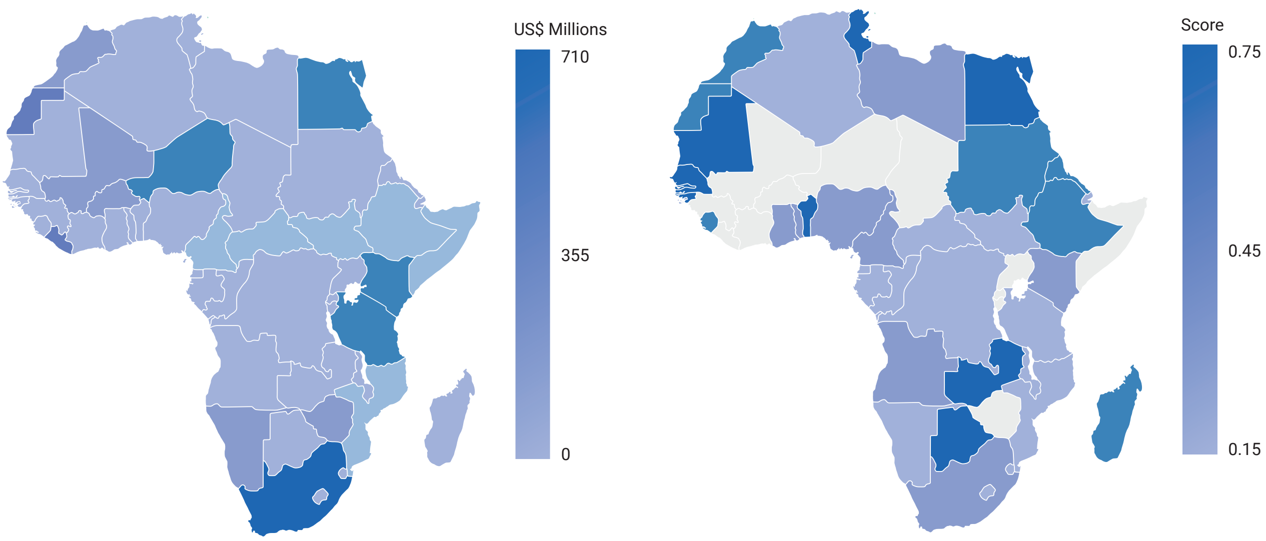
Source: Authors, with data from OECD (2021). OECD.Stat database

Existing investments in making infrastructure climate resilient also hide significant regional and socio-economic disparities, exacerbating gaps in access to basic infrastructure services. A comparison of the total flow of global funding for adaptation for the transport and energy sectors with the vulnerability of infrastructure calculated by the Notre Dame Global Adaptation Initiative (ND-GAIN) index highlights that the most vulnerable countries received the least investments (Figure 2).[26] For example, Mauritania had an exposure of 52 percent but received US$ 1 million, while South Africa had an exposure of 25 percent but received a total of US$ 710 million for adaptation investments.

Finally, infrastructure access gaps are endemic in fragile states but investments to build climate resilient infrastructure remain extremely low in these contexts. Extremely fragile countries receive only 13 percent and 1 percent of total adaptation investments in transport and energy, respectively. However, least developed countries do receive a significant proportion of global adaptation investments in the transport sector (Figure 3).

Figure 2: Regional distribution of global funding for adaptation and vulnerability of infrastructure

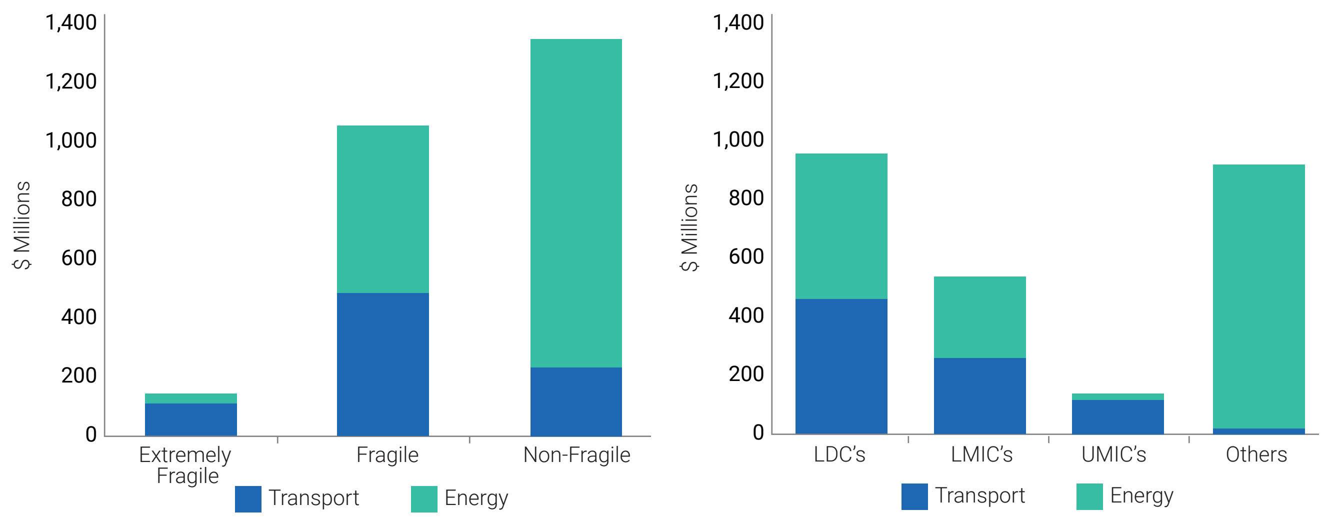
(a) Transport and energy adaptation ODA *(b) Vulnerability*



Source: Authors, with data from OECD (2021). OECD.Stat database; and University of Notre Dame (2021). ND-GAIN: Notre Dame Adaptation Initiative – Country Index

Figure 3: Allocation of adaptation ODA in the transport and energy sectors

(a) per income group *(b) per fragility level*



Source: Authors, with data from OECD (2021). OECD.Stat database

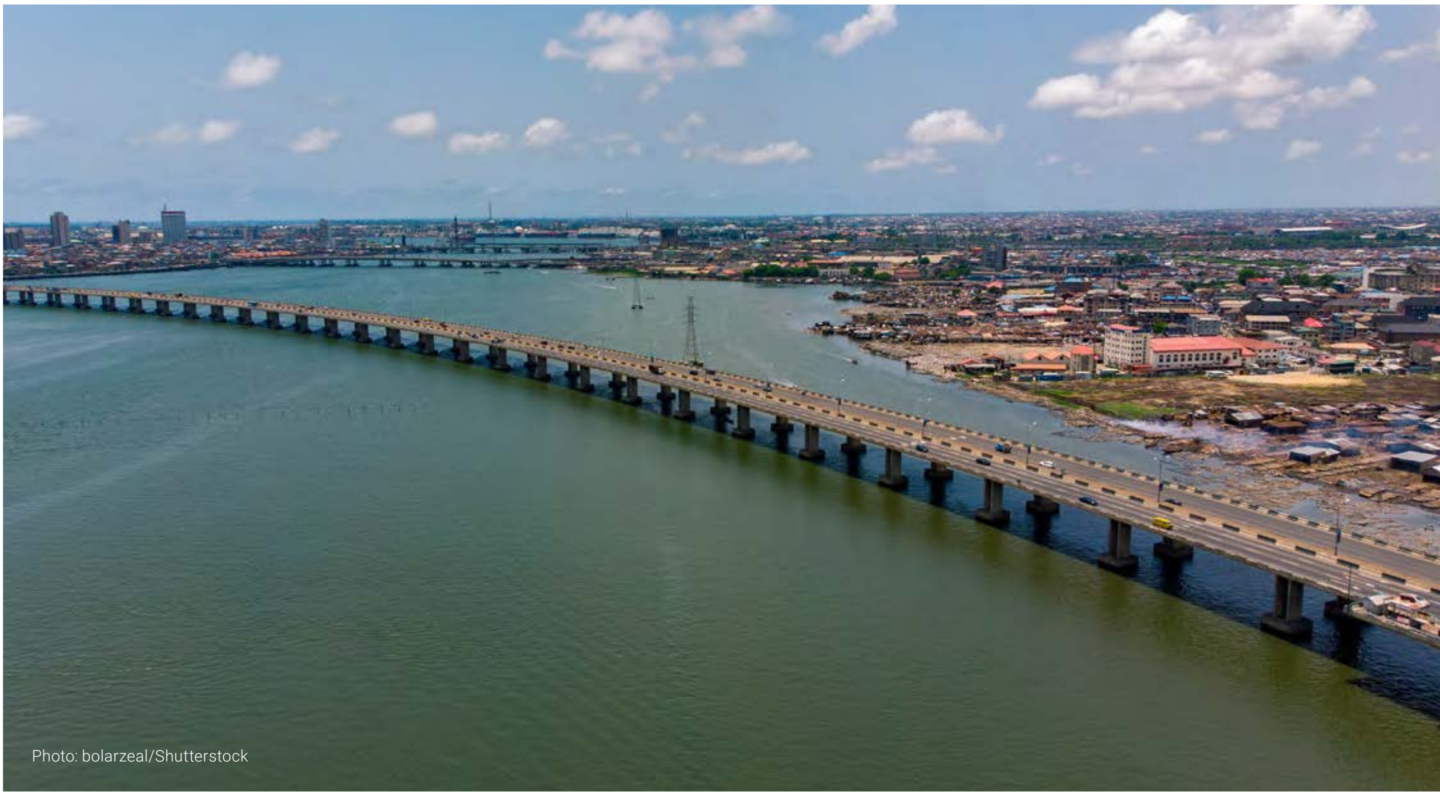


Photo: bolarzeal/Shutterstock

KEY CONSIDERATIONS FOR MAKING INFRASTRUCTURE RESILIENT

As African governments take on the daunting task of building resilience into infrastructure, they will face many difficult decisions and challenges. This section highlights key elements to maximize effectiveness.

Begin at the beginning

The best opportunity for managing climate risks is when infrastructure projects are being conceived. Adaptation and resilience should be proactively embedded throughout the life cycle of infrastructure planning, project preparation, finance, design, delivery, operation, and maintenance. This requires a strong commitment from governments (national, city, and local), who play leading roles in steering the provision of infrastructure, and in mainstreaming sustainability through adaptation. Decision-makers need to recognize that infrastructure assets that may exist for decades, face a very uncertain future. Infrastructure investments need to be designed and implemented to cope with unpredictable threats and extreme events, and design standards and codes of practice need to incorporate the effects of climate change.

Such ‘proactive adaptation’ in the energy and transport sectors in response to climate change is a no-regret option. For instance, the exposure of infrastructure to the impacts of climate change depends on its location. The decision on the location, made early in the planning process, is therefore critical for determining the level of exposure, and taking climate projections into account during this stage can reveal opportunities for making infrastructure more resilient. (Although, in some cases, the choices may be limited – ports, for example, must be located on the coast or along inland waterways). Energy supply in low-income African countries is particularly vulnerable due to their higher dependence on hydroelectricity and biomass energy supplies. According to the World Bank, the early integration of resilience in hydropower infrastructure, considering the river basin level and predicted changes in rainfall patterns in the pre-feasibility, planning and design stages, can considerably reduce and mitigate future climate risks in a cost-effective manner.[27] Examples of no-regret options in the African context include early warning systems, and the diversification of energy sources.[28]

Account for uncertainty

Investment decisions need to account for the significant uncertainty and local variability associated with climate change in Africa. For example, although the mean costs of reactive responses to climate change are US$ 56 billion[29] over 2015-2050 for the PIDA+ road network[30] (instead of US$ 15 billion without climate change)[31] the World Bank highlights that there is significant uncertainty, ranging from almost no increase to as much as three times the mean.[32] This uncertainty highlights the need to optimize investments under a range of projected climate scenarios.

The impacts and nature of climate change will not be equally distributed across Africa. Zambia, for instance, is projected to experience more extreme climate events than neighboring Malawi and Mozambique.[33] Countries such as Angola, Nigeria, Botswana, Togo, South Sudan, Mozambique, Benin, and Cameroon will be exposed to significant precipitation-related disruption even from moderate climate changes.[34]

These geographic differences have implications for the design of adaptation responses. Revenue losses from climate-related damage to hydropower can range from anywhere between 5-60 percent,[35] depending on the location of the asset and the water basin, with climate projections suggesting that countries in east and southern Africa will be most at risk. Losses are projected to be higher for higher temperature increase scenarios. For example, Morocco's hydropower capacity will decrease by 9 percent (relative to today) under a scenario of lower warming (RCP 2.6); and by 24 percent in a higher warming scenario (RCP 6.0). In contrast, hydropower capacity is projected to increase by 0-2 percent under RCP 2.6 in the Nile Basin Countries (Egypt, Kenya, Sudan, and Uganda), and increase by 4-8 percent at RCP 6.0.[36]

Consider indirect costs

Investments in proactive adaptation (which anticipates climate change and incorporates upstream resilience into the design, construction, and rehabilitation of infrastructure) often don't seem justifiable. For example, unpaved roads are more likely to be damaged by floods, but proactive adaptation (paving the roads) is prohibitively costly and does not generate sufficient cost savings from reduced maintenance costs. However, if the service disruptions across sectors (such as disruptions in trade and healthcare) caused by damage to unpaved roads are quantified and considered, proactive adaptation may become justifiable. In Nigeria and the Democratic Republic of the Congo, for example, proactive adaptation for key bridges is likely to be economically justifiable because they provide critical links within the countries, and there are no alternative routes.[37]

The first step is to understand these wider, indirect impacts and costs. Ghana is taking the lead in assessing systemic risk by enhancing capacity to assess how climate change will impact existing and planned energy, transport, and water infrastructure systems and services. The Ministry of Environment, Science, Technology, and Innovation in Ghana, infrastructure ministries and departments, and the GCA are working with the UN Office for Project Services, UN Environment Programme, and Oxford University to develop tools and methodologies that can be used for upstream planning. These will be scaled up to inform adaptation investments across Africa through the flagship Africa Adaptation Accelerator Program (AAAP), launched by the GCA and the African Development Bank.

Photo: Tetyana Dotsenko/Shutterstock

Box 3: Systemic risk and resilience assessment of Ghana's transport networks

Ghana is taking the lead in using geospatial infrastructure modelling and rigorous quantitative and qualitative assessment tools to pinpoint areas of vulnerability in the transport, energy, and water sectors.

In the transport sector, upstream assessments reveal an increasing risk of damage from direct and indirect climate impacts, including sea level rise, inland flooding, and landslides. Current flooding probability and geospatial hazard maps were created based on a methodology provided by the National Disaster Management Organisation, which involves geospatial analysis of physical parameters within catchments, including upstream areas and height and distance from drainage systems. The A1B scenario from the IPCC's 2000 Special Report on Emissions Scenarios (SRES) was selected for future climate projections up to 2050, as it uses a regional climate model and therefore provides more detailed spatial information for Ghana, as well as more realistic future projections based on a business-as-usual scenario. This scenario projects a balanced energy mix, consistent with Ghana's aim to move towards renewable energy, and includes projected socio-economic changes, including rapid economic growth and the quick spreading of new and efficient technologies. The analysis of flood hazards is based on an understanding of flood extent, with the assumption that a flooded area of road is no longer usable but does not include an assessment of flood depth or further nuance on flood characteristics beyond area extent.

Flooding is found to pose a significant hazard to the country's transport assets. By overlaying transport asset data with climate hazard data in the form of flood maps, the study found that 19 percent of Ghana's roads, 54 percent of railway assets, 27 percent of the railway network, 20 percent of port assets, and 44 percent of airport assets are exposed to flooding in a high hazard scenario by 2050. In the capital city of Accra, 27 percent of the road length (600 kilometers) is exposed to flooding, with potential damage costs of US$ 130 million.

The impact of flooding on access to health care was also calculated by intersecting flood and road data with routing to health care facilities, and the vulnerability index of districts derived from measures of adaptive capacity included in the country's Fourth National Assessment. Across all flood scenarios, the GCA finds that 12-14 million people in the country will need to travel more than 100 km to access basic health services because of damage to roads. Similarly, Ghana's supply chains are at risk from flood impacts. Flood exposure is concentrated in the Greater Accra area, which is likely to impact the movement of freight to the capital.

Table 1: Property Ownership in Sub-Saharan Africa

Sub-sectors	Hazard	National-scale exposure to hazard, including service disruptions	Population affected
Roads	Flood	**19 percent** of Ghana's 137,000 km of roads exposed	Access to healthcare for approximately **13 million** people affected
Rail	Flood	**27 percent** of total rail network length exposed	**44,700** customers face potential disruptions per day (Eastern and Western line only)
Rail	Landslide	**1 percent** of total rail network length exposed	**39,700** customers on the Eastern line face potential disruptions per day
Airports	Flood	**44 percent** of all airports potentially exposed	Approximately **460,000** passengers could face travel disruptions annually
Ports	Flood	**25 percent** of the main cargo ports are potentially exposed to flood scenarios	

As the existing problems of increased demand for roads and traffic congestion are exacerbated due to the increased number of automobile users, the existing road and railway networks across the country will need to be expanded while both existing and future transport networks are made more resilient. Ghana plans to scale up railway infrastructure by 2050 and increase the current stock of 1128 km to 4,000 km to enable cross-country freight movement across the North and South. Flooding poses high risk to future railway investments, with GCA analysis suggesting 22 percent of proposed future network will be exposed to high floods.

Ghana already pays a high economic cost for flooding. Following the 2015 flooding, the Government of Ghana had to secure funding of US$ 6.4 million for emergency repairs. Without proactive adaptation, it is estimated that maintenance and repair costs following road damage during the 2020-2100 period will amount to US$ 473 million.

Integrate 'green' with 'grey'

The integration of nature-based solutions (NbS) in infrastructure planning and decision-making – including the restoration, protection, management, or creation of natural and semi-natural terrestrial and marine ecosystems – can make infrastructure more sustainable and resilient.[38] For example, coastal ecosystems such as salt marshes, coral reefs, and mangroves can help protect coastal roads and ports by reducing wave height and the extent of flooding, and by buffering winds.[39] Salt marshes can reduce non-storm wave heights by an average of 72 percent, coral reefs by 70 percent, seagrass beds by 36 percent, and mangroves by 31 percent.[40]

In the energy sector, NbS can safeguard the storage capacity of hydropower reservoirs during droughts or high temperatures by regulating and storing water, recharging groundwater supplies, and reducing sedimentation. The degradation of catchments in Kenya, for instance, has already led to high sedimentation of two hydropower reservoirs along the Tana River, and reduced total reservoir storage capacity by as much as 10-15 percent within the last three decades. NbS can also help regulate water flow to reservoirs during high rainfall events and reduce the frequency at which dams need to be discharged. In Ghana, for instance, the Atewa Forest regulates water flow to the Weija Dam, reducing the need for discharge, and preserving downstream infrastructure and communities.[41]

In the transport sector, NbS can increase the resilience of assets by shading and cooling. This slows the deterioration of streets and pavements, decreases maintenance, and provides additional benefits such as improved water management and more productive use of land. Green spaces, green roofs, and green walls can safeguard roads in African cities by improving stormwater management, and at the same time reduce the need and costs of engineered solutions such as stormwater drains.

There are significant opportunities to enhance NbS across Africa. East and southern Africa, including Tanzania, Kenya, Madagascar and Mozambique, have a total restorable area of mangroves of 41,200 hectares, with the Mozambique coast showing highest potential.[42] West and central Africa have 44,000 hectares of restorable mangroves, with the highest opportunities found in Senegal, Nigeria, Cameroon, and Gabon. To attract investments, however, this added value of restoring these ecosystems will need to be quantified.

At the same time, integrating NbS into infrastructure sectors can benefit 14 of the 17 SDGs, and impact all 17 SDGs through the delivery of wider economic, social, and environmental co-benefits.[43] Integrating NbS in the energy and transport sectors can benefit more than 40 of the 169 SDG targets, and can have co-benefits for approximately 90 SDG targets.

"The shock that the pandemic and climate change have in common is that they affect particularly the more fragile and vulnerable communities."

H.E. President Condé of Guinea, Champion of Africa Renewable Energy
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

Photo: Dennis Diatel/Shutterstock

Box 4: The economic benefits of Nature-based Solutions in the Weija Dam catchment in Ghana

Photo: Nature, Parks/Outdoor/Shutterstock

NbS can help countries adapt to climate change, and at the same time offer multiple benefits to stakeholders, including tangible financial returns. The Weija Dam in Ghana, for instance, currently supplies drinking water to one million citizens of Accra. This number can be doubled, and an additional one million thirsty citizens of Accra can potentially gain access to drinking water through NbS.

Using the GIS-based Revised Universal Soil Loss Equation (RUSLE) modelling approach, the GCA estimates that a 15 percent increase in erosion due to rainfall in the Dam's catchment area will increase sedimentation by 15 percent under business-as-usual (BAU) climate projections.[44] This will reduce reservoir storage capacity and increase the cost of water production. Assuming a linear cost increase for water production due to increased sediment loads caused due to climate change, the GCA estimates that the net present values for Ghana Water Company will decrease by up to 9 percent by 2050, compared to BAU.

However, a combination of forest conservation in Atewa Forest and agroforestry systems that provide overhead canopy shade for cocoa trees can reduce this sedimentation. The Economics of Ecosystems and Biodiversity (TEEB), a global initiative focused on "making nature's values visible", estimates that these NbS measures can boost the economic benefits for farmers by 32 percent and for the Ghana Water Company by up to 97 percent. Across all sectors, the potential returns can be as much as US$ 315 million. Potentially, therefore, NbS can more than offset the costs induced by climate change.

Leverage public-private partnerships

Leveraging public-private partnerships (PPPs) for climate-resilient infrastructure can help countries in Africa to mobilize funds to bridge the existing infrastructure gap, while accounting for climate change. The incentive structure of PPPs provides opportunity to establish project requirements that include resilient and adaptive assets or services. The focus on outputs and performance, meanwhile, can stimulate innovations in the integration of resilient design and NbS, to reduce costs over the lifecycle of the infrastructure. PPPs also enable the allocation of risk between public and private partners in ways that best manage uncertain climatic conditions and achieve resilience benefits.

While African governments are increasingly turning to PPPs to attract private capital for infrastructure projects, the World Bank's Private Participation in Infrastructure (PPI) database shows that Africa has secured less than 7 percent, or only US$ 74.8 billion, of global PPP investments over the last decade. In Sub-Saharan Africa, PPP investments between 2010 and 2020 amount to US$ 59.3 billion, directed to 275 projects mainly related to electricity, ports, and information and communications technology. Only seven of these PPPs were for road networks. If the PPPs integrate climate resilience and adaptation considerations, they could contribute to bridging the existing infrastructure gap in Africa.

According to the Infrastructure Consortium for Africa (ICA), uncertainty and the lack of political commitment are key barriers for infrastructure PPPs.[45] Although 35 out of 54 African countries have PPP legislation and units, most African countries have not yet incorporated resilience and adaptation into their PPP frameworks.[46] More work is therefore needed in updating regulatory frameworks to provide a strong enabling environment for climate-resilient PPPs; accounting for climate risks, to ensure an acceptable level of risk in projects; incorporating adaptation interventions from the outset to deliver efficient services and provide resilience co-benefits; and ensuring adequate project preparation to make projects commercially attractive. However, while there are strong bodies of knowledge on PPPs and on climate-proofing infrastructure, information on how to bring those two fields together is lacking.[47] The GCA has developed guidance and training for PPP practitioners across Africa to fill this gap, in partnership with the World Bank, the Ministry of Infrastructure of the Netherlands, and other multilateral development banks (MDBs).

Optimize lifecycle costs

Investments with lower up-front costs are attractive for countries that need to bridge infrastructure access gaps within significant financial constraints. However, this can result in higher lifecycle costs due to climate change, where countries must spend large amounts to repair and maintain infrastructure. The chronic lack of investment in downstream operations and maintenance carries additional risks, as countries cannot benefit from the full value of assets.


Photo: Belen B Massieu/Shutterstock

In the transport sector, proactive 'upstream' investments to increase the adaptive capacity and resilience of assets can have additional up-front investment costs but reduce 'downstream' operations and maintenance costs. Studies in Malawi, Mozambique, and Zambia have revealed, for instance, that investments in proactive adaptation of road networks can reduce maintenance costs by as much as 90 percent in some cases. Adapting unpaved roads to increased precipitation in Zambia can save, on average, US$ 177-193 million annually on maintenance.

At the same time, increasing the resilience and adaptive capacity of all infrastructure assets is not feasible or optimal. There will always be a residual risk of a climatic extreme that exceeds the design condition of any asset, especially as future climatic conditions are highly uncertain. In Ghana, for example, the GCA estimates that while 19 percent of the country's 137,000 km of existing roads and highways will be exposed to flooding by 2050 in a high hazard scenario. Retrofitting adaptation options into these assets will not be affordable. While 27 percent of the country's railway network will be exposed to flooding by 2050 in a high hazard scenario, this only represents 890 km of track. Roads as an asset are therefore more exposed.

Mainstream adaptation in infrastructure networks

Infrastructure networks can be characterized as a "system of systems" that cuts across government structures, institutional coordination, political commitment, regulations, enforcement, technical and human resource capacity, funding and financing of adaptation activities, and climate hazard and infrastructure-related data management and sharing.

Various agencies hold different responsibilities across the infrastructure lifecycle for data collection, sharing and management resulting in disconnected solutions across the sectors. The technical nature of climate change impacts requires specialized knowledge, understanding, and skills in developing targeted solutions for infrastructure resilience development and management. There is increasing

Photo: KRISS75/Shutterstock

recognition of the need for long-term infrastructure planning that adopts an integrated systems approach across infrastructure sectors, including energy, mobility, digital connectivity, water, and sanitation.

While climate adaptation for infrastructure in Africa is often reflected in policy and legal frameworks, the translation of high-level policy objectives into design, construction, and management processes remains a challenge in most countries and across all infrastructure sectors.

A growing number of countries around the world are adopting National Infrastructure Plans that are based on systematic analyses of future needs for infrastructure and exploration of options for meeting those needs through portfolios of investments and policies. These plans provide the opportunity to explore future climate risks to infrastructure and to embed adaptation in the infrastructure planning process, as a necessary component of an integrated, systems-level approach. They also provide an opportunity for innovation and new technologies – for example, for integrating nature-based solutions where possible to reduce costs, yield benefits for nature, and enhance resilience.

National Infrastructure Plans also need to be integrated into other ongoing and existing policy and planning processes, such as the Nationally Determined Contributions (NDCs) and National Adaptation Plans. The African Development Bank's review of the 44 NDCs submitted by African countries indicate that while all governments considered adaptation as a priority to some extent in vision statements, outcomes, or processes and actions, only 18 NDCs specifically mentioned adaptation priorities in the energy sector, and eight NDCs in the transport sector.[48]

Building resilience in the transport and energy sectors will require new tools and approaches that allow climate and disaster risks to be systematically identified, prioritized, and built into investment planning and decision-making processes. These range from upstream sectoral assessment and spatial planning to post disaster risk and recovery support; and from infrastructure system solutions and support, to building an enabling environment.

Act now

Transformation is urgent and necessary because climate change will fundamentally alter the context in which infrastructure is financed and delivered in Africa over the next few decades. Events that were rare will become much more common. As investors are now aware, these changes are an economic and financial risk for infrastructure. African governments and private infrastructure providers will need to prepare for increased risks of asset-value losses, increases in capital and operating costs, and/or a decline in the economic benefits or revenues that infrastructure assets generate. Acting now is much cheaper than deferring action to the future and will generate greater economic benefits. The magnitude of the costs of inaction – versus the benefits of proactive action – are large. Delaying action will make it much harder to tackle the climate risks and could make large future costs inevitable. Moreover, the opportunities for building resilience into the planning stages for infrastructure will decline over time.

Adapting infrastructure to climate change in Africa will have implications for the entire (systems-level) approach to planning, delivering, financing, and managing infrastructure in a country, and thus on the national public finances. This is generally due to four key issues:[49]

1. The increased chance of cascading risks, as damage to critical infrastructure leads to knock-on impacts in other sectors and geographies, will magnify the economic damage and fiscal impact of climate-related disasters.
2. As credit rating agencies factor climate change risks into sovereign creditworthiness, this could result in higher risk premiums, and increase borrowing costs – diverting government spending on debt servicing rather than development.
3. Contingent liabilities due to climate change could have potential implications for financing models. For instance, difficulties in allocating climate risks could make PPPs increasingly unattractive for infrastructure financing.
4. Rising climate extremes could reduce the availability of insurance or result in higher prices for insurance, increasing the risk of financial instability.

POLICY RECOMMENDATIONS

The scale and multi-sectoral scope of interventions to increase infrastructure adaptation and resilience creates a complexity that is difficult to navigate. Together with African governments, many private and public investors are already exploring – or have committed to – major new infrastructure projects over the next decade. Africa's current pipeline of infrastructure projects includes US$ 2.5 trillion worth of projects estimated to be completed by 2025, across all asset classes. Over 50 percent of these projects are still in the early feasibility stages, and while not all of them are expected to succeed, will a critical mass of the projects that move from feasibility to completion be resilient to climate change? The answer to this question will determine whether Africa will progress in closing its infrastructure gap, and climate-proof these investments to make them sustainable and resilient.

The following recommendations help chart the way forward:

- **A transformational shift is necessary in how infrastructure is planned and designed, with systemic climate risks and resilience integrated upstream.** While infrastructure development in energy and transport sector is vital to Africa's growth, there is a high potential that climate change will offset or reduce the benefits of such infrastructure. Adaptation has great potential to reduce the negative impacts of climate change, but the planning and design of infrastructure in Africa is still conducted largely without taking climate change into account. Failing to adjust designs ex ante to improve infrastructure performance over a range of climate futures may be an economic loss for the economy and the society in the long term. Proactive adaptation in the energy and transport sectors, meanwhile, is a no-regret option. There is momentum building for national governments, development partners, and the private sector to integrate climate change into asset design. Development partners such as the World Bank and the African Development Bank, for example, already screen projects for adaptation. However, there needs to be a fundamental shift further upstream to integrate climate resilience into how country and sector projects pipelines are planned, financed, and developed. Ghana's ongoing efforts to implement a national risk and resilience assessment provides a roadmap for other countries. While this shift needs to be country-led, MDBs can rapidly catalyze this change by integrating national and regional systemic risk and resilience assessments into their country strategies.

- **Invest in integrated systems to generate data for investment planning.** To bring down the cost of the analysis needed to integrate climate considerations into energy and transport development, and to mainstream systemic risk and resilience, significant amounts of data on climate, infrastructure assets, supply chains, the environment, economic activities, and other socio-economic aspects is needed. Most African countries and their development partners already have existing systems and projects that generate the required data, but these systems are siloed and mostly disconnected from decision-making processes. Data on climate change and hazard projections, for example, is often held within environment departments and MDBs. Similarly, data on supply chains and economic output may not be readily available or used for planning investments in transport and energy infrastructure. While data alone will not increase infrastructure adaptation and resilience, it is a vital entry point for putting in place the building blocks for climate-smart investments in infrastructure. African countries should focus on two priorities:
    - Climate data needs to be ubiquitous and tailored for actionable decisions. While countries and cities increasingly have climate risk projections, the data is difficult to comprehend and typically focused on longer-term projections that are not helpful for short-term planning.
    - Infrastructure asset data needs to include spatial markers and be integrated, or at least available, across sectors. This will also improve assessments of key vulnerabilities of infrastructure when used with the climate data and help to prioritize investments.
- **Transport assets tend to be long-lived and adaptation to new norms takes time.** Adequate road maintenance is the most critical and efficient way of reducing the impacts of a changing climate on the road system in Africa. However, adaptation often requires technological changes (such as

Photo: Vadim Petrakov/Shutterstock

the use of innovative materials that can withstand long periods of flooding); and involves transitional phases (such as ensuring redundancy in the connectivity of rural and urban areas).
- **Invest in tools and methodologies to quantify energy, transport, and infrastructure related ecosystem services provided through natural assets.** NbS, implemented on a large scale, could reduce costs by 90 percent for the same level of adaptation benefits. With the increased urgency to protect 30 percent of land by 2030, as proposed under the UN Convention on Biodiversity, it is essential to find opportunities for investment programs to achieve multiple objectives. Quantifying these benefits will provide the data required to structure NbS investment models. It will also provide the adaptation link with carbon markets and could help reduce speculative pricing of carbon. This in turn can also derive additional revenue streams for NbS and climate-resilient infrastructure. There is a need to ensure sharing of research within and across sectors and to standardize methodologies and approaches for integrating NbS in infrastructure planning and implementation where appropriate, while recognizing the context-specificity of NbS projects.
- **Leverage PPP frameworks that promote incentives for climate resilience and adaptation of infrastructure projects.** While PPPs represent a relatively small proportion of infrastructure

investments in Africa, they provide a clear entry point for integrating adaptation and resilience into infrastructure design and asset management. A robust PPP framework is imperative to attract private capital for infrastructure, particularly in Africa where market conditions are more sensitive, given the complexity of PPP projects, contract size, and risk exposure.[50] Four key aspects need to be considered to integrate climate adaptation and resilience into PPPs in Africa:

- Accept uncertainty of climate risks and account for future climate scenarios in the decision-making process. Managing climate risks can be translated into improvements during the design and operations of infrastructure, as well as the use of innovative financing mechanisms to transfer those risks. This can also be reflected in "force majeure" clauses or relief and compensation events in the PPP contract.
- Enhance capacity of practitioners to understand and integrate climate resilience into infrastructure PPPs. Besides the legal, financial, and public knowledge required to structure PPPs, there are other skills that can support the development of climate-resilient PPPs, such as climate change policy, environmental engineers and economists, and stakeholder engagement experts. These capabilities should be readily available for collaboration across PPP units, line Ministries and government agencies, and the private partners.
- Develop innovative financing and funding instruments to support resilient investments and facilitate the allocation of climate-related risks between the public and private partners. This includes insurances, guarantees and green bonds, and alignment of investments with green finance measures and standards.
- Integrate NbS into PPP design and tender documents. PPPs can provide a vehicle to finance and scale up the implementation of NbS. However, NbS should be mainstreamed from project identification and considered as a key solution in the resilience options appraisal, along with grey infrastructure solutions, to adapt and mitigate identified climate risks.

- **Governments must drive reforms for improved operations and maintenance asset management.** Planning, designing, and financing climate-smart infrastructure represents only one portion of the infrastructure lifecycle. Asset management is often ignored or de-prioritized in the drive to finance and increase infrastructure capacity in Africa. Countries must enhance fundamentals of climate-smart infrastructure governance by reflecting climate change in asset management practices through clearly defined system performance metrics and levels of service. Specific recommendations to integrate climate change into asset management practices include:

- Define requirements: Asset lifecycles and management timelines should reflect climate change and projections. Resilience measures that define how quickly services need to be restored should include projected climate hazards.
- Assess climate impacts on the asset base: Detailed spatial climate hazard data should be used to assess vulnerabilities across all assets; and asset management plans should identify climate risk and key performance thresholds that place people and services at risk.
- Develop climate-smart capital works strategies: Risk analysis should inform operational expenditures and procedures; and capital expenditures should address key asset vulnerabilities including through retrofitting infrastructure where required.
- Integrate climate risk in financial plans: Financial models should integrate climate risk in cash flow projections through climate-sensitive demand and supply assessments and projected asset maintenance costs. Asset managers should run climate-risk scenarios to stress test systems.
- Integrate climate change and hazard data in management information systems (MIS): Managing climate risk is a data-intensive process, but climate hazard data needs to be integrated into decision-making. MIS offer a viable entry point to mainstream climate risk into asset management.

"Climate change would lead to 55 million people who are undernourished in 2050, but without adaptation through trade, the impact of global climate change would increase to 70 million, an increase of 33%."

Jamal Saghir, GCA Board Member and Professor of Practice, McGill University
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Bamboo bikes: A small innovation with big wins

Ghana Bamboo Bikes Initiative

The transport sector is a major driver of development in Ghana, playing a fundamental role in key sectors such as agriculture, trade, education, and health. As in other parts of the world, however, it is heavily reliant on fossil fuel-powered motorized vehicles, and is therefore a major contributor of greenhouse gas emissions, and of other pollutants with significant impacts on human health and the environment.

Motorized transport is also infrastructure intensive and needs extensive and expensive road networks that require regular upkeep. Low farm productivity, due to unpredictable weather among other things, has driven populations further into the hinterlands of the country in search of better farming conditions and other livelihoods, but the road infrastructure has not been able to keep up. Roads, where they exist in these remote regions, are in poor condition and unfit for most motorized form of transport, particularly during and after torrential rainfall. Most people have to rely on bicycles as a more reliable and affordable means of transport – even so, bicycles are a privilege that only a few can afford.

Over the past few years, a novel initiative to overcome these transport challenges in remote areas has been trialed in the Ashanti, Eastern, and Northern Regions,

A group of students at Nabdam Girls Model School in the north ready to head home after class hours during a field visit

Source: Authors

"I love to be in school, but sometimes I had to absent myself twice a week because my mother could not afford to pay the fare for transport," says 15-year-old Adwoa Kra Veronica, from Amasu. "Each day, I had to travel over 10 kilometers through a bushy foot path to get to school, and my mother was very concerned about the risks involved. After I was gifted this bamboo bicycle in 2017, I have consistently performed well in class since I am among the few students who come to school early for morning studies."

where livelihoods are primarily agrarian, and rely on the ability to transport perishable agricultural commodities from aggregation centers to markets in time. The Ghana Bamboo Bike Initiative (GBBI), a social enterprise, has distributed over 500 bamboo bicycles to select members of the community in these regions, including farmers, students, teachers, and social workers. GBBI developed the bicycles as a means of addressing, among other things, challenges related to climate change, poverty, unemployment, and education; and trains rural women and youth in bamboo bicycle building to enable them to earn a sustainable income.

The bikes have had a transformational impact on the lives of the recipients. "A major problem of farming in the Northern Region is the dry, hot climate," says Tembire Yensomre, a farmer in Kong-Daborin. "The farms are very far because that is where we can find some spots of water to grow crops. Transportation has been a great challenge for me for quite a long time. The day I received this bicycle, I wondered if it could last long on our very poor roads. As you can see, it is very strong – I have only had a flat tire once. Now, I farm yam in addition to millet because I can spend more time on the farm, and expect to produce 500 kilograms of yam this year!"

Built from a native bamboo species, local fiber materials, and plant-based resin, the bicycles have proven their potential to bolster the adaptive capacity and resilience of communities that are outside the mainstream transport system in Ghana. Encouraging their use through subsidies, and providing climate-resilient infrastructure necessary to increase user safety and extend the product life of the bicycles, will go a long way towards meeting the goals of existing national and regional policies and strategies that seek to promote non-motorized transport, and ensure better transport accessibility in the face of climate change, economic growth, clean air, and reduced emissions. These include the National Transport Policy, Non-Motorized Transport Strategy, Nationally Determined Contribution, Growth and Poverty Reduction Strategy, and the Action Framework of the Africa Sustainable Transport Forum.

Urban development

KEY MESSAGES

- **At 4.4 percent, Sub-Saharan Africa is the region with the fastest urbanization rate globally, with about 40 percent of its population living in urban areas, up from 22 percent in 1980.** With close to one billion urban residents, the growth will continue and double in number by 2050. On average, 60 percent of Africa's urban residents live in slums.
- **The COVID-19 pandemic is having severe economic impacts in Africa and its cities. Economic activity in Sub-Saharan Africa is estimated to have contracted by 2 percent in 2020.** The region has seen its first recession in over 25 years, with activity contracting by nearly 5 percent on a per capita basis. Local governments could experience a drop in local finances of 30–65 percent, on average.
- **Low-lying coastal areas have specific climate risks due to sea level rise and, in many areas, increased flood frequency.** Climate risks are compounded by demographic trends in coastal areas. About half of the African settlements with 1–5 million inhabitants are located in low-elevation coastal zones. By some estimates, Africa's populations in low-elevation coastal zones (LECZ) will rise at more than double the world's average.

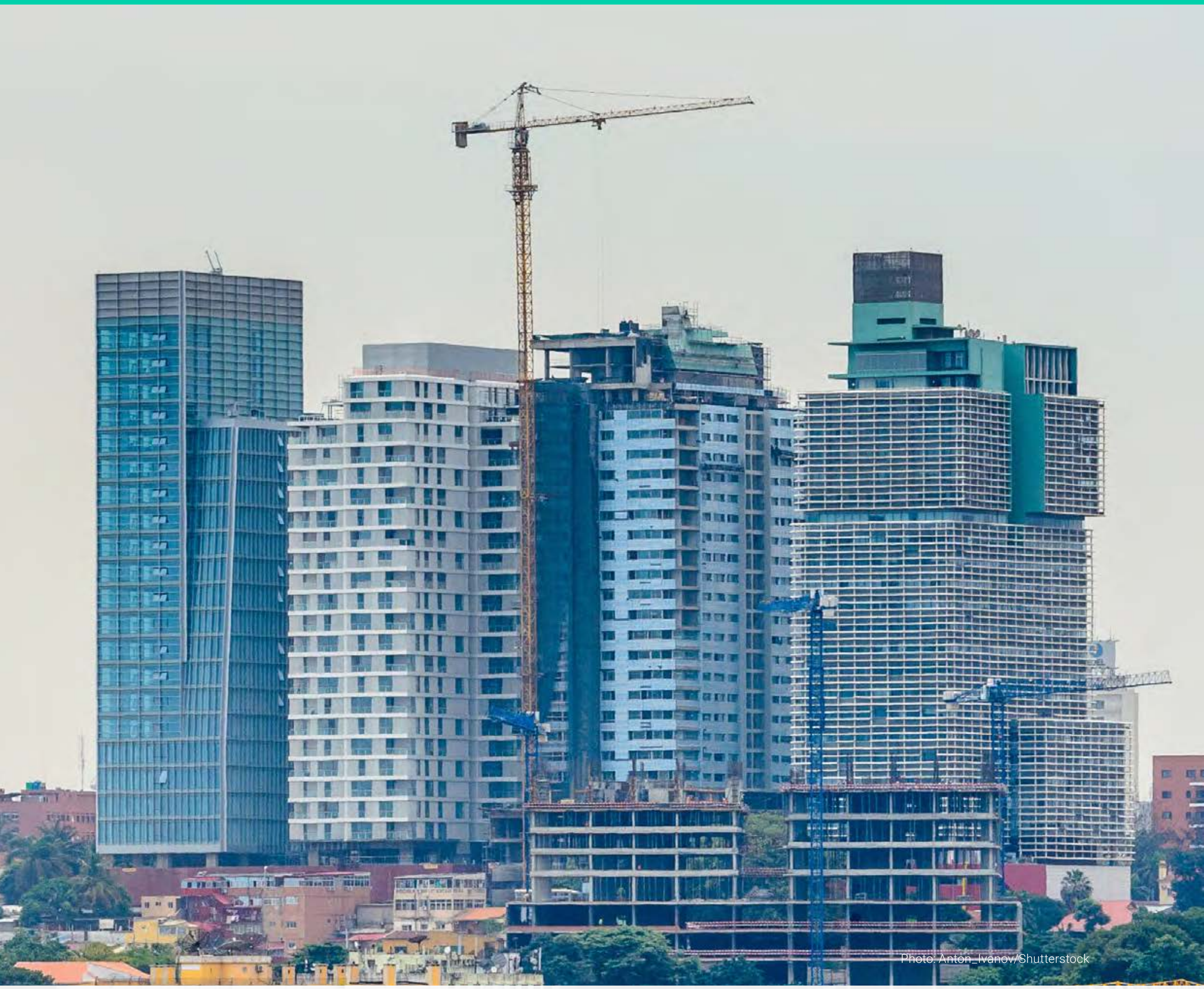


Photo: Anton_Ivanov/Shutterstock

- **The early stages of urbanization in most Sub-Saharan African cities provide a unique opportunity.** The low levels (40 percent) of urbanization of the region and the low density of its large cities offer opportunities for low-cost actions that can prevent locking-in errors made by other highly urbanized regions of the world.
- **African cities can undertake a range of adaptation opportunities that require fewer financial resources** and can generate immediate and significant benefits or set up the planning basis for enhanced adaptation measures as part of their post-COVID recovery.

> **“Climate change is disrupting the continent’s agriculture and water supply, is threatening coastal zones and cities. Moreover, the Covid-19 pandemic is eroding recent progress in building resilience, leaving countries and communities more vulnerable. This is why we need to step up efforts for climate adaptation and resilience in Africa.”**
>
> **Flemming Møller Mortensen, Minister for Development Cooperation, Denmark**
> Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

This chapter reviews the current state, past trends, and project of urbanization in Africa. It analyzes present and projected climate risks in urban areas, focusing on floods, specific risks for low-lying urban centers, the impacts of droughts on water supply services, heatwaves, and coastal erosion and its linkage to sea level rise. The chapter then reviews adaptation options for African cities in three groups: (i) untapped opportunities and early wins; (ii) urgent adaptation actions in the post-COVID recovery; and (iii) medium- to long-term measures after the economic recession caused by the pandemic.

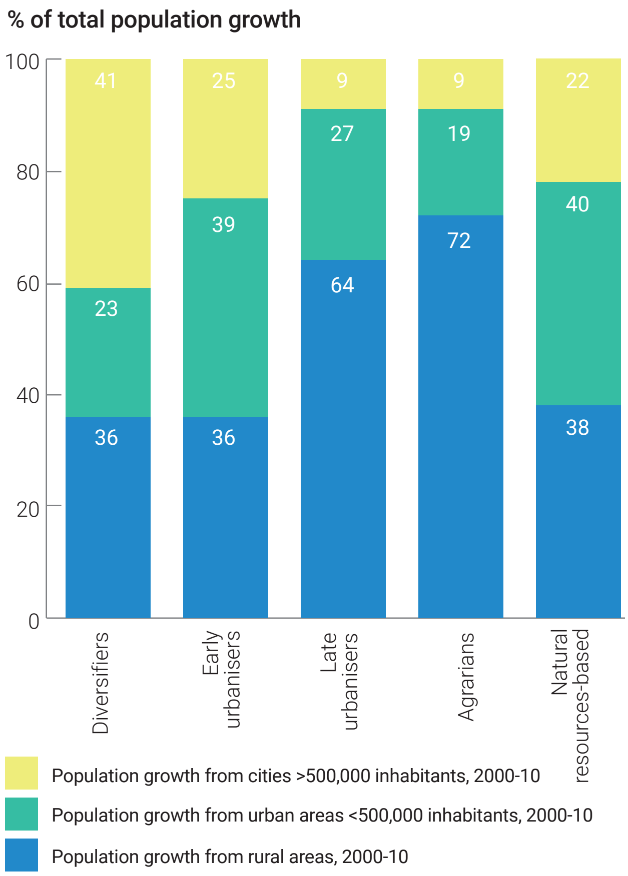
Photo: Andreas Marquardt/Shutterstock

State and trends of urban Africa

Africa is urbanizing fast. At 4.4 percent, Sub-Saharan Africa is the region with the fastest urbanization rate globally, with about 40 percent of its population living in urban areas, up from 22 percent in 1980. With close to one billion urban residents, the growth will continue and double in number by 2050. On average, 60 percent of Africa's urban residents live in slums.[1,2] Africa has 34 percent of its population living in cities with more than one million inhabitants.[3]

The urbanization path of different countries in Africa is quite diverse, ranging from early urbanizing countries in West Africa, to natural resources-rich countries with high urbanization concentrated in their capital cities, to late urbanizing countries in East Africa, and many agrarian countries at an early stage of urbanization like Chad, Niger, and Malawi. Figure 1 presents the contribution to urban growth in these categories of countries.[4]

Figure 1: Contribution to population growth by city size and rural-urban interface by type of African country, 2000–2010

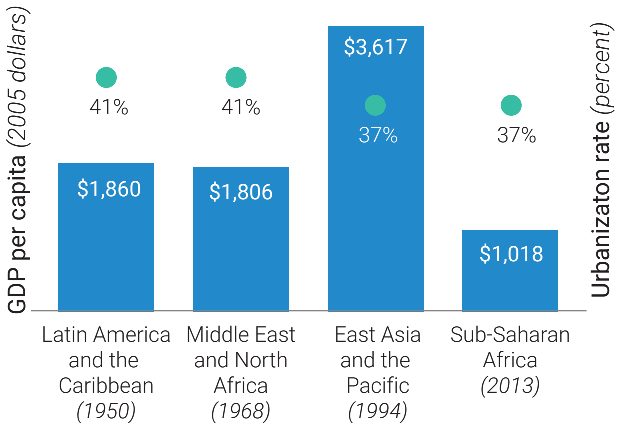


Source: African Development Bank, OECD, UNDP (2016), *African Economic Outlook*

The financial resources available to provide urban infrastructure services in Africa are quite limited. While urban infrastructure investment needs for Africa vary greatly, estimates indicate a requirement of about US$ 20 billion per year. Countries in the region would need to spend 5–7 percent of their GDP on public infrastructure, but only invested about 2 percent between 2009 and 2015.

A significant challenge for the region is that urbanization is taking place at lower levels of income compared to other regions. In 2005, dollars, the GDP per capita of Sub-Saharan Africa at close to 40 percent urbanization was about US$ 1,000. At that same rate of urbanization, the GDP per capita for the Middle East and North Africa was US$ 1,800, and for East Asia and Pacific it was US$ 3,600, as shown in Figure 2.[5]

Figure 2: Levels of per capita GDP in different regions when their urbanization level was about 40 percent



Source: Lall et al. (2017), "Africa's Cities: Opening Doors to the World"[6]

Note: years in parentheses are those with available data in which the region was closer to about 40 percent.

Furthermore, municipal governments have very little revenue to confront these infrastructure needs. Intermediary cities only spend about $1 per capita per year. Even large cities with more resources, like Addis Ababa with US$ 124/cap, or Nairobi with US$ 118/cap, do not have the resources needed to respond to the rapidly growing populations.

The urbanization process in Africa has not achieved its full economic potential. Economic transformation and growth have not followed urbanization in most of Sub-Saharan Africa. This discrepancy is related to the shape and density of cities. Even large cities have low density, and in many cases, the footprint of cities is growing faster than the population. This footprint

Photo: Salvador Aznar/Shutterstock

growth makes the provision of infrastructure services more expensive and the job opportunities more difficult. Around 60 percent of urban unemployment and over 90 percent of jobs are informal. African cities also have high inequality, with Gini coefficients at 0.54 in a sample of 12 countries.[7]

The COVID-19 pandemic is having severe economic impacts in Africa and its cities. Economic activity in Sub-Saharan Africa is estimated to have contracted by 2 percent in 2020. The region has seen its first recession in over 25 years, with economic activity contracting by nearly 5 percent on a per capita basis.[8] These impacts have the potential to erase the development progress of the last decade. In Africa, local governments could experience a drop in local finances of 30–65 percent, on average, depending on the severity of the crisis.[9]

PRESENT AND PROJECTED CLIMATE CHANGE IMPACTS ON AFRICAN CITIES

African cities face rapidly growing climate risks but with large variations across the continent that need targeted responses. Climate risks in urban areas of Sub-Saharan Africa include floods, droughts, sea-level rise, heat waves, and increased risks to diseases like malaria, cholera, and rodent-borne diseases (see the Health chapter).

Floods

Climate impacts fall disproportionately on the urban poor, in particular floods (see Water Resources Management, Floods, and Disaster Risk Management chapter). These risks are more pronounced in southwest Africa where poor households are overexposed, and in countries with large rivers in West Africa (e.g., Benin, Cameroon, and Nigeria). The topography of some cities, combined with deforestation and encroachment into floodplains, leads to multi-risk situations that are aggravated by climate change. The massive landslide in Freetown in August 2017 left more than 1000 missing or dead (see Box 1).[10]

Box 1: Multiple Factors at Play in Climate Risks – The 2017 Landslide in Sierra Leone

Sierra Leone is highly exposed to natural disasters and climate shocks. The Notre Dame Global Adaption Index ranks Sierra Leone 158 out of 182 countries in terms of vulnerability to climate change. In the last 15 years, four major floods have affected over 220,000 people. Freetown is a coastal city located on the mountainous Sierra Leone peninsula, in the west of the country.

On August 14, 2017, a massive landslide slipped into the Babadorie River Valley and exacerbated existing flooding in Freetown, affecting about 6,000 people of which 1,141 have been declared dead or missing.

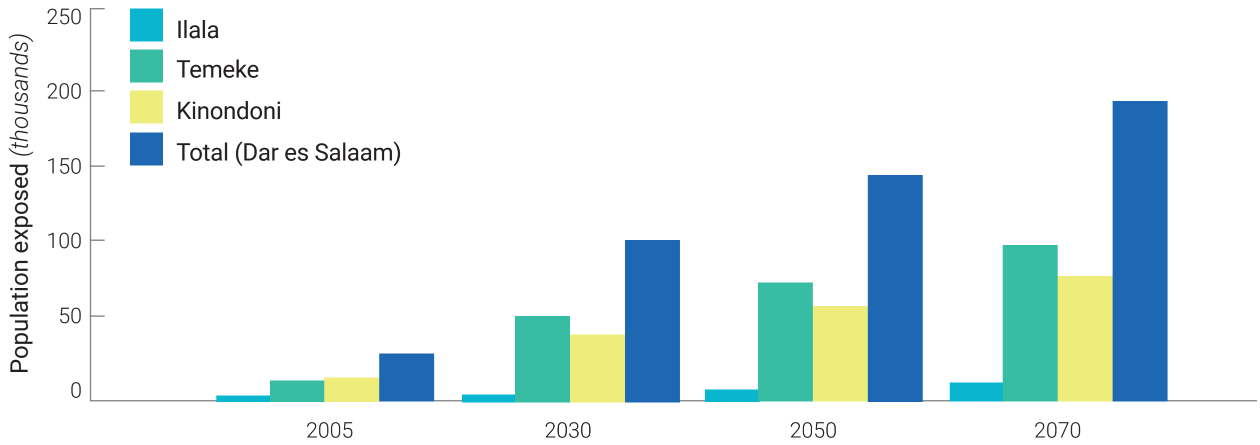
Following three days of intense rainfall, a mountain valley side slope in the Regent area below Sugar Loaf, the highest peak in the north of the Western Area Peninsula, collapsed and caused a major landslide. Up to 40 cubic meters traveled from high up of the slope with huge energy and momentum. The main landslide caused major destruction of infrastructure in the upstream areas of the river, while flooding in areas outside the landslide zone affected 55 percent of the households in the Culvert and Dwazark neighborhoods of Freetown on the same day.

The damages and losses to housing (about US$ 15 million) was higher than that of the other infrastructure sectors, which is typical of a disaster caused by a natural hazard event in an urban area. Damage impact also varied by geography, with lower income settlements being at the recipient end of the floods. The more upstream housing close to the landslide were better built and larger in size. The total damage and lost estimate of the disaster was close to US$ 32 million.

Source: World Bank (2017) Sierra Leone Rapid Damage and Loss Assessment of August 14th, 2017 Landslides and Floods.

The rapid urban growth of African cities has also led to a substantial transformation of open space areas. All cities face a strong demand for housing close to the city center and its employment opportunities. The lack of adequate transport options means that central land faces substantial pressures, including wetlands and river floodplains. Despite the high risk of flooding, low-income communities are built in these areas. For example, in Dar es Salaam, informal communities along the riverbanks and floodplains of the Msimbazi River system are at high risk. Figure 3 shows the projected exposed population under current trends without adaptation measures or changes to urban growth patterns.[11]

Figure 3: Exposed population in Dar es Salaam to a 1 in 100-year flood event, 2005–2070



Source: White et al. (2017)[12]

Photo: Romas_Photo/Shutterstock

Coastal cities

Low-lying coastal areas have specific risks. Climate risks are compounded by demographic trends in coastal areas. About half of the African settlements with 1–5 million inhabitants are located in low-elevation coastal zones. The density in these zones is much higher than inland, and the projections indicate further concentration. For example, Senegal had 20 percent of the population living in these zones but is projected to have about 50 percent by 2060. By some estimates, Africa's populations in low-elevation coastal zones (LECZ) will rise at more than double the world's average. LECZ populations are at high risk from current and projected climate change. About 30 million Africans live within the flood hazard zone around the Atlantic and Indian Oceans.[13]

Furthermore, about 56 percent of the coastlines of Benin, Côte d'Ivoire, Senegal, and Togo are eroding rapidly, and sea-level risk, while not a dominant factor today, will exacerbate the impacts of coastal erosion and ultimately threaten the livelihoods/settlements of millions of people (see Box 2).

Box 2: Coastal Erosion in West Africa

Photo: Africanway/istock

West Africa's coastal areas generate 56 percent of its GDP and host about one-third of the population. Coastal areas face rapid urbanization with all its demands on land, water, and other natural resources. In addition, infrastructure and sand extraction have contributed significantly to coastal retreat.[14] Coastal erosion is caused by a combination of poor management of coastal sediment flow around infrastructure such as ports, retention of sediment in dams, mining of riverine and beach sand, and loss of coastal habitat that would otherwise physically protect or slow down retreat of the coast. Furthermore, coastal erosion is a regional issue. Modeling by Deltares and the World Bank shows that the effect of coastal infrastructure on sediment movement could be seen up to 50 km downdrift.[15]

The coastal degradation in Benin, Côte d'Ivoire, Senegal, and Togo cost US$ 3.8 billion, or 5.3 percent of the four countries' GDP, in 2017. In Nigeria, the cost of coastal degradation amounts to US$ 9.7 billion, or 8.1 percent of the GDP in Cross River, Delta, and Lagos States in 2018.[16] Climate change exacerbates the coastal erosion issue. Projections indicate that by 2050, Mauritania and Senegal could experience 60 cm of sea level rise, while in Togo and Benin it would be about 30 cm.[17]

West Africa is one of the regions in the world with the most mobility, with migration of people deeply embedded in local economies and traditions. Without concrete climate and development action, initial estimates indicate that the region could reach a high of 27.3 million climate migrants (3.4 percent of the total projected population) by 2050 under a pessimistic scenario with continued high emissions and unequal development pathways.[18]

Responding to the request from West African countries, the World Bank set up a ten-year program of support to manage coastal erosion in the region, the West Africa Coastal Areas Management Program (WACA). The program was launched in 2018 and it now works across nine countries, supports coastal protection at 22 sites and works with over 1,000 microprojects. The program is designed to operate at four levels in parallel: (i) country-led national projects; (ii) regional integration and capacity-building of regional institutions to manage environmental flows across borders and create common policies (via regional economic commission and the Abidjan Convention); (iii) a scale-up platform where institutions with compatible instruments mobilize to accelerate knowledge transfer and simplify investment processing; and (iv) partnerships.

The 2019 Call for Innovation generated 20 innovations, of which three were awarded as transformational. These were: the WAC-App to model impact on coastal sediment from infrastructure, the Trans-Sand mechanism for a pooled dredging capacity and governance to ensure sediments are being conserved in the coastal zone and not dropped where they do not serve natural processes, and the Port-System-Approach that engages affected stakeholders in port development processes.

Droughts

One of the urban services that will be most affected by climate change is water supply. Access to piped water supply has progressively increased in Africa (from 82 million urban dwellers with piped water in 2000 to 124 million in 2015). However, given the rapid urban population growth, the percentage of urban dwellers receiving piped water actually declined from 40 percent in 2000 to 33 percent in 2015. Most of the increase came from increased access to piped water off premises and self-supply.

As informal settlements have grown swiftly, informally, and without adequate urban planning or space, the provision of water infrastructure is complex. The residents of most African cities receive water services from a range of formal, informal, or self-provided systems. Low-income residents generally pay more for unsafe water sources. The performance of water utilities in Africa is generally weak, although there are examples of well-performing agencies. Most utilities register an efficiency of 0.30 (which is far below the highest score of 1).[19]

Droughts are expected to become stronger in many parts of Africa, as discussed in the Present and Projected Climate Risks chapter. Droughts will have significant impact on water utility services. A recent example was the water crisis in Cape Town which received global attention as it came close to being the first major city in the world to have run out of water. After a continuous decline of water levels in the major dams serving the city, the crisis peaked in 2017–18 when the city approached "Day Zero," a reference to the day when municipal water supply could not function.[20] The city implemented broad and significant water restrictions and a massive behavioral change campaign that reduced daily water usage by more than half, thereby averting the crisis.

An additional important challenge for many African water utilities is the reliance on watersheds outside the administrative responsibility of the municipalities they serve. Urban water utilities cannot undertake effective resilient measures without elevating the adaptation agenda to the national or river basin authorities, as discussed in the Water Resources Management, Floods, and Disaster Risk Management chapter. For cities to tackle water resilience, they need to engage with stakeholders that are not traditionally seen as part of the water sector such as land management agencies, planning, farmers, and forestry, among others.[21]

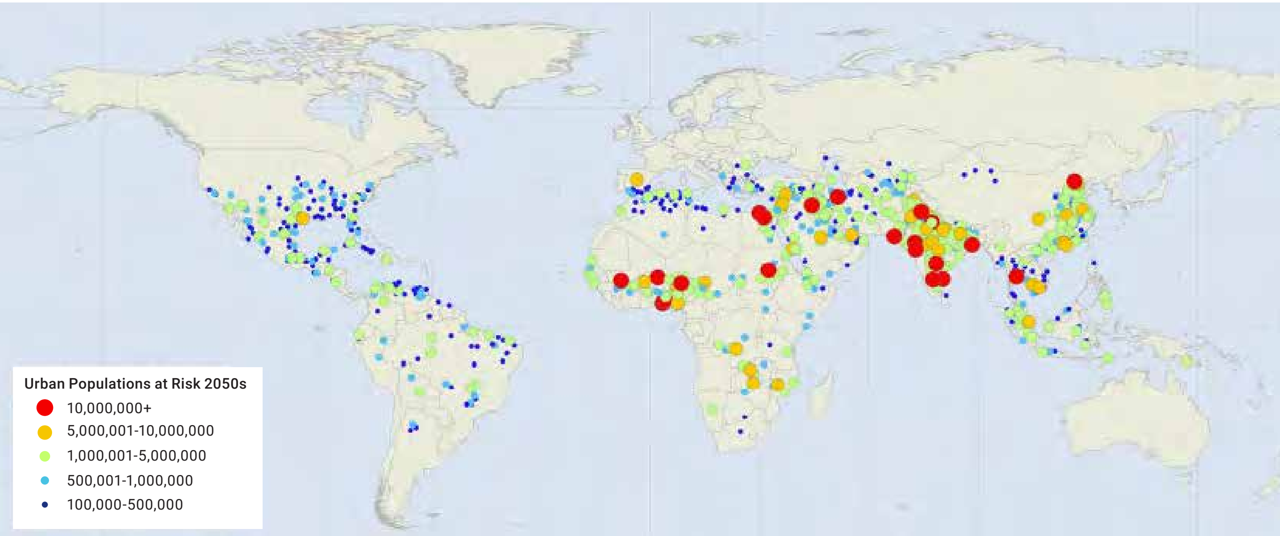
Photo: Jjumba Martin/iStock

Heatwaves

The impact data of heatwaves is limited in Africa, but the trends are worrisome. Combining temperature and population growth projections for 150 large African cities, a recent study showed that the number of people that will be subject to dangerous and lethal heat conditions will be 20 to 52 times higher at the end of the century compared to current conditions.[22] Heatwaves have particularly strong impacts on residents of informal settlements, those who work outdoors, and children and the elderly. Figure 4 shows the estimated urban populations at risk of extreme heat by 2050. The Health chapter reviews in greater detail the impact of heatwaves on African populations.

The rapid population growth of African cities and the current and projected climate risks compound economic risks. A combined analysis of population growth projections and climate vulnerability in cities worldwide shows that cities in Africa are growing the fastest (86 of the 100 fastest growing cities), and 79 of these cities fall in the "extreme risk" category of their climate index. A total of 15 African capitals has significant combined risk factors of rapid population growth, economic growth, and climate risk, including Addis Ababa (Ethiopia), Luanda (Angola), Dar-es-Salaam (Tanzania), Kampala (Uganda), and Lagos (Nigeria), among many others.[23]

Figure 4: Urban population at risk of extreme heat by 2050[32,33]



Source: UCCRN – Urban Climate Change Research Network (2018), *The Future We Don't Want – How Climate Change Could Impact the World's Greatest Cities*

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We do not lack ideas, we lack actions on the ground."

