State and Trends in Adaptation Report 2022

Adaptation at the core of a prosperous Africa in an uncertain and warming world

Report Direction and Preparation

The State and Trends in Adaptation 2022 report was co-directed by Ede Jorge Ijjasz-Vasquez (Senior Advisor) and Jamal Saghir (Senior Advisor). The reports were prepared with the support of numerous knowledge partners, institutions, researchers, and practitioners who brought their best expertise from diverse technical and policy perspectives. We wish to acknowledge their contributions.

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Cover photo: Trials of CIAT-improved "magic beans" in Malawi, which have performed well despite the worst drought in three decades (Photo: CIAT/NeilPalmer)

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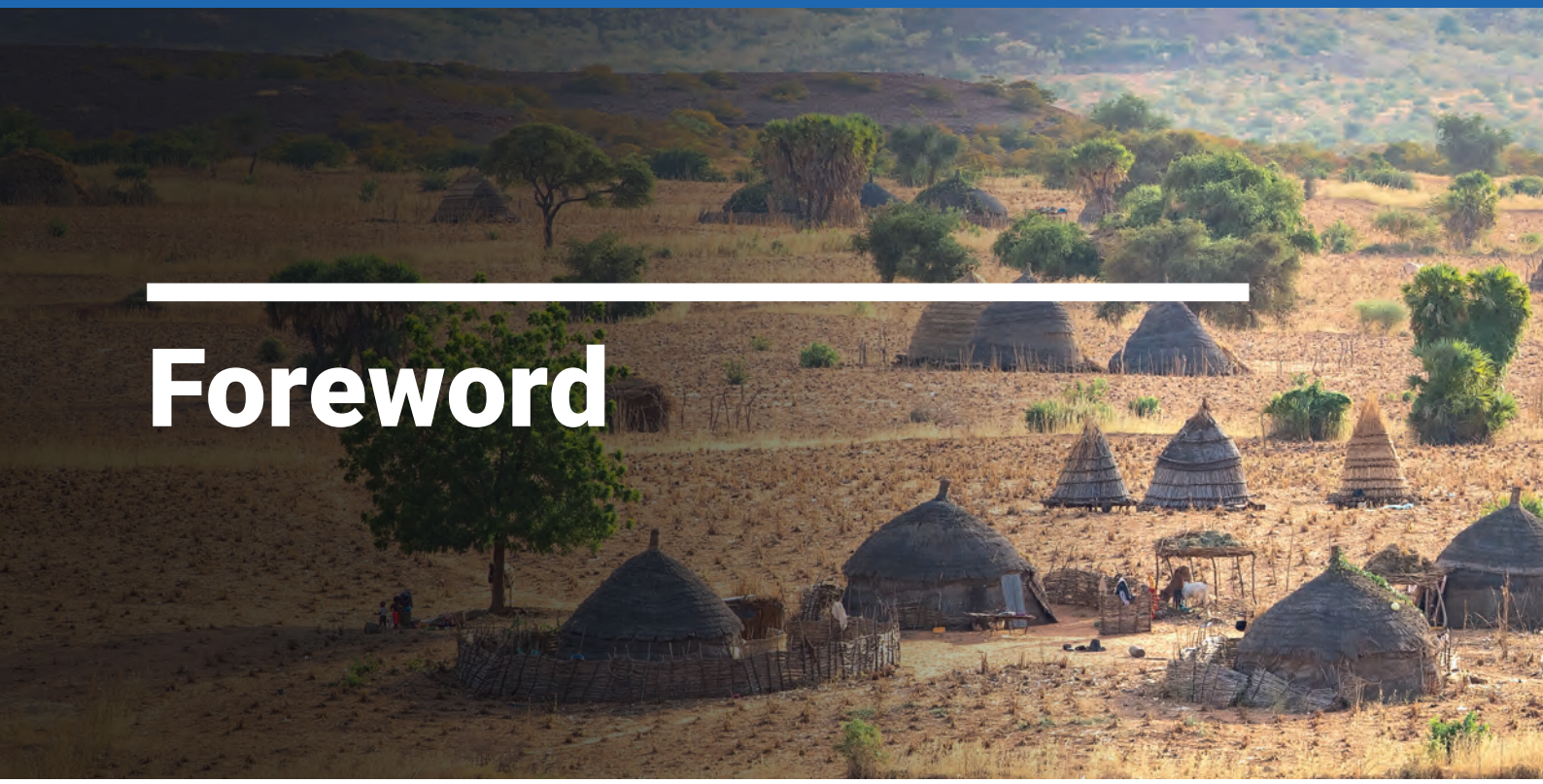


Foreword

A year on from State and Trends in Adaptation 2021 (STA21) which set out our blueprint for adaptation action, the evidence of the impact of deepening, growing climate change daily invades our screens.

2022 has seen record-breaking extreme weather globally, with mighty floods, vast wildfires, enduring heatwaves, and drought on every continent. More frequent and intense extreme weather and climate-related events are creating new and increasing risks everywhere.

But Africa is especially vulnerable. In the last 21 months more than 52 million people—some 4 percent of the continent's population—have been directly affected by drought and floods. Temperatures are increasing across all regions of Africa and the continent is warming faster than the global average over both land and sea.

Climate change poses risks to health, ecosystems, agriculture, infrastructure, cities, and economically and socially vulnerable communities. Nevertheless, with wars and pandemics being fought, the nature-born catastrophes that flash across our screens still struggle to make the political and public impact they merit amid all the noise of the 24-hour news cycle.

Tackling the causes of climate change is a Sisyphean challenge when its consequences are already wreaking havoc and destruction. If we have any remaining hope of achieving the goal of limiting global warming to 1.5°C by 2030 it must be aided and matched by massive scaling up of adaptation to the climate change that is happening here and now.

This report, State and Trends in Adaptation 2022 (STA22), builds upon the innovative adaptation and resilience ideas, solutions, and policy recommendations that STA21 presented. In this latest edition, we remain focused on Africa. We are right to do that, because Africa is the continent with the most to lose from climate change and the most to gain from adaptation to it.

Adaptation to climate change is urgently needed to reduce its impact on people and build resilience. Disaster risk management, climate services, and risk spreading and sharing can all contribute to this.

In the following pages we dive deeper into individual countries, as well as analyzing sectoral and thematic areas. We take a forensic look at the climate finance instruments available, the means by which resources can be mobilized for mainstreaming climate into public budgets, and how to attract and apply private adaptation finance.

In spite of the scale of the challenge posed by climate change, I remain optimistic about the future of Africa and the world, because I am confident that our Africa Adaptation Acceleration Programme (AAAP) is a roadmap that can lead the continent to a more stable, secure, and resilient future.

Photo: mbrand85/Shutterstock

The AAAP will mobilize US$25 billion for adaptation in food security, resilient infrastructure, climate finance, and crucially, youth employment. Adaptation in Africa is a jobs agenda that equips young people with the skills and resources to become the entrepreneurs that will power the continent's economic ascent while reducing the impact of extreme climate events.

As the evidence mounts that our world is changing around us, as extreme weather events become stronger and deadlier, the existential threat of climate change is clear. But how humanity will answer it is not yet clear.

My hope and belief is that this report—and its predecessor STA21 and subsequent editions in the years to come as we count down to 2030—will become a global primer for adaptation.

Resisting change is a default human reaction, but it is no longer an option. As Tancredi says in The Leopard, the iconic novel by Tomasi di Lampedusa, "Things will have to change if they are to stay the same." Adapting to climate change is our best hope of preserving our way of life. This report's purpose is to help us achieve that goal.

Dr. Patrick Verkooijen

Chief Executive Officer
Global Center on Adaptation

Executive Summary

Accelerating Progress Toward a More Resilient Africa

THE BACKGROUND

Last year, the Global Center on Adaptation (GCA) published its State and Trends in Adaptation 2021 report (STA21). The report described the urgent need to adapt to climate change, as rising temperatures cause more extreme storms and floods, rising sea levels, more intense heatwaves, and longer and more severe droughts.

As the report documented, 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-won development and reverse decades of economic progress.

This year, the impacts of the conflict in Ukraine on agricultural exports and fertilizers, the resulting food price hikes, inflationary pressures, unsustainable debt levels for many countries, and the possible global economic recession are severely impacting African economies and communities.

Though the risks are great, so too are the opportunities that successful adaptation can bring. The 2021 report presented a comprehensive 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.

Moreover, the report showed, these adaptation measures are enormously cost-effective, working hand in hand with development to put Africa on a more resilient path to growth and to create a virtuous cycle. Even as adaptation measures 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, further increase resilience, enabling communities to better cope with future extreme weather events or other climate change impacts. Most of the adaptation measures reviewed in this report have important climate mitigation, biodiversity, and sustainability benefits.

THE CURRENT CHALLENGE: INCREASING THE PACE OF PROGRESS

The 2021 report laid a strong foundation for creating a more resilient, more prosperous Africa. This new 2022 State and Trends in Adaptation report is designed to build on that foundation, with a goal of accelerating the pace of progress while considering the challenging global and regional

economic conditions. The 2022 report builds upon and complements the 2021 report. The first report includes topics ranging from food systems to gender and water that are not repeated here. We recommend that readers view the two reports as an integrated review of climate adaptation for the region.

This report first updates the growing impacts of climate change on African nations. In 2021 and 2022, for example, major wildfires swept across Algeria; devastating floods stuck Niger, Sudan, South Sudan, and Mali; the Horn of Africa region was struck by drought; and three strong tropical cyclones hit Mozambique and other Southern African countries, destroying buildings, displacing thousands of people, flooding farmlands, and crippling economies. Such impacts pose increasing threats to food systems, ecosystems, water resources, human health, and economic growth. The magnitude of many of these climate shocks can overwhelm communities, entire regions, or even small nations. The global humanitarian support system is stretched in its mission to help affected populations and economies.

The report then uses in-depth analyses and numerous case studies to identify innovative adaptation and resilience ideas, new solutions, the most effective regulatory and legal instruments, and new recommendations for action. Given the tight fiscal situation of most African nations and the economic challenges of their communities, the report pays special attention to adaptation actions with lower costs and significant benefits, including nature-based solutions (NBS) and locally led adaptation programs. In particular, the report covers three major topics in its three sections.

The first point of focus is boosting the amount of finance that is available for adaptation and using that money in the most effective ways. Some of the key opportunities lie in the private sector, where companies can not only reduce their own risks from the impacts of climate change but also take advantage of new markets and new businesses in the adaptation space.

The second topic is how to accelerate progress on adaptation in individual sectors, such as agriculture or cities. This section also provides a comprehensive evaluation of the innovative Africa Adaptation Acceleration Program (AAAP), developed as an Africa-owned and Africa-led response to the climate crisis. The AAAP supports programs across multiple sectors.

The third section covers the themes and opportunities that cut across multiple sectors. They include improving education, empowering youth and stimulating entrepreneurship, improving security, and identifying further research to help unlock the many benefits of successful adaptation measures.

INCREASING FINANCE FOR ADAPTATION

The Finance Gap

The Paris Agreement includes a global goal for adapting to the effects of climate change. At COP26, new financial pledges were made to support developing countries in achieving this goal. Moreover, at COP26 new rules for the international carbon trading mechanisms ("Article 6") were agreed upon to support adaptation funding.

While significant work is being done toward those goals, it remains clear that mitigation is still receiving considerably more attention and funding support than adaptation. Indeed, adaptation finance has remained at between 20 and 25 percent of committed concessional finance across all sources. COP26 urged developed countries to at least double their aggregated provision of adaptation finance from 2019 levels by 2025, in order to achieve a fair balance between adaptation and mitigation. The pressure to increase and deliver substantial adaptation financing is likely to continue in COP27 and beyond.

Analysis shows that current annual spending on adaptation across all of Africa is US$11.4 billion, which represents about 39 percent of total climate finance committed to Africa annually. This amount falls far short of what is needed. Simply meeting the goals set out in the Nationally Determined Contributions (NDCs) of African countries would require additional funding of US$41.3 billion each year. In addition, much of this adaptation finance (53 percent) comes from just one source—multilateral development finance institutions (DFIs)—with national governments a distant second at 23 percent.

There is thus a serious and urgent need to both dramatically increase the flow of adaptation finance in Africa and to develop new sources of financing. Those could include commercial banks, private equity and venture capital, institutional investors, insurers, large corporations, national development banks, multilateral and national climate funds, foundations, and non-profits.

Closing the funding gap will not be easy. This report identifies and acknowledges numerous barriers to increasing the flow of adaptation dollars. To name just a few: Adaptation measures are complex. There are challenges in understanding and recovering the costs of projects. Reliable and accessible information about climate risk is often lacking. Regulatory incentives for crucial adaptation measures like climate-smart agriculture have yet to be developed and implemented. And given that every sector has many stakeholders, coming to an agreement on projects can be difficult.

In addition, these existing problems have been made more challenging by global strains and conflicts. The COVID-19 crisis and the war in Ukraine have raised energy and food prices, for example, while also massively disrupting international trade and supply chains.

Lessons from Individual Countries and Regions

To pinpoint specific barriers and initiatives that have been successful in increasing adaptation finance, in-depth studies of such finance in Ghana, Rwanda, Kenya, and Egypt were conducted. The analysis found, for instance, that while Ghana has created a promising Ghana Infrastructure Investment Fund and is now seeking Green Climate Fund (GCF) accreditation for it, the country may be missing out on US$1.2 billion annually in general tax revenues that could be used for climate finance because of misaligned tax incentives. Meanwhile, Kenya's adaptation efforts could be improved by modernizing its public financial management system to enable better climate finance expenditure tracking.

In the four countries studied, one promising model that others might adopt is Egypt's Green Sovereign Fund. Investor interest in the green bonds was so strong that the Egyptian Ministry of Finance

increased the sale from the initial US$500 million to US$750 million. Of that, roughly US$400 million has been spent on 14 water and wastewater projects, and the rest on a clean monorail system that connects Cairo to the new capital. Three crucial ingredients have made the Fund successful: early involvement from key ministries; using the nation's largest private bank to issue the green bond sale; and partnering with the World Bank and the International Finance Corporation (IFC).

The report also presents a detailed analysis of one important region of the continent—North Africa. The region faces an even larger financing gap than Africa as a whole, with total public climate finance between 2010 and 2020 at a level that is only 7 percent of that needed to meet NDC goals over the next 10 years. Moreover, only 20 percent of that finance went to pure adaptation projects. Making the task in the region even more challenging are the historically high and still rising debt service burdens.

One potentially effective strategy for this region (and other African countries as well) is using innovative debt-for-climate swaps, like one being piloted in Jordan. A task force, with members from the ministries of planning, finance, energy, environment, and water, has identified projects in areas like forest management, water supply, and energy efficiency that could be supported by the debt swap.

Recommendations for Increasing the Flow of Finance

To mobilize the levels of investment needed to close the huge gap between current spending and the urgent need, and to increase the resilience impact of these investments, African nations can succeed by adopting three main strategies:

- **Mainstream adaptation and resilience into all investment decision-making:** That requires increasing access to climate information, such as groundwater data and precipitation predictions; building the capacities of financial institutions and governments to evaluate and act on climate risk; and requiring the disclosure of climate risk in line with the recommendations of the Task Force for Climate-related Financial Disclosures (TCFD) (see also next section on risk regulation). The International Monetary Fund's (IMF) perspective on adaptation policies includes three pillars for mainstreaming adaptation—prevention, alleviation, and strategies for fiscal resilience.
- **Build an enabling environment for adaptation investment:** Only six countries in Africa have submitted National Adaptation Plans. Such plans


Photo: GCA

are particularly important in mainstreaming climate adaptation into procurement plans to ensure that the construction of new infrastructure will build in resilience. Countries should also build capacity to make policies and projects science-based, and work to relieve existing debt burdens. Mainstreaming climate considerations into public budgets and incorporating adaptation finance into all stages of the budgeting process can provide a direct channel of funding for dedicated climate adaptation projects. Also, multilateral development banks (MDBs) need to be more focused on adaptation finance and action. They have a critical role to play in the adaptation finance architecture.

- **Deploy innovative financial instruments:** One example is the AAAP, jointly developed by the GCA and the African Development Bank (AfDB), which provides upfront capital and makes projects more attractive to private investors by improving their risk-return profiles (see later section for more details). Another way to achieve this is for debt-swap mechanisms to be scaled up, and by moving away from ad hoc bilateral deals for debt-for-adaptation swaps to a more institutional approach. Blended finance resources could incentivize institutional investors to invest in adaptation and could also unlock the potential of institutional investors such as pension funds, sovereign wealth funds, and insurance companies in scaling up climate adaptation finance.

Identifying and Regulating Climate Risks

One of the general recommendations in the previous finance flow section—regulating climate risks—is so important that this report devotes a whole chapter to the impact of climate risks on African financial systems. It includes in-depth case studies on the Democratic Republic of the Congo (DRC), Egypt, Ghana, Kenya, Mali, Mauritius, Morocco, Nigeria, Rwanda, South Africa, Tunisia, and Zimbabwe, supported by interviews and discussions with regulators and stakeholders in these countries.

African nations are among the most vulnerable in the world to climate risks. In 2019, five African nations ranked among the 10 countries around the globe most affected by extreme weather. Topping the list was Mozambique, which was struck by two devastating cyclones and a severe long-lasting drought.

Such severe impacts not only take a huge toll in terms of human suffering, they also have major consequences for financial institutions and financial markets. Across all of Africa, climate change is already reducing economic growth and reversing hard-won gains, the Intergovernmental Panel on Climate Change (IPCC) reports. Unless banks

Photo: Tommy Trenchard/Panos Pictures

and other institutions take action to identify and manage these risks, they will experience a damaging deterioration of credit quality and profitability.

There are two main types of climate risk: 1) property damage, business disruption, and other physical risks from such impacts as more severe floods and droughts; and 2) the transition risks from falling behind in the global effort to reduce greenhouse gas emissions. Those transition risks can include stranded fossil fuel assets and the need for increased capital spending on cleaner technologies.

Some Africans have recognized the need to identify and regulate such risks. The Bank of Ghana has issued voluntary "sustainable banking principles" as part of its environmental and social risk management, for example, while Kenya's 2016 Climate Change Act provides both a regulatory framework that responds to climate change and a mechanism for climate finance. Moreover, interviews with finance officials show that climate risk is a top and urgent priority for almost all financial officials.

Yet the efforts to integrate climate risk in financial systems face significant challenges, including the lack of data on climate risks and the lack of internal capacity to develop regulations and guidelines. Key recommendations thus include:

- Develop the capabilities of public authorities and financial regulators, such as by highlighting best practices and offering training programs.
- Mandate minimum disclosure standards, covering governance, strategy, risk management, metrics, and targets.
- Identify both physical and transition risks and make the data more accessible.

Refocusing and Increasing Investment by the Private Sector

Successful adaptation and resilience efforts will depend heavily on the involvement of the private sector. In Africa, the private sector currently is responsible for two-thirds of the continent's investment. It generates 75 percent of the total economic output and provides 90 percent of the total employment.

Companies are also increasingly threatened by climate change. Floods, droughts, heatwaves, and more extreme storms are damaging factories, warehouses, and other assets; disrupting supply chains; reducing productivity; threatening workers' wellbeing and safety; and raising insurance premiums, among many other consequences.

That is why it is important for companies to reduce their exposure by relocating their facilities or supplies away from high-risk areas, and to invest in projects that strengthen their resilience. For example, the OCP Group, a global fertilizer producer based in Morocco, has invested in desalination stations and wastewater recycling plants to reduce water pollution and to increase water supplies, bringing benefits both to its own production systems and to North African communities.

Such adaptation measures can also open new markets and businesses. In one example, the Swiss multinational Holcim and UK development finance institution British International Investment have created a joint venture called 14Trees that uses innovative construction technology, such as 3D printing, to rapidly build energy-efficient affordable housing in Africa, especially in response to damaging natural catastrophes. In addition, a survey of small and medium-sized businesses showed that 81 percent of them anticipated markets for new or more sustainable products, such as drought-resistant seeds, farm machinery powered by renewable electricity, enzymes for the food and beverage industries that reduce water consumption, more detailed weather predictions, and new insurance products.

Taking advantage of these new opportunities and reducing the harm from the impacts of climate change will require collaboration across the private sector, the public sector (with public–private partnerships), and the financial and insurance sectors.

Resilient Recovery in Senegal and Côte d'Ivoire

To illustrate how investments in adaptation and green sectors can deliver a sustainable and environmentally friendly recovery from the COVID-19 pandemic and from the stresses caused by the war between Russia and Ukraine, the report looks in detail at Senegal and Côte d'Ivoire, both of which have suffered large economic hits. In Senegal, 85 percent of households reported significant income losses in the first few months of the pandemic, and many businesses closed. In Côte d'Ivoire, sectors like education,

tourism, restaurants and hotels, and financial services were hit especially hard. More than one-third of firms closed, some permanently.