Mohammed Adjei Sowah, Mayor, Accra, Ghana
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Photo: Uwe Michael Neumann/Shutterstock

CLIMATE ADAPTATION IN AFRICAN CITIES

The early stages of urbanization in most Sub-Saharan African cities provide a unique opportunity. The low levels (40 percent) of urbanization of the region and the low density of its large cities offer opportunities for low-cost actions that can prevent locking-in errors of other highly urbanized regions of the world.

The IPCC Special Report on Global Warming of 1.5°C (SR1.5), and its accompanying Summary for Urban Policymakers,[24] reviews five important climate adaptation transitions for urban infrastructure systems of direct relevance to African cities: (i) sustainable land-use and urban planning; (ii) sustainable water management; (iii) green infrastructure and ecosystem services; (iv) building codes and standards; and (v) disaster risk management. The report recognizes the challenges of implementing these transitions due to a range of tradeoffs, particularly for cities in low-income countries and cities with limited financial resources.

Through effective land management and city planning, up-to-date knowledge of current and future risks based on cost-effective data collection, and effective education and engagement with communities, most African cities can significantly reduce the impact of climate change. The prioritization of investments based on climate risks and bottlenecks, combined with an approach that focuses on resilience jobs, SMEs, and market creation, can help cities reduce risks and leverage opportunities for a climate-smart urban development and economic growth.

The limited financial resources available to African cities impose significant constraints that require a balanced approach to climate adaptation and resilient urban development. City authorities and communities need to tackle most of the climate impacts described in other chapters of the report. They also need to localize most of the recommendations presented in this chapter. At the same time, cities in Africa should provide the economic opportunities to their citizens not only to escape poverty but also to prosper. Climate change is already a drag on these opportunities, so it deserves an appropriate level of attention and resources, alongside the many other challenges that urban centers in Africa face.

The local implementation of the Sendai Framework (see Water Resources Management, Floods, and Disaster Risk Management chapter for more details) is a good roadmap to support the journey towards enhanced resilience and adaptation at the city level. Box 3 presents the "Ten Essentials" for disaster risk reduction in urban areas.

An essential area of work to enhance the resilience and climate adaptation of cities in Africa is urban planning. Several cities have prepared resilience strategies. There are still opportunities to strengthen the connection between these local planning exercises with the National Adaptation Plans and the updated Nationally Determined Commitments for better vertical coordination between different levels of government. Box 4 presents an example of the city resilience strategies recently developed.

Box 3: The Ten Essentials – Implementation of the Sendai Framework at the City Level

Photo: Viktoriia Vyshnevetska/Shutterstock

1. Organize for disaster resilience
2. Identify, understand, and use current and future risk scenarios
3. Strengthen financial capacity for resilience
4. Pursue resilient urban development and design
5. Safeguard natural buffer to enhance the protective functions offered by natural ecosystems
6. Strengthen institutional capacity for resilience
7. Understand and strengthen societal capacity for resilience
8. Increase infrastructure resilience
9. Ensure effective disaster response
10. Expedite recovery and build better

Source: UNISDR (2017), *How to Make Cities More Resilient: A Handbook for Local Government Leaders*

Box 4: The Lagos Resilience Strategy

Photo: FOTOGRIN/Shutterstock

The 100 Resilient Cities (100RC) was established by The Rockefeller Foundation in 2013. The program enabled participating cities to hire a Chief Resilience Officer, develop a resilience strategy, and receive global support. The Resilient Cities Network continues to work with these cities in future-proofing their communities. In Africa, the participating cities include Accra, Addis Ababa, Cape Town, Dakar, Durban, Kigali, Lagos, Luxor, Nairobi, and Paynesville.

As an example, the Lagos Resilience Strategy, published in 2020, is the State's first urban resilience strategy document. Lagos State joined the 100RC in 2016. The Lagos Resilience Strategy was produced collaboratively with engagement from civil society, academia, private sector, government, and community groups from across the state.

With a GDP of US$ 137 Billion (about 26 percent of Nigeria's GDP), Lagos is the fourth-largest city economy in Africa. Its population was estimated to be 26 million in 2018 and increasing by nearly 3,000 persons a day, making it the fastest growing city in Africa. Water bodies and wetlands cover over 40 percent of the total land area of Lagos and an additional 12 percent is subject to seasonal flooding.

Among the most critical climate-related shocks affecting Lagos' resilience are storm surges and flooding. Climate change and the city's location at sea level increase the flood vulnerability of Lagos. The city's barrier islands and sand spits are shrinking, due to coastal erosion. In addition, flooding has been a recurrent challenge for the city, due to inadequate storm water drainage systems and improper waste disposal into open drainage. The city has limited mechanisms for predicting and managing the occurrence of flash flooding. The city's resilience strategy indicates that many past efforts have tended towards engineering solutions, which have not yielded the desired results.

Some of the most significant measures proposed in Lagos' Resilience Strategy related to climate change shocks include community participatory flood management, strengthening the state's emergency response system, strengthening the information management and disaster preparedness for the state, and enhancing the city's resilience through land-use planning.[25]

POLICY RECOMMENDATIONS

Adaptation in the post-COVID recovery of cities

Given the limited financial resources African cities currently have, it is important to prioritize the adaptation actions that are feasible and have the greatest impact. Our GCA analysis has grouped these possible avenues in two groups: (i) the untapped opportunities and early wins; and (ii) the urgent options in the recovery.

African cities can undertake a range of opportunities that require fewer financial resources and can generate immediate and significant adaptation benefits or set up the planning basis for enhanced adaptation measures as part of the post-COVID recovery. The first group of measures includes:

- Rapid climate risk assessments that gather recent disaster information, infrastructure bottlenecks, and information gaps for a rapid evaluation of critical weaknesses of the city, some of which could be resolved with less financial resources, and others that will require deeper evaluation and technical designs.
- Community engagement, including the youth, for resilient action in the low-cost measures identified in the rapid climate risk assessments. Many of these measures can be undertaken through social entrepreneurs and resilient SMEs that will create new jobs and enterprises (see Jobs chapter for further details).
- Basic urban planning, to reduce uncontrolled sprawl in areas of high climate risk. This is a measure that requires active community engagement and a plan to offer alternatives to the growing population of the city.
- Early warning systems by connecting the city to the national warning systems and hydrometeorological agencies to ensure that the information on upcoming climate disasters is received by municipalities, transmitted to the communities, and acted upon. This requires building the capacity of communities to understand the information provided in the warnings, and drills to ensure every household knows what actions to take to protect their lives and assets.
- Individual and community resilience, including behavior change, climate risk communications, children education, and women and youth empowerment for resilience and disaster preparedness.
- Maintenance of existing infrastructure and enhanced safety measures for non-networked water and informal waste solutions. Keeping drainage canals, ditches, and other flood evacuation infrastructure before the rainy seasons can provide the capacity to reduce the impact of high-water levels. Geotechnical monitoring of steep hills during the rainy season can provide early warning to communities.
- Land and property rights and urban planning are indispensable elements of a resilient city. The first basic steps of mapping and data collection can be done at low cost and serve as the basis for a long-term transformation process. Box 5 presents an example of this type of programs being undertaken in several African cities.
- Leveraging the resilient power of nature by protecting existing buffers like mangroves, wetlands, and floodplains. These green spaces are rapidly disappearing in African cities and the cost of building gray infrastructure in future years to compensate for the disappearance of the natural buffers will be expensive. Box 6 presents an example of these measures in the city of Beira, Mozambique.

Photo: THEGIFT777/iStock

Box 5: Open Data for Urban Resilience and Disaster Risk Management in Africa

Photo: Natalia Pushchina/Shutterstock

Urban planners and community leaders cannot design adaptation plans and take informed adaptation actions without vital knowledge on who, what, and where is at risk. The World Bank and the GFDRR Labs are supporting The Open Cities Africa initiative that currently works with 12 cities in Africa to systematically gather and share critical risk data.

This initiative connects local community members with geospatial experts to undertake a bottom-up risk data in disaster-prone areas. This data is made open and accessible through a range of user-centered platforms, from web applications like OpenStreetMap to paper atlases. The Open Cities Africa program uses drone imagery capture and open-source community mapping techniques. So far, the initiative has collected data on more than half a million buildings, mapped over 30,000 kilometers of roads, and captured hundreds of square kilometers of drone imagery.

An important feature of Open Cities Africa is capacity building. The program has trained more than 500 people in digital cartography. Young people develop skills that they can leverage in the growing geospatial technologies job market.

The initiative also fosters sustainable communities. For example, the Pointe-Noire OpenStreetMap community in the Democratic Republic of Congo now counts with over 50 mappers. In Tanzania, the local Red Cross is using real-time flood data to respond more effectively to disasters. In Ngaoundéré, Cameroon, community groups are utilizing paper atlases developed as part of this initiative to facilitate risk reduction efforts at the local level.[26]

“Now is the time for us all to come together and focus on delivering a landmark COP setting the trajectory for the next crucial decade and the tools that will help us all deliver on our commitments. Adaptation and resilience must be in that future.”

Anne-Marie Trevelyan, UK Minister and International Champion on Adaptation and Resilience for the COP26 Presidency
High-Level Dialogue “An adaptation acceleration imperative for COP26”, September, 2021

A second group of adaptation and resilience measures requires more financial resources, but their urgency resides on the avoidance of growth patterns that will lead to the need for retrofits, or in the high benefit-to-cost ratios in terms of lives saved or assets protected. These measures include:

- A comprehensive urban resilience and adaptation master plan that considers the various climate risks of the city, combines them with urban growth needs, and provides a climate-smart development path in the medium term.
- Prioritized infrastructure retrofits and enhancements that solve the critical bottlenecks and priority risks for the city for the more recurrent climate shocks, such as floods and related landslides. Small targeted civil works, enhanced maintenance and repair of infrastructure, and simple prevention measures can go a long way to prevent damages to households and communities.
- Resilience business and market opportunities associated with the infrastructure actions above, designed to support the creation and growth of SMEs that would generate new jobs for adaptation and resilience. SMEs providing infrastructure maintenance services, climate risk monitoring services, early warning and mobilization, and rapid repairs after disasters can reduce the impacts of climate change and generate the jobs needed by African youth.
- Continuous capacity strengthening of city officials, both municipal staff and delegated staff of national agencies, in the areas of climate adaptation and resilience. City adaptation programs require multi-disciplinary and cross-agency actions. These require, in turn, staff with the understanding, tools, and skills necessary to design and undertake these programs and actions.
- Climate adaptation project preparation, to ensure engineering designs and bidding documents for the most critical medium- and large-size projects are ready when the economic conditions recover after the COVID pandemic.

Box 6: Nature-based solutions in Beira, Mozambique


Photo: Victor Espadas Gonzalez/Shutterstock

Mozambique is subject to high levels of coastal and river flooding and is among the most vulnerable countries to current and projected climate risks. Several development partners have supported gray and green infrastructure solutions to enhance the resilience of the city of Beira, Mozambique. Beira has a population of over half a million inhabitants. Due to its exposed coastal location (low-lying land and high tidal range), its vulnerable infrastructure and population, Beira is one of the cities most threatened by climate in the region.

One of the green infrastructure projects supported by the World Bank, with funds from the Pilot Program for Climate Resilience (PPCR), and by the German Cooperation through the KfW Development Bank, is the Green Urban Infrastructure (GUI) intervention.

The first phase of the project restored the natural drainage capacity of the Chiveve River, a 3.5 km long tidal river flowing through Beira's central business district and low and medium-income residential neighborhoods. A second phase focused on further restoring the river's ecosystem (in particular, its mangroves and other natural habitat on the riverbanks). In addition, the river was upgraded to be a green urban park for dual purposes of climate resilience and recreation.

The planned green and grey infrastructure is intended to stop further encroachment into the Chiveve River floodplain and protect this sensitive environment. Income-generating facilities related to the park space were included in the design to provide financial resources for maintenance.[27]

Priority actions for urban water services

As discussed earlier, water services are one of the municipal services that is at higher risk from climate impacts.

The global total is about US$ 73 billion per year through to 2050, and the additional cost to adapt to climate impacts on water availability are estimated at about US$ 12 billion per year. Most of these costs would be incurred in developing countries and the highest costs would be in Sub-Saharan Africa.[28]

As discussed in the Present and Projected Climate Risks chapter, water utilities in Africa will face more frequent or more severe floods and droughts, higher temperature ranges, different rainfall patterns and seasonal shifts. Incorporating climate projections in water utility planning is not an easy task because of limited knowledge about the potential risks to operations over multi-year cycles, and inadequate access to relevant climate and weather information that is useful for infrastructure design, operations and maintenance, and business continuity and resilience plans.

Climate models are not able to specify with sufficient precision the changes in flood and drought characteristics at the level of a city and for the expected life of water utility assets. Utilities need to plan for an uncertain future not only because of climate change, but also due to rapid demographic changes, different economic conditions and future shocks, and new technological innovations. Utilities need more systematized approaches to deal with the deep uncertainties associated with climate change.[29]

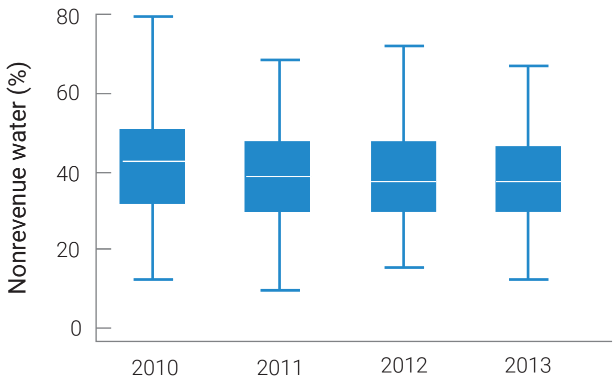
Dealing with the uncertainty of the specific trajectory of climate change impacts at the city level requires a vulnerability analysis to identify threats that may affect specific elements of the water supply system and the possibility of individual or joint failure due to specific climate shocks. The design of more robust systems is built around scenarios that apply diverse stress tests to determine critical elements over a range of future scenarios.

Most water utilities globally do not integrate crisis responses and master planning efforts. The new challenges brought by climate change cannot be handled with the traditional reactive contingency plans.

For water utilities and cities with limited financial resources, it is important to identify near-term no-regret projects that can be undertaken today without reducing the flexibility needed to adapt as future climate conditions evolve. Dealing with every possible risk and scenario is extremely costly and unfeasible. The traditional approach of safety factors cannot be the only adaptation solution. The decision to balance between improving the resilience of the system (and its associated costs) with the expansion and improvement of water supply services is not an easy one. Leveraging nature-based solutions, as discussed later in this chapter, can provide enhanced resilience with an overall better cost-benefit ratio.[30]

An important climate adaptation measure for water utilities in Africa is to reduce nonrevenue water (NRW). One measure of NRW is the percentage of water production that is lost due to technical or billing reasons. Figure 5 shows the levels of NRW in 119 water utilities across Africa. The level of NRW is very high compared with global benchmarks. The reduction of NRW is a difficult technical and managerial challenge for utilities. As climate shocks increase the frequency and intensity of droughts, utilities operating in areas of high-water scarcity will need to focus on NRW improvement programs. The data shows that in Africa, in general, larger utilities tend to have higher NRW losses than smaller utilities, possibly related to the more recent installation of network systems in smaller cities. Finally, utilities with 24 hours of supply tend to be associated with significantly lower levels of NRW.[31]

Figure 5: Nonrevenue water as percentage of water production in Africa



Source: World Bank (2017), *Performance of Water Utilities in Africa*

POLICY RECOMMENDATIONS: ADAPTATION AND RESILIENCE AFTER THE COVID ECONOMIC CRISIS

In the medium- to long-term, our GCA research indicates that African cities need to undertake a more comprehensive adaptation and resilience strategy based on the following nine areas:

- Strengthen the capacity of all city stakeholders to minimize the economic impact of disasters through early planning, preparedness programs, community engagement, and rapid reconstruction using "build-back-better" principles. The shorter the interruption of economic activity caused by climate disasters, the smaller will be the economic impact on the city, its residents, and businesses.
- Deepen the resilience of the private sector, as discussed in the Private Sector chapter. The resilience capacity of SMEs, in terms of understanding, preparedness, and continuity plans for climate disasters is low. The municipality can take an active role to encourage and support the building of that capacity through information and training, ideally in partnership with larger enterprises with more knowledge and capacity, as these companies will benefit from stronger supply chains and economic continuity after disasters.
- Explore new financial mechanisms for enhanced resilience, beginning with simple ones such as insurance for the most critical municipal assets, PPPs for resilient infrastructure, land-value capture to finance flood control infrastructure, and others described in the Finance chapter of the report.
- Scenario planning, based on continuous data collection and partnership with scientific bodies and network of cities with more experience in robust planning and climate projections at the local level. This also requires continuous data collection of climate, environmental, and urban growth trends, among others, that are indispensable to understand current and projected climate risks.


Photo: Lucian Coman/Shutterstock

- Multi-level government coordination, as many of the climate risks of the city require coordination and action with other jurisdictions such as neighboring municipalities in metropolitan areas, or river basins for watersheds providing water to the city or flood protection.
- Progressive institutional reform and continuous capacity building that approaches adaptation and resilience as a cross-departmental platform.
- Leverage new technologies and bring the best elements of smart cities and disruptive digital technologies to improve the preparedness of citizens and enterprises to climate disasters, expand the data and knowledge base of climate risks, and reduce the cost of adaptation measures.
- New alliances to ensure adaptation and resilience are seen as everybody's job and not only a responsibility of the municipal government. The ability of the municipal administration leadership to connect vertically with higher and lower levels of government (from the national to the community), and horizontally with sectoral ministries and neighboring municipalities is critical. Equally important are the partnerships with expert bodies, universities, and researchers, as well as international financiers, city networks, and UN agencies.
- Inclusive approaches to adaptation to ensure that socially vulnerable groups, from persons with disabilities to unemployed youth, migrants, and internally displaced populations, are all part of the resilience plans and programs of the city.

Photo: Vadim Petrakov/Shutterstock

Developing Adaptive Capacity in Productive Coastal Zones of Tanzania

Geography: Tanzania (Dar es Salaam, Pangani, Bagamoyo, Rufiji, Mijni and Mkoani districts along the eastern coast, reaching 36 communities).

Adaptation measures: This project implemented green-gray infrastructure and restoration measures to protect against sea level rise and inundation, through construction of sea defense structures and restoration of mangrove and coral reefs. It also improved access to water during climate extremes via boreholes and additional rain harvesting and storage capacity devices.

Key outcomes: The project has benefited 526,000 people through improved sea defenses,[34] including 10,000 people who have improved access to drinking water during climate extremes; it resulted in a 20 percent increase in water availability to communities in dry periods.

Partners and funding: UNEP, Global Environment Facility, Adaptation Fund, Government of Tanzania (Vice President's Office, Division of Environment), Ministry of Water, University of Dar es Salaam and NGOs Network/Consortium, District Councils, and other implementing partners. Least Developed Countries Fund. 2012–2019. US$ 3.4 million (for Developing Core Capacity to Address Adaptation to Climate Change in Productive Coastal Zones). Adaptation Fund. 2012-2019. US$ 4.4 million (for Implementation of Concrete Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal Communities of Tanzania.

PROJECT SUMMARY

Sea level rise and an increased occurrence of flooding, often combined with storm surges, pose a major threat to livelihoods and communities along the coastal belt in Tanzania, where 25 percent of the country's population (approximately 14.5 million people) reside.[35] In the densely populated metropolis of Dar es Salaam (population 4.3 million), about 143,000 people and US$168 million worth of assets are based within the city's low-elevation coastal zone[36]. In total, Dar es Salaam has approximately US$ 5.3 billion worth of assets at risk from projected future floods.[37]

Moreover, communities in Tanzania are also grappling with saltwater intrusion as a result of sea level rise and groundwater extraction,[38] which has led to an acute shortage of drinking water and loss in agricultural productivity.[39] For example, farmers estimate that rice and maize yields have fallen by as much as two thirds over the past 10 years,[40] which is partially attributed to increased salinity, with higher impacts closer to the coast.[41]

The project was implemented in Dar-es-Salaam and in the coastal districts of Pangani, Rufiji, Bagamoyo, Mkoani and Mijni.[42] The project innovated with green-gray infrastructure measures providing buffer zones that minimize the impacts of sea-level rise by combining construction of seawalls (2.4 km long) with restoring 1,000 ha of mangrove forests and 3,000 m^2 of coral reefs. Seawalls, groynes and dikes were built in seven locations along the coast to stop shoreline erosion and saltwater intrusion and flooding. Improved drainage brought flood protection to about 1,500 households in Dar es Salaam. Water availability under increased climate extremes (both floods and droughts) in Bagamoyo district was improved through the relocation of boreholes to protect local communities from rising seas and adding 15 m^3 of water storage capacity. Rain water harvesting devices and storage were added in two schools.

The project not only delivers benefits for adaptation through improved sea defense system but also contributes to mitigation through mangrove restoration and to reduced environmental degradation through delineation of no-take zones to reduce deforestation. Participatory processes, local capacity building, and institutional integration from the local to national level were implemented to ensure buy-in by key local stakeholders and thus sustainability in the uptake of these measures and generation of co-benefits. The participatory processes were introduced through training events in integrated coastal zone management and climate change vulnerability assessment for local representatives, along with related assessments and awareness workshops.

The project also led to the establishment of climate change community based organizations (CBOs) and water committees that informed national planning processes through reports and policy briefs, workshops with regulators on cost-effectiveness of adaptation and lessons learned, and integration of coastal management plans into regional and district action plans.[43] To this end, project implementation was done in partnership with national ministries dealing with water and public works and local governing bodies as well as a consortium of NGOs. In collaboration with the University of Dar es Salaam, the project has also provided training to more than 100 people in coastal and vulnerability mapping and has supported subsequent research undertaken by 27 master's students on themes related to the project, ensuring the development of local capacities for further scaling actions.

The projects have followed priorities set out by Tanzania's National Adaptation Programme of Action (NAPA), and were designed to execute its goals, which are related to protecting water supplies and coastal regions,[44] on prioritized sites.

Photo: Framalicious/Shutterstock

Strengthening Climate Resilient Systems for Water, Sanitation and Hygiene services in Ethiopia

Geography: Ethiopia: Afar, SNNPR, Amhara, Gambella and Somali, Oromiya and Tigray.

Adaptation measures: The project is working to develop climate-resilient WaSH facilities for year-round access to services in targeted drought/flood-prone and water-stressed areas in the most vulnerable states, including during extreme events. The services are delivered by rural village management units and urban utilities through efficient and self-sustained systems.

Key outcomes: The project aims to establish building blocks for transformational change in the delivery of WaSH services. It expects to provide improved access to climate-resilient water and sanitation services and good hygiene practices for 1.2 million people in areas affected by climate extremes.

At the end of 2020, some of the project's achievements include: six climate-resilient water supply schemes were designed and moving into the implementation phase, with capacity to serve 20-30,000 people each; nearly 7,000 ministry and community experts had been trained in climate-resilient WaSH, supporting behavioral change and capacity building; and about 154,000 new and 23,000 rehabilitated latrines had been constructed.

Partners and funding: The five-years program (2019-2024) received £95 million UK funding. Other contributors to the overall program include World Bank, AfDB, UNICEF, Saudi Fund for Development, Finland, South Korea, and Netherlands.

PROJECT SUMMARY

Extreme climate-related disasters have been common across Ethiopia for decades and are expected to increase. At least 15 major droughts and five major floods in the last 50 years have had devastating consequences. More than 80 million people have been affected by these droughts,[45,46] which have particularly impacted the poorest and most vulnerable communities, and climate projections indicate worsening trends. For example, an already high variability in year-to-year precipitation (with differences between 28 and 62 percent in annual mean rainfall between dry and wet years)[47] is projected to be combined with an increased share of total rainfall during "heavy" events (up to 18 percent) by 2050.[48] Furthermore, the number of poor people exposed to floods will increase nationwide by 12 percent by 2050 (this figure masks expected regional differences).[49]

The SCRS-WASH project is responding to climate threats with new and rehabilitated climate-resilient WaSH services for year-round access, such as at the household, community and institutional levels, including WaSH for households, schools and health facilities in drought-affected and remote areas (Afar, SNNPR, Amhara, Gambella and Somali States).[50]

Measures such as deeper boreholes and piped networks will ensure service provision under scenarios of increased climate variability, protect the water resource base and mitigate costs for relief operations. Where possible, WaSH services have been set up to depend on groundwater sources, which are better able than surface sources to secure the supply under climate extremes. When surface water supply is the only available option, services can be complemented with water treatment plants to address high-fluoride and salinity issues. The sustainability of the system will be supported by developing local maintenance providers, providing technical support, and addressing institutional capacity gaps.

WaSH investments are key to supporting the most vulnerable in Ethiopia. Diarrheal disease causes 15 percent of post-neonatal deaths and 13 percent of deaths among children aged 1-4 years in the country. Climate change threatens to further increase this child mortality, as diarrheal disease outbreaks are exacerbated during periods of flooding.[51] Furthermore, carrying water, especially by children, causes musculoskeletal strain and can lead to debilitating pain and disability.[52]

The project contributed to the outcomes achievement of the Government of Ethiopia's flagship One WaSH National Program (OWNP). Climate Resilient WaSH is one of the program's five pillars. The project brings together government ministries, research and academia, development partners and civil society; and its implementation has provided lessons that can be applied at a larger scale. For example, lessons from early project actions for water provision led to a plan for a groundwater mapping assessment to identify potential groundwater source areas, since they are more resilient to climate extremes than areas supplied by surface sources.

The project puts an emphasis on groups that are disproportionately vulnerable to poor WaSH. For example, women and youth groups were empowered to engage in spare part supply and service maintenance to support the service delivery systems. They were also engaged in producing locally manufactured reusable menstrual hygiene products and building inclusive WaSH facilities. Future climate-resilient WaSH investments are expected to result in more inclusive job creation and increased labor productivity and domestic manufacturing.

Viewpoint:
Greening slums with vertical farms

Federal University of Technology, Akure, Nigeria

Over 50 percent of Africa's urban poor live in dense slums and informal settlements, without access to basic services and infrastructure, and are especially vulnerable to the impacts of climate change. They usually lack space to grow their own food, and even if land is available, the soil is often polluted or unfit for agriculture. In such circumstances, vertical greening systems – plants grown on vertical surfaces – can not only contribute to food security, but also supplement livelihoods, provide micro-climate control, and contribute to a circular economy by promoting the reuse of waste material.

An adaptation research project hosted at the Federal University of Technology Akure, Nigeria developed two vertical farm prototypes: one using polyethylene terephthalate (PET) bottles, readily available from urban waste; and the second using high-density polyethylene (HDPE) pipes, a common building material. These prototypes were piloted in urban informal settlements in Lagos and Akure in Nigeria, and in Dar es Salaam, Tanzania.

Implementation of vertical greening in slums

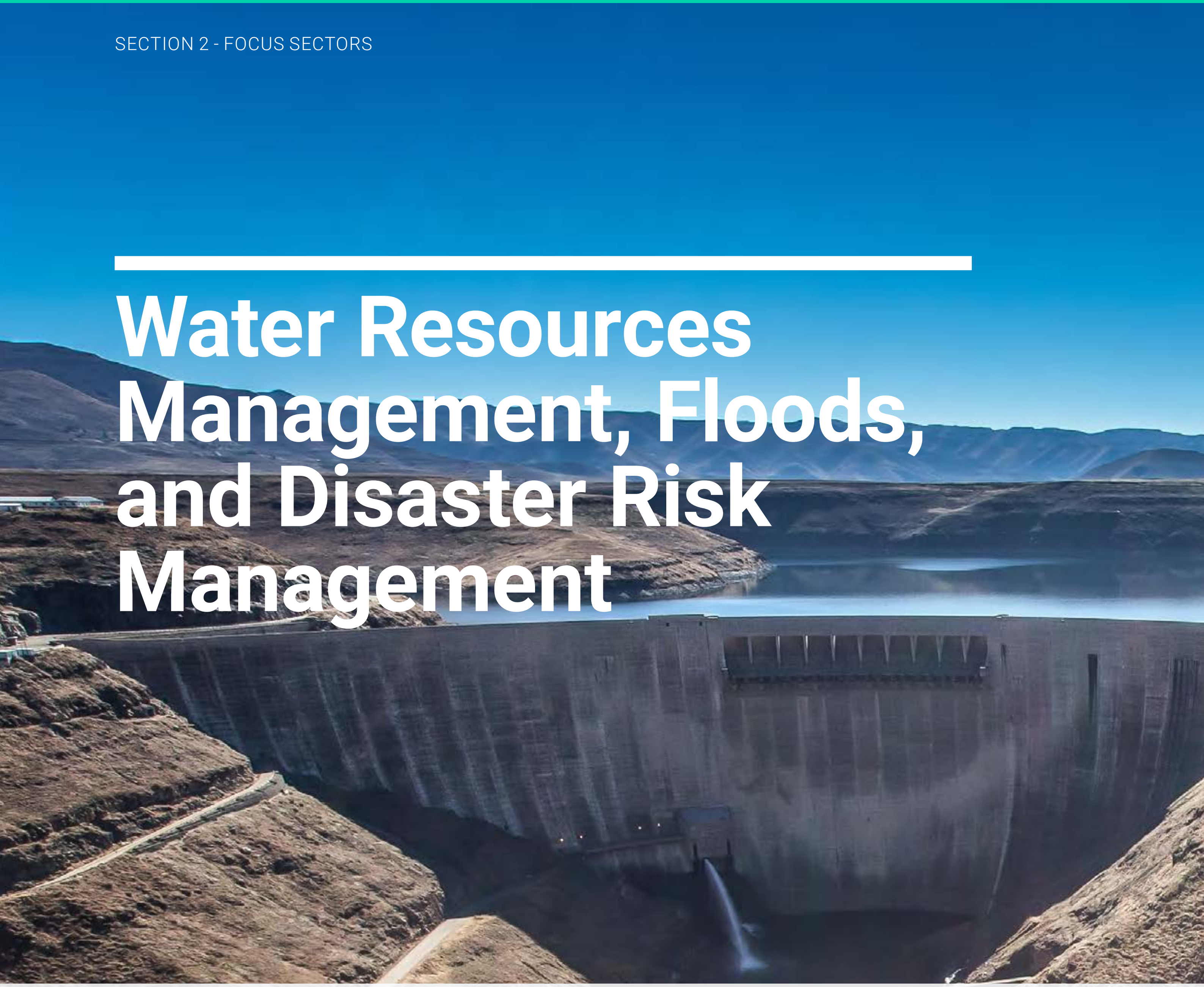
Source: Author

The vertical farms yielded up to three kilograms of vegetables every six weeks or so, in a one-bedroom dwelling. They contributed to micro-climate control, reducing wall temperature by as much as 5°C and indoor air temperature by as much as 2°C. This compares well with previous comparable work on shade trees in a non-slum setting, where indoor air temperature is reduced by up to 3°C. Cooling from the trees can result in estimated annual cooling energy cost savings of about US$ 218.

Feedback received through phone calls, reports from neighbors, and post-implementation interviews shows that the pilots were generally well received, particularly for their potential to produce vegetables. Before the pilots can be scaled up, however, a few challenges must be overcome, such as high maintenance (mostly labour) requirements; few available vertical services; and misgivings about growing vegetables on walls.

Efforts to build urban parks and green spaces usually focus on formal and affluent neighborhoods. Policy initiatives and programs that promote citizen-led, community-based vertical farming in low-income urban informal areas are also necessary. A strong push, along with incentives, is needed to promote vertical greening systems in slum areas, to improve food and livelihood security, control micro-climate, and for aesthetic reasons.

Water Resources Management, Floods, and Disaster Risk Management



KEY MESSAGES

- **The most important manifestation of climate change in Africa is through water. Climate change is likely to greatly increase the number of people exposed to floods.** In Africa, over the period 2008–2018, floods accounted for 65 percent of disaster events and caused 24 percent of deaths.
- **Global research, including GCA work, has shown that those living in poverty are particularly vulnerable to climate shocks such as floods.** Floods also have long-term human capital impacts beyond their immediate disruptive effects. Globally, four out of the top ten subnational regions by the absolute number of poor with high flood exposure are located in Sub-Saharan Africa. This makes systematic disaster risk reduction (DRR) an indispensable step in the journey towards climate adaptation, and also of any wider program of equitable development in Africa.
- **Adaptation is a key component of disaster risk management.** Flood-informed land use planning and early prevention of construction in high-risk zones are a lower-cost alternative than reconstruction after flood damages, construction of expensive structural engineering solutions, or retrofits.
- **Integrated water resource management (IWRM) is another key aspect of DRR, as the flooding risks of cities or coastal areas depends in many cases on the characteristics and management practices of river basins and water catchments**

Photo: Gil.K/Shutterstock

upstream. Currently, 42 African nations have institutionalized most IWRM elements, providing a solid foundation to accelerate progress.

- **Transboundary cooperation is another important dimension of managing the water resources of Africa, as the 48 mainland countries of Africa share 134 transboundary basins and aquifers.** As over 90 percent of Africa's surface water is in transboundary basins, regional cooperation, ranging from simple data sharing to joint implementation of large transboundary infrastructure projects, greatly expands the range of possibilities for effective climate adaptation.

> **"It is imperative that we urgently reverse the current scenario, increasing the volume of funding for adaptation intervention, climate resilience, and recovery of the life and economy after the Covid-19 pandemic."**
>
> **H.E. President Filippe Nyusi of Mozambique**
> Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

This chapter concludes Section 2 of this report by bringing together two areas that connect several previous chapters. These areas are, first, disaster risk management (and the closely associated issue of flood risks) and, second, integrated water resources management. The most important manifestation of climate change in Africa is through water. The Agriculture and Food Systems chapter examines the economic and poverty consequences of droughts. The Urban Development chapter reviews the impacts of climate change on urban services, including water and sanitation and flood protection. The Transport and Energy chapter examines how floods impact countries' transport networks and services throughout Africa, and how droughts make hydropower generation vulnerable.

This chapter discusses how three major international agreements reached in 2015 connect to climate adaptation and resilience: the Sendai Framework for Disaster Risk Reduction (DRR), the Sustainable Development Goals (in particular, Goal 6.5 on integrated water resources management), and the Paris Climate Change Agreement.

In this chapter, we review the Sendai Framework and the additional five targets that the African Union identified as part of its Programme of Action (PoA) for implementation. Disaster risk reduction is an indispensable step in the journey towards climate adaptation. Countries, economies, and communities cannot be prepared for future climate disasters if they are not ready for current disasters. We review the progress made by African countries and the level of mainstreaming of disaster risk reduction and climate change adaptation in planning documents and processes in the region.

The chapter then reviews the state of flood risks in Africa, the implication of floods on poverty, projections of climate change and their impact on poverty, and policy recommendations on flood risk management for the continent. Finally, it discusses the state of integrated water resources management (IWRM) in Africa. Even though IWRM has traditionally included flood and drought risk management through water storage infrastructure solutions, the IWRM and DRR programs and policies have not been well coordinated.

A rapidly changing climate requires a change of this situation. A review of the complementarities of IWRM and DRR and the comprehensive management of floods and droughts, from prevention and mitigation; to preparedness; to response and recovery, is presented, with specific policy recommendations based on successful case studies in the continent.


Photo: George Nazmi Bebawi/Shutterstock

DISASTER RISK REDUCTION

Disaster risk reduction and the Sendai Framework

In 2015, the Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR) was endorsed by the UN General Assembly. The SFDRR advocates for "The substantial reduction of disaster risk and losses in lives, livelihoods, and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities, and countries."[1] The SFDRR focuses on the three dimensions of disaster risk (exposure to hazards, vulnerability and capacity, and hazard characteristics) to prevent the creation of new risk, reduce existing risk, and increase resilience.[2] As such, the SFDRR plays a critical role in the climate adaptation plans of African nations.

All African countries signed up for the Sendai Framework.[3] The African Union and its member countries identified five additional targets specific to the region. A Programme of Action (PoA) for implementing the SFDRR was adopted in 2016.[4] The seven targets of the SFDRR and the five targets of the PoA are presented in Table 1.

Table 1: The seven targets of the SFDRR and the five targets of the Programme of Action

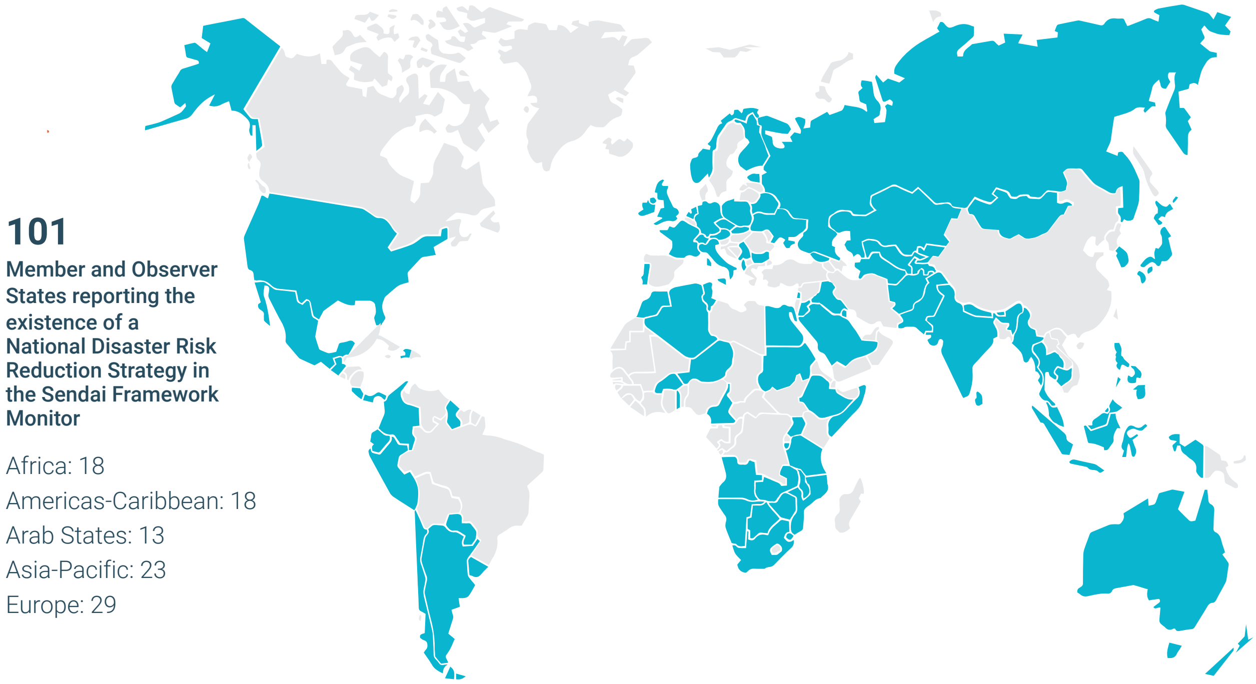
The Seven Targets of the SDFRR	The Five Targets of the Programme of Action
a. Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005–2015 b. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015 c. Reduce direct disaster economic loss in relation to the global gross domestic product (GDP) by 2030 d. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030 e. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020 f. Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030 g. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030	1. Substantially increase the number of countries with DRR in their educational systems at all levels, as both stand-alone curriculum and integrated into different curricula 2. Increase integration of DRR in regional and national sustainable development and climate change adaptation frameworks, mechanisms, and processes 3. Substantially expand the scope and increase the number of sources for domestic financing in DRR; Increase the number of countries with, and periodically testing, risk-informed preparedness plans, and response, and post-disaster recovery and reconstruction mechanisms 4. Substantially increase the number of regional networks or partnerships for knowledge management and capacity development, including specialized regional centers and networks

“As you discuss climate change action and adaptation, please give water a central place in the discussion.”

Jakaya Mrisho Kikwete, Chair, GWP Southern Africa & 4th President of the Republic of Tanzania
High-Level Dialogue “An adaptation acceleration imperative for COP26”, September, 2021


Photo: Belikova Oksana/Shutterstock

Figure 1: Progress towards Target (e) of the SFDRR



Source: UNDRR (2020) Annual Report

A key target of the SFDRR is the development of national and local disaster risk reduction strategies with a deadline of 2020. In Africa, 18 countries have validated strategies or policies aligned to the SFDRR, and seven more countries are developing or validating their strategies. Figure 1 shows the 101 countries worldwide that have reported the existence of national DRR strategies in the SFDRR framework monitor used to measure progress.[5] Africa is not too far behind the global average of developing regions.

Photo: Vadim Petrakov/Shutterstock

The African Union Commission (AUC), as the custodian of the PoA, prepares a biennial report on the implementation of the PoA. The latest report published in 2020 covers the period 2015–2018 and compiles data from 50 countries.[6] The report notes the significant progress in several areas of the SFDRR and the PoA, including establishing specialized DRR agencies in several countries. The AUC and the Regional Economic Communities have also established dedicated DRR units.

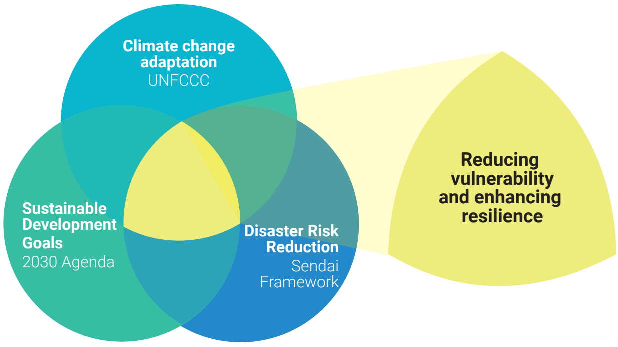
Our review of the various assessments of the state of DRR in Africa shows that financial resources are still insufficient to develop DRR and resilience programs. As discussed in the Present and Projected Climate Risks chapter, it is urgent to set up and expand multi-hazard early warning systems. Finally, the national planning and development processes have not yet fully mainstreamed DRR.

In-depth research of progress with the SFDRR and the PoA in Africa shows that African states are making progress. Still, better data and information systems are needed, and national programs need more robust local and community-based programs to build resilience.[7]

Disaster Risk Reduction and Climate Adaptation in Africa

In 2015, two other major international agreements were reached: the SDGs and the Paris Climate Change Agreement. Since then, there have been concerted efforts to coordinate these agreements at the country level. Climate adaptation and resilience reside at the center of these agreements (Figure 2).[8] However, the different institutional arrangements for DRR and climate change adaptation (CCA) lead to mismatches in governance, data and information, and funding streams.

Figure 2: Integrating adaptation with Sustainable Development Goals and the Sendai Framework



Source: UNSCCC (2017)

The UNDRR assessed 50 planning documents for DRR and CCA to evaluate their policy coherence and level of integration in 32 countries in Sub-Saharan Africa.[9] The review finds that coherence is more incidental than structural, and it happens on an ad-hoc basis. Specifically, the integration of CCA into DRR strategies varies widely. In contrast, the reciprocal integration of DRR into CCA strategies is partial primarily.

The operational elements of the documents indicate overlapping activities and a general lack of collaboration. The UNDRR makes a comprehensive set of recommendations for African nations, including:

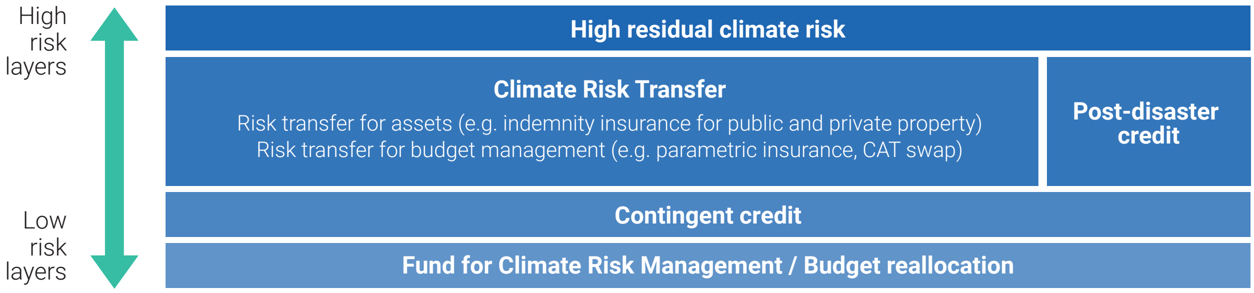
- Develop coordinated DRR and CCA risk assessments that can inform policymaking and educate all stakeholders in society.
- Strengthen governance for policy coherence between DRR and CCA, including more robust and formal vertical and horizontal collaboration between the two practices.
- Leverage existing planning processes (National Development Plans, NAP, and DRR strategies) and use the NDP as the overarching planning vehicle to support the policy and programming coherence of DRR and CCA.
- Promote legal frameworks that integrate DRR and CCA, clarify mandates, roles and responsibilities.
- Conduct risk-sensitive budget reviews and expenditure reviews and use them to identify investments and budget needs for DRR and CCA. Recently, 16 African countries have prepared Disaster Risk-Sensitive Budget Reviews.
- Develop joint risk financing strategies combining budget support, risk transfer, and insurance mechanisms.
- Ensure systematic integration of CCA to inform recovery planning.

DRR Financing

The level of domestic financial resources dedicated to DRR activities is insufficient in most African countries.[10] On average, 4 percent of national budgets, at the planning stage, is related to DRR. Some countries like Eswatini and Rwanda allocate more than 8 percent, while others like The Gambia and Sao Tome and Principe assign less than 0.5 percent. It is important to note that only 1 percent of the national budgets, on average, is directly dedicated to DRR interventions. Given the substantial economic losses resulting from disasters, there is an opportunity and urgency for increased resources—domestic government, private sector, and international—to support DRR interventions, particularly those linked to climate-related disasters.

The Finance chapter presents a variety of mechanisms to fund climate adaptation. Some of these are linked and should be coordinated with DRR financing. A wide range of instruments can be combined and leveraged in a multi-layer financial architecture for DRR and climate-related disasters (Figure 3). A key objective of this architecture is to mobilize as fast as possible the resources needed for post-disaster reconstruction and recovery.

Figure 3: Multi-layer financial architecture for DRR and climate disasters



Source: GCA (2020), *State and Trends in Adaptation*, adapted from The World Bank (2016), *Colombia: Policy strategy for public financial management of natural disaster risk.*

A case study in Malawi shows that instantaneous support by governments can minimize household costs related to disasters. However, a four-month delay can increase those costs to US$ 50 per household. A nine-month delay can go up to as much as US$ 1,300, due primarily to the impacts on the development of children and the distress sales of assets, in particular livestock.[11]

Photo: Vadim Petrakov/Shutterstock

FLOODS

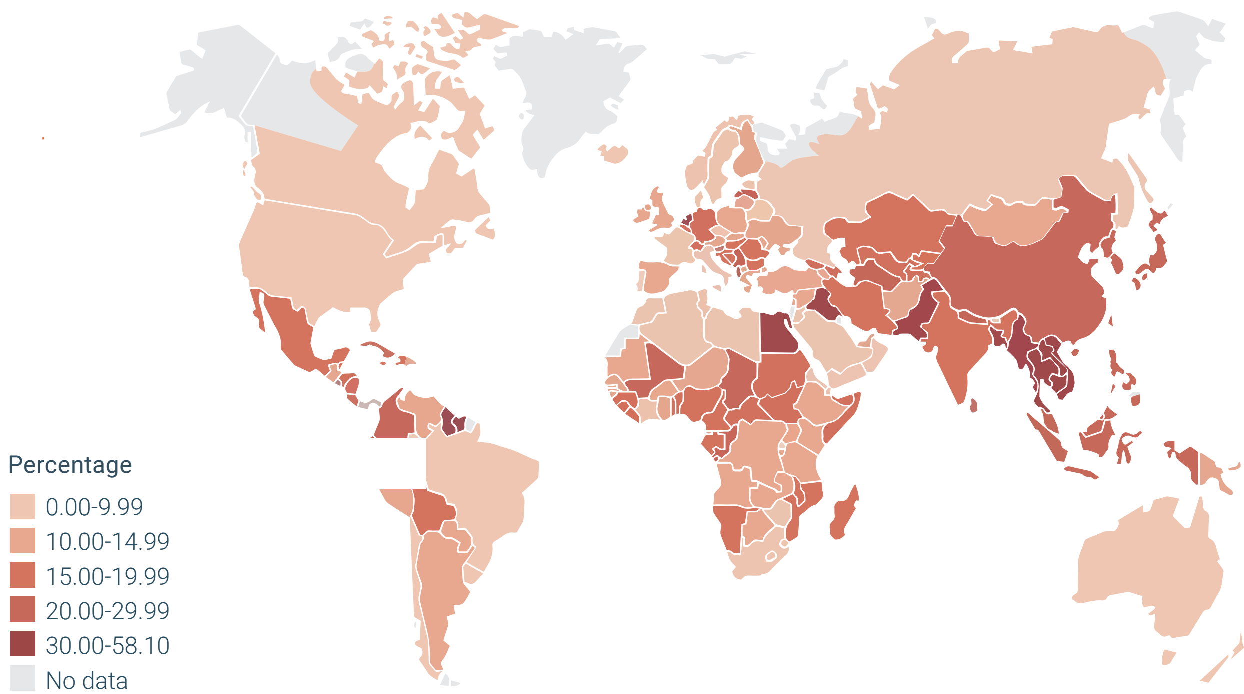
Flood risks in Africa

In Africa, over the period 2008–2018, floods accounted for 65 percent of disaster events and caused 24 percent of deaths. The 2018–2019 cyclone season caused the most considerable flood damage seen in the region. The leading cause was Cyclone Idai, which primarily affected Mozambique and Zimbabwe with at least 900 deaths and infrastructure damage estimated at more than US$ 1 billion.[12] The Transport and Energy chapter and the Agriculture and Food Systems chapter detail the level of current and projected damages by floods in these sectors.

The rainfall and river basin flows in the continent have a wide range of variability, which poses significant challenges for managing floods. These challenges range from managing floods in large transboundary river basins, understanding the extreme floods in ungauged catchments with minimal information, and reducing the vulnerability of low-income informal settlements in African cities.[13]

Recent advancements allow quantification over many possible flooding scenarios, probabilistic risk assessments, and estimations of potentially impacted populations. These quantitative results allow for cross-country comparison, hence providing valuable information for transboundary risk management. Figure 4 shows the very diverse flood exposure across Africa. It shows the percentage of the national population exposed to 15cm or more flood inundation risk in the event of a 1-in-100 year flood (before taking into account flood protection systems).[14] Countries with a high share of the population exposed to floods include Egypt, Sudan, the Central African Republic, Somalia, and Mali.

Figure 4: Relative population exposure to 15cm or more flood inundation risk at the country level (percentage)



Source: World Bank (2020), *People in Harm's Way: Flood Exposure and Poverty in 189 Countries*

Flood and poverty

Global research, including GCA work, has shown that those living in poverty are particularly vulnerable to climate shocks such as floods. This means that the poor lose more when such shocks hit them. This is due to a variety of factors linked to vulnerability which are particularly relevant for Africa, such as: (i) lower-quality housing that is more vulnerable to damage and loss; (ii) greater income dependence on climate-dependent agricultural and ecosystems; (iii) less-resilient infrastructure services; (iv) greater susceptibility to diseases linked to floods such as diarrhea and cholera; and (v) long-term human capital impacts through compromised health and education systems during floods.[15]

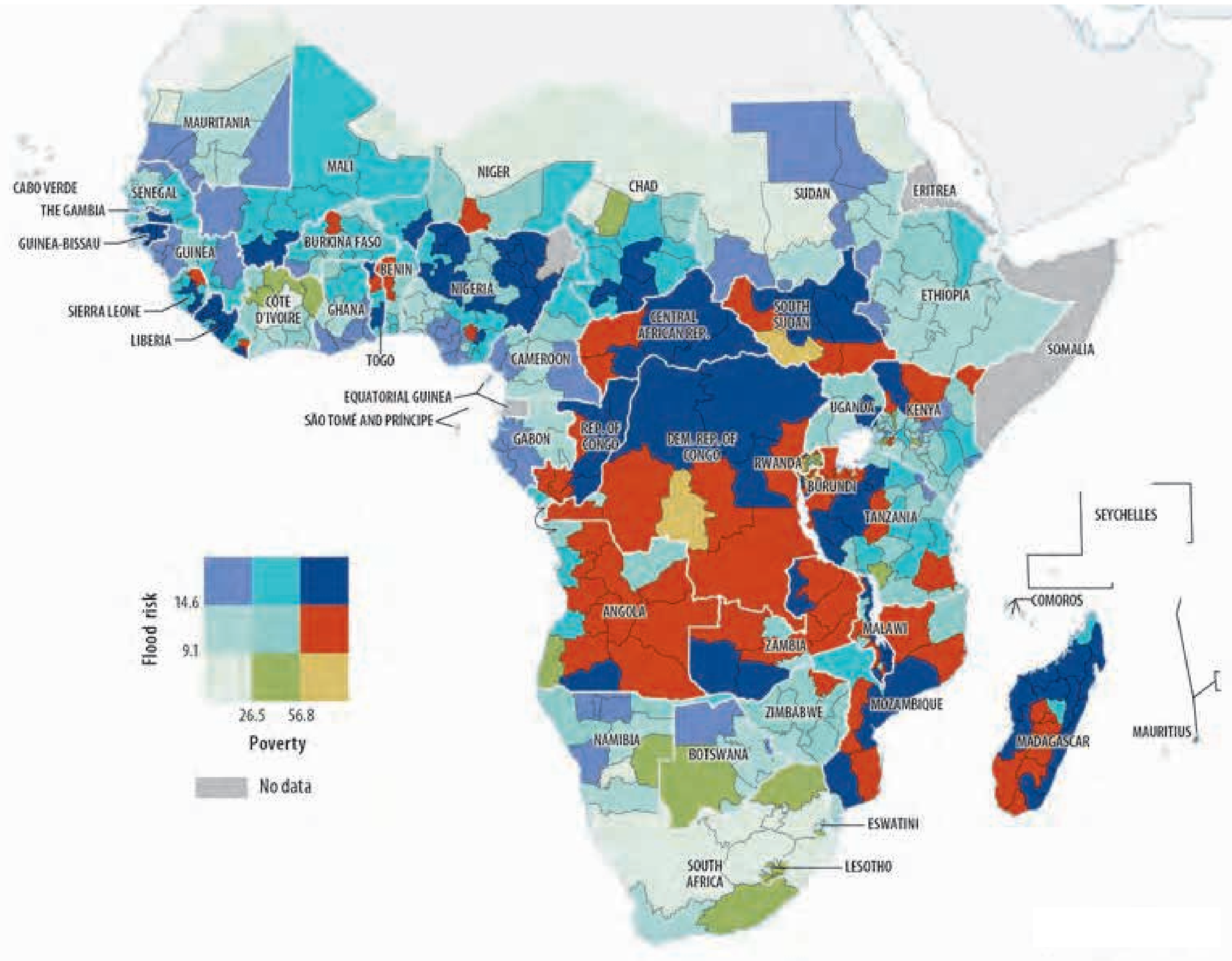
Globally, about 1.47 billion people are estimated to be living in areas with high flood risk. Of these, about 132 million people live under the poverty line (US$ 1.90 a day). Among world regions, Sub-Saharan Africa stands out. It accounts for slightly more than 10 percent of the total population with high flood risks, but for more than half of the global poor who face high flood risks. These numbers reflect the multidimensional character of poverty. Sub-Saharan Africa lags behind other regions on monetary poverty measures, and the poor also suffer from greater exposure (and vulnerability) to climate change risks such as flooding.[16]

At the local level, the relationship between poverty and flood exposure can be complex. For example, economically active coastal cities may be more exposed than other areas of a country. However, within cities, poor people in informal, unplanned settlements are more likely to be exposed. The World Bank analyzed data from 52 countries and found that poor people are often overexposed to urban floods. Some countries in Southern Africa, the Horn of Africa (except for Ethiopia, Rwanda, Zimbabwe, and Mozambique) and Egypt have a strong over-exposure of poor people to floods. In Western Africa, countries with larger rivers and delta areas (notably Benin, Nigeria, and Cameroon) tend to have poor people disproportionally exposed to floods. Overall, 73 percent of analyzed populations live in countries with a positive poor-exposure bias to fluvial floods, notably in Angola, Cameroon, the Democratic Republic of Congo, Nigeria, and Zambia.[17] In these countries, proactive land-use policies in cities to reduce exposure of the poor to floods can be a cost-effective measure, as discussed in the Urban Development chapter.

At the sub-national level, analyzing the distribution of floods and poverty can provide insights for spatially targeted policies to reduce flood vulnerability of the poor. Figure 5 shows the joint distribution of poverty and flood risk in Sub-Saharan Africa. There is a wide diversity of circumstances that call for targeted action. For example, the map shows areas in the Republic of Congo, Ethiopia, Gabon, and South Africa with a relatively high share of the poor exposed to flood risks but low poverty rates. In other areas of Central and West Africa, there are both high poverty and considerable exposure among poor people to flood risks. Globally, four out of the top ten subnational regions by the absolute number of poor with high flood exposure are located in Sub-Saharan Africa.[18]

Photo: Peter Titmuss/Shutterstock

Figure 5: Joint distribution of poverty and floods in Sub-Saharan Africa



Source: World Bank (2020), *Poverty and Shared Prosperity 2020: Reversals of Fortune*

Finally, flood management and poverty targeting based on demographics alone may not be sufficient. For example, the joint incidence of conflict and other climate risks is likely, as discussed in the Conflict and Migration chapter. The share of the poor in areas with a history of conflict and those with high exposure to flooding in countries with high degrees of exposure to both do not appear to be systematically linked. However, many countries in Sub-Saharan Africa, like Cameroon, Liberia, and South Sudan, have a relatively large share of the poor living in areas both affected by a history of conflict and facing high exposure to floods. Adaptation policies need to take into account conflict history.

“

How do we best capture the outcomes so people around the world understand not just the challenge, but also the opportunity, the possibility: [adaptation] is not a message of despair, it is a message of hope and of action needed.”

Vijay Rangarajan, Director General, Americas and Overseas Territories at the Foreign, Commonwealth & Development Office (FCDO), Government of the United Kingdom
High-Level Dialogue “An adaptation acceleration imperative for COP26”, September, 2021

Climate projections and floods

As discussed in the Present and Projected Climate Risks chapter, the Sixth Assessment Report of the IPCC indicates, with high confidence, that the frequency and intensity of heavy precipitation events are projected to increase almost everywhere in Africa with additional global warming. The data in the IPCC report shows that there has been an observed increase in flooding in West, East Southern, and West Southern Africa. Projected increases in pluvial flooding are expected for all sub-regions in Africa, except for North Africa (Mediterranean areas).[19]

Partly driven by population increase, the number of people exposed to river flooding in Africa is predicted to rise to 23.4 million by 2050, with a 57 percent increase in fatalities if global average temperatures increase by 1.5°C. Without additional flood protection and following the projected substantial increase in economic value in flood-prone areas, the projected economic damage in the region could reach US$ 266 billion per year by 2050. With a 3°C rise, the number of people exposed to floods will rise to US$ 33.7 million, and the death toll by 135 percent. Sub-Saharan Africa is predicted to have an increase in the share of the population exposed to flooding, driven by substantial population growth, migration to urban areas, and slum expansion.[20]

Climate change is likely to increase the number of people exposed to floods. Under a high-emissions scenario (RCP 8.5), the number of people exposed to river floods could increase by 4 to 15 percent in 2030 and 12 to 29 percent in 2080. In some regions, the population exposed to floods rises rapidly with global warming, such as in the Horn of Africa and parts of West Africa and Egypt. Some countries will see a combined increase in exposed people larger than 10 percent and a high percentage of poor people disproportionately exposed. Under RCP 8.5, in 2050, some of these countries in Africa include Egypt, Guinea, Kenya, Nigeria, Sierra Leone, and Uganda.[21]

Flood risk management

Current and projected flood risks in Africa are significant and growing. The practice of flood risk management in Africa is nascent. It has grown in importance in urban areas and some of the largest river basins (Congo/Zaire, Niger, Nile, Zambezi, Senegal, and Lake Chad), where population growth in the floodplains has been fast. Our GCA analysis suggests that the following policy recommendations bring together regional and international good practices applicable to Africa:

Understanding flood risk is fundamental: Flood risk management requires not only understanding the types, causes, and likelihood of flood events but also the population and assets in potentially affected areas and their vulnerability and understanding of floods. The low data coverage of most river basins in Africa is an essential barrier to flood management.

Traditional structural flood reduction infrastructure is expensive and needs careful targeting: The traditional structural measures to reduce floods such as dams and reservoirs, dikes and levees, embankments and diversions, or river and channel improvements are a necessary part of flood risk management.[22] However, they have high costs, and their location and design need to be carefully planned for areas with a high risk of life losses and high-value asset damages, such as densely populated urban areas. For areas where structural flood risk reduction infrastructure is not economically viable, other lower-cost measures are required.

The most essential and cost-effective non-structural flood risk management measures are planning and preparedness: Non-structural measures as part of disaster risk management programs can significantly reduce the loss of life and the protection of mobile assets, as discussed earlier in this chapter. Non-structural measures include emergency planning and management, including early warning systems and evacuation plans, preparedness via awareness campaigns, drills, and continuous information to communities and households. Non-structural measures are needed even when structural measures are in place. Structural measures will never prevent every possible disaster, including those that may have more substantial impacts due to climate change. The need for continued awareness and preparedness over years or decades without a destructive flood event is an important challenge for these non-structural measures.

The next level of non-structural measures is related to land use planning and management: This is particularly relevant for rapidly growing urban areas, as discussed in the Urban Development chapter. Flood-prone areas are often economically productive and attractive for agriculture and housing. This dichotomy creates a tension between economic and social uses, on the one hand, and flood risk management, on the other. Flood-informed land use planning and early prevention of construction in high-risk zones are a lower-cost alternative than reconstruction after flood damages, construction of expensive structural engineering solutions, or retrofits.

Rapid changes in Africa make flood prediction in the short- and medium-term challenging: In addition to insufficient data, the ability to project future flood risk is affected by rapid changes in African societies and economies, from urbanization to land-use change, development of floodplain areas, and climate change. Defending against future floods in Africa will require more robust, flexible, and incremental approaches that can adapt to a broader range of future development paths and a changing climate.

Other structural measures to reduce flood risks with lower costs and greater flexibility are nature-based solutions: These include, among many others, the preservation of wetlands, the preservation or restoration of natural floodplain storage, and the management of forest and vegetation cover. Structural and non-structural measures are not exclusive. Instead, flood management strategies need both types. The balance will depend on the level of economic development and population density of areas affected, the existing risk and projected changes in risk levels, and an open science-based discussion among stakeholders on preferred levels of risks and their management.

Flood risk management needs, at times, to look at large spatial scales: The flooding risks of cities or coastal areas depends in many cases on the characteristics and management practices of river basins and water catchments upstream. Often the most practical option to prevent flooding downstream is to take action upstream.[23] The following section of this chapter reviews the importance of water resources management in the reduction of flood risks and the adaptation to various water-related risks in a changing climate.

Photo: Lucian Coman/Shutterstock

INTEGRATED WATER RESOURCES MANAGEMENT

The state of IWRM in Africa

One of the most direct transmission channels of the consequences of climate change is through water: too much, too little, at unexpected times. The Agriculture and Food Systems chapter discusses the enormous implications of droughts on African economies and the malnutrition of its population. The Urban Development chapter reviews the challenges to provide safe water and sanitation in the face of a rapidly changing climate and the impacts of floods on the concentrated economic assets and lives in urban areas. This chapter has discussed the impacts of floods on poverty. The rapidly growing population of Africa, more water-intensive growth paths worldwide and in the region, and increasing pollution, are all factors that, combined with the projected increase in rainfall variability, will make climate adaptation more complicated and more urgent. The solutions and policy recommendations described in those chapters point to the need for integrated water adaptation solutions that connect economic sectors and different levels of government. The river basin is the spatial scale required for such integration.