Those countries now face a choice. They could try to recover from these stresses by investing in traditional approaches, such as stimulating the mining of gold, phosphate, and other metals and minerals. Or they could use a green stimulus approach that boosts adaptation through investments in ecotourism services, coastal protection, climate-smart agriculture, ecosystem restoration, renewable energy, energy efficiency, electric vehicles and rapid transit, green buildings, flood mitigation, and wastewater treatment.

Modeling shows that the green stimulus approach is substantially better. Not only would it improve resilience to the impacts of climate change, it would also bring much higher economic returns—creating 700 percent higher returns over 20 years in Senegal and 265 percent higher in Côte d'Ivoire.

Lessons from the AAAP Technical Assistance Program (TAP)

As this report describes, filling the huge gap between the current level of adaptation funding and what is needed requires innovative financing approaches. In one effort to close the gap, the United Nations Framework Convention on Climate Change created the GCF to help developing countries reduce their greenhouse gas emissions and adapt to climate change.

To access funds from the GCF, countries first must have an ambitious national climate strategy, a government institution capable of overseeing the use of the funds, and a pipeline of projects that meet the GCF's requirements. To help African countries meet these conditions, the AAAP created a TAP to build capacities for adaptation planning and to promote large-scale transformational adaptation projects.

The TAP was launched just over a year ago in Burkina Faso, the DRC, Niger, Nigeria, Seychelles, Côte d'Ivoire, Senegal, and Ghana. In Ghana, for example, the program held two workshops with the staff of the Ghana Infrastructure Investment Fund; one to explain the accreditation process for the GCF and the second to discuss the details of the technical assistance offered. In another example, the program worked with Ethiopia, Guinea, Senegal, and Togo on an ambitious US$427 million proposal to create "staple crop processing zones" that promise to boost agricultural productivity, employment, and incomes, while reducing both greenhouse gas emissions and vulnerabilities to climate change.

To assess the performance of the TAP after a year, key officials, partners, and other stakeholders were interviewed. The feedback shows that the program is effective, but it also highlighted areas for improvement, such as maintaining a regular presence in partner countries, offering a roster of experts, and strengthening partnerships with other providers.

SECTORS

The Africa Adaptation Acceleration Program (AAAP)

Launched in April 2021, the AAAP is the flagship program of an Africa-owned and Africa-led response to the threats from climate change and to the opportunities for more sustainable growth and development. It will mobilize US$25 billion by 2025 to accelerate adaptation action across multiple sectors, focusing in particular on investments that will bring large dividends. Those include improving productivity and reducing vulnerabilities in agriculture and the food supply chain, thus improving food security; making forestry more sustainable; reducing risks and vulnerabilities in both urban and rural areas through measures like more resilient infrastructure; restoring ecosystems and increasing biodiversity; empowering youth and creating jobs; and increasing climate finance.

The first set of projects under the AAAP are spread across multiple sectors in 18 countries: Senegal, Kenya, Uganda, The Gambia, Benin, Ghana, Tanzania, Liberia, Gabon, Guinea, Madagascar, Chad, Burundi, Burkina Faso, Mali, Mauritania, Niger, and Ethiopia. The targeted areas include renewable energy, transmission, and distribution; highways, railways, and ports; and water infrastructure, such as dams and treatment plants. In The Gambia, for example, the program is assessing the risks from sea level rise and flooding to the Port of Banjul—the vital gateway to the country's economy—to ensure that planned increases in cargo handling and storage capabilities will make the operations less vulnerable to climate change impacts. Another study is aimed at improving resilience in Chad's flood-prone capital city,

N'Djamena. And a US$380 million "desert to power" initiative will finance renewable energy investments in Burkina Faso, Chad, Mali, Mauritania, and Niger (for details, see the Insert: Adaptation in the Desert to Power Program in the full report).

The success of the AAAP to date is leading the GCA to expand the number of its partners to scale up and accelerate the mainstreaming of climate adaptation in Africa and in other regions in the world, such as South Asia.

The needs and opportunities for adaptation in specific sectors were also analyzed, and are described in detail in subsequent individual chapters in this report.

Improving Productivity and Resilience with Livestock

Raising livestock provides a living for millions of Africans. In Kenya, the dairy sector provides three million jobs—15 percent of the country's labor force. Overall, the livestock sector accounts for 55 percent of the household income in pastoral systems across Africa. The sector will become even more important as the demand for meat and dairy in Africa is predicted to triple by 2050.

These livestock systems and livelihoods are being increasingly threatened by rising temperatures, more extreme precipitation and droughts, and other climate change impacts. Just one impact—heat stress suffered by cattle—could reduce the production of milk and meat by hundreds of millions of dollars per year by 2085, modeling studies suggest. Climate change is also enabling pests like ticks to expand their ranges in Africa, and is reducing the productivity of the grasslands and agricultural crops that cattle, camels, and other animals need for feed.

There is thus is an urgent need for adaptation measures. Potentially effective interventions fall into several broad categories: breeding cattle and other livestock to be more heat- and drought-tolerant and disease-resistant; improving management of rangelands and croplands to make the feed supply more sustainable; developing better treatments for diseases; establishing feed inventories and feed stores; and providing both early-warning alerts and adaptive safety nets for herders and livestock farmers. One promising approach is adding trees to rangelands in "silvopastoral" systems, where the trees provide shade to reduce heat stresses. It may also be possible to boost local incomes through carbon credit trading and benefit sharing when rangelands are restored.

However, there currently is little direct information on the cost of implementing large-scale livestock adaptation programs in Africa, pointing to the need for more research and support.

Improving Productivity and Resilience in Agriculture

Agriculture is the foundation of lives and livelihoods in Africa. More than 60 percent of Sub-Saharan Africans are smallholder farmers, and nearly a quarter of Africa's GDP comes from agriculture. As the State and Trends in Adaptation 2021 report described, however, farmers in Africa are already being harmed by extreme weather events, and a planetary warming of 3°C in the next 30 years would be catastrophic. At the same time, increases in yields are essential to meet the growing demand for food by a rapidly increasing African population.

Photo: GCA

As a result, many recent reports, such as the Food and Agriculture Organization of the United Nations (FAO) Strategic Framework 2022–2031, see adaptation in food and agriculture as essential for reaching Sustainable Development Goals. Not only can successful adaptation improve yields and livelihoods, studies show, adaptation measures also are far less expensive than paying for repeated disaster relief and recovery efforts in the wake of extreme weather events. Moreover, effective adaptation measures will enable agriculture to be an important part of the effort to mitigate climate change, because it has the potential to offset or sequester as much as 20 percent of annual emissions through improvements in soil management.

Realizing these benefits requires a transition to a new way of thinking about agriculture—so-called climate-smart agriculture. Its key elements include:

- **Taking advantage of advances in breeding technologies and tool development:** New techniques and tools, such as sequence-based trait mining and CRISPR-Cas9-based gene editing, have made it possible to pinpoint genes that boost crop yields, allow crops to tolerate harsher conditions like more severe droughts, or better fight off pests. Then the tools can precisely insert those genes into the major crop plants. One effort already under way is the Genomics Open-source Breeding Informatics Interface (GOBii), funded by the Bill & Melinda Gates Foundation, which is systematically mapping genes in rice, wheat, maize, sorghum, and chickpea with the goal of breeding improved versions. Elsewhere, the National Root Crops Research Institute in Nigeria has bred a new stain of cassava called Gamechanger cassava that is resistant to both diseases and pests.
- **Improving soil health:** Soils in many parts of Africa have been badly degraded, and in the Sub-Saharan region as much as 40 percent of the soils are low on nutrients. Degraded soils not only reduce yields, they are also more susceptible to erosion and desertification. In contrast, healthy soils increase water retention, resilience to flooding, and carbon sequestration. One successful strategy for creating healthier soils and improving crop productivity has been allowing trees to naturally regenerate on fields in countries such as Niger and Burkina Faso. Another is planting new forage grasses. In Tanzania, a leafy deep-rooted perennial called Bracharia is being used to increase soil carbon and reduce nitrous oxide emissions, while also providing a useful animal feedstock. Still another approach is replacing fertilizers with natural nitrogen-fixing in the soil through the association of legumes with nitrogen-fixing bacteria like *Rhizobia* species. The N2Africa project, funded by the Bill & Melinda Gates Foundation, is working in 11 African countries to optimize crop types and *Rhizobia* strains in many important legumes, including the common bean, chickpea, cowpea, fava bean, groundnut, and soybean.
- **Harnessing smart technologies, such as artificial intelligence, robotics, and smart sensors linked to the internet and big data:** These technologies have been called a "fourth agricultural revolution." They enable farmers to access markets, to anticipate and manage the impacts of weather events, to guide inputs of water, fertilizer, or pesticides; to spot diseases; and to increase agricultural productivity and sustainability. Numerous apps and services already exist in this realm. The Farmerline app in Ghana and DigiFarm in Kenya provide access to business intelligence, quality inputs, and access to financial services, for instance, while PlantVillage Nuru enables farmers to diagnose crop diseases in the field.

Photo: Golden_Brown/iStock

Implementing these climate-smart approaches will require investing more in rural agricultural infrastructure, expanding broadband internet availability, bundling digital services, and creating regional networks of plant breeders and other scientists to share knowledge, tools, and equipment. Careful consideration of barriers caused by the knowledge and preferences of farmers and herders will also be critical for success. Moreover, these efforts must specifically target women, since women account for about half of the world's smallholder farmers and grow 70 percent of Africa's food.

Making Cities More Resilient

The populations of major cities in Africa, especially the capital cities, are growing rapidly, both because of migration from rural areas and small towns and because of natural population growth. Of the 100 fastest-growing cities in the world, 79 are in Africa.

But the provision of basic urban infrastructure has not kept pace with population growth. Water supplies, sanitation, energy, transport, durable housing, and other vital services are inadequate. Jobs are in short supply. As a result, many cities now are seen as being at "extreme risk" of climate hazards, especially because of large informal settlements that are particularly vulnerable to flooding, heatwaves, droughts, and (in coastal cities) sea level rise.

A case study of Accra, Ghana, shows that more than 60 percent of the city's households live in informal settlements with substandard housing, where regular flooding is a major problem. The city faces numerous barriers in improving resilience, such as lack of planning, authority, and trust in government, but it has begun to make some infrastructure investments, such as improving drains and paving alleyways to reduce flash flooding.

Many African cities are still in early stages of urbanization, so there is a unique opportunity to get things right. To help realize that opportunity, the GCA has developed an approach called Rapid Climate Risk Assessment (RCRA) and has implemented it in five cities: Antananarivo, Madagascar; Bizerte, Tunisia; Conakry, Guinea; Dodoma, Tanzania; and Libreville, Gabon. The RCRA gathers key information on climate hazards and risks, infrastructure bottlenecks, past and current initiatives, and relevant policies and institutions. It also identifies specific neighborhoods and districts that have recently experienced floods and other high-impact climate-related disasters.

The assessment then identifies the most cost-effective measures (including those in the "no-regrets" category) for reducing the toll in human suffering and economic damages from extreme weather events and other climate impacts. For the cities studied, effective measures include strengthening disaster evacuation planning, investing in water and sanitation infrastructure, and creating parks and other green spaces (or restoring wetlands and ecosystems) to reduce both flood risks and the urban heat island effect.

One of the key lessons learned is the importance of having strong local champions within municipalities to help identify problems and climate risks, generate data, and develop solutions. In the next round of RCRAs, the GCA will focus specifically on a large informal section in a major African city to gain more experience in involving local community members.


Photo: Nyani Quarmyne/Panos Pictures

Implementing NBS such as Agroforestry

As many other sections of this report describe, the power of nature can be harnessed to successfully adapt to the impacts of climate change and to increase resilience. Restoring forests or wetlands upstream of cities can help solve problems like urban flooding and water scarcity, for example. Protecting and regrowing mangrove forests fights coastal erosion and enhances local fisheries. Creating parks and green spaces in cities reduces the urban heat island effect and the risks of flash floods. In fact, more than a third of the priority adaptation actions in the NDCs of African countries involve so-called NBS.

One especially effective NBS in many parts of Africa is agroforestry—a land management practice where trees are grown around or among crops, pastureland, or homes to provide shade, shelter, fertilizer, fuel, food, fodder, and other products. Not only can agroforestry increase crop yields, land productivity, and local incomes, it also fits well with current African farming systems, skills, and livelihoods.

Agroforestry can involve a variety of practices and forms. In the Sahel region, many farmers have allowed the regeneration of root stocks or seeds long buried in the soil, thus regrowing a few dozen trees per hectare on their fields. This practice, called Farmer Managed Natural Revegetation (FMNR), is credited with helping to "regreen" hundreds of thousands of hectares of farmland in countries such as Niger and Burkina Faso, bringing substantial increases in yields and incomes, while also helping to restore soils and water resources.

In another example, experiments on 25 agroforestry plots in Togo show that most beneficial agroforestry mix includes shade trees, fruit trees, palms, and bananas. In addition, in other parts of Africa, a tree called *Faidherbia albida* offers substantial benefits. A nitrogen-fixing tree that is widespread and native to Africa, *Faidherbia* has an unusual annual growth cycle. Because it sheds its foliage early in the rainy season and regrows it early in the dry season, it does not compete with crop species, which grow during the rainy season. Its leaves also provide useful fodder for livestock.

It is now essential to continue building the case for NBS in general, and for agroforestry in particular, as critical adaptation measures. Unfortunately, there are still too many examples of poorly designed agroforestry efforts that end up undermining development, mitigation, and adaptation. As a result, it is necessary to provide more support for research that pinpoints which actions are most cost-effective and most beneficial for both farmers and ecosystems, and to take better advantage of the considerable traditional and local knowledge of workable solutions. A genuine co-creation of solutions that will be adopted by farmers will help maximize the potential of agroforestry.

Improving the Sustainability of Africa's "Blue Economy"

Africa's 34 coastal countries depend heavily on a "Blue Economy" based on fisheries, aquaculture, tourism, transport, ports, coastal mining, and energy. Continent-wide, these coast-based activities are worth more than US$300 billion per year and support 49 million jobs.

The Blue Economy will become even more important if countries seize the opportunity to increase the amount of carbon captured and stored by coastal ecosystems such as mangroves, kelp forests, seagrass beds, and salt marshes. This "blue carbon" could be used to help countries meet their greenhouse gas emissions reduction targets and to bring in new revenue through carbon capture credits.

As with other sectors, however, the Blue Economy faces huge challenges. Fisheries are being overexploited. Coral reefs, kelp beds, and mangrove forests are disappearing. With sea levels rising and natural protections being lost, coastal erosion is increasing (see next section). Marine heatwaves and water acidification are predicted to reduce primary production by phytoplankton, further bleach coral reefs, and change fish distribution and abundance—with profound potential consequences for fisheries and tourism.

Yet only 26 of the 34 coastal countries have formal strategies or policies to protect their Blue Economies. There is thus an urgent need to create such plans.

The important elements of effective national strategies include coastal and marine spatial planning that takes climate change into account, fisheries regulations that adjust allowable catches based on real-time fish stock data, efforts to protect marine and coastal ecosystems, and rehabilitation and restoration measures such as planting of nursery-grown corals back onto natural reefs or creating artificial reefs; planting mangrove and seagrass seeds in damaged habitats; and transplanting kelp.

One of the success stories in making the Blue Economy more sustainable is the Seychelles Marine Spatial Plan (SMSP) Initiative. The plan set a goal of expanding marine protected areas from only 0.04 percent of the country's marine waters to 30 percent—a goal that was reached in March 2020, 10 years ahead of schedule. The Seychelles government succeeded because the effort was backed by strong political will; because it tapped into numerous resources, experts, and scientific data to understand the problem and solutions; and because it developed an effective funding strategy (in this case, a debt conversion). Those lessons should be applied in other African countries.

Protecting Coasts from Erosion

Africa's ports are tremendously important as drivers of Africa's economic growth, especially in West and North African countries with no land access to distant consumer markets, but they are suffering from serious erosion. A 2021 World Bank study showed that the costs of erosion in the Maghreb countries of North Africa already range from US$273 million per year in Libya to more than US$1.1 billion per year in Tunisia. Sea level rise, more extreme storms, ecosystem degradation, and the trapping of sediment by upstream dams are making the problem worse, helping to create coastal erosion rates up to 10 times higher than the global average.

Traditionally, countries around the world have used "hard" infrastructure, such as groynes, breakwaters, jetties, revetments, and dikes to protect ports. Hard infrastructure is expensive, however, and does not provide long-term protections without costly long-term maintenance.

The better solution for West African countries is using NBS, also known as "soft" or "green" infrastructure, such as restoring mangroves, dunes, seagrasses, wetlands, and other ecosystems. One promising project is the "Management of Mangrove Forests from Senegal to Benin" initiative funded by the European Union for a period of five years (2019–2024).

To scale up the use of such NBS, it is necessary to:

- Improve access to data so that erosion hotspots can be clearly identified and studied.
- Monitor and model coastal morphology, sediment flows, and fluid mechanics, as well as the impacts of coastal developments in many locations.
- Share information, work together across national boundaries, plan and implement coastal ecosystems restorations, and consider altering upstream dams to allow more sediment to flow to the coast to support coastal protection.

CROSS-SECTORAL THEMES

Realizing the Promise of "Locally Led Adaptation"

Whether they live in rural farming communities, urban informal settlements, or other areas, local people often have unique perspectives and knowledge about the risks from the impacts of climate change, and the barriers and opportunities for adaptation. The evidence shows that taking advantage of that knowledge and giving local people more control over defining, designing, monitoring, and evaluating adaptation actions can lead to more effective adaptation actions and raise the benefits relative to the costs.

This new paradigm of "locally led adaptation" builds on existing ideas of community-based adaptation and community-driven development, which are designed to reflect the views of communities and ensure that interventions are aligned with local norms and values. However, locally led adaptation goes a step further by putting local leaders in charge.

Implementing locally led adaptation can be challenging. International finance institutions are typically mandated to deliver finance through multilateral actors or national government agencies, not local leaders. In addition, local actors often do not have a complete understanding of the climate risks they face or have the capacity for effectively accessing, managing, and using climate finance.

Case studies show, however, that when these challenges can be met, locally led adaptation can deliver benefits that far outweigh the costs. In Kenya, Tanzania, Mali, and Senegal, for example, climate change committees were established at the local level using subnational climate funds. Those locally led committees identified and implemented a total of 284 highly cost-effective adaptation projects in water, soil, agroforestry, livestock, natural resource management, and food security. Similarly, a locally led effort in Mukuru, one of Nairobi's largest slums, identified key investment priorities for improving water supplies and sanitation.

The promise of this approach has led more than 80 international organizations, national governments, multilateral organizations, bilateral institutions, non-governmental organizations, climate funds, private sector companies, and social enterprises to formally endorse the Principles for Locally Led Adaptation. Taking advantage of that promise, however, will require scaling up financing from international funders for adaptation at the local level, moving some of the planning for climate action to local governments, and exploring how the private sector can better support local adaptation.

Improving Education

Africa is experiencing a silent crisis in education. If current trends continue, it will take 100 years to reach universal primary education, and another 235 and 280 years to reach universal lower secondary and universal upper secondary education, according to UNICEF and the African Union Commission.

These low levels of education threaten the prosperity of individuals, communities, and nations, and can lead to a vicious cycle in which poverty forces people to withdraw their children, especially girls, from school, and makes communities even more vulnerable to the impacts of climate change.

In addition, climate change increases the size of the education challenge. Many schools cannot cope with impacts like heatwaves, water scarcity, or extreme weather. In Mozambique alone, for example, Cyclone Idai destroyed 3,400 classrooms and left 305,000 children without a place of learning in 2019.

But even as education is threatened by both climate change and economic conditions, it is also a crucially important solution to both problems. Education enhances the adaptive capacity of people, especially children, by building critical green skills for adaptation action, in addition to providing a more skilled workforce to improve the economies of African countries.

This report recommends four ways to accelerate education for adaptation:

- Better monitor, diagnose, and address both the local climate vulnerabilities of the education sector and the local climate impacts across the continent.
- Invest in schools to enable them to better withstand or adapt to climate-related shocks, such as higher temperatures or more extreme floods: In 2010, for example, the UNEP/UNDP, CC DARE, and the Danish International Development Agency began a project to harvest and store rainwater during the rainy season in schools around the

Seychelles. The project solved a pressing problem of schools running out of affordable water in the dry season while also educating schoolchildren and the community about climate change and its effects on water resources.

- Invest more in the education workforce: More money is needed to end a serious teacher shortage, to raise salaries, and to provide the training and resources needed to support climate adaptation, local adaptation needs, local resilience practices, and adaptation solutions.
- Invest in climate literacy: Teaching about the anthropogenic causes of climate change and how individuals, communities, and societies can both mitigate against further environmental damage and adapt to present and future impacts of climate change has been shown to reduce the toll from climate disasters and build community resilience. In one example, the Campaign for Female Education (CAMFED) is teaching thousands of female "Agriculture Guides" about climate-smart agriculture. The project is helping to improve the productivity, sustainability, and profitability of local smallholder farms, while also reducing the school interruptions that girls often experience.