Integrated water resources management (IWRM) is a holistic framework used to address the diverse demands and pressures on water resources across sectors and at different scales – from the local to the transnational – in an equitable, sustainable manner. The African Ministers' Council on Water (AMCOW) was established in 2002 to promote cooperation and socioeconomic development by effectively managing the continent's water resources and providing water supply services.[24]

In the most recent status report on the implementation of IWRM in Africa,[25] AMCOW highlights that, based on data submitted by 51 African countries, the region's overall performance of IWRM (linked to SDG indicator 6.5.1) is a bit lower than the global average (41 compared with 49 in a scale 0–100). AMCOW estimates that, based on current trends, almost 36 out of 51 countries will not meet SDG target 6.5 by 2030, namely to implement IWRM at all levels, including through transboundary cooperation. At the same time, 42 nations have institutionalized most IWRM elements, providing a solid foundation to accelerate progress. Implementing IWRM is a critical element of the AMCOW Strategy 2018–2030.

Transboundary cooperation is an important dimension of managing the water resources of Africa, as the 48 mainland countries of Africa share 134 transboundary basins and aquifers.[26] Over 90 percent of Africa's surface water is in transboundary basins, and transboundary aquifers underlie over 40 percent of the continent.[27] For this reason, River Basin Organizations are important for the region. Africa has the largest number of transboundary river basins globally, with the Nile, Niger, Senegal, Zambezi, Congo, Volta Rivers, and Lake Chad as the region's primary regional growth arteries.

Photo: Dennis Wegewijs/Shutterstock

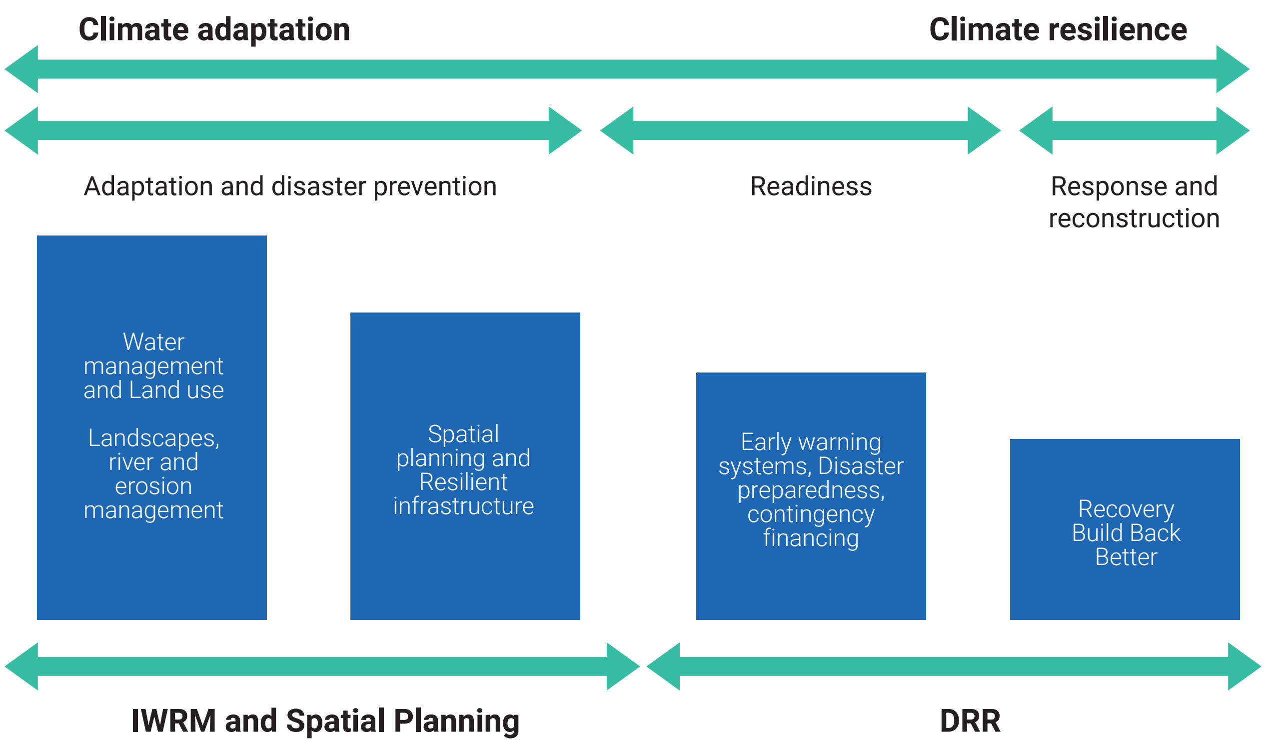
IWRM, DRR, and climate adaptation

In its last IWRM status report, AMCOW highlights the need to enhance investments in disaster risk management, especially in water management plans and systems, to enhance the continent's adaptation and resilience to water-related disasters in a changing climate.[28] These plans and strategies need strengthening in information, institutions, and infrastructure (both natural and built) with a lens of climate adaptation.

IWRM has traditionally included flood and drought risk management through a combination of water storage solutions and water availability information for decision-making under stress conditions. Generally, IWRM and DRR have not coordinated actions and programs under different institutions with different approaches and areas of focus. Our GCA analysis shows that the growing urgency of climate adaptation actions makes this coordination even more critical.

Figure 6 illustrates the complementarities of IWRM and DRR by viewing all phases of a comprehensive management strategy of floods and droughts, from prevention and mitigation; to preparedness; to response and recovery. Prevention and mitigation include upstream land use measures that help manage downstream water flows; and spatial planning, landscape, and infrastructural developments for water storage. Although drought and flood risks can be reduced, it will not always be possible to fully mitigate their threats. Upfront investments in preparedness, response, and recovery, including social protection and cash transfer programs—practices traditionally part of the DRR domain—will be necessary to deal with residual flood risks. Upfront investments will also be needed in more effective early warning systems, better ex-ante planning, rapid response in the aftermath of a disaster, and overall resilience building of vulnerable populations.[29]

Figure 6: Integrated flood risk management – The links of IWRM, DRM, and climate adaptation



Source: Authors, adapted from Johannessen, A. and C. Wamsler (2021). "Extraordinary Governance to Avoid Extraordinary Events." Chapter in J. Baird, R. Plummer (eds.), *Water Resilience*, Springer Nature.

As over 90 percent of Africa's surface water is in transboundary basins, climate adaptation options will be a lot more limited if they only consider national boundaries. Regional cooperation expands the range of possibilities for climate adaptation. The collaboration can range from simple data sharing to joint implementation of large transboundary infrastructure projects. The World Bank's Cooperation in International Waters in Africa (CIWA) partnership has identified lessons from case studies on resilience and adaptation in transboundary waters in Africa. These are presented in Box 1.[30]

Good examples of basin-wide collaborations include the Niger Basin Agreement, where nine countries have come together to develop a sustainable development action plan (SDAP) and climate resilience investment plan (CRIP). The SDAP aims to protect resources and ecosystems; build infrastructure, including transboundary infrastructure; and build capacity for managing the basin. CRIP, meanwhile, aims to increase knowledge related to impacts and vulnerabilities and integrate adaptation into the activities of basin institutions.[31] Other examples include the "Eco-DRR" project by the UN Environment Programme and the European Commission. The project established the Lukaya River Basin Users Association in the Democratic Republic of the Congo to reduce flood and gully erosion risks and support community livelihoods by integrating IWRM and DRR.[32] The World Bank-supported "Enable Plan Invest Control" (EPIC) Response Framework is also promising. It combines existing flood and drought approaches into a unified framework that allows hydro-climatic risks to be managed synergistically, and promotes collaboration between agencies in the DRM and IWRM domains.[33]


Photo: Migel/Shutterstock

Box 1: Lessons on Resilience and Adaptation in Transboundary Waters in Africa

Photo: Nebojsa Markovic/Shutterstock

A series of case studies prepared for the World Bank report "Climate Resilience in Africa the Role of Cooperation around Transboundary Waters" show that appropriately planned transboundary cooperation can improve the resilience of economies, livelihoods, and ecosystems in Africa. Specifically, the case studies show that

1. Shared, trusted information enables:
    - Preparedness through cross-border sharing of information that can greatly improve prediction and help avert large losses of lives and property; and
    - Shared planning tools that can help riparian communities jointly decide ways to optimize water use, manage trade-offs, and share benefits;
2. Flexible, adaptive institutions enable:
    - Alignment of regional and national policies that help countries build climate resilience through integration and interconnectivity of regional systems; and
    - Frameworks for cooperative action that help countries learn together and collectively manage their responses to a changing climate in a flexible and adaptive manner;
3. Shared approaches to infrastructure enable:
    - More cost-effective, efficient, sustainable, and climate-robust investments in both natural (for example, watershed management, and reforestation) and built (for example, multipurpose dams) infrastructure. Since infrastructure represents both a major cost, and sometimes a major ecosystem risk, the potential benefits of a joint approach can be considerable; and
    - Resource and capacity stretched countries to pool together technical capacity, mobilize financial resources, and adopt increased transparency to facilitate improved design, operation, and restoration of built and natural infrastructure.

Source: World Bank (2017). Climate Resilience in Africa: The Role of Cooperation around Transboundary Waters. World Bank, Washington, DC

Photo: IUCN - Poorly maintained traditional water source in Ariwi West village, Mutu parish, Paimol Sub County, Agago District in Northern Uganda.

Community Environment Conservation Fund for Water Resources Management

Geography: Upper Aswa sub-catchment (Lira and Otuke districts) in northern Uganda.

Adaptation measures: The project provided support to village natural resource micro-catchment plans and bylaws to implement fencing and greening of water supply areas, no-cultivation zones in wetland and riparian areas and micro-business development.

Key outcomes: A total of 4,346 households are served by 196 improved water sources managed by community committees and protected by green and grey infrastructure enhancements; and 168 km of riverine areas were restored and protected to provide improved water quality and flow regulation, particularly during dry periods. The project also nearly doubled the yearly income of participating households (from US$ 550 to US$ 1,000) through small enterprises, and it improved communities' and local governments' adaptive capacity to manage natural resources and monitor progress towards locally-set goals.

Partners and funding: IUCN, Austrian Development Cooperation, Ministry of Water and Environment, district local governments, community leaders, NGOs and CSOs. 2011-2016. € 680,000.

PROJECT SUMMARY

Uganda is experiencing an increased frequency of extreme weather events, with an average of 200,000 Ugandans affected each year. In 2010 and 2011, the country saw losses of more than $60 million/year from floods and US$ 1.2 billion (7.5 percent of the GDP in 2010) from droughts.[34] Climate change is projected to increase mean annual temperature by 1.2 to 2.5^{o}C between 2040 and 2059 and will also impact water availability. The central and southern regions will experience a greater risk of flooding due to increased intensity of rainfall, while the northern, northeastern, western and southwestern regions can expect continued aridity and increased drought frequency.[35] Some climate models predict a 14 percent increase in heavy rain events by 2060.[36]

The Aswa catchment basin in northern Uganda is no exception, with an expected increase in temperature of more than 3°C and an annual coefficient of variability of precipitation between 14 and 56 percent,[37] causing precipitation patterns to become increasingly erratic by end of this century.[38] Increased climate variability will impact the agriculture, water, wetlands and forestry sectors, as well as livelihoods that depend on ecosystem services and biodiversity. Up to 97 percent of the land in Uganda also suffers from human-induced land degradation,[39] increasing the susceptibility of smallholder farmers to production shocks.[40] Impacts on food crops like cassava, corn, millet and groundnuts could bring economic losses of up to US$ 1.5 billion by 2050, in a sector employing 70 percent of the working population and contributing 25 percent of the GDP.[41] Reducing these risks requires an integrated approach to strengthen climate change adaptation, combat land degradation and enhance food security.

IUCN, through its Community Environment Conservation Fund (CECF), applied the principles of integrated water resources management (IWRM) in this project. Management of local water sources was brought under community committees, with women, as primary water users, constituting the majority of the committee members. All water source points were fenced (to prevent degradation and overuse) using locally available materials and schedules were drawn for periodic cleaning. The catchments of these water sources were protected with planted grass and trees, in accordance with government water source protection guidelines. The committees also mobilized their communities to stop farming in wetlands and along stream and river banks. As a result, they reported natural vegetation regeneration, improvement of water quality and turbidity and increased water flows, especially during the dry season.

Each of the 100 participating villages accessed a grant of US$ 1,500 to provide its community members with microcredits. The funds are managed by locally elected committees that reports progress and households' participation on a monthly basis in coordination with local government officials. Access to the CECF microcredits enabled small-scale enterprises to access landscape restoration markets, including through establishing tree nurseries and preserving shea trees to sell the nuts instead of producing charcoal. As a result, household income in participating communities nearly doubled. The project showed positive initial results with regards to repayment (often recovered at no additional charge) and has laid the foundation to explore institutional arrangements to scale the approach and ensure its


Photo: IUCN - Part of the water source still has signs of protection in Akileng village, Akileng parish, Alito Sub County, Kapelebyong District in Northern Uganda.

sustainability. Areas for improvement were identified with relation to capacity building, funding thresholds and the need to implement processes to avoid elite capture of funds.

The funding has also catalyzed the development of natural resource management bylaws, which were approved and implemented at the community level, increasing communities' capacity for an adaptive management of the impacts of climate change.

The National Water Policy Committee recommended in 2014 that the CECF approach should be adopted and scaled up as a tool for natural resources management, economic empowerment and social cohesion. The CECF fund is still being managed by the communities after the end of the Building Drought Resilience (BDR) project life cycle in 2018. Further scaling of the approach requires fund capitalization efforts to avoid dependency on donor contributions.[42]


Photo: IUCN - A well-protected community water source (borehole) in Tetugo village, Mutu parish, Paimol Sub County, Agago District in Northern Uganda. This water source has a committee that manages its daily operation.


Photo: IUCN - Monitoring of CECF in Mutu and Arwotngo parishes, in Agago and Otuke districts, northern Uganda respectively.

Photo: leshiy985/Shutterstock

Earth observations to monitor disasters and build resilience in the nile basin and the north coast of Egypt

Geography: Egypt

Adaptation measures: The project focuses on integrating remote sensing and Earth observation data to monitor extreme events and downscale assessment of impacts and damages to sub-national and basin level, and on building the capacity of personnel at national statistical offices.

Key outcomes: The project aims to promote the integration of remote sensing and geospatial information with official statistics to improve disaster monitoring and to better understand the impact of extreme events on people, land and infrastructure; inform disaster management approaches; and support data-driven advocacy and decision making.

Partners and funding: UNESCWA, Google Earth Engine (GEE), Group on Earth Observation (GEO) and the Central Agency for Public Mobilization and Statistics (CAPMAS), the official statistical agency of Egypt. US$ 3 million. 2020–2022.[43]

Figure 1: CHIRPS Daily Precipitation Data on March 12, 2020-Egypt

PROJECT SUMMARY

Observational data since the 20th century have provided evidence of consistent and significant warming trends across the Arab region, with increased frequencies of warm days and warm nights, more extreme temperatures, fewer cold days and nights and shorter cold spells since the early 1970s.[44] In Egypt, warming has increased at a rate of 0.1^{0}C per decade on average between 1901 and 2013; however, a substantial increase to 0.53^{0}C per decade has been observed over the past 30 years (compared with the per decade global average increase of 0.08^{0}C since 1880s and 0.18^{0}C since 1981).[45,46] Since the 1960s, there has been an increase in daily minimum temperatures throughout the country, with warming having been more pronounced in the winter (0.31^{0}C) than in the summer (0.07^{0}C).[47] Climate models[48] predict an increase in mean annual temperature of 1.5^{0}C-3^{0}C by 2040-2059, with more rapid increases in the interior parts of the country.[49] Increased temperatures are also expected to impact precipitation patterns, with models suggesting a prevalence of drier conditions in most months by 2050 and dry spells expected to increase by 75 days per year by the 2080s.[50]

These climate change impacts pose a critical threat to Egypt's Nile Delta, which has been recognized as one of the world's three extreme vulnerability hotspots. Future projections point towards a greater risk arising from sea level rise, water scarcity, and greater frequency of extreme events such as heatwaves, flash floods and sand and dust storms. In addition to being the most populated area in the country, the Nile Delta also contains 50 percent of Egypt's agricultural land, while the Nile River supplies 95 percent of the country's water.[51,52] Climate change is expected to impact water flows in the Nile, affecting water supply not only in Egypt but in other countries in the Nile Basin (e.g. Ethiopia, Sudan, South Sudan and Uganda). Studies estimate that by the late 21st century the frequency of hot and dry years will increase by a factor of 1.5-3, even if warming is limited to 2^{0}C. Combined with increasing population, this will exacerbate chronic water scarcity in the Upper Nile Basin, leaving an additional 5-15 percent of the population at risk of having insufficient water.[53]

Climate change is also projected to cause inundation of the coastal areas due to sea level rise. About 6.1 million coastal inhabitants could be displaced and 4,500 km^2 of cropland lost, which would result in GDP losses of up to 6 percent for a 1 m sea level rise scenario and 16 percent in case of 5 m sea level rise.[54] Rising sea level threatens facilities at Port Said with economic damage of more than US$ 2 billion at 0.5 m and US$ 4.4 billion at 1.25 m, respectively. In Alexandria, the estimated cost of constructing sea walls for shoreline protection is around US$ 300 million per year.[55]

In the face of these growing climate risks, programs and projects that strengthen and improve disaster monitoring are essential for adaptation. UNESCWA's Google Earth Engine Project on the Use of Remote Sensing for Disaster Monitoring in the Nile Basin and North Coast in Egypt is one such project. The project falls under UNESCWA's mandate to

Figure 2: Affected Areas from Floods in 2020

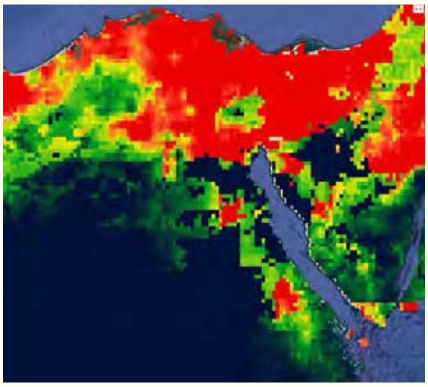
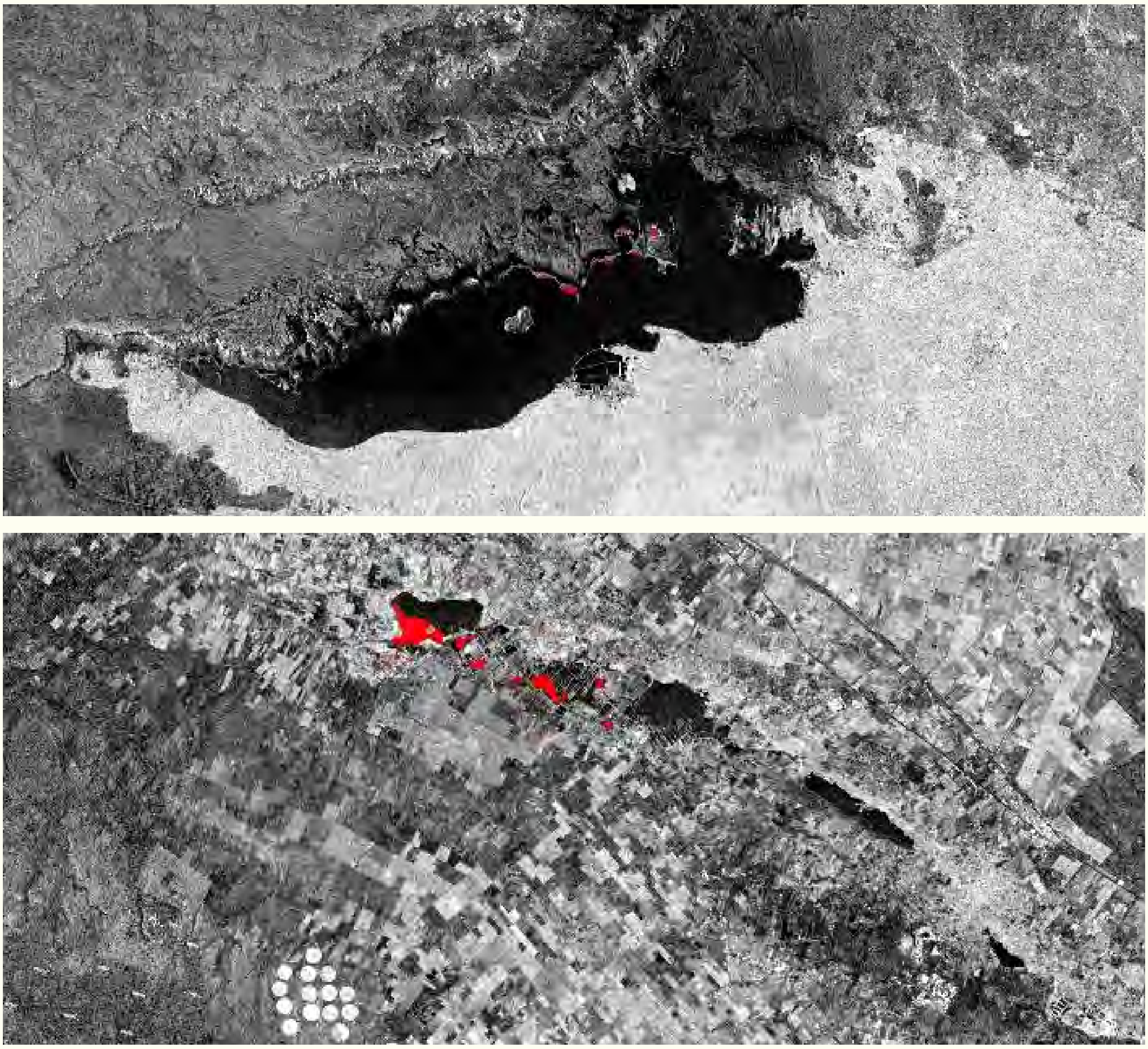


Figure 3: Affected Areas from Floods in 2020

Figure 4: Affected area in Qarun Lake

Figure 5: Affected area in Al Natron Valley



support the modernization of national statistical offices across Arab countries, while promoting the integration of geospatial information and big data. Its overall objective is to assess the utility of open medium-resolution satellite data for extreme event monitoring and impact evaluation, and to support the national statistical offices and their counterparts with supplementary data to enable damage assessment, reduce disaster risk and strengthen resilience, allowing for more effective monitoring and reporting on the Sendai Framework for Disaster Risk Reduction[56] and the Sustainable Development Goals (SDGs). The approach combines several datasets, including: remote sensing data from Sentinel-1&2, part of the Copernicus program of the European Space Agency; world population data from the Gridded Population of the World from NASA's Socioeconomic Data and Applications Center; land use data from Copernicus Global Land Covers; climate hazards from CHIRPS'[57] daily rainfall dataset and Emergency Events Database; and national databases including census, disaster and infrastructure data. Analyzing these, the project evaluates the magnitude of potentially inundated agricultural and urban areas and affected population.

Despite these advancements, there are several technical limitations that may limit the feasibility and usability of this approach; for instance, cloud cover can limit the utility of multispectral satellite imagery, and the existing resolution of images received from satellites limits the ability to accurately detect urban floods.

In addition to providing analytical support, the project provides training and builds the in-house capacity of national statistical offices to make use of Earth observation data to analyze and improve disaster assessment. This includes increasing understanding of flood-prone areas like Wadi Al Natron and Ras Ghareb, the damages to crops in flooded areas, and associated loss of biodiversity and ecosystems services. The project can also help in assessing the impact of planned interventions, such as understanding future changes in the flow and level of the Nile River due to Al Nahda Dam.

The project takes a complementary approach to the broader Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR), which has helped to deepen the understanding of the impact of climate change on water resources, water-dependent sectors and associated implications for socio-economic vulnerability in the Arab region through regional climate modeling. UNESCWA Google Earth Engine project enhances capacity and advocacy for better use and integration of remotely sensed geospatial data to improve data-driven decision making in Egypt and other Arab countries in relation to disaster risk management through replicating the GEE codes from the case study of Egypt for applications in other areas in the Arab region. Thus, it informs progress towards the SDG targets related to climate change and disasters.

AfDB's new water policy

In line with Africa Water Vision 2025, the goal of the African Development Bank (AfDB) is for a water secure Africa with equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and stable and peaceful societies.

The African Development Bank's new water policy is based on the principles of integrated water resources management.

In the medium-to long-term, AfDB seeks to ensure that sound economic, social, and environmental considerations influence water sector investment decisions in African countries, across regional bodies and in watersheds. As of 2021, the Bank's active water sector portfolio stood at US$ 4.3 billion, with nearly a hundred national projects implemented in 40 countries, and six multinational projects.

AfDB's new water policy, approved in May 2021, includes four key implementation pillars: enabling environment; institutions and participation; management instruments; and financing. Recognizing the clear need to address water security in areas where it directly contributes to fragility, or where enhanced water security will resolve conflicts and bring peace to communities, AfDB interventions are informed by assessments using the Country Resilience and Fragility Assessment tool and the integrated Climate Safeguards Screening tool.

The new water policy is guided by seven operational elements:

- **Economic valuation of water, pricing of water services, and cost recovery.** This contributes to evaluating the trade-offs involved in the allocation of water resources between competing needs, while reflecting the resources used for investment, and expenditures for operations and maintenance.

- **Sustainable, smarter, and resilient infrastructure.** This contributes to achieving water security at national and regional levels, and to addressing the issues of sustainable access to water resources and maintaining a high quality of water services.
- **Governance and enabling environment.** Institutional and human resources capacity for sustainable water sector services delivery remains a challenge in Africa. Capable results-oriented institutions and good governance are crucial for attaining water security, sustainable implementation of water policies, and effective operations and maintenance at household, community, local, national, and regional levels.
- **Financing and investments.** Sustainable and innovative financing, including from the private sector and micro-finance schemes, is important to develop, implement, and maintain the hard and soft infrastructure and institutional components of water systems.
- **The multi-purpose use of water and ecosystem services-based approach.** This provides multiple benefits from a single investment, promoting efficiency, while fostering equality and sustainability.
- **Knowledge management, innovation, technology, and research**. This supports the water sector in Africa to make evidence-based decisions, using innovative and technologically-sound solutions.
- **Participation and inclusion.** It is only through the support of stakeholders, their willingness to


Photo: AfDB


Photo: AfDB


Photo: AfDB


Photo: AfDB


Photo: AfDB


Photo: AfDB

- pay, and their compliance with user guidelines that countries can move towards achieving water security. Consulting stakeholders in a timely, transparent, and inclusive manner is therefore critical.

Africa needs adequate infrastructure to access, store, and conserve its water resources; and to strengthen resilience against disasters and climate change effects. Only 68% of Africa's population has access to improved water supply. Considerable investments in infrastructure are therefore required to improve access, manage water-related risks, and increase water security. The integration of green infrastructure and nature-based solutions (NbS) plays an increasingly important role in providing safe, clean, and regular water flows – including, for instance, by preserving wetlands that buffer coasts from storms, aquifers that store water, and forests that reduce erosion and help keep water free of sediment. Integrating NbS approaches into conventional water system infrastructure planning can be cost-effective; regulate water supply and quality; and reduce climate vulnerability.

AfDB is currently implementing innovative projects such as the Strengthening Climate Resilience in the Kafue Sub-basin Pilot Program for Climate Resilience (SCRiKA) project in Zambia, launched in 2014 with US$ 38 million in funding from the Climate Investment Funds. SCRiKA helps farmers develop greater resilience to floods and droughts through community-driven activities such as micro-projects for flood control and diversion structures, small-scale irrigation schemes, and water reservoirs. Activities are selected through a demand-driven process facilitated by qualified non-governmental organizations and local governments. About 1,200 micro-projects had been rolled out by the end of 2020, helping 800,000 Zambian farmers develop greater resilience to floods and droughts.

The Urban and Municipal Development Fund (UMDF) is another innovative initiative, a multi-donor trust fund that aims to quickly roll-out support to African cities for climate diagnostics, the identification of local vulnerabilities, and the implementation of transformative solutions. AfDB will assist African countries and regional bodies in developing climate change adaptation and resilience strategies, and tackling climate change impacts on the water-related sectors. Activities related to diagnostics are already planned in five cities, following which a vision for each city will be developed, along with a prioritized list of projects to achieve future sustainability.

Mukuru lights the way for resilience-building in slums

Akiba Mashinani Trust

A staggering 60 percent of the residents in African cities live in slums, on average.[58] These "informal citizens" are among Africa's most vulnerable, living in fragile and dangerous conditions with high levels of poverty, and without risk-reducing infrastructure and support to cope with shocks. They are at the very frontline of the urban risks that, according to the Intergovernmental Panel on Climate Change (IPCC), are rising rapidly due to climate change – including heat stress, extreme precipitation, flooding, and water scarcity.

Providing even basic services like roads and water and sewage systems to crowded informal settlements can be a challenge, given the lack of space for infrastructure, and limited flexibility in planning regulations and city masterplans. Existing efforts to provide these services, including by non-government organizations, are generally piecemeal, sector-by-sector, and small scale.

Against this complex background, the story of Mukuru, a large slum in east Nairobi, Kenya, lights the way forward for efforts to build the resilience of informal settlements. It demonstrates how locally-led efforts that engage the residents in finding solutions, combined with the support and flexibility of local governments, a multisectoral approach, and the concerted support of multiple partners can provide basic services, and at the same time reduce climate vulnerability.

Mukuru is spread over 689 hectares of land, most of which was gifted to select private citizens in the 1990s as political patronage, despite the presence of pre-existing tenements. The constant threat of eviction by these owners became a rallying point for the residents of Mukuru, and they came together under the Muungano alliance to seek legal recourse.

Water and sanitation

Source: Author

Electricity and fires

Source: Author

The alliance was created by three organizations: Muungano wa Wanavijiji' ("united slum dwellers" in Kiswahili); Slum Dwellers International Kenya; and Akiba Mashinani Trust (AMT, a fund for the urban poor and SDI affiliate). Over time, the efforts of the alliance expanded to efforts to improve the quality of life of Mukuru's residents.

These efforts were buoyed by Kenya's new Constitution in 2012, which devolved power, resources, and representation down to the local level. With the full support of the local government, Mukuru was declared a "Special Planning Area" (SPA) in 2017, to allow flexibility in city planning regulations on account of Mukuru's special circumstances. This set in motion a locally-led process for developing a Mukuru Integrated Development Plan covering three settlements in Mukuru, with around 300,000 residents, for integration into Nairobi's 20-year City Integrated Development Plan.

The Mukuru approach to planning is considered "ground-breaking" because it sought to engage the residents of Mukuru in a community-wide, iterative planning process for the provision of basic services, while minimizing displacement and disruption to their lives.[59] The process was driven from within the community, with a strong element of ownership. The planning process first identified seven sectors as priorities (mirroring sectoral departments in the Nairobi City County): housing, infrastructure and commerce; education, youth affairs and culture; health services; land and institutional frameworks; finance; water, sanitation and energy; and environment and natural resources. To ensure that the planning process for each sector has adequate technical support, technical experts from 46 organizations (local government, academia, and international and local NGOs) were grouped into seven "consortia," each led by Nairobi City County staff.

The planning process was not without conflict with residents (who feared it was an innovative way of evicting them), and with private service providers (who saw it as a threat to their businesses and livelihoods). These had to be allayed through awareness creation efforts, including through local radio.

While it is early to judge the resilience impacts of the planning process, over 50 kilometers of roads are under construction in Mukuru, stormwater drains are being laid, and each plot is being connected to electricity, clean (free) water, and to the sewerage network. Reducing basic service deficits and building resilient infrastructure systems in urban areas can significantly reduce hazard exposure and vulnerability to climate change, according to the IPCC.[60] Effective upgrading can also provide a foundation into which climate-change resilience and disaster risk reduction can be integrated.[61]

The Mukuru planning approach has been endorsed by the President of Kenya, and is being replicated in Kibera and Mathare, two other informal settlements in Nairobi. The scale of the achievement is already inspiring work in other informal settlements across Africa, and in Asia. Replicating and scaling up this planning approach, with a stronger climate resilience component, can provide a locally-led solution to the complex but urgent problem of reducing the climate vulnerability of 200 million people living in slums across the continent.

Flooding

Source: Author

Aerial view of Mukuru


Source: Author

Section 3
Cross-cutting themes

Photo: Adeyinka Yusuf/iStock

Health

KEY MESSAGES

- **Health care service coverage in Africa is very low at 48 percent.** Every year, 15 million people are pushed into poverty due to out-of-pocket health care expenses.
- **Currently climate change is known to account for only a modest share of the health and disease picture in Africa.** But in the absence of suitable adaptation strategies, climate change will have a disruptive effect on population health in Africa. It will do so through a range of direct and indirect effects, including heatwaves, the spread of infectious diseases like malaria, and a greater incidence of food- and water-related diseases because of climate shocks.
- **Without the impacts of climate change, projections show, the number of people in Africa facing chronic hunger would reduce by more than half between 2010 and 2050.** The impacts of climate change would slow this progress, with an additional 78 million people facing chronic hunger by 2050, over half of them in Sub-Saharan Africa.

Photo: Riccardo Mayer/Shutterstock

- **In a quarter of African countries, a number equivalent to half the population is affected by a climate-related disaster each decade.** As the population of Africa grows from the current 1.3 billion inhabitants to a projected 2.5 billion by 2050, and urbanization expands in areas exposed to natural hazards, the number of deaths, injuries, and disabilities due to climate disasters will continue to increase rapidly if no adaptation measures are implemented.

“

The health sector is one of the most vulnerable to the impacts of climate change, and a key priority for adaptation. Despite this, only 0.5 percent of multilateral climate finance is currently spent on health protection.”

Dr. Tedros Adhanom Ghebreyesys, Director-General of the WHO
Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

THE HEALTH CHALLENGE IN AFRICA

Health indicators and services in Africa have made substantial progress in recent years before the COVID-19 pandemic, but still lag behind the rest of the world. Figure 1 shows a composite measure of 40 out of the 41 performance indicators for the health-related Sustainable Development Goals (SDGs). This measure ranges from 0 to 100 to describe the overall progress worldwide towards meeting the health-related SDGs.[1] Only countries in northern and southern Africa show medium to considerable progress in meeting the health SDGs.

Health care service coverage in Africa is low at 48 percent. Approximately 615 million people do not receive the health care services they need. When the quality of services is considered, the coverage scores are even lower. Every year, 15 million people (1.4 percent of the region's population) are pushed into poverty due to out-of-pocket health care expenses.[2]

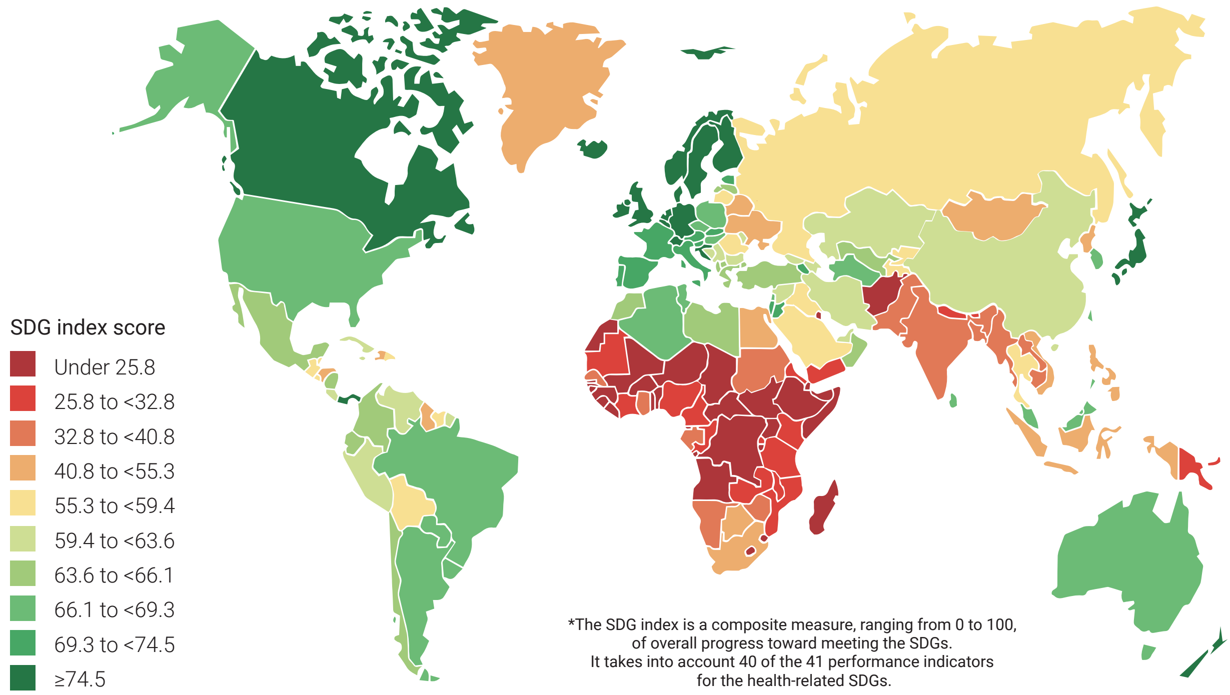
The COVID-19 pandemic continues to be a devastating shock to the region. As of end-June 2021, over 5.4 million confirmed cases of COVID-19 were reported in Africa, with the most cases and deaths in South Africa. Countries in North Africa have the next highest confirmed cases and deaths. The number of cases and deaths are widely acknowledged to be undercounted. The initial slow vaccine roll-out, with very small numbers of people vaccinated because of short supply, puts Africa at increased risk of new waves of infection.

This chapter reviews the impacts of climate change on various health factors in Africa, projected trends, and possible climate adaptation solutions. The chapter also examines progress towards mainstreaming adaptation in health systems.

IMPACTS OF CLIMATE CHANGE ON HEALTH IN AFRICA

Climate change is a modest factor today in the overall burden of disease and health indicators in Africa. However, the trends are of concern and decisive action is needed to mainstream practical adaptation strategies in health services and sectoral factors that impact health outcomes.

Figure 1: Health-related SDG index* score 2017



Source: Healthdata.org (2017)

Population health is impacted by climate change through multiple exposure pathways. The most significant factors linked to weather and climate shocks today and climate change trends in future years include:

- Heatwaves
- Infectious diseases
- Hunger and malnutrition, particularly due to the impact of climate shocks on agricultural production
- Water- and food-borne diseases linked to climate shocks
- Long-term health and developmental challenges on children
- Injuries, disabilities, and deaths resulting from floods
- Damage to health facilities and access disruptions caused by floods
- Inequality and vulnerability as amplifying factors

Heatwaves

Worldwide evidence shows higher ambient temperature is associated with higher morbidity and mortality. Heatwaves are causing avoidable morbidity and mortality across Africa, with most evidence available from South Africa.[3] Adverse health impacts increase mortality rates among the elderly or those with chronic non-communicable diseases. They also increase adverse pregnancy and birth outcomes such as pre-term birth and stillbirths, and also aggression and suicide. Rates of visits to emergency rooms and hospitalizations increase during heatwaves, with a concomitant escalation in health care costs. Further, temperatures in Africa are rising to levels that reduce worker productivity. It is important to note that limited information available in Africa suggests lower heat-related mortality than many other parts of the world, but this may mask lack of data and research. This hypothesis needs to be substantiated by further research and greater awareness and reporting of the health impacts of high ambient temperatures.[4] Until there is further Africa-specific information, global syntheses should be applied with caution. The chapter on Jobs discusses the growing impact of heatwaves on labor days lost.

The Urban Development chapter discusses practical measures cities can take to reduce the impact of heatwaves, from urban design and parks to early warning systems, and readiness of health facilities to respond to increased occurrences of heatstroke.


Photo: Martchan/Shutterstock

Infectious diseases

Malaria continues to be a challenge in Africa. Of the estimated 229 million malaria cases in 2019, 215 million were in Africa in 2019 (94 percent). Most (67 percent) of the 386,000 deaths in Africa in 2019 comprised children under the age of five years. Nigeria (23 percent), DRC (11 percent), Tanzania (5 percent), Mozambique (4 percent), Niger (4 percent), and Burkina Faso (4 percent) accounted for about 51 percent of all malaria deaths globally.[5]

Climate change is likely to expand the range of areas subject to malaria risks. The trend will continue to worsen with climate change.

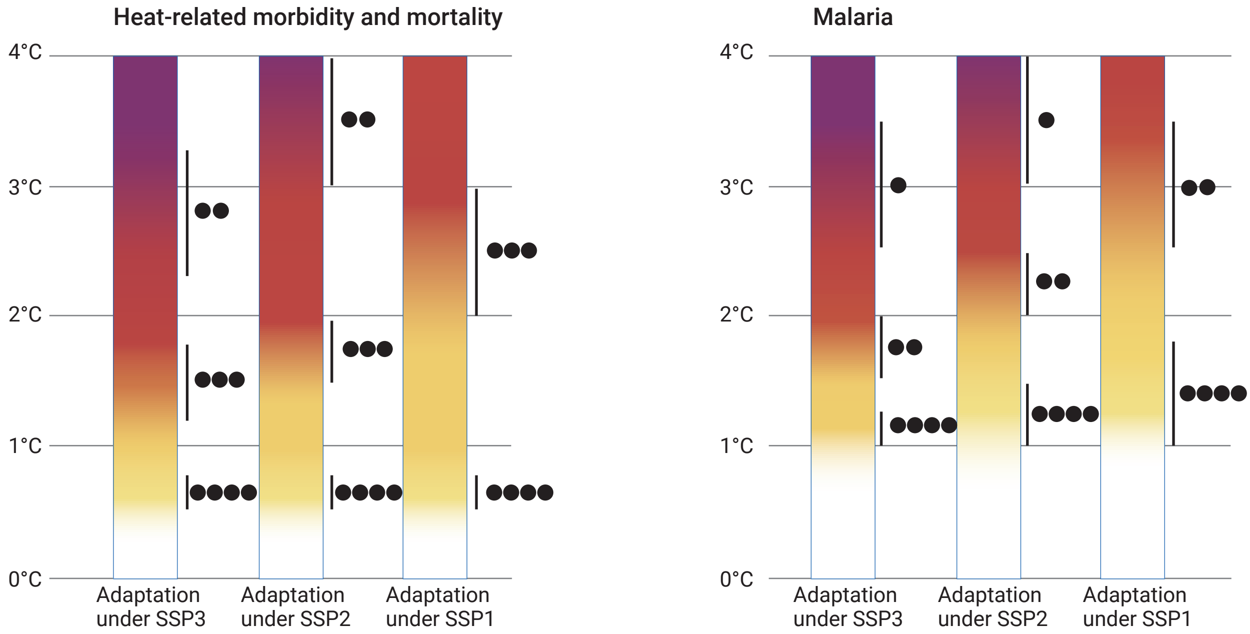
Further, diseases carried by *Aedes aegypti* and related species (e.g., dengue, chikungunya, and Zika virus) may increase in Africa.[6] Dengue is the most common arboviral disease globally, with approximately 390 million cases annually.[7] There is insufficient climate change research on a range of diseases from Rift Valley fever to schistosomiasis to understand the magnitude and pattern of risks and the extent to which weather and climate are causing shifts in the numbers of cases and deaths.

Figure 2 shows global projections for heat-related morbidity and mortality and for malaria, with different climate change and development pathways.[8] There are minimal data on heat-related morbidity and mortality in Africa, but there is no evidence to suggest Africans would have greater resilience than other regions. The malaria embers are based primarily on projections for Africa. Risks for both are projected to increase with additional climate change, with higher risks under the 3°C scenario compared with 1.5°C.

Risks are highest under SSP3 because of more significant challenges to adaptation. Although the overall projections are for an increase in the risk of malaria, the pattern will be complex, with some regions becoming too hot or too dry, while others may become newly suitable for transmission of malaria along the current edges of its distribution.[9]

In Figure 2, SSP1 represents a world aiming for sustainable development, SSP2 a world with medium challenges to adaptation and mitigation, and SSP3 a world with high challenges to adaptation and mitigation. The dots show the confidence in the transitions, with four dots indicating very high confidence, three dots high confidence, two dots medium confidence, and one dot low confidence. White indicates that no impacts on heat or malaria are detectable and attributable to climate change. Yellow indicates that impacts or risks are detectable and attributable to climate change with at least medium confidence. Red indicates

Figure 2: Burning embers for heat-related morbidity and mortality and for malaria under three adaptation scenarios



Source: Ebi et al. (2021)

severe and widespread risks. Purple indicates very high likelihood of severe risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or risk.

Hunger and malnutrition

More than 250 million people in Africa (19 percent of the population) are undernourished. The number is growing faster than other world regions and with women and children more affected than men.[10] The majority of undernourished Africans are in Sub-Saharan Africa, which has showed an increase of about 32 million undernourished people since 2015.

Throughout Sub-Saharan Africa, at least 57 percent of the population cannot afford a healthy diet. Sub-Saharan Africa is the only subregion with a rising number of stunted children; 40 percent of all stunted children live in Africa.

According to IFPRI projections,[11] without the impacts of climate change the number of people facing chronic hunger would reduce by more than half between 2010 and 2050. The impacts of climate change would slow this progress, with an additional 78 million people facing chronic hunger in 2050, over half of them in Sub-Saharan Africa. The Agriculture and Food Systems chapter presents a variety of possible adaptation measures to reduce these impacts.

Photo: CatherineLProd/Shutterstock

Water- and food-borne diseases

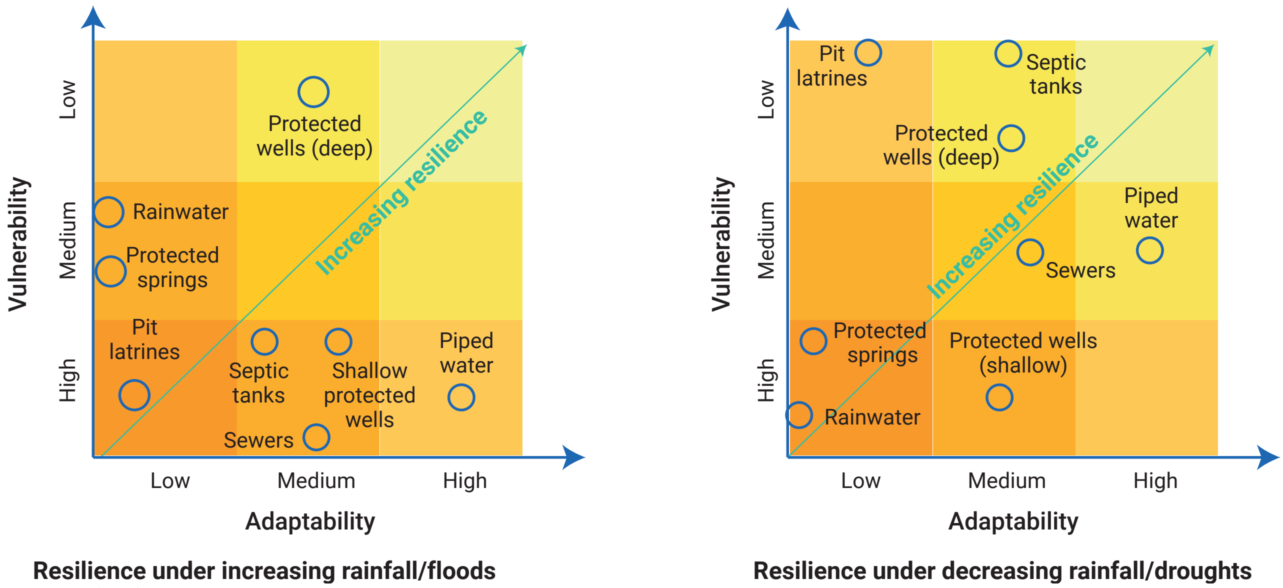
Diarrheal disease outbreaks are associated with heavy rainfall and flooding events.[12] A historical review of these outbreaks after extreme water-related weather events shows that they were often caused by the contamination of drinking-water supply sources.

Diarrhea is the leading case of disease and death in children under five in Africa. In 2015, there were an estimated 30 million cases of severe diarrhea and 330,000 deaths.[13] About 45 percent of all child deaths are associated with malnutrition.

There is a perverse correlation between diarrhea and undernutrition. Undernourished children are more susceptible to diarrheal disease, and children with diarrheal disease are more prone to undernutrition.

Diarrheal diseases are preventable through access to safe drinking water and adequate sanitation and hygiene; they also are treatable. The design and operation of safe drinking water and sanitation needs to take climate change into account. Different technologies are more or less resilient to a changing climate depending on the extreme event, as shown in Figure 3.[14]

Figure 3: Climate resilience of water supply technologies



Source: WHO (2009)

Pit latrines are highly vulnerable to floods, but little affected by droughts. They have low adaptability to both floods and droughts and so should be avoided wherever possible.[15] An alternative, septic tanks, are also highly vulnerable to floods, but there are more opportunities to adapt them by modifying construction techniques to prevent the septic system from being flooded. They have low vulnerability to droughts, but they should also be adapted to recycle or minimize water use and are thus the better choice. But the extent of resilience will vary by the local context, requiring careful evaluation.[16] The Urban Development chapter presents a variety of possible adaptation measures to reduce these impacts.

Long-term health and developmental challenges on children

Climate disasters and related shocks have long-lasting impacts on child development and health. Impact of climate disasters on parents' nutrition and income can have profound consequences on children. Inadequate nutrition in pregnant women can cause permanent impairments to cognitive and social development to their children. Reduced parental income results in increased child mortality, malnutrition, and stunting. The impact of climate disasters on education facilities, even if temporary, can have serious impacts on children's education, particularly those in disadvantaged situations and especially girls. Setbacks to a child's early health and education can have long-term impacts on their development and productivity.[17]

Injuries, disabilities, and death caused by climate disasters

Over the last decade (2010–2019), climate-related disasters have caused about 46,000 deaths in Africa, with droughts responsible for 46 percent and floods for 32 percent, respectively. In recent years the share of deaths in Africa has risen. There is insufficient data on injuries and disabilities caused by climate disasters like floods and storms. In a quarter of African countries, a number equivalent to half the population is affected by a climate-related disaster each decade. This represents a massive loss of livelihoods, assets, and educational opportunities, and exposes those affected to disease and nutrition-related health risks. As the population of Africa grows from the current 1.3 billion inhabitants to a projected 2.5 billion by 2050, and urbanization expands in areas exposed to natural hazards, the number of deaths, injuries, and disabilities due to climate disasters will continue to increase rapidly if no adaptation measures are implemented.

Damage to health facilities and access disruptions caused by floods

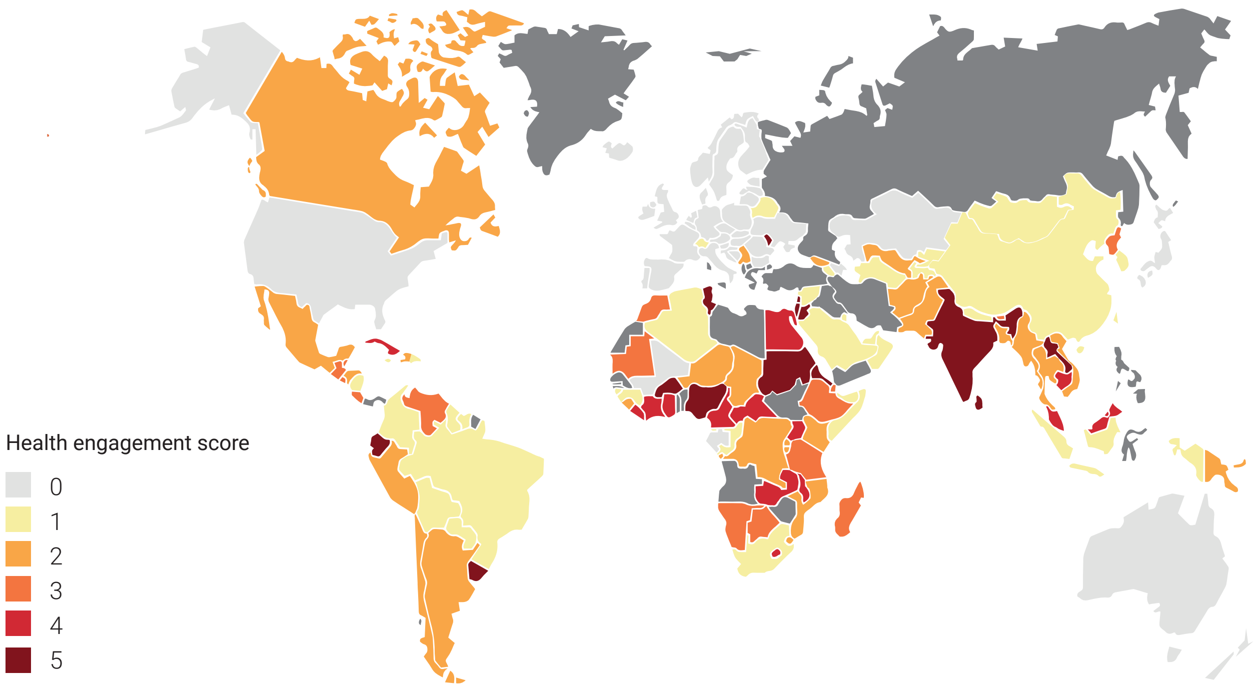
Health care services are also impacted by climate change. Health care infrastructure is vulnerable to floods, storm surges, landslides, and other extreme events that can cause physical damage. If located in coastal areas, water quality, waste management, sanitation, and other infrastructure can be threatened by sea-level rise and unpredictable, more intense rainfall. The delivery of health services in Africa is vulnerable to disruptions in transport, energy and communication networks brought on by extreme weather events. In the medium-term, health facilities in many places in Africa will need relocation away from hazardous areas affected by floods, storm surges and landslides.

Equally important are the disruptions caused by climate disasters on the transportation network and access to health facilities. For example, in inner Kampala, a network analysis shows that health service providers can be reached from most locations within 15 minutes by car. Usually, a timespan of 60 minutes after an incident is considered as a threshold for higher survival rates in case of life-threatening health issues. However, a flood with a 10-year return period in Kampala causes severe disruptions to roads. The consequence is that about one-third of locations in inner Kampala would not be accessible by an ambulance from a health center within 60 minutes.[18]

Inequality and vulnerability as amplifying factors

Climate change predominantly affects children, exacerbating leading causes of death. The risks are unevenly distributed, with poor and marginalized communities at higher risk, as has been discussed in other sections of the report. Populations living in low-income urban communities and in vulnerable drylands and lagging rural areas are not only less prepared for climate shocks, but the health services that they can access are of poorer quality. This combination results in higher health impacts today to climate shocks and, if no adaptation actions are taken, worse health outcomes in the future. Adaptation in health systems must take inequality and exclusion into account.

Figure 4: Health engagement score in NDCs by country



Source: Dasandi et al. (2021)
Source: Dasandi et al. (2021)

Photo: sqofield/Shutterstock

ADAPTATION, PLANNING AND RESILIENCE FOR HEALTH

Health care systems in Africa face enormous challenges due to the many and varied vulnerabilities of its population. These systems are in the frontline of responding to crises of various kinds, from flood-induced cholera outbreaks to hunger caused by droughts. Equally important, health care systems are indispensable to mitigate the severe and long-lasting effects of climate shocks on children as discussed earlier. These challenges need decisive action to increase not only the quality and coverage of health care systems but also their resilience to disasters, shocks, and a rapidly changing climate.[19]

Improved health outcomes for the population of Africa will not depend only on health systems, but also on investments to make progress on the SDGs in ways that are adapted to a changing climate. These investments range from safe water and sanitation to food security, and from basic services in low-income urban communities to early warning systems.

This section reviews the importance assigned to health in adaptation planning processes in Africa. It also covers indicators to monitor progress towards enhanced adaptation in health systems; suggests areas of action to enhance the resilience of health systems to climate shocks; and emphasizes the importance of early warning systems.

Health in adaptation planning processes

An analysis of the Nationally Determined Contributions (NDCs) to evaluate how public health was incorporated, including impacts, adaptation, and co-benefits, concluded that most countries in Africa referred to health in their NDC.[20] Figure 4 shows the degree of health engagement based on a score measuring health engagement based on the specificity and detail of health references. Nearly 100 percent of countries in the Africa region had a mention of health in their NDCs, and more than 40 percent had a section on health. As of 31 March 2021, only Burkina Faso, Togo, Cameroon, Sudan, Kenya, and Ethiopia have completed their National Adaptation Plans: all identified health as a high-priority sector.

Indicators to measure climate adaptation in health systems

The *Lancet Countdown* is an international collaboration established to provide an independent, global monitoring system dedicated to tracking the emerging health profile of the changing climate.[21] The Lancet Countdown has proposed four groups of indicators to track adaptation, planning and resilience for health:

1. Adaptation planning and assessment
    a. National adaptation plans for health
    b. National assessments of climate change impacts, vulnerability, and adaptation for health
    c. City-level climate change risk assessments
2. Climate information services for health
3. Adaptation delivery and implementation
    a. Detection, preparedness, and response to health emergencies
    b. Air conditioning
    c. Urban green space
4. Spending on adaptation for health and health-related activities

Two of the indicators on adaptation and planning are drawn from the WHO Health and Climate Change Survey, a voluntary national survey sent to all WHO member states, to be completed by ministry of health focal points. Of the 194 WHO member states, 101 participated in the 2018 survey. The main findings were:

- National planning on health and climate change is advancing, but the comprehensiveness of strategies and plans need to be strengthened
- Implementing action on key health and climate change priorities remains challenging
- Results from Vulnerability and Adaptation Assessments are influencing policy prioritization
- Barriers persist in accessing international climate finance
- Multisectoral collaboration on health and climate change policy is evident, with uneven progress

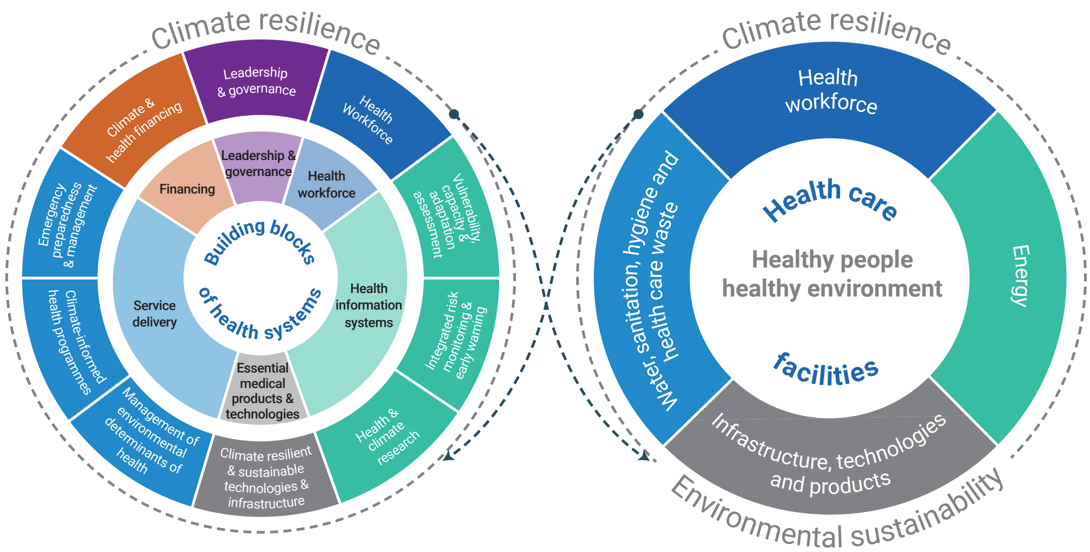
In 2019, only 12 of 47 countries in the WHO Africa region reported having medium-to-high levels of multi-hazard preparedness and capacity for a national health emergency, as reported under the International Health Regulations.[22]

Photo: Leonie Broekstra/Shutterstock

Climate-resilient and environmentally sustainable health systems

Figure 5 shows the components of climate-resilient health systems, and on the right, the components of climate-resilient and environmentally sustainable healthcare facilities. There are six building blocks of health systems shown in the center of the left circle; implementing strategies, policies, and measures shown in the ten surrounding components can build climate-resilient health systems. The right figure shows the components of healthcare facilities where strengthening can build resilience and sustainability.

Figure 5: Components of climate-resilient and environmentally sustainable healthcare facilities



Source: World Health Organization (2021)

Becoming resilient to today's disasters is a step towards making health systems better adapted to climate change. The interlinkages with emergency response systems and infrastructure planning are equally important.

These principles are designed not only for climate disasters, but also to support health systems respond better to a wide range of shocks and stresses. Table 1 summarizes these pillars and recommendations for government action.[23]

Table 1: Five pillars of resilient health systems and associated priority actions

Resilience in Health Systems	Objectives	Examples of policy actions
Resilient health facilities	Enhanced capacity and resilience of facilities by:	• Understanding climate risks today and in the future • Upgrading structures to withstand climate shocks • Enhancing staff capacity to deal with climate shocks and emergencies • Preparing crisis protocols, business contingency plans, and emergency stocks of essential supplies
Resilient health systems	Integrate individual health facilities into a coordinated network by:	• Using data-driven decision-making process to optimize resources during climate shocks • Improving communication and cooperation between diverse entities of health system • Leveraging facilities outside the health system to delivery emergency services • Deploying mobile clinics to underserved and disaster-hit areas to boost capacity during crisis
Integrated emergency response	Integrate health care into climate shock response systems by:	• Coordinating closely with search and rescue agencies to manage health needs • Establishing inter-agency communication channels and coordination before climate shocks • Clearly defining roles and mandates for crisis response • Enhancing early warning systems and disseminating information to the health system • Integrating health system needs in climate risk finance strategies
Resilient infrastructure	Ensure resilience of critical infrastructure systems on which health facilities depend by:	• Upgrading transport, water, electricity, and telecommunications assets vulnerable to climate shocks, especially those needed for health systems operations • Identifying redundancy in infrastructure assets • Leveraging new technologies for service and supply delivery

Source: Adapted from World Bank (2021), *Frontlines*

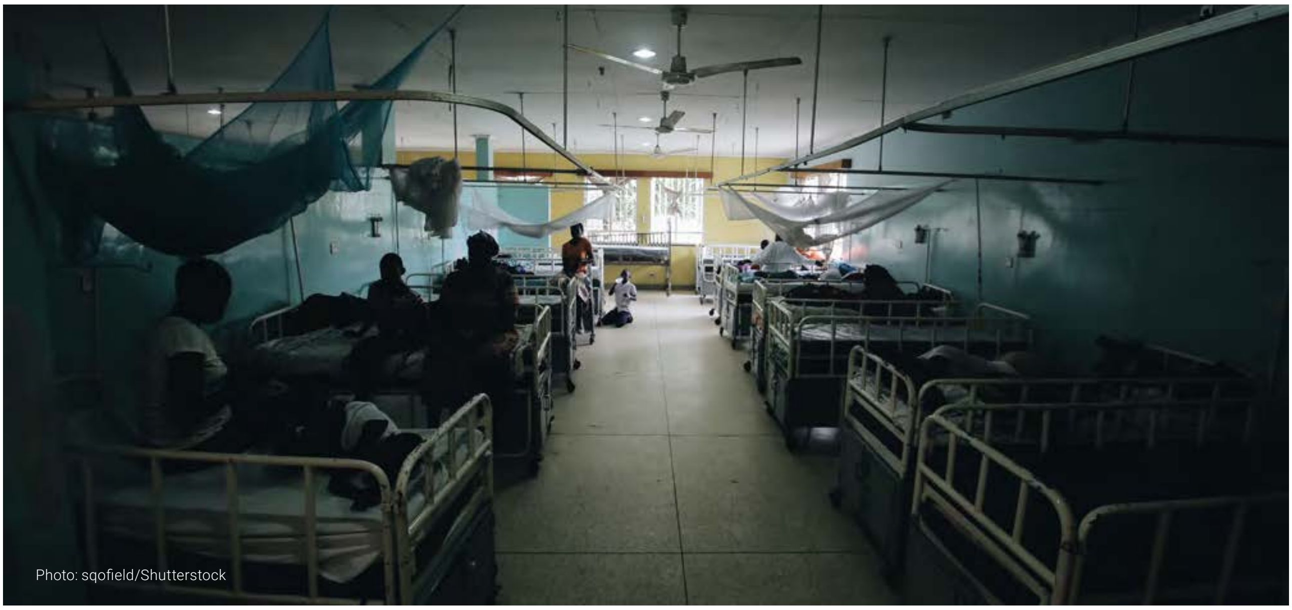


Photo: sqofield/Shutterstock

Capacity building of climate adaptation in health systems in Africa

The importance of coordination of health and environment (including climate change) institutions and programs in Africa has received increased attention in Africa in the last decade. The 2008 Libreville Declaration on Health and Environment in Africa, signed by African ministers responsible for health and environment,[24] calls for the development of frameworks to address the environmental impacts more effectively on health, and for stronger capacities to prevent environment-related health problems. A second interministerial conference on health and environment was held in Luanda, Angola, in 2010. A self-assessment for the third such conference in 2018 indicated that while progress has been made, only nine countries implemented at least 10 of the 11 priority actions of the Libreville Declaration, with the pace remaining slow or uneven for many countries. It was concluded that there is a need for more harmonized national tools for monitoring and evaluation of intersectoral health and environment projects; for increased capacity building and technical assistance, especially in areas of risk analysis and research; for a more integrated functional health-environment surveillance system; and for increased allocation of funds to the health and environment sectors for the implementation of joint activities.