Photo: Laurent Weyl/Panos Pictures

Creating Stronger Institutional Arrangements to Support Adaptation Actions

To successfully plan, legislate, and manage their activities to meet climate targets and to design and implement adaptation solutions, governments need strong institutional arrangements. Last year's GCA STA21 analysis found that while significant strides have been made in African countries in integrating climate adaptation and resilience into long-term planning, there still is room for improvement.

Two important tools can help countries identify the strengths and weaknesses of their institutional frameworks. The World Bank's Climate Change Institutional Assessment (CCIA) evaluates five crucial components of effective governance: organization, planning, public finance, subnational governments and state-owned enterprises, and accountability. Meanwhile, the Capacity for Disaster Reduction Initiative (CADRI) has developed a digital disaster risk reduction tool for assessing countries' capacities for reducing disaster and climate-related risks.

Effective institutional arrangements can take different forms. In the DRC, the National Committee on Climate Change coordinates climate efforts with relevant ministries and governmental bodies. In Angola, the main authority lies with the Ministry of Culture, Tourism, and Environment (MCTA), while mitigation and adaptation policies will be implemented by ministries in charge of core adaptation strategies.

To improve institutional arrangements, this report recommends:

- Additional mainstreaming of finance and disaster risk reduction considerations throughout the institutions.
- More effective systems for monitoring, reporting, and verifying the effectiveness of adaptation measures.
- Ensuring that disaster risk reduction and disaster risk management are important components of climate mitigation and adaptation institutional frameworks, policies, and processes, while also working harder to move from response strategies to disaster preparedness and risk reduction.

Photo: Media Lens King/Shutterstock

Youth and Entrepreneurship

Africa has a large and growing young population, with about 60 percent of the total population under the age of 25. While the sheer size of this young population poses challenges in terms of providing education and employment, it also brings major opportunities. As the most educated generation ever in Africa, African youth today bring unprecedented innovativeness, energy, and entrepreneurship that can accelerate economic growth, build resilience, and drive transformational adaptation.

To better unlock this potential, GCA and AfDB created and organized the Youth Adaptation Solutions Challenge, an annual competition and awards program for youth-led enterprises under the AAAP framework. The goal of the Challenge is to spark a revolution in young business entrepreneurship on adaptation.

In its first year, the Challenge received more than 2,000 applications from small- and medium-sized businesses led by young people. From those, 10 winners were chosen and honored at an award ceremony at COP26 in 2021. Most of the winning companies are focused on making agriculture more productive and sustainable. In Ghana, for example, grain producer Global Farmers is teaching smallholder farmers to intercrop their grain with trees and adopt good conservation practices like zero tillage. In rural Nigeria, agro-processor Simkay Green Global Ventures has trained 400 farmers in a technique of growing crops in bags at different heights—called vertical sack farming—that boosts yields and productivity and protects crops from flooding.

Other companies are providing early-warning systems to farmers, promoting hydroponic farming methods, cleaning drainage channels and waterways to improve irrigation and limit flooding, and converting plastic waste collected from drainage channels into products like shoes.

To better understand the challenges young entrepreneurs face in developing innovative adaptation solutions, the Challenge team conducted interviews with the winners and reviewed their business plans. The interviews revealed six main barriers:

1. Limited access to financing.
2. Lack of business development and operational skills.
3. Knowledge gaps.
4. Uncertainties about the impacts of climate change on everything from greenhouses to roads.
5. Resistance to changing behavior among farmers and customers.
6. Difficulties caused by lack of infrastructure, such as poor roads or unreliable electricity, or by licensing and regulatory requirements.

Key recommendations for overcoming these barriers include:

- Making access to financial capital easier for young entrepreneurs, such as with simplified loan systems, lower interest rates, or more visible grant and funding opportunities.
- Offering tax incentives, such as early-stage tax cuts or adaptation tax rebates.

- Increasing training and mentorship programs.
- Giving youth a seat at the table during policy formation.

Reducing Conflicts and Making Countries More Secure

Climate change is a "threat multiplier" that exacerbates fragile situations and worsens social tensions and upheaval. It is no coincidence that six of the eight African countries most affected by the impacts of climate change are also currently experiencing armed conflicts.

A 2022 study by The Hague Centre for Strategic Studies (HCSS) identifies seven ways that climate change can lead to conflict. For instance, climate change can lead to shortages of water, food, or land resources, forcing pastoralist groups to alter their routes and compete for resources, or causing people to migrate, sparking social unrest. (For a detailed discussion, see the Insert on Migration in the full report). Climate change can also create fertile ground for armed conflicts and radical Islamist groups, as experienced in countries like Mauritania, Mali, Niger, and Chad. Social unrest and conflicts then make adaptation even more challenging. Without effective governance and social and political stability, adaptation projects can fall by the wayside, or may even risk making populations more vulnerable.

As a result, there can be no adaptation without security, just as there is no security without adaptation.

This report describes a detailed five-step framework and policy recommendations for achieving both successful adaptation and improved security:

- Identify and analyze the pathways from climate impacts to potential conflicts, as the Hague Centre study has done.
- Implement forecasting and early-warning systems that predict where climate change will pose the greatest security risks. Systems that already exist for Africa or globally include the African Union's Continental Early Warning System, which spots areas where resources are limited, and USAID's Famine Early Warning Systems Network, which looks for weather-related or economic shocks that could lead to famines.
- Develop conflict-proof adaptation planning. Measures that restore degraded farm and pasturelands will also reduce the potential for conflicts between farmers and pastoralists, for example.
- Translate climate-security risk assessments into localized action.
- Improve links between security with climate policies and action. The military, especially local security forces, are often the first and best equipped to take rapid action when disasters hit.

The Unfinished Research Agenda

The report and many others draw on a huge and growing body of research on adaptation in Africa. However, there are areas where research efforts in climate science, economics, psychology, and other social sciences are still needed to fill in present and future knowledge gaps on adaptation.

In particular, additional research is needed to provide:

- More climate risk data and models for actors seeking to invest in adaptation, particularly at more detailed levels.
- A better understanding of adaptation to the possible impacts from more extreme climate change, if the planet warms by 3–4°C.
- More knowledge about the social acceptability of adaptation measures, the institutional barriers that can make adaptation more challenging, and the exact roles adaptation can play in the larger challenges of economic development and social evolution.
- A deeper understanding of behavioral change at the local level in response to adaptation measures, and of how to ensure that such measures address underlying vulnerabilities as well as climate change impacts.

More broadly, to successfully bring effective adaptation measures to millions of people in Africa, research is needed to better understand how to produce and productively use comprehensive and localized information on climate risks, to identify the best adaptation solutions for every type of community or situation, and to develop and use the tools that can scale up adaptation efforts to reach all those who might benefit.

Synthesis

INTRODUCTION

Last year, the Global Center on Adaptation (GCA) published its 2021 State and Trends in Adaptation report (STA21). The report described the urgent need to adapt to climate change in Africa, as the continent is one of the regions in the world most affected by the extreme impacts of climate change to its economies, infrastructure, agriculture, livelihoods, and every aspect of society and communities.

The 2022 issue of the State and Trends in Adaptation flagship series again focuses on Africa, with an update on some of the most important trends in climate adaptation finance and economics, along with deep dives on new topics from low-income urban communities to livestock, security, and education, among many others. This synthesis presents a brief summary of the report, with a special focus on the challenges and practical recommendations for action.

The 2022 report builds upon and complements the 2021 State and Trends in Adaptation report. The 2021 report covers a wide range of economic and social sectors that are not repeated in this 2022 report. We advise readers to view the two reports as an integrated review of climate adaptation for the region, covering a range of critical sectors for adaptation, including food systems, gender, health, and water, among many others.

In 2022, Africa faces additional headwinds caused by the invasion of Ukraine and its impacts on agricultural exports and fertilizers. Equally important, inflationary pressures, risks of global and regional economic recession, and unsustainable debt levels for many countries are amplifying the impacts of climate shocks on African economies and communities. The limited resources available to Africa for adaptation need to be used in the most efficient and productive manner to dampen the combined impacts of climate shocks and economic downturns. Nature-based solutions (NBS) and locally led adaptation (LLA) programs are critical in this respect. This report pays special attention to this category of actions.

CLIMATE RISKS IN AFRICA

This chapter provides an update on new climate data published since STA21. It presents an overview of climate-related disasters experienced in Africa in the last year; a closer look at high-impact events across the continent; and outlines the expected impacts of physical changes to the climate system, highlighting the critical interconnection between climate change, society, and nature for climate-resilient development.

Challenges

Africa is substantially impacted by natural hazards, which are set to increase in severity and frequency with climate change. Between January 2021 and September 5, 2022, more than 54 million people were affected by disasters linked to storms, droughts, wildfires, floods, and landslides in Africa. Drought-related disasters affected the most people in Africa over this period, followed by floods. Eastern Africa has been hit the hardest by climate-related disasters,


Photo: Rwanda Green Fund/Flickr

with a total of more than 33 million people who were injured, affected, or killed. In North Africa, the greatest impacts were from floods and wildfires. In the past decade, most disasters triggered by natural hazards globally were caused by extreme weather and climate-related events such as heatwaves, floods, and storms. This number has been increasing since the 1960s and has risen almost 35 percent since the 1990s. Between 2011 and 2020, the disasters that have affected Africa have mostly involved droughts and floods. On average, approximately 13 million people per year were impacted by droughts over that period, and 3.5 million were impacted by floods.

For Africa, climate risks are expected to pose significant challenges to food security. African food systems are particularly vulnerable to climate extremes and shifts in weather patterns, as food production is largely dependent on rainfed agriculture and pastoralism. Considerable negative impacts of a changing climate are also expected for marine and inland fisheries.

Water-dependent sectors across Africa are also largely and negatively impacted by extreme variability. Extreme hydrological variability will progressively amplify under all climate change scenarios (relative to the current baseline), depending on the region. The number of people projected to experience water stress by the 2050s varies widely, with decreases or increases by hundreds of millions. This requires planning under high uncertainty.

Adaptation to climate change is more than ever a crucial strategy to minimize the impacts on livelihoods and build resilience in the long run. While it cannot prevent all losses and damages, there are a range of options that can be broadly applied across sectors, including disaster-risk management, climate services, and risk spreading and sharing. Multi-Hazard Early Warning Systems (MHEWS) are critical for adaptation and disaster risk reduction. Barriers to climate change adaptation in Africa include a lack of access to climate information, inadequate research opportunities, and a funding gap for adaptation. It is important to strengthen adaptation finance flows to Africa, develop legislative frameworks that facilitate effective design and implementation of adaptation responses, and emphasize good governance for climate-resilient development.

SECTION 1—ECONOMICS AND FINANCE

Adaptation Finance Flows in Africa

The impacts of climate change in Africa are being exacerbated by rapid urbanization, geopolitical tensions, and the impact of global shocks such as the COVID-19 pandemic and the ongoing war in Ukraine. Rising prices of energy, food, and other commodities have worsened the climate-related food security and energy access risks to the population of Africa. Despite these challenges, there is a significant opportunity for climate investments in Africa to mainstream resilience and low-carbon development in the long term. Current adaptation finance flows in Africa are insufficient to meet the growing adaptation needs on the continent.

Funding for Climate Adaptation

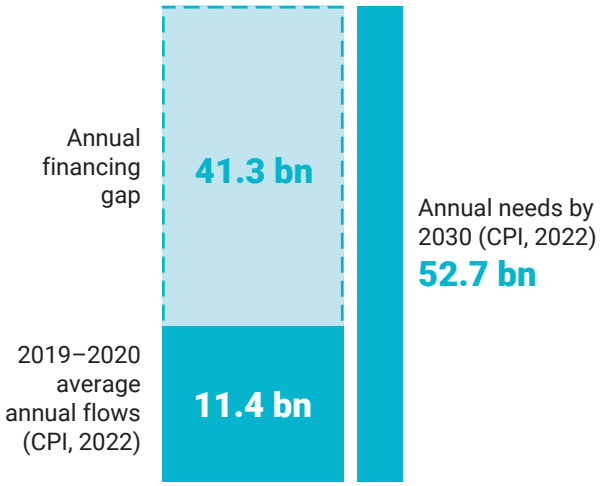
The Paris Agreement includes a global goal for adapting to the effects of climate change. At COP26, new financial pledges were made to support developing countries in achieving this goal. Moreover, at COP26 new rules for the international carbon trading mechanisms ("Article 6") were agreed upon to support adaptation funding.

While significant work is being done toward those goals, it remains clear that mitigation is still receiving considerably more attention and funding support than adaptation. Indeed, adaptation finance has remained at between 20 and 25 percent of committed concessional finance across all sources. COP26 urged developed countries to at least double their aggregated provision of adaptation finance from 2019 levels by 2025, in order to achieve a fair balance between adaptation and mitigation. The pressure to increase and deliver substantial adaptation financing is likely to continue in COP27 and beyond.

Our report shows that multilateralism and collaboration between governments, international organizations, international financial institutions, civil society, and the private sector are critical to ensure more support for adaptation.

Africa faces a serious and urgent shortfall in funding for climate adaptation, even as the costs of delayed action rise. Cumulative analysis of the Nationally Determined Contributions (NDCs) of 51 African countries show a need for an estimated US$579 billion in funding for adaptation through 2030. The analysis indicates that an annual average of US$29.5 billion in climate finance was committed to Africa in the years 2019 and 2020. Approximately 39 percent of those commitments, amounting to US$11.4 billion, targeted adaptation activities. (Figure 1). Most of the funding for adaptation presently comes from the public sector. To tap a wide range of potential actors, it is necessary to build the enabling environment for adaptation investment and aggressively deploy innovative finance instruments at scale toward adaptation activities.

Figure 1. Adaptation Finance Commitments (US$ billion) vs. Needs in Africa



Across Africa, multilateral development finance institutions (DFIs) were the most significant source of adaptation finance flows (53 percent, US$6 billion), followed by governments (23 percent, 2.6 billion) and bilateral DFIs (16 percent, US$1.8 billion). In line with the global trend of increasing prioritization of adaptation in development finance institutions' climate portfolios, the 2019–2020 period was the first period where more finance commitments tracked from multilateral DFIs were directed to adaptation than to mitigation in Africa.

More than half (53 percent) of the adaptation finance commitments to Africa in 2019–2020 were loans. A high share of financing from multilateral DFIs was committed in the form of commercial-rate loans (41 percent) and concessional loans (32 percent), whereas bilateral DFIs primarily committed

concessional loans (82 percent). By contrast, more than 90 percent of adaptation finance committed from governments was in the form of grants, with less than 6 percent in the form of loans. The share of grants and loans varies across regions and the income profile of countries. Low-income countries primarily attracted grant commitments for adaptation financing, whereas lower-middle-income countries largely saw commitments of loans at market rate (58 percent). As shown in Figure 2, there is limited to no correlation at the country level between tracked adaptation finance and climate vulnerability.

Figure 2. Tracked Adaptation Finance (US$ million) vs. ND-GAIN Vulnerability by Country

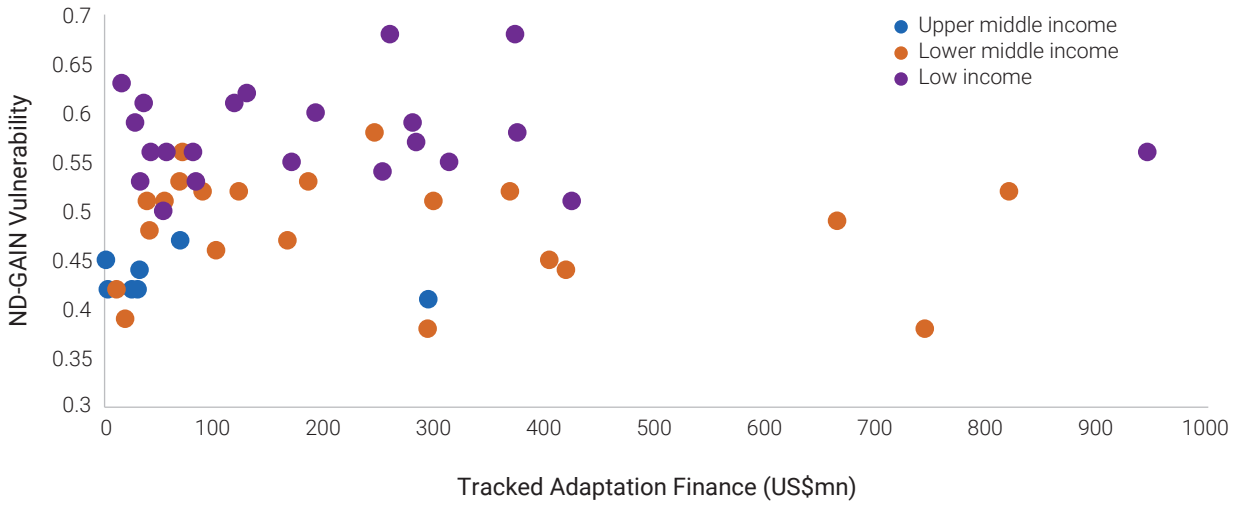


Photo: Simon Townsley/Panos Pictures

Adaptation finance commitments to Africa remain substantially below the estimated needs detailed in NDCs.

To mobilize further adaptation investment and to increase the impact of investments in terms of building resilience, a wide variety of sources of finance need to be tapped 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.

Lessons Learned from Case Studies

A number of case studies in the chapter focused on adaptation and funding strategies in Rwanda, Ghana, Kenya and Egypt offer insights into best practices that, given the right context, can be modeled in other African countries.

- Private-sector adaptation finance mobilization remains a challenge in Rwanda and Ghana. To date, most entities engaging in climate finance have focused their efforts on mitigation. Lack of government incentives for private-sector involvement and limited awareness of public initiatives in this space are often cited as key barriers to private-sector finance for adaptation. Moreover, small and medium enterprises in these countries often lack access to credit and funding, which limits their ability to invest in resilience measures.
- In Rwanda, supported by several grants, the Rwanda Green Fund (FONERWA) has developed capacity-building training specific to private-sector actors and routinely holds private-sector stakeholder engagement workshops. The Fund, which also received grant funding to build capacity to identify climate interventions within the private sector, actively seeks out private-sector project co-finance and reserves 20 percent of funds for private-sector projects. More generally, in both Rwanda and Ghana, public–private partnerships (PPPs), the use of compliance, and voluntary carbon market mechanisms have been put forward as potential options to attract private-sector funds.
- There is a need for African nations to modernize their public financial management systems to enable more granular levels of climate finance expenditure tracking. In the case of Kenya, adaptation frameworks need to be institutionalized into ministries and departments that oversee tagging and tracking of climate finance expenditures.
- There is a need for these existing taxonomies and frameworks to be substantively used and to filter down to the line ministries that are tasked with tagging climate finance. This will help align climate projects implemented by entities at different levels of government as that data is fed into a public financial management system, thus streamlining data reconciliation and improving the quality of the qualitative information that is reviewed and tagged for adaptation.
- Though Egypt's green bond is not solely climate adaptation-focused, it has significant potential to deliver climate-resilience benefits. Other countries can benefit from the lessons learned from Egypt's implementation to move forward with similar initiatives. African DFIs and ministries of finance can, for example, look to leverage and potentially replicate Egypt's Regional Center for Sustainable Finance (RCSF) to build institutional capacity. Following the launch of the green bond program, Egypt established the RCSF with the aim of removing market barriers in the Middle East and North Africa region to integrate sustainable finance practices, instruments, and management models. African nations should take advantage of RCSF's training and educational institutes for capacity building on sustainable finance literacy, debt management operations, cross-ministry coordination, and technical support for setting up their own green finance programs.
- Egypt's green bond issuance benefited from the establishment of a robust legal and green financing framework in collaboration with international finance institutions including the World Bank and the International Finance Corporation (IFC). Egypt brought together three crucial ingredients that enabled the right economic and political conditions for its green bond program, setting a template for other African nations to model. First, early involvement from key ministries that established a guiding green bond framework. Second, utilizing the Commercial International Bank (CIB), the nation's largest private bank, to issue the green bond sale. Lastly, partnering with the World Bank and IFC to act as

technical advisors on the project created global credibility on the execution of the sale and use of proceeds and served to guide assessments of impact indicators.