The WHO is supporting countries in Africa to build climate-resilient health systems and to track national progress in protecting health from climate change. Recent examples from 2020 include the implementation in Tanzania and Malawi of the "Global Framework for Climate Services Adaptation Programme in Africa"; the implementation in Mozambique, Malawi, and Ethiopia of the "Delivering Climate-Resilient Water and Sanitation in Africa and Asia" program; support of the WHO Ghana country office for strengthening climate change and health interventions;[25] and a rapid assessment of health facilities in Zimbabwe of readiness to deal with climate change-induced drought and subsequent undernutrition.[26]

There is a need for larger investment programs to mainstream adaptation in health systems in Africa. The few projects under implementation typically focus on:

- Service delivery, including climate-informed health policies and programs; management of the environmental determinants of health; and emergency preparedness and management.
- Health information systems, including health and climate research; integrated risk monitoring and early warning; and vulnerability, capacity, and adaptation assessments.

The projects include key enabling conditions, including leadership and governance, and a health force with training and capacity to manage changing risks.[27]

Finally, adaptation projects that enable community engagement in developing and piloting interventions can facilitate health-promoting environments to prevent climate-sensitive diseases. This include establishing community-level knowledge exchanges, and developing participatory monitoring, evaluation, and learning.

Climate-informed advisory services and early warning systems

A critical component of adaptation action in health systems is climate-informed advisory and management services. These services include early warning and response systems for climate-sensitive infectious diseases, such as malaria, dengue fever, Rift Valley fever, and schistosomiasis, among others.

Early warning systems based on temperature, precipitation, and other environmental data provide an opportunity for early detection, leading to early action and response to potential pathogen threats.[28] Improving the timing and confidence of seasonal climate forecasting, coupled with knowledge of exposure-response relationships, can identify prior conditions conducive to disease outbreaks weeks to months in advance of outbreaks. This information could then be used by public health professionals to improve surveillance in the most likely areas for threats. Early warning systems are more effective and have higher uptake when developed in collaboration with vulnerable populations and communities.

Developing and deploying early warning and response systems at scale can effectively reduce the burden of some infectious diseases and of heat-related morbidity and mortality. The high correlation between precipitation and malaria in rainforest and mangrove zones can be combined with seasonal to sub-seasonal forecasts to create early warning and response systems to protect vulnerable populations. Such early warnings were shown to be skillful at regional and local scales in Uganda up to four months ahead of an outbreak, providing time for health authorities to put into place preventive measures.[29] Longer-term evaluation is needed, as is research to identify how to most effectively modify current early warning systems to maintain their relevance in a changing climate.

The collaboration between ministries of health and national meteorological and hydrological services is essential for the development and effective operation of climate-informed advisory services and early warning systems. The World Meteorological Organization reports that out of the 86 member states that reported such collaborations, 19 were from the African region.[30]

Health and Africa at the UNFCCC COP26

In May 2021, the African Regional Consultation on Climate Change and Health was co-organized by HQ and Global Climate and Health Alliance (GCHA), and co-chaired and facilitated by the WHO Regional Office for Africa (WHO-AFRO). The aim of the Regional Consultation was to bring together important health leaders of the Africa region to further work on growing and enhancing health action for climate. The Consultation was designed to generate country- and region-specific feedback on climate-health priorities, and opportunities to inform global advocacy efforts and advance the process of integrating health messaging into all COP26 priority areas.

In the frames of the Regional Consultation, specific case studies on climate change and health have been presented to showcase the important climate change and health initiatives undertaken in the region. Specifically, climate change and health case studies were prepared from São Tomé & Principe, Mozambique, Ethiopia, and Ghana. Other countries, including Malawi, Kenya, South Africa, and Zimbabwe are preparing additional case studies to feed into a special COP26 Health Report to be presented during the UNFCCC COP26 in Glasgow.

CONCLUSION

Africa is presently confronted with a huge and complex health care challenge, with its current health care capacity and coverage grossly inadequate to meet the needs of a rapidly growing population. The looming impacts of climate change could therefore have a very disruptive impact on its long-term health care picture. This chapter shows how climate change can exacerbate some kinds of disease linked to warmer climates and extreme weather events, disproportionately affecting the most poor and vulnerable sections of the population. In such a scenario, efforts to apply the insights and strategies of a well-thought-out and systematic climate adaptation strategy can go a long way in forming a strong line of defense against the health impacts that will almost inevitably accompany a warming climate. There is a need for larger investment programs to mainstream adaptation in health systems in Africa, and for thoughtful leadership and governance to ensure that such investment is directed towards adaptation projects that prioritize climate-informed health advisory services and community engagement.

“Climate change is a common threat and severe challenge faced by humanity (...) We must raise the importance of adaptation to be at the same level as mitigation.”

Huang Runqiu, Minister of Ecology and Environment, People's Republic of China
High-Level Dialogue “An adaptation acceleration imperative for COP26”, September, 2021


Photo: Dietmar Rauscher/Shutterstock

Photo: R. Bociaga/Shutterstock

Strengthening Public Health Surveillance and Early Warning System Capacity

Geography: Ethiopia

Adaptation measures: The project has focused on strengthening health surveillance systems with climate and weather data, improving management of groundwater resources, mainstreaming climate resilience measures in national WASH programs, building the capacity of health surveillance professionals and water managers and formulating norms and standards to improve access to water and sanitation during extreme weather events.

Key outcomes: The project goals are to develop resilient water and sanitation services and ensure that health surveillance systems are effective in assessing future risks, as well as to help in mainstreaming adaptive planning for public health amid climate change.

Partners and funding: World Health Organization; Government of Ethiopia; Ministry of Health; Ministry of Water, Irrigation and Energy ; National Meteorology Agency; Water Development Commission; National Disaster Risk Management Commission; Ministry of Agriculture; Environment, Forest and Climate Change Commission; Ethiopian Public Health Institute; United Kingdom's Department for International Development (DFID). 2018-2022.

PROJECT SUMMARY

Climate impacts on health may be the result of direct causes like heat stress and weather-related extreme events or of indirect causes such as incidence of infectious diseases, water scarcity and impacts on health infrastructure.[31]

Climate change has created conditions that are increasingly conducive to the transmission of numerous infectious diseases.[32] Anecdotal evidence from Ethiopia reveals a high burden of morbidity and mortality linked to water-, food- and vector-borne diseases and therefore to climate change.[33] Studies have identified malaria, yellow fever and dengue fever, meningitis, leishmaniasis and diarrheal diseases as some of the most common climate-sensitive diseases.[34]

The effects of climate change in Ethiopia are expected to cause an increase in temperature between 1.2 and 2.6^{0}C by 2040-2059;[35] greater variability in precipitation, with a decline of up to 20 percent in summer and spring rainfall in the southern, central and northern regions; and higher frequency and magnitude of extreme events, particularly droughts.[36] Nearly 25 percent of Ethiopia's population (27 million people) lives in areas of high-water stress, with only 13 percent of the population (14.5 million) having access to safely managed drinking water and only 7 percent (7.8 million) having access to safely managed sanitation services.[37,38] The risks to the water supply will be exacerbated by recurrent droughts, the effects of which will be continually compounded by increasing demand and watershed degradation. These factors will affect the reliability, quality and quantity of water available, disrupting the vulnerable population's access to drinking water and sanitation services and resulting in compromised personal hygiene.

Cholera and acute watery diarrheal disease in Africa have shown a higher occurrence due to water shortages during dry periods, while diseases like leptospirosis that result from the contamination of water supplies are likely to increase due to more frequent instances of flooding.[39,40] Increasing temperatures are fostering more favorable conditions for the transmission of malaria into the highlands of Ethiopia. While the dynamics of malaria transmission are complicated and control efforts may significantly limit the impact of these temperature changes, studies show a clear softening of the climate barrier to transmission in the Ethiopian highlands, potentially putting more people at risk of malaria outbreak.[41]

In an effort to better monitor the impacts of climate change on health and build resilience in Ethiopia, the WHO launched a project to strengthen the country's public health surveillance and early warning system capacity. This project is part of a broader DFID funded endeavor to deliver climate-resilient water and sanitation in Africa and Asia, which is also targeting Malawi, Mozambique, Bangladesh and Nepal. The program aims to build resilience through two major components. The first of these works to improve disease surveillance systems through an integrative and resource-efficient approach, wherein countries receive support to integrate national health and climate/weather data for better monitoring and surveillance of climate-sensitive diseases. The second component aims to improve the management of water, sanitation and hygiene (WASH) services to make them more resilient to increasing climate variability.

Gender

KEY MESSAGES

- **Women in Africa are heavily reliant on environment-related livelihoods.** They tend to work in the informal economy, and in low value-added activities that reap marginal returns, making them vulnerable to climate change effects.
- **Women remain absent from climate change politics and policymaking.** This is largely because climate change debates have been shaped by stereotypically masculine discourses that work to exclude or alienate women and their concerns in climate change issues. Climate change is widely represented as a techno-scientific problem requiring technical solutions, yet women with expertise continue to be largely sidelined from participating in the development of such solutions. Without women's inputs on climate change policy, climate change could itself become another barrier to gender equality.
- **Women's awareness and agency should be harnessed for gender-responsive and sustainable climate action.** Their unique knowledge, skillsets and perspectives, borne out of how they interact with food systems, technology, and institutions, can improve the effectiveness of climate action.

Photo: Dennis Diatel Photography/iStock

- **Many climate change interventions prioritise productivity at the expense of issues such as gender, social inclusion and equity.** This trend must be checked. For effective assessment of progress towards gender equality in climate action and to adequately report on instruments, robust monitoring and evaluation (M&E) systems, with sex-disaggregated data and sufficient funding support, are a must.

"We have to prioritize the most vulnerable. We know already that climate change disproportionately impacts women and girls, elderly, people with disabilities, and historically marginalized communities."

John Kerry, Special Presidential Envoy for Climate, USA
GCA Ministerial Dialogue on Adaptation Action, January 2021

INTRODUCTION

Climate change and gender inequalities are linked in complex ways. On the one hand, climate change can be a barrier to progress towards gender equality. But equally, gender inequality can exacerbate the effects of climate change. Women and men are not only affected differently by climate change, but they also contribute differently to climate change action. Women and men experience different levels of exposure, vulnerability and resilience to climate risk and climate change impacts because of gender differences in rights, responsibilities, and opportunities. They experience differing vulnerabilities because of differences in workloads, in access to and control over productive assets and resources, and in participation in household decision-making and access to information and technology.[1] Their vulnerability varies not only because of gender, but also ethnicity, religion, class, location and age. Rural women are at high risk of being negatively affected by climate change, due to household responsibilities, increased agricultural work resulting from climate impacts, and male out-migration—with consequences on family nutrition, childcare, and education.[2]

The importance of gender integration in climate action has been appreciated globally, though at a slow pace. There has been a realisation of the importance of the role of women in core climate change sectors, including agriculture, livestock management, energy, disaster risk reduction, forestry, water management, and health.[3] Women make up two-thirds of the world's 600 million small livestock managers.[4] Women's local and environmental knowledge, in addition to their survival strategies, play a major role in recovery and resilience,[5] with women acting as major contributors to adaptation and mitigation in water management, food security, agriculture and fisheries, biodiversity, ecosystem services, health, energy and transportation, human settlements, disaster management, and conflict and security.[6] Particularly at the local level, women's knowledge is a valuable resource for adaptation. For example, in agriculture, women are knowledgeable about sowing seasons, multi-cropping, local crops, trees, herb varieties, wild edible plants, crops suitable to particular climatic conditions, seed selection, seed storage, preparation of biofertilizers, pesticides, manure application, pest management, post-harvest processing, and value addition.[7]

UNPACKING GENDER DIFFERENCES IN CLIMATE CHANGE EXPOSURE AND VULNERABILITIES

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, the poorest segments of society are the most vulnerable to climate change, with poverty being a key determinant of vulnerability for several reasons, principally access to resources to allow coping with extreme weather events and marginalization from decision-making and social security.[8] For men and women, vulnerability to climate change can be a result of gender roles and gendered differences in responsibilities, time-use patterns, and access to and control over land, money, information, credit, inputs and tools, household labour, good health, education, agricultural extension, markets, household entitlements, food security, secure housing, and freedom from violence, all of which are not readily accessible to women.[9] Social norms compound these constraints by restricting women's freedom of movement, choice, and voice.

Water, energy, and food shortages, caused in part by climate change, result in time-consuming labour as well as increased costs on the part of women and girls as they must travel further and pay more to collect these resources. In rural Mali, for example, water scarcity is a growing challenge for women who are responsible for fetching it. The cost of water during the dry season in these areas is 20–40 times more expensive than water in Mali's major cities. Case studies from Ghana and Uganda show that one of the most significant social impacts of environmental stress in farming systems is the intensification of women's workloads and the decreases in the assets of poor households.[10] This indicates that climate change effects on local environments will add additional burdens to women's time. The adverse effects of climate change have also resulted in an increase in climate-induced migration, leading to some men moving to urban centres to pursue better incomes. In turn, women take up leading roles in rural agriculture, resulting in the feminization of agriculture and additional familial responsibilities left to rural women.

In Mozambique, Malawi, and Zimbabwe, of the almost two million people affected by Cyclone Idai in March 2019, close to 75,000 pregnant women were left vulnerable owing to lack of reproductive health services, sanitation and clean water. Within the camps set up by aid agencies and at host families, women and adolescent girls traditionally entrusted with care and domestic work took on additional responsibilities during the crisis, figuring out where to get clean water and find firewood for cooking. Women and girls queued for long hours to receive food aid to ensure families had food. Owing to their gender roles, women spend a significant amount of time ensuring that other members in their household, including men, children, and the elderly, are adequately and properly nourished. When climate change leads to shortages of food, cultural norms may lead to greater malnutrition among girls and women. For example, women are expected to eat only once they have fed their families, which affects the share of food they receive.[11]

The increase in time allotted to domestic activities limits the time women and girls have to engage in public decision-making, attend meetings, develop and incorporate income-generating strategies into their households, and take part in education and community activities. This further restricts their opportunities for empowerment or strategic change. In relation to property ownership, a 2018 World Bank working paper on gender gaps in property ownership in Sub-Saharan Africa reveals that 13 percent of women claim sole ownership to land, compared to 36 percent of men.[12] The gap narrows when joint ownership is included.

Table 1: Property ownership in Sub-Saharan Africa

	Type of ownership	Ownership					
		Rate in percent			Number of people in millions		
		Female	Male	Gap	Female	Male	Gap
Land	Sole	13.1	36	22.9	21.8	60	38.1
	Sole and joint	37.8	50.6	12.8	63.2	84.2	21
Housing	Sole	12.9	39.2	26.2	21.6	65.3	43.6
	Sole and joint	43.1	55.0	11.9	72.1	91.6	19.5

Source: Africa-wide explorations based on Demographic and Health Survey data for 27 (land) and 28 (housing) countries from 2010–2016

Photo: zeljkosantrac/iStock

Only 15 percent of land in this region is managed by women. The Sub-Saharan average of 15 percent masks wide variations, from fewer than 5 percent in Mali to over 30 percent in Botswana and Malawi. Women's lack of property and land tenure rights often forces them to work on less productive land, makes them less likely to be reached by extension agents, and results in a lack of access to climate change information as well as inputs that might enable them to diversify their livelihoods and increase their resilience to climate-related shocks.[13] Statistics show that in Africa, women receive seven percent of agricultural extension services and less than ten percent of credit offered to small-scale farmers.[14]

The evidence reviewed for this GCA analysis shows that women in Ghana, Burkina Faso, the Gambia and Kenya are much less likely to use purchased inputs such as fertilizers and improved seeds or to make use of mechanical tools and equipment,[15] making them vulnerable to climate change effects such as extreme weather conditions. In Ghana, for example, 39 percent of female farmers adopted improved crop varieties compared with 59 percent of male farmers. Relatedly, men have better access to climate and weather information than women, implying better adaptive capacity.[16] Also, the gender digital gap in mobile phone ownership and internet use, as well as other information and communications technology (ICT), is significant in Sub-Saharan Africa and exposes women to vulnerability to climate change. According to the 2021 Mobile Gender Gap Report, the mobile ownership rate (a person having sole or main use of the mobile phone) for women in Sub-Saharan Africa is 75 percent and the gender gap (how less likely a woman is to own a mobile phone than a man) in mobile ownership is 13 percent.[17] Data on mobile ownership and mobile internet use in selected countries (See Table 2) shows what is what is typical of countries in Sub-Saharan Africa.

The gender gap in access to productive resources shapes climate change impacts on men and women and how they can respond to the those impacts. Women's limited access to productive assets and services compromises their adaptive capacity. It means that they cannot access credit to finance climate-smart agriculture innovations and have little access to services that could help facilitate investments to obtain new technologies, improve their natural resource management practices, or adopt more efficient and productive cropping and livestock management practices, all of which could help them address the degradation of natural resources and build their resilience to climate change and recover from shocks.[18]

The COVID-19 crisis poses additional risks to women in general due to high exposure to the coronavirus pandemic, partly because they predominate (representing approximately 70 percent)[19] in the global health and social sector workforce. African women are largely dependent on natural resources, agriculture and other climate-sensitive sectors, and are more vulnerable to the economic and

Table 2: Mobile phone ownership and internet use in Sub-Saharan Africa

Country	Mobile ownership			Mobile internet use		
	Male	Female	Gender gap	Male	Female	Gender gap
Algeria	91%	86%	5%	63%	58%	8%
Kenya	92%	86%	7%	56%	32%	42%
Mozambique	64%	47%	27%	28%	18%	36%
Nigeria	89%	86%	4%	56%	40%	29%

Source: Mobile Gender Gap Report (2021)
Note: The gender gap in mobile phone ownership and mobile internet usage refers to how much less likely a woman is to own a mobile, or to use mobile internet, than a man.

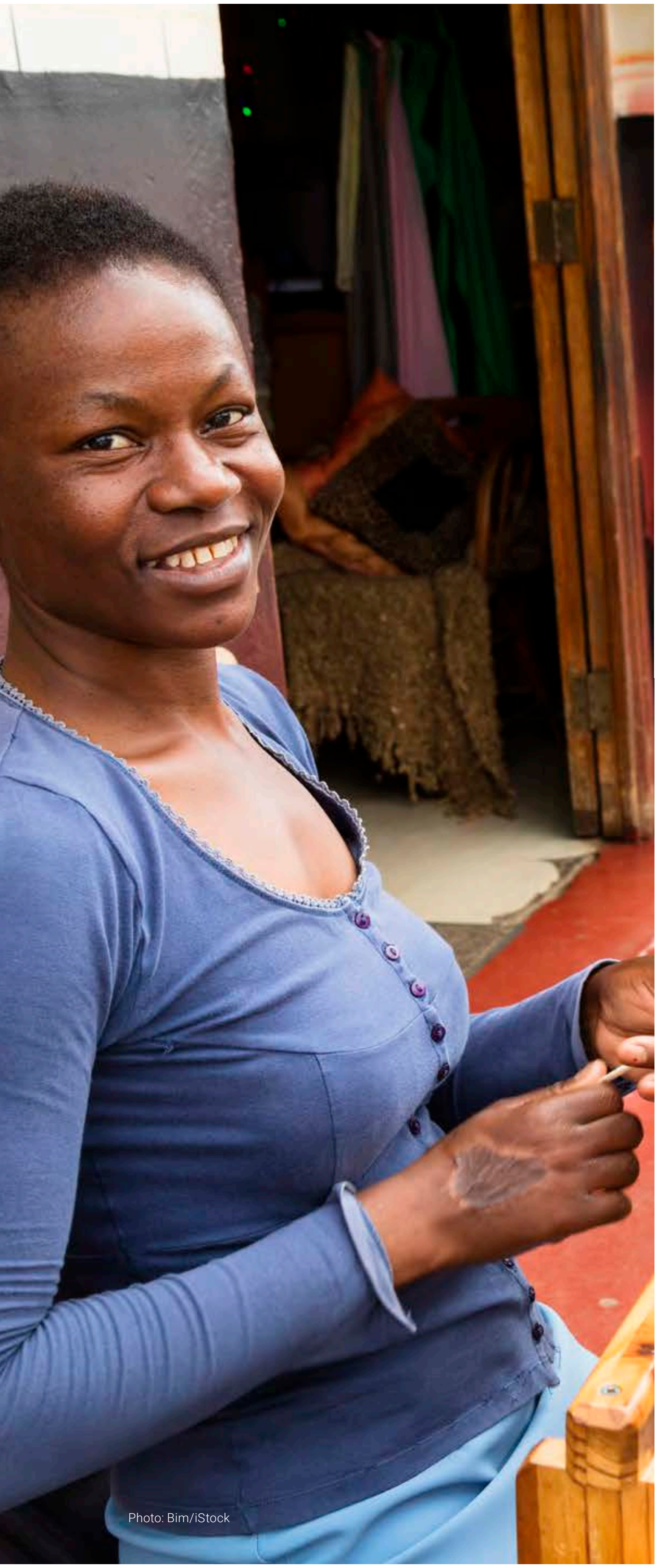


Photo: Bim/iStock

social consequences of the crisis. The pandemic has clearly led to aggravated gender-differentiated impacts, exposing women to poverty and inequalities and threatening their wellbeing, and so it needs to be viewed with a gender-responsive lens.[20]

The state of infrastructure and technology, ecosystem degradation, and multifaceted disasters and conflicts places Africa at high risk to projected climate change.[21] Women in the continent are heavily reliant on environment-related livelihoods and tend to work in the informal economy in low value-added activities that reap marginal returns, making them vulnerable to climate change effects. It is however important to point out that the knowledge and skills in managing natural resources that women have acquired historically in their various gender roles are essential for effective mitigation and adaptation policies. They have also been agents in dealing with climate change.

“My proposal is that we join forces (...) and design a high impact investment facility that focuses on supporting brilliant ideas from entrepreneurs fighting climate change and providing ideas for adaptation.”

Karin Isaksson, Managing Director, Nordic Development Fund
Leader's Dialogue on the Africa Covid-Climate Emergency,
April, 2021

BARRIERS TO RESOLVING INEQUALITIES

Barriers to resolving gender inequalities in climate change mitigation and adaptation processes continue to persist and still need to be addressed. Women remain absent from climate change politics and policymaking. This is largely because climate change debates have been shaped by stereotypically masculine discourses that work to exclude or alienate women and their concerns in climate change issues.[22] Women are underrepresented in climate change decision-making, as their participation is low in all spheres of climate change governance.[23] As a result, women often feel like they cannot enter climate change discussions, although it is an issue that women in general care about.[24] A worrying reality around the world is that some women with expertise in climate change management and authority on environmental protection are alienated from the dominant issues and solutions on climate change.[25] Climate change is widely represented as a techno-scientific problem requiring technical solutions, yet women with expertise continue to be sidelined from participating in the development of such solutions.[26]

Although initiatives to involve women in decision-making have been put in place, mostly in the form of policy in land management, desertification, and climate decision-making processes, their voices are not yet equally represented,[27] particularly voices from African women. This means their limited input into climate change policies and programmes is a concerning gap. In 2012, during the UN Climate Change Conference (COP 18) in Qatar, parties to the conference reaffirmed the urgent need to ensure gender balance in all aspects of negotiations and decision-making, including national delegations to climate conferences. Achieving this is still a challenge. Although, over the past 25 years, Sub-Saharan Africa has registered a modest increase in the proportion of women in political decision-making from 9.8 percent in 1995 to 24.7 percent in 2020, only four countries have passed the 40 percent mark, namely Rwanda, 63 percent; Namibia, 43.3 percent; Senegal, 43 percent; and Mozambique, 41 percent. Women's representation in half of the African countries as of 2020 was still below 20 percent. The number of women appointed in cabinets is generally low despite the policymaking power of cabinets. Only eleven countries reached the 30 percent mark in 2019, with Rwanda and South Africa reaching parity, at 52 percent and 50 percent respectively. The cabinets of more than half the countries (31) have a female representation of less than 20 percent.[28] The number of women attending intersessional and Conference of the Parties (COP) meetings remains at below 40 percent.

To increase the effectiveness of climate action, both men and women should participate in and contribute to climate decision-making, policy formulation and implementation action. Meaningful participation by women in decision-making around climate change requires more than the presence of women in climate change institutions and processes. It also requires attention to the deep-rooted sociocultural inequalities that can act as constraints to women's real inclusion and prevent them from participating equally in these processes. These constraints include economic dependency and lack of adequate financial resources, illiteracy and limited access to education, lack of information, lack of the same work opportunities as men, and time poverty.[29] All these issues need to be addressed if the barriers to women's inclusion are to be overcome.

Women's associations can play a major role in fostering the development of gender-responsive policies. An example is that of the Soulaliyat women from Kenitra province of Morocco, whose initiative to claim their rights to land access resulted in a circular issued by the Ministry of the Interior urging provincial authorities to ensure that the principles of gender equality are upheld in the transfer of communal land.[30] The Women Environmental Programme in Nigeria played an integral role in facilitating a National Action Plan on Gender and Climate Change, which is currently under review.[31] Women's agency should therefore be harnessed for gender-responsive and sustainable climate action. Their unique knowledge, skillsets and perspectives borne out of how they interact with food systems, technology, and institutions can improve the effectiveness of climate action.

Promoting women's voice in policy, planning and implementation needs to be supported by funding. Building on the good progress being made with the Green Climate Fund Gender Policy and Action Plan, further work is needed to prioritise funding for grassroots and women organisations to empower local civil society and to complement the large financing mechanisms. The implementation of gender actions in projects requires dedicated funding; hence it is a good practice to allocate a sufficient budget for the project to support activities promoting gender equality.[32] If the funds are not allocated or the implementing project does not have funds to implement specific actions, the gender mainstreaming process will be adversely impacted and delayed. This is the case in most African countries.[33]

Where gender-sensitive policies to climate change exist, effective implementation in practice has not been achieved on the ground due to the lack of technical capacity, added to lack of understanding of structural gender inequalities.[34] There is lack of capacity in governments and other agencies for gender mainstreaming in general and to undertake gender analysis and gender-responsive budgeting for climate action, calling for more gender and climate change experts and capacity development of stakeholders. In addition, gender issues in general and within climate action in particular are treated as cross-cutting rather than standalone issues that deserve serious attention. As a result, the issues are lost or diluted along the way. A review of NDCs found that many of these documents identify gender as a cross-cutting policy priority or commit to mainstreaming gender but do not articulate specific strategies or actions.

Although there are progressive laws at both global and local levels for the promotion of gender equality and women's empowerment, these are not harnessed effectively in climate change adaptation planning and implementation. Hence the notion of policy evaporation. Gender-sensitive climate policy instruments in some countries inform NDC priorities and actions, but few countries include gender outcomes in monitoring. Most NDCs do not address structural causes of gender inequalities and mentions of gender in many tend to be brief. Only 10 countries have developed gender and climate change plans (GCAPs) in the last few years: Bangladesh, Cambodia, Haiti, Kenya, Mozambique, Nigeria, Panama, Peru, Tanzania and Zambia. Half of these countries are in Africa.[35]

Furthermore, synergies and coherence among stakeholders such as Ministries of Agriculture, Climate, Environment, Water, Land and Gender at national and subnational levels are often notably absent.

There is also a gap on the documentation of best practices as well as statistical infrastructure to better understand gender-differentiated climate impacts and inform policy design, planning and implementation. This is accentuated by a lack of sharing platforms to promote learning.

Many climate change interventions prioritise productivity at the expense of issues such as gender, social inclusion and equity. For effective assessment of progress towards gender equality in climate action and to adequately report on instruments, well-structured and robust monitoring and evaluation (M&E) systems, with sex-disaggregated data and sufficient funding support, are a must. M&E systems generate key lessons and provide evidence of progress which can then inform the strategic direction of a country's gender mainstreaming initiatives. To put it simply, if an initiative is not being measured or assessed in some way, then progress, or the lack of it, cannot be seen and the matter cannot be managed.

PROVEN, PROMISING AND INNOVATIVE ADAPTATION SOLUTIONS

There is a growing realisation that preparation for and responses to climate change need to be sensitive to gender issues. To this end, there are a number of strategies that can act as proven, promising and innovative adaptation solutions that take into account women's and men's respective capacities, power, social resilience, vulnerabilities, and resources as a consequence of gender norms, roles and relations.[36] Some of the most interesting examples that emerged in this GCA analysis include:

Use of gender analysis tools to optimise gender-responsive adaptation in Mali

The International Fund for Agricultural Development (IFAD) reports how it uses gender-analysis tools to optimise gender-responsive adaptation. Mali was committed to securing agricultural production in a context of increased drought-like conditions, greater heat and lower rainfall. In order to do this in a gender-responsive way, the Fostering Agricultural Productivity Project used participatory approaches to identify, document and understand differences in women's and men's knowledge, their respective vulnerabilities, and their existing capacities for adaptation. This step was critical to developing effective, well-targeted interventions. The process allowed men and women to assess their situation and vulnerability to different threats and see how these affected them in different ways because of gender roles, social patterns, and their knowledge about different aspects of environmental management. The process allowed them to develop adaptation plans that involved women and men in areas where their concerns were greatest and where their knowledge and skills could have the best results. Consequently, one of the main gender-related benefits is in allocations of irrigated land, which are now more inclusive of women, supporting improved livelihoods and family food security. The project will also collect and analyse male/female household headship data, sex-disaggregated information on agricultural yields for specific products, and data on producers adopting new technologies. Further, it will track the numbers of women benefiting from specific subprojects, including newly irrigated land areas.

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Climate change gender action plans in Liberia

The aim of Liberia's Climate Change Gender Action Plan (ccGAP) is to ensure that national climate change strategies and programs are gender-responsive across sectors. The ccGAP therefore ensures that as policies are developed and planning is undertaken, governments align their climate change priorities and other national policies to address gender considerations. The overarching objective was to ensure that gender equality is mainstreamed into the country's climate change policies, programs, and interventions so that both men and women have equal opportunities to implement and benefit from mitigation and adaptation initiatives in combating climate change and positively impact on the goal of "Liberia Rising 2030". Agriculture, coasts, forestry, health, water and sanitation, and energy were the sectors covered by the plan. Drawing from the Liberia Priority sector, much focus was put on coastal erosion, which greatly impacts the livelihoods of the surrounding population. It is estimated that 230,000 people are at risk and 2,150 km of coastline will be significantly affected by a 1-meter sea level rise, including land and infrastructure in much of the capital Monrovia, valued at $250 million. Liberia's ccGAP therefore includes actions in the coastal sector with the objective to implement a robust gender-balanced monitoring system in coastal zones with concrete activities and quantifiable indicators of output. For example, this includes consultation with stakeholders in the selection of gender-balanced coastal monitoring indicators and the number of women trained in coastal monitoring. To address the lack of human resources in collecting observed climate data, various women's associations assisted the meteorological services by collecting this information when provided with mobile phones.

Generation of and use of evidence

In 2020, the African Development Bank conducted a gender-climate hotspot analysis at the continental level in Africa. This analysis examined gender-agriculture-climate change impact hotspots for both adaptation and mitigation in agriculture by mapping women's participation in agriculture (the percentage of women employed in the agriculture sector by country), climate risk in agriculture (the percentage of land under various climatic risks), agricultural emissions (percentage of emissions contributed by agriculture sector) and the Gender Inequality Index (GII). The study revealed geographical and thematic areas where gender and climate gaps exist and proposed some measures to address the vulnerabilities. The study showed how differences between countries in a region could provide insights into policies or programs that allow for the development of effective climate change strategies at national and subnational levels.

Innovative financing

In Uganda, the Centenary Bank of Uganda provides financial services to more than 1.4 million clients, with a focus on microfinance.[37] In 2013, it developed an agricultural finance department and, by 2017, introduced a new initiative to provide preferential interest rates on loans for farmers who buy climate-resilient seeds and/or irrigation kits.[38] One of the project goals was to incentivize climate risk management and climate change adaptation actions for local farmers, especially women. For the initiative, the Bank partnered with a domestic seed company and a company with expertise in irrigation technologies. Although established before Uganda's draft National Adaptation Plan (NAP) document, the Centenary Bank scheme aligns with its identified priority actions, especially as they pertain to climate-resilient crops and strengthened irrigation farming.[39] The NAP process provides a basis to support these initial efforts by Centenary Bank and will contribute to the further scaling up of the initiative. By facilitating direct financing to farmers in Uganda, the initiative will contribute to Uganda's NAP process and adaptation efforts.

Afforestation

In Rwanda, UNDP supported the women's group Twiyubake Turengara Ibidukikije (Empowering Ourselves in order to protect the Environment) in 2008 for a bamboo-growing project. The women used the grant to plant 60 hectares of bamboo trees for use in making furniture, baskets and handicrafts. Besides offsetting GHG emissions, the project is reducing deforestation and erosion in the Nyungwe Forest National Park and offers women a stable income of between $10 and $200 per month.

POLICY RECOMMENDATIONS

It is crucial to have women represented in decision-making at all levels in order to be able to influence innovative, sustainable solutions to climatic challenges. Gender balance in national delegations to the UNFCCC should be encouraged and women supported to maximize their voice, confidence and negotiation skills while 'at the table'. Where women are excluded from governance, decision-making processes are more likely to result in policies that ignore the unique needs, knowledge, and contributions of women. Currently, women's representation in different structures is limited due to various socioeconomic and cultural issues. To create and foster an enabling environment, it is essential, in addition to strengthening their skills and their decision-making ability, to promote women's access to knowledge related to climate change across all the relevant sectors. This capacity-building would enable them to develop sustainable climate resilience practices and promote gender-sensitive development sector projects. More funding at grassroots level will help empower women. Relatedly, gender and climate policies and practice need to be strengthened in climate funding instruments at all levels.

It is essential to develop tools/methodologies/guidelines and indicators for the monitoring, reporting and verification of the development and implementation of gender-responsive climate policies and strategies in Africa to facilitate tracking of progress in this area. Data collection tools such as the Women's Empowerment in Agriculture Index (WEAI) and the Gender Empowerment Index for Climate-Smart Agriculture (GEI-CSA) provide a good starting point to measure the impact of climate interventions on women and men and address areas of disempowerment.[40]

Governments need support to build their capacity to integrate gender into national adaptation and mitigation plans, NDCs, and into sectoral plans and programs through training in gender-responsive policy analysis, policy development, planning, budgeting, implementation, monitoring and evaluation. In addition, there is need to strengthen the capacity of farmers' groups for gender-responsive service delivery in the face of climate change, for example through access to resources and services such as land, fertilizers, seeds, and markets.

We need more predictable and concessionary climate finance as well as innovative financing mechanisms and instruments that engage more partners and crowdsource for adaptation."

Rola Dashti, Executive Secretary, UNESCWA


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Conflict and migration

▶ KEY MESSAGES

- **Currently, 26 out of the 54 African countries which are highly vulnerable to climate change are considered fragile or extremely fragile.** Out of the ten most vulnerable countries to climate change, eight are in Africa, and six are currently facing armed conflict.
- **Climate and environmental change are never the sole causes of conflict and migration.** Instead, they interact in complex and context-dependent ways. However, people living in conflict-prone settings are highly vulnerable to climate change.
- **A substantial set of studies focuses on how, w hen and under what conditions climate change can translate into conflict.** Some countries are more vulnerable to climate-related conflict than others if they experience ethnic fragmentation, high dependence on rainfed agriculture, low human development levels, and political and economic marginalization. Mediating factors such governance and institutions, adaptive capacity, and existing vulnerabilities also play a significant role in shaping conflict outcomes.

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- **There is limited evidence about the viable role of adaptation and disaster risk reduction (DRR) in conflict settings.** However, there is a consensus that poorly designed adaptation and DRR interventions can compound existing inequalities and exacerbate the risk of conflicts.

"

There is urgent need for Africa to have long-term strategies to guide the transition towards green and climate-resilient economies. This process requires blending our adaptation options and climate change mitigation actions through the implementation of nationally determined contributions."

H.E. President Mnangagwa of Zimbabwe
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

INTRODUCTION

Globally, the link between climate change, conflict and migration is gaining academic and policy salience. For this chapter, GCA conducted a detailed literature review of the connections and pathways between climate change, conflict, and migration.

In 2007, the United Nations Security Council first established the link between climate change and security across policy arenas, recognizing it as a 'risk multiplier' which exacerbates existing vulnerabilities.[1] However, the evidence attesting to the causal link, and to the mechanisms through which climate change may affect conflict and/or migration, remains weak and often contradictory. Whilst research clearly indicates that climate change is not the sole cause of violent conflict or migration, a growing evidence base supports the 'threat multiplier' discourse. Nonetheless, deeper questions in the climate context—such as who is migrating, where, when and more importantly why—remain difficult to answer. Equally difficult questions include those concerning where tensions are likely to escalate to violent conflict, why, and under what climatic conditions.

What has been established so far is that the root causes of migration or conflict are almost never one-dimensional. In the case of violent conflict, they intersect with poverty, unemployment, marginalization, historical legacies, perceptions of injustice, environmental degradation and of course climate change. Given this largely complex and layered context, proposed humanitarian, peacebuilding, conflict resolution, disaster risk reduction, and adaptation and resilience solutions need to take into account the interdependent nature of these factors, or risk deepening existing challenges. This chapter aims to unpack the climate-conflict-migration nexus and the nuanced pathways in which they interact, to better understand the role of climate adaptation and resilience in addressing these risks, as well to identify areas for further research.

This debate is particularly relevant in the African context. Conflict and migration trends have been on the rise in Africa. State and non-state-based armed conflict have steadily increased since 2007.[2] Additionally, Africa is the only continent that witnessed an increase in political violence by state and non-state actors in 2020, even as the pandemic contributed to a slight decrease of conflict in the rest of the world.[3] Increasing inequalities laid bare by COVID-19 appear to have contributed to drivers of conflict, further deepening the 'conflict trap'.[4] Furthermore, the African population is one of the most mobile in the world. Despite COVID-related border closures and travel disruptions hampering mobility in the region, loss of labour and economic instability brought on by the pandemic still forced people to migrate, often by resorting to more dangerous routes.[5] In parallel, negative climate impacts have been multiplying, including rising temperatures, shifting rainfall patterns, and extreme weather events, all of which can influence underlying causes of conflict and migration.

Currently, 26 out of the 54 African countries which are highly vulnerable to climate change are considered fragile or extremely fragile.[6] Out of the ten most vulnerable countries to climate change, eight are located in Africa, and six are currently facing armed conflict. The year 2020 also marked the highest number of internal displacements recorded, the majority of which were located in north and Sub-Saharan Africa.[7] New and repeated displacements were also recorded when conflict overlapped with extreme weather events, triggering an estimated 4.3 million new displacements in Sub-Saharan Africa alone.

While climate change is almost never the sole contributor to these phenomena, a solid understanding of the possible pathways from climate change to conflict and migration can help design focused interventions that are specific in terms of context and location. This chapter aims to elucidate the different mechanisms through which climate change interacts with conflict and migration. It does not cover an exhaustive review of the evidence; instead, it aims to highlight robust empirical findings from the most recent literature, assess as best as possible conflict and migration under different climate pathways, and evaluate the potential role of climate change adaptation and resilience building in addressing these challenges. Assessments of the experience of existing investments and programs in adaptation, conflict and migration in Africa are also excluded from this chapter.

Definitions of key terms

Some definitions of key terms used in this chapter are in order. When talking about *violent conflict* we refer to state-based (where at least one of the actors involved is the state), one-sided (usually involving terrorist groups), or non-state armed conflict. This category does not include inter-state conflict, which usually pertains to tensions regarding transboundary waters. *Migration* refers to seasonal, periodic or permanent mobility, and in this chapter, we distinguish between forced displacement as a result of the rapid onset of extreme weather events (such as floods, storms or cyclones), and migration induced in part by environmental and climate change.[8] The former can be clearly defined in time and space and is usually temporary, whereas the latter can be considered somewhat of a choice. However, we recognize the complexity of this distinction, in line with Kälin and Schrepfer (2012), who write: "voluntary and forced movements often cannot be clearly distinguished in real life but rather constitute two poles of a continuum, with a particularly grey area in the middle, where elements of choice and coercion mingle".[9]

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POLICY CONTEXT: CLIMATE CHANGE, CONFLICT, AND MIGRATION

In our GCA analysis, most recent reviews of the nexus point to conflicting evidence, to methodological differences between studies which make comparisons more difficult, and to a general lack of longitudinal studies which prevent the adequate sampling of climate variables. Frequently, the research literature fails to distinguish between *climate change* and *environmental change/ degradation*, using the terms interchangeably. Here, climate change is considered as a compounding factor which can induce natural disasters, sea-level rise, and changes in land ecosystems which lead to resource scarcity. This includes a spectrum of weather events with a slow or rapid onset and a short or long-term duration. The distinction between 'natural' and 'climate-induced' disasters is often difficult to establish. For this reason, unless stated otherwise, such events will be considered as climate-related in this chapter's discussion.

Several studies recognize that factors such as poor governance and fragility, ethnic fragmentation, community marginalization, the level of economic development, the presence or absence of mediating institutions and others take precedence over climate change as key drivers of conflict. That is to say, research shows that climate change is almost never the sole cause of conflict.[10] The IPCC's latest report, for example, stated with low confidence—due to weak evidence and scientific agreement that climate change and its interaction with land degradation could be a source of conflict in the coming decades.[11] Similarly, through expert elicitation, a study on climate change and armed conflict highlighted that climate variability and/ or change was one of the less influential factors affecting conflict risk, and experts were uncertain about their influence.[12] Additionally, reviews of existing studies highlight that it was impossible to distinguish between the effects of climate variables and socioeconomic and political factors on conflict.[13]

In parallel, there is significant evidence that populations have been migrating for centuries as a coping mechanism in the face of natural resource scarcity.[14] There are currently three main frames linking environmental and climate change to migration.[15] The first type frames environmental and climate-related migration as irregular, posing threats to security in areas of destination, and reinforcing narratives of national border controls. The second frame adopts a more empathetic approach, viewing migration in the context of environmental and climate change as closely associated with the mobility of vulnerable populations who have a right to work and basic services. The third frame views mobility as a form of adaptation to climate-related impacts and risks, including migration, displacement, and planned relocation.[16] Currently migration can be seasonal, periodic or permanent, and can be considered as a successful adaptation strategy when managed carefully. This however will depend largely on the migrants themselves, as well as their community of origin and destination. 'Adaptive' migration differs from traditional nomadic migration. The latter kind usually occurs along well-established corridors, which are approved by local communities. With the rise in resource scarcity and irregular rainfall patterns—some of this attributable to the impacts of climate change—nomadic communities are often forced to resort to other routes, which is increasing communal tensions and conflict.[17]

Against this backdrop, the African Union (AU) has been employing an innovative discourse on climate security risks. Climate change is increasingly becoming a prime policy issue for the AU, which is recognizing the imperative need to collectively address its impacts on socioeconomic development, peace, security and stability. In March 2021, the AU's Peace and Security Council organized the "Sustainable Peace in Africa: Climate Change and its Effects on Peace and Security in the Continent" discussion.[18] It placed particular emphasis on the importance of comprehensively assessing the climate, peace, and security nexus, but also the need to link early warning systems with violent conflict prevention. The Peace and Security Council also reiterated the importance of existing frameworks such as the Johannesburg Declaration on Silencing the Guns in Africa, which recognizes the intersections of climate change and violence through its 'Silencing the Climate Crisis' component.[19] Another relevant framework is the Bamako Declaration on Access to Natural Resources and Conflicts between Communities, which stresses the need to better govern and manage natural resources in a way that minimizes local conflict and communal violence.[20] Of equal significance is the AU's Kampala Convention for the Protection and Assistance of Internally Displaced Persons—a legally binding instrument which has been adopted by 40 member states and, as of February 2020, ratified by 29 of them.[21] Additionally, the AU Commission, along with the International Organization for Migration (IOM), launched their first report on African in October 2020, with a chapter dedicated to environmental degradation, climate change and human mobility, reiterating the importance of this issue.[22] Despite the commitment of African countries to tackle the climate-conflict-migration nexus, actual policy implementation remains limited, and more targeted and effective evidence-based decision-making is warranted to address mounting challenges.


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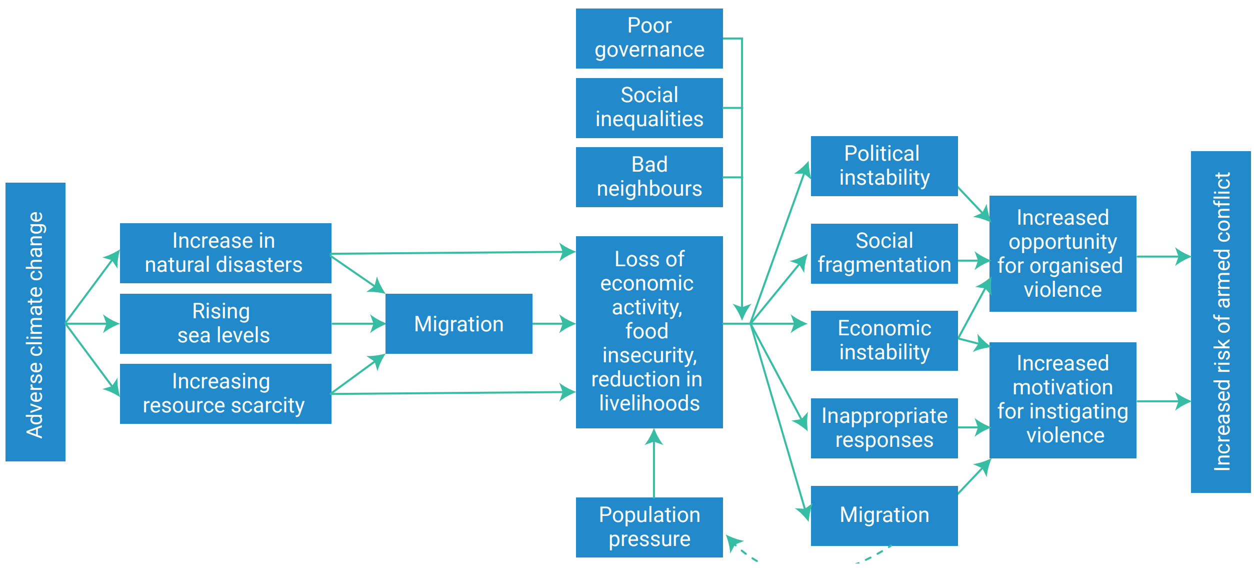
PATHWAYS FROM CLIMATE CHANGE TO CONFLICT

Climate change is an increasing challenge in Africa. In 2020, the continent was plagued with the triple threat of the COVID-19 crisis, escalating conflict, and climate change. Terms such as 'climate wars' started gaining traction in countries like Sudan.[23] Similarly, stark predictions became more prevalent in climate policy narratives, estimating that with each 1°C rise in local temperature, the risk of intergroup conflict increases by more than 10 percent.[24] However, the reality is more complex and fragmented. Conflicts emerge spontaneously from human interactions[25]; but they are a result of a myriad of context-specific and interconnected factors that climate change may or may not exacerbate. In this section, we analyze the pathways connecting climate change and conflict, the role of contextual factors, and the state of the evidence pertaining to this causal link.

Our GCA analysis shows that beyond the streams of research which focus on whether climate change can be a contributing factor to violent outcomes, a substantial literature focuses on how, when and under what conditions climate change can translate into conflict. Throughout these pathways, climate change is hypothesized to exacerbate conflicts through resource scarcity, sea-level rise and increased natural disasters. These can have impacts on livelihoods, food security and migration, and, mediated by external factors such as poor governance, inequalities, and existing competition for resources, they can exacerbate more traditional drivers of conflict. In Africa, the West African Sahel and the Horn of Africa are considered hotspots where these phenomena closely intertwine. Conflicts between herders and farmers are increasingly on the rise as grazing land and natural resources are becoming more precarious.[26] In the Lake Chad Basin, seasonal migrations of pastoralists are leading to a rise in tensions with sedentary farmers as instability and resource scarcity are becoming more pervasive. Loss of livelihoods, coupled with poor governance and military state interventions, gave rise to opportunities for the recruitment of individuals by terrorist groups such as Boko Haram, increasing conflict and instability in the region.However, these events are not linked in a linear fashion, and instead interact in a multifaceted and highly complex way. Figure 1 highlights these major causal pathways.[27]

Figure 1: Causal pathways from climate change to risk of conflict



Source: adapted from Friedrichs, 2014

Studies across the literature have attempted to support this causal pathway with empirical evidence. Although they differ significantly in terms of defining conflict and climate variables, methodological framing, and time and scale of observation, key findings and their implications for programs on conflict and climate change are worth mentioning. In a mixed-methods study, Ide et al. (2020) identify four factors which make countries particularly vulnerable to this nexus: (i) large populations, (ii) political exclusion of some ethnic groups, (iii) a low level of human development and (iv) a high level of dependence on rainfed agriculture.[28] The authors evaluate climate-related disasters with respect to the risk of armed conflict, and highlight that in such vulnerable countries, almost one-third of conflicts have been preceded by a disaster within seven days, over the period 1980–2016. Evidence from eight case studies in which armed conflict escalated within this 7-day window points to improved opportunities for armed groups as the main mechanism connecting disasters and conflict. For example, the 2009 drought in Mali presented an opportunity for Al Qaeda militants based mainly in southern Algeria to recruit fighters and extend their operations into Mali. The authors utilized an evidence coincidence analysis to draw such conclusions. However, when applied at the global level, no conclusive results were reached. There is therefore a variable relation between conflict and disasters which is highly context dependent.

In a similar assessment, a comprehensive report examining the link between climate change and conflict in the Lake Chad Basin concluded the following: "climate change and conflict dynamics interact in a vicious circle, where climate change impacts feed additional pressures and tensions while conflict undermines communities' abilities to cope and adapt".[29] Climate change in the basin interacts with key drivers of conflict, namely livelihood insecurity, weak governance, poverty and underdevelopment, and migration. In this context, the main mechanisms linking climate and conflict were the following: (i) reduced livelihood security, (ii) increased competition for resources, mainly between farmers and herders, (iii) increased opportunity for recruitment by non-state armed groups and (iv) heavy-handed military responses. The latter includes military operations such as "Exercise Cat Race" and "Operation Whirl Stroke"


Photo: Katja Tsvetkova/Shutterstock

launched by regional governments to address the crisis. These interventions, instead of addressing the root causes of the problems, led to further livelihood deterioration.[30] This reduced the adaptive capacity of the population to climate change and further exacerbated the situation. These interactions, often referred to as the 'conflict trap', highlight the dynamics between drivers of conflict and consequent decreased adaptive capacity in a positive feedback loop. This is particularly relevant in fragile contexts, where states usually have weak capacity to manage existing challenges. Communities are thus left in a poorer condition after the experience of such a cycle and are usually less resilient and less equipped to cope with the impacts of climate change.[31]

There is increasing evidence that poorly designed climate adaptation and mitigation measures have the potential to further deepen existing conflict.[32] Indeed, solutions which do not embed a conflict-sensitive lens can have unintended consequences by creating more inequalities and tensions among societies, which could escalate into conflict. Maladaptive interventions have the potential to marginalize particular segments of society, exclude them from essential decision-making, create unfair power structures, or engender job losses and potential land grabs. Thus, conflict sensitivity is an essential lens to be considered when designing climate adaptation interventions, particularly in countries which are more susceptible to the climate-conflict nexus.

A new stream of research examines the interlinkages between climate, conflict and energy. Energy systems can play a contributory role in increasing the risk of conflict, and this role will likely be more prominent in the context of increasing climate change. Disruption of energy flows at the local, national, regional and global scale can increase the risk of conflict.[33] Beyond the geopolitical aspect of energy-conflict risks, energy systems are also the target of sabotage or attacks, particularly by non-state armed groups. Additionally, there is a close link between energy and food security. Restricted energy access and increased energy prices can have significant impacts on overall food security, contributing to drivers of conflict. More empirical evidence is required to examine this nexus, particularly in the African continent, and to understand the specific mechanisms of interaction. This can be achieved by simultaneously tracking conflict, climate and energy databases, and creating models which take into consideration the complex feedback mechanisms between them.

Some caveats are in order, both about the scope of interpretation of the available evidence about climate change, conflict and migration, and about the assumptions underlying such interpretation. So far, the growing policy and academic attention on the climate-migration-conflict nexus has not been matched by a more solid understanding of the linkages between these phenomena. Simplistic assumptions about this nexus have the potential to securitize climate discourses without substantial evidence and could lead to the design of maladaptive solutions which do not address causal roots of these events. Current research on climate change and violent conflict has often faced the "streetlight effect": a sampling bias whereby studies focus primarily on accessible areas where conflict data is readily available, without sampling on independent climate variables.[34] This trend tends to overemphasize the actual link between these two phenomena, and significantly contributes to the securitization of the climate change discourse, particularly in Africa.

Similarly, the majority of the climate and mobility reports tends to also focus on case studies in the Global South with a particular focus on Africa and the Middle East, with the exception of the United States of America.[35] This 'uneven' geography of research cannot be solely attributed to the higher vulnerability of communities in the Global South to climate change. Rather, it falls within a wider discourse which presents climate migration as a security threat to the Global North.[36]

The role of climate change in multiplying risks of conflict and migration should not be undermined. However, stigmatizing the African continent as more 'naturally violent' or stating that mass migration is likely to occur as a direct result of climate change in certain locations only risks reinforcing policies and funding which undermine climate adaptation and sustainable development. The next section will attempt to highlight scientific and evidence-based information to better inform policies regarding the climate-conflict-migration nexus.

Box 1: The Sahel and the Horn of Africa

Photo: mbrand85/Shutterstock

Despite the persistent dissonance on the topic, existing mechanisms under which climate change might lead to violent conflict need to be explored. The Sahel and the Horn of Africa are two particular regions of focus when it comes to the climate-conflict nexus literature. Most of the literature has focused on tensions between farmers and pastoralists over access to land and water, which have then escalated into violence. Through its projects, USAID identified different mechanisms under which climate change can escalate drivers of conflict, each playing out differently in each country and context.[37] The pathways are summarized in Figure 2.

Figure 2: Causal pathways from climate change to conflict risks in the Sahel and the Horn of Africa

Reduced livelihood security

The impacts of climate change, including rising temperatures, persistent droughts, unpredictable rainfall patterns, and disasters such as floods, cyclones and cyclones impact communities' livelihoods and food security through loss of income.

Increased patterns of marginalization and exclusion

Resource competition is often reinforced in countries where poor governance prevails, or where political elites can exploit local struggles while excluding marginalized groups from the decision-making process.

Rise in terrorism and non-state armed groups

High rates of unemployment, a rise in poverty and inequality and the marginalization of communities, particularly in fragile countries, can be conducive to the rise in terrorist and non-state armed groups. Similarly, in areas where violent extremist groups are already present, such as in northeast Nigeria, the recruitment of unemployed youth becomes more prevalent, generating instability and insecurity in the region. This also includes recruitment for organizations involved in organized crime, trafficking and sex work.

Competition over scarce resources

Water and land scarcity exacerbated by the effects of climate change, particularly in countries rooted in ethnic divisions, can lead to tensions. In fragile settings, these tensions can escalate into violence and conflict.

Increased migratory movements

Migration is one possible adaptation strategy in the face of resource scarcity and livelihood insecurity. However, when not managed carefully: (i) migratory movements across borders to neighboring regions or within a country's borders towards neighboring communities can escalate tensions among different ethnic groups, particularly when natural resources are scarce (ii) migration to urban areas could put additional strain on governments to deliver basic services, secure decent housing and job opportunities.

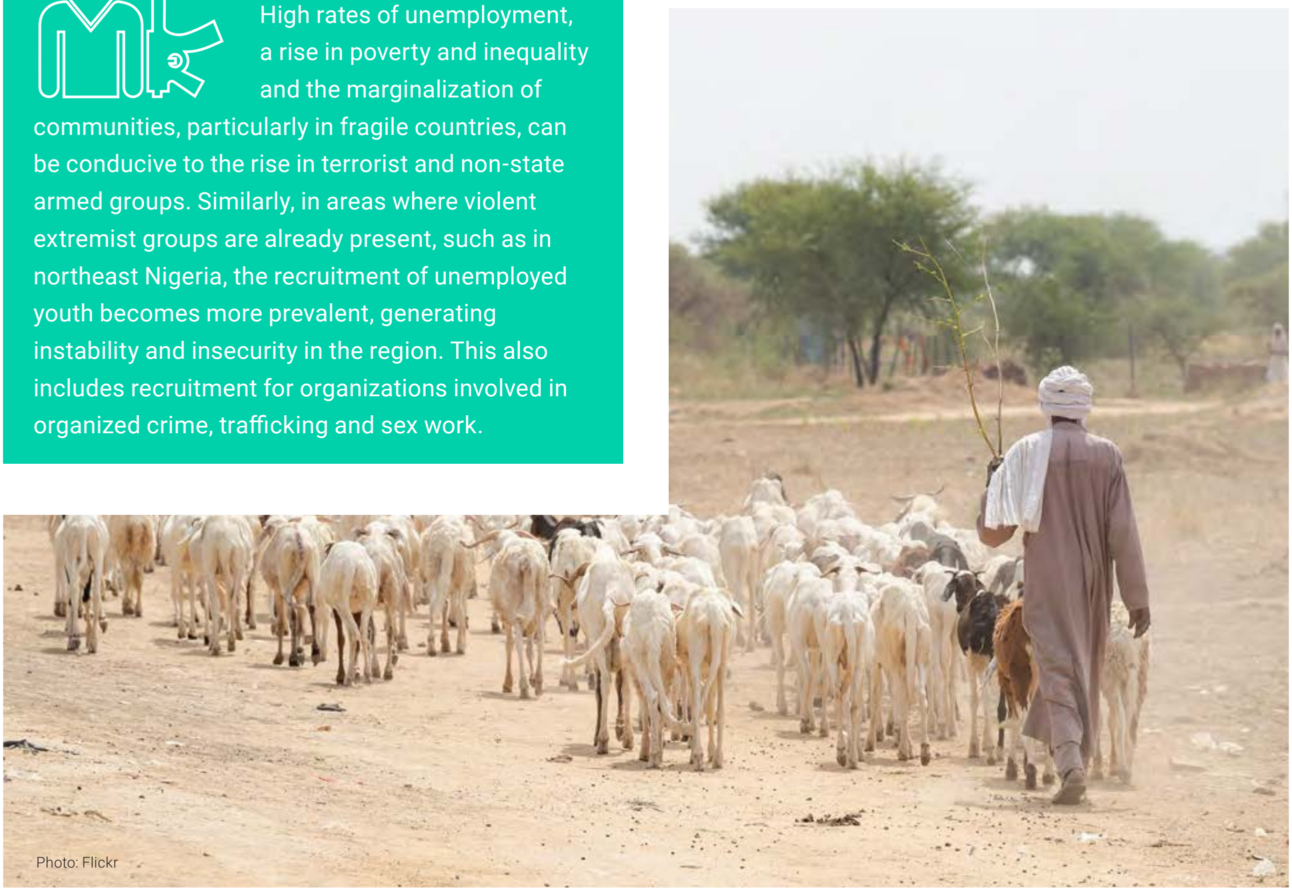


Photo: Flickr

PATHWAYS OF MIGRATION AND CONFLICT

Evidence on the links between climate change, migration, and conflict is also contested and inconclusive, as this GCA analysis shows. The causal link between resource scarcity and mobility, as well as out-migration and the subsequent emergence of conflict in the area of destination, is difficult to establish.[38] This is mainly because migration is driven by multiple factors, and the ways in which migrants might contribute to conflict is not well understood. The possibility and ways in which migration and conflict interact are highly context dependent. Freeman (2017) identifies five pathways linking climate and environmental change, migration and conflict.[39]

In 2021, IDMC's Global Report on Internal Displacement reported that conflict and disasters triggered 40.5 million new internal displacements in 2020 across 149 countries.[40] Most newly recorded displacements occurred in Sub-Saharan Africa, 6.8 million of which were triggered by conflict. In total, 21.8 million people across the region were living in internal displacement, mostly as a result of emerging new armed groups.

For example, the violence committed by Boko Haram in Nigeria and the subsequent military response triggered the displacement of 86,000 people in Adamawa and Borno. While the government attempted to redress this with a policy of relocation, persistent threats have jeopardized the process, exacerbating the insecurity in the region. Furthermore, 14 percent of new internal displacements were recorded only in Burkina Faso, Mali and Niger, in the Liptako Gourma region. Prolonged periods of drought and resource scarcity have escalated existing grievances between herders and farmers, which gave extremist groups the opportunity to establish a foothold in the three countries, expand their influence, and cause further displacement.