Recommendations

1. **Mainstream adaptation and resilience into investment decision-making.** To enable financial institutions to mainstream resilience into the investments they are making, the following steps are critical:
   - Increase access to robust climate information.
   - Build capacity of African financial institutions and government entities to evaluate and act on climate risks.
   - Require disclosure of climate risks, via national legislation and/or via DFI on-lending.
2. **Build the enabling environment for adaptation investment.** To build the enabling environment of countries, key actions needed include:
   - Articulate investment-ready National Adaptation Plans (NAPs) and mainstream climate resilience in government procurement.
   - Build capacity to develop science-based policy and projects.
   - Improve macroeconomic environments and adopt a multifaceted approach to address debt burdens faced by African countries.
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. 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. Key factors that must be considered when designing an instrument include currency stability, strength of the project pipeline, strength of debt capital markets, presence of a strong policy environment, existence of a sovereign credit rating, existence of a corporate bond market, robustness of climate information, and engagement/existence of a domestic private sector.

Multilateral development banks (MDBs) committed US$66,045 million in climate finance in 2020–US$49,945 million or 76 percent of this total for climate change mitigation finance and US$16,100 million or 24 percent for climate change adaptation finance. This is far from the objective of reaching 50 percent for adaptation. It is recommended that MDBs be more focused on adaptation finance and action. They have a critical role in the architecture of adaptation finance.

Fiscal Policies For Adaptation—The IMF Perspective

Climate change is emerging as a critical threat to long-term economic growth and stability. The fiscal impacts of climate shocks are very important for many economies with weak resilience. The International Monetary Fund (IMF) policy guidance on adaptation focuses on financial and institutional resilience-building against natural disasters and infrastructure investments to cope with rising sea levels and other warming-related phenomena.

Climate change impacts and adaptation to it will affect economies across the world. However, these impacts will be heavier for lower-income and small vulnerable nations with a higher proportion of economic activity in climate-sensitive sectors. The complexity, cost, and limits of adaptation increase with the speed and severity of climate change.

Despite its many benefits, adaptation to climate change cannot replace mitigation. Both are necessary to reduce damages from climate change. Adaptation can only partly compensate for delayed mitigation efforts, and without stark greenhouse gas (GHG) reductions, the stabilization of global temperature will not be possible, making adaptation impossible or too expensive for some countries.

Climate adaptation can lead to productive and stable economies in Africa in the long term. Deliberate investment in risk reduction results in significant development co-benefits. For example, adaptation actions have resulted in the decline in deaths from climate disasters over the last hundred years (especially from droughts), and the modest or no upward trend in economic losses due to climate disasters at the global level. However, climate change

can exacerbate inequalities between and within countries and will disproportionately affect the poorer sections in countries of all income levels.

Some countries are on the verge of entering a poverty trap through a vicious cycle of low economic growth and increasing climate vulnerability. Sub-Saharan Africa, with limited adaptation capacity, is at particular risk from extreme weather. Capacity development, large investments, and external aid are indispensable to prevent such vicious cycles.

According to recent IMF calculations for Sub-Saharan Africa, each large-scale drought reduces medium-term growth by one percentage point, with low-income households severely affected. IMF research reflects that key adaptation policies integrated into the near- and medium-term budgets can impactfully reduce vulnerability to climate shocks and support sustainable and inclusive growth. For instance, in Ghana, the use of improved seed varieties and irrigation has bolstered cocoa's drought resistance and increased productivity. Similarly, the development of rust-resistant wheat varieties has increased yields by up to 40 percent in some cases in Ethiopia.

Recommendations

The IMF recommends:

- Decision-makers should use principles of welfare economics to make informed choices on adaptation policies and programs to climate change. The priority adaptation policies are those that can be achieved by removing market imperfections and implementing policies that hinder adaptation actions by the private sector. Given that adaptation benefits tend to be local and private, individuals and firms are strongly incentivized to adapt.
- Considering adaptation and other development priorities together, including synergies and tradeoffs among different development goals. Consistent investment in projects with the highest returns will maximize the impacts of governments' spending. Estimating net benefits for adaptation

Photo: Mikkel Østergaard/ Panos Pictures

programs and monetizing the benefits far in the future is fraught with deep uncertainty, but using cost-benefit analysis African policymakers can estimate the benefits over the entire lifetime of the project, including the growing risks linked to climate change.

- Giving preference to a combination of efficient adaptation policies with dedicated redistributive programs if they have larger aggregate net benefits for the entire population and the most vulnerable. It is important to ensure a consistent approach to analyze diverse programs through a standardized assessment of tradeoffs across different ministries and agencies, investment programs, and targeted groups in society.

Macro-Fiscal Implications of Adaptation to Climate Change

Natural disasters worsen fiscal balance ex post, creating explicit and implicit liabilities that trigger additional borrowing. Assessing disaster risks would help countries calculate the size of required fiscal buffers. Examining both explicit and implicit liabilities can inform financial planning and post-disaster response.

Climate change costs are calculated as the sum of the cost of adaptation and the costs of residual risks. Experience shows that these costs can be greatly reduced by timely adaptation. Estimating and incorporating projected climate damages into macro-fiscal policies can aid government planning for climate change.

Global estimates of public funding needs for adaptation are 0.25 percent of world GDP per year on average. However, this is not representative of the challenges faced by many countries. For some lower-income vulnerable countries, bottom-up self-assessment of their needs tends to be larger, ranging from 100 to 250 times higher than global averages.

According to IMF calculations, strengthening exposed existing and projected public assets could cost between 0.2 and 0.4 percent of GDP annually from 2021 to 2025 with large disparities across countries. The largest costs would be faced by emerging markets, followed by low-income countries. The costs of improving private-sector asset resilience could be twice as high, though more evenly distributed across income groups.

Recommendations

- Market distortions arising from policy failures can be addressed by governments as part of a comprehensive plan to improve the efficiency of the economy while considering the distributional implications of these measures.
- Subsidies can help deliver a socially optimal amount of climate change adaptation with positive externalities: for instance, subsidies for investments in research and development in agriculture, energy technology, etc.
- Costs and benefits of adaptation investments must be weighed by international donors if the investments are not additional to existing development assistance or if they do not have significant development benefits. This will ensure that adaptation projects effectively contribute to development goals of the society.
- For longer horizons, macro-frameworks should reflect all climate change effects, additional to disaster episodes.

Financial Instruments in North Africa

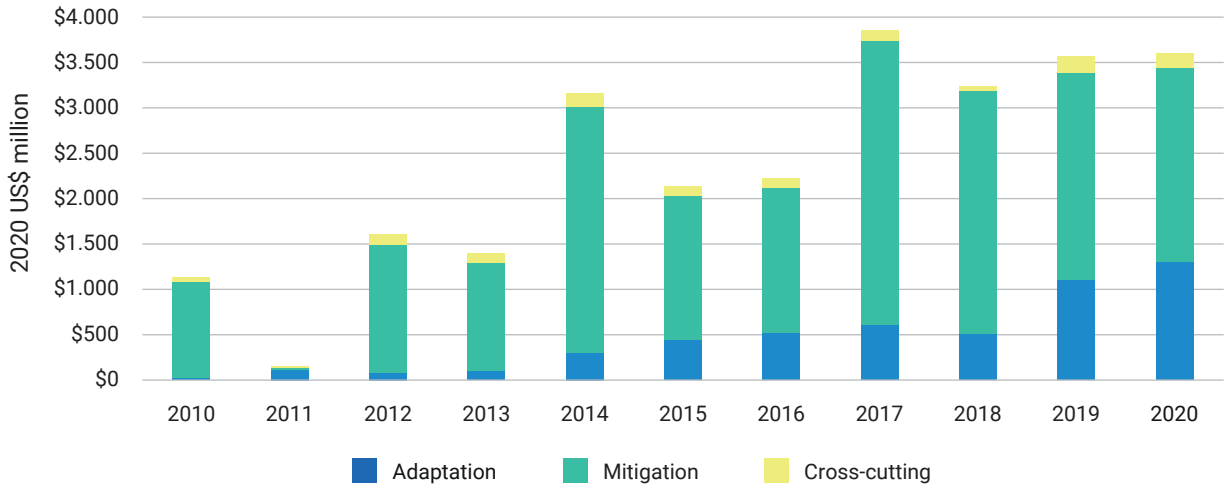
Despite the pressing adaptation needs expressed by several countries in the North Africa region in their NDCs, current adaptation finance represents less than 30 percent of total climate finance received. At the policy and prioritization level, many countries in North Africa have identified their climate financing needs. A review of the updated NDCs for five North African countries (Egypt, Mauritania, Morocco, Sudan, and Tunisia) indicates that climate financing needs total US$393 billion for the implementation of the NDCs over the next decade. Of this amount, almost three-quarters (US$288 billion) are requested for climate mitigation actions, and US$105 billion for adaptation.

Mobilizing the climate finance that responds to the country needs and avoids potential sustainable development tradeoffs remains challenging for many states in North Africa. Nevertheless, promising signals exist. A slight increase in climate financial flows to the region has been witnessed since 2018 (Figure 3). Climate finance also continued to be disbursed to the region even after the onset of the COVID-19 pandemic in 2020. However, total public climate finance between 2010 and 2020 totaled only US$26.1 billion, which represents less than 7 percent of the amount of financing required for NDC implementation over the coming decade.

Access to Adaptation

Access to adaptation financing is particularly difficult. Of the US$26.1 billion the region received in total public climate finance over the past decade, on average only 20 percent was directed at pure adaptation projects; and 4 percent supported cross-cutting climate mitigation and adaptation projects. Mitigation projects received the largest share of public climate finance. The share of adaptation finance in total public climate finance flows has been growing slightly since 2017, but remained at just 31 percent in 2019 and 36 percent in 2020. Comparing across African sub-regions, the imbalance between adaptation and mitigation finance seems particularly high in North Africa, while the allocations are closer to parity between

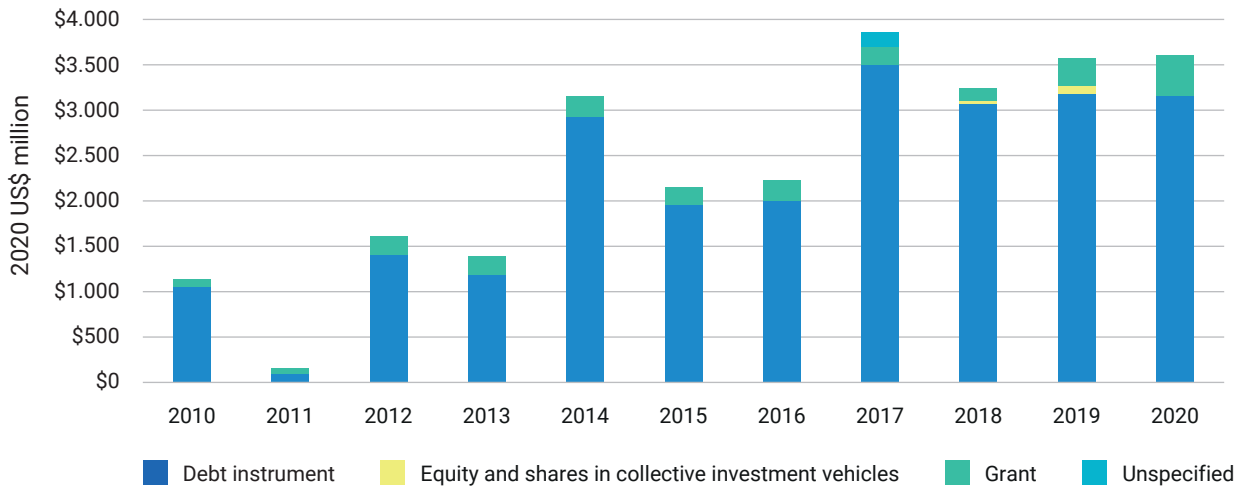
Figure 3. Climate Finance Flows to North Africa by Purpose (2010–2020)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cross-cutting	$55.12	$0.19	$125.60	$111.30	$157.30	$104.60	$104.30	$110.40	$44.79	$184.80	$167.50
Mitigation	$1,071	$29.19	$1,389	$1,188	$2,693	$1,588	$1,600	$3,127	$2,675	$2,290	$2,131
Adaptation	$17.60	$125.70	$96.85	$108.10	$308.50	$447.80	$523.80	$612.90	$515.90	$1,103	$1,310

Source: ESCWA calculations based on OECD DAC data (recipient perspective)

Figure 4. Climate Finance Flows to North Africa by Type of Financial Instrument (2010–2020)



Source: ESCWA calculations based on OECD DAC data (recipient perspective)

mitigation and adaptation finance for West Africa (54 percent for mitigation), Central Africa (52 percent for mitigation) and East Africa (52 percent for mitigation) for the period 2014–2018.

In addition, climate finance flows to North Africa were almost exclusively in the form of debt-based instruments (88 percent), despite the large debt burden many countries in the region are currently facing (Figure 4). There are also large regional disparities in received climate finance. Egypt and Morocco have been most successful in attracting public international climate finance, while the least developed countries Mauritania and Sudan received only 3 percent of total flows to the sub-region.

Challenges

Countries can mobilize climate finance from a broad range of sources and in many different forms. There are public and private as well as national and international financing instruments. Furthermore, in addition to mobilizing external funds, existing national resources can be freed for financing climate action by mainstreaming climate into public budget and expenditure processes as well as fiscal mechanisms. Unlike mitigation projects, adaptation projects tend to accrue benefits over a longer time horizon and face more difficulty in ensuring cost recovery and profitability. This renders them less attractive for private-sector investment.

At the same time, countries in the region face a contraction in their fiscal space. Public debt has been rising in an unprecedented way over the past decade. Debt burdens have been aggravated further by the COVID-19 pandemic and the Russian invasion of Ukraine, particularly through price increases for energy and wheat, of which many North African countries are net importers. For middle-income countries in the Arab region, the total public debt more than doubled between 2008 and 2020, reaching US$658 billion in 2020, which implies a debt-to-GDP ratio of 91 percent. This severely limits the resources available for investing in climate action. In addition, debt vulnerability considerations might limit a country's external borrowing ability. More innovative financial instruments are needed to ensure that the cost burden for adaptation is not placed exclusively on the public purse.

A country's legal and regulatory framework can create an enabling environment for mobilizing adaptation finance and climate-proofing public and private-sector investments. Dedicated climate laws, national strategies, and directives from financial authorities help set the scene for adaptation finance and define the overall level of ambition by showcasing high-level endorsement. For example, Egypt recently published its National Climate Change Strategy 2050.

Institutional structures can also help to create an enabling environment for mobilizing adaptation finance. Several North African countries have passed decrees to establish national management units to coordinate, streamline, and monitor national climate-related activities.

Further, an enabling environment for mobilizing adaptation finance should engage all levels of government and involve local stakeholders. Drawing upon local knowledge helps to develop tailored solutions responsive to stakeholder needs. As such, a bottom-up approach can help strengthen local authorities and actively engage communities in the planning and implementation of projects as well as in knowledge and capacity-building processes.

A better understanding of climate risks and vulnerabilities for individuals, firms, and the public sector is paramount in defining adaptation needs and thus for mobilizing and accessing adaptation finance. Climate-related financial risk disclosures regarding adaptation and disaster risk can do just this.

Establishing a reliable system for tagging and tracking climate-related public expenditures is important to earmark funds and assess whether public budgets have been used to their designated end in a results-based framework. Thus far, climate-related budget tagging and budget tracking are still rare in the North Africa sub-region, which can in part be attributed to the lack of data and monitoring capacity, including a clear taxonomy and performance indicators, manifest in several countries in the region.

Another public budget instrument is the provision of dedicated national funds to allow both for ad hoc financing in the aftermath of a disaster as well as for investing in strategic adaptation measures.

Financial Instruments for Adaptation

Green Bonds

Recent years have witnessed an increasing interest in green bonds. Egypt and Morocco are both active on the green bond market. However, bond proceeds have primarily financed climate mitigation projects. Morocco issued its first green bond in 2016 for a total of US$447 million. Additional bonds were issued in 2018 and 2020, financing renewable energy, energy efficiency, and sustainable housing projects. Egypt issued its first sovereign green bond in September 2020 with a five-year term worth US$750 million. As of November 2021, 75 percent of the net proceeds of the issuance (US$564.46 million) have been used to finance eligible projects. Of these, 46 percent are being used for the Cairo Monorail as a clean transportation project. The remaining 54 percent are supporting 14 sustainable water, water desalination, and wastewater management projects.

Debt Swaps

Debt-for-climate or debt-for-nature swaps present an innovative financial tool that can help secure funding for adaptation projects and thus accelerate climate action while not increasing the country's debt service burden further. A debt swap converts national debt servicing payments on external debt into domestic investments, which can in turn be directed toward projects or programs that support national sustainable development or climate goals. Egypt is currently implementing a debt swap program with Germany over three phases with a total value of €240 million. The United Nations Economic and Social Commission for Western Asia (ESCWA) launched the Climate/SDGs Debt Swap-Donor Nexus Initiative in 2020 to provide an alternative to debt restructuring by facilitating a debt swap between bilateral creditors and middle-income countries that are facing increasing fiscal pressure, but which are not at risk of defaulting on their payments. ESCWA's debt-swap initiative is currently being piloted in Jordan.

Our analysis shows that for the debt swap mechanism to be scaled up, there is a need to move from ad hoc bilateral deals for debt-for-adaptation swaps to a more institutional approach.

Multilateral Development Banks and Climate Funds

MDBs and climate funds provide climate finance through different channels, some of which specifically focus on adaptation. These funding instruments support readiness projects to help prepare countries for securing climate finance. They also finance climate adaptation and mitigation projects through grants. Concessional international finance can be used catalytically for crowding in new finance, including from the private sector, which tends to charge commercial rates.

MDBs have become the dominant source of climate finance, providing almost two-thirds of total public

climate finance flows to the Arab region between 2013 and 2019. However, most of these flows have been non-concessional debt instruments with a very small share of grants offered. MDBs have also diversified their offerings into green financial instruments, in support of commitments made to align their operations with the Paris Agreement and the 2030 Agenda.

Climate funds can also play an important role in providing alternative forms of financing, but their overall contributions remained at 1 to 2 percent of total public climate finance.

This report highlights the need to address the imbalance in adaptation finance generated by the public and private sectors. We indicate that of the US$11.4 billion in adaptation commitments tracked from 2019 to 2020, more than 97 percent came from public actors, while less than 3 percent was tracked from the private sector. In total, private-sector adaptation finance commitments tracked in 2019 to 2020 in our analysis come to just under US$250 million annually. Of that total of approximately US$250 million, nearly 90 percent was committed by institutional investors (which includes foundations, insurance companies, asset management firms, pension funds, and endowments), 9 percent was committed by commercial financial institutions, and the remaining 1 percent was committed by corporations and other private sources.

The African Development Bank (AfDB) estimates that about 75 percent of the financing required for successful implementation of African NDCs needs to be provided through private investments. It is therefore important to promote innovative financing solutions, including more blended finance resources, and incentivize institutional investors to invest in adaptation to unlock the potential of institutional investors such as pension funds, sovereign wealth funds, and insurance companies in scaling up climate finance on the continent and helping bridge the continent's adaptation finance gap.

Mainstreaming Climate Considerations Into Public Budgets

Mainstreaming climate considerations into public budgets and incorporating adaptation finance into all stages of the budgeting process can provide a direct channel of funding for dedicated climate adaptation projects. It can also facilitate the climate-proofing of planned or ongoing public investments, such as in infrastructure or housing. Transparency and strengthened fiscal discipline can improve the efficiency of climate expenditure management as well as the intersectoral allocation of climate funds to maximize the value of existing budgetary resources.

Recommendations

- Innovative financial approaches and instruments can help access additional funds and maximize the value of existing ones. As such, financial instruments for adaptation range from greening public budgets and climate-proofing public expenditures to the mobilization of private-sector financing through an enabling institutional environment, and from regulatory provisions as well as credit guarantee schemes to traditional revenue-oriented financing instruments such as green bonds, innovative debt swap programs, or MDB and climate fund financing.
- In order to enhance access to adaptation finance and maximize the value of existing resources, current barriers and challenges need to be overcome. In particular, standardized methodologies are vital for assessing country-specific climate vulnerabilities and risks and in turn identifying adaptation needs. In addition, a clear taxonomy and well-defined evaluation methodology are important to create a collective understanding of what qualifies as adaptation action. Fostering cooperation and communication between ministries and decision-makers at all levels of policymaking can create an enabling institutional framework and support the prioritization of adaptation at the planning and funding stage. This can help generate synergies and avoid distortions.
- A clear policy, legal, and regulatory framework that takes international standards and good practices into account while at the same time responding to local needs and circumstances is needed to establish an enabling investment environment for project identification and active private-sector engagement.
- Similarly, a comprehensive monitoring and evaluation system and ambitious budget tagging and tracking will allow countries to supervise whether funds have been used for their purpose, help to respond to reporting requirements by funders, enhance transparency, and build trust.