Countries where conflict and instability reign are also conducive to more displacement when conflict overlaps with natural disasters or environmental degradation. In 2020 floods in Sub-Saharan Africa helped fuel one of the worst locust outbreaks across the continent, which triggered the displacement of thousands of farmers in Somalia and exacerbated food insecurity in already fragile countries. Deliberate attacks on civilians restricting their livelihoods or limiting their access to natural resources is also prevalent in such contexts. This was the case in Nigeria in 2018, where communal clashes between farmers and herders resulted in the displacement of over 300,000 people, as attackers burned villages and stole food supplies.[41]

Table 1: Pathways connecting climate change migration and conflict

Scenario 1: Abundance
Environmental change ▶ migration conflict
Scenario 2: Scarcity
Environmental change ▶ constrained migration ▶ conflict
Scenario 3: Conflict-induced migration
Conflict ▶ migration ▶ environmental degradation ▶ conflict
Scenario 4: Environmental degradation as a method of conflict
Conflict ▶ environmental degradation ▶ constrained migration
Scenario 5: Independently occurring climate change and migration lead to conflict
Climate change + migration ▶ conflict

Source: Freeman (2017)

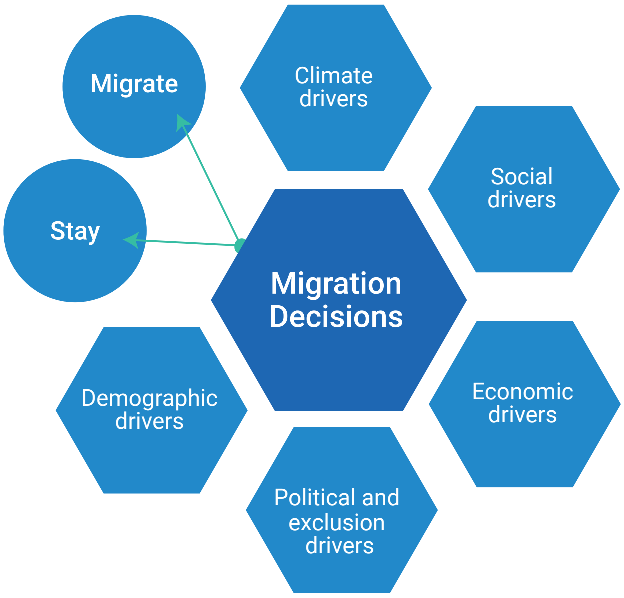
Photo: mbrand85/Shutterstock

PATHWAYS FROM CLIMATE CHANGE TO MIGRATION

The African population is one of the most mobile in the world. While the received narrative describes African migration as being largely Eurocentric, there is substantial evidence that African migrants cross land borders instead of crossing oceans.[42] Indeed, around 80 percent of Africans who contemplate migration actually have no interest in leaving the continent.[43] Moreover, and contrary to common beliefs, 94 percent of African migration across oceans takes a regular form. Thus, when talking about migration in the African context, we focus mostly on intra-African migration. Current trends indicate that Africans will continue to migrate at an increasingly high rate in search for opportunities and safety, as threats are becoming more pervasive across the continent.[44]

Every year, environmental stress shapes the mobility of millions of individuals globally, in anticipation of or in response to related events.[45] Rapid-onset events such as floods, cyclones, and storms often displace people temporarily or permanently. On the other hand, the slow onset of climate impacts affects human health and livelihoods by compounding stress on freshwater resources and coastal erosion, contributing to water and food insecurity, and potentially influencing the decision of individuals to move in search of better living conditions. These types of movements are either seasonal, or permanent in the form of planned relocation. As climate impacts will become more severe, more and more people are expected to move in new and diverse ways.[46,47]

Figure 3: Conceptual framework detailing drivers of migration



Source: adapted from Black et al. (2011)

Migration is usually shaped by factors such as timing, duration, direction, distance, and degree of voluntariness.[48] It can include seasonal, rural-to-urban, or cross-border migration from one low-income country to another, or from low-income to high-income countries, and to a lesser extent, across oceans.[49] Mobility responses to the same climate-related event, whether a slow or fast-onset one, can be very different. Household characteristics and social relations preceding an event, as well as post-disaster responses, also deeply influence whether or not people move. All of these dimensions, rather than being clear-cut alternatives, can be characterized as continuums.[50]

Despite the recognition of climate change as an important risk multiplier, causal attribution cannot be established.

Migration remains a highly complex phenomenon where social, demographic, cultural, political, economic and environmental factors closely intertwine to shape migrants' decisions. Even when climate change does play a role, it is the latter factors which eventually enable or restrict people's ability to cope where they are or result in their decision to move.[51] These 'push and pull factors' interact and accumulate until they reach a 'tipping point' which makes individuals or households decide to move. In contrast, people who are unable to make this decision, usually the most vulnerable, are sometimes considered 'trapped'.[52] Figure 3 details the complex drivers influencing individuals and or households' decisions to migrate.[53] The impacts of climate and environmental change on human mobility depend, therefore, on a complex combination of exposure to risk, and pre-existing vulnerabilities.

Photo: MikeDotta/Shutterstock

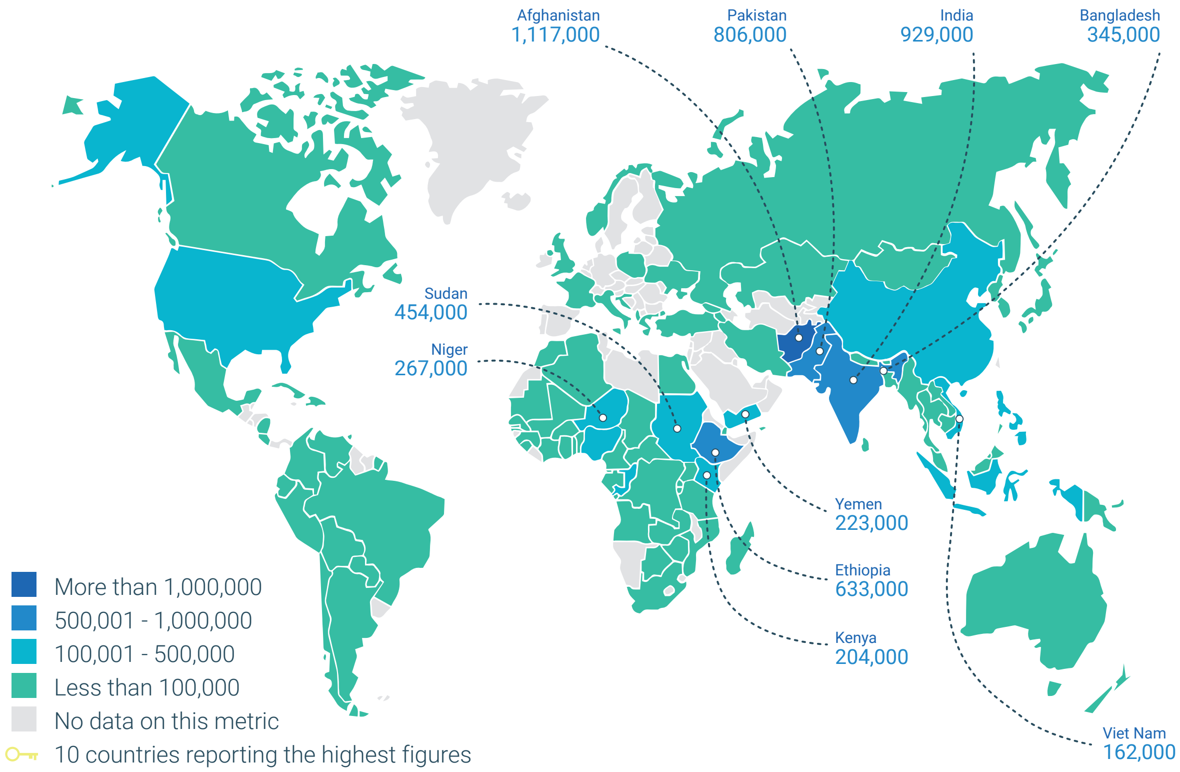
> **Partnerships are at the heart of our adaptation plan, at the heart of effective adaptation action. We need partnerships to bring together climate science, policy, and finance."**

Werner Hoyer, President, European Investment Bank
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

In January 2020, the United Nations High Commissioner for Refugees (UNHCR) recognized for the first time that States shall refrain from sending back people to their countries of origin, if they are fleeing situations where the impacts of climate change pose a risk to their life, or are incompatible with the right to life with dignity.[54] This landmark decision offers international protection for individuals displaced in the context of climate change and natural disasters, despite its application in situations where "risks are imminent". When it comes to forced displacement, the link between rapid-onset extreme weather events and mobility is more evident. However, migration is also shaped by the lack of preparatory measures such as early warning systems, building codes, and cyclone shelters.[55]

There is robust evidence that disasters are displacing people worldwide, but there is limited evidence on whether or not these are caused by climate.[56] In 2020, disasters have contributed to massive displacements in Sudan, which has witnessed its most severe flood in 60 years, displacing over 500,000 people and destroying over 5.5 million acres of farmland.[57] In Mozambique, irregular migration is becoming more prevalent as increased flooding and devastating cyclones are pushing thousands of families into displacement after losing their homes and livelihoods.[58] In 2021, IDMC's Global Report on Internal Displacement reported that conflict and disasters triggered 40.5 million new internal displacements in 2020 across 149 countries.[59] Most newly recorded displacements occurred in Sub-Saharan Africa, where 4.3 million were triggered by disasters, accounting for 14 percent of the world's internally displaced population (IDP). Floods but also cyclones and droughts were particularly intense and prolonged in South Sudan, Burkina Faso, Cameroon, Mali, Nigeria and DRC in 2020. By the end of the year, more than 2.3 million people were living in internal displacement. Figure 4 highlights the number of IDPs as of the end of 2020.

Figure 4: Total number of IDPs by disasters as of 31 December 2020



Source: IDMC, Global Report on Internal Displacement 2021
Note: An additional 742,000 people were internally displaced in other countries across the African continent, with a total record of 2.3 million IDPs recorded in Africa by the end of 2020

On the other hand, mobility linked to the slow onset of environmental and climate change is a complex phenomenon. Slow-onset factors have the ability to impact people's livelihoods, particularly those of agricultural, pastoral and fishing communities susceptible to droughts and coastal erosion. In this context migration can serve as one form of adaptation strategy to sustain livelihoods. However, it is typically not the first response that households or individuals resort to when confronted with environmental stress. Instead, individuals typically focus primarily on alternative approaches to secure immediate assistance, such as selling livestock or seeking government and community support. Further, slow-onset factors often result in the migration of one member of the household, typically younger males, particularly for rural-urban migration or long-distance migration.[60] Key factors such as access to money and social networks in the country of destination are influential in shaping decisions.[61] Even in the case of forced displacement, IDPs tend to travel along familiar and pre-existing paths to destinations where they have a social network, generally within their own country.

Studies have shown that it is impossible to isolate climate variables from key drivers of migration.[62] Decisions to migrate depend on the cost or opportunity perceived by the migrants themselves and can rarely be linked solely to climatic factors. Further, slow-onset climate hazards are usually unevenly distributed across local, national and regional levels. Impacts are therefore perceived differently, making universal comparisons very complicated.[63] This notion of perception is essential in quantifying environmental stressors.[64] This is mostly because most of the data collected relies on surveys and ethnographies where participants could be subject to recall biases.[65] More importantly, such perceptions of environmental change do not always correspond to scientifically measured changes in weather patterns.[66]

Instead, these are often shaped by cultural and social factors, which again take precedence over actual environmental change in motivating migration decisions. Here again climate variables should be measured scientifically using robust indicators over appropriate periods of time, which is not consistently carried out in the climate migration literature.[67] Overall, databases regarding migration are inadequate and incomplete, lagging in their scope, quality and reliability.[68] While individual country surveys could help fill these gaps, this approach is not cost-efficient and in the absence of standardized definitions and criteria for climate-related migration, this process itself can be inefficient. This gap is primarily an impediment to humanitarian aid in the case of forced migration. But it also has implications for climate and conflict studies and will need to be further systematized to accurately portray the actual scale and dynamics of this issue.

Photo: Sun_Shine/Shutterstock

Migration projections under different emission pathways

The African continent is a vulnerability hotspot for climate impacts, as they threaten food and water security as well as socioeconomic development.[69] Key risks include decreased rainfall and water availability, subsequent loss of crop productivity, rising temperatures and sea-levels and extreme weather events such as floods, cyclones and storms. Climate models have attempted to quantify these impacts over time and to project implications for climate-related conflict and migration. Although the evidence is patchy and varied, the following trends as a result of increased climate change could have consequences on conflict and mobility. Due to the complexity and lack of robust assessment for climate-related conflict trends, projections of conflict risks will not be included in this section.

Rising sea levels, coastal degradation, and migration

In 2019, the African continent experienced an above average sea-level rise (SLR), reaching 5 mm per year in several oceanic areas surrounding it, and even exceeding this level around the south-western Indian Ocean from Madagascar towards Mauritius.[70] Adding to that, the population in Africa inhabiting low-level coastal zones is rising at an annual rate of 3.3 percent per year, more than double the global average. By 2050, between 72 to 94 million people are expected to inhabit several of West Africa's low-lying urban centres. The African population is therefore at high risk from future SLR. Although the impacts of climate-related SLR are well known, studies focusing on Africa are limited due to a lack of longitudinal and systemic observations and climate modelling. Evidence is limited to the West African coast, yet current models do not allow for projections with high confidence. These impacts are further discussed in the chapter on Present and Projected Climate Risks.

In the context of migration, there is robust evidence that SLR will impact the size and direction of migration flows.[71] However, there is limited evidence to support the theory that climate related SLR will be the main driver of migration, with more evidence supporting the idea that households subjected to SLR will only migrate if it is their only option. Social, economic, demographic and policy incentives encouraging, or obstructing migration will play a bigger role. Predicting actual numbers of migrants is quite difficult, mainly because of the uncertainty of models.[72] However, West Africa appears to be significantly vulnerable to SLR impacts. Other vulnerable areas include the Nile Delta, the Alexandria coast, and Eastern Africa, in Tanzania, Somalia and Mozambique, where regional development is planned through strong coastal growth.[73] More studies are required to build robust models which would enable a granular understanding of migration patterns, as a result of SLR.

In the case of conflict, warming temperatures, ocean acidification and coastal degradation will have significant impacts on fisheries. Here again, West African countries stand to suffer the most from such effects, with forecasts estimating a 30 percent decrease or more in the Maximum Catch Potential (MCP) by 2050, and 40 percent by 2100. This includes the Democratic Republic of Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Liberia, and São Tomé and Príncipe.[74] This decrease would significantly impact fishermen's livelihoods and could force them to cross borders to fish, triggering risks of violent conflict with the coastguards of neighbouring countries.[75] Loss of livelihoods could eventually push fishermen to migrate in search of means of survival.

Box 2: Migration projections under different scenarios for East Africa[76]

Photo: Billy Miaron/Shutterstock

In a recent study, the World Bank adopted a population gravity model to project mobility under different climate scenarios, with a specific focus on East Africa. It estimated changes in population distribution by the year 2050 as a result of climate and development trends across three climate scenarios: a pessimistic RCP 8.5 scenario; another RCP 8.5 scenario with more inclusive development; and an RCP 2.6 scenario. (RCPs refer to "Representative Concentration Pathways", or different projections of future GHG emissions and atmospheric concentrations of greenhouse gases.) The model correlates special patterns with population change while inputting geographic, socioeconomic, and demographic characteristics of the landscape and existing population distribution. It accounts for climate impacts through four models with indices on water and crop productivity. Outputs were averaged to have a mean result.

According to the model, under the pessimistic RCP 8.5 scenario, the region could witness 10.1 million internal refugees by 2050. Under RCP 2.6, East Africa could record 6.9 million 'climate migrants'. Areas such as the Lake Victoria Basin, the eastern highlands of Ethiopia, and the area around Lilongwe would be in-migration hotspots. Major out-migration hotspots include the coastal zone in Kenya and Tanzania, western Uganda, and parts of the northern highlands of Ethiopia. As rainfall variability increases, population decline is likely to occur in rainfed croplands as a result of out-migration. In-migration is likely to be recorded in pastoral and rangeland areas, in all scenarios. Finally, population growth in both RCP 8.5 scenarios is considered to inhibit development progress.

While this study constitutes a robust model with important insights for the future, it still contains a lot of uncertainties. Particularly, these projections are based only on populations at risk, rather than the population who might take the decision to migrate. The model also fails to account for the adaptive capacity of individuals, or their degree of agency. In Table 2, results for other regions in the continent are presented, excluding North Africa.

Figure 5: Areas projected to have high in-migration as of 2010 and 2050 in East Africa

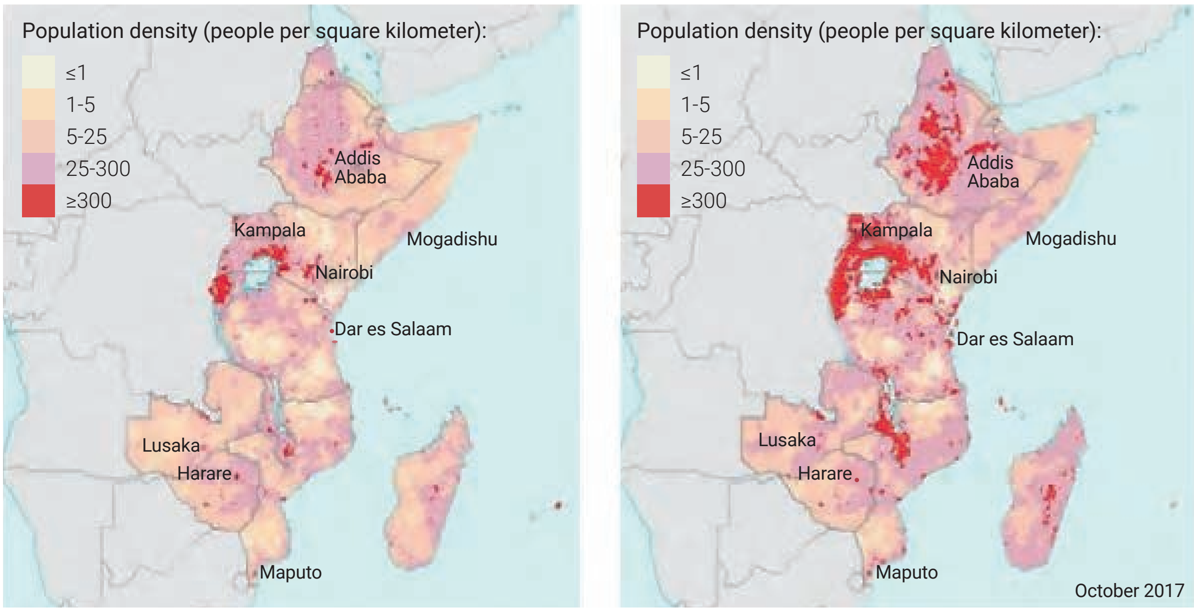


Table 2: Projected share of internal climate migrants in Sub-Saharan Africa

Region	Scenario					
	Pessimistic reference		More inclusive development		More climate-friendly	
East Africa						
Average number of internal climate migrants by 2050 (million)	10.1		9.2		6.9	
minimum (left) and maximum (right)	*8.1*	*12.1*	*7.2*	*11.2*	*4.3*	*9.3*
Internal climate migrants as percentage of population	1.28%		1.37%		0.87%	
minimum (left) and maximum (right)	*1.03%*	*1.54%*	*1.06%*	*1.66%*	*0.56%*	*1.19%*
West Africa						
Average number of internal climate migrants by 2050 (million)	54.4		38.5		17.9	
minimum (left) and maximum (right)	*44.8*	*64*	*32*	*45*	*11.1*	*24.8*
Internal climate migrants as percentage of population	6.87%		5.67%		2.27%	
Minimum (left) and Maximum (right)	*5.67%*	*8.08%*	*4.71%*	*6.63%*	*1.4%*	*3.13%*
Central Africa						
Average number of internal climate migrants by 2050 (million)	5.1		4.3		2.6	
minimum (left) and maximum (right)	*3.1*	*7.1*	*2.9*	*5.7*	*1.7*	*3.5*
Internal climate migrants as percentage of population	1.31%		1.31%		0.66%	
minimum (left) and maximum (right)	*0.8%*	*1.81%*	*0.83%*	*1.65%*	*0.43%*	*0.89%*
Southern Africa						
Average number of internal climate migrants by 2050 (million)	1.5		1.6		0.9	
minimum (left) and maximum (right)	*0.6*	*2.5*	*0.07*	*2.5*	*0.1*	*1.6*
Internal climate migrants as percentage of population	2.31%		1.98%		1.4%	
minimum (left) and maximum (right)	*0.85%*	*3.77%*	*0.09%*	*3.86%*	*0.85%*	*3.77%*

Source: World Bank (2018)

Migration as a potential adaptation strategy

With the lack of strong empirical evidence linking climate change and migration, scholars have opted to focus on a narrative that sees migration as one option for a successful adaptation strategy when planned carefully.[77] This is particularly relevant when such migration is planned and facilitated to reduce vulnerabilities and improve livelihoods and mediated by holistic and inclusive development and adaptation plans. Benefits of migration include better social, economic and even environmental prospects (in the context of disaster recovery for example).[78] Pre-existing socioeconomic status plays an important role in shaping the success of this strategy. Migrants with a lower socioeconomic status face greater challenges in finding employment and dignified and secure living conditions. They are often left in poverty as remittances constitute the majority of their income.[79] Migration flows from rural to urban areas can also add significant pressures on already stressed cities, exacerbating urban challenges and social cohesion, and pushing some migrants further into poverty as they struggle to gain access to basic services. In this context, robust and holistic migration policies which intersect with development and adaptation agendas can serve as a basis to plan for and regulate the increasing mobility which climate change will induce.

Photo: Sopotnicki/Shutterstock

POLICY RECOMMENDATIONS

Our GCA analysis of the connections between climate change, conflict, and migration shows that there are important opportunities to tackle these challenges in a coordinated manner through investments, governance and institutional capacity building, and national and regional plans.

Investments

1. Promote holistic and multi-sectoral investments in adaptation and resilience, which integrate climate hazards and pre-existing vulnerabilities.
2. Invest in robust databases with more consistent monitoring of climate variables, as well as migration and conflict triggers and trends.
3. Invest in key areas of research such as localized and context-specific research on the climate-conflict-migration nexus, particularly in vulnerable areas, and empirical evidence on the viability of adaptation and DRR and preparedness in conflict settings.
4. Invest in early warning systems, preparedness, and management systems for climate change, conflict, and migration.

Governance and institutional capacity

1. Build the capacity of institutions to create an enabling environment for peace and sustainability while promoting inclusive and participatory governance, with a specific lens towards climate change.
2. Promote solutions which foster social dialogue and cohesion by recognizing existing social, political and economic inequalities in communities, building resilience for the impacts of climate change.
3. Build the capacity of national statistical systems to collect better quality data on climate-related conflict and migration to allow combined analysis and design of policies and programs linked to climate change adaptation.

National and regional plans

1. Conducting localized climate-conflict assessments and including them in countries' NDCs and NAPs as well as regional cooperation agreements.
2. Planned migration can be a successful adaptation strategy, especially when it is aims to alleviate poverty and reduce vulnerability to climate change. Migration needs to be embedded into regional, national and local development planning, as well as NAPs and NDCs.
3. Development frameworks will need to consider the different phases of migration and provide assistance accordingly. The World Bank identifies three key phases[80] (i) Before migration: provide local adaptation when possible in the form of social protection programs and climate-smart infrastructure, so that people 'adapt in place'; (ii) During migration: facilitate mobility, particularly when people are forced to move as a result of extreme events, by providing safe movement towards lower-risk areas, or as a last resort, planned relocation; (iii) After migration: ensure that migrants and their people are well-connected, particularly in terms of remittance transfers, by establishing direct connections and easy-to-use methods of transfers.

"If we are really serious about climate adaptation, we have to partner with the local communities (...) Until and unless bold action gets grounded in local communities, we will not be successful."

Jagan Chapagain, Secretary-General, International Federation of Red Cross and Red Crescent Societies
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Sustainable Development Goals

KEY MESSAGES

- **A climate risk-blind pursuit of the Sustainable Development Goals (SDGs) can exacerbate climate-related impacts in Africa**, whereas an integrated approach to achieve the SDGs and build climate resilience at the same time can significantly reduce systemic vulnerability, optimize the use of resources, and enable transformational adaptation.
- **The current adaptation ambition of Nationally Determined Contributions (NDCs) in Africa may not be sufficient.** African NDCs should strengthen SDG-related adaptation action, in particular action related to SDG 3 (health); SDG 4 (quality education); SDG 5 (gender equality); SDG 9 (infrastructure); SDG 10 (reducing inequalities); and SDG 11 (sustainable cities). Measures that target national vulnerabilities, build the resilience of human systems, and deliver multiple SDGs should be prioritized to synergize efforts and optimize the use of resources.

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- **Single climate disaster events can negatively impact multiple SDGs** through, for instance, loss of life, increase in malnutrition and disease, and the destruction of water sources, arable land, infrastructure, and the natural environment. The only way to stop this cycle of negative synergies is to accelerate effective action to achieve the SDGs and adapt to climate change.
- **Unlike adaptation, the SDGs are supported by a robust set of indicators and targets to measure progress.** Identifying the links between the SDGs and adaptation can therefore help track progress on adaptation, and to identify gaps.

> "We need massively scaled-up investment in adaptation and resilience. This is absolutely critical for those at the frontlines of the climate crisis. Yet, only 21% of climate finance is channelled to adaptation efforts. (...) We have a moral imperative to close this gap."

Amina Mohammed, Deputy Secretary-General of the United Nations

INTRODUCTION

In 2015, two major international agendas were agreed: the Paris Agreement and the 2030 Agenda for Sustainable Development. The adaptation component of the Paris Agreement focuses on building adaptive capacity, reducing vulnerability to climate change, and enhancing resilience.[1] The 2030 Agenda seeks to advance social, economic, and environmental dimensions of development through 17 Sustainable Development Goals (SDGs).[2] Despite apparent differences in primary objectives, the two agendas overlap considerably. There are significant opportunities for catalytic synergies and linkages between the two—along with the significant danger that lack of progress in one could heavily compromise progress in the other.

The GCA analysis presented in this chapter explores these synergies and linkages between efforts to adapt and build resilience to climate change in Africa, and to achieve the SDGs. It then identifies opportunities to strengthen links between strategies, plans, and actions to achieve the SDGs and the Nationally Determined Contributions (NDCs); explores the multiple negative impacts of climate disasters on SDGs; and finally offers some recommendations for the way forward.

LINKAGES BETWEEN CLIMATE ADAPTATION AND SDGS

Sustainable development and climate change adaptation are inextricably intertwined. Climate change can undermine sustainable development efforts without adequate adaptation responses to support food security, poverty alleviation, human health, and other determinants of sustainable development for Africa. Adaptation and resilience actions, meanwhile, can lower the impacts of climate change and variability, and help deliver sustainable development.[3] Similarly, robust sustainable development measures can help build adaptive capacity and reduce vulnerabilities.[4] The Intergovernmental Panel on Climate Change (IPCC) finds that sustainable development can enable transformative adaptation when an integrated approach is taken, social inequalities are addressed, and multiscale planning considers wider socioeconomic barriers to enable effective local participation and promote livelihood security.[5]

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The sustainable development, adaptation, and resilience-building agendas are therefore mutually reinforcing, and their convergence presents a significant opportunity to deliver mutual benefits.[6] Despite this opportunity for alignment, only 13 SDG targets and 21 indicators (eight percent) of the 169 targets and 232 indicators include an explicit reference to adaptation and resilience (mentioning adaptive capacity, vulnerability, hazards, exposure, and/or resilience), as shown in Box 1. A further 27 SDG targets that contribute to resilience and adaptive capacity for disaster risks, and enable inclusion and accessibility through good governance, have been identified by the UN Office for Disaster Risk Reduction (UNDRR).[7] Other SDG targets may also be relevant to climate change adaptation,[8] depending on the underlying vulnerability contexts.[9]

> **“Scaling up resources to support adaptation for the most vulnerable is particularly important and yet, while climate finance will be key, our recent analysis shows that only 21% of flows to developing countries were going to climate adaptation.”**
>
> **Mathias Cormann, Secretary-General, Organisation for Economic Co-operation and Development**
> High-Level Dialogue “An adaptation acceleration imperative for COP26”, September, 2021

Box 1: Explicit references to adaptation and resilience in SDG targets

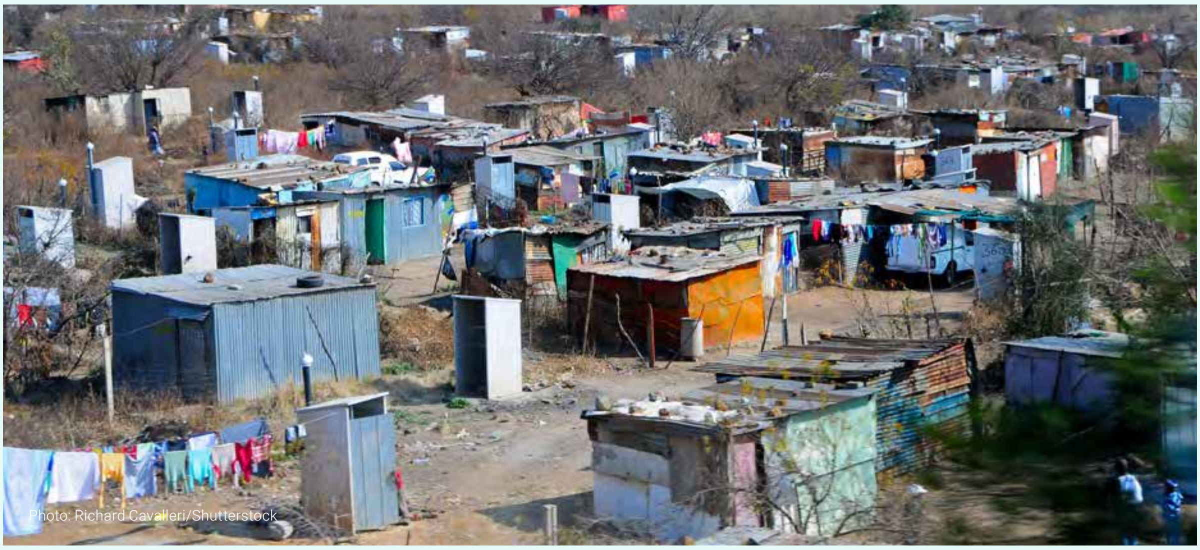
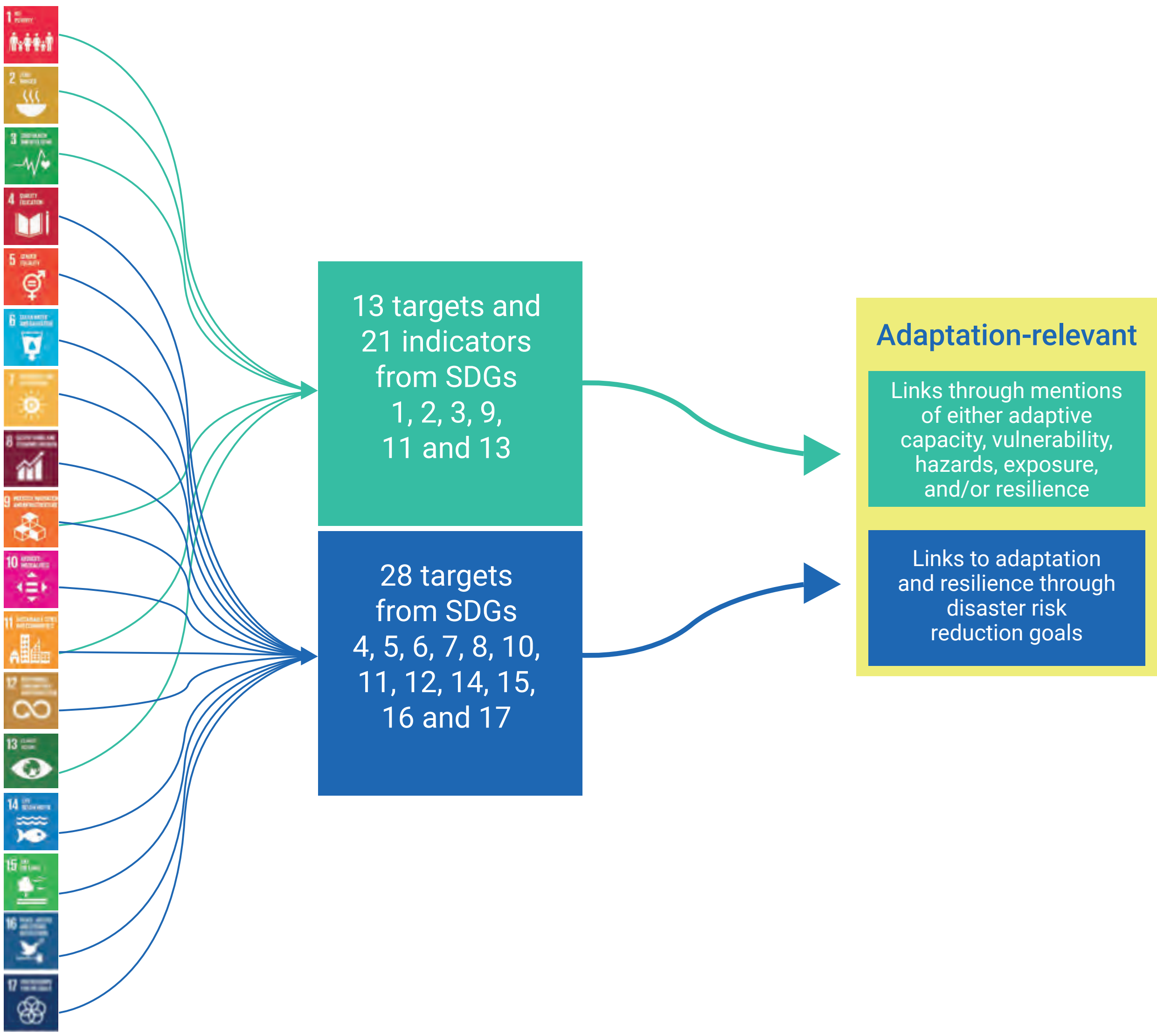


Photo: Richard Cavalleri/Shutterstock

- **SDG 1 (no poverty), target 1.5:** By 2030, reduce by at least half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.
- **SDG 2 (zero hunger), target 2.4:** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters, and that progressively improve land and soil quality.
- **SDG 3 (good health and well-being) target 3.d:** Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.
- **SDG 9 (industry, innovation, and infrastructure) target 9.1:** Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. **9.a** specifically mentions Africa: Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological, and technical support to African countries, least developed countries (LDCs), landlocked developing countries, and small island developing States (SIDS).
- **SDG 11 (sustainable cities and communities) target 11.5:** By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. **11.b** calls, by 2020, for substantially increasing the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters; and developing and implementing, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels. **11.c** calls to support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.
- **SDG 13 (climate action) target 13.1:** Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. **13.2** calls for integration of climate change measures into national policies, strategies, and planning. **13.3** calls for improved education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. **13.a** calls on developed country parties to the UN Framework Convention on Climate Change to meet their commitment to jointly mobilize US$ 100 billion annually by 2020 from all sources, to address the needs of developing countries. **13.b** calls for the promotion of mechanisms for raising capacity for effective climate change-related planning and management in LDCs and SIDS, including focusing on women, youth, and local and marginalized communities.

Failure to integrate the adaptation and resilience agenda into sustainable development action will therefore substantially hinder progress towards the SDGs, especially for developing countries.[10] Parallel agendas can increase the risks of negative outcomes (maladaptation) to additional target groups and actors (rebounding vulnerability); compromise the ability of other groups to respond to climate change (shifting vulnerability); and result in failure of or constraints on sustainable development.[11] An example is shown in Box 2.

Figure 1: Connections between SDGs and adaptation*



*Other SDG targets may be adaptation-relevant when applied in an adaptation and resilience context

Box 2: Siloed approaches can lead to maladaptation

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The case of the Sebou-Saïss basin in northern Morocco illustrates how siloed decisions to cope with climate variability can deliver short-term positive outcomes for one SDG (in this case, SDG 2 on zero hunger), but can also have long-term negative impacts on other SDGs (SDG 6, on water and sanitation, and potentially, through the loss of livelihood, on SDG 1, SDG 2, and others).

The Saïss Plain is home to 1.8 million people. It faces chronic water scarcity due to a combination of reduced and unpredictable rainfall due to climate change.[12] Groundwater has helped the population deal with climate impacts in the short term and enlarge agricultural production and food safety (linked to SDG2). However, the Saïss aquifer faces significant pressures, and it is expected to deplete in 25 years if current unsustainable water abstraction practices continue. The significant reductions in precipitation and surface runoff predicted by most climate change models will make the situation worse. A collapse of the groundwater aquifer will result in the collapse of agricultural production and of rural livelihoods in a country where 40 percent of the population—particularly the poor—rely on the agricultural sector for jobs (hence affecting SDGs 1 and 2). It will also affect drinking water sources (SDG 6).[13]

In 2017, the US$ 203 million Saïss Water Conservation Project was initiated with grant and loan funding from the European Bank for Reconstruction and Development, the Green Climate Fund, and the government of Morocco. It aims to strengthen the adaptive capacity of the community through the adoption of efficient drip-irrigation techniques under a public-private partnership scheme. The project will also improve the efficiency of irrigation systems, prevent the depletion of the Saïss aquifer, and raise climate-resilience awareness. The project will finance infrastructure for a bulk water transfer scheme from the M'dez Dam to the Saïss Plain. It is expected to deliver climate-resilient irrigation services for more than 2,800 farms and increase irrigated agricultural land in the Saïss Plain from 18,450 hectares to 21,600 hectares.[14] The project demonstrates how an integrated approach can reduce the risks of maladaptation and maximize links between the SDGs.

The risk-blind pursuit of SDGs can create and exacerbate climate-related risks and disasters in Africa.[15] For example, pursuing SDG 2 (zero hunger) targets without consideration of disaster risk or climate change impact projections may result in agricultural, husbandry, fishery, and forestry policies and practices that degrade ecosystems, exacerbate existing risks, or introduce new hazards. Social protection programs (SDG 1, target 1.3) that do not consider climate risks and potential climate disasters in their design could potentially hinder progress and push vulnerable communities back into poverty, creating a two-step-forward, one-step-back scenario in Africa.[16] Healthcare facilities (SDG 3) may deteriorate or collapse when exposed to climate hazards if they are not designed and built for resilience. Risk-blind urbanization, industrialization, and construction (SDG 9 and 11) can all have detrimental effects on water quality, watercourses, and ecosystems such as wetlands silting up, deforestation, and polluting incidents.[17]

It is therefore critical that climate considerations are integrated into the design and implementation of actions delivering SDGs targets. Failure to do so may create or exacerbate climate-related impacts and hazards and perpetuate existing systemic patterns of disaster risk that hinder progress in achieving the SDGs.[18]

Measures such as improving climate and disaster risk information systems and services, strengthening risk governance, and awareness-raising can enable decision-makers to make risk-informed decisions. This, in turn, enables the effective implementation of impactful risk management activities such as risk-proofing the built environment; risk transfer mechanisms such as climate- and shock-responsive scalable social safety nets; and nature-based solutions, such as the protection and restoration of seagrasses, sand dunes, and mangroves. Establishing inclusive multi-sectoral and multi-hazard rapid early warning systems and effective dissemination structures builds anticipatory capacities at multiple levels, and contributes to effective emergency preparedness, response, and recovery mechanisms.[19] Measures need to be context-specific and focused to optimize the use of resources and deliver across agendas.

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SYNERGIES BETWEEN SDGS AND NDCS

This GCA analysis explored the potential synergies and linkages between SDGs and the strategies, plans, legislation, projects, and actions included in African NDCs to address climate vulnerabilities.[20] While these synergies and linkages can be a key element for creating an enabling environment for climate-resilient sustainable development, many of them have not yet been considered by several countries. This is an area for improvement of NDC effectiveness. Moreover, unlike adaptation, the SDGs are supported by a robust set of indicators and targets to measure progress. Identifying the links between the SDGs and adaptation can therefore help track progress on adaptation, and to identify gaps. Table 1 shows examples from African NDCs that illustrates the strong synergies with SDGs.

Table 1: Examples of potential synergies between NDCs and SDGs

Country	NDC actions that contribute to SDG 2.4
Niger	Niger's intended NDC aims to restore 1,030,000 hectares (ha) of agricultural, forest and grazing land; assist natural regeneration in 1,100,000 ha of land; conduct dune fixation activities in 550,000 ha of land; manage 2,220,000 ha of natural forests; promote 75,000 ha of private forestry; and plant 145,000 kilometers of hedgerows, 750,000 ha of multi-use species, and 125,000 ha of Moringa oleifera, in addition to seeding of 304,500 ha of roadways. Such sustainable land management practices can contribute not only to adaptation and mitigation, but also to SDG 2.4.
Morocco	Morocco's NDC includes several activities related to irrigation, including switching from current irrigation systems to localized irrigation systems over 550,000 ha; developing public-private partnerships to irrigate 15,000 ha with desalinated water; irrigate over 3,200 ha in the coastal Azemmour-Bir Jdid area; build hydro-agricultural infrastructure over 160,000 ha around dams; and offer climate-risk insurance for cereals and legumes over a million hectares.
Mozambique	Mozambique's NDC aims to increase the resilience of agriculture, livestock, and fisheries to guarantee adequate levels of food security and nutrition.
Sudan	Sudan's NDC aims to diversify crops and introduce improved drought-resistant and early maturing varieties in areas affected by rainfall decease and variability; introduce agroforestry in vulnerable areas to enhance agricultural production and empower vulnerable communities through community forestry; and restock animal herds in areas affected by climate change.
Comoros	Comoros' NDC includes a project on Capacity Building and Resilience of the Agricultural Sector to Climate Change in Comoros (CRCCA).

Source: Climate Watch SDG-NDC Platform (16 August 2021)
This table lists activities related to adaptation and mitigation in the agriculture sector in five African NDCs, with clear synergies with SDG target 2.4 (by 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality).

As of the time of this report's publication, out of 55 African countries, 53 have submitted NDCs, and seven have already submitted an updated version (Kenya, Rwanda, Ethiopia, Zambia, Cabo Verde, Angola, and Morocco). Most NDCs describe plans for adaptation and resilience. Few, like Rwanda, explicitly identify synergies with other agendas like the SDGs to optimize the use of available resources; identify a monitoring framework to measure progress; and identify gaps in finance and external funding and capacity building needs. Table 2 shows the climate-vulnerable sectors identified in African NDCs, based on a GCA analysis.

Table 2: Climate-vulnerable sectors identified in NDCs by African countries

		Vulnerable sectors identified (number of countries)							
Sub-region	Total countries	Water	Food and Agriculture	Health and well-being	Biodiversity and ecosystems	Infrastructure and transport	Human settlements	Education	Highly vulnerable groups
Central Africa	9	7	9	7	8	4	7	2	6
Eastern Africa	14	14	14	12	12	8	10	0	10
Northern Africa	5	5	5	4	5	2	5	0	1
Southern Africa	10	10	10	9	9	5	8	1	7
Western Africa	15	14	15	10	11	6	13	1	10

Color code for Table 2, indicating percentage of countries that mention a specific vulnerability	100%	≥75%	≥50%	≤50%	0

Source: Nature-based Solutions Policy Platform, University of Oxford


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Agriculture, water, and biodiversity—the focus of SDGs 2, 6, 14, and 15—are also identified as key vulnerable sectors in the African NDCs and targeted through policies and strategies that will impact the achievement of the SDGs. For instance, agriculture is covered in 94 percent of the African NDCs, with actions geared towards the implementation of climate-resilient agriculture (target 2.4). Water is addressed in 70 percent of African NDCs, with efforts focused on increasing water-use efficiency and ensuring sustainable withdrawals of freshwater (target 6.4). Biodiversity and ecosystems are addressed in 88 percent of the African NDCs, with responses aimed at increasing afforestation and reforestation (target 15.2). In all these three sectors, trends indicate that SDG targets are not on the path to being achieved, and more action is needed.

Further synergies are also necessary between the three sectors. For instance, agriculture is one of the major contributors to land-use change, land degradation, and desertification; and it accounts for 70 percent of water withdrawals.[21] In the short term, targeted actions towards ensuring the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems and their services (target 15.1) in the NDCs can deliver positive outcomes across all three sectors.[22] In the middle- and long-term, the promotion of sustainable agriculture techniques and technology through policies and plans that enable crop rotation, efficient irrigation, agroforestry, and seed and plant diversity can improve soil and water quality, ecosystem functions, and crop resilience to pests (SDGs 2, 6, 13, and 15).

Additionally, considering that there are an estimated 33 million smallholder farms in Africa, enhancing the adaptive capacity of smallholder farmers through adaptive strategies is essential.[23] The capacity of smallholder farmers to cope with climate change can be improved by providing them with mechanisms that protect and empower them, including climate risk insurance, safety nets, ex-ante access to resources, digital services, and economic resources. These responses can also help deliver results across multiple SDGs, including SDGs 1, 2, and 13.

The vulnerability of human settlements is mentioned in 81 percent of the African NDCs, with responses targeting the enhancement of inclusive and sustainable urbanization, and the capacity for participatory, integrated, and sustainable human settlement planning and management (target 11.3).

While 79 percent of the African NDCs mention the vulnerability of the health sector, only 57 percent address it through strengthening the capacity for early warning, risk reduction, and management of national health risks (target 3.d).

Only 45 percent of the African NDCs refer to building the resilience of the poor and those in vulnerable situations and reducing their exposure and vulnerability to climate-related extreme events and other economic, social, and environmental shocks and disasters (target 1.5). Progress on the adaptation-relevant SDGs (SDGs 3, 5, and 11) is static, with only some countries on track to achieve SDG 1 before the COVID-19 pandemic.[24]

Given that 60 percent of the urban population live in slums in Africa and that the urban population is

Photo: xxxxxx/iStock

projected to double by 2050,[25] more effort is needed to build the resilience of highly vulnerable groups. In the short term, the NDCs need to place greater emphasis on SDG targets that relate to ensuring the participation of women in decision-making (target 5.5); sustaining income growth for the bottom 40 percent (target 10.1); financial measures for greater equality (target 10.4); affordable housing and upgrading slums (target 11.1); and raising capacity for effective planning (target 13.b). In the middle- to long-term, improving access to adequate housing to reduce sensitivity and exposure to climate change, communicable diseases, and hazardous substances will deliver benefits across SDGs (particularly SDGs 1, 3, 11, and 13) and adaptation. Urban and rural social protection programs can enhance the adaptive capacity of vulnerable groups and lift them out of poverty, delivering benefits for SDGs 1, 2, 10, 11, and 13. Strengthening early warning systems for climate-related urban and agricultural risks can prevent deaths and minimize losses, also benefiting SDGs 1, 3, 11, and 13.

Education and infrastructure are not often mentioned as vulnerabilities in African NDCs, but they are both important crosscutting topics. While education, awareness-raising, and capacity building are key components for mainstreaming adaptation into planning and implementation, the impacts of climate disasters on infrastructure can seriously hamper progress on sustainable development by disrupting access to basic services and causing economic and social losses. Short- and middle-term actions require targeted responses to enhance policies, strategies, and legislation that address these two challenges at multiple government levels, with more robust integration in the NDCs. In the long-term, climate change should be included in school curricula; and the inclusion of nature-based solutions for infrastructure can serve as a low-cost option that brings environmental, economic, and social benefits to multiple stakeholders.[26]

Based on an analysis conducted by GCA, Table 3 shows the number of countries for each sub-region in African NDCs that identify specific climate vulnerabilities related to various SDGs.

Table 3: Number of countries with climate vulnerabilities that are related to SDGs identified in NDCs

Region	Total countries	NDC Vulnerabilities	Water				Agriculture	Health	Education			Transport and Infrastructure		Highly Vulnerable groups							Human Settlements			Biodiversity and Ecosystems						
		SDGs																												
		SDG Targets	6.4	6.5	6.6	15.1	2.4	3.d	4.7	4.a	13.3	9.1	9.a	1.5	5.5	10.1	10.4	11.1	11.5	13.b	11.1	11.3	11.b	2.4	6.6	14.2	15.1	15.2	15.3	15.4
Central Africa	9		2	4	2	3	8	3	4	0	8	4	0	3	0	0	0	0	1	1	0	1	0	8	2	6	3	8	4	0
Eastern Africa	14		11	11	7	9	14	12	6	0	13	11	0	9	2	1	1	1	1	1	1	6	7	14	7	8	9	13	9	2
Northern Africa	5		4	3	4	2	4	3	2	0	5	4	0	3	0	0	0	0	1	0	0	0	0	4	4	3	3	4	4	0
Southern Africa	10		9	5	5	5	9	5	2	1	10	5	0	4	1	0	0	0	1	1	0	3	2	9	5	3	5	8	6	1
Western Africa	15		11	6	7	3	15	7	5	0	14	9	0	5	3	0	0	2	0	1	2	2	1	15	7	13	3	14	10	0

% of countries with NDCs linked to adaptation-relevant SDG

	W	A	H	E	T	HVG	HS	BE
100%								
≥75%								
≥50%								
<50%								
0								

Source: Color code for Table 3, indicating the percentage of countries that mention an NDC action that, according to Climate Watch's NDC-SDG Linkages platform, will also deliver SDG benefits

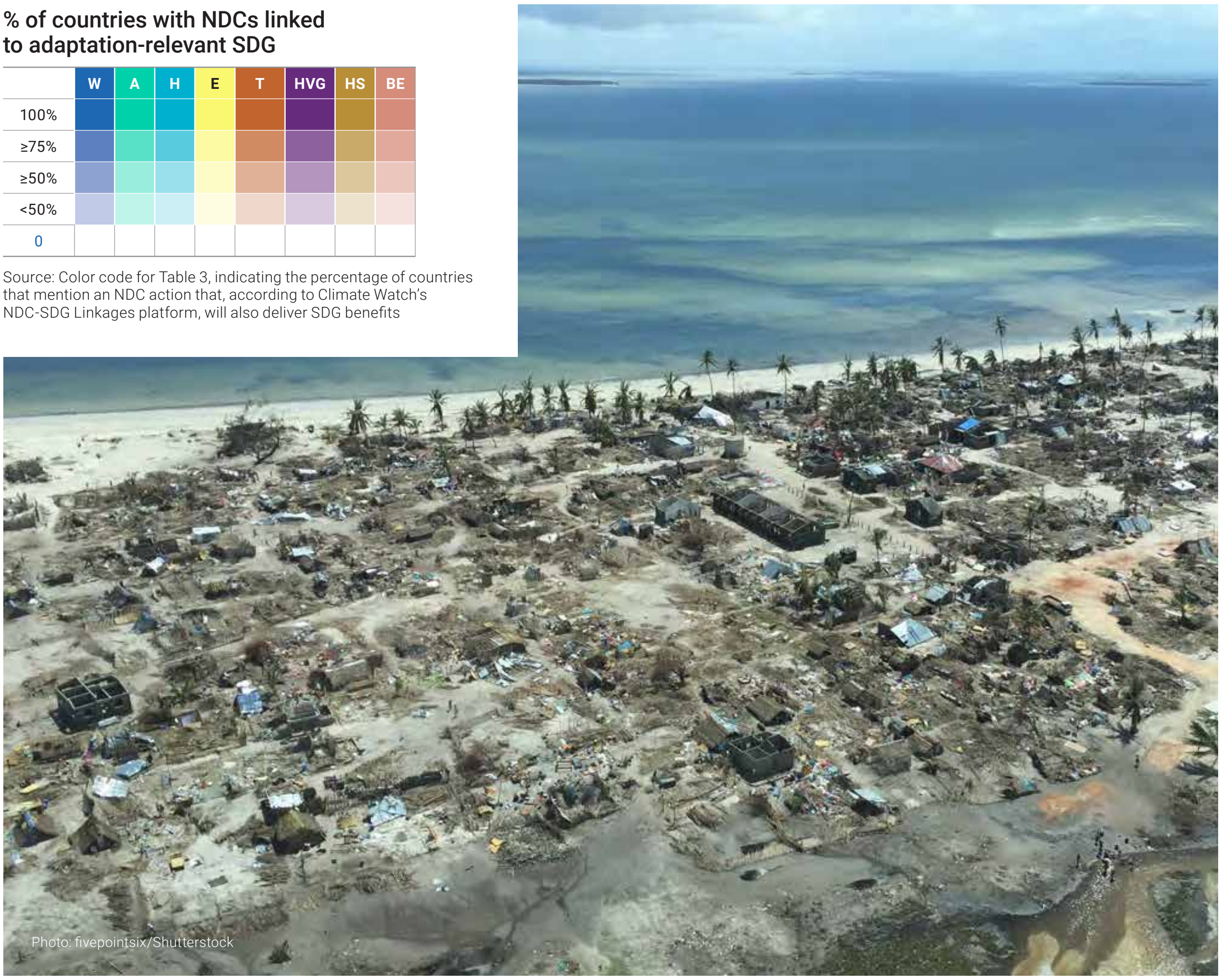


Photo: fivepointsix/Shutterstock

MULTIPLE IMPACTS OF DISASTERS ON SDGS

Climate disasters like droughts, floods, hurricanes, and cyclones have multi-dimensional impacts, affecting several SDG indicators at the same time. This section presents the GCA analysis of seven recent climate-related disasters in Africa related to water scarcity (drought), and excess water (floods and cyclones).

Cyclone Idai in Zimbabwe

Strong winds, heavy rains, overflowing rivers, and storm surges caused by Cyclone Idai affected millions of people across Mozambique, Zimbabwe, Malawi, and Madagascar in 2019. Coinciding with the annual harvest season, Idai destroyed 1.4 million hectares of arable land in Zimbabwe alone, affecting 50,000 farming households and causing losses and damages worth US$ 311 million to the agricultural sector (SDG 2, target 2.4).[27] Rural provinces in the country were worst affected, with schools shut down due to the complete or partial destruction of buildings and property, including teaching materials and damage to sanitary facilities (SDG 4, targets 4.7 and 4.a). Flooding devastated urban and rural infrastructure in the country, destroying 18,000 houses, and causing over US$ 205 million in damages. Significant environmental damage was also caused: 1.17 million hectares of forests were destroyed in Zimbabwe, including over 100,000 hectares within protected areas, causing US$ 37.4 million in losses and damages (SDG 15, targets 15.1, 15.2, 15.3, and 15.4). In neighboring Mozambique, the destruction of 240,000 houses resulted in damages worth over US$ 410 million (SDG 11, targets 11.1, 11.3, and 11.b).

Flooding in Mozambique

In 2015, heavy rains hit central and north Mozambique, exposing the Zambezi, Licungo, and Shire River basins to flooding that resulted in water pollution and salinization and destroyed irrigation systems (SDG 6, targets 6.4, 6.5, and 6.6). The destruction of schools, which were not built to withstand the flooding, impacted education. Proximity to riverbeds and the lack of levee protection, drainage ditches, or high foundations resulted in damage to other buildings (SDG 4, targets 4.7, and 4.a). The disaster caused damages worth 2.4 percent of Mozambique's GDP, exacerbating the country's upward debt trajectory.[28]

Drought in Somalia

In Somalia, the drought in 2016/2017 caused US$ 1.5 billion in economic losses to the agricultural sector, pushing a further 50 percent of the population into food insecurity, while eroding around 93,000 tons of topsoil (SDG 2, target 2.4). The drought caused large-scale malnutrition, mass displacement, and the outbreak of diseases like diarrhea, cholera, measles, and malaria (SDG 3, target 3.d). During the drought period, an average of around 18 percent of the total national landmass with natural standing vegetation was lost, costing US$ 1.18 billion in environmental damages (SDG 15, target 15.1). It is important to note that the SDG indicators do not fully capture the impacts of the drought. The health consequences of drought build up over time and can be indirect; and the overall impacts of drought are exacerbated by the wider socioeconomic and political context around political instability and poverty.

Floods and landslide in Sierra Leone

In 2017, a landslide exacerbated existing flooding in Western Area Rural and Western Area Urban of Sierra Leone, leaving 1,141 people dead or missing, 6,000 people directly affected, and economic losses worth US$ 31.65 million (SDG 1, target 1.5). Sierra Leone is one of the poorest and most vulnerable countries in Sub-Saharan Africa, ranking 179th out of 188 countries in the 2016 UN Human Development Index,[29] and 157th out of 182 countries in climate vulnerability as per the latest ND-GAIN index.[30] The disaster exacerbated existing inequalities, with an aggregate impact that is much higher than official figures suggest. The flooding had a devastating environmental impact, particularly in the 17,000-hectare Western Area Peninsula National Park which holds approximately 85 percent of the country's biodiversity (SDG 15, target 15.1).

Floods in Malawi

The highest amount of rainfall in Malawi was recorded in 2015, causing significant flooding in the southern part of the country and triggering a state of disaster for 15 districts. The floods destroyed over 7,000 hectares of forest, over 1,000 beehives, and large areas of fertile land (SDG 15, target 15.1). Although trees and wetlands absorbed much of the damage, illustrating the adaptation benefits of ecosystem services,[31] 10 percent of the railway track in the country was damaged, along with 185 bridges and 1,220 kilometers of road (SDG 11, target 11.2). 461 of the country's 2,662 predominantly rural public schools were impacted. A further 222 schools were converted into camps for displaced people, and consequently suffered damage to property, playgrounds, and sanitary facilities (SDG 4, target 4.7). Overall, the floods triggered a loss in GDP growth of 0.55 percent (SDG 8, target 8.3).

Cyclone Fantala in Seychelles

In 2016, the Farquhar Atoll in the Seychelles was hit by Tropical Cyclone Fantala, damaging most of the infrastructure and 95 percent of the coconut groves in the area (SDG 2, target 2.4). The strongest tropical cyclone ever recorded in the Indian Ocean basin, Fantala caused damages worth US$ 7.5 million (SDG 8, target 8.1). Of this, around 30 percent was sustained by the government sector, and about 40 percent by the environment (SDG 15, target 15.1), a public asset. The impacts of the disaster will continue to accumulate over time: agricultural losses will accrue during the seven years that it will take to replace the coconut groves; and tourism, fishing, and agricultural productivity will only resume once the infrastructure assets have been replaced. The losses to Farquhar Atoll's unique ecosystems cannot be accounted for.

This GCA analysis of the most important recent climate disasters in Africa illustrates how they slow progress towards achieving SDGs, and the multi-dimensional impacts they cause. There is an opportunity to better integrate the SDG framework in post-disaster assessments to map impacts across different socioeconomic systems.

Climate disasters can reverse the progress achieved in SDG indicators at the sub-national level, and even at the national level for small countries. Mainstreaming adaptation and enhancing the resilience of SDG investments can reduce the impact and avoid such reversals. The achievement of the 2030 targets will depend on how well the SDG plans incorporate climate change and adaptation in their design and execution.

Table 4: Multi-dimensional impact of disasters on SDG targets and indicators in Africa

				SDG 1	SDG 2		SDG 4	SDG 8	SDG 11	SDG 15
				Target 1.5 / Target 11.5	Target 2.4		Target 4.7	Target 8.1	Target 11.5	Target 15.1
				Indicator 1.5.1/11.5.1: Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	**Indicator 2.4.1:** Proportion of agricultural area under productive and sustainable agriculture		**"Indicator 4.a.1** Proportion of schools offering basic services, by type of services	**Indicator 8.1.1:** Annual growth rate of real GDP per capita	**Indicator 1.5.2 / 11.5.2:** Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters	**Indicator 15.1.1:** Forest area as a proportion of total land area
Country	**Disaster (year)**	**Total national population (million)**	**Affected population in millions (percent)**	**Number of directly affected persons in millions** (percentage of total national population) (percentage of population in affected area)	**Number of farming households affected**	**Arable land destroyed**	**Number of schools affected**	**Decline in GDP** (percentage, projected to real)	**Number of houses destroyed**	**Environmental damage (US $)**
Mozambique	**Hurricane Idai** (2019)	**27.91**	**13.5** (48%)	1.51 (5.4%) (11.2%)	433,056 (equivalent to 2.1 million people, 7.5% of total population, 15% of pop in affected provinces)	4,309 ha	1,372	4.7% to 2.5%	240,000	79.8 million
Zimbabwe	**Hurricane Idai** (2019)	**16.5**	**6.3** (44%)	0,27 (1.6%) (4.3%)	50,000	1.4 million ha	Not available	-2.1% to -3.6%	18,000	37.4 million
Sierra Leone	**Flood and Landslide** (2017)	**7.81**	**1.49** (19%)	0,006 (0.08%) (0.4%)	Not available	Not available	59	Not available	349	7,440
Somalia	**Drought** (2016-2017)	**12.3**	**12.3**	0,001 deaths	900,000	93,000 tonnes (topsoil erosion)	Not available	Not available	Not available	1.18 billion
Seychelles	**Cyclone Fantala** (2016)	**0.09**	Not available	Not available	Not available	95% of coconut groves	Not available	Not available	Not available	2.4 million
Malawi	**Flood** (2015)	**16.3**	**1.37** (8.4%)	1.1 (6.7%) (80%)	146,310 (10% of smallholder households)	89,110 ha	461	0.55% loss in growth	52,3347	Not available
Mozambique	**Flood** (2015)	**26.2**	**11.5**	0,16 (0.6%) (1.4%)	102,000	104,430 ha crops lost, 23,000 ha pastoral land flooded	Not available	Not available	30,000	Not available

Source: Adapted from GFDRR (2021). Post-Disaster Needs Assessments. Global Facility for Disaster Reduction and Recovery.

> There is a momentum as we recover from the Covid-19 pandemic: we need to mobilise to build back better and greener. This requires both political and financial determination and imagination."

Per Olsson Fridh, Minister for International Development Cooperation, Sweden
Leader's Dialogue on the Africa Covid-Climate Emergency, April, 2021

CONCLUSIONS

Sustainable development is a key priority for African countries, given its prominence in Agenda 2063, Africa's blueprint for the future. So is adaptation and resilience-building, given the continent's extreme vulnerability to climate change. Unlike adaptation, however, the 2030 Sustainable Development Agenda and the SDGs are supported by a robust set of indicators and targets to measure progress. Identifying the links between the SDGs and adaptation can help track progress on adaptation, and to identify gaps. Both adaptation and the achievement of the SDGs will make the countries on the continent more resilient to the impacts of climate change.

Photo: Vlad Karavaev/Shutterstock

Africa Adaptation Partnerships

Photo: Wazzkii/Shutterstock

While the challenges of climate change are expected to manifest in different ways across the African continent, to effectively mitigate and adapt to them will require a unified effort. The partnerships described below are working to develop such an overarching approach among national and local authorities and civil society organizations, thus strengthening the capacity of institutions at all levels of society to adapt.

Africa Adaptation Initiative[32]

Launched at the 21st UN Conference of Parties in 2015, the African Adaption Initiative (AAI) is an initiative of the African heads of state to adapt to the adverse effects of climate change. The initiative, with GCA acting as the lead coordinating partner, aims to enhance action on adaptation by addressing financing gaps and connecting regional partners to find solutions.

Through partnerships with institutions that are undertaking relevant work on the continent, the AAI is scaling up and replicating successful ongoing initiatives and developing proposals for new ones. This begins by coordinating with partners to support four AAI flagship programs: Climate Information Services, Advancing Risk Transfer in Africa, Lake Chad River Basin Early Warning System, and Knowledge Management Programme for Adaptation Planning in Africa. Two additional flagship programs – Adaptation of African Agriculture and African Climate Finance Forum – are also in the pipeline.

AUDA-NEPAD[33]

Established in 2010 as the New Partnership for Africa's Development (NEPAD), the NEPAD Planning and Coordination Agency was transformed into the African Union Development Agency (AUDA - NEPAD). The mandate of AUDA-NEPAD is to coordinate and execute priority regional and continental projects to promote regional integration towards the accelerated realization of Agenda 2063; and to strengthen the capacity of African Union (AU) member states and regional bodies, advance knowledge-based advisory support, mobilize the full range of available resources, and serve as the continent's technical interface with all of Africa's development stakeholders and partners.

The Agency implements its mandate through six thematic areas: economic integration; industrialization; environmental sustainability; technology, innovation and digitization; knowledge management; and human capital and institutions development. The AUDA-NEPAD provides innovative incubator programs and technical, implementation and capacity support to regional economic communities and member states, especially in key areas such as food and nutrition, energy, water, infrastructure, information and communication technology and digital economy, natural resource governance, climate change and institutional and human capital development and innovation.

It also offers advisory support and technical backstopping to the AU; monitoring and assessment of progress and development trends across Africa; promotion of research to inform policy development; facilitation of cooperation with stakeholders in the private sector and African academia, among other sectors; and improved coordination between AU specialized agencies, organs and other institutions to create an enabling and supportive environment to achieve the goals and priorities of Agenda 2063.

The AUDA-NEPAD leads several adaptation-relevant initiatives, such as the African Forest Landscape Restoration Initiative, Comprehensive Africa Agriculture Development Programme (CAADP), Climate Smart Agriculture, Climate Change Fund, etc. The Agency has impacted the lives of nearly 1.2 million women across 38 countries in areas such as business development, microfinance, agriculture, nutrition, and information and communication technologies; 47 countries have signed the CAADP Compact to increase public agricultural expenditure by more than 7 percent per year; regional integration has been strengthened through infrastructure (16,066 km of roads and 3,506 km of power transmission lines built); 85 million ha of degraded and deforested land have been designated for restoration; and 112,900 direct and 49,400 indirect jobs have been created through cross-border infrastructure projects.