Climate Risk Financial Regulation in Africa

This chapter focuses on the impact of climate risks on African financial systems. Financial regulations and self-regulation practices of financial institutions are critical enablers of a resilient financial system and encourage more climate investment in the region. The increased quantification, pricing, and management of physical climate risks by financial institutions can help foster social resilience, not only by assuring the financial system's resilience to climate change, but also by providing price signals that influence economic behavior.

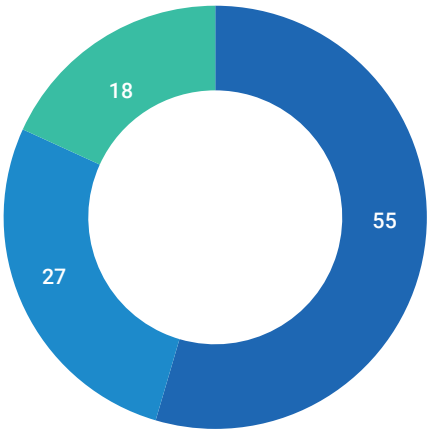
As long-term measures to address climate-related financial risk, all 54 African countries have signed the Paris Agreement and submitted ambitious Intended Nationally Determined Contributions (INDCs), while the majority have ratified NDCs. However, many of their commitments require financial, technical, and capacity-building support. In the financial-sector, the African Financial Alliance on Climate Change (AFAC) brings together leaders in the African financial industry: central banks, insurance companies, sovereign wealth and pension funds, stock exchanges, and commercial and development banks. AFAC aims to increase financial-sector participation in climate action to raise the share of investments supporting low-carbon and climate-resilient development in Africa.

The effects of climate change on financial stability depend on the distribution of financial exposure and the evolution of prospective financial-system losses. African banks are vulnerable to climate change shocks increasing in frequency and severity, as they are projected to do. An analysis by Moody's Analytics found that 49 banks across 14 African countries had extended US$218 billion of credit to environmentally sensitive sectors—about 29 percent of their total loans.

The chapter focuses on the exposure of Africa's financial sector to climate-related risks, pointing out that some African nations are among the most vulnerable in the world to climate risks. It shows that there is a growing momentum globally among financial authorities, including in Africa, to develop a broad-based regulatory framework to address such risks, and details the transmission channels through which climate risks threaten the stability of the financial system. It also presents the research and findings of the 2021 McKinsey report on climate risk integration in Africa's financial regulatory network, carried out in collaboration with AfDB, GCA, and UNEP FI.

This study, based on a series of semi-structured interviews and a questionnaire for each country, included 19 African countries with different levels of financial-system sensitivity to climate-related hazards. Overall, 25 organizations were surveyed, including 11 financial regulators and 14 private entities. The study shows African financial authorities and the private sector have a growing awareness of climate-related risks, which can be divided into physical risks and transition risks. Climate risks pose a significant threat to financial stability by reducing the collateral value of economic agents and jeopardizing the soundness of financial institutions.

Figure 5. Priority Perception of Climate Risk Among Financial Authorities



82% of the authorities interviewed considered climate risk a high or very high priority

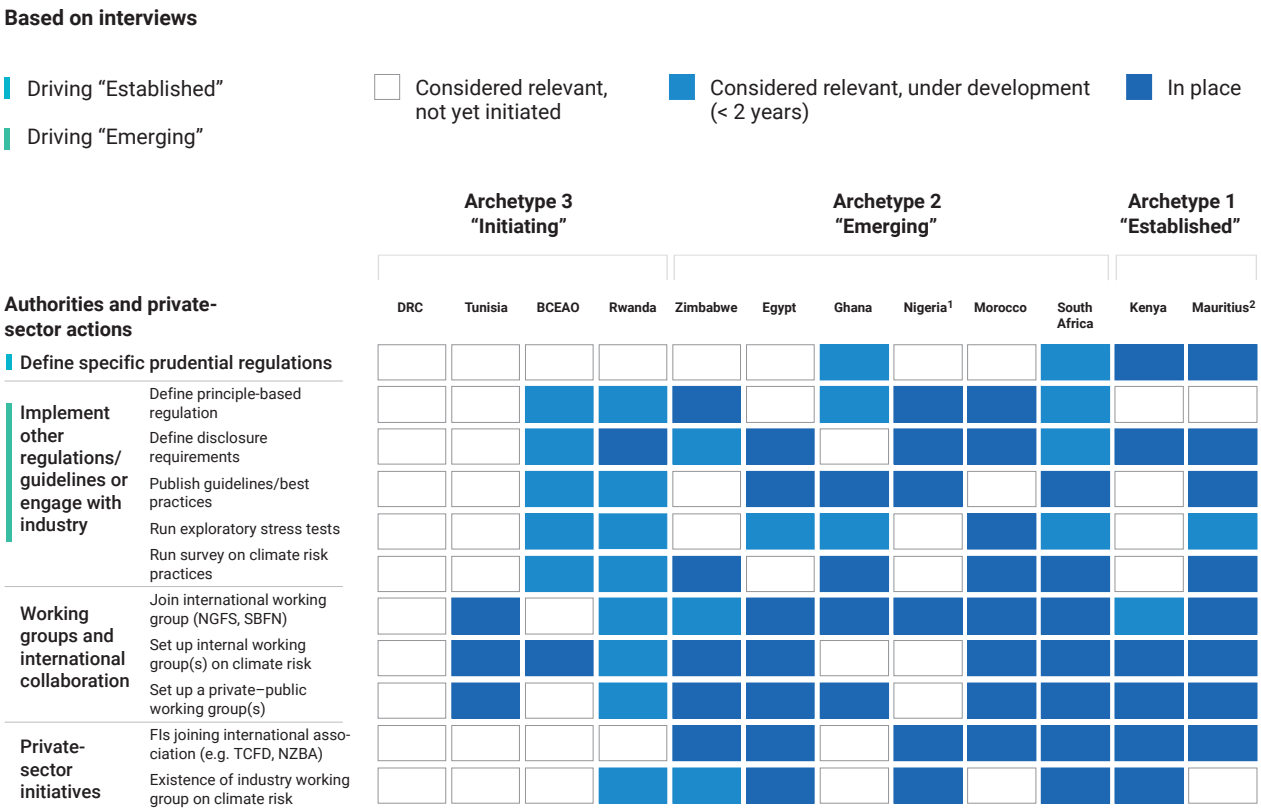
"With monetary policy, climate risk has become our top concern"

Central Bank – Head of Sustainability Department

Source: Reproduced from Figure 5 in AfDB et al. (2021), Climate Risk Regulation in Africa's Financial Sector and Related Private Sector Initiatives

Climate-related risks have been added to the research agendas of various central banks and supervisory organizations as governments acknowledge the threat that climate change could

Figure 6. Overview of Climate Risk-Related Regulations and Initiatives Across African Regions



Notes: Archetypes were defined in terms of regulatory advancement. (1) Implementation Guidance to the Nigerian Sustainable Banking Principles are not binding per se, but can generally be considered detailed. (2) Mauritius has drafted its prudential regulations and should be finished by the end of the year 2021.

Source: Reproduced from Figure 6 in AfDB et al. (2021)

pose to their economies and financial systems, including financial losses caused by climate-related disasters and implications on financial valuations of a necessary transition away from high-emitting sectors of the economy.

However, very few authorities and supervisors in the financial sector have established regulations or supervisory expectations. According to the report's conclusions, most regulators and supervisors in the financial industry have not addressed climate-related risks or more significant sustainability-related concerns through binding rules and supervisory guidelines. Although authorities can evaluate these risks as part of their existing duties, there are ongoing attempts to build effective and comprehensive frameworks to detect, analyze, manage, and communicate climate-related risks that are connected to developments in the private sector.

There are three significant challenges that African governments are currently facing in their efforts to integrate climate risk into their financial systems: a lack of data; a lack of internal capability to define regulations and guidelines; and a lack of international standards or common methodologies, such as stress tests.

Recommendations

- **Address the lack of capacity and capabilities of authorities.** Public authorities and financial regulators should be encouraged to develop their own capabilities while also contributing to the capacity development of private-sector players, for example by highlighting best practices, offering training programs, forming working groups, and so on. Several interviewees mentioned the importance of collaborating with external organizations and initiatives to implement this approach.

- **Set standard disclosure instructions/Set mandatory reporting and disclosures.** Consider mandating minimum disclosure standards for the financial and non-financial sectors in accordance with the Task Force on Climate-Related Financial Disclosures (TCFD) recommendations, covering governance, strategy, risk management, metrics, and targets. Consider specific regulations and supervisory guidelines and metrics to ensure that financial institutions adequately consider climate risk and facilitate interactions with counterparties, investors, and clients.
- **Promote access to data and information/develop stress test models and scenarios analysis.** Make physical and transition risk-related data and information more accessible, for example by incorporating reliable sources into a central repository. Develop stress test models and scenario analyses for supervisory purposes as well as institutional reference points.
- **Promote non-bidding measures.** Non-regulatory actions are often the most effective ways to raise awareness about climate change. For instance, conducting awareness-raising events and surveys is often the most effective way to gather information about the financial sector's exposure to climate risk. Sharing best practices, for example via guides and roundtables, publishing assessments of the financial sector's aggregate climate-risk exposure, and defining a taxonomy for economic activities are other tools and resources that can help financial stakeholders make informed decisions when assessing their exposure to climate risk.


Photo: JordiRamisa/iStock

Resilient Recovery: The Cases of Senegal and Côte d'Ivoire

In STA21, the report covers the role that adaptation and resilience programs can have in the post-COVID recovery trajectory of a selected group of African countries. This year, two additional countries were analyzed. Senegal and Côte d'Ivoire face steep challenges, including from climate change, in making a transition to the next stage of economic prosperity. As these countries plan for the future, investment in green sectors could deliver a sustainable and environmentally friendly post-pandemic recovery.

Both economies exhibit a recovery path from COVID-19, with real GDP growth in 2021 of 6.1 percent and 7 percent respectively. However, the economic fallouts of the outbreak, the appearance of new variants, and the low rates of vaccines still threaten their recovery. Further, the tensions between Russia and Ukraine have led to a steep increase in food and energy prices, a deterioration of terms of trade, and a shortage of fertilizers, threatening the macroeconomic outlook and food security.

Crucial for an effective green recovery plan is mainstreaming climate change adaptation into it. Adaptation measures must be implemented in every sector—agriculture, transportation, energy, trade, water resources, and urban development. It is important to invest in NBS, such as restoring mangroves to protect coastal communities or creating urban parks that absorb stormwater and moderate heatwaves in cities. Given the vast human and natural resources of Senegal and Côte d'Ivoire, there is immense potential to move forward rapidly in labor-intensive modern industries such as ecotourism services, climate-smart agriculture, renewable energy, green building, and infrastructure.

Such adaptation measures will have several co-benefits. Adaptation measures can be enormously cost-effective and have the potential to start a

positively reinforcing cycle of benefits. Adaptation measures could help lift people out of poverty, reduce hunger and undernourishment, fight diseases, create jobs, reduce inequality, mitigate the risk of conflicts, and give voice to the most vulnerable. Specifically, in Côte d'Ivoire, adaptation measures could increase the productivity and resilience of smallholder cocoa farmers. There is strong potential to pair adaptive investments in Côte d'Ivoire with several support initiatives in different sectors, including agriculture, fisheries, and forestry, to promote sustainable and efficient practices. Strategically targeted investments in adaptation can help expand opportunities for the labor force, which is currently tied up in informal work characterized by irregular and volatile incomes. These realizable results, in turn, further increase resilience to climate impacts. This chapter presents an analysis of the economic and employment potential of green investments relative to traditional and high-carbon investments in Senegal and Côte d'Ivoire.

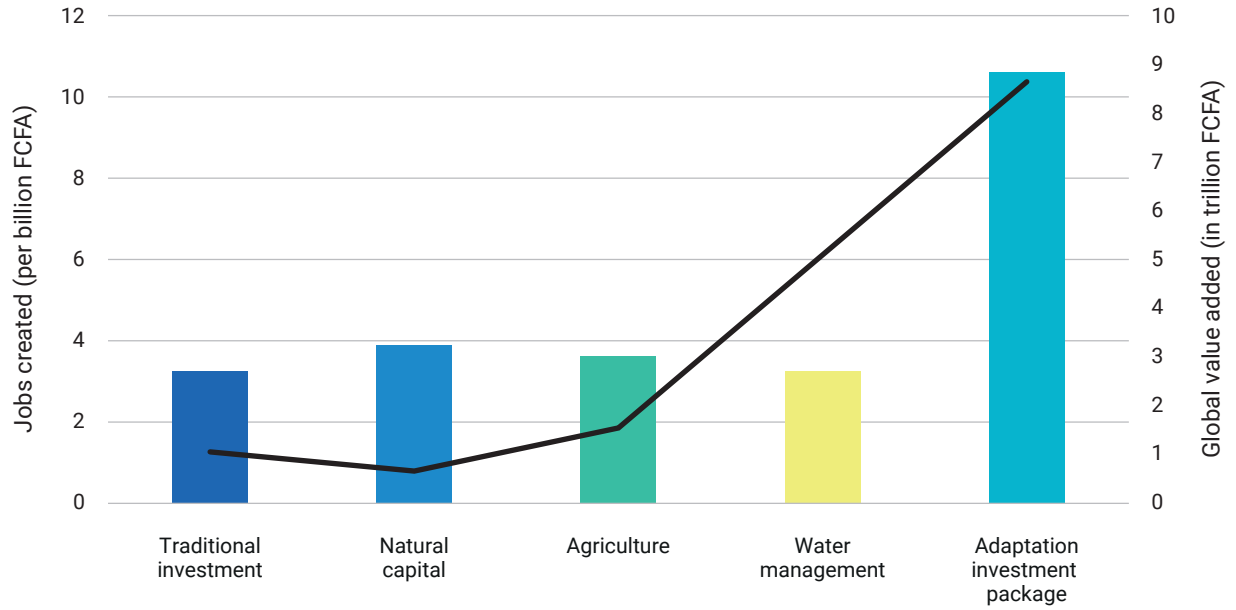
Senegal

The Senegal green stimulus package is compared to an investment in the mineral extractive sector. The choice of the extractive sector as a counterfactual is based on the different country's priority plans, especially the "Plan Senegal Emergent" (PSE).

This development strategy aims at addressing the medium and long-term social and economic challenges of Senegal to become an emerging country by 2035. This strategy is implemented through several short-term actions plan "Plan d'Actions Prioritaires (PAPs)." The two first PAPs (2014–2018 and 2019–2023) identified the mining sector as one of the high-growth potential sectors, requiring the Government to prioritize investments to develop the sector including gold and phosphate mining and the creation of hub mining.

Our analysis shows that adaptation measures in Senegal would provide the highest returns in terms of jobs and economic value, among the set of green investments. Investment in adaptation initiatives could create 230 percent more jobs within five years (600 percent within 20 years) and 695 percent greater economic value in the long term (within 20 years) relative to the extractive sector stimulus package in Senegal. Climate change adaptation spending is estimated to boost employment by 14,098 job years directly and 16,571 job years indirectly (through supply chains). In contrast, the traditional package would support employment by creating 127 job years directly and 1,251 job years indirectly. (Figure 7)

Figure 7. Total Job Creation and Gross Value Added by Different Investment Packages, Senegal



Source: Author's calculations based on estimates

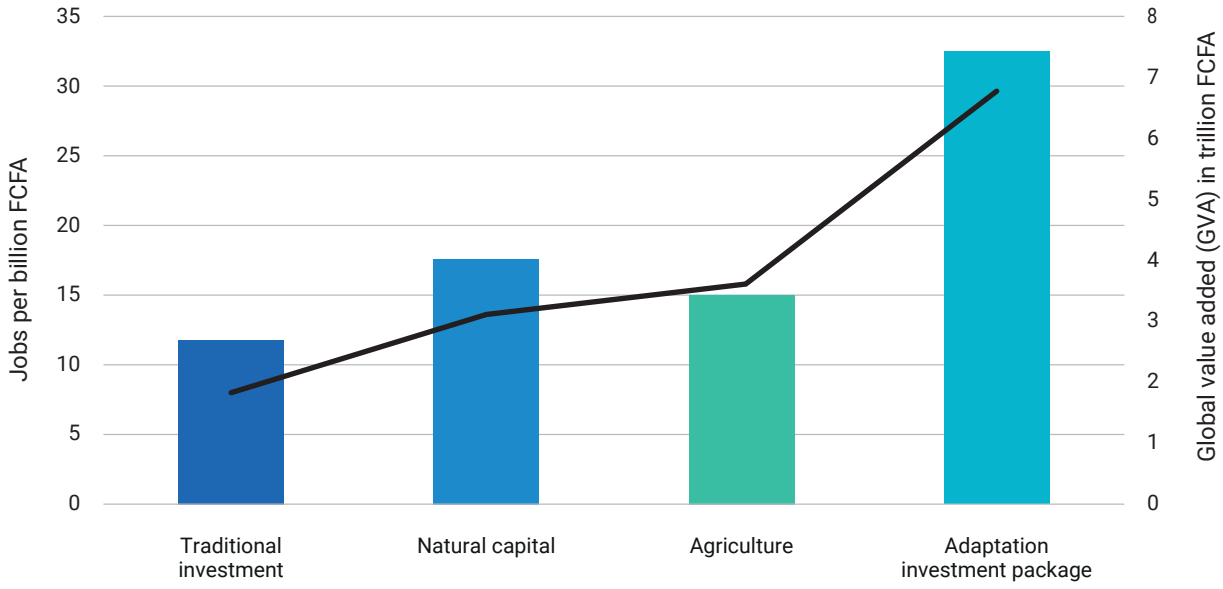
Analysis shows that, compared to high-carbon investments, flood adaptation, wastewater, and water demand management can generate an economic return of 380 percent while coastal protection, aquaculture, reforestation, and resilient seeds could generate more than 100 percent economic return. The potential for development of each of these sectors is now presented in greater detail.

Côte d'Ivoire

The Côte d'Ivoire green stimulus package is compared to an investment in the mineral extractive sector. The choice of the extractive sector as a counterfactual is based on the different country priority plans, especially the National Development Plan (NDP) 2021–2025. The NDP is a national development planning model adopted by the Government of Côte d'Ivoire. This development strategy aims at addressing the medium- and long-term social and economic challenges of becoming an emerging country.

Our analysis shows that among the set of green investments, adaptation measures in Côte d'Ivoire would provide the highest returns in terms of jobs and economic value. Investment in adaptation measures, among several other green interventions, has the highest social-economic returns, generating up to 180 percent more jobs within five years (400 percent within 20 years) and 265 percent more economic value in the long term (within 20 years) relative to traditional investments. Adaptation spending is estimated to boost employment by 84,792 job years directly and 66,926 job years indirectly (through supply chains). In contrast, the traditional high-carbon investment package would increase employment by 1,854 job years directly and 497 job years indirectly.

Figure 8. Total Job Creation and Gross Value Added by Different Investment Packages, Côte d'Ivoire



Source: Author's calculations based on estimates

Analysis indicates that aquaculture and reforestation can generate an economic return of 165 percent in the long term, while resilient seeds, agroforestry, and solar irrigation systems could generate more than 100 percent economic returns compared to high-carbon investments.

Recommendations

Based on the findings of the analysis for Senegal and Côte d'Ivoire, three key recommendations can be derived to unleash the potential of a green economy and ensure economic prosperity and sustainable development:

- **Public finance should mainstream climate investment in order to attract private-sector actors.** Investment in adaptation is no longer an option, but a priority, in order to preserve economic growth, ensure food security and attenuate the detrimental effects of climate change on the coastline, agriculture, and water availability. Governments need to consider a holistic approach to integrating public and private adaptation initiatives. Governments can prioritize public investments in adaptation programs with positive externalities, address market imperfections and policies that make the adaptation of the private sector inefficient, and mobilize revenues for and distribute the benefits of adaptation. Better planning can enable an increase in the share of public investment in adaptation, and/or increase the efficiency of public adaptation initiatives.
- **There is a need for proactive action on innovative finance sources and to work toward eligibility for sustainable bonds for adaptation**. Current adaptation finance flows are insufficient to meet growing adaptation needs on the continent. Innovative climate finance may allow grants or different funding sources to be combined with traditional climate loans, which enables investment in new sectors and facilitates the development of large-scale programs with improved effectiveness, impact, and replicability. Green and sustainable bonds, together with the increased level of transparency that they bring, can help secure market financing for future investments. To be able to attract financing, countries should create enabling conditions and incentives.
- **Promote an adaptation-mitigation approach.** Adaptation measures in mitigation projects could address potential climate risks, making mitigation projects more resilient to a changing climate. Renewable energy, including hydropower, solar photovoltaic, solar individual systems, and onshore winds, have considerable potential to provide energy access to rural communities by increasing interconnected networks. Climate change adaptation was perceived as a project safeguard that would provide benefits to local communities and project developers, as well as global benefits because carbon storage would be more permanent, particularly for forestry projects.

Photo: Fabian Plock/Shutterstock

The Private Sector

The private sector in Africa currently generates two-thirds of the continent's investment, 75 percent of its economic output, and 90 percent of employment. Across multinationals and micro-, small and medium-sized enterprises (MSMEs), climate hazards are expected to increase the costs for private-sector actors by impacting assets and worker productivity and by disrupting operations and value chains. Revenue may also decrease due to changes in demand related to fluctuating population, income, and migration patterns. Finally, as increased costs and reduced revenues are expected to affect cash flow and company performance, unfavorable expected rates of return for investors may affect international investment attractiveness and thus the flow of investment into perceived high-risk countries.

Challenges

Climate hazards are expected to translate into higher costs, ranging from asset restoration to disruptions to the supply chain. First, climate hazards are expected to translate into challenges for workers' wellbeing and safety, as well as higher costs tied to productivity reduction. Second, heat stress, flooding and drought can impair the functionality of and accessibility to on-site infrastructure and capital, translating into higher costs for maintenance and repair and requiring investment in more efficient and resilient technology. For example, South Africa, Zambia, Malawi, Benin, Mozambique, and Kenya have the largest number of businesses reporting detrimental water-related impacts globally, which includes physical damage to property from flooding and extreme weather events. Third, climate hazards may impact upstream and downstream value chains and increase the procurement and distribution costs of companies. Grid inefficiencies and impacts to transport infrastructure driven by climate risks create disruptions that reduce the reliability of utility services and can increase operational and procurement costs. Similarly, climate hazards can disrupt upstream value chains and increase producers' off-site costs when key infrastructure and transport routes or distribution warehouses and services are damaged, inaccessible, or destroyed. For low- and middle-income countries, the World Bank has estimated that globally, disruptions to water, power, and transportation services cause losses of over US$150 billion every year.

Photo: Big Red Design Agency/Shutterstock

Climate hazards are also expected to put pressure on revenues by altering the demand base of the private sector. An increasing number of companies have been considering the impact of climate change on their own operations as climate risks impact their revenues through customer base loss due to displacement, changes in income, or supply-chain paralysis. The World Bank projects that by 2050, climate change may be a driving force for over 100 million Africans to migrate within their countries, away from areas with lower water availability and crop productivity or rising sea level and storm surges.

Additionally, climate change is expected to have an impact on the cost of financing and insurance, which may hamper the ability to fund growth. Over a third of the expected US$2.5 trillion increase in insurance premiums is likely to be driven by climate change. As critical assets and infrastructure are damaged, cascading risks could magnify the economic damage and fiscal impact of climate-related disasters, potentially making affected companies less attractive recipients of investment. The negative effect of physical damage could be exacerbated by a subsequent decrease in funding for recovery and future economic growth, due to perceptions of heightened risk. For example, flooding is expected not only to damage properties but also to raise insurance costs, affect the property values of exposed capital, and in turn reduce property tax revenue for communities, which could hinder socio-developmental gains.

Rising climate extremes are also expected to reduce the availability or increase the price of insurance, increasing the risk of financial instability. In Africa, insurance penetration is already very limited. The insurance market was valued at US$68 billion in 2018, with 80 percent of premiums concentrated

in South Africa, and much of the rest in just a few countries, such as Egypt, Morocco, Nigeria and Kenya, mainly involving large corporations. Insurance premiums tend to be high for MSMEs, which in turn struggle to assess and provide insights into residual risk exposure and struggle to lower uncertainty.

Climate-risk assessments can help companies target their risk mitigation countermeasures. Leveraging different climate and socioeconomic scenarios, such as the reports by the Intergovernmental Panel on Climate Change (IPCC), companies can understand their exposure to hazard changes in frequency and intensity. Those must then be translated into direct and cascading operational, financial, and social impacts on companies. However, limitations and lack of granularity in climate and socioeconomic data can be salient bottlenecks in risk quantification. These limitations can range from sparse time series to complex circulation patterns, lack of locally relevant damage functions to assess vulnerability, or lack of asset values across the supply chain.

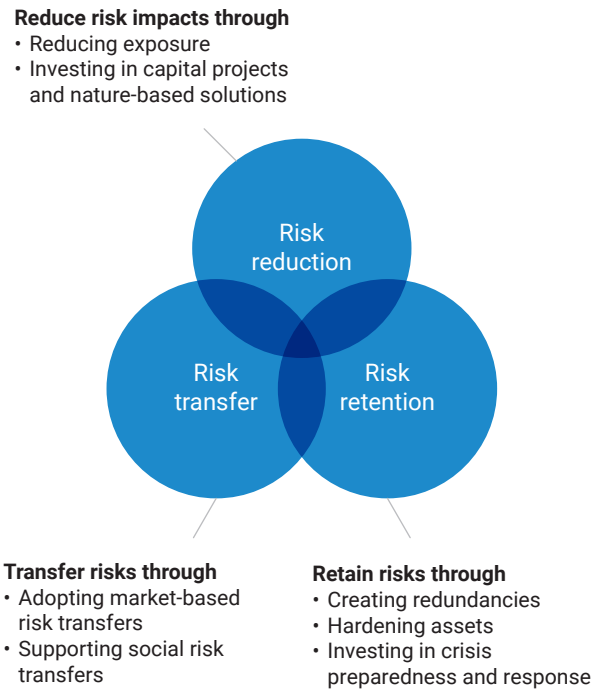
Recommendations

A range of adaptation measures to reduce, retain, or transfer climate-related risks can help private-sector companies navigate their exposure to climate change.

- When it comes to **risk reduction**, companies can reduce their exposure by relocating their sites or supplies away from high-risk areas. In addition, private-sector actors can invest in projects that strengthen the resilience of their capital and infrastructure against extreme weather and climate conditions. Further, the private-sector has additional opportunities to capture co-benefits and reduce its exposure to climate risks by investing in NBS. While it can be costly and take a long time to set up and generate substantial income, preserving ecosystems by leveraging Africa's vast NBS potential can generate added benefits such as an increase in biodiversity, access to the carbon credits market, and support for the security of local communities.
- Regarding **risk retention**, companies can take steps to create redundancies, harden assets, and invest in emergency response. Creating redundancies mainly includes developing distributed and diversified networks to avoid being reliant on a sole origination point for supplies. Hardening assets means fortifying them against climate hazards or developing new products and services that can sustain chronic and physical hazards.
- As far as **risk transfer** is concerned, private-sector companies can leverage different mechanisms. There is a wide array of available investment instruments, risk-financing mechanisms and broader finance-relevant solutions that financial actors are already mobilizing in support of climate resilience across Africa. Financial instruments can be used to finance activities that build physical resilience to climate change impacts, reducing physical risk, and can also be used to respond to risks where physical climate impact cannot or has not been eliminated. Risk transfer mechanisms can be designed to compensate climate-related losses if a contingent variable falls outside an established range (for example a predetermined drop in commodity prices).

In addition, companies could consider embedding climate-risk management into their governance, strategy and risk management processes.

Figure 9. Measures to Negotiate Climate-Related Risks



Source: McKinsey Global Institute staff

Access to Global Climate Finance—The Technical Assistance Program

Many African countries need institutional and technical capacity building with regard to planning for, accessing, and delivering climate finance, including when engaging with multilateral climate funds. To address the problem of the adaptation finance deficit in Africa, Pillar 4 of the Africa Adaptation Acceleration Program (AAAP) is focused on innovative financing. One of its core elements is a Technical Assistance Program (TAP) that aims to reduce barriers to large-scale access to multilateral climate funds in Africa and significantly increase the flow of adaptation finance to the region. This chapter aims to draw the first lessons learned after one year of implementation to measure the progress and achievements of the program, and to identify areas for improvement to achieve more significant impact and sustainability. To this end, the GCA conducted a series of semi-structured interviews using a questionnaire customized to the stakeholders involved in implementing the TAP, including National Designated Authorities (NDAs), officials from different ministerial departments, Accredited Entities (AEs), development partners, and GCA programs.

The needs of African countries for financing adaptation to the impacts of climate change are significant and cannot be covered by a single financial mechanism. Actions to close the adaptation financing gap must therefore target multiple sources, both public and private, international and domestic, while exploiting complementarities. Multilateral climate funds 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. Given the central role of the Green Climate Fund (GCF), the unprecedented volumes of funding it offers, the range of financial instruments it provides, and its blended funding strategy, the TAP initially focuses on accessing GCF resources. This is especially true since the same capacity developed to access the GCF will allow access to any other multilateral climate funds. The basic requirements for accessing GCF funding include:

- **Having in place an ambitious and coherent national climate strategy/policy:** Funding requests submitted to the GCF must demonstrate alignment with national priorities.
- **Having in place an NDA and Focal Point:** NDAs are government institutions that provide broad strategic oversight of the GCF's activities in the country and communicate the country's priorities for financing low-emission and climate-resilient development.
- **Identifying AEs through which funding proposals are submitted to the GCF:** Direct Access Entities (DAEs) are to be endorsed by the NDA before applying for accreditation to the GCF.
- **Developing a pipeline of projects that fulfill GCF requirements:** Ideally/increasingly based on the GCF Country Program and relevant Entity Work Program.

Technical Assistance Program (TAP) for Access to Adaptation Finance

The TAP is tackling the main barriers that African countries face in accessing adaptation finance at scale. These include significant gaps in adaptation planning and decision-making; poor technical capacities for adaptation project development and implementation; and lack of valorization of the groundbreaking direct access modality. The TAP includes three inter-related components:

- Building capacities for adaptation finance planning and decision-making, laying the ground for a long-term partnership for adaptation finance mobilization and implementation.
- Strengthening direct access by facilitating new accreditations and supporting the upgrade of existing National Implementing Entities while ensuring complementarity with the international access modality.
- Promoting intersectoral, large-scale, and transformational adaptation projects and programs through inclusive consultative processes aligned with national and regional priorities.

All African countries are eligible for TAP, but in the interests of practicability, a gradualist approach is being adopted, starting with a small number of countries and gradually expanding to others. During the first year of implementation, the TAP has engaged stakeholders in about 12 countries, including Burkina Faso, the Democratic Republic of the Congo, Niger, Nigeria, Seychelles, Côte d'Ivoire, Senegal, and Ghana.

The GCA engagement strategy through TAP aims to foster country ownership and alignment with national priorities, laying the ground for a long-term partnership for adaptation finance mobilization and implementation. In addition, where practicable, GCA encourages the consolidation of isolated sectoral initiatives into large programs and pushes for the acceleration of ongoing processes in line with the objectives and approach of the AAAP.

Lessons Learned and Recommendations

Several African countries have requested GCA support for carrying out a Climate Public Expenditure and Institutional Review/Budget Screening (for example, Côte d'Ivoire and the DRC) or support for the development of a framework and systems for the monitoring, reporting, and verification of climate finance flows (Seychelles). These processes are at different stages of implementation.

Stakeholders and counterparts have found the TAP to be an effective program to create the conditions for improved access to adaptation finance and effective and transformative use of public climate funds, particularly GCF. The TAP core principle of country ownership has also been appreciated. Not only are the work programs built on national priorities, but more importantly, national counterparts are directly and entirely involved in the planning and implementation of activities. The program's openness to partnerships and collaborations was also identified as an asset.

Because the TAP program was launched during the COVID-19 pandemic, initial engagement with countries has been chiefly virtual, which has affected communications, coordination, and practical implementation. The implementation of the initial TAP projects has thus been delayed at times. Fortunately, the TAP is designed to be implemented progressively and flexibly. As lessons are learned, the approach and implementation arrangements are reviewed and updated for more significant impact and efficiency.

The issue of data is a crucial one, both in terms of availability and access. Through interactions with country counterparts, it was found that the confidentiality and sensitivity of some economic data may constitute a significant challenge when undertaking national budgeting and finance activities. Furthermore, the formulation of adaptation project concept notes was impeded by the availability of or access to climatic and socioeconomic data related to the targeted intervention areas.

The areas for improvement identified through interviews with TAP counterparts and partners include:

- **Maintaining a regular presence in partner countries:** The lack of human resources and the fact that institutions sometimes operate in silos can slow down or even compromise the implementation of activities. A presence in the field makes it easier to facilitate consultations between institutions and deal more effectively with deadlocks.
- **Prioritizing integrated multi-year work programs through cross-sectoral consultative processes and in coordination with other GCA programs:** This allows for a more programmatic approach to GCA intervention in each country. This also makes it possible to anticipate procurement plans and save time on recruitment.
- **Developing a roster of experts based on the different components of the TAP:** TAP interventions span multiple areas of expertise and having such a roster in place will save time in recruitment processes.
- **Strengthening partnerships with other readiness providers, with the GCF and the Adaptation Fund (AF) at the forefront:** GCA resources could be used as "seed money," allowing countries to quickly carry out initial studies needed to inform the design of funding proposals. In the same vein, GCA and these Funds could also collaborate on workshops to build the capacities of countries in the preparation of funding proposals. Finally, areas of collaboration could also encompass the piloting of the GCF's "Project-Specific Assessment Approach" (PSSA) once it is operationalized.

Implementing these recommendations should allow GCA to achieve the AAAP's objectives for the TAP program to leverage US$1.55 billion by 2025 through 15 adaptation and resilience projects and programs, with funding from public climate funds. It should also allow for getting six new DAEs accredited to the GCF and the AF, and two existing GCA DAEs having their accreditation standards upgraded.

Photo: European Union (photo by Anouk Delafortrie)/Flickr

SECTION 2—SECTORS

The Africa Adaptation Acceleration Program

The AAAP is Africa's response to the impacts of the climate crisis. This flagship program for Africa has been endorsed at the largest-ever gathering of African Heads of State and Government focused on adaptation. The AAAP delivers on the ground to support African countries for a faster, stronger post-COVID-19 economic recovery based on climate-resilient development pathways. Through AAAP, the AfDB and GCA are mobilizing US$25 billion by 2025 to accelerate adaptation action in Africa through interventions in four priority areas/ pillars: food security, resilient infrastructure, youth entrepreneurship and job creation, and innovative climate adaptation finance.

The AAAP is an Africa-owned and Africa-led response to the continent's expressed needs and priorities to reduce its vulnerabilities to climate change as well as harness the opportunities that result from climate change. The AAAP is the translation of the Africa Adaptation Initiative (AAI) into actual projects and programs on the ground. More than 30 African heads of state and other global leaders have rallied behind the AAAP, endorsing it as a key vehicle to operationalize the AAI's mandate. The AAAP builds on the priority areas identified by the countries in their NDCs and NAPs and accelerates momentum through large-scale proof-of-concept investments, innovations, and knowledge and technical assistance initiatives.

AAAP's Four Pillars and Results Achieved as of End-June 2022

The AAAP focuses on four main pillars, and, within them, on specific business lines derived from the NDCs, NAPs, and other national and regional climate change strategies, where action is most needed, and where investments in adaptation and resilience building can yield high dividends to achieve the Sustainable Development Goals (SDGs). The four key pillars and their business lines are:

- **Agriculture and Food Security:** with a goal to scale up access to climate-smart digital technologies, and associated data-driven agricultural and financial services, for at least 30 million farmers in Africa. The program also has the aim of supporting food security in 26 African countries and reducing malnutrition for at least 10 million people.
- **African Infrastructure Resilience Accelerator:** with a goal to scale up investment for climate-resilient urban and rural infrastructure in key sectors such as water, transport, energy, and waste management to help the continent close the infrastructure gap and achieve sustainable development in the face of climate change. The program aims to integrate climate resilience into about US$7 billion worth of infrastructure investments.
- **Empowering Youth for Entrepreneurship and Job Creation in Climate Adaptation and Resilience:** with a goal to support one million youth with entrepreneurship skills and job creation, and to ensure that millions of new jobs being created will support adaptation. The program supports developing skills and knowledge on adaptation, promoting equality and equal opportunities, building the entrepreneurial capacity of African youth, and facilitating access to funding and mentorship to youth-led businesses, half of which will be women-led, in the adaptation space.
- **Innovative Financial Initiatives for Africa:** with a goal to build the capacity of African countries to drive adaptation at a much greater scale by planning differently and accessing the key sources of adaptation finance. In addition, this AAAP pillar aims to support the design of innovative public and private financial instruments, ranging from resilience bonds and debt-for-resilience swaps to aggregation mechanisms for adaptation investment assets and monetization of adaptation benefits.

Since its launch in April 2021, the AAAP Upstream Financing Facility, managed by GCA, has enabled the mainstreaming of adaptation into investments worth over US$3 billion. GCA's interventions with the AfDB, World Bank, and other development partners are delivering high-yielding adaptation dividends and accelerating adaptation impacts through large-scale investments, innovations, knowledge, and technical assistance initiatives. The AAAP Upstream Financing Facility is aligned with the effective regional implementation of the new IMF Resilience and Sustainability Trust, the replenishment of the African Development Fund, and the leveraging of innovation and multi-stakeholder partnerships.

The AAAP Upstream Financing Facility

The technical assistance, policy advice, analytical work, and capacity-building work described in this chapter is supported by the AAAP Upstream Financing Facility housed in the GCA. This Upstream Financing Facility supports transformational adaptation shifts at the country level, the supporting research and monitoring for rapid extraction and replication of lessons, and the policy support to steer the economic directions at the national and regional level.

The AAAP Upstream Financing Facility aims to ensure with high confidence that all AAAP investments are as effective as possible and underpinned by the best data, science, and global practice on adaptation as managed by GCA teams. The GCA-administered Upstream Facility has an influencing funding leverage ratio of 1:100, meaning that every dollar invested in the Upstream Facility influences 100 dollars of resilient investments. In only 18 months of operation, the Facility has already helped prepare US$3 billion of AAAP investments. GCA is mobilizing US$250 million for this Facility over five years to bring the best global and local adaptation practice to every AAAP investment.

Future Plans for the AAAP

As GCA and partners gain experience through project implementation on the business lines, the intention is for GCA to evolve toward new challenges once partners mainstream the tools into their institutions and work programs. The AAAP aims to evolve constantly as African countries' priorities and financial needs are further refined. For example, under the Climate-Smart Digital Technologies for Agriculture and Food Security (CSDAT) pillar, the AAAP will continue to provide technical assistance to identify digital tools to support the mainstreaming of adaptation into investment projects of international financial institutions (IFIs) dealing with agriculture; use the experience gathered so far from ongoing projects to launch new project interventions and partnerships as may be appropriate in the Central and North Africa region; and initiate steps to expand

the range of IFIs by engaging in discussions on new projects with other IFIs and DFIs, such as the International Fund for Agricultural Development (IFAD) and the French Development Agency (AFD).

Under the African Infrastructure Resilience Accelerator pillar, the Infrastructure and NBS Program and the Urban and Water Programs will continue to provide technical assistance and capacity-building support to integrate climate adaptation and resilience into infrastructure projects across the African continent. Building on GCA's experiences in Ghana and Bangladesh, the national infrastructure risk and resilience assessments will be scaled up to other African countries, starting with Kenya and Senegal. These national programs will support the prioritization of adaptation investment options to be financed by implementation partners such as IFIs, development partners, and climate funds.

The City Adaptation Accelerator will continue to expand and, based on these learning opportunities, develop a set of tools and methodologies to support urban resilience building. Examples of these tools are: the Locally Led Adaptation Toolkit for Urban Informal Settlements, the Rapid Climate Risk Assessment, the investment prioritization tool, and the climate vulnerability assessment. A similar strategic framework will be developed for the Water Program.

The AAAP will work with MDBs to integrate adaptation and resilience, focusing on NBS, into downstream investment projects. The portfolio will be diversified to further include projects in transport and logistics, urban infrastructure services, infrastructure for agriculture services, renewable energy, and information and communications technology (ICT). This will include the development of innovative solutions in disruptive technologies for infrastructure solutions and in the structuring of NBS investment cases. Further, the Masterclasses on Climate-Resilient PPPs will be scaled up through local institutions to ensure sustainability and reach a wider audience over time while supporting capacity building for AAAP projects.

GCA is gradually expanding its partners, such as the AFD and other financiers, to influence and scale up the mainstreaming of climate adaptation. The AAAP will also have closer interaction with the GCA Research for Innovation team and, through them, with academia to bring the latest science and learning into the AAAP programs. GCA is also calling for partnerships through which the upstream activities of the AAAP will be delivered. This is targeted at African, not-for-profit institutions with an excellent track record of working in the field of Africa's climate change adaptation and resilience.

The AAAP has been set up to serve as a vehicle to mobilize US$25 billion of adaptation investments in Africa. Drawing from this practical experience, GCA will work with partners to scale up the model of AAAP to other regions in the world, including South Asia and Small Islands and Developing States. Also, through the Global Hub on Locally Led Adaptation, GCA seeks to work with institutions that have experience in successfully promoting and scaling up LLA.