African Risk Capacity[34]

African Risk Capacity (ARC) is a specialized agency of the African Union established to help African governments improve their capacity to plan, prepare for, and respond to extreme weather events and natural disasters. ARC works towards these objectives by providing access to customized early warning information for droughts through its Africa RiskView software, supporting governments as they prepare contingency plans to minimize the impacts of disasters, disbursing funding for pre-approved contingency plans to respond rapidly and predictably to disasters, and promoting innovative financing mechanisms (including risk pooling and transfer through African Risk Capacity Insurance Company Limited or ARC Ltd.).

ARC and ARC Ltd. have provided support to several African countries. For instance, in 2020, ARC Ltd. made parametric drought risk insurance payouts of $1.4 million to the Government of Zimbabwe and $290,288 to the UN World Food Programme (WFP) to support extensive drought response efforts in Zimbabwe. In 2018, ARC Ltd. disbursed $2.4 million to the Government of Mauritania in response to a progressively severe drought, with the funds going to subsidize livestock feed for pastoralists in the most affected areas. ARC also provides other capacity building and technical programs and services; e.g. its capacity building program, outbreaks and

Photo: _am_zews/Shutterstock

epidemics program, replica coverage program to mobilize humanitarian funds for complex risks, the Extreme Climate Facility to secure additional funding to respond to any increase in the frequency and magnitude of extreme events, and the pan-African flood model, a tropical cyclone risk model to inform parametric insurance measures.

Since its launch, ARC has assisted more than 2.1 million vulnerable people, disbursed more than $61 million in payouts for early responses and provided more than $600 million in drought risk coverage.

Least Developed Countries Universities Consortium on Climate Change[35]

The Least Developed Countries Universities Consortium on Climate Change (LUCCC) is a South-South, long-term capacity-building initiative involving universities in LDCs, with a focus on climate change adaptation, especially community-based adaptation. The main purpose of LUCCC is to help LDCs to build their own capacity to address climate change through research, knowledge sharing and education. The initiative was first conceived at the 22nd Session of the Conference of Parties to the United Nations Framework Convention on Climate Change in Marrakech in 2016 under the leadership of the International Centre for Climate Change and Development (ICCCAD) at Independent University, Bangladesh, and the Makerere University Center for Climate Change Research & Innovations (MUCCRI) in Uganda. Its objectives include:

- Fostering a South-South collaborative network for enhancing research capacity and expertise in climate change.
- Increasing opportunities for networking and enhancing the capacity of universities in the Global South to develop common research projects and implement teaching and training programs on various climate change topics.
- Promoting work with the most vulnerable countries and for the most vulnerable communities.
- Fostering two-way collaborative learning and capacity-building.
- Enabling LDC universities and research institutes to serve as repositories of knowledge and suppliers of capacity in efforts to enable national agencies to effectively implement community-based adaptation initiatives.

The LUCCC membership includes 15 universities, out of which 11 are in Africa (Ethiopia, Malawi, Rwanda, Sudan, Tanzania, Uganda, Burkina Faso, Liberia, The Gambia, Senegal and Mozambique).

United Cities and Local Governments of Africa[36]

Founded in 2005, the United Cities and Local Governments of Africa (UCLG Africa) is an umbrella organization that represents local governments in Africa. It was formed as a result of the unification of three continental groups of local governments; namely, the African Union of Local Authorities, the Union des Villes Africaines, and the Africa Chapter of the Unao dos Ciudades y Capitaes Lusofono Africana. UCLG Africa's mandate is to support the development of local governments to better serve their communities by improving living conditions and driving development from the grassroots. The programs and interventions of UCLG Africa broadly fall under three pillars: institutional

Photo: Dennis Diatel/Shutterstock

capacity development to ensure representation of stakeholders and financial sustainability; advocacy and mobilization to bring together decision makers and facilitate action towards a more decentralized system of governance; and corporate learning and knowledge management to build the capacity of officers in local economic development and provide them with access to best practices and knowledge resources.

One of the key initiatives of the UCLG Africa is the African Local Government Academy. The academy aims to invest in the human capital of African local governments, notably through the expansion of its network of anchor institutes in Africa and partners around the world, the promotion of quality standards in training and capacity building targeting the local level, designing trainings that respond to the needs and priorities of UCLG Africa members and networks, promotion of human resources at the local level and sharing knowledge, tools and methodologies. As of 2020, the initiative had reported more than 10,000 beneficiaries.[37]

Other programs implemented by UCLG Africa include: Africities and the Africities Summit, which aim to improve livelihoods and promote integration, peace and unity at the grassroots level; the Climate Change Task Force, which is committed to promoting multi-stakeholder initiatives and supporting local governments to access climate financing, particularly the Green Climate Fund; continental dialogues to enhance the role of African local authorities within the African Union; and the Pan-African Peer Review Facility to promote cooperation, learning and organizational improvement of local governments and their associations.

The membership of UCLG Africa includes more than 40 national associations of local governments and the municipal governments of 2,000 cities representing nearly 350 million African citizens.

Global Water Partnership Southern Africa[38]

Global Water Partnership Southern Africa (GWPSA) is one of the 13 regional networks that make up the Global Water Partnership (GWP), an international network created in 1996 to foster the implementation of integrated water resources management and the coordinated development and management of water, land, and related resources that maximize economic and social welfare without compromising the sustainability of ecosystems and the environment. The GWPSA offers practical support in sustainable management of water resources to 16 countries in the Southern African Development Community region. It manages activities and convenes stakeholders in this region and at a pan-African level to address issues that have an impact on water security. GWPSA hosts the coordination unit for all five GWP regions in Africa, known as the Africa Coordination Unit or ACU.

Together, the GWPSA and ACU support the development and implementation of the Continental Africa Water Investment Program (AIP) – a pan-African program to address bottlenecks in financing and transform water and sanitation investments. The AIP aims to mobilize $30 billion in investments by 2030, while creating 5 million direct and indirect jobs.[39] As of April 2020, the GWPSA had initiated implementation of the AIP in five pilot countries (Benin, Cameroon, Uganda, Tunisia and Zambia) across five transboundary basins (North-West Sahara Aquifer System, Volta Basin, Lake Chad Basin, Kagera/Lake Victoria Basin and Zambezi River Basin). The approach of the AIP includes: mobilizing high-level leadership to accelerate water investments, improving the enabling environment to fast-track finance and investment mobilization, addressing bottlenecks during project preparation, strengthening and promoting public-private partnerships, implementing gender-transformative approaches, and supporting regional and national water investment programs. In 2021, the AIP was adopted by the African Union as part of the Programme for Infrastructure Development in Africa (PIDA) Priority Action Plan.

GWPSA is working with representatives of the African Ministers' Council on Water (AMCOW), African Union Development Agency (AUDA-NEPAD), African Development Bank (AfDB) United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), Global Water Partnership (GWP), and GCA to convene an international high-level panel, which aims to drive global political mobilization and international engagement to narrow the water investment gap in Africa and enhance efforts to meet the social-economic needs of the continent, to reach the Sustainable Development Goals' water-related targets and to address the twin challenges of climate change and the COVID-19 pandemic.

Pan African Climate Justice Alliance[40]

The Pan African Climate Justice Alliance (PACJA) is a consortium of more than 1,000 organizations from 48 African countries that brings together a diverse membership drawn from grassroots, community-based, faith-based and non-governmental organizations, trusts, foundations, indigenous communities, farmers and pastoralist groups. The overarching goal of PACJA is to mobilize and empower African civil society to ensure the realization of environmental and climate justice for all African people.

The Alliance focuses on targeted research, particularly on monitoring the outcomes of PACJA's advocacy agenda, mobilizing public engagement on climate change; informing policy formulation, providing a platform for civil society and facilitating civil society organizations' participation in policy making through regional and global dialogues, and ensuring the accountability of governmental and inter-governmental bodies. PACJA works through its national chapters across three thematic areas: climate finance, just transitions and resilient people.

Among the key initiatives of the PACJA are the African Climate Change and Environmental Reporting (ACCER) Awards – which recognize journalists reporting on climate change across Africa, thereby encouraging proactive media participation in African climate change discourse – and the Nairobi Summer School, which aims to bring the issue of climate justice to the forefront of climate change discourse and promote North-South cooperation and knowledge exchange.


Photo: YolLusZam1802/Shutterstock

Annex

- Country profiles
- Endnotes

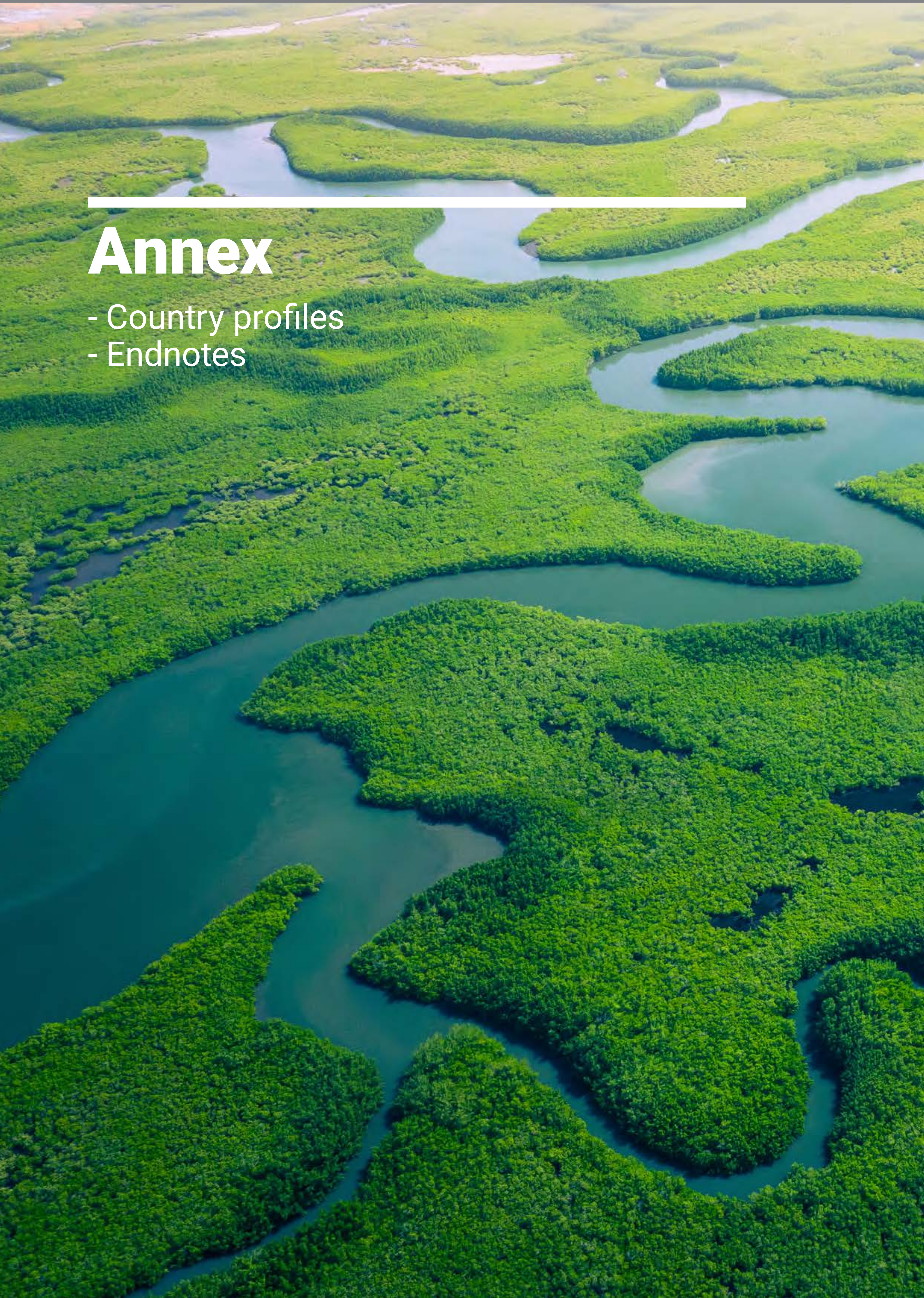


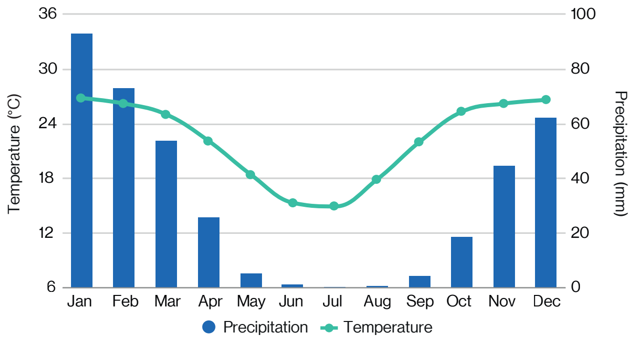
Photo: Curioso.Photography/Shutterstock

Botswana

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 21.6°C; 396.2mm
Mean annual max/min T (1901–2020): 29.6°C; 13.6°C

Country context

Population **2.3m (2019)**	Annual growth rate **2.2% (2019)**
GDP **$18.3bn (2019)**	Annual growth rate **3% (2019)**
GDP per capita **$7900 (2019)**	

Literacy rate, adult female/male: 87%/86% (2013)
Geography: Landlocked country in southern Africa; land surface dominated by Kalahari Desert, Okavango swamps, Zambezi River, Makgadikgadi Pans; land area: 600,370km²
Broad climate: Arid to semi-arid; warm winters, hot summers

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +2.2** (+1.4°C)	**+1.6 to +3.5** (+2.5°C)	**+2.8 to +5.2** (+3.8°C)	**+3.9 to +7.1** (+5.0°C)
Annual Precipitation Anomaly (mm)	**−18.8 to +11.9** (−2.4mm)	**−24.9 to +9.5** (−5.3mm)	**−25.6 to +9.3** (−7.1mm)	**−32.1 to +6.1** (−9.5mm)

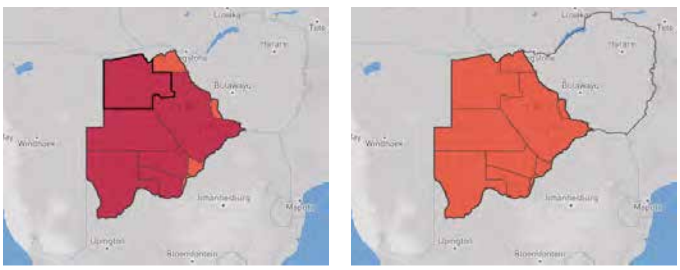
Climate hazards

- Droughts and floods are the most destructive climate-related natural hazards
- Flood disasters have occurred mainly along the Zambezi, Okavango, Boteti and Limpopo Rivers; several urban areas impacted
- Heightened dry conditions and increased pressure on water resources expected by mid-century, particularly for northern, eastern and central areas; severe drought conditions and water scarcity expected by end of century
- Mean monthly temperature expected to increase by 2.5°C by the 2050s and 5°C by end of century under RCP8.5
- Number of hot days expected to increase by 138 days by end of century under RCP8.5

Natural hazards occurrence from 1991-2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		2	-	38,000	0.69%
Flood	Unstated	2	-	7,475	2.39%
	Riverine	6	15	120,602	
	Flash	1	20	3,500	
Storm	Tropical	-	-	400	0.01%
	Convective	1	-	-	-
Total		**12**	**35**	**169,977**	**3.09%**

Risk of water scarcity (left)[4], Risks of extreme heat (right)[5]



High Medium Low Very low

ENABLING ENVIRONMENT

Leadership and governance

Climate change (CC) focal point: Department of Meteorological Services, under Ministry of Environment, Wildlife and Tourism
Implementation of CC response policy: Central government. National Climate Change Unit for implementation, monitoring and compliance currently under development
Advisory body to government: National Climate Change Committee

Key adaptation policies

Key policy documents: NAP framework (2020); Climate Change Policy draft (2017); NDC (2016); Botswana Vision 2036 (2016); Integrated Water Resources Management and Water Efficiency Plan (2013); National Water Policy (2012)

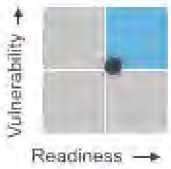
Disaster risk management

- Working to integrate an effective disaster management strategy into sectoral policies and programs and to scale efforts across sectors
- Legislation and policies currently coordinated through National Disaster Risk Management Plan (2009)
- **Priorities include:** public awareness and education, improving multi-hazard risk analysis, strengthening early warning systems (EWS) at regional and national level
- **Strategies include:** National Disaster Risk Reduction Strategy 2013–2018 (2013); Africa Regional Strategy for Disaster Risk Reduction (2004); Southern African Development Community's Disaster Risk Reduction Strategy and Plan of Action 2010–2015

ND-GAIN Index[6]

Country Index rank (score): 88 (48.9)
Vulnerability: 0.450
Ecosystem Services 13%, Food 18%, Human Habitat 19%, Health 17%, Infrastructure 19%, Water 13%

Readiness: 0.427
Economic 35%,
Governance 49%,
Social 15%



ND-GAIN Evolution

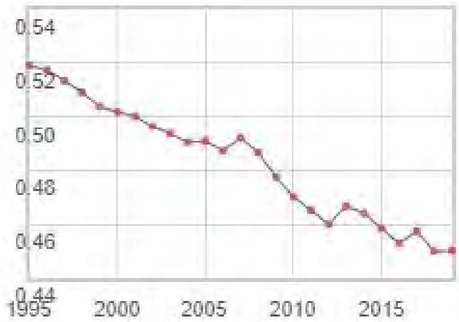


Photo: Lucian Coman/Shutterstock

Botswana

SECTORAL ADAPTATION PLANNING

AGRICULTURE

Rain-dependent, agricultural land (2018): 46% of total land area; most cultivated land is in the eastern region

- **Crops:** sorghum, corn, millet

Main climate change impacts

- Decreased maize & sorghum yields (from 45% to 35% by mid-century) from increasing temperatures and reduced precipitation; decreased recharge & water quality from reduced precipitation
- Increased presence of pests and diseases due to increased temperatures and waterlogging of fields
- Soil erosion and loss of soil fertility due to precipitation seasonality changes
- Droughts and prolonged dry periods will increase soil erosion and exacerbate land degradation, with total annual cost of land degradation estimated at US$ 353 million, 3.2% of GDP
- Extreme events may change/impact species' composition and alter soil water maintenance, base flows and filtration

Proposed adaptation strategies

- Focus on increasing sustainable crop production and livestock practices such as investment in irrigation structures, conservation agriculture, watershed management, and nutrient and crop management
- Use of more drought-resistant crop varieties; shifting from maize to sorghum to pearl millet
- Diversification of income and greater accessibility of financing options
- Improved livestock diets and genetic characteristics for breeds

WATER

Villages: groundwater reliant
Urban areas: surface water reliant

Main climate change impacts

- Changes in water quality and availability; stream flows for the Okavango catchment expected to decrease by 20%
- Reduced water availability in water-scarce regions (northern, eastern and central) due to increased frequency of droughts, evaporation and evapotranspiration
- Changes in rainfall patterns and evaporation impact the degree of surface water infiltration and recharge rates for groundwater
- Increased soil moisture deficits due to temperature increases, even under conditions of increasing rainfall

Proposed adaptation strategies

- Transboundary water management
- Investment in improved monitoring of irrigation, groundwater wells and aquifers, and investment in water infrastructure
- Increasing pressure on water demands and related infrastructure is expected as development and urbanization occurs. Development planning for urban expansion should be coordinated through CC adaptation strategies to ensure appropriate water management strategies and actions

HEALTH

30% of population exposed to some risks of malaria infection every year, with majority of cases occurring in northern districts of Bobirwa, Tutume, Serowe, Palapye and Boteti

Main climate change impacts

- Malaria infection is influenced by periods of heavy rainfall; risk of malaria expected to increase through the 2050s under a high-emission scenario; increased rainfall variability and extreme events may impact geographic and seasonal distribution of malaria risk
- Vulnerable groups at risk of increased undernutrition and food insecurity if exposed to extreme events
- Increased heat-related deaths, specifically in the elderly (65+ years): Projected increase from ~3 per 100,000 deaths p/y (between 1961 and 1990 baseline) to 136 per 100,000 deaths p/y by 2080s, under RCP8.5 scenario

Proposed adaptation strategies

- Upgrade health-care infrastructure
- Support training and capacity building efforts across the sector
- Support an Integrated Disease Surveillance and Response system
- Improved access and support for social safety nets and public works programs to support food security

Milestones

- Malaria Control Program and Control of Diarrheal Diseases Program have been implemented for combatting CC impacts on health

NEEDS

Research

- Increase understanding of CC vulnerabilities, impacts and possible adaptation responses within key sectors
- Widen participation of public, scientific institutions, women and local communities in planning and management
- Invest in weather stations and expanding national hydro-meteorological and seismological monitoring systems
- Strengthen technical capacity for integrating climate-smart agriculture (CSA) and CC risk management into agriculture sector
- Technology needs assessment to inform adaptation strategies and planning

Institutional

- Ensure that National Environmental Strategy goals are developed within sectoral and regional plans
- Implement cross-sectoral climate-smart solutions at national and subnational levels
- Integrate climate change concerns into relevant policies and planning processes
- Collaborate with climate technology centers for training and information provision to strengthen national capacities

Data and information

- Improve observational data through the addition of weather stations and hydro-meteorological and seismological instrumentation
- Improve technical capacity for analyzing hydro-met data
- Establish institutional capacity for providing timely EWS in coordination with Integrated Disease Surveillance and Response systems
- Promote development of guidelines for green economy transitions

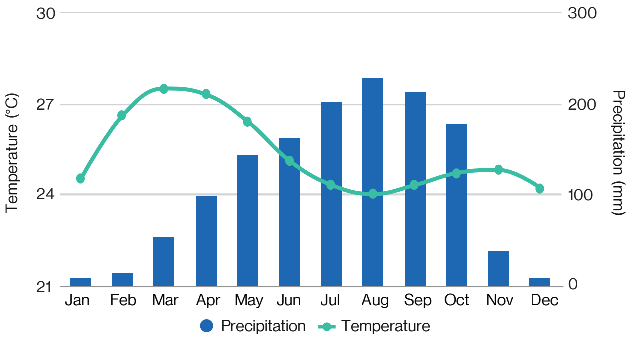
[1]WB Climate Change Knowledge Portal (CCKP, 2021). Botswana
[2]WB Climate Change Knowledge Portal (CCKP, 2021). Botswana Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Botswana. Water Scarcity
[5]ThinkHazard! (2020). Botswana. Extreme Heat
[6]ND-Gain: ND-GAIN Country Index: Botswana

Central African Republic (CAR)

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 25.1°C/1396.6 mm
Mean annual max/min T (1901–2020): 31.6°C/18.6°C

Country context

Population
4.7m (2019)

Annual growth rate
1.7% (2019)

GDP
$470bn (2019)

Annual growth rate
3% (2019)

GDP per capita
$2.2bn (2019)

Literacy rate, adult female/male: 26%/50% (2018)
CPIA gender equality rating: 2.5 (2019)
Geography: Landlocked country in central Africa; land area: 623,000 km^2
Broad climate: Favorable conditions, primarily hot and humid

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.7 to +1.5** (+1.1°C)	**+1.4 to +2.7** (+1.9°C)	**+2.3 to +4.2** (+2.8°C)	**+3.1 to +5.7** (+3.8°C)
Annual Precipitation Anomaly (mm)	**−18.4 to +21.9** (+0.8mm)	**−21.0 to +29.6** (+1.7mm)	**−21.5 to +38.5** (+3.8mm)	**−28.2 to +50.4** (+5.0mm)

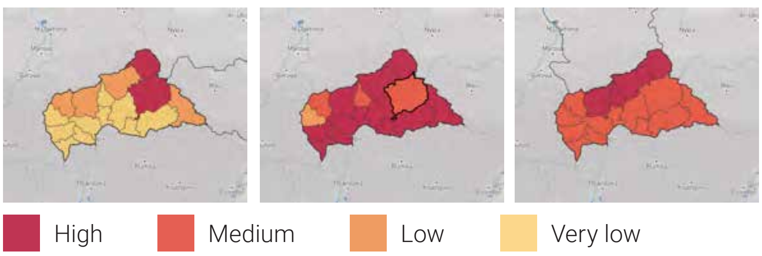
Climate hazards

- Natural hazards dominated by floods, wildfires and droughts. Poverty and political insecurity exacerbate vulnerability to these hazards
- Excess rainfall expected to be strongest in central and southern areas of the country, and is expected to result in flooding, causing riverbank erosion and/or overflows, landslides and waterlogging of agricultural fields leading to likely crop failures
- Climate change (CC) expected to increase risk & intensity of flooding, amount of heavy rainfall received during heavy rainfall events, and likelihood of aridity and water scarcity for some areas
- CC, deforestation, watershed degradation, land use, urbanization and poor management of settlements, slash and burn agricultural techniques have exacerbated issues and impacts from flooding and droughts, and increased the risk of wildfires

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	7	7	61,457	0.85%
	Riverine	6	6	40,578	
	Flash	3	3	2,935	
Storm	Unstated	1	-	-	0.20%
	Tropical	-	5	24,476	
	Convective	8	3	-	
Wildfires		2	1	-	0.00%
Landslides		-	-	85	0.00%
Total		**27**	**25**	**129,531**	**1.05%**

Risk of water scarcity (left), Risk of river flood (centre) and Risks of extreme heat (right)[4]



ENABLING ENVIRONMENT

Leadership and governance

- The Ministry of Environment, Ecology and Sustainable Development is responsible for guiding the country's environmental sustainability plans and climate change responsibilities
- CAR is a member of the Central African Forest Commission (COMIFAC), a treaty organization established to harmonize regional policies on forestry and biodiversity conservation

Key adaptation policies

Key policy documents: NDC (2016); Second National Communications (2015); Law on the Protection of Nature (2015); Environmental Law on Biofuels (2008); Forestry Code (2008); National Adaptation Program of Action (2008); Poverty Reduction Strategy Paper (2007)

Disaster Risk Management (DRM):

- No specific DRM entity wholly responsible for Disaster Risk Reduction (DRR); Ministry of Planning, Economy and International Cooperation has coordinated past efforts
- CAR has partnered with the World Bank and received resources from the GFDRR to develop and conduct risk assessments and institutional capacity building efforts through implementation of short- and medium-term flood mitigation programs
- DRM options include hydro-meteorological services and expansion of observation and forecasting infrastructure to forecast disasters, national Early Warning System (EWS) programs, flood and drought management programs, and riverbank development projects

ND-GAIN Index[5]

Country Index rank (score): 181 (29.0)
Vulnerability: 0.561
Ecosystem Services 18%, Food 21%, Human Habitat 24%, Health 29%, Water 7%

Readiness: 0.141
Economic 16%, Governance 44%, Social 39%

ND-GAIN Evolution

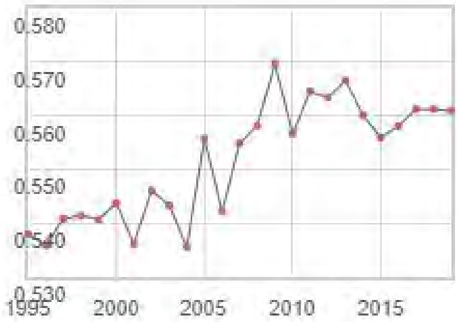


Photo: mbrand85/Shutterstock

Central African Republic (CAR)

SECTORAL ADAPTATION PLANNING

AGRICULTURE

25% of GDP, employs 72% of the population

- 15m ha of agricultural land; 7000km^2 cultivated p/y
- **Crops:** major staples are beans, maize and cassava

Main climate change impacts

- Extreme rainfall, prolonged dry spells and rising temperatures will impact crop selection and productivity, alter farming practices and pressure farmers to expand cropland into forests
- Rising temperature may increase pest and pathogen dynamics (such as for the cassava mosaic virus) and negatively impact processing/storage of agricultural/perishable products
- Damaged ground transportation infrastructure from floods/rain may increase erosion, raise transport costs, prevent products reaching market before spoiling, negatively impacting farmers
- Planting timelines altered from increased/prolonged dry spells

Proposed adaptation strategies

- Develop and implement environment and agricultural protection policies
- Improve financing mechanisms for small-scale farmers and commercial industries
- Research to increase CC knowledge on the agricultural sector, such as on seasonal information to inform farmers about planting
- Training for farmers to improve sowings and soil quality
- Agricultural extension programmes
- Community involvement for forest ecosystem management
- Improve road & transportation networks for market access
- Crop diversification, establishing seed banks, and promoting sustainable soil management

WATER

Main climate change impacts

- Depends on groundwater & local springs; large availability of water resources but little institutionalised water infrastructure
- Intense rainfall can exacerbate poor water quality especially in urban areas, and increase risk of flooding, pollution, and contamination of drinking water
- Changes in rainfall and evaporation impact surface water infiltration and groundwater recharge, which could decrease reliability of groundwater/surface water sources during droughts
- Increasing temperatures could result in soil moisture deficit, even if rainfall increases

Proposed adaptation strategies

- Mobilization of financial investment opportunities to support key infrastructural investment in water access, irrigation and the potential for hydropower generation
- Comparative assessments and collaborative efforts to support public-private partnerships of sector management
- Improvements to hydro-meteorological forecasting to enhance planning and investment capabilities and for more effective planning and preparation for major rainfall events and flooding
- Research on surface and underground water quality to enhance resource allocation planning
- Adaptation infrastructure to support hydrological variations, to reduce flooding, and improve transport networks
- Improve water management
- Improve supply of potable water

HEALTH

Main climate change impacts

- Increased temperature and rainfall may open new locations suitable for malaria transmission, impacting on lifecycle and habitat of malaria-carrying mosquito and parasites
- Increased temperature and rainfall likely to impact spread of waterborne diseases and emerging infectious diseases
- Higher temperatures, water scarcity, flooding and drought to negatively impact agriculture, leading to increased food insecurity
- Flooding may displace communities and increase the risk of water-borne diseases
- Higher temperatures may threaten food and nutritional security, agricultural livelihoods, and increase heat-related deaths

Proposed adaptation strategies

- Health financing, including the supply of medicines
- Strengthen institutional governance to operationalize health districts, strengthen capacity to manage the district and regional health teams, and organize monitoring and evaluation of service delivery in health facilities at health-district level
- Integrated Disease Surveillance and Response mechanism being reviewed and established
- Human resources observatory being established to develop a human resources plan, including reform of the Health Sciences Faculty and its annexes in the short and longer term

NEEDS

Research

- Increase meteorology, climatology and hydrology teaching in higher education and university
- Research existing resilience mechanisms across sectors
- Develop system for monitoring underground & surface water; establish early warning network for hydrologic hazards & floods
- Strengthen monitoring for environmental management
- Evaluate needs and develop national strategy for technology transfer to support NDC adaptation measures

Institutional

- Establish land-use plans by type of use
- Integrate CC concerns into relevant policies/planning processes
- Finalize and adopt the framework bill on the environment as well as outstanding nature conservation bills
- Finalize regulations to fund and implement impact studies regarding climate change impacts for the country and key sectors

Data and information

- Improve technical capacity to analyze hydro-met data and project impacts across sectors, and establish institutional capacity for timely early warning systems for farmers
- Increase understanding of water resource threats for better long-term management and water use efficiency
- Regulation and enforcement to protect forests, rainforests, and Protected Areas
- Improve data collection on forest loss and land degradation

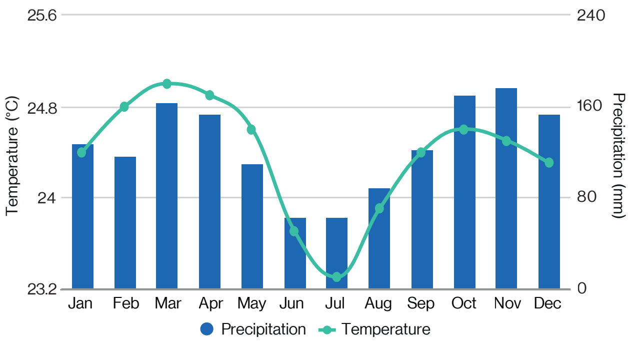
[1]WWBG Climate Change Knowledge Portal (CCKP, 2021). CAR
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Central African Republic Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database – Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). CAR Overview
[5]ND-Gain. ND-Gain Index: Central African Republic

Democratic Republic of the Congo (DRC)

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 24.1°C; 1,500mm
Mean annual max/min T (1901–2020): 29.7°C/18.5°C

Country context

Population **86.7m (2019)** | Annual growth rate **3.2% (2019)**

GDP **$50.4bn (2019)** | Annual growth rate **4.4% (2019)**

GDP per capita **$424 (2019)**

Literacy rate, adult female/male: 67%/89% (2019)
CPIA gender equality rating: 3.0 (2019)
Geography: Landlocked country on the equator in central Sub-Saharan Africa; contains 62% of the Congo Basin; land area: 2,345,408 km^2
Broad climate: North and west in the Congo River Basin: hot and humid; south, central & east: cool and dry

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.5 to +1.4** (+1.0°C)	**+1.2 to +2.4** (+1.7°C)	**+2.0 to +3.7** (+2.5°C)	**+2.7 to +5.1** (+3.5°C)
Annual Precipitation Anomaly (mm)	**−13.7 to +21.6** (+2.6mm)	**−17.1 to +25.2** (+3.5mm)	**−17.0 to +34.0** (+6.7mm)	**−17.8 to +44.0** (+10.5mm)

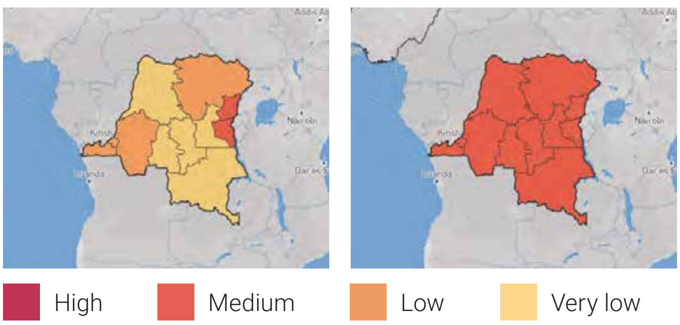
Climate hazards

- Increased rainfall may lead to soil erosion and waterlogging of fields, leading to decreased yields and increased food insecurity
- South especially vulnerable to rising temperature and increased aridity, which will negatively impact water storage capacity
- Deforestation, watershed degradation, land use changes, urbanization and poor management of growing settlements have exacerbated impact from floods, droughts, water scarcity and pollution, limiting water for drinking, agriculture, and other uses
- Heavy rainfall can trigger riverine, coastal and flash floods, especially common in the country's mountain areas and can also trigger landslides and mudslides
- Water drainage systems non-existent and increasing urbanization into flood plains and/or low-lying areas has increased flood risk
- Competing demands between household consumption & agriculture may increase water stress
- Increased heat will further strain water resources, as will impacts from changing rainfall patterns

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	11	275	412,560	0.59%
	Riverine	19	235	513,260	
	Flash	4	206	67,628	
Storm	Unstated	1	17	-	0.04%
	Tropical	1	24	75,000	
	Convective	3	8	-	
Wildfires		3	11	-	0.03%
Landslides		6	280	57,003	0.00%
Total		**48**	**1,056**	**1,125,451**	**0.66%**

Risk of water scarcity (left)[4], Risks of extreme heat (right)[5]



ENABLING ENVIRONMENT

Leadership and governance

Sustainable Development Directorate within the Ministry of Environment, Nature Conservation and Tourism

- Responsible for Climate Change (CC) adaptation efforts since early 2000s
- Aims to implement recommendations of the World Commission on Sustainable Development and the COP to the Conventions of Biodiversity, Climate Change and Desertification

Environmental Protection Law

- Promotes mainstreaming of sustainable development issues into policies, plans and programmes across all relevant sectors
- Includes obligation to adopt and implement national measures for adaptation and disaster management

Key adaptation policies

Key policy documents: Climate Change Profile (2018); NDC (2016); Law on the Protection of Nature (2014); Poverty Reduction Strategy Paper (2013); NAPA (2006); NAP (2006)

Disaster Risk Management (DRM):

- Currently working with UNDP on country's first DRM policy
- National Strategic Development Plan (2019–2023) includes climate adaptation and DRM as core pillar
- DRM priorities: improve national capacity to monitor & forecast hazards and transfer this into decision making and planning; strengthen early warning systems; national capacity strengthening; and investments in hydro-meteorological observations

ND-GAIN Index[6]

Country Index rank (score): 178 (32.4)
Vulnerability: 0.592
Ecosystem Services 14%, Food 20%, Human Habitat 20%, Health 22%, Infrastructure 11%, Water 12%

Readiness: 0.241
Economic 50%, Social 49%

ND-GAIN Evolution

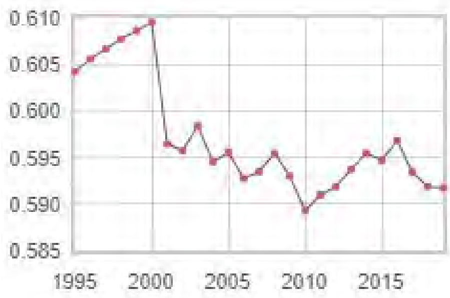



Photo: Travel Stock/Shutterstock

Democratic Republic of the Congo (DRC)

SECTORAL ADAPTATION PLANNING

AGRICULTURE

40% of GDP, employs 70% of the population

- **Arable land:** 80m ha of agricultural land; 12.5% cultivated currently
- **Crops:** Major staples are maize, cassava; other staples: plantains, maize, sweet potato, beans, groundnut, mangoes

Main climate change impacts

- Change in rainfall intensity will damage crops and erode fertile soils, introducing/intensifying crop diseases
- Prolonged dry spells/rising temperatures will reduce yields, pressuring farmers to expand their cropland into forests
- Rising temperatures likely to threaten yield and quality of plantains, soy, dry beans, and coffee
- Prolonged dry spells could lead to significant losses of livestock and/or spoilage of livestock products
- Heavy rainfall and floods may force shifts in the timing of the planting and harvesting seasons, and damage road networks, decreasing access to markets and isolating rural communities

Proposed adaptation strategies

- Research to increase knowledge on CC impacts and improve access to seasonal information to inform timing of planting. Land use zoning plan (in progress) to limit the areas to be allocated specifically to agricultural activities
- Improve transport networks to safeguard market access
- Introduce high-yield crops & improve post-harvest techniques
- Increase funding for agricultural research & extension systems for technologies to be tested and adapted to local environment

WATER

Main climate change impacts

- DRC holds 12,000 km of navigable water and 62% of the Congo Basin. It has one of the highest volumes of freshwater in Africa. However, access to safe water is an issue for rural populations due largely to lack of investment in service provision
- Rising temperatures to impact storage, infiltration, and increase the risk from contaminants
- Rainfall events push rivers and streams beyond their banks, disrupting transportation and damaging infrastructure, and can increase the risk of flooding in rivers, streams and drainage ditches
- Water quality is at risk from more intense rainfall events, especially in urban areas where open sewerage and rubbish can contaminate water sources and increase sedimentation
- Basic sanitation services are limited: an estimated 50 million Congolese lack access to safe water and 80–90% of the population lack access to improved sanitation

Proposed adaptation strategies

- Targeted research to identify water resource challenges and geographic hotspots of risk at community & regional levels
- Hydrological data to address quality of surface and underground water resources
- Target improvement of water infrastructure
- Invest into water management

HEALTH

Main climate change impacts

- In 2014, less than 30% of health facilities were operational
- Damaged sanitation infrastructure through flooding is likely to increase water-borne and diarrheal diseases such as cholera
- Increased forest clearing, leading to increased contact between humans and wildlife, is projected to increase the transmission of Monkeypox virus from wildlife to humans
- Rising temperatures and increased humidity will impact the lifecycle and habitat of malaria-carrying mosquito and parasites
- By 2040, malaria cases are projected to triple; the number of people at risk from endemic malaria projected to increase by 65,000–80,000 in areas where environmental suitability for malaria was previously low

Proposed adaptation strategies

- Investment into climate-sensitive health issues
- Climate vulnerability and risk assessments on human health could help inform priority areas for investments such as health monitoring, and epidemiological tracking of risks and surveillance
- Capacity building of health care to identify diseases as they emerge

NEEDS

Research

- Increase understanding of vulnerabilities and possible adaptation responses
- Improve teaching of meteorology, climatology and general hydrology in higher education and university
- Strengthen monitoring for more effective environmental management
- Rehabilitate the network for collecting meteorological, climatological and hydrological data

Institutional

- Improve National Environment Act
- Integrate CC into policies and planning at state and national levels
- Finalise framework bill on the environment and nature conservation bills, and regulations to fund impact studies on CC on key sectors

Data and information

- Improve technical and institutional capacity for analysing hydro-meteorological data and providing early warning systems to farmers
- Increase understanding of water resources threats and groundwater risks
- Improve regulation and enforcement to protect forests and protected areas; and data collection on forest loss and land degradation

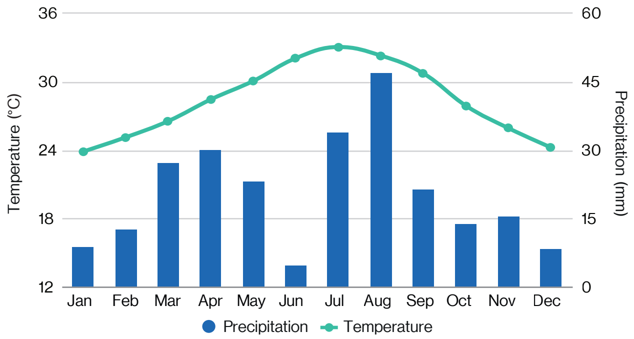
[1] WBG Climate Change Knowledge Portal (CCKP, 2021). DRC
[2] WBG Climate Change Knowledge Portal (CCKP, 2021). DRC Projected Future Climate
[3] Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium
[4] ThinkHazard! (2019). Overview: DRC
[5] ND-Gain. ND-Gain Index: DRC

Djibouti

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 27.8°C; 244.6mm
Mean annual max/min T (1901–2020): 32.2°C/22.5°C

Country context

Population **974,000 (2019)**
Annual growth rate **1.5% (2019)**

GDP **$3.3bn (2019)**
Annual growth rate **7.5% (2019)**

GDP per capita **$3,100 (2018)**

Literacy rate, adult female/male: 88.54%/88.29% (2019)
CPIA gender equality rating: 3.0 (2019)
Geography: Located in the Horn of Africa along the Gulf of Aden; land area: >23,000 km^2, coastline: 372 km; maritime area: 7,190 km^2
Broad climate: Arid tropical climate of semi-desert; cool season: mild temperatures, high humidity, sea winds; hot and dry season: high temperatures, hot and dry sand winds

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.4** (+1.0°C)	**+1.3 to +2.5** (+1.9°C)	**+2.1 to +4.1** (+2.9°C)	**+2.6 to +5.4** (+3.8°C)
Annual Precipitation Anomaly (mm)	**−8.1 to +20.7** (+2.4mm)	**−8.7 to +25.6** (+2.0mm)	**−10.3 to +38.0** (+3.2mm)	**−10.1 to +49.5** (+7.2mm)

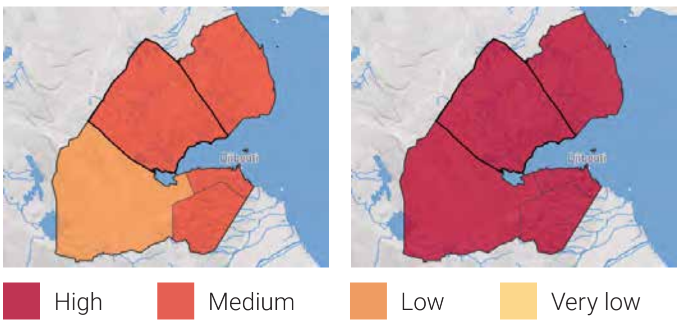
Climate hazards

- An estimated 33% of the population lives in high hazard risk zones
- 35% of the economy is chronically vulnerable to floods and drought; the 2008–2011 drought decreased GDP by 4% and agriculture GDP by 50%, with farmers and herders being the most affected
- Risk and intensity of water scarcity and drought, as well as increased frequency and intensity of extreme rainfall events, is expected to increase under a high emissions scenario
- Average monthly temperatures expected to increase by 1.9°C by 2050s and 5.4°C by end of century
- Sea level rise (SLR) threatens the coastline due to inundation and salinization, increasing risk to port infrastructure and tourism along the coast

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		6	-	933,008	39.14%
Flood	Unstated	1	8	110,000	24.27%
	Riverine	2	145	120,000	
	Flash	2	62	348,500	
Storm	Unstated	1	2	25,000	1.08%
	Tropical	1	-	-	
	Convective	-	-	775	
Total		**13**	**217**	**1,537,283**	**64.49%**

Risk of water scarcity (left)[4], Risks of extreme heat (right)[5]



ENABLING ENVIRONMENT

Leadership and governance

Climate change (CC) coordination and planning: National Climate Change Committee (CNCC); Secretariat hosted by the Department of Environment and Sustainable Development, within the Ministry of Housing, Urban Planning and Environment. Key priorities of CNCC:

- Water access; promote best practices in agriculture, forestry, fishery and tourism sectors; reduce CC vulnerability for the most exposed sectors; protect and enhance ecosystems and maintain their services; development of sustainable and resilient cities; increase infrastructure resilience and sustainability

Key adaptation policies

Key policy documents: NDC (2016); Strategy of Accelerated Growth and Promotion of Employment (SCAPE) (2015); Vision Djibouti 2035 (2014)

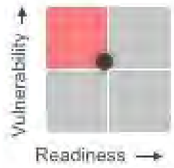
Disaster Risk Management (DRM):

- Working to improve hazards monitoring and communication, specifically for seismic and flood risk, focused around Djibouti City
- Priorities include: strengthening preparedness and response capacities, mainstreaming DRM in land-use planning, increasing awareness and understanding of hazard risk, promoting community-based DRM, disaster risk financing and insurance mechanisms, enhancing early warning systems (EWS)

ND-GAIN Index[6]

Country Index rank (score): 124 (42.4)
Vulnerability: 0.478
Ecosystem Services 19%, Food 18%, Human Habitat 21%, Health 26%, Infrastructure 15%

Readiness: 0.327
Economic 39%, Governance 38%, Social 22%



ND-GAIN Evolution

Photo: Homo Cosmicos/Shutterstock

Djibouti

SECTORAL ADAPTATION PLANNING

AGRICULTURE

Less than 1,000 km^2 of arable land, 4% of GDP, engages approximately 30% of the population

Main climate change impacts

- Rising temperatures, increasing water scarcity and increased evapotranspiration expected to threaten yields of rainfed crops as well as livestock health
- Increased temperature, sea level rise, and decreased precipitation will exacerbate existing water resources challenges for the sector
- Increase in weeds and diseases due to rising temperatures
- Floods and droughts expected to worsen food security and impact distribution efforts
- Decreased water availability and soil moisture likely to reduce yields and alter suitable areas for agriculture
- Increased evapotranspiration expected to contribute to crop failures and overall yield reductions

Proposed adaptation strategies

- Improve water management capabilities, particularly for water shortages and prolonged periods of drought
- Introduce shaded agro-pastoral perimeters to support agro-pastoral systems
- Increase awareness of diversification options in rural communities
- Increase institutional and sectoral understanding of CC impacts and key adaptation measures

WATER

- High water scarcity, no permanent source of surface water such as rivers or freshwater lakes, relies on deep underground water tables

Main climate change impacts

- Drying up of cisterns and shallow wells during dry season, exacerbated by periods of intense aridity and drought
- Reduced soil moisture, surface water and underground water stocks, and increased desertification due to increases in temperature
- Impact on surface water infiltration and recharge rates for groundwater due to rainfall and evaporation changes

Proposed adaptation strategies

- Improved governance of water points via Community Water Management Committees and Water User Associations
- Building a water pumping plant and aqueducts for conveying water from Ethiopia to supply Ali Sabieh, Dikhil, Arta regions, and Djibouti City
- Improve water management for agro-pastoral resources regarding surface water mobilization
- Repair and construction of tanks for drinking water and livestock, and construction of two small dams
- Sustainable land management for protecting hydraulic infrastructure and regenerating plant cover

COASTAL ZONES AND SEA LEVEL RISE

Coastal zone houses over two-thirds of the population as well as many socio-economic activities

Main climate change impacts

- Coasts are at high risk from sea level rise, coastal erosion and storm surges, with significant retreat of the coastline expected by end of century
- Coastline around and south of Djibouti city at risk of gradual inundation
- Salt water intrusion presents risks specifically for low-lying barriers and river mouths along the country's coastline
- Coastline of the estuaries located between the Eritrean border and Gulf of Tadjoura at risk of erosion

Proposed adaptation strategies

- Construction of coastal protection structures to preserve coastal land and infrastructure
- Rehabilitation efforts of mangroves are ongoing
- Improve management of marine resources as well as develop ecotourism in rural coastal areas
- Increase community awareness about the risks of coastal zone erosion, aquifer salinization and sea level rise

NEEDS

Research

- Increase understanding of vulner-abilities and possible adaptation responses specifically for water resources and sea level rise
- Conduct nationwide water supply, demand and management studies
- Improve cataloging of the fisheries sector to better understand sectoral risks and support local livelihoods along coastal zones
- Widen participation of the public, scientific institutions, women and local communities in planning and management
- Conduct community-level hazard risk assessment
- Strengthen environmental resource management through improved environmental and biodiversity monitoring capabilities
- Increase understanding of coastal zones and SLR impacts specifically for port infrastructure and tourism sectors

Institutional

- Ensure that National Environmental Strategy goals are developed within sectoral and regional plans, in line with financial opportunities with donors
- Develop a national monitoring, reporting and verification (MRV) system
- Consolidate macroeconomic and budgetary frameworks to determine international restraints and opportunities and potential for further economic investment and growth
- Improve understanding of cross-cutting CC impacts
- Improve the validation of mechanisms and tools for continuous evaluation at national, sectoral and regional levels

Data and information

- Develop EWS for hydrometeorological phenomena and improved climate risk management, specifically for SLR, water resources and agriculture and livestock impacts
- Conduct analysis on water transmission infrastructure to determine faults in lines to reduce loss during transport
- Technology transfer, specifically regarding renewable energy and for the construction of geothermal, wind or photovoltaic power plants

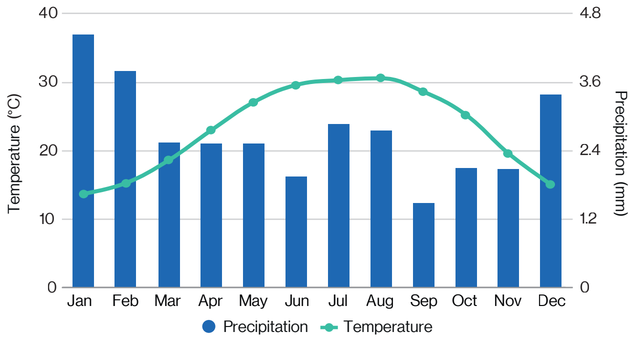
[1] WB Climate Change Knowledge Portal (CCKP, 2020). Djibouti.
[2] WB Climate Change Knowledge Portal (CCKP, 2020). Djibouti Projected Future Climate.
[3] Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium.
[4] ThinkHazard! (2020). Djibouti – Coastal Flooding.
[5] ThinkHazard! (2020). Djibouti – Extreme Heat.
[6] ND-Gain: ND-GAIN Country Index: Djibouti.

Egypt

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 22.5°C; 33mm
Mean annual max/min T (1901–2020): 29.9°C/15.1°C

Country context

Population
100.3m (2019)

Annual growth rate
2% (2019)

GDP
$250.9bn (2019)

Annual growth rate
5.6% (2019)

GDP per capita
$2,500 (2019)

Literacy rate, adult female/male: 66%/77% (2019)
Geography: Located in the northeast of Africa, with the northern border on the Mediterranean Sea. Land area: 995,450 km^2. Coastline: 3,500 km along the Mediterranean and the Red Sea
Broad climate: Dry, hot, and dominated by desert

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.7** (+1.6°C)	**+1.5 to +3.0** (+2.1°C)	**+2.4 to +4.5** (+3.3°C)	**+3.4 to +6.2** (+4.4°C)
Annual Precipitation Anomaly (mm)	**−21.6 to +20.1** (−0.5mm)	**−27.3 to +21.0** (−1.9mm)	**−26.3 to +26.7** (+1.6mm)	**−30.2 to +26.2** (−2.9mm)

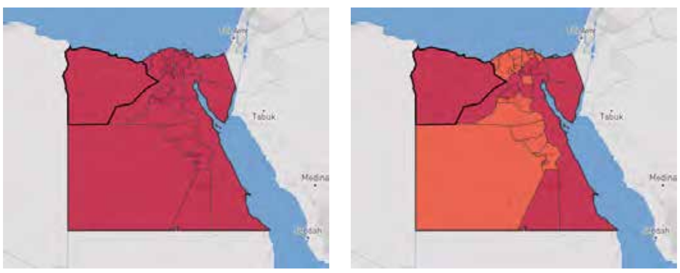
Climate hazards

- Egypt's Nile Delta is recognized as one of the world's three 'extreme' vulnerability hotspots: dependence on the Nile River's water makes Egypt vulnerable to rising temperatures, reduced rainfall for the upper Nile Basins as well as the reduction of rainfall on the east Mediterranean coastal zone
- Sea level rise is projected to lead to the loss of much of the northern part of the Nile Delta due to inundation and erosion, leading to loss of agricultural land, infrastructure and urban areas
- Most of the population and infrastructure are concentrated in the Nile Delta and along the Mediterranean coast, making Egypt additionally vulnerable to sea level rise
- Key sectors impacted include water resources, agriculture, fisheries, health, housing, biodiversity, telecommunications, energy, tourism, and coastal zones
- Increased temperatures and degraded agricultural conditions will adversely affect 'working days', impacting vulnerable groups

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	2	18	-	0.06%
	Riverine	5	638	114,960	
	Flash	3	53	20,260	
Storm	Unstated	1	-	-	0.01%
	Tropical	-	106	32,600	
	Convective	5	13	-	
Extreme temperatures	Cold	1	3	-	0.00%
	Heat	3	164	-	
Total		**20**	**995**		**0.07%**

Risk of water scarcity (left), Risks of extreme heat (right)[4]



High   Medium   Low   Very low

ENABLING ENVIRONMENT

Leadership and governance

- **Climate change (CC) adaptation efforts:** led by the Environmental Affairs Agency and Ministry of State for Environmental Affairs
- The National Committee of Climate Change spearheads UNFCCC implementation and representation
- Other national partners include the Ministry of Foreign Affairs, the Ministry of Water Resources and Irrigation, the Ministry of Agriculture and Land Reclamation, the Ministry of Electricity and Energy, the Ministry of Trade and Industry, Economic Development and Defense, and the New and Renewable Energy Authority

Key adaptation policies

Key policy documents: NDC (2016); Third National Communication (2016); Climate Change Adaptation Strategy (2013); National Strategy for Adaptation to Climate Change and Disaster Risk Reduction (2011); Egypt National Environmental, Economic and Development Study for Climate Change (2010); Egyptian National Action Plan to Combat Desertification (2005)

Disaster Risk Management (DRM):

- Crisis and DRM department established in 2000 at the Information and Decision Support Center of the Egyptian Cabinet of Ministers
- DRM priorities include: strengthening regional coordination and investment in technological innovations to address water scarcity; exploring disaster risk financing and insurance mechanisms; enhancing early warning systems; and building the capacity and financial resources of its Information and Decision Support Center

ND-GAIN Index[5]

Country Index rank (score): 110 (44.9)
Vulnerability: 0.438
Ecosystem Services 15%, Food 19%, Human Habitat 13%, Health 17%, Infrastructure 17%, Water 18%

Readiness: 0.241
Economic 30%,
Governance 35%,
Social 34%

ND-GAIN Evolution

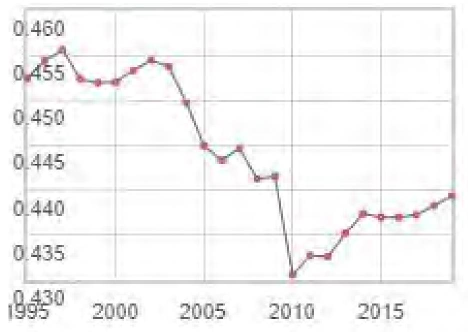


Photo: givaga/Shutterstock

Egypt

SECTORAL ADAPTATION PLANNING

AGRICULTURE

13.5% of GDP, employs 55% of the population

- 2.8% of land is arable; predominantly irrigated
- Agricultural land categorised into: 'Old land', comprising the Nile Valley and Nile Delta, heavily irrigated and intensively cultivated since early civilisations; 80% of the cultivated area. 'New land' is recently reclaimed land; 20% of the cultivated area
- Cultivated field crops include maize, rice, cotton, and sugarcane in the summer, and alfalfa, wheat, barley, green bean, clover, and sugar beet in the winter

Main climate change impacts

- Subsistence dryland farmers vulnerable to CC due to their small scale and reliance on rainfed agriculture and water resources
- Fruit species are grown under marginal chilling conditions and are susceptible to even small temperature increases
- Warming trends expected to adversely impact yields, which will likely result in price increases for rice, wheat, and maize
- As evaporation increases, crops will consume more water leading to decrease in productivity of wheat, maize, rice, tomatoes (staple foods), and sugar cane and milk
- Wheat, rice, maize, and citrus expected to decrease between 10%-20%; cotton yields expected to increase by 20% by the 2060s
- Heat stress from radiation, temperature, humidity and wind speed makes heat dissipation difficult, reducing milk production and reproduction, particularly for dairy cows

Proposed adaptation strategies

- Climate smart agriculture practices, improved water management and early warning systems, and development of new crop varieties and technologies to support farming
- Introduce high-value and drought-resistant crops
- Improve biological diversity of livestock, fishery and poultry
- Agro-economic systems to protect land from degradation

WATER

- Rain falls mainly on the north coast; Egypt is solely dependent on the Nile river for water

Main climate change impacts

- CC may impact River Nile's natural flow: increased evaporation rates from rising temperatures could decrease water availability by up to 70%, or, increased rainfall in the Ethiopian highlands & Blue Nile Basin may increase flows by 15%-25%
- Most of the population lives close to the Nile and are exposed to flood events. The urban poor are particularly vulnerable
- River Nile sources are located outside Egypt, so the country is vulnerable to changing conditions and shocks within and outside its borders
- Rainfall and evaporation changes also impact rates of surface water infiltration and the recharge rates for groundwater. Low water storage capacity increases the country's dependence on unreliable rainfall patterns

Proposed adaptation strategies

- Adaptation actions under implementation: upgrading water quality & sanitation to minimize pollution; constructing new infrastructure for water collection in flash flood areas; increasing use of renewable energy for water desalination, increasing storage of drainage & fresh water in coastal lakes; improving public awareness campaigns on water scarcity & water shortage
- Investment in modern irrigation systems, and developing policies to encourage citizens to use water responsibly

HEALTH

Main climate change impacts

- Dust and sandstorms, expected to increase in severity and frequency, linked to infectious diseases like influenza and pneumonia, and non-infectious diseases like asthma and pulmonary fibrosis
- Indirect health effects from flooding: impact on food production, water provision, ecosystem disruption, infectious disease outbreak and vector distribution
- Diarrheal deaths and heat-related deaths projected to increase
- Vector-borne diseases and respiratory infections, sensitive to shifts in climatological environments, expected to worsen

Proposed adaptation strategies

- Health surveillance, risk mapping, and monitoring systems to address the potential adverse outcomes to health
- Research to identify key health vulnerabilities, such as urban heat islands, as well as vector-borne and communicable diseases
- Raise community awareness about CC induced risks and adaptation options; increase the efficiency of the healthcare sector to improve the capacity for dealing with CC related health concerns

NEEDS

Research

- Improve understanding of CC-related vulnerabilities and adaptation responses, and enhance public, community and institutional participation in adaptation planning
- Invest in risk assessments, particularly in coastal zones
- Research on vulnerabilities and adaptation of biodiversity
- Strengthen technical capacity to integrate climate-smart agriculture and CC risk management into agriculture sector
- Design and implement a Technology Needs Assessment

Institutional

- Integrate National Environmental Strategy goals within sectoral and regional plans and in line with financial opportunities with donors
- Institutionalise systematic observations of sea surface temperature, coastal land use & sea level variations to ensure availability of results for scientific community and policymakers
- Implement cross-sectoral climate-smart solutions at national & subnational levels for agriculture & water management sectors

Data and information

- Map agricultural products for more effective land use
- Improve early warning systems for water management
- Enhance nation-wide CC and atmosphere monitoring systems

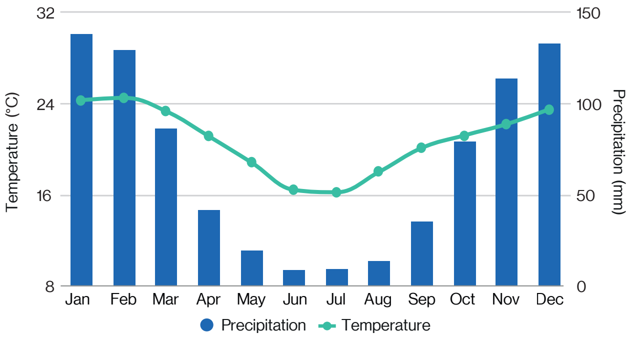
[1]WB Climate Change Knowledge Portal (CCKP, 2020). Egypt
[2]WB Climate Change Knowledge Portal (CCKP, 2020). Egypt Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Egypt: Overview
[5]ND-Gain. ND-Gain Index: Egypt

Eswatini

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 20.7°C /810.8mm
Mean annual max/min T (1901–2020): 27°C/14.6°C

Country context

Population **1.16m (2019)**	Annual growth rate **1% (2019)**
GDP **$3.9bn (2020)**	Annual growth rate **–1.6% (2020)**
GDP per capita **$3,400 (2020)**	

Literacy rate, adult female/male: 88.54%/88.29% (2018)
Geography: Situated in southeastern Africa, total land area: 17,360 km^2
Broad climate: Subtropical with wet hot summers and cold dry winters

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+5.1 to +1.48** (+0.97°C)	**+1.23 to +2.40** (+1.75°C)	**+2.17 to +3.73** (+2.79°C)	**+3.04 to +5.15** (+3.82°C)
Annual Precipitation Anomaly (mm)	**–26.03 to +27.56** (0.29mm)	**–30.45 to +27.75** (–1.96mm)	**–32.11 to +31.08** (–0.06mm)	**–37.25 to +32.71** (–1.13mm)

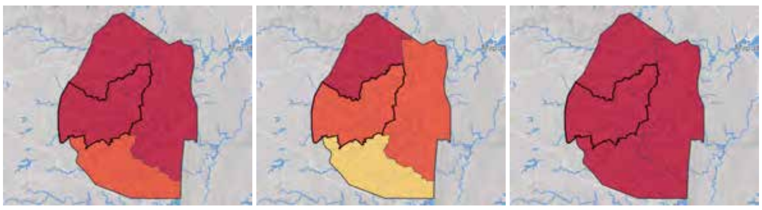
Climate hazards

- Eswatini is at high risk of natural hazards, which are expected to primarily affect the agricultural sector through seasonal flooding and periods of drought
- Changes in rainfall regimes, including heavy rainfall events and extreme weather conditions, as well as land degradation and resulting erosion, are also expected to have increasingly adverse effects on agricultural production
- Eswatini is at high risk to river flooding as well as urban flooding and wildfire, which will impact project design, construction and infrastructure development, and have potential health ramifications on the population
- Increased heat will further strain existing water resources, increase evapotranspiration and impacts from changing rainfall patterns

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		4	-	2,104,000	67.69%
Flood	Riverine	2	-	274,500	8.84%
	Flash	1	11	400	
Storm	Unstated	2	-	-	0.24%
	Convective	-	1	7,425	
Wildfires		1	2	-	0.05%
Total		**10**	**14**	**2,387,825**	**76.82%**

Risk of river flood, urban flood and wildfires (left to right)[4]



High Medium Low Very low

ENABLING ENVIRONMENT

Leadership and governance

Institutionalization of climate change (CC) issues and processes:

- Eswatini Meteorological Services, under the Ministry of Tourism and Environmental Affairs, which also houses the National UNFCCC Focal Point

Development and coordination of adaptation programs and projects, and education and public awareness campaigns:

- National Climate Change Committee (NCCC)

Additional partnerships include the University of Eswatini, the Eswatini Water and Agricultural Development Enterprise, the Eswatini Water Services Corporation, and the Eswatini Electricity Company

Key adaptation policies

Key policy documents: NDC 2016; Third National Communication to the UNFCCC (2016); National Sustainable Energy for All, Country Action Plan (2014); Comprehensive Agricultural Sector Policy (2005); National Food Security Policy for Eswatini (2005); National Biodiversity Conservation and Management Policy (2001)

Disaster Risk Management (DRM):

- Working to implement a drought monitoring and early warning system, produce drought vulnerability profiles and related costs, design drought contingency plans, and establish risk financing measures for affected communities
- Key policies and frameworks include: National progress report on the implementation of the Hyogo Framework for Action (2013–2015), Disaster Management Act (2006), and the National Disaster Preparedness and Response Plan

ND-GAIN Index[5]

Country Index rank (score): 139 (40.4)
Vulnerability: 0.512
Ecosystem Services 20%, Food 21%, Human Habitat 19%, Health 22%, Water 17%

Readiness: 0.321
Economic 31%, Governance 44%, Social 24%

ND-GAIN Evolution


Photo: Sopotnicki/Shutterstock

Eswatini

SECTORAL ADAPTATION PLANNING

AGRICULTURE

11% of GDP; occupies 75% of cropland

Main climate change impacts

- Projected decrease in precipitation may determine if certain crops or farm practices remain viable, and if reduced water availability might require a shift to more drought-resistant crops or if farmers are required to shift investments into irrigation
- Changes in precipitation provides a critical background to understand which other factors can become important, such as the temporal gaps between individual rainfall episodes, the availability of water during critical times of the seasonal cycle, or the intensity of individual rainfall events
- As temperatures increase, daily maximum temperatures may offer insights on these upper thresholds for specific crops, translating these potentially into changing yields

Proposed adaptation strategies

- Increase contribution of agriculture to economic development, and focus on poverty reduction to make poorer farming households more resilient to anticipated climatic changes
- Specific activities: conservation tillage, crop diversification, greenhouse farming, hydroponics, livestock selective breeding, micro irrigation and organic farming
- Crop production: shifting planting periods, growing of drought-tolerant crops, and raising suitable crops in appropriate regions
- Adaptation in livestock production: raising dairy cattle mainly in the Highveld and wet Middleveld which is typically cooler
- Invest in agricultural development opportunities to reduce the country's food insecurity

WATER

Primary water sources are surface water

- Seven river catchment/drainage systems are the Komati, Lomati, Mbuluzi, Usutu, Ngwavuma, Pongola and Lubombo
- Irrigation uses 95% of surface water resources

Main climate change impacts

- Grasslands likely impacted by decreasing water availability, impacting vegetation, biodiversity & people's livelihoods
- Riskier agricultural production environment from increased temperatures will result in greater cropland evapotranspiration, resulting in an arid production environment reliant on already stressed and deficient water resources
- Increasing number of consecutive dry days will increase evaporation and stress limited water resources, affecting irrigation
- Changing rates of surface water infiltration & groundwater recharge will reduce reliability of unimproved groundwater and surface water sources during droughts or prolonged dry period

Proposed adaptation strategies

- Align national climate change policy with the National Water Policy and Water Act (2003)
- Develop water pricing structures to encourage efficient water use as well as reduce consumption throughout the value chain
- Integrate water resource management systems across all sectors, including land use and the environment
- Artificial groundwater recharge, integrated river basin management, leakage detection systems, scaled use and access for rainwater harvesting mechanisms, sand dams, solar pumps for borehole water pumping, and water recycling and reuse

HEALTH

Main climate change impacts

- Increasing temperatures and changing precipitation patterns will affect the basic requirements for maintaining a healthy population requiring clean air and water and sufficient food
- Catastrophic weather events, variation in weather systems that affect food and water supplies, ecosystem changes all pose health risks
- These risks may result in increased deaths due to heat waves, and natural hazards such as floods, vector-borne diseases such as malaria, and other existing and emerging infectious diseases
- Record high temperatures and increased night temperatures can result in decreased opportunity for natural cooling

Proposed adaptation strategies

- Develop and/or implement a health adaptation strategy for CC
- Increase awareness and understanding of relationship between CC and health impacts through training of personnel
- Increase in training & capacity to improve level of knowledge and skills to prevent diseases connected with climatic factors
- Improve monitoring and surveillance systems to allow observations of trends and make advance forecasts to direct interventions against climate-sensitive diseases
- Increased investment, and climate-health-adaptation research agenda, to support the identification and analysis of trends and develop indicators to improve health sector capacity to react

NEEDS

Research

- Improve science-based understanding of the nature and magnitude of physical and biophysical climate change impacts
- Improve understanding of key vulnerabilities, development impact, cost, and adaptation needs
- Widen participation of the public, scientific institutions, women and local communities in planning and management

Institutional

- Upscale construction of small dams and enable communities to use captured water to produce crops
- Implement cross-sectoral climate-smart solutions
- Establish a National Steering Committee on Climate Change to ensure the integration of low-carbon, climate-resilient considerations into development planning
- Establish Regional Southern African Steering Committee on Climate Change to serve as a platform for continuous coordination of regional efforts to address and adapt to CC

Data and information

- Improve collection of observational data through addition of weather stations and hydro-meteorological instrumentation
- Establish early warning systems for dangerous hydro-meteorological phenomena and climate risk management
- The National Meteorology Department should produce simplified versions of seasonal weather forecast reports
- Train agricultural extension officers on CC issues, as well as in interpreting seasonal weather reports

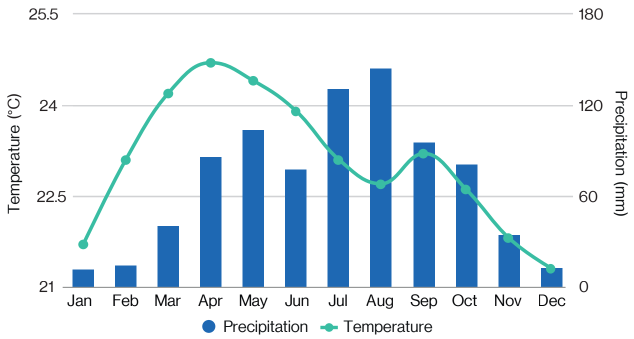
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Eswatini
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Eswatini Projected Future Climate
[3]ThinkHazard! (2020). Eswatini: Overview
[4]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[5]ND-Gain. ND-Gain Index: Eswatini

Ethiopia

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 22.6°C; 815.8 mm
Mean annual max/min T (1901–2020): 29.5°C/15.8°C

Country context

Population **112m (2019)** | Annual growth rate **2.6% (2019)**

GDP **$95.5bn (2019)** | Annual growth rate **8.4% (2019)**

GDP per capita **$4,300 (2019)**

Literacy rate, adult female/male: 89%/88% (2019)
Geography: Landlocked country in northeast Africa; land area: 1,104,300 km²
Broad climate: South & southwest: equatorial rainforest, high rainfall and humidity; northeast, east & southeast lowlands: desert-like conditions

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.5** (+1.0°C)	**+1.2 to +2.6** (+1.8°C)	**+2.1 to +4.0** (+2.8°C)	**+2.8 to +5.5** (+3.7°C)
Annual Precipitation Anomaly (mm)	**–14.4 to +21.2** (+2.2mm)	**–16.8 to +27.4** (+3.1mm)	**–18.8 to +37.6** (+6.0mm)	**–17.5 to +50.0** (+9.7mm)

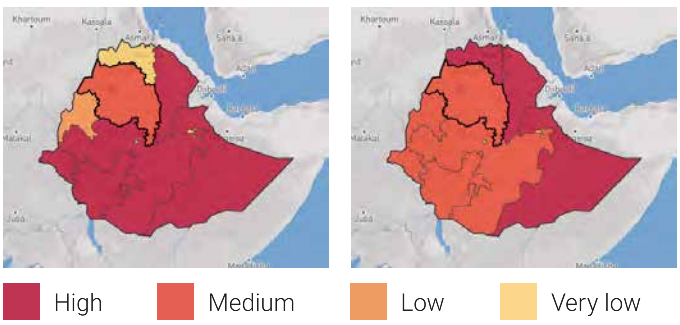
Climate hazards

- Drought is the single most destructive climate-related natural hazard in Ethiopia with the southern and eastern parts of the country often severely hit; recent major droughts have reduced the country's GDP by 1% to 4%
- Average number of hot days per year projected increase: 19–40% of days by the 2060s; 26–69% of days by the 2090s
- Floods regularly cause crop and infrastructure damage and contribute to widespread land degradation
- Expected 20% increase in extreme high rainfall events by the end of century
- Other primary environmental problems are soil erosion, deforestation, desertification, and loss of biodiversity and wildlife

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		10	-	49,691,879	21.10%
Flood	Unstated	10	86	516,630	1.24%
	Riverine	29	1,096	1,376,297	
	Flash	8	863	1,029,182	
Wildfires		1	-	-	0.00%
Land-slides		7	115	-	0.00%
Total		**65**	**2,160**	**52,613,988**	**22.34%**

Risk of river flood (left)[4], Risks of extreme heat (right)[5]



ENABLING ENVIRONMENT

Leadership and governance

Disaster risk management (DRM) leadership:

- Disaster Management and Food Security Sector under the Ministry of Agriculture

Management of climate finance flows:

- Climate Resilient Green Economy (CRGE) Secretariat

Implementation of CRGE strategy: Ministry of Agriculture and Natural Resources, Ministry of Industry, Ministry of Mines, Petroleum and Natural Gas, Ministry of Transport, Ministry of Urban Development, Housing and Construction, and Ministry of Water, Irrigation and Electricity

Provision of guidance and sector-specific support: Commission of Environment, Forest and Climate Change and the Ministry of Finance and Economic Cooperation

Key adaptation policies

Key policy documents: Updated NDC (2021); NAP (2019); Multi Sector Investment Plan for Climate Resilient Agriculture and Forest Development 2017–2030; Growth and Transformation Plan (GTP II) (2016); Climate Resilient Green Economy (CRGE) Strategy (2011)

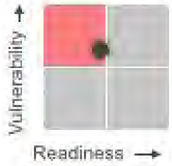
Disaster Risk Management:

- National Policy and Strategy on Disaster Management (2007)
- Disaster Risk Management Strategic Program and Investment Framework (2007)
- Climate Change National Adaptation Program of Action (2007)

ND-GAIN Index[6]

Country Index rank (score): 157 (37.8)
Vulnerability: 0.559
Ecosystem Services 14%, Food 18%, Human Habitat 18%, Health 23%, Infrastructure 11%, Water 15%

Readiness: 0.315
Economic 38%, Governance 37%, Social 24%



ND-GAIN Evolution

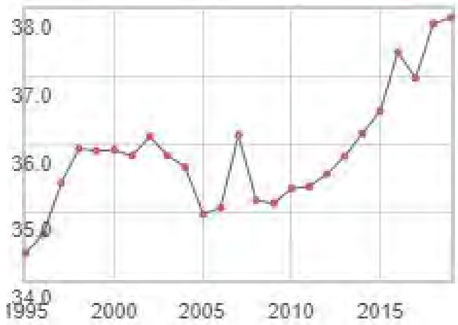



Photo: ivepointsix/Shutterstock

Ethiopia

SECTORAL ADAPTATION PLANNING

AGRICULTURE

34% of GDP; rain dependent; agricultural land: 71.05% of land area; 1% of all cultivated land is irrigated
Smallholder farming households account for approximately 95% of agricultural production and provide around 85% of all employment

Main climate change impacts

- Loss of arable land due to recurring drought and increased desertification, resulting in increased dependence on food aid
- Decreased recharge and quality of ground and surface water supply due to reduced precipitation
- Increased presence of pests and diseases due to increased temperatures and waterlogging of fields
- Increased soil erosion and loss of soil fertility due to changes in seasonality of precipitation and intense rainfall and flooding
- Heat stress impacts on livestock through reduced milk production and reproduction in dairy cows
- Reduced crop yields and crop failure due to increased heat and water scarcity conditions (further exacerbated by resulting increased evapotranspiration)
- Decreased productivity due to land degradation and soil erosion, exacerbated by recurrent flood and drought

Proposed adaptation strategies

- Improved water capture and storage, and investments in irrigation structures, particularly in more arid agricultural areas
- Conservation practices regarding soil erosion, watershed management, and nutrient and crop management
- Semi-stabled cattle systems in highland agricultural areas
- Diversification of income through more accessible financing options such as climate insurance schemes, safety net programs and food security initiatives
- Improved weather monitoring network and weather information systems, and improved data dissemination

WATER

Sources include 12 river basins with groundwater potential of approximately 2.6bn m^3

Main climate change impacts

- Changes in rates of surface water infiltration and groundwater recharge due to changing rainfall and evaporation rates, exacerbating impacts of unreliable and unimproved water sources during droughts or prolonged dry seasons
- Reduced water availability in water-scarce regions (particularly southern, eastern and central areas) due to increased frequency of droughts, increased evaporation and evapotranspiration, and changes in rainfall patterns and runoff
- Increased soil moisture deficits due to rising temperatures, even under conditions of increasing rainfall
- Increased water contamination of surface sources and shallow wells due to storms and flooding
- Despite progress in water, sanitation and hygiene services, decreased availability and/or compromised quality of surface water supply will heighten vulnerabilities

Proposed adaptation strategies

- Investments to support existing monitoring of groundwater wells and aquifers, improve water management infrastructure and alignment with sanitation and quality
- A water resources management policy to enhance and promote national efforts towards the efficient, equitable and optimum utilization of water resources
- National Irrigation Policy objectives include increasing irrigated surfaces and improving their management

HEALTH

75% of the population lacks access to clean water, 80% live without adequate sanitation; 50% live over 10 km from the nearest health facility

Main climate change impacts

- Expanded range of malaria to highland areas from increased temperatures
- Increased flooding may spread more water-borne diseases
- Over 70,000 deaths annually are tied to indoor and outdoor air pollutants, which a hotter, more drought-prone climate will aggravate

Examples of adaptation strategies

- Extensive health system reviews to identify and prioritize highly vulnerable areas and population segments
- Adopting standardized international methodologies and links with meterological and geographic information systems (GIS) for strengthened monitoring and improved forecasting

Milestones

- Ethiopia's Growth and Transformation Plan II has emphasized improved implementation of environmental and health services in poor, rural and urban areas

NEEDS

Research

- Increase understanding of vulnerabilities and possible adaptation responses
- Widen participation of the public, scientific institutions, women and local communities in planning and management
- Strengthen technical capacity to integrate climate-smart agriculture and climate change risk management

Institutional

- Ensure that National Environmental Strategy goals are developed within sectoral and regional plans
- Implement cross-sectoral climate-smart solutions at national and subnational levels
- Integrate climate change concerns into relevant policies and planning processes

Data and information

- Improve observational data through the addition of weather stations and hydro-meteorological instrumentation
- Establish institutional and technical capacity for providing timely early warning systems

Other

- Cross-sectoral integration of development and adaptation planning

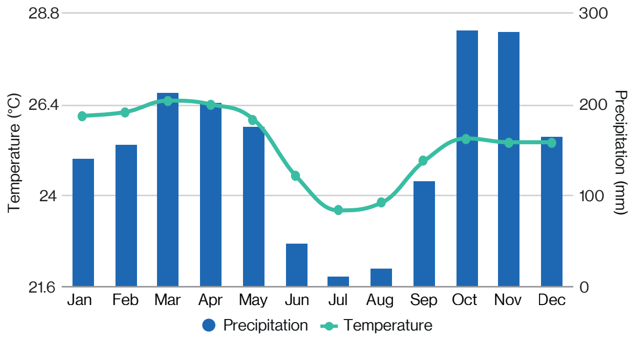
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Ethiopia.
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Ethiopia Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha–Sapir, Brussels, Belgium.
[4]ThinkHazard! (2020). Ethiopia River Flood.
[5]ThinkHazard! (2020). Ethiopia Extreme Heat
[6]ND-Gain: ND-GAIN Country Index: Ethiopia

Gabon

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 25°C/1,800 mm
Mean annual max/min T (1901–2020): 29.4°C/20.9°C

Country context

Population
2.2m (2019)

Annual growth rate
2.5% (2019)

GDP
$16.6bn (2019)

Annual growth rate
3.4% (2019)

GDP per capita
$7,800 (2019)

Literacy rate, adult female/male: 44%/59% (2017)
CPIA Gender Equality Rating: 3.5 (2019)
Geography: Located in West Africa; coastal border runs along the Atlantic Ocean south of Bight of Biafra; land area: 268,000 m²
Broad climate: Tropical region, moist & hot

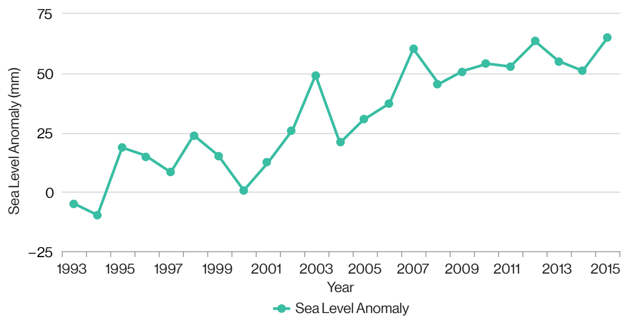
Climate Projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.3** (+0.9°C)	**+1.3 to +2.3** (+1.6°C)	**+2.0 to +3.6** (+2.5°C)	**+2.7 to +4.8** (+3.3°C)
Annual Precipitation Anomaly (mm)	**−18.2 to +30.6** (6.2mm)	**−15.1 to +52.7** (17.0mm)	**−7.3 to +80.5** (31.5mm)	**−12.0 to +87.3** (37.7mm)

Climate hazards

- Rising temperatures and extreme weather events are expected to impact agriculture & water sectors, and wider population health. Rural communities, the poor and elderly are at particular risk
- Coastal, urban & riverine floods are high-hazard. Life-threatening, damaging river floods expected at least once in the next 10 years
- Flood-risk regions are concentrated in central Gabon along Ogooué river with 2 hotspots: Ogooué-Ivindo and Moyen-Ogooué provinces. River flooding expected as an immediate and long-term hazard for rural and urban areas
- Sea level rise and coastal area flooding may impact coastal cities by damaging infrastructure (e.g., the port of Gentil is only 4m above sea level), and oil extraction operations

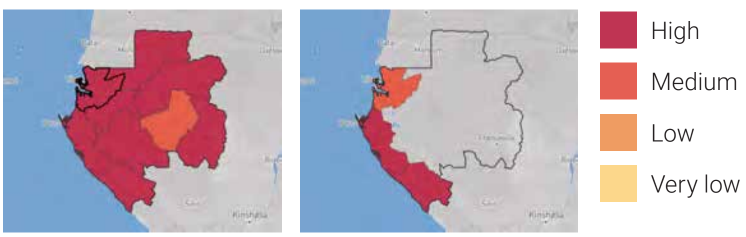
Sea level rise[3]



Climate hazards from 1991–2020[4]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Riverine	1	1	77,845	1.81%
Storm	Tropical	-	-	3,530	0.08%
	Convective	3	-	-	
Total		**4**	**1**	**81,375**	**1.90%**

River flood risk (left) and coastal flood risk (right)[5]



ENABLING ENVIRONMENT

Leadership and governance

- Climate change (CC) strategies led by Ministry of Forests, Water, Fisheries and the Environment and the Protection of Nature
- Member to the Central African Forests Commission (COMIFAC)
- National Council on Climate Change and its Climate Change Communication Committee established in 2010, prepares and manages the National Climate Plan

Key adaptation policies

Key policy documents: NDC (2016); Second National Communication the UNFCCC (2011); National Strategy on Coastal Adaptation to Climate Change (2013); National Climate Plan (2012)

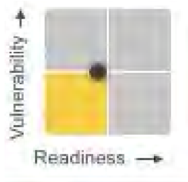
Disaster Risk Management (DRM):

- No sectoral risk assessments, or functional data flow mechanism to understand impact of hazards
- Working to establish scientific and technical expertise within the Disaster Management Agencies
- Department of Disasters to scale up operational capacities and collaboration across existing sectors, and institute contingency plans and procedures

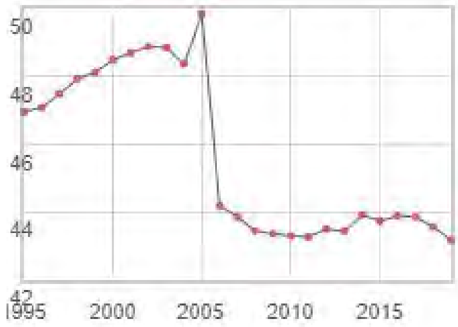
ND-GAIN Index[6]

Country Index rank (score): 116 (43.6)
Vulnerability: 0.418
Ecosystem Services 19%, Food 19%, Human Habitat 29%, Health 17%, Infrastructure 6%, Water 15%

Readiness: 0.289
Economic 24%,
Governance 41%,
Social 24%



ND-GAIN Evolution



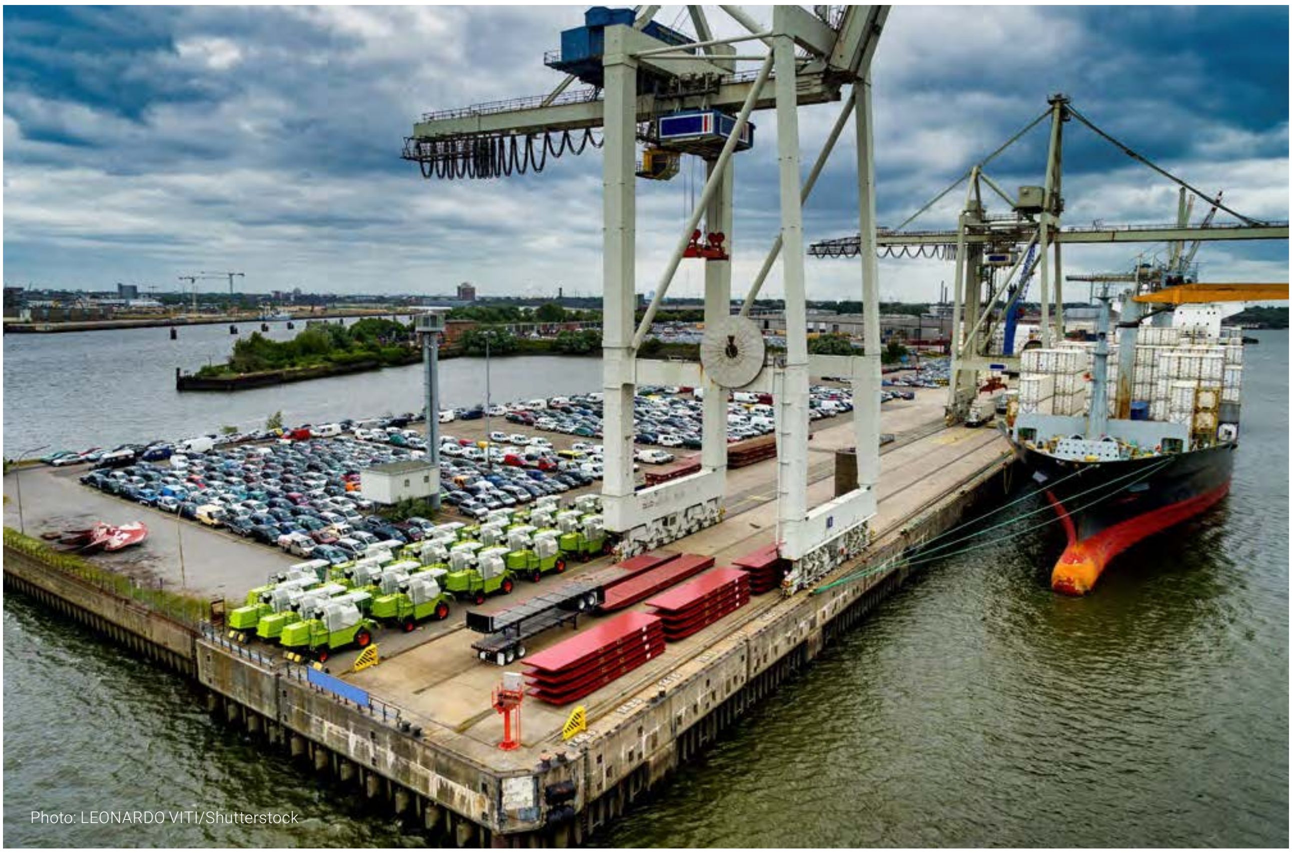


Photo: LEONARDO VITI/Shutterstock

Gabon

SECTORAL ADAPTATION PLANNING

AGRICULTURE

5% of GDP; employs 20% of the population (2014)

- Relies on food imports for majority of domestic food consumption sourced from France, South Africa and Cameroon
- 22m ha of forest; 1m ha (5%) of arable land

Main climate change impacts

- Changes in temperature and precipitation expected to impact composition of soil, erosion, and balance of micro-organisms
- Increased temperatures will stress crops and alter the length of growing seasons and increase likelihood of pests and fire; water scarcity likely to increase evapotranspiration
- Droughts and dry periods will exacerbate land degradation

Proposed adaptation strategies

- Irrigation to minimise CC impacts; research to define climate thresholds for local crops; Improved technical capacity for traditional cultivation practices
- Soil protection & restoration measures to improve soil fertility
- Enhance non-timber forest products

WATER

Main climate change impacts

- Increased rainfall may impact discharge, intensity, time period/frequency of floods & droughts, soil humidity, ground water recharge, and amount of water flowing through rivers
- This may impact vegetation, marshlands, fish population distributions, and water-borne diseases
- Flooding may damage sanitation infrastructure and spread faecal waste through flood water

Proposed adaptation strategies

- Dikes/flood protection to control water flow & protect embankments; dams/basins to increase water storage capacity
- Dredging to reduce water flow resistance, and enlarging waterways for lower water levels and improved navigability
- Early Warning Systems (EWS) to manage rapid water rise (e.g., in the Ogooué Basin); flood risk prevention plans and mapping to identify at-risk areas
- Social protection measures for populations living in at-risk areas
- Integrating climate resilience into technical designs, management and operation of water and sanitation systems
- Develop national database and rainfall-runoff models to project the effects of rainfall changes (for climate variability and CC) on runoff and discharges (including peak and low flows)

COASTAL ZONE AND SEA LEVEL RISE

Maritime area: 265,000 km^2; territorial sea of 12 nautical miles

Main climate change impacts

- Increase in sea surface temperature, ocean acidification, decline in oxygen content, sea level rise, and increased ultraviolet exposure will adversely affect marine organisms and associated ecosystem goods & services derived from them, like fisheries

Proposed adaptation strategies

- Construction and expansion of embankments, dikes and walls along the sea front form Pointe Clairette to Pointe Iguiri
- Beach recharging form Cape Lopez to Pointe Ozouri
- Backfilling of the lowlands inland along the Atlantic coastline and the deltaic plain of Mbéga-Mandorové
- Invest in municipalities for water treatment infrastructure
- Research to define sea level rise, ongoing coastal erosion, and increasing risk of salinization of fresh water sources
- Better coastal resources management

HEALTH

Main climate change impacts

- More frequent heat waves will threaten human health, particularly for the elderly and chronically ill
- Major health risk from climate variability will be the projected increase in water-borne diseases
- Projected temperature increase will present more conducive environments for bacteria, pathogens & vector borne diseases
- Warmer and drier conditions may favor spread of diseases borne by food or water, such as diarrhoea and dysentery

Proposed adaptation strategies

- Training and capacity building of healthcare personnel on adaptation to CC to mitigate negative health impacts; general awareness campaigns on CC and health for vulnerable groups
- EWS for timely information on effects of atmospheric state on organisms; biometeorological forecasts to provide daily public information on expected meteorological conditions to give reliable advice on health protection and symptoms prevention
- Strengthen screening for river blindness and improved drinking water purification and delivery systems
- Research on links between population displacement, human health and the risks of climate-related diseases

NEEDS

Research

- Data collection on the nature and magnitude of CC impacts under differing scenarios, specifically for health sector and coastal zones
- Risk assessments to understand indicators of CC impacts to define key vulnerabilities in the energy, agriculture and fisheries sectors
- Develop monitoring and evaluation systems to observe changes to coastlines and land usage
- Widen the participation of public, scientific institutions, women and local communities in planning and management
- Invest in technical improvements to national hydrometeorological observation equipment, networks and technical analysis capabilities

Institutional

- Establish institutional capacity for providing timely early warning systems
- Coordinate the activities of various actors and sectors, including government agencies, ministries, and private entities and firms
- Integrate climate into national planning: sectoral plans should be developed for the next 20–30 years and beyond

Data and information

- Improve meteorological database and weather service capabilities, especially coastal storm detection
- Improve data availability for key sectors such as agriculture, tourism, water resources, and others, to estimate future CC impacts
- Make data openly available and paid for by the public budget

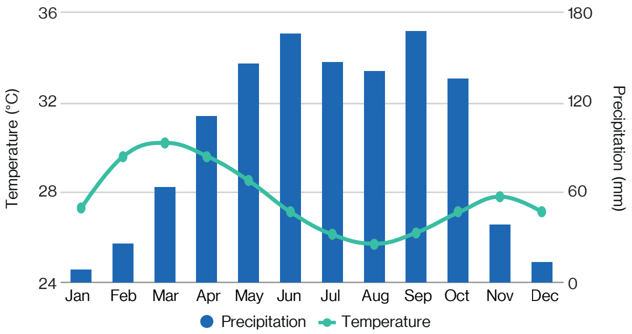
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Gabon
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Gabon Projected Future Climate
[3]WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Risk Country Profile: Gabon
[4]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[5]ThinkHazard! (2020). Gabon: Overview
[6]ND-Gain. ND-Gain Index: Gabon

Ghana

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 27.3°C; 1,190 mm
Mean annual max/min T (1901–2020): 32.5°C; 22.1°C

Country context

Population
30.4m (2019)

Annual growth rate
2.2% (2019)

GDP
$66.9bn (2019)

Annual growth rate
6.5% (2019)

GDP per capita
$2,200 (2019)

Literacy rate, adult female/male: 42%/62% (2015)
CPIA gender equality rating: 3.50 (2019)
Geography: Located along the south-central coast of west Africa; land area: 239,460 km^2; sea territory: 200 nautical miles
Broad climate: Southern region: forest zone; rest of country: Northern Savannah Ecological Zone

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.5** (+0.9°C)	**+1.2 to +2.7** (+1.7°C)	**+1.7 to +3.8** (+2.7°C)	**+2.3 to +5.3** (+3.6°C)
Annual Precipitation Anomaly (mm)	**−16.7 to +22.0** (+0.9mm)	**−22.2 to +30.4** (+0.3mm)	**−22.9 to +38.9** (+2.9mm)	**−29.7 to +45.2** (+1.6mm)

Climate hazards

- The country is exposed to risks from weather-related hazards, primarily those from floods and droughts in the Northern Savannah belt
- Heightened dry conditions and increased pressure on water resources expected by mid-century; severe drought conditions and water scarcity expected by end of century
- Average number of hot days and nights (under RCP8.5 scenario; reference period 1986–2005) expected increase by 18-59% by mid-century
- Primary sectors affected by climate change are water, agriculture, forestry, and health
- Climate change (CC) and variability are already affecting Ghana's water resources; increased exposure and flood damages are projected to cost US$ 160 million annually

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	7	95	1,126,283	7.07%
	Riverine	15	402	3,619,124	
	Flash	1	13	-	
Storm	Tropical	-	20	-	0.00%
	Convective	1	-	-	
Total		**24**	**530**	**4,745,407**	**7.07%**

Risk of water scarcity (left)[4], Risks of extreme heat (right)[5]

High Medium Low Very low

ENABLING ENVIRONMENT

Leadership and governance

- **Disaster risk management (DRM):** Ghanaian Government
- **Coordination of CC strategy:** Environmental Protection Agency
- **Strategy leadership:** Ministry of Environment, Science, Technology and Innovation
- **Cross-sectorial efforts:** National Development Planning, Forestry, and Energy Commissions and the Ministries of Food and Agriculture, Lands and Natural Resources, and Power

Key adaptation policies

Key policy documents: NDC (2016); National Climate Change Master Plan Action Programs for Implementation 2015–2020 (2015); National Climate Change Adaptation Strategy (2012)

Disaster Risk Management:

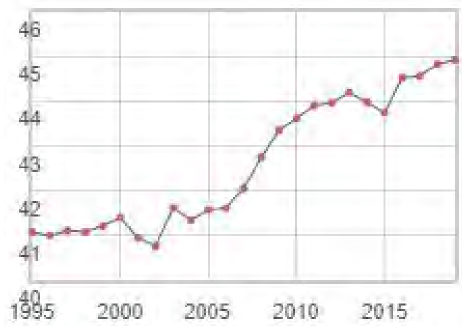
- Working on greater integration of DRM in national and local development policies and urban and land use planning
- Ghana Plan of Action for Disaster Risk Reduction and Climate Change Adaptation (2012)
- National Disaster Risk Reduction Policy (2011–2015)
- DRM priorities include addressing flood risks in major urban areas, and increasing the resilience of coastal communities

ND-GAIN Index[6]

Country Index rank (score): 111 (44.8)
Vulnerability: 0.456
Ecosystem Services 17%, Food 21%, Human Habitat 23%, Health 16%, Infrastructure 11%, Water 11%

Readiness: 0.353
Economic 33%, Governance 46%, Social 20%

ND-GAIN Evolution



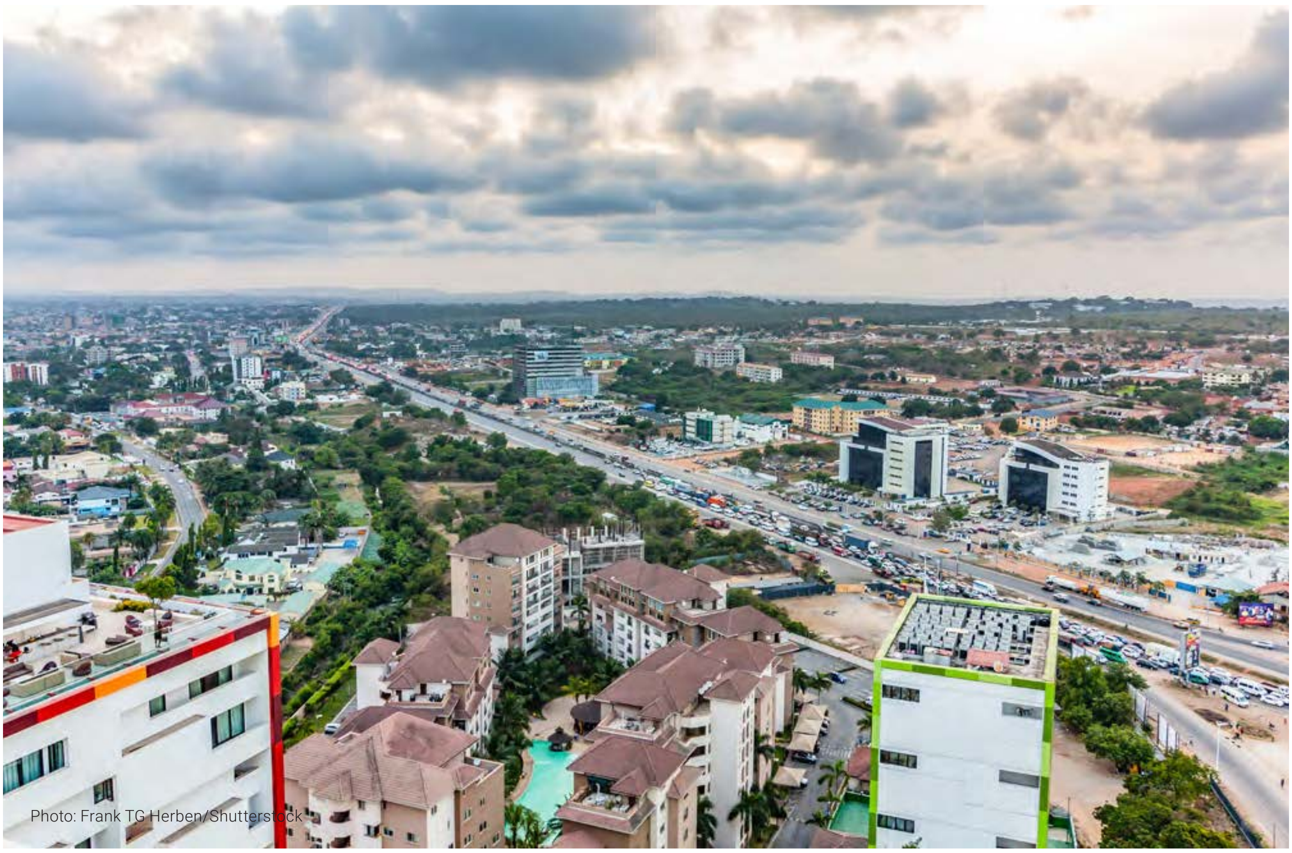


Photo: Frank TG Herben/Shutterstock

Ghana

SECTORAL ADAPTATION PLANNING

AGRICULTURE

~20% of GDP, ~50% of export earnings, employs over 50% of the population, rain-dependent, agricultural land (2018): 59.78% of land area, 2% irrigation potential in use, Fisheries: 4.5% of GDP and provides livelihoods for 2.2m people

- **Crops:** Industrial: cocoa, rubber, oil palm, coconut, cotton; starchy and cereal staples: cassava, yam, maize, rice, plantain; fruits and vegetables: pineapple, banana, cashew, citrus, mango
- **Key fish species:** anchovies, sardines, tilapia, catfish

Main climate change impacts

- Lowered yields in staple crops due to rising temperatures, increasing interannual rainfall variability, and shortened growing seasons. Expected decrease in cassava: 29.6% by 2080, and maize: 7% by 2050
- Crop failure cases projected to occur once every five years in northern region due to delayed or diminished rainfall
- Decreasing suitability for cocoa production, mainly along the coast, due to temperature increase, floods, soil salinization & coastal erosion
- Increased presence of pests, diseases and wildfire risks due to rising temperatures
- Altered migratory patterns and reproductive cycles of key fish species

Proposed adaptation strategies

- Investment in climate-smart agriculture, improved water management, monitoring and early warning systems, knowledge and decision-support systems
- Increased drought-resistant crop varieties and integration of nutrient management for improving staple crops yield
- Household practices in northern savannah zone include expansion of cultivated areas, dry season gardening, cultivation of early yielding and high value crops, diversification into livestock rearing, and increasing fertilizer use
- Aquaculture development, more formal restocking of fingerlings, and improved extension services

Milestones

- The Climate Smart Agriculture Investment Plan (CSAIP) identifies interventions that will help the agriculture sector deal better with climate change

WATER

- Freshwater covers nearly 5% of total land area (primarily made of the Volta, southwestern and coastal river systems)
- Around 50% of water originates from international rivers (Volta, Bia, Tano)

Main climate change impacts

- Around 25% of the population lacks access to clean water. This issue will be compounded by declining rainfall, increased levels of drought and rising temperatures
- Volta Basin flows could be reduced by 24% by mid-century and 45% by end of century
- Increased salinization in coastal water sources and wells due to rising sea levels
- Impact on rates of surface water infiltration and recharge rates for groundwater due to rainfall and evaporation changes
- Soil moisture deficits due to rising temperatures, even under conditions of increasing rainfall

Examples of adaptation practices

- Water harvesting and improved rainwater collection and storage at household or community levels
- Flood retention development is ongoing in upper east and central regions. Additional dam construction, rehabilitation and de-silting is also essential
- The National Irrigation Policy objectives include increasing irrigated surfaces, improving their management, and increasing climate change resilience as a result of sustainable irrigation service delivery

NEEDS

Research

- Increase understanding of climate risks and vulnerabilities
- Greater participation of the public, scientific institutions, women and local communities in planning and management processes
- Increase effectiveness of environmental management through strengthened monitoring capabilities
- Investment in weather stations for improved hydro-meteorological monitoring systems
- Strengthen technical capacity for integrated climate-smart agriculture into the agriculture sector
- National CC impacts assessment for the health sector

Institutional

- Incorporate National Environmental Strategy goals into sectoral and regional plans
- Implement cross-sectoral climate-smart solutions
- Ensure climate-informed policies and planning processes at state and national levels

Data and information

- Develop early warning systems
- Ensure maintenance and enhancement of national CC and atmosphere monitoring systems

Other

- Available surface water resources are reported to be adequate to meet projected demand through to 2025, but significant investments in, for example, irrigation, water supply, sanitation, and electricity, are required to achieve mid- and long-term objectives
- Irrigation infrastructure and access to reliable water for agriculture would make a substantial difference for the country’s resilience, as well as boost production opportunities and thus livelihoods for smallholder farmers


Photo: DreamBig/Shutterstock

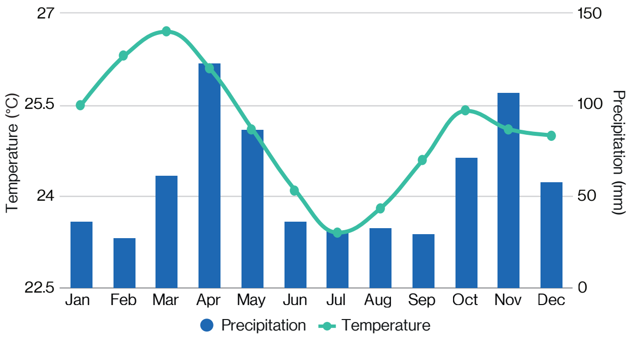
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Ghana
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Ghana Projected Future Climate
[3]Authors’ summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium
[4]ThinkHazard! (2020). Ghana – Extreme Heat
[5]ThinkHazard! (2020). Ghana – Water Scarcity
[6]ND-Gain: ND-GAIN Country Index: Ghana

Kenya

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 24.3°C/670 mm
Mean annual max/min T (1901–2020): 30.3°C/18.3°C

Country context

Population **52.6m (2019)**	Annual growth rate **2.3% (2019)**
GDP **$95.5bn (2018)**	Annual growth rate **5.4% (2019)**
GDP per capita **$1,800 (2019)**	

Literacy rate, adult female/male: 31%/62% (2014)
CPIA gender equality rating: 2.0 (2019)
Geography: Located in east Africa; Kenyan highlands in southwest; southeast coastline borders Indian Ocean; land area: 582,646 km[2]

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.5 to +1.4** (+1.0°C)	**+1.2 to +2.4** (+1.7°C)	**+2.0 to +3.7** (+2.5°C)	**+2.7 to +5.1** (+2.5°C)
Annual Precipitation Anomaly (mm)	**−13.7 to +21.6** (2.6mm)	**−17.1 to +25.2** (3.5mm)	**−17.0 to +34.0** (6.7mm)	**−17.8 to +44.0** (10.5mm)

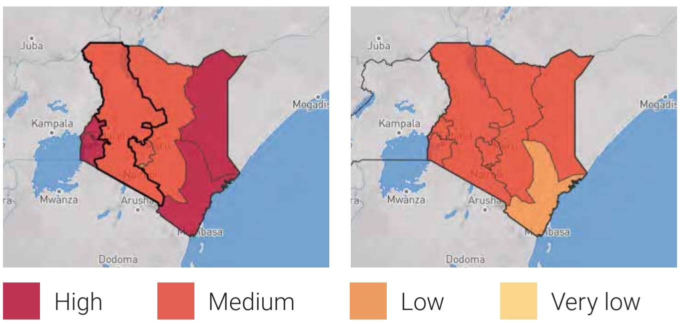
Climate hazards

- Drought has impacted GDP by 8% every five years, with drought cycles increasing in frequency from every 5–10 to every 2–3 years
- Average number of hot nights expected to occur on: 45-75% days by mid-century and 64-93% days by end of century
- Average number of hot days expected to occur on 19-45% of days by mid-century
- Floods risks expected to increase, leading to mudslides and landslides, particularly in mountainous areas; flash floods common in high plateau areas, and can trigger mudflows
- Climate change (CC) expected to impact water, agriculture, health, and forestry sectors, as well as coastal zones

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		12	196	53,350,000	47.23%
Flood	Unstated	8	586	1,941,810	3.94%
	Riverine	36	1,106	2,225,120	
	Flash	7	128	279,893	
Land-slides		5	153	-	0.00%
Total		**68**	**2,169**	**57,796,769**	**51.17%**

Risk of river flood (left)[4]**, Risks of water scarcity (right)**[5]



ENABLING ENVIRONMENT

Leadership and governance

Disaster risk management (DRM) preparedness and response: Disaster Risk Management Authority
Coordination of CC activities: National Climate Change Council (2016), housed in the Ministry of Environment and Forestry
Tracking progress: Ministry of Planning and Devolution
Data generation for forecasting and early warning systems (EWS): Kenya Meteorological Department
Access to climate finance: Through the National Environment Management Authority

Key adaptation policies

Key policy documents: Landscape of Climate Finance in Kenya (2021); updated first NDC (2020); Climate Smart Agriculture Implementation Framework 2018–2027 (2018); Climate Change Act, National Climate Change Policy Framework (2016); NAP (2016); National Climate Change Action Plan 2013–2017, Vision 2030; National Climate Change Action Plan: Adaptation Technical Analysis (2012)

Disaster Risk Management:

- DRM Authority working at national and sub-national levels to implement Vision 2030 strategy. Capacity building of DRM is ongoing
- Common Program Framework for Ending Drought Emergencies (2015)
- National Policy for Disaster Risk Management (2009)

ND-GAIN Index[6]

Country Index rank (score): 148 (38.9)
Vulnerability: 0.518
Ecosystem Services 15%, Food 19%, Human Habitat 18%, Health 20%, Infrastructure 10%, Water 17%

Readiness: 0.297
Economic 36%, Governance 42%, Social 21%

ND-GAIN Evolution

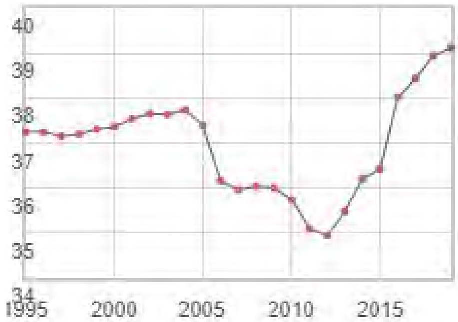



Photo: Sopotnicki/Shutterstock

Kenya

SECTORAL ADAPTATION PLANNING

AGRICULTURE

28% of GDP; contributions to agricultural GDP: Crops (78%); livestock (20%); fisheries (2%). Over 65% of exports, rain-dependent, agricultural land (2018): 28.99% of total land area; provides 80% of total employment and supports over 80% of rural population

- **Crops:** maize, wheat, rice, tea, coffee

Main climate change impacts

- Increased short-term crop failures and long-term production declines due to changes in precipitation patterns
- Production losses magnified by indirect impacts of drought and flooding such as increased rates of runoff and soil erosion, and insect, disease and weed infestations
- Altered mix and distribution of agriculture and livestock pests due to rising temperatures
- Crops yields may increase in temperate and tropical highlands, Rift Valley and high plateaus, due to increases in rainfall and slightly warmer temperatures
- Decrease in key crops yields in arid and semi-arid regions due to drought, rising temperatures and increased pests and diseases
- Reduced productivity and livestock numbers due to increasing water scarcity

Proposed adaptation strategies

- Improved knowledge base of CC-related impacts; and improved accessibility of seasonal information for farmers and fishers
- Improved water resources management, specifically increased use of irrigation and water management models at basin scales
- Improved land management action for conservation of grasslands and forests
- Use of water and resource-efficient technologies (e.g., drip irrigation), or more resilient crop varieties

WATER

Main climate change impacts

- Kenya categorized as water scarce in 1992; expected decrease in water scarcity index from 586m^3 per capita in 2010 to 293m^3 per capita by 2050
- Increasing challenges of water availability in cities (e.g., Mombasa) (which result in rationing and use of private sources) due to rising temperatures and rainfall variability
- Reduced water supply and increased salinization in coastal areas due to sea level rise
- Accelerated glacial loss on Mount Kenya due to rising temperatures
- Impact on river flows, irrigation potential, and water management due to annual decreases in rainfall
- Changes in rates of surface water infiltration and groundwater recharge due to changing rainfall and evaporation rates

Proposed adaptation strategies

- Currently government is encouraging states, via Kenya's devolution structure, to enact adaptation strategies alongside sub-basin management plans
- Support implementation of National Water Master Plan
- Restoration of regenerative ecological and physical functions of water bodies through improved water resource management
- Identify water resource challenges at community and regional level through targeted research
- Implement large-scale irrigation projects that are informed by vulnerability assessments

HEALTH

Main climate change impacts

- Increased risk of water-borne diseases and displacement due to flooding
- Threatened food and nutritional security due to higher temperatures
- Increased heat-related deaths, specifically in the elderly (65+ years): Projected increase from <2 per 100,000 deaths per year (between 1961 and 1990 baseline) to 45 per 100,000 deaths per year by 2080, under RCP8.5 scenario
- Rises in respiratory illnesses and urban air pollution (Nairobi, Mombasa) due to warmer and drier conditions

Proposed of adaptation strategies

- Ongoing climate vulnerability and risk assessment of CC impacts and variability on human health
- Increasing public awareness of CC impacts on human health
- Design and implementation of disease surveillance and monitoring to enhance health early warning systems

NEEDS

Research

- Increase understanding of CC vulnerabilities, impacts and possible adaptation responses within key sectors
- Invest in weather stations and expand the Kenya Meteorological Department's national hydro-meteorological and seismological monitoring system

Institutional

- Ensure that National Environmental Strategy goals are developed within sectoral and regional plans
- Implement cross-sectoral climate-smart solutions at national and subnational levels
- Integrate CC concerns into relevant policies and planning processes
- Integrate seasonal forecasts and long-term climate change trends into healthcare policy and planning

Data and information

- Improve observational data through the addition of weather stations and hydro-meteorological and seismological instrumentation and mapping
- Improve technical capacity for analyzing hydro-met data, particularly for monitoring sea level rise
- Establish institutional capacity for providing timely early warning systems
- Increase understanding of water resource threats and groundwater risks to improve water use efficiency in agriculture and urban management

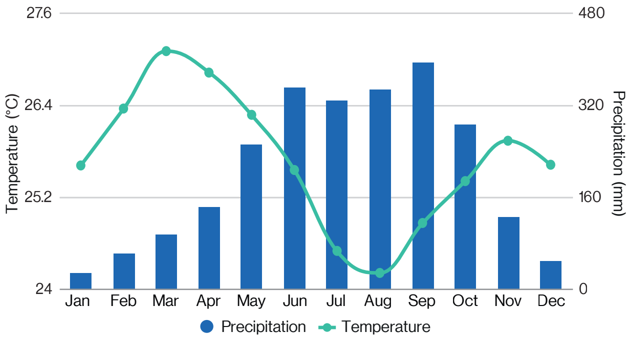
[1]WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya
[2]WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir
[4]ThinkHazard! (2020). Kenya River Flood
[5]ThinkHazard! (2020). Kenya Water Scarcity
[6]ND-Gain: ND-GAIN Country Index: Kenya

Liberia

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 25.7°C /2,467.07mm
Mean annual max/min T (1901–2020): 31.2°C/20.3°C

Country context

Population
5m (2020)

Annual growth rate
2.4% (2020)

GDP
$2.95bn (2020)

Annual growth rate
-2.9% (2020)

GDP per capita
$580 (2020)

Literacy rate, adult female/male: 85%/68% (2014)
CPIA gender equality rating: 4.0 (2019)
Geography: Located in the centre of the Upper Guinea Rainforest Region along the west coast of Africa; land area: 111,369 km²
Broad climate: Predominantly equatorial climate; one of the wettest countries in the world

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.3** (+0.9°C)	**+1.2 to +2.4** (+1.6°C)	**+1.7 to +3.6** (+2.4°C)	**+2.1 to +4.8** (+3.2°C)
Annual Precipitation Anomaly (mm)	**−28.9 to +32.5** (−1.17mm)	**−37.1 to +33.8** (−1.3mm)	**−40.5 to +51.5** (+4.4mm)	**−47.9 to +63.0** (+4.7mm)

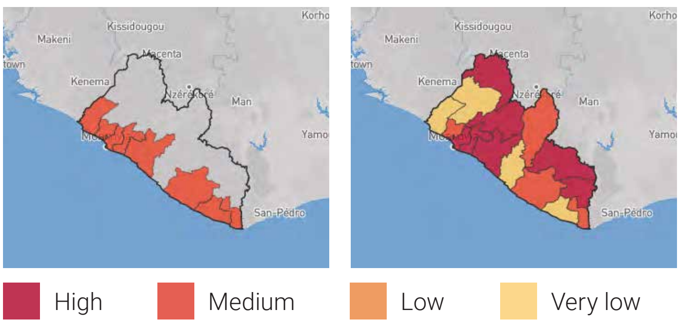
Climate hazards

- Vulnerability to climate hazards is exacerbated by the high levels of poverty and high dependence on climate change (CC) sensitive sectors: agriculture, fisheries, mining and forestry
- Liberia has a high number of rivers, catchments and aquifers as well as its low-lying coastal zone, and so changes to precipitation are likely to result in high-risk flooding scenarios
- CC may reduce land area along the Mesurado river delta and along the coastline exposed to erosion and sea level rise
- River flood hazard is classified as high, with potential for damaging, life-threatening river floods occurring throughout the country
- Population densities, i.e. capital city of Monrovia, the urban area of Greater Monrovia, and coastal urban areas, overlap with key flood zones and areas of high vulnerability

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	1	-	15,431	0.54%
	Riverine	5	14	38,070	
Storm	Unstated	1	-	-	0.00%
	Convective	1	-	-	
Total		**8**	**14**	**53,501**	**0.54%**

Coastal flood risk (left) and urban flood risk (right)[4]



ENABLING ENVIRONMENT

Leadership and governance

- Liberia's Environmental Protection Agency (EPA) is the primary agency responsible for preparing the National Communication under the UNFCCC and the National Adaptation Programme of Action (NAPA)
- The EPA is focused on integrating CC across government ministries
- The National Environmental Policy Council shapes priorities for environmental targets & objectives
- The National Climate Change Steering Committee and Secretariat are responsible for creating an intergovernmental framework for combatting CC

Key adaptation policies

Key policy documents: Updated NDC (2021); Second National Communication (2021); National Policy and Response Strategy on Climate Change (2018); Initial National Communication (2013); National Disaster Management Policy (2012); National Adaptation Programme of Action (NAPA) (2008); Environmental Protection and Management Law (2002)

Project foci to address main CC issues:

- Agriculture adaptation
- A National Meteorological and Hydrological Monitoring System
- Coastal defence

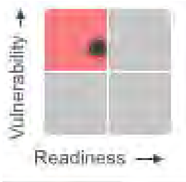
Disaster Risk Management (DRM):

- DRM guided by National Disaster Management Policy to ensure the reduction disasters through coordinated efforts across agencies
- Working to improve resilience to increased risk of natural hazards and extreme events, and to reduce vulnerability of local communities and institutions in order to better prepare for, mitigate and respond to natural hazards and increased threats from CC

ND-GAIN Index[5]

Country Index rank (score): 173 (34.1)
Vulnerability: 0.606
Ecosystem Services 18%, Food 21%, Human Habitat 23%, Health 24%, Water 13%

Readiness: 0.289
Economic 28%, Governance 40%, Social 31%



ND-GAIN Evolution

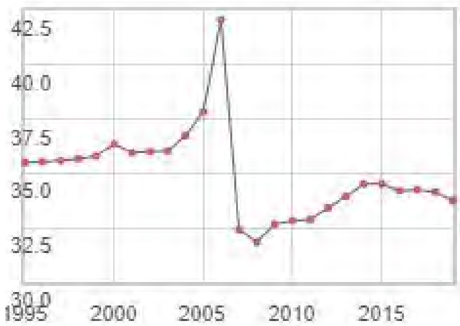



Photo: Gianfranco Vivi/Shutterstock

Liberia

SECTORAL ADAPTATION PLANNING

AGRICULTURE

42.6% of GDP

- Rice, cassava and vegetable production: 85% of cultivated land
- 80% of agriculture sector is made up of subsistence farming dependent on rainfed agriculture
- Primary staple crop: rice, cultivated by 74% of farmers; cassava is the country's second most important staple; major agricultural exports: rubber, cacao and coffee

Main climate change impacts

- Rice is sensitive to increased humidity temperatures, intense rainfall, and to the pests that thrive in these conditions
- Increasing intensity of rainfall may damage rubber production and increase costs to maintain proper drainage on plantations
- Rising temperatures, reducing moisture levels, and proliferating pests and diseases may stress cacao and coffee

Proposed adaptation strategies

- Cassava, more resilient to CC (particularly higher temperatures), may provide a key alternative food source
- Expanded areas of cultivation should be considered and trialled in the central and northern agricultural zones of the country
- Investments in research and extension services can enhance the capacity and delivery of information to the agricultural sector
- Harness land & water resources that sustain crop-area expansion in an appropriate policy, legal, and investment environment
- Improvements to weather monitoring network and associated weather information systems

WATER RESOURCES AND SANITATION (WASH)

Main climate change impacts

- Poor water quality from mining, farming, & industrial activities
- Water in rural areas mainly supplied from shallow wells whose levels fluctuate with rainfall variability; intense precipitation in urban areas to impact sewer systems & water treatment plants
- Increased water volumes could overwhelm sewer systems and water treatment plants, washing sediment, nutrients, pollutants, trash, animal waste, etc. into water supplies
- Increased rainfall, flooding and heat expected to increase prevalence of water & vector-borne diseases
- Storms and flooding may cause storm water flows, increasing water contamination of surface sources and shallow wells

Proposed adaptation strategies

- Investment into WASH and water management infrastructure, planning for urban expansion, and quality drinking water
- Support protection of river catchments and other sources of freshwater (including aquifers) to secure a steady supply of freshwater across all sectors and communities
- Vulnerability Assessment for water resources sector
- An increase in urban and rural domestic water supplies and urban sewage services to combat sanitation vulnerabilities
- Mainstream CC impacts in water resources management plans and programs to secure environmental safety and sustainable fresh water supply for the country

COASTAL ZONES AND SEA LEVEL RISE

Main climate change impacts

- Approximately 95 km^2 of land in the coastal zone will be inundated from 1m sea level rise, with about 50% of total land loss from inundation on the sheltered coast and shoreline retreat
- 230,000+ people are at risk and 2,150 km^2 will be lost with a 1m sea level rise by the end of the century
- Damages and losses (infrastructure and land) for major cities are estimated at US$ 250 million
- Rapid coastal erosion (both from sea level rise and sand mining) puts settlements and infrastructure at risk
- Sea level rise will increase migration to higher lands and/or result in shock waves of migration to the interior
- Much of the country's coast is protected by mangroves, at risk from erosion from rising sea temperatures and intense rainfall

Proposed of adaptation strategies

- Develop policies for aquaculture, urban infrastructure, integrated coastal management and flood-related disaster risk responses
- Institute physical planning and building control measures to protect coastline; avoid allocating in flood-prone areas
- Build coastal infrastructure such as roads, seaports, fish landing and hotel and residential buildings so marginal increase in the height of the structures for sea level rise can be mitigated
- Offer incentives for people in high-risk areas to relocate
- Direct support towards rehabilitation, management, and protection of wetlands and mangroves to buffer coastal communities from storm surge and coastal erosion
- Coastal Defence Strategies to reduce vulnerability of coastal urban areas to erosion, floods, and siltation

NEEDS

Research

- Improve understanding of occurrence and magnitude of CC trends, key vulnerabilities, development impact, and adaptation responses, and enhance public, community and institutional participation in adaptation planning
- Strengthen environmental monitoring capabilities and technical capacity for CC risk management at farmer level
- Rebuild national hydro-meteorological monitoring system
- Assessment of geographic risks & role of gender in adaptation
- Research to estimate cost of implementing NDC

Institutional

- Integrate NDC goals & adaptation efforts into sectoral/regional plans, city governments, land authorities & DRM agencies
- Ensure long-term spatial planning in urban zones considers projected disaster and CC impacts
- Implement cross-sectoral, climate-smart solutions, and regional-scale cooperation among west African countries
- Establish a National Steering Committee on CC to ensure integration of climate resilience in development planning
- Ensure policies are designed to create an enabling environment for agriculture and improved education, as well as expanded WASH services
- Develop systems to appropriately manage natural resources, and resolve disputes over natural resources and land

Data and information

- Utilise weather stations and hydro-met instrumentation
- Establish institutional capacity for early warning systems
- Increase data on urbanisation and information settlements to determine settlements located in disaster areas or flood zones

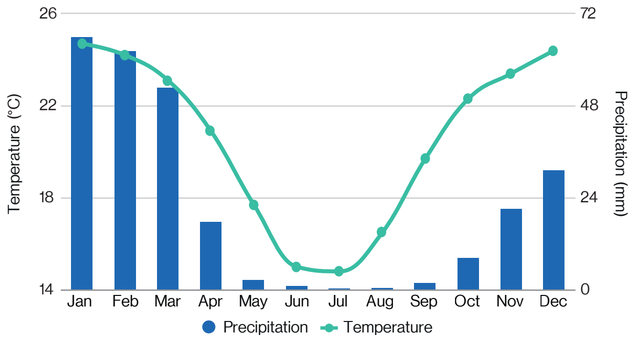
[1]WBG Climate Change Knowledge Portal (CCKP, 2020). Liberia
[2]WBG Climate Change Knowledge Portal (CCKP, 2020). Liberia Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Liberia: Overview
[5]ND-Gain. ND-Gain Index: Liberia

Namibia

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 20.6°C /270mm
Mean annual max/min T (1901–2020): 28°C/13.2°C

Country context

Population
2.5m (2020)

Annual growth rate
1.8% (2020)

GDP
$10.7bn (2020)

Annual growth rate
-8% (2020)

GDP per capita
$4,211 (2020)

Literacy rate, adult female/male: 50%/73% (2017)
CPIA gender equality rating: 3.50 (2019)
Geography: Located in southwest Africa; land area of 825,418 km^2; 1,500 km coastline along South Atlantic Ocean
Broad climate: Droughts, unpredictable rainfall patterns, high temperature variability, and water scarcity

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.8** (+1.2°C)	**+1.5 to +2.9** (+2.1°C)	**+2.5 to +4.5** (+3.2°C)	**+3.3 to +6.0** (+4.3°C)
Annual Precipitation Anomaly (mm)	**−11.8 to +10.2** (−1.2mm)	**−15.7 to +69.9** (−3.4mm)	**−17.7 to +5.9** (−4.3mm)	**−21.3 to +5.2** (−6.1mm)

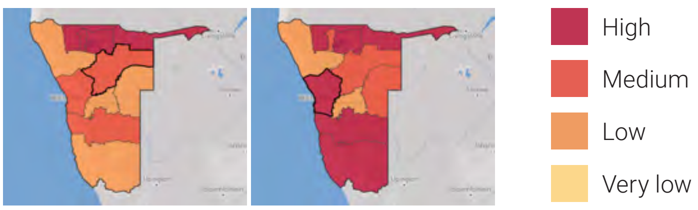
Climate hazards

- Namibia is prone to recurrent drought conditions and wildfires due to its hot and dry climate and erratic rains. Drought is the most devastating hazard
- It is likely that climate change trends will lead to an increase in drought frequency and intensity as well as an increase in the physical area of drought proneness; this will likely impact water scarcity
- Daily maximum temperatures are projected to increase by 5°C to 6°C by end of century
- Flooding is an annually recurring event which is worsening each year, with the northern and northeastern regions being the worst affected. Flooding frequency has increased in recent years and is estimated to impact 70,000 people annually, and is estimated to have potential economic damage for up to US$ 100 million per year
- Forest and wildfires are common, especially in the northeastern part of the country; an estimated damaged of 3-7 million ha of land annually