Livestock

Livestock plays a crucial role in the economic and social life of Africa, supplying meat and milk for food and commerce, generating a large part of household incomes, fulfilling many functions, and occupying a range of niches within both pastoral and mixed crop-livestock systems. They are especially crucial to smallholder farming and therefore deserve a special focus when it comes to adaptation.

This chapter describes the importance of the livestock sector for Africa; presents the impact of climate change on livestock; presents some of the most promising technical interventions to strengthen adaptation and resilience in the livestock sector; and estimates the cost of adaptation inaction and action in livestock.

Challenges

Livestock accounts for around 55 percent of total household income in pastoral systems in Africa and 35 percent for mixed crop-livestock systems, where animals are also used for tasks like plowing. Rising temperatures, changing precipitation patterns, and an increase in extreme weather events mean there is an urgent need to develop adaptation measures for Africa's livestock farmers. Modeling studies suggest that under higher GHG emission scenarios, global cattle production losses from heat stress alone could amount to nearly US$40 billion per year by 2085—equivalent to 9.8 percent of the value of production of milk and meat from cattle in 2005. Under lower


Photo: 1001slide/iStock

emission scenarios, losses could amount to nearly US$15 billion.

Rising temperatures, changing patterns of precipitation, and an increase in extreme weather events mean there is an urgent need to develop adaptation measures for Africa's livestock farmers. This will not be achieved by a single strategy, but a combination of different interventions. These will include developing breeds that are better adapted to high temperatures, new disease threats and other challenges; matching stocking rates with pasture production; improving the quality of diet; and changing management practices.

The supply of livestock feed will need to adjust to a changing climate. As it is inherently adaptable, options do exist. The major macronutrients required by livestock can come from a range of sources and the feed industry is accustomed to adjusting based on the availability of different commodities. Changes in the climate will inevitably make such adjustments more commonplace in future. For example, shifts from maize to dryland crops such as sorghum and millet will lead to differences in the mix of crop residues available for livestock.

Recent advances in precise phenotyping, genotyping, and related molecular technologies have huge potential to improve the yield and nutritional quality of livestock feed, enhance disease resistance, and improve drought tolerance of forage species. Ongoing breeding efforts are already targeting resilience, and these will need to be intensified. For example, breeding programs will increasingly need to focus on drought tolerance.

Harvesting and managing rainwater can increase water availability and help to maintain feed and forage productivity during the dry season. Small-scale irrigation has enormous potential to smooth seasonal deficits in feed supply and increase overall feed availability in smallholder systems in tropical regions, provided such irrigation is managed sustainably.

The seasonal scarcity of feed supply already poses significant problems, particularly in tropical latitudes, and this is likely to intensify with the increasing incidence of drought and less certainty in growing seasons. To counter this, better feed conservation and storage methods are required, including better use of hay and silage. Creating denser feeds will facilitate storage and transport.

Feed production potential varies both temporally and spatially. It is influenced by agroecological conditions such as temperature and rainfall and this can lead to feed being abundant in geographic zones where livestock production is unimportant. Obvious solutions to this mismatch include the transportation of feed, and its storage for use in periods of scarcity. However, this can be challenging in places where there are poorly developed livestock feed value chains, a lack of business skills, and a lack of mechanization for processing feed. Interventions to enhance feed business development could significantly improve the resilience of livestock production systems to the effects of climate change.

The most direct impacts of climate change can affect the capacity of animals to ward off infection. For example, heat-stressed animals are less productive and have weakened immune systems, although this varies by breed and species. With severe heat stress, mortality can increase. Heat stress can also decrease reproductive capacity and milk yields. Simple interventions to keep animals cool include shelter from roofed sheds or trees; these can be easily incorporated into current mixed and extensive systems. The distribution of disease vectors and pathogens will change significantly with new precipitation patterns and temperatures.

Adaptation of livestock will require a combination of different interventions, some having to do with livestock themselves (breeding, pest management) and others about land management and the development of financial instruments to deal with climate risk.

Although livestock is a key component of mixed crop-livestock systems, most climate change adaptation work has focused solely on the crop side. There is little direct information on the cost of implementing large-scale livestock adaptation programs in Africa. The research base required for building climate-resilient livestock systems is underdeveloped and needs greater support.

A few adaptation actions of direct relevance to livestock systems include implementing early-warning systems (EWS) and adaptive safety nets for farmers in climate-risk hotspots and taking climate services to scale by connecting millions of farmers and agribusinesses to ICT-enabled bundled advisory services by 2030.

Recommendations

- Building climate-resilient livestock systems to cope with climate challenges requires concerted, coordinated action from investors and policymakers at the national and global levels. This will need to be informed by a solid research base that scientists have only started to assemble with the minimal funds allocated so far.
- Researchers need to develop a toolbox of effective adaptation practices, technologies and policies that are robust across different scales, priorities, and climate futures. They must also work with funders and governments to prioritize investments in the livestock sector. It is not just technical inputs that are needed, but institutional change in the way that livestock is viewed by funders and governments. This will require a considerable evidence base. And this evidence and technical support are also needed to enhance monitoring and reporting for national, regional, and continental planning.
- Build capacity at national levels to understand how to prioritize interventions for the livestock sector across development and climate change planning.

- Develop policy to allow livestock development strategies that support rural development and contribute to a restoration economy, including the development of national policies and mechanisms to allow for carbon credit trading and benefit sharing for communities that implement rangeland restoration practices.
- Design and update national and subnational animal feed strategic plans and strategic feed reserves; support predictive livestock EWS and early warning-early action approaches, including for disease; establish feed inventories and feed stores; and promote the establishment of intercommunity landscape grazing plans and natural resource management plans at community and farmer level.

Innovation in Agriculture

More than 60 percent of people in Sub-Saharan Africa are smallholder farmers, and nearly a quarter of Africa's GDP comes from agriculture. Climate-smart agriculture is an integrated approach to managing landscapes, including cropland, livestock, forests, and fisheries, that addresses the interlinked challenges of food security and climate change. Agriculture and land-use changes contribute 25 percent of heat-trapping GHG emissions. Without interventions, this number will likely increase. However, agriculture can also be part of the solution to climate change, with the potential to offset and sequester about 20 percent of annual emissions through improvements in soil management.


Photo: 2016CIAT/Georgina Smith/Flickr

While the Green Revolution had positive impacts on food security, there were uneven outcomes for human nutrition, crop resilience, and the environment. As a consequence of the focus on staple grains and the adoption of expanded irrigation, the major benefits were in Asia, while Sub-Saharan Africa received fewer investments, particularly in orphan crops.

Challenges

The combination of changing consumer needs and demands coupled with climate and environmental challenges is accelerating the transition to a new way of thinking about agriculture. Meeting these needs and challenges will require a whole-system approach, involving the sustainable intensification of agriculture to increase productivity while minimizing environmental impacts through increased resource-use efficiency.

Advances in breeding technologies and tool development are allowing improvements for multiple traits in the context of overall crop productivity. The extension of these tools to underserved crops that are climate-resilient will be key to meeting future climate adaptation goals.

The wealth of genetic diversity available in public germplasm repositories, including CGIAR genebanks, can provide the basis for improving existing crops, as well as developing new crops, to meet specific and local climate adaptation needs. This will allow a move away from reliance on a few intensively farmed grain crops for food security to a broader collection of climate-resilient crops that includes a greater representation of legumes for smallholder farmers.

Livestock is an important component of any climate-resilient agricultural strategy, accounting for 40 percent of the global value of agricultural output and directly supporting the livelihoods and nutritional security of 1.3 billion people. More than 500 million pastoralists worldwide depend on livestock as a means of income, food security, and asset storage.

These pastoralists are among the most vulnerable to climate change. Conversely, the livestock sector emits an estimated 7.1 gigatons of CO_2-equivalent per year, representing 14.5 percent of human-induced GHG emissions. Improving the efficiency and resilience of livestock supply chains is key to both limiting the growth of GHG emissions and protecting the food security and livelihoods for billions.

Many strategies exist to both minimize the climate impact of livestock and to improve climate adaptation of the livestock sector. Enteric methane produced by livestock is a significant source of GHG emissions. Work to mitigate the sector's emissions is under way through the development of technological solutions, developments in feed additives, and genetic efforts to develop lower methane-producing livestock breeds. Meanwhile, livestock animals are particularly at risk from pests and diseases whose ranges are expanding with climate change. Advances in vector control, vaccines and antimicrobials, and veterinary epidemiological monitoring systems are all under way to help mitigate these emerging threats.

Photo: U.S. Air Force (photo by Senior Airman Kaitlyn Johnson)/Flickr

Capacity building for climate-smart agricultural practices will require incentives and innovative finance mechanisms to lower the upfront cost barriers to adopting new practices and minimize the risk exposure—real and perceived—of smallholders as they adopt new production systems.

Recommendations

Capacity improvements are needed across the whole agricultural value chain if the challenges of climate change are to be met. However, there are some key intervention points that could have immediate impacts on existing strategies:

- Advances in breeding technologies and tool development are allowing improvements for multiple traits in the context of overall crop productivity. The availability of these tools needs to be expanded to underserved crops that are climate-resilient, including the diverse germplasm available in public genebanks.
- A major barrier to expanding digital agriculture is the lack of investment in rural agricultural infrastructure as well as insufficient investment in research and development, agro-innovation (for example, in sensor development) and agricultural entrepreneurship. Expansion of broadband internet availability is needed to support data collection, forecasting, and dissemination of real-time information.
- Filling in gaps in digital data for areas like soils will be important for farmers to be able to access more precise forecasts and solutions to potential climate-related challenges.
- Bundling of digital services is needed so that farmers can receive information as well as possible courses of action, from sources of seed to fertilizers, and funding.
- Improved networking is needed for stakeholders on the research side with downstream users, from extension agents to farmers. As climate-related challenges intensify, the existing tools will need to be adapted and improved to include the information that farmers need to make decisions about what to plant, when to plant it, and what inputs will be needed.
- There is a need for regional networks of scientists such as plant breeders to share knowledge, tools, and equipment, as well as innovative approaches for sharing resources.

- Innovations in energy services to farms are an integral part of adaptation, as energy access sustains the productivity of farmers and herders and serves many other adaptation areas.
- Increased alignment of different sectors on policy, financing, and strategy will be essential to successful implementation of climate-smart agriculture strategies to ensure the resilience of and sustainability of agricultural systems as the impacts of climate change increase.

Incentives will be needed to promote adoption of new climate-resilient strategies. Fostering an enabling environment for the update of these strategies will prove to be a critical step, with a conscious effort needed to link climate-resilient policies, science, and food security within national agricultural implementation schemes.

Effective capacity building will also require a focused gender lens. Women account for about half of the world's smallholder farmers and grow 70 percent of Africa's food. As they are the majority food producers on the continent, research and innovation must keep women as the primary target audience. Any mechanism designed to improve capacity through climate-resilience practices and investments or through the wider enabling environment must prioritize their needs and preferences. Implementation efforts, likewise, must ensure gender-equitable access to new technologies and products to avoid exacerbating gender-based inequalities.

Innovative finance mechanisms are another area for innovation to help farmers and businesses adopt climate-smart practices and technologies. Often the upfront costs, real and perceived, of new practices can prove a roadblock to adoption and implementation while risk mitigation remains a major concern both for businesses and farmers. Finance mechanisms, like innovative insurance or credit programs, that build onto existing financing arrangements with producers will aid in end-user adoption of climate-smart practices and tools.

Advisory services play a critical role in educating farmers and producers on use and adaptation of new technologies. As such, expanded capacity is needed among climate-smart advisory services as a key intervention to help farmers in their transition to more resilient practices and systems. Effective capacity building among climate-smart advisory services in turn allows for the effective distribution of the climate-smart practices and technologies discussed above and is a requisite step in ensuring effective uptake of these innovations and practices by end users.

However, it is important to emphasize that incentives, capacity building, finance, and advisory services may not be sufficient. Numerous programs have failed despite being motivated by good intentions to bring innovative technologies to farmers and herders. It is fundamental to understand preferences, co-create solutions with users, and utilize behavioral science to increase the chances for success in the use at scale of these innovations.

Urban Informality

Sub-Saharan Africa is both the poorest region in the world and the one that is urbanizing most rapidly. Yet Africa's rapid urbanization at low levels of national income, combined with insufficient structural transformation, has also brought major challenges.

This chapter addresses these challenges at the intersection between informality in housing and employment, and climate change adaptation. Following a brief review of the economic and political forces perpetuating the informal city, the chapter presents a discussion of the threats that advancing climate change poses for communities of people living and working informally. A framework is articulated that illustrates the links between climate change threats and informality while also delineating the necessary interventions to address these threats. In doing so, the framework emphasizes that political economy (dis)incentives and limited state capacity impede countries in moving from statements of intent to implementing new policies that would create a more equitable and sustainable city for all. The framework is illustrated with a case study of Accra, Ghana, which epitomizes the challenges of many of the region's urban agglomerations struggling to manage informality and climate change.

Challenges

While informality in employment and informality in housing have different causes and consequences, they are interlinked phenomena with a similar underlying origin: low income. Typically, they operate with little organization and on a small scale. Earnings depend on income after costs of production; they

are commonly called "nonwage earnings" or gross profits. In Africa today, about 65 percent of total employment is in the informal sector.

Most African countries are in transition from a mostly informal to a mostly formal economy, but at a disappointing pace. Importantly, Africa's urbanization is not following the historical pattern of today's higher-income countries, where industrialization and the creation of larger formal firms in urban areas fueled urbanization by increasing demand for labor, pulling the working-age population from rural areas and towns into emerging cities.

Most African countries have not been able to match the share of employment or value addition from formal firms that today's high-income countries had at African levels of urbanization. As a result, new wage jobs are not yet employing the majority of the labor force in African cities. The reasons for the African pattern are complex, and include both the natural resource curse, which induces industrialization but does not create formal jobs outside the private sector; and globalization and technology, which make it harder for late industrializers to develop a job-creating manufacturing sector. As a result, both migrants from other parts of the country to Africa's larger cities as well as urban natives are forced to create their own employment by starting a business in the informal sector. Regardless of which factors dominate in a particular context, the important point is that the informal sector is not likely to disappear soon.

A critical factor reducing the supply of informal housing in African cities is a lack of clear and uniform property rights and a well-functioning land market with low transaction costs. Insecurity of tenure, especially in slums that started out as squatter settlements, usually precludes the provision of public urban services such as utilities, garbage pick-up, roads, and even safety. Either the formal legal system or the policies of public utilities may prohibit service provision. But even if a slum is a legal development of an indigenous community, it is often unfeasible for public utilities to provide services because roads and pathways within a slum are not wide enough or suitable for utility infrastructure.

Photo: Moehring/Shutterstock

Our research highlights the need for transformational change within urban areas to meet the coming climate challenges, and to avoid locking in unsustainable practices. In cities such as Accra, with overlapping mandates for action but weak accountability structures, envisaging the planning, financing, and implementation process for transformational change is difficult. Some climate adaptation plans, such as Accra's Resilience Strategy, do articulate objectives and intentions toward the transformational, and recognize the needs and rights of the informal city. But actual transformational change in the current political and economic environment, where informality is often seen as being undesirable and/or illegal, the value of the land where informality takes place continues to rise fueling land contestations, and alternatives to informality are mostly not available, seems improbable. And, if a transformative process does start, it seems unlikely to be inclusive of the needs of the informal city. A deteriorating fiscal environment in African countries such as Ghana limits financing for needed public investments in urban services, further constraining implementation of NAPs.

Local governments within the Greater Accra Metropolitan Area (GAMA) are closer to their citizens' needs. The entities have been assigned many of the responsibilities for the planning, project development, and implementation that effective adaptation strategies involve. Yet these entities have neither the funds nor the capacity to undertake these responsibilities. Thus, plans and frameworks articulated by the national or regional government mostly represent unachievable intentions. This problem is replicated in other African cities, with variations dependent on the degree of decentralization of power and money.

It may be that the most inclusive approaches in the short to medium term will involve minor, low-cost, *in situ* adaptation investments, and increased coping measures. As the example of Accra shows, simply advancing proactive climate change–induced disaster planning could benefit city residents living in communities of informal housing who work on the street or at home. Partnerships between a leading national ministry, the GAMA regional coordinating administration, the Accra Metropolitan Assembly (AMA), and community groups for the purpose of effective disaster management could produce results if they were focused on a limited set of coping outcomes.

Actually recognizing land rights in slums and the right of the informal sector to occupy urban spaces in order to work would itself be transformational, even if it is only step one on a long path toward adaptation. The problem for African cities, especially ones such as Accra and Nairobi, where land rights are highly contested, is that the time clock on climate change is advancing, not slowing. The cost of the current inertia is therefore rising.

City Resilience

Underpinning all climate adaptation solutions—from climate-adaptive planning and infrastructure investment to service delivery, community development, land management, and NBS is a solid sense of the current climate risk context. Cities, especially, are where this downscaled knowledge is needed to inform the prioritization, design, implementation and operations and maintenance (O&M) of localized action.

While climate risks and vulnerabilities abound in African cities, there nevertheless remains a unique opportunity to get things right, as much of Sub-Saharan Africa (approximately 40 percent) remains in the early stages of urbanization. Understanding the climate risk of current and future development through climate-risk assessments can provide the basis for identifying, prioritizing, and implementing low-cost actions that can prevent locking in errors made by other highly urbanized regions of the world. Thankfully, working toward resilience is not cost-prohibitive. Some estimates suggest designing more resilient assets in the energy, water and sanitation, and transportation sectors in low- and middle-income countries would amount to an additional 3 percent in costs.

It is in this context that GCA has developed and implemented its Rapid Climate Risk Assessment (RCRA) methodology, in response to the strong need and demand in Africa's rapidly urbanizing cities. An RCRA for a city gathers key information on climate hazard and risk, the development context, infrastructure bottlenecks, past and current initiatives as well as relevant policies and institutions. To keep costs down and to better ensure time efficiency, the approach relies heavily on globally available free data.

Summary of Resilience Assessments in Five Cities

In its first round, GCA has implemented RCRAs in (a) Antananarivo, Madagascar; (b) Bizerte, Tunisia; (c) Conakry, Guinea; (d) Dodoma, Tanzania; and (e) Libreville, Gabon. The most noteworthy findings from each city resilience assessment, with key takeaways, are summarized in Table 1.

Table 1. Summary Comparison Table of Five African Cities

Factors	Antananarivo	Bizerte	Conakry	Dodoma	Libreville
Population	~3–4 million inhabitants	~150,000 inhabitants	~1.6 million inhabitants	~580,000 inhabitants	~850,000 inhabitants
Key Attributes	Capital city; swampy plain bordered by hillsides	Secondary city; coastal city with extensive shoreline	Capital city; coastal city situated on low-lying wetland peninsula	Capital city; low density; semi-arid plain with highly impermeable soils	Capital city; coastal hilly city with developments in marshy valleys
Informal Sector	~70%	Unknown	~67%	~67%	~80%
Key Hazards	Floods; landslides; increasingly frequent droughts and cyclones	Floods; sea-level rise; coastal erosion; wildfire; drought; water scarcity and salination; extreme heat	Floods; sea-level rise; coastal erosion; cyclones; water scarcity	Extreme heat; drought; water scarcity; floods	Extreme rainfall; floods; sea-level rise and coastal erosion
Key Risks	Displacement and loss of lives; food insecurity; damages to buildings and infrastructure; negative health; increased rural-to-urban migration	Loss of economic assets and activity (e.g. beaches and tourism, fishing); damage to buildings and infrastructure; adverse health outcomes	Loss of economic assets (e.g. land, beaches); increased water scarcity; destruction of ecosystems and fisheries; adverse health outcomes	Loss of agricultural productivity, soil fertility and incomes; increased waterborne disease; adverse health outcomes; food shortages	Damage to infrastructure; displacement; post-flood disease; adverse health outcomes
No-regrets Measures Identified	Strengthening adaptive capacity; disaster evacuation planning; climate-resilient water and sanitation infrastructure; nature-based flood risk reduction	Stormwater drainage management; rainwater-harvesting; resilient urban planning; resilient mobility; sustainable forest management	Climate-resilient urban and land-use planning; nature-based solutions; stormwater drainage management; improved sewerage and solid waste management; water management; coastal protection	Climate-resilient farming and water management; improved solid waste management; urban greening; climate-resilient infrastructure; flood defenses	Flood prevention; improved solid waste management; climate-resilient water and sanitation infrastructure; urban greening
Institutional Mandates for Climate Adaptation	Strong	Medium	Limited	Medium	Limited

Recommendations

- **Recognize the value of qualitative data.** RCRAs found that generating any kind of data (even qualitative) is better than no data at all. Using an RCRA opportunity to ask consultants/firms to gather as much qualitative data as possible can be useful to help provide more context to inform existing and future quantitative work. The efficiency resulting in doing a desk review further ensures that future analytical work builds on what is already there. Thus, dedicating time to mapping the literature can prove a huge efficiency gain, and should be commended for its contribution in itself. Often, the information resulting from an RCRA is sufficient to begin project scoping within a city, whereby challenges are identified that can

be further investigated during project identification and prioritization. By mapping the gaps and prioritizing need, future, more in-depth engagement can be better tailored, based upon strategic need. This can be pursued in a future, more in-depth, focused and strategic climate-risk assessment.