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		7	-	2,182,844	36.91%
Flood	Unstated	3	-	8,502	18.65%
	Riverine	11	262	1,082,450	
	Flash	1	2	12,000	
Total		**22**	**264**	**3,285,795**	**55.56%**

Risk of river flood and urban flood (left to right)[4]



Risk of water scarcity and wildfires (left to right)[4]

ENABLING ENVIRONMENT

Leadership and governance

Implementation of climate change (CC) policy: National Climate Change Committee (NCCC), chaired by the Ministry of Environment and Tourism (MET) and reporting to the Permanent Secretary of the MET via the head of the Department of Environmental Affairs

Key adaptation policies

Key policy documents: NDC (2016); Fourth National Communication (2020); Third Biennial Update Report (2018); National Policy on Climate Change (2011); National Agricultural Policy (2015); Water Sanitation and Supply Policy (2008); National Policy on Tourism (2008); National Health Policy Framework (2010–2020) (2010); National Disaster Risk Management Policy (2012); Climate Change Strategy and Action Plan (2013–2020) (2013)

Disaster Risk Management (DRM):

- The National Disaster Risk Management Policy (2009) prioritizes improvement of early warning system (EWS) and the tracking, monitoring, and disseminating of information on disaster-related phenomena
- National Disaster Risk Management Plan (NDRMP) and Emergency Management Operational Procedures to support NDRMP

ND-GAIN Index[5]

Country Index rank (score): 107 (45.7)
Vulnerability: 0.469
Ecosystem Services 18%, Food 18%, Human Habitat 19%, Health 17%, Infrastructure 15%, Water 13%

Readiness: 0.383
Economic 33%, Governance 48%, Social 18%

ND-GAIN Evolution

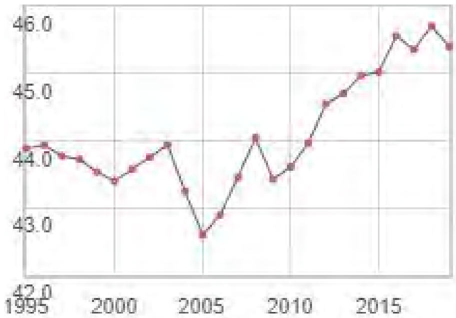


Photo: Hendrik Werner/Shutterstock

Namibia

SECTORAL ADAPTATION PLANNING

AGRICULTURE

7–10% of GDP

- 2% of total surface area is arable; 46% is appropriate for perennial natural pasture

Main climate change impacts

- From temperature increase and rainfall changes, cereal crop yields estimated to decline by up to 20% in the northeastern region and by 50% in the northcentral region
- In the central savannah and woodland areas, rainfed crop production could cease as cereal crop farming becomes futile
- Heat & water stress on such livestock likely to lead to decreases in feed intake, milk production, and rates of reproduction
- Productive fishing grounds are due to the Benguela current, which causes up-welling, bringing nutrient-rich waters up from the depths which stimulate growth of microscopic marine organisms that support fish populations. Fish stocks could be reduced by lower coastal upwelling and increased frequency of Benguela Nino events

Proposed adaptation strategies

- Expand irrigation infrastructure
- Introduce drought-tolerant and early maturing crop varieties
- Increase & upgrade storage facilities increase food security
- Enhance agricultural extension services
- Coordinating timing of ploughing/planting with rainfall events
- Implementing soil & water conservation policies and practices
- Foster year-long food production through irrigation, water harvesting, and conservation agriculture
- Increase access to seed and fertilizer
- Restore rangelands & improve livestock management strategies

WATER

45% from groundwater sources; 33% from the Border Rivers; 22% from impoundments on ephemeral river

Main climate change impacts

- Projected changes in rainfall over Angola and Zambia of up to between 10–20% by 2050 likely to lead to reduction of 20–30% in runoff and drainage of perennial rivers in northern Namibia
- Changing rainfall patterns over the catchments of the Zambezi, Kavango, Cuvelai, and Kunene rivers likely to lead to a 25% reduction of runoff and drainage in these river systems by 2065
- Droughts likely to result in falling groundwater tables and reduced surface water flows
- A temperature rise of 3°C will likely increase evaporation by 5%–15%, thereby leaving even less water available for discharge and storage, reducing the length of inundation of seasonally flooded wetlands, drying out shallow floodplains which could disrupt the seasonal breeding of many invertebrates and fish
- Increased salt content of pans and pools, decreasing their consumption suitability, due to drying wetlands

Proposed adaptation strategies

- Measures to reduce evaporation and to enhance efficiency of water resources utilization
- Water reclamation, artificial recharge of aquifers and desalination of both saline inland resources and seawater
- Optimization of surface and ground water use and improved water demand management
- Recycling of waste water

HEALTH

Main climate change impacts

- Increased temperatures, more intense and frequent extreme weather events, and increased duration and severity of aridity and drought likely to result in increased water and food insecurity, higher exposure to ultraviolet radiation, and changes in infectious and vector-borne disease transmission patterns
- Heat stress likely to increase due to increases in extremely hot days, thereby increasing incidences of dehydration, and reduced ability to cope with other stressors/diseases
- Floods likely to increase water-borne diseases (cholera, typhoid, leptospirosis, E. coli, and hepatitis A) in northern regions
- Increased occurrence of intense rainfall events and water runoff may induce formation of open waters, presenting more breeding grounds for vector borne diseases and insects
- Flooding and drought will pose health threats through the destruction of sanitation facilities and roads, as well as shortages of water
- Increased malnutrition due to decreased food security

Proposed of adaptation strategies

- DRM and preparedness
- Improved cholera outbreak and malaria control
- Improved nutrition through improved nutrition surveillance and staff trainings for malnutrition prevention and treatment
- Strengthening transport and communication systems between health facilities
- Improved water and sanitation systems
- Improved data collection and management

NEEDS

Research

- Improve teaching of meteorology, climatology, and general hydrology in higher education and university channels
- Enhance capabilities for handling CC data
- Evaluate needs and develop a national strategy for technology transfer to support NDC adaptation measures
- Monitor ecosystem and biodiversity changes and their impacts
- Undertake research on impact of sea level rise along the coast
- Develop and project CC scenarios at higher resolutions

Institutional

- Institutionalize DRM & mainstream CC in national/local policies
- Strengthen & enhance international collaboration, linkages, and networking among stakeholders involved in CC related issues
- Review and update existing legislation to reflect CC issues
- Establish land-use plans by type of use
- Integrate CC concerns into relevant policies and planning
- Finalize regulations to fund and implement impact studies regarding CC impacts for the country and key sectors

Data and information

- Improve technical capacity to analyse hydro-met data
- Establish institutional capacity for early warning systems
- Improve regulation and enforcement to protect forests, rainforests, and protected areas
- Strengthen information exchange by enhancing technology transfer and capacities necessary to promote environment and CC adaptation through education
- Increase active public participation in CC adaptation debate
- Establish Climate Change Resource Centre and CC database

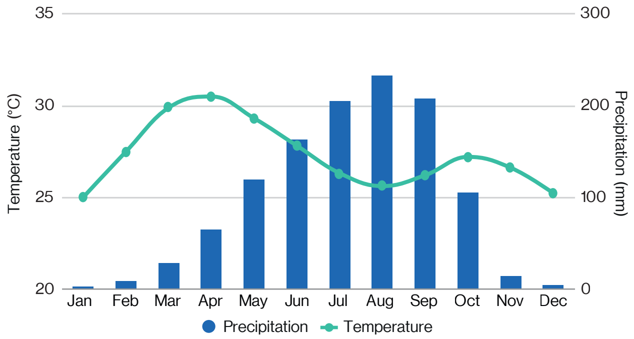
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Namibia Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Namibia: Overview
[5]ND-Gain. ND-Gain Index: Namibia

Nigeria

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 27.2°C / 1,160mm
Mean annual max/min T (1901–2020): 33.2°C/21.3°C

Country context

Population
206.1m (2020)

Annual growth rate
2.5% (2020)

GDP
$432.29bn (2020)

Annual growth rate
1.8% (2020)

GDP per capita
$2,100 (2020)

Literacy rate, adult female/male: 27%/44% (2018)
CPIA gender equality rating: 2.50 (2019)
Geography: Located along the inner corner of the Gulf of Guinea on the west coast of Africa; land area: 923,768 km^2; coastline: 853 km
Broad climate: Characterized by high temperatures with a relatively wet coastland and highly arid northern zones

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.0 to +1.5** (+1.0°C)	**+1.3 to +2.8** (+1.8°C)	**+2.0 to +4.2** (+2.7°C)	**+2.9 to +5.7** (+3.7°C)
Annual Precipitation Anomaly (mm)	**−18.6 to +21.5** (+0.4mm)	**−25.6 to +29.6** (−0.3mm)	**−28.0 to +39.4** (+2.3mm)	**−36.0 to +47.0** (+1.6mm)

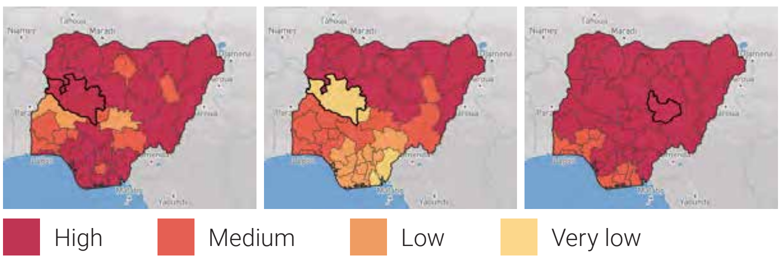
Climate hazards

- Agriculture is heavily impacted by flooding and drought
- 25% of the population (41 million people) living in high climate exposure areas, with highest exposure in coastal states; 27–53 million people at risk from relocation from 0.5m sea level rise
- Coastal erosion, rising seas & oil pollution destroying mangrove forests, which buffer against sea storm surges
- Disasters result in land & infrastructure degradation from erosion, direct crop failure from floods and heavy rains, and nutrient leaching, and fungal growth from humidity
- Heavy rainfall can trigger riverine & flash floods, common in hill areas, triggering landslides & mudslides and consequently gully erosion in sedimentary terrains
- Climate change (CC), deforestation, watershed degradation, land use, urbanization have exacerbated impacts from flooding & droughts and have increased the risk of wildfires
- Water stress likely to be exacerbated with competing demands from household, industrial consumption and agriculture

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	20	587	2,268,267	2.75%
	Riverine	26	980	9,411,491	
	Flash	6	330	98,565	
Storm	Unstated	2	-	-	0.00%
	Tropical	-	54	16,000	
	Convective	3	100	-	
Extreme Tempera-tures	Cold	1	18	-	0.00%
	Heat	1	60	-	
Land-slides		2	32	-	0.00%
Total		**61**	**2,161**	**11,794,323**	**2.76%**

Risk of urban flood, water scarcity and extreme heat (left to right)[4]



ENABLING ENVIRONMENT

Leadership and governance

- **Coordination of CC:** Department of Climate Change (DCC)
- Inter-Ministerial Committee on Climate Change facilitates cross-sector coordination
- In 2012, the Federal Executive Council adopted the Nigeria Climate Change Policy Response and Strategy. Several sector- or issue-specific policies and programs were created under this strategy

Key adaptation policies

Key policy documents: Updated NDC (2021); Third National Communication (2020); First Biennial Update Report (2018); National Agricultural Resilience Framework (2015); Second National Communication (2014); Post-Disaster Needs Assessment 2012 Floods (2013); National Adaptation Strategy and Plan of Action for Climate Change for Nigeria (2011); National Disaster Framework (2010); First National Communication (2003)

Disaster Risk Management (DRM):

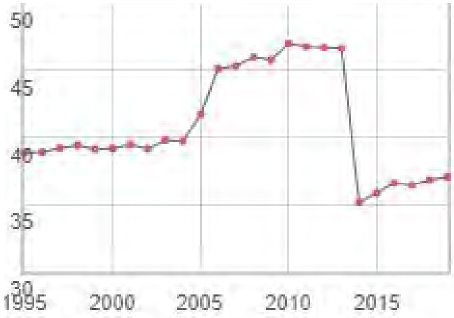
- Nigeria passed the National Disaster Management Framework in 2011; the 2012 flood was a turning point in national strategy to support long-term DRM
- Annual release of the Seasonal Climate Prediction by Nigeria Meteorological Agency (NiMET) and the Annual Flood Outlook by the Nigeria Hydrological Services Agency (NIHSA)

ND-GAIN Index[5]

Country Index rank (score): 161 (36.8)
Vulnerability: 0.493
Ecosystem Services 15%, Food 19%, Human Habitat 20%, Health 19%, Infrastructure 9%, Water 17%

Readiness: 0.23
Economic 33%,
Governance 39%,
Social 27%

ND-GAIN Evolution



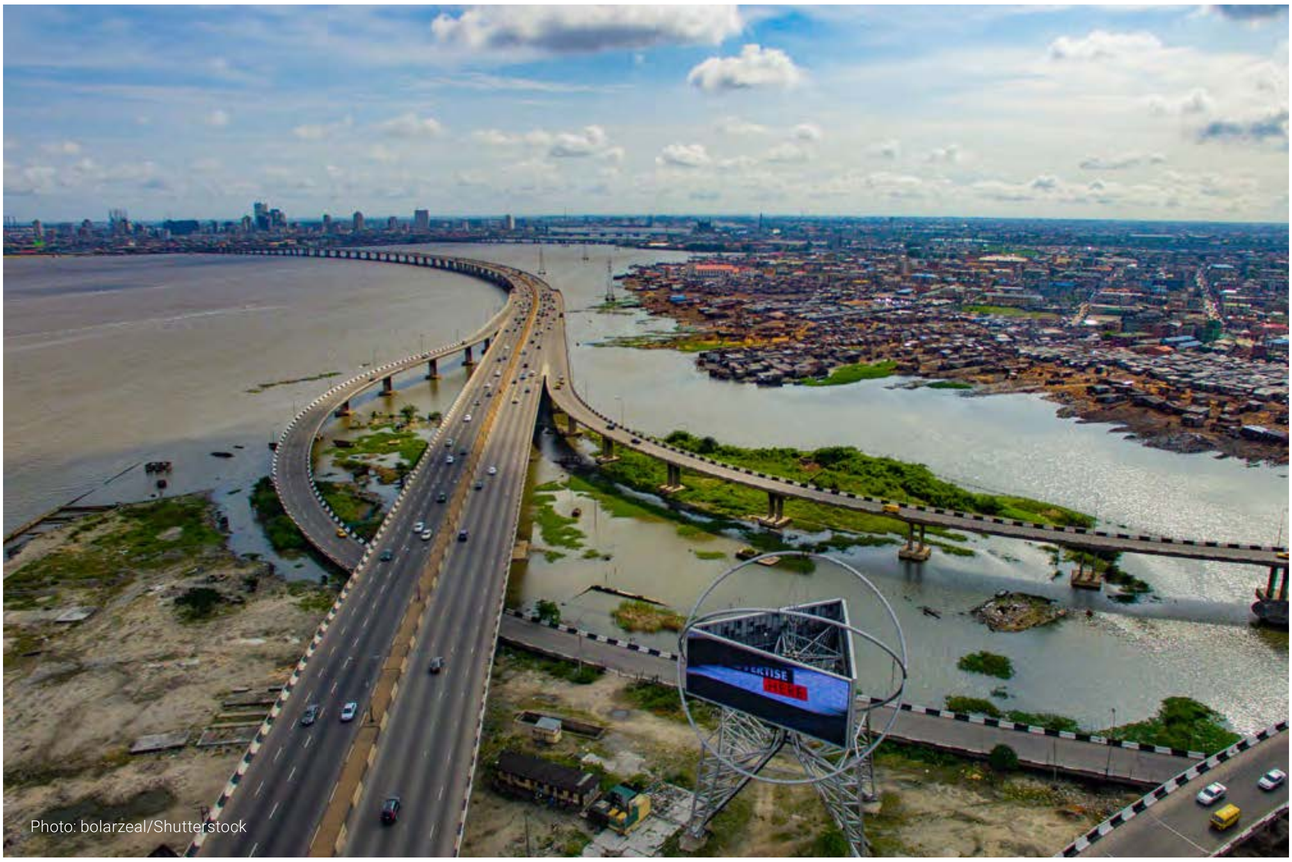


Photo: bolarzeal/Shutterstock

Nigeria

SECTORAL ADAPTATION PLANNING

AGRICULTURE

24.4% of GDP (2016)

- 78% of total land (708,000 km^2) is cultivated: 48% arable lands; 42.8% permanent meadows; 9.2% permanent crop production
- Significant imports: wheat, fish, rice, sugar; second-largest rice importer & one of the largest producers of cassava in the world

Main climate change impacts

- High CO2 levels may lead to nutrient declines in rice of 17%; cassava is well adapted to hot, dry conditions, but is susceptible to water logging/ production yields from heavy rainfall
- In southern zones, flooding, erosion and soil loss are likely; in the north, a traditional livestock production zone, decreasing precipitation and increased temperatures are likely
- Trends are likely to adversely impact livestock productivity in arid & semi-arid regions, affecting ecosystems due to over-stressed grazing lands and the direct impacts of heat on livestock
- Shortened growing seasons likely due to higher temperatures, impacting rice production

Proposed adaptation strategies

- Expanding and optimising irrigation infrastructure through national investment schemes and private sector companies leading procurement opportunities
- Agricultural insurance and enhancing extension services
- Diversify livestock and improve range management; increase access to drought-resistant crops and livestock feeds; adopt better soil management practices; and provide early warning/meteorological forecasts and related information
- Increase irrigation systems that use low amounts of water; increase rainwater & sustainable ground water harvesting; plant native vegetation cover; intensify crop and livestock production

WATER

214 km^3 of fresh water covering a surface area of over 20M ha

Water resources include 200 dams storing 31bn m^3

In rural areas, 88% of households use surface water, with 83% of those being among the poorest households in the country

Main climate change impacts

- Much of the population is at risk of water stress, with under 40% with access to potable water
- Rainfall variability may lead to flooding in humid areas in the south; reduced precipitation in the northern savannah may result in droughts
- Drought and desertification are resulting in biodiversity loss, loss of land cover and depletion of water resources; and will impact population dynamics through migration to urban areas
- Changes in hydrology expected from reduction in water sources
- Rising temperatures and dry spells will impact water quality by raising water temperature, accelerating bacterial growth

Proposed adaptation strategies

- Empowering agencies under the Ministry of Water Resources to focus on strategies to optimize use of Nigeria's water resources
- Ongoing adaptation strategies include reducing water loss from dams such as Kainji, Challawa, Tiga and Bakolori, like use of biodegradable suppressants
- Implement more irrigation and enhance storage of reservoirs
- Recycle wastewater to improve agriculture in peri-urban areas
- Water transfers to redistribute freshwater
- Improve water management strategies and domestic/industrial waste management practices

HEALTH

Main climate change impacts

- Under a high-emissions scenario, diarrheal deaths from CC in children under 15 years old projected to be about 9.8% of the over 76,000 diarrheal deaths projected in 2030
- Heat-related deaths in the elderly (65+ years) projected to increase to 80 deaths per 100,000 by 2080 compared to baseline of about 3 deaths per 100,000 p/y from 1961–1990
- Flooding from sea level rise could result in increased risk of water and vector-borne diseases
- Air pollution is expected to worsen with rising temperatures; extreme heat intensifies ground-level ozone, which combines with fine particulate pollutants (soot and dirt from coal combustion, diesel engines, or fires) and chemicals like carbon monoxide or sulfur dioxide to reduce air quality

Proposed of adaptation strategies

- Undertake research to understand health impacts of CC and strengthen disease protection, early warning, and treatment
- Promote adoption of practices and technologies that reduce exposure and health impacts from extreme heat
- Increase high quality health services and promote climate-health education in schools
- Train health care system personnel on relationship between CC, seasonal variability and health impacts

NEEDS

Research

- Improve meteorology, climatology and hydrology scientific capabilities for the Nigerian Meteorological Agency
- Enhance capabilities for handling CC data through the Climate Change Department of Federal Ministry of Environment
- Develop early warning systems

Institutional

- Establish land-use plans by type of use (road infrastructure, oil and gas distribution, agriculture and animal husbandry, forests, coastal zones, urban spaces etc.)
- Finalize regulations to fund and implement impact studies regarding CC impacts for the country and key sectors
- Develop Monitoring, Evaluation and Learning (MEL) framework to assess the efficiency of policies and measures to increase resilience

Data and information

- Strengthen transboundary flood monitoring, forecasting and nation-wide probabilistic flood modelling
- Increase understanding of water resource threats and groundwater risks to improve water use efficiency
- Improve regulation and enforcement to protect forests
- Strengthen information exchange to promote environment and CC adaptation through education and public awareness

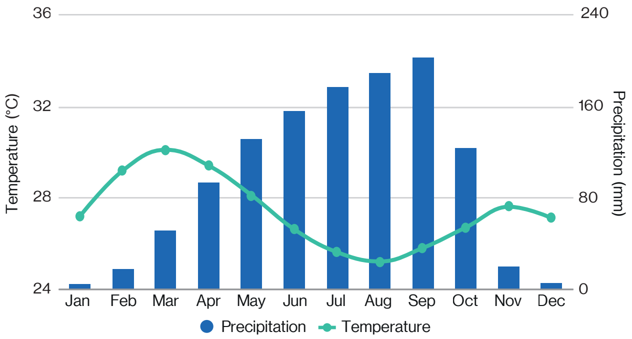
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Nigeria
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Nigeria Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Nigeria: Overview
[5]ND-Gain. ND-Gain Index: Nigeria

Togo

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 27.0°C/1,169.9 mm
Mean annual max/min T (1901–2020): 32.7°C/21.5°C

Country context

Population **8.1m (2020)** | Annual growth rate **2.4% (2019)**

GDP **$5.5bn (2019)** | Annual growth rate **5.3% (2019)**

GDP per capita **$680 (2019)**

Literacy rate, adult female/male: 73.09%/83.20% (2015)
CPIA gender equality rating: 3.0 (2019)
Geography: Located in west Africa, along the Gulf of Guinea; land area: 54,600 km^2
Broad climate: Northern area: dry with prevailing south-westerly winds; southern area: wet and humid

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.6 to +1.5** (+1.5°C)	**+1.2 to +2.7** (+1.7°C)	**+1.8 to +4.1** (+2.6°C)	**+2.5 to +5.6** (+3.5°C)
Annual Precipitation Anomaly (mm)	**−16.8 to +21.3** (1.3mm)	**−24.1 to +29.2** (−0.5mm)	**−24.8 to +36.1** (2.8mm)	**−32.5 to +41.6** (0.6mm)

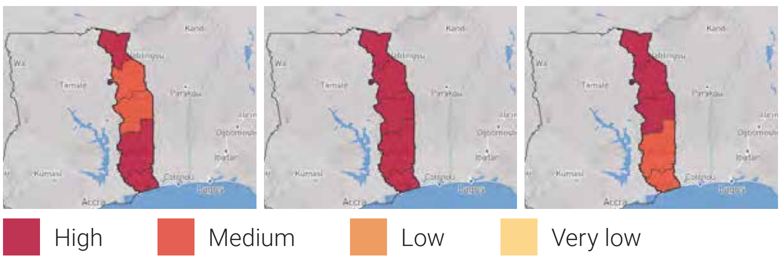
Climate hazards

- Climate change is expected to increase the risk and vulnerability of local communities to extreme events, coastal storms, and natural hazards such as heatwaves, droughts, floods, and wildfires
- Average temperatures are projected to increase, while rainfall may decrease or increase in parts of the country. Agriculture, energy, health, housing, water resources, and coastal areas will be particularly vulnerable to these climatic changes
- Flooding is intensified by deforestation, increasing its effects on infrastructure, food security and land resources. Events have become more widespread across the country and future floods are likely to encourage communicable and water-borne diseases
- Coastal areas are subject to flooding due to high levels of coastal erosion; expected increased coastal flooding could cover 20%–35% of coastal areas

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Unstated	5	11	115,465	3.32%
	Riverine	8	72	459,165	
Total		**13**	**83**	**574,630**	**3.32%**

Risk of river flood (left)[4]**, Risk of wildfires (centre) and Risk of extreme heat (right)**[5]



ENABLING ENVIRONMENT

Leadership and governance

- **Implementing environmental management and climate change (CC) policy, and designated authority to UNFCCC:** Environmental Directorate within the Ministry of the Environment and Forest resources
- **Committees:** National Climate Change Committee; National NAPA Committee; National NAMA Committee; Designated National CDM Authority
- **National programs, strategies and plans for planning, monitoring and evaluation:** National Environmental Policy; National Environmental Management Program; National Sustainable Development Strategy (NSDS); National Medium Term Priority Framework (NMTPF) for Togo (2010–2015); Adapting Agriculture in Togo to Climate Change (ADAPT)

Key adaptation policies

Key policy documents: NAP (2018); NDC (2016); National Multi-Risks Contingency Plan (2021); First Biennial Update Report (2017); Third National Communication (2015); Forest Action Plan (2009)

Disaster Risk Management (DRM):

- Togo has integrated DRM activities through its Accelerated Growth and Employment Promotion Strategy (2013) and National Development Plan (2018–2022)
- Strategies and plans include: National Action Program for Adaptation to Climate Change (2009); National Investment Program for Environment and Natural Resources (2010); and National Strategy for Reducing the Risk of Catastrophes in Togo
- DRM priorities include developing analytical tools to enhance risk identification, elaborating the National Strategy for Disaster Risk Reduction (SNRRC), operationalization of the flood early warning system (EWS); establishing a disasters database (DesInventar); establishing a Sendai Framework Monitor (SFM) database

ND-GAIN Index[6]

Country Index rank (score): 139 (40.4)
Vulnerability: 0.505
Ecosystem Services 17%, Food 19%, Human Habitat 20%, Health 18%, Infrastructure 14%, Water 11%

Readiness: 0.313
Economic 35%, Governance 38%, Social 26%

ND-GAIN Evolution

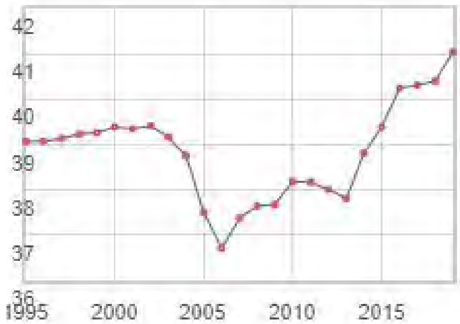



Photo: mbrand85/Shutterstock

Togo

SECTORAL ADAPTATION PLANNING

AGRICULTURE

- ~40% of GDP; 26% food crops, 4% cash crops, 5% livestock products, 2% fishery products and aquaculture, 2% forestry production; employs over 70% of the population; 20% of export revenue; rainfed dependent; agricultural land (2018): 44.76% of land area; 2% of cultivated land is irrigated

Main climate change impacts

- Decreased productivity of coffee and cocoa due to increasing temperatures
- Maize yields could decline by more than 25% by mid-century
- Tuber crops, such as yams, may benefit from higher temperatures and increasing rainfall; cassava yields could double by end of century
- Increased prevalence of pests and diseases due to increasing temperatures and rainfall, thereby affecting crop yields
- Flash flooding may introduce diseases in livestock, such as trypanosomiasis in cattle, while drying of watering points and pasture degradation may lead to death of livestock
- Decrease in fish production due to disturbances in fish productivity cycles and salinization of freshwater bodies
- Rising sea surface temperatures may lead to increased evapotranspiration in surface water and force fish to lower depths, thereby decreasing catches

Examples of adaptation practices

- Building technical capacity of key research institutions
- Breeding crops and livestock resistance to pests and diseases and promoting small-scale irrigation
- Improving sustainable forest and land management through promoting fast-growing tree species for wood energy and developing a national monitoring program for land use
- Construction and/or improvement of reservoirs for micro-irrigation and livestock watering in rural areas
- Support for vulnerability mapping
- Promotion of rice production systems

Milestones

- The country has committed to the Climate-Smart Agriculture process laid out in the agricultural policy of the Economic Community of West African States (ECOWAS) and the National Policy for the Agricultural Development of Togo 2013–2022

COASTAL ZONE

More than 500,000 people live in precarious housing along the coast; 250 m coastline recession due to coastal erosion

Main climate change impacts

- Projected increase in sea level rise (baseline 1986–2005): by up to 0.16 m (by 2025), 0.34 m (by 2050), 0.55 m (by 2075) and 0.74 m (by end of century), based on conservative RCP2.6 scenario
- Increased salination in drinking water due to salt water intrusion from rising sea levels
- Loss of farms for those carrying out farming activities such as market gardening along the coast
- Rising sea levels will exacerbate coastal erosion, impacting coastal infrastructure; current average loss of coastline of 5 m/year likely to reach recession of 10 m/year, with an annual erosion rate of 20 m along the eastern section of Lomé
- Increased flooding in the lower region of the city of Lomé, where 40%–50% of the population lives and 80% of infrastructure, industries and hotels are located
- Rising sea surface temperatures may lead to losses of coastal habitats such as mangroves as well as key food sources such as plankton. Continued ocean acidification will result in reduced protein intake and nutrition deficits for human population

Examples of adaptation practices

- Intensifying national action under the west African regional program against coastal erosion (West African Economic and Monetary Union) and West Africa Coastal Areas management program (WACA)
- Awareness raising on coastal vulnerabilities and sustainability
- Consolidation of data observation and databases
- Construction of barriers against salt water intrusion
- Resettlement of those in risk zones along the coast
- Rehabilitation of lagoons

Milestones

- Plans to be adopted: A Coastal Development Master Plan (SADL); Multisectoral Investment Plan (MSIP); Strategie Nationale pour la Mer et le Littoral (SNML); Cadre Strategique pour le Developpement de l'Economie Maritime et Cotiere au Togo

NEEDS

Research

- Improve understanding of vulnerabilities and possible adaptation responses
- Education on meteorology, climatology and general hydrology
- Build capacity of hydro-met service staff
- Enhance capabilities for handling climate change data at national, regional and local levels
- Research into renewable energy and sea level rise
- Improve cooperation between research institutions and universities on climate change issues; develop early warning systems for climate change related human diseases
- Enable informed decision-making and action through research

Institutional

- Institutionalize and strengthen disaster risk management with strengthened capacities at all levels of government and communities
- Mainstream climate change in national, local and sector policies and reinforce institutional frameworks for implementation of UNFCCC commitments
- Strengthen and enhance international collaboration, linkages and networking among stakeholders
- Strengthen institutional and regulatory framework for action on health and environment
- Build capacity of national experts in various state departments for implementation, follow-up, quality control and reporting
- Integrate climate change concerns into relevant policies and planning processes at the state and national levels

Data and information

- Improve technical capacity to analyze hydro-met data and project impacts across sectors, specifically regarding health and natural disaster events
- Create national observatories and strengthen national capability for documenting, archiving and storing observational data
- Establish institutional capacity for providing timely early warning systems to farmers
- Increase understanding of water resource threats and groundwater risks
- Improve regulation and enforcement to protect forests, rainforests and protected areas
- Enhance technology transfer to promote climate change adaptation through education and public awareness

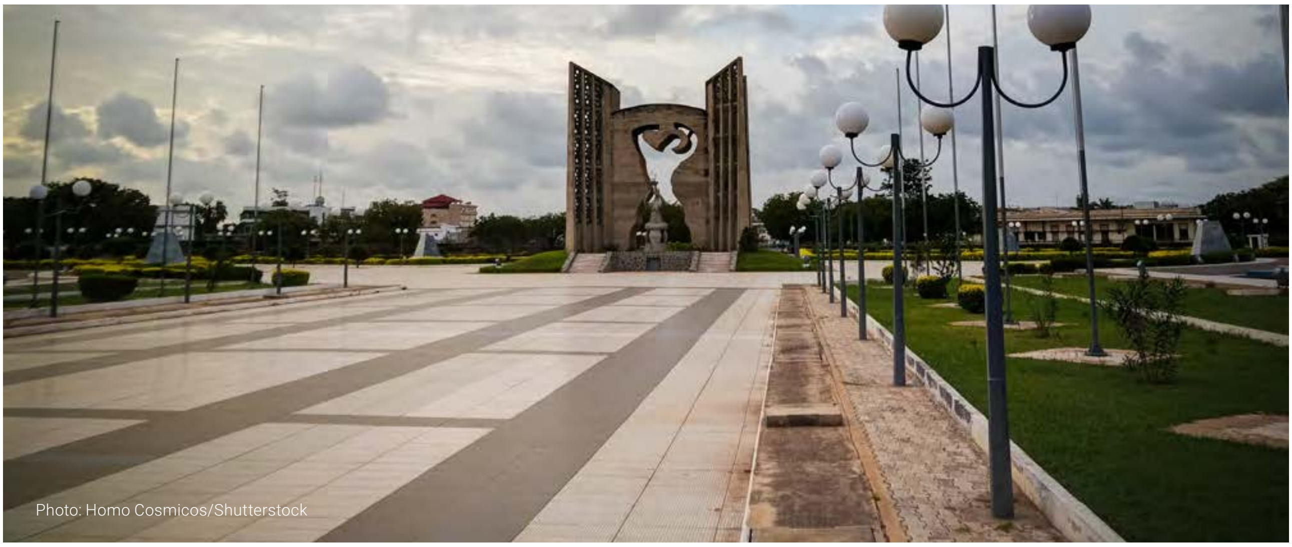


Photo: Homo Cosmicos/Shutterstock

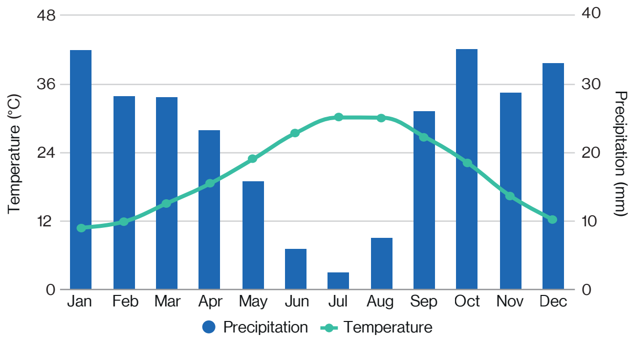
[1]WBG Climate Change Knowledge Portal (CCKP, 2021). Togo
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Togo Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Togo River Flood
[5]ThinkHazard! (2020). Togo Extreme Heat
[6]ND-Gain. ND-Gain Index: Togo

Tunisia

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2019[1]



Mean annual T/Ppt (1901–2020): 19.4°C/263.5 mm
Mean annual max/min T (1901–2020): 25.4°C/13.5°C

Country context

Population **11.7m (2019)** | Annual growth rate **1.1% (2018)**

GDP **$38.7bn (2019)** | Annual growth rate **1% (2019)**

GDP per capita **$3,400 (2018)**

Literacy rate, adult female/male: 51.24%/77.26% (2015)
CPIA gender equality rating: 3.0 (2019)
Geography: Located in North Africa, along the southern shore of the Mediterranean sea; land area: 164,000 km^2; coastline: 1,300 km^2
Broad climate: Northern area: hot summers and rainy winters; western, central and mountainous area: arid steppe climate; southern area: semi-arid to arid

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+0.5 to +2.2** (+1.3°C)	**+1.5 to +3.3** (+2.3°C)	**+2.0 to +4.9** (+3.3°C)	**+3.0 to +6.5** (+4.6°C)
Annual Precipitation Anomaly (mm)	**−5.9 to +5.2** (−0.5mm)	**−7.0 to +4.9** (−1.3mm)	**−8.8 to +4.5** (−1.6mm)	**−9.4 to +3.7** (−3.0mm)

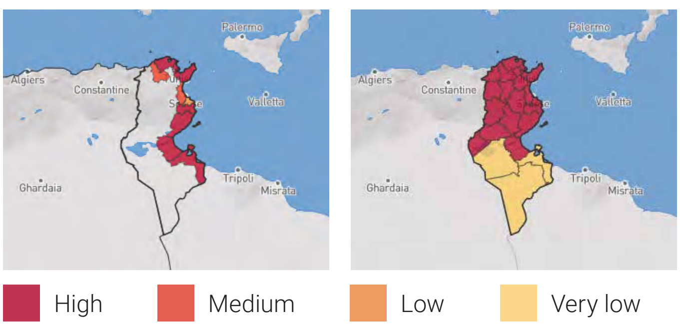
Climate hazards

- Tunisia is projected to experience heightened dry conditions and drought severity
- Water stress likely to be experienced most acutely in the central and northwestern areas, in the 2050s and 2090s, respectively
- Sea level rise is projected to lead to the loss of a sizable proportion of the northern and eastern coastlines due to a combination of inundation and erosion, with consequential loss of agricultural land, infrastructure, and urban areas
- Increased frequency of intense precipitation events will lead to a heightened risk of flooding, river bank overflow, and flash flooding

Natural hazards occurence from 1991-2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Flood	Riverine	3	12	28,500	0.34%
	Flash	5	52	75,000	
Wildfires		1	-	-	0.01%
Land-slides		1	-	-	0.00%
Total		**9**	**64**	**105,000**	**0.34%**

Risk of coastal flood (left)[4] and Risk of wildfires (right)[5]



ENABLING ENVIRONMENT

Leadership and governance

Coordination of climate change (CC) agendas and adaptation efforts: Ministry of Local Affairs and Environment, National Agency for Energy Management, Ministry of Agriculture, and the Ministry of Water Resources and Fisheries. These agencies also serve as the Designated National Authority for the Clean Development Mechanism of the Kyoto Protocol

Responsible for updating water policies and strategies: National Water Council (2013)

Key adaptation policies

Key policy documents: NAP (2016); NDC (2016); Third National Communication (2019); Second Biennial Update Report (2016); De-Risking Renewable Energy Investment (2014)

Disaster Risk Management (DRM):

- Disaster Risk Management directed and managed by the Tunisian Civil Protection National Office; Tunisia's Civil Protection program is under preparation
- DRM priorities include strengthening regional coordination and investment in technological innovations to address water scarcity, sea level rise and storms; disaster risk financing and insurance mechanisms; enhancing early warning systems (EWS); integrating resilience into urban infrastructure investments

ND-GAIN Index[5]

Country Index rank (score): 69 (52.1)
Vulnerability: 0.382
Ecosystem Services 16%, Food 17%, Human Habitat 18%, Health 14%, Infrastructure 18%, Water 16%

Readiness: 0.423
Economic 39%, Governance 35%, Social 25%

ND-GAIN Evolution

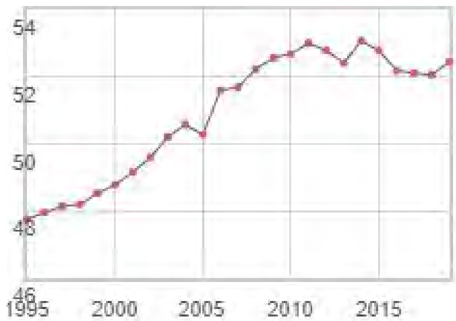


Photo: Romas_Photo/Shutterstock

Tunisia

SECTORAL ADAPTATION PLANNING

AGRICULTURE

~14% of GDP (2012); provides income for 470,000 farmers; more than 10m ha of agricultural land; 62% of total land area; currently uses 80% of all water resources

- Top agricultural commodities: olive oil, dates, citrus, grain, meat, poultry
- Main export crops: cereals, olive oil, dates, citrus fruits

Main climate change impacts

- Threatened yields of irrigated and rainfed crops by end of century due to rising temperatures, increasing evapotranspiration, and decreasing availability of water resources
- Area of non-irrigated orchards could be reduced by 800,000 ha (nearly 50% of current production area), particularly in central and southern areas
- Areas of irrigated cereals expected to decrease by 20% in the 2020s; rainfed cereal crops could decrease by 30% by the 2030s
- Increased weeds and diseases due to higher temperatures
- Crop losses, mainly wheat, barley, and irrigated potatoes, and increased food insecurity, due to floods and droughts
- Dryness and impaired soil health will negatively impact fruit and olive oil production

Examples of adaptation practices

- Increased meteorological and climatic monitoring, primarily focused on extreme events which can cause significant crop damage
- Strengthened participative debates between managers, farmers and rural inhabitants for improved localized adaptation planning
- Introducing climate monitoring and early warning systems
- Climate insurance mechanisms for agriculture
- Developing innovative systems for arable crops

Milestones

- Adoption of the National Program on Water Savings in 1995 has resulted in localized irrigation (drip irrigation) now applied to 46% of the total area of irrigated land

WATER

Significant imbalances in water resource distribution regarding service availability, water quality and access; 81% of water needs of the irrigated sector from underground resources

Main climate change impacts

- Increased intensity and frequency of dry periods and water scarcity due to decreases in average rainfall, likely to most affect those in rural areas (due to drying up of springs) and women (due to household responsibility for supply and hygiene)
- Reduced soil moisture, surface water, and underground water stocks due to increased temperatures
- Coastal aquifers threatened by sea level rise and increased threats from overexploitation, degradation and salinization
- Impact on surface water infiltration and recharge rates for groundwater due to rainfall and evaporation changes

Examples of adaptation practices

- Re-use of wastewater
- Transference of surplus water from northern to inland regions
- Water and soil conservation to reduce water demand from key sectors

Milestones

- The Djerba desalinization plant became operational in 2018. Investment in this, as well as the Sfax, Zarrat, and Sousse plants, are projected to secure drinking water supply required though 2030

NEEDS

Research

- Improve understanding of vulnerabilities and possible adaptation responses
- Widen participation of the public, scientific institutions, women and local communities in planning and management
- Strengthen environmental monitoring capabilities for more effective environmental management
- Increase understanding of climate risks and impacts on coastal zones, sea level rise and coastal agricultural zones
- Strengthen technical capacity for integrating climate-smart agriculture and climate change risk management into the agricultural sector
- Design and implement a technology needs assessment

Institutional

- Develop and implement a national monitoring, verification and reporting (MRV) system
- Ensure integration of National Climate Change Strategy goals within sectoral and regional plans
- Support facilitation of energy efficiency options through improved financing and legal backing for public-private partnerships
- Implement cross-sectoral climate-smart solutions at national and subnational levels

Data and information

- Develop EWSs for improved climate risk management, specifically for sea level rise, water resources and health impacts
- Improve EWSs to support agriculture, livestock and water resources and strengthen preparedness for increased aridity and longer dry seasons
- Ensure maintenance of EWSs, including monitoring networks at appropriate spatial density and frequency


Photo: Romas_Photo/Shutterstock

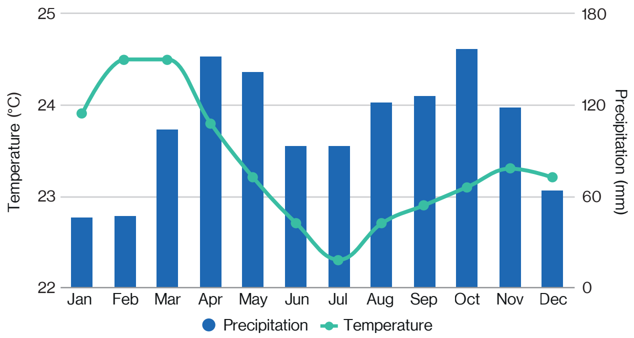
[1]WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia
[2]WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2019). Tunisia - Coastal Flooding
[5]ThinkHazard! (2019). Tunisia - Wildfire
[6]ND-Gain: ND-GAIN Country Index: Tunisia

Uganda

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 22.4°C /1,200 mm
Mean annual max/min T (1901–2020): 28.7°C/16.2°C

Country context

Population
44.3m (2019)

Annual growth rate
3.6% (2019)

GDP
$35.1bn (2019)

Annual growth rate
4.5% (2019)

GDP per capita
$4,400 (2019)

Literacy rate, adult female/male: 72%/86% (2014)
Geography: Landlocked country in eastern Africa lying in both the northern & southern hemispheres; land area: 241,500 km²
Broad climate: North lies outside tropical zone; rest: humid equatorial climate zone

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (ºC)	**+0.6 to +1.5** (+1.0ºC)	**+1.2 to +2.5** (+1.8ºC)	**+1.9 to +3.9** (+2.8ºC)	**+2.6 to +5.2** (+3.7ºC)
Annual Precipitation Anomaly (mm)	**−23.5 to +25.9** (+1.4mm)	**−25.9 to +32.5** (+2.9mm)	**−26.5 to +45.1** (+7.4mm)	**−26.0 to +63.1** (+13.6mm)

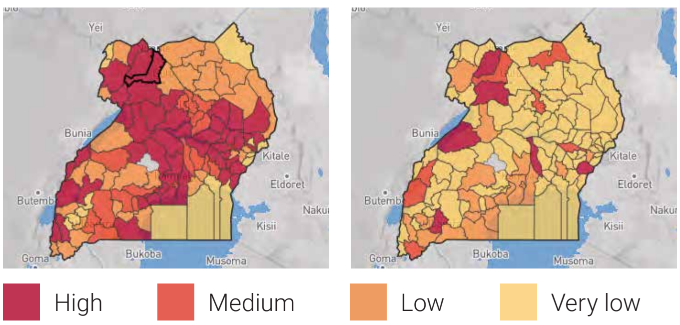
Climate hazards

- Flooding presents the largest risk, particularly in low-lying areas
- During rainy seasons, heavy rainfall can cause flash flooding, destroying roads and bridges and causing food shortages and inaccessible health facilities & schools as areas become impassable
- Each year, floods impact ~50,000 people and cost over US$ 62 million
- Extreme weather events lead to landslides & mudslides, especially in the mountain regions such as Mbale in the Mt Elgon region
- Drought affected around 2.4 million people from 2004-2013. Drought conditions from 2010-2011 caused a loss and damage value of around US$ 1.2 billion, 7.5% of Uganda's 2010 GDP
- Most drought-prone areas are the districts in the 'Cattle Corridor'. Extreme drought has been most prevalent in the Karamoja region

Climate hazards from 1991–2020[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		6	194	3,850,000	4.49%
Flood	Unstated	9	82	77,000	1.13%
	Riverine	16	278	786,730	
	Flash	5	79	108,600	
Storm	Unstated	3	-	-	0.01%
	Tropical	-	31	8,700	
	Convective	2	-	-	
Wildfires		-	-	147,069	0.00%
Land-slides		9	591	-	0.17%
Total		**50**	**1,255**	**4,978,099**	**5.81%**

River flood risk (left) and urban flood risk (right)[4]



ENABLING ENVIRONMENT

Leadership and governance

- **Lead entity responsible for climate change (CC) issues:** Ministry of Water and the Environment
- Ministry's Climate Change Directorate is the lead facilitator to regional and international actors on behalf of the government, including the development of National Communications and the 2015 National Climate Change Policy
- Disaster risk management (DRM) coordinated through the Department of Disaster Preparedness and Management

Key adaptation policies

Key policy documents: Uganda One Health Strategic Plan (2018); National Adaptation Plan for the Agricultural Sector (2018); NDC (2016); National Climate Change Policy (2015); Climate Smart Agriculture Policy (2015); Uganda Vision 2040 (2007)

Disaster Risk Management (DRM):

- Economic development framework and 2010 Poverty Reduction Strategy Paper state DRM as an enabling sector to achieve sustainable development
- Disaster Management Policy (2011) outlines DRM priorities: strengthening institutions & financing for CC adaptation; developing multi-sectoral adaptation plans; implementing programs to reduce the socio-economic impact of CC and natural disasters; and increasing community-level resilience to CC
- DRM support for municipalities enables leaders to establish their own Disaster Prevention, Mitigation, and Response Committees

ND-GAIN Index[5]

Country Index rank (score): 167 (35.9)
Vulnerability: 0.582
Ecosystem Services 18%, Food 22%, Human Habitat 19%, Health 25%, Water 15%

Readiness: 0.299
Economic 35%,
Governance 43%,
Social 21%

ND-GAIN Evolution

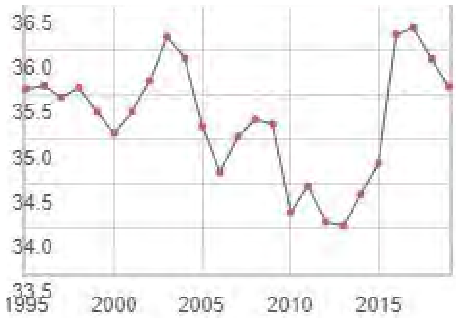


Photo: Travel Stock/Shutterstock

Uganda

SECTORAL ADAPTATION PLANNING

AGRICULTURE

25% of GDP; employs 70% of the population (2014)

Main climate change impacts

- Rising temperatures will increase crop diseases like blast and bacterial leaf blight in rice, aflatoxin in maize, fungal/viral diseases in banana & beans, coffee rust in coffee trees
- Rainfall may impact post-harvest storage, for example on maize, beans, coffee and rice which need to be dried in the sun
- Coffee & tea, major export crops, could see reduction in yields. Combined economic losses: US$ 1.4 billion by mid-century
- Climate-induced losses: 10–50% yield losses; reduction in foreign exchange earnings by US$ 15–US$ 80 million per year
- Water scarcity risks quality of fields through waterlogging, decreasing recharge, and increased evaporation
- Animals are vulnerable to heat stress, which may reduce milk production and reproduction for livestock

Proposed adaptation strategies

- Improve water capture and storage; invest in irrigation in arid areas, and introduce flood- and drought-prone crops
- Pasture management such as no-burn agricultural practices
- Semi-stabled cattle systems
- Income diversification for farmers and financing options such as climate-risk insurance schemes
- Improve weather monitoring systems; frequent publication & distribution of agriculture-specific weather forecasts

WATER

Main climate change impacts

- Unmet water demand by 2050 could reach US$ 5.5 billion. Largest losses expected in Lake Victoria and Albert Nile, and Lake Kyoga Watersheds
- 82% of recharge water in Lake Victoria comes from precipitation from two main rainy seasons (2,100 mm per year). In 2006, Lake Victoria reached an 80-year low
- Risk of water contamination of surface sources & wells from flooding
- Surface water infiltration and recharge rates for groundwater at risk from changes in rainfall

Proposed adaptation strategies

- Focus adaptation strategies on increasingly variable rainfall patterns, with specific attention on the most at-risk area on the cattle corridor axis
- Support groundwater monitoring wells
- Improve water infrastructure and protection of lake and river catchments, and other sources of freshwater including aquifers
- Adaptation strategies for water should be included in development strategies for agriculture, infrastructure, and energy sectors
- Mainstream CC in all water resources management plans and programs

HEALTH

Main climate change impacts

- Under high & low emissions scenarios, by 2070 around 108 million people are projected to be at risk of malaria
- Increased temperatures and flooding around rivers and lakes likely to increase vector and water-borne diseases such as schistosomiasis, dengue, and cholera. Districts such as Buikwe, Masaka, Mpigi, Jinja and Mayuge are at risk
- Under a high emissions scenario, heat-related deaths in the elderly (65+ years) are projected to increase to about 81 deaths per 100,000 by the 2080s compared to the estimated baseline of under 2 deaths per 100,000 annually between 1961 and 1990
- Outdoor workers and the agricultural industry are at risk to heat stress, dehydration and prolonged exposure can lead to chronic kidney disease and cardiovascular diseases

Proposed adaptation strategies

- Training and capacity building of healthcare personnel on relationship between CC and health, and adaptation to CC to mitigate negative health impacts
- Improve monitoring and surveillance systems of trends to forecast direct interventions against climate-sensitive diseases
- Investment and research to support identification and analysis of trends and develop indicators to improve health sector capacity to react
- Develop health early warning systems (EWS), especially for heat wave and flooding warnings

NEEDS

Research

- Increase understanding of vulnerabilities and adaptation responses
- Involve public, scientific institutions, women and local communities in adaptation planning
- Strengthen environmental monitoring
- Invest in weather stations and expand hydro-meteorological monitoring systems
- Strengthen technical capacity to integrate climate-smart agriculture and CC risk management into the agricultural sector
- Conduct household surveys to collect poverty data for climate resilience

Institutional

- Integrate National Environmental Strategy goals in sectoral & regional plans
- Implement cross-sectoral climate-smart solutions at national and subnational levels
- Integrate climate change concerns into relevant policies and planning processes at the state and national levels

Data and information

- Improve observational data by adding weather stations and hydro-meteorological instrumentation
- Improve technical capacity to analyse meteorological data
- Institutional capacity strengthening for EWS
- Develop a tool to quantify economic losses from disasters in various infrastructure sectors

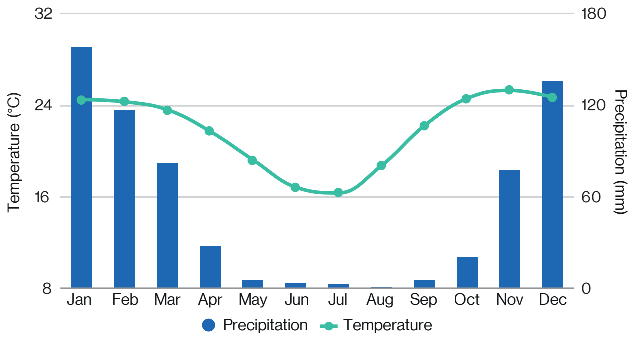
[1]WBG Climate Change Knowledge Portal (CCKP, 2021).Uganda
[2]WBG Climate Change Knowledge Portal (CCKP, 2021). Uganda Projected Future Climate
[3]Authors' summary based on CRED EM-DAT database, accessed 10 May 2021: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium
[4]ThinkHazard! (2020). Uganda Urban Flood
[5]ND-Gain. ND-Gain Index: Uganda

Zimbabwe

Adapted from the World Bank's Climate Risk Country Profiles Series, 2021

Climate trends

Average monthly Temperature (T) and Precipitation (Ppt), 1991–2020[1]



Mean annual T/Ppt (1901–2020): 21.3°C /669.9mm
Mean annual max/min T (1901–2020): 28.2°C/14.5°C
Mean annual T increase (1970–2016): 0.03°C p/y

Country context

Population
14.6m (2019)

GDP
$21.4bn (2019)

Annual growth rate
-8.1% (2019)

GDP per capita
$1,700 (2019)

Literacy rate, adult female/male: 83%/91% (2018)
Geography: Landlocked country in southern Africa; Land area: 390,757 km^2
Broad climate: North: subtropical climate with dry winter/hot summer; South: hot arid, steppe climate

Climate projections[2]

CMIP5 Ensemble Projection	2020 - 2039	2040 - 2059	2060 - 2079	2080 - 2099
Annual Temperature Anomaly (°C)	**+1.1 to +1.5** (+1.2°C)	**+1.9 to +2.7** (+2.2°C)	**+3.2 to +4.0** (+3.4°C)	**+4.2 to +5.8** (+4.6°C)
Annual Precipitation Anomaly (mm)	**−12.5 to +1.0** (−3.3mm)	**−19.6 to +1.9** (−5.1mm)	**−27.8 to −1.3** (−7.4mm)	**−32.3 to − 0.1** (−8.2mm)

Climate hazards

Drought

Annual likelihood of severe drought projected increase compared to 1986-2005 baseline under RCP8.5 scenario:

- 21% in 2040–2059; 47% in 2080–2099

Number of very hot days (Tmax >35°C) per year expected increase (from reference period under RCP8.5):

- 39 days in 2040–2059; 108 days in 2080–2099

Number of days of consecutive dry spell per year (or days without significant rainfall of at least 1mm) projected increase:

- 13 days in 2040–2059; 25 days in 2080–2099

CMIP5 multi-model ensemble projection

Climate hazards from 1991–2017[3]

Hazard	Subtype	Events	Deaths	Affected	Affected per capita per decade
Drought		6	-	21,022,618	57.65%
Flood	Unstated	1	13	30,000	0.76%
	Riverine	9	271	247,020	
	Flash	2	29	1,000	
Storm	Unstated	-	887	370,000	1.02%
	Tropical	4	41	2,000	
	Convective	2	-	-	
Total		**24**	**1,241**	**21,672,638**	**59.43%**

ENABLING ENVIRONMENT

Leadership and governance

Governmental level

The Ministry of Environment, Water and Climate (MEWC)

- Guides compliance to multilateral agreements; chairs national technical committee responsible for NDC implementation; Initiated NAP development process

High Level National Steering Committee

- Provides policy direction on NDC implementation in line with National Development Objectives

The Environmental Management Agency (EMA)

- Responsible for natural resource management (NRM), environmental protection, and preparation of Environmental Plans

International level

Zimbabwe Vulnerability Assessment Committee (ZimVAC)

- Responds to food insecurity, a consortium of Government, UN agencies, NGOs, etc., led and regulated by the government, chaired by Food and Nutrition Council (FNC)

Key adaptation policies

Key policy documents: NAP (2019); National Climate Policy (2016); NDC (2016); Zimbabwe Agriculture Investment Plan (2013–2017); National Climate Change Response Strategy (2015)

Disaster Risk Management (DRM):

- Disaster Risk Management Bill focuses on reactive DRM
- New policy and act under development with emphasis on DRM preparation, response and recovery
- DRM options: adopting multistakeholder approach; enhance early warning systems (EWS), hydro-meteorological services and building standards and codes; investing in climate-resilient social infrastructure; promoting climate-indexed insurance and enabling market frameworks

ND-GAIN Index[4]

Country Index rank (score): 171 (34.9)
Vulnerability: 0.520
Ecosystem Services 20%, Food 21%, Human Habitat 22%, Health 25%, Water 11%

Readiness: 0.219
Economic 39%,
Governance 40%,
Social 20%

ND-GAIN Evolution


Photo: Eva Mont/Shutterstock

Zimbabwe

SECTORAL ADAPTATION PLANNING

AGRICULTURE

Agricultural area: 42% of total land area; accounts for 56% of employment; rainfed agriculture 80%, irrigated 20%; total irrigated area: 123,000m ha

- **Crops:** Grain: maize, sorghum, mhunga, rapoko, oilseeds; Industrial: tobacco, cotton, edible dry beans and paprika; High market value: tobacco, cotton and maize

Main climate change (CC) impacts

- Rainfed and irrigated agriculture at risk from droughts & floods
- Limited precipitation & extreme heat likely to diminish rangeland productivity and decrease livestock production. Net primary production projected to drop from 8 tons per hectare p/y to 5 tons per hectare p/y by 2080
- Zimbabwe is trending towards more arid and nonarable climatic conditions, which could lead to food insecurity, an increase in unemployment and reduction in economic growth

Proposed adaptation strategies

- Financial needs: US$ 34.9 billion by 2030 under business as usual (BAU) (75% international support, 25% from national budget)
- Frameworks for sustainable intensification, commercialization of agriculture, science-based crop production, post-harvest technologies and management practices
- Capacity strengthening for new knowledge, technologies and agricultural support services; and to identify and promote livestock breeds tolerant to climate-related stresses
- EWS on cropping season quality, rangelands conditions, droughts and floods to enhance farmer preparedness
- Research for development and integrated management of agricultural water resources

WATER

Annual water generation: 23bn m^3; surface water resources: 90%; ground water resources: 10%; 8000 dams in total; river catchments: Gwayi, Manyame, Mazowe, Mzingwane, Runde, Sanyati & Save

Main climate change impacts

- Impacts of CC on water resources management include increased water loss through evapotranspiration
- Lower rainfall may negatively affect groundwater recharge and water runoff, with such changes limiting hydropower generation
- Without adaptation measures, the population at very high risk of groundwater drought could rise from 32% to 86%
- Analysis of mean annual river runoff and potential evapotranspiration (PET) using 121 climate scenarios (CMIP3 and CMIP5) showed similar conclusions

Proposed adaptation strategies

- Water sector is mainly guided by the Water Act of 1998 and National Water Policy of 2013; a National Water Resources Master Plan for 2020–2040 (NWRMP) is in the process of being developed
- Promote water harvesting as an adaptation strategy
- Rehabilitate and maintain surface and groundwater resources
- Strengthen and intensify monitoring systems for hydrometeorological parameters
- Strengthen institutional capacity, research and extension for integrated water resources management
- Conduct more frequent yield assessments of surface and groundwater resources

FORESTRY

Forestry rents: 4.1% of GDP

Main climate change impacts

- Ratio of forest area to total land area decreased from 57% (1990) to 36% (2015) from lack of sustainable land-use and forest management systems, and frequent wildfires
- CC expected to influence plantation species composition of forest ecosystems, extents of forest ecosystems, species volume and density, biodiversity, frequency and intensity of forest fires
- High fire density appears in northern and southeastern parts of the country. Wildfire is associated with more than 1 million ha of loss in rangelands and forests per year

Proposed adaptation strategies

- Develop and enforce policies that regulate change from one land-use to another, especially the clearance of forests and woodlands to other land-uses
- Promote establishment of land-use plans at district, ward, village and farm management levels that clearly identify forestry as a recognized land-use
- Strengthen research, planning and financial support to forestry and natural resources management in order to develop cost-effective adaptation options
- Build capacity for forest management in a changing climate
- Promote and strengthen biodiversity conservation management and the integrity of natural ecosystems by using an ecosystem-based approach to adapt to climate change

Estimated groundwater recharge (Giga-Liter/Year) for Zimbabwean catchments[5]

Catchment	Current (World Climate Data)	2050 Business as usual scenario (A2a)	2050 Ecologically aware scenario (B2a)	2080 Business as usual scenario (A2a)	2080 Ecologically aware scenario (B2a)
Gwayi	1,596	1,438 (–10%)	1,520 (–5%)	1,359 (–15%)	1,549 (–3%)
Manyame	1,907	1,868 (–2%)	1,932 (1%)	1,839 (–4%)	1,944 (2%)
Mazowe	1,918	1,791 (–7%)	1,901 (–1%)	1,811 (–6%)	1,844 (–2%)
Mzingwane	632	537 (–15%)	558 (–12%)	473 (–25%)	566 (–12%)
Rundee	1,449	1,215 (–16%)	1,277 (–12%)	1,096 (–24%)	1,265 (–13%)
Sanyati	2,750	2,549 (–7%)	2,668 (–3%)	2,441 (–11%)	2,694 (–2%)
Save	2,660	2,279 (–14%)	2,439 (–8%)	2,197 (–17%)	2,418 (–9%)

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2. CPI analysis, based on submitted NDC documents. As the methodologies for providing investment estimates varied widely, this aggregate figure should be considered only a rough estimate of the lower bound of investment needs, given 14 countries have not provided estimates and the scale of climate adaptation needs are likely to increase through 2030 beyond what is addressed by current finance levels. The authors have not identified any other robust estimates of future adaptation finance needs in Africa from other sources.
3. Angola, Benin, Central African Republic, Chad, Democratic Republic of the Congo, Eritrea, Ethiopia, Ghana, Kenya, Niger, Republic of Congo, Rwanda, Senegal, Sudan, Zimbabwe
4. "Conditional" refers to funding dependent on international support.
5. Alongside public finance tracked to adaptation, the private sector is a critical component of addressing the adaptation finance gap, as public resources are limited and will not be sufficient to meet all adaptation needs alone. Private actors are investing in climate adaptation, but there is a lack of systematic data collection for climate-related private finance flows globally, due to lack of incentives for tracking, difficulties in identifying climate-related finance, restrictions based on confidentiality, and conceptual and accounting issues. While there are some nascent approaches and methodologies under development, there are currently no robust private sector adaptation finance estimates at the global, sectoral, or regional levels.
6. Per Climate Policy Initiative's (CPI's) Global Landscape of Climate Finance (Landscape). In order to determine what constitutes adaptation finance in the Landscape, CPI relies on current tracking practices from: i) the members of the OECD's Development Assistance Committee and publicly available through the Creditor Reporting System database; ii) dedicated reporting of the group of Multilateral Development Banks jointly reporting on climate finance and the members of the International Development Finance Club; and iii) Climate Funds.
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4. Own-account workers are those workers who, working on their own account or with one or more partners, hold the type of jobs defined as a self-employment jobs (i.e. remuneration is directly dependent upon the profits derived from the goods and services produced), and have not engaged on a continuous basis any employees to work for them.
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Trade

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Drylands

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