- **Consult and bring on board entities that have public investment decision-making power, early in the process.** This ensures that the needs, incentives, and challenges faced in infrastructure investment can be better reflected in an RCRA meant to inform actual investment. Getting the buy-in of investment-able entities further helps ensure findings from RCRAs continue onto more long-term outcomes.
- **Conducting RCRAs where there is strong local government appetite for investment can be a critical enabling factor for a well-informed assessment.** The success of an RCRA process is often best enabled when there is a strong local champion, who can help in framing the local context as well as making the time within their already full work program to secure the contacts and clearances needed to secure information and data. This is often the case when the local municipality in itself is interested in seeking climate adaptation investment. Even during the process of procuring consultant services, GCA can begin discussion with local municipal counterparts about data requirements, so that the process of securing data is more advanced by the time the consultant is contracted. Often data can be made available for free, provided that there is enough notice. A strong local champion within the municipality can also help in the generation of data.
- **Informality represents a significant portion of urban economies in the developing world and must be understood if climate adaptation activities are to be effective.** Experience from the RCRA process has demonstrated the importance of identifying a socially focused focal point early in the process (e.g. a university, researcher, NGO, social development organization, local knowledge institute) that can be useful in answering questions pertaining to informality or making the contacts needed to gain this perspective. A semi-structured interview with a well-informed set of socially focused counterparts can serve as a critical input to an RCRA—to at the least get a finger on the pulse of critical items to consider when mapping hazard and risk (and their potential effects and impacts on the informal economy).
- **Dedicate time and space for reflective learning and experience exchange:** Taking a dialogue and learning approach can increase connectivity of the city actors to fit the new climate realities. The connections do not necessarily need to be solid or formal, but climate adaptation works across sectors and line budgets, and coordination and collaboration are needed to pool resources and efforts. For example, many of the recommended no-regret measures (e.g. cleaning up drainage from improved waste management) are part of existing measures in a city, and often not traditionally identified as climate adaptation; the RCRAs provide an important opportunity for providing an additional rationale to prioritize these actions on the urban agenda, as they contribute to resilience. As such, the RCRAs can provide a mandate for increased coordination and dialogue across sectors, benefiting existing actions on the sustainable development agenda such as climate-adaptive waste management.

Moving forward, the GCA RCRA methodology has been further fine-tuned based upon implementation experience shared by both the supervision team and firms. These changes will be reflected in the implementation of GCA RCRA methodology in a second batch of African cities.

Nature-based Solutions in Agroforestry

This chapter reviews a particularly important category of NBS for Africa: agroforestry. It presents a deep dive into agroforestry as NBS in Africa, with a specific review of lessons learned from programs that did not achieve their full potential. It also proposes institutional and policy changes needed to make agroforestry an effective solution to climate adaptation and multiple other benefits.

NBS are being applied widely across Africa including in water security, human health, livelihoods, disaster risk reduction and climate change mitigation and adaptation. They are a core component of the AAAP, the Green Cities Initiative, and the West Africa Coastal Areas Management Program (WACA). There is a huge potential for NBS in Africa. NBS are best planned at a landscape scale and designed to meet critical needs both now and under future climates. NBS also tend to create job opportunities

Photo: P. Kimeli (CCAFS)/Flickr

for local people and encourage local ownership of the outcomes.

NBS can be combined with "hard" interventions such as re-contouring landscapes or canal construction to assist in managing water flow (these are often called green-grey solutions). The important point is not to jump immediately to an engineered solution to the problem, but to integrate both green and grey solutions from the outset, while also looking more widely at actions that will provide additional benefits to communities and help maintain biodiverse and healthy ecosystems.

Agroforestry, a land management practice where trees are grown around or among crops, pastureland or homes to provide shade, shelter, fertilizer, fuel, food, fodder and other products, is an important NBS that fits well with African farming systems, skills and livelihoods. Many have simply called for more agroforestry and the planting of more trees. But agroforestry solutions must be carefully tailored to location, to existing livelihoods, community skills and priorities, and to local markets.

Despite lamentably poor financial support African scientists are tackling questions of finding the best solutions—site selection, farming system, species selection, etc.—but there is a need to blend this knowledge with that of communities to find solutions that fit the physical location and the communities' priorities. This requires a true co-production of solutions. This will require new modes of continuous learning, better mechanisms for financing multiple agroforestry projects, and possibly re-creating forms of governance based on traditional multilayered structures rather than the currently dominant top-down structures. Many smallholders will also need external knowledge and financial support to make the transition from their current practices and turn to or retain cropping systems integrated with natural resources.

It is essential to continue building the case for NBS as a critical adaptation measure, to set goals, and to seek financial support. However, it is equally important to mobilize the necessary support to identify which actions are cost-effective and most beneficial for both the farmers engaging in NBS and the ecosystems on which they are based. There are many examples of poorly designed efforts that are likely to undermine the goals of development, biodiversity maintenance, mitigation and adaptation.

Each type of project (agroforestry, catchment protection, barriers to desertification, or cooling villages and even cities) and each region will need to ask local questions of how to match an NBS with the needs and skills of local communities, as also questions such as where to establish agroforestry and where to conserve or regenerate forests, and what type of plantings and with which species. To answer these questions traditional and local knowledge must be brought together with wider scientific knowledge in a true co-production of workable solutions.

Blue Economy

The Blue Economy of coastal countries in Africa is critical for their development. The potential of sustainable and integrated management of coastal and marine resources can be immense in areas such as job creation, poverty elimination, and prosperous coastal urban and rural development. The Blue Economy includes critical sectors such as tourism and fisheries, and holds enormous potential for future sectors such as blue energy, ocean mining, and blue carbon. According to the African Union, the Blue Economy of the continent generates nearly US$300 billion and supports 49 million jobs.

However, Africa's Blue Economy is currently facing enormous challenges, from overexploitation of fisheries to coastal erosion. The pollution and the loss of coastal and marine biodiversity are putting substantial pressure on economic sectors that depend on a healthy environment. This chapter reviews the climate risks to the African Blue Economies, the status of Blue Economy strategic development in African countries, and adaptation measures necessary for the sustainable development of African Blue Economies.

Institutional Development of Africa's Blue Economies

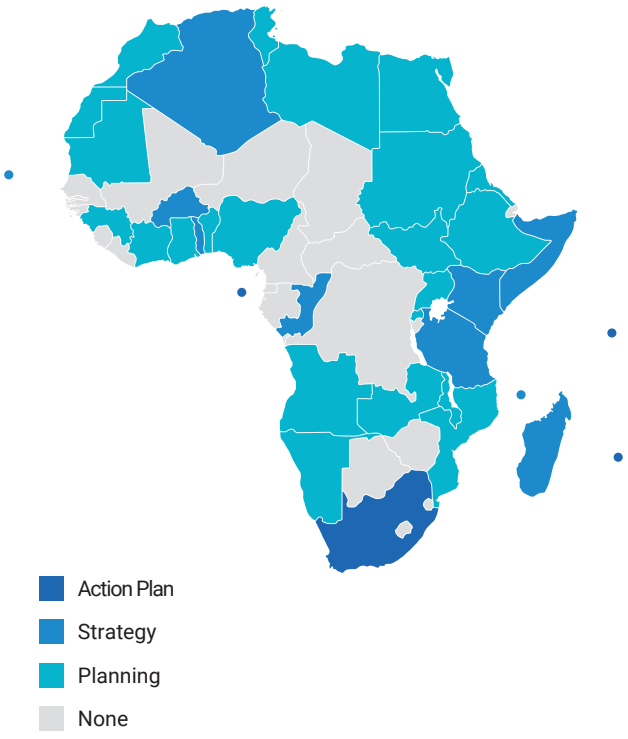
For this chapter, the status of institutional development of Blue Economies in Africa was analyzed. The analysis showed that 10 coastal countries have no strategic or policy documents guiding their blue economies. An additional 16 countries have indicated that they intend in the future some form of Blue Economy planning or policies. This means that, in total, 26 of the coastal countries, or about two-thirds, have no formal strategies or policies on their Blue Economies. Eight countries have drafted and published official Blue Economy strategies, and only four additional countries have drafted action plans for their strategies. No African

Photo: Salvador Aznar/iStock

country has a holistic Blue Economy policy passed into law, with regulatory tools for Blue Economy development over the long-term future.

The assessment also shows that the island nations of Seychelles and Mauritius are the most advanced in their institutional approach to the Blue Economy, given the significant role in the overall economy. Both nations have an active Blue Economy coordinating unit (the Ministry of Fisheries and Blue Economy in the Seychelles, and the Ministry of Blue Economy, Marine Resources, Fisheries and Shipping in Mauritius). Few countries in Africa have put systems in place for blue financing, the most developed of which is the Seychelles.

Figure 10. Institutional Status of the Blue Economy in Coastal African countries as of June 2022



Source: Authors

However, regional and overseas bodies have played a notable role in supporting Blue Economy development across the continent. The United Nations Economic Commission for Africa (UNECA) was instrumental in the drafting of the Blue Economy strategies and action plans of several African states.

Furthermore, it has pioneered the construction and application of the Blue Economy Valuation Toolkit in African countries. The African Union has developed and promoted a Blue Governance Framework for the implementation of the African Blue Economy Strategy. Several African Regional Economic Communities (RECs) have drafted Blue Economy strategies. As the natural resources critical to blue economies (e.g. river deltas, large marine ecosystems, and fish stocks) are often shared by several countries, RECs have a unique opportunity to contribute to shared resource management and encourage such management to follow sustainable Blue Economy principles.

Adaptation in Blue Economy Policies

The most important approaches to enhance adaptation of Blue Economies include climate-informed coastal and marine spatial planning (MSP); protection of marine and coastal ecosystems; and rehabilitation and restoration of marine and coastal areas.

For the 12 African coastal countries that are implementing Blue Economy strategies or action plans, two (Mauritius and Seychelles) recognize the severity of climate change and have practical activities for adaptation. Four countries (Algeria, São Tomé and Príncipe, Somalia, and Togo) have some planning for adaptation responses included in their Blue Economy action plan or strategy. Four countries (Comoros, the DRC, Madagascar, and Tanzania) recognize the threats of climate change and the need to respond accordingly but have little to no planning or activities in place to do so.

When looking at NDCs, there is a general tendency of these documents to focus more on land-based spatial planning than marine planning, despite most countries recognizing the potential devastating impacts that ocean-related climate change impacts could have on the environment and people.

In sum, Blue Economy development varies considerably across Africa. There are however countries with excellent progress toward climate-smart Blue Economies that include drafting and implementation of strategies and action plans in areas such as spatial planning and MSP; protection of marine and coastal habitats; restoration, NBS and ecological engineering.

Photo: Africanway/iStock

Coastal Erosion

Coastal erosion is the result of several processes that occur naturally, typically driven by the combined action of waves, currents, wind, tides, and mass wasting processes. As a result, some sections of the coast are gaining land (accreting), while others are losing land (eroding). Coastal erosion is exacerbated by the effects of anthropogenic climate change, namely sea-level rise and an increase of waves and extreme events. It is also harshly impacted by human activities such as sand mining, development of coastal infrastructure, inland river damming, and mangrove removal, all of which can significantly alter natural processes.

This chapter focuses on adaptation to coastal erosion in two regions of the African continent: West Africa and North Africa. These regions, specifically from Mauritania to Gabon in West Africa and the Maghreb in North Africa, were selected since they are experiencing most of the coastal area changes adjacent to seaports observed in the continent. It presents a deep dive for the two focus regions, including the state of the coast and intervention examples.

Challenges

Coastal erosion rates on the West and North African coast are among the fastest in the world. Africa's coastal zones are highly vulnerable to these changes because of the presence of extensive and densely populated low-lying deltas with poor planning, limited levels of protection, and minimal EWS.

In West Africa and North Africa, anthropogenic pressures are the main drivers of coastal erosion, primarily due to the presence of large ports and river dams. Africa's ports are tremendously important as drivers of Africa's economic growth, but their activities could negatively impact Africa's coast and ecosystems if appropriate care is not taken. Many African deep-water ports were built without sufficient considerations of the potential impacts to adjacent communities and ecosystems. The lack of adaptation over the years has resulted in creating significant hazards for people, the built environment, and infrastructure, and the natural environment.

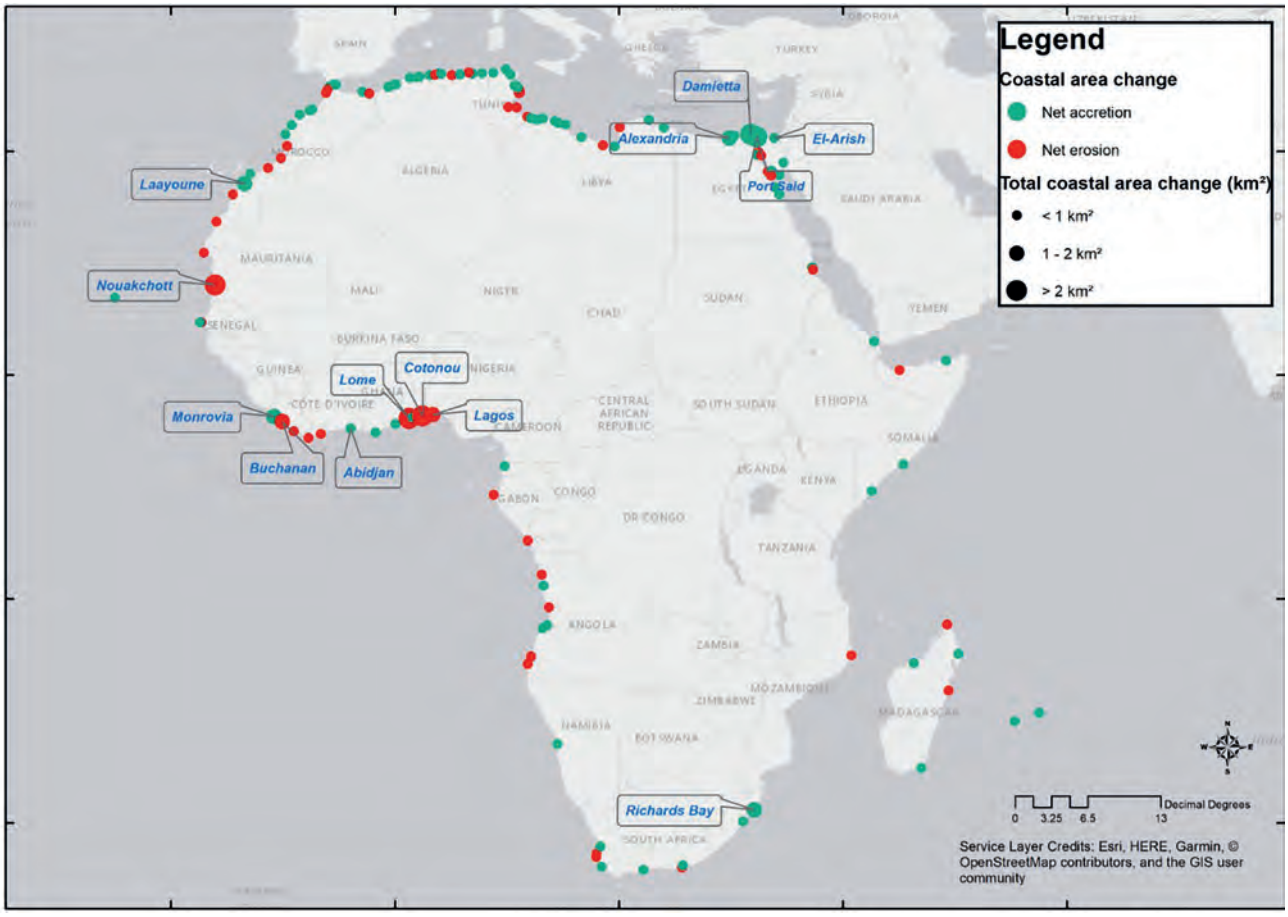
At least 13 large ports in Africa are characterized by severe erosion on beaches adjacent to them. Most of these ports are in the West and North Africa region, located in open coastlines with significant alongshore sediment transport, and represent the top 10 percent hotspot ports in Africa, in terms of gross historic coastal area changes.

Of these, the most significant example is certainly the port of Nouakchott, in Mauritania, which over the course of the last 30 years has experienced extensive beach erosion downdrift of the port, in the order of 20 meters per year.

The presence of large river-transversal barriers, such as dams, also play an important role in coastal erosion as they block fluvial sediment transport and lead to coastal sediment deficit and shoreline recessions. Due to the interconnectedness of river mouths and deltas to upstream river basins, variability of sediment supply caused by its interception by dams can result in coastal sediment deficits on the coast. Such sediment deficits resulting from dam construction have been observed in the Nile Delta, the Yangtze Delta, the Mekong Delta, and the Ebro and other Mediterranean deltas. This issue is significant for Africa, especially considering that several large dams were built across the continent in recent years, all with limited or nonexistent plans to manage sediment transport, and that numerous new ones are planned in the coming years.

Without major planning and climate adaptation efforts, more catastrophic impacts to people, infrastructure, and the environment are expected along most of Africa's low-lying coast. It is therefore critical to implement efficient but inexpensive solutions, starting with no-regrets measures like NBS, and thereby set the basis for further adaptation efforts.

Figure 11. Geographical Overview of the Gross Coastal Area Changes adjacent to 130 African Seaports



Note: The size of the dots represents the gross beach area change. The colors represent whether this change is dominated by accretion (green) or erosion (red).

Source: de Boer et al. (2019)

Recommendations

- **Multi-stakeholder cooperation is required to overcome institutional and governance barriers,** as well as to accelerate the mobilization of finance and the implementation of solutions implementation. Joint public and private initiatives related to transboundary sustainable and resilient coastal management, such as the World Bank's WACA, must be expanded upon and supported. Participatory legal and institutional reforms are to be implemented to ensure transboundary Integrated Coastal Zone Management (ICZM) schemes can be prepared, and identified solutions executed.
- **Improve access to data.** To effectively address the problem of coastal erosion, the problem itself must be understood in all its complexity. Access to data must be improved so that erosion hotspots can be clearly identified and studied. The use of communities' local knowledge, interdisciplinary scientific studies and technicians' operational know-how is also recommended, as it promotes the acceptability, efficiency and sustainability of management solutions envisaged.
- **Promote holistic and multisectoral investments that support a green, resilient, and inclusive development, and the use of NBS on land and sea.** Countries affected by coastal erosion can increase the natural protection provided by coastal vegetation cover and ecosystems through planting or restoring mangroves, dunes, seagrass fields, coral reefs, wetlands and other natural vegetation and ecosystems in coastal zones. These NBS are not only cost-effective options that can help address coastal erosion and other forms of coastal degradation, but they can also be used to boost the health of coastal and marine ecosystems and their performance. If suitably planned, NBS can enhance the provisioning to coastal communities, including food, fuel, timber, and other material provisioning, and support ecosystem services like carbon sequestration, climate regulation, water purification, and biodiversity.
- **Address the problem of coastal sediment deficit because of dams.** The damming of rivers often has the unintended consequence of reducing sediment fluxes to the coast. One option to restore the sediment transport deficit is to alter dams to reduce the amount of sediment that they trap, or to completely remove redundant dams or in-river structures altogether. For this, it is necessary to better assess the volume of sediment trapped behind existing and planned dams and the opportunities of effective sediment management to support coastal protection. This transboundary information, which should be included in the ICZM schemes, should be joined with institutional and financial reforms to encourage relevant stakeholders to take actions to directly restore sediment budget deficits and promote beach accretion.
- **Adopt a flexible approach during policy and program implementation.** It is necessary to adopt a flexible approach to ensure management plan objectives can be re-evaluated and activities adjusted according to the evolution of the risk environment. Some options could include a combination of short-term effectiveness, for example protecting infrastructures with a dike, with long-term effectiveness, such as the relocation of the infrastructure.

Photo: Sylvain Cherkaoui/Panos Pictures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SECTION 3—CROSS-SECTORAL THEMES

Locally Led Adaptation

LLA is being widely recognized as an effective, efficient and equitable paradigm of delivering adaptation action. This approach to adaptation is about ensuring that local people have individual and collective agency over defining, prioritizing, designing, monitoring and evaluating adaptation actions. LLA ensures that mechanisms for managing risks are aligned with local contexts, embedded within local institutions, deliver a high return on investment, and result in outcomes that are more equitable than "business as usual" approaches.

For Sub-Saharan African countries, where over 60 percent of the population are smallholder farmers and where over 55 percent of the urban population live in informal settlements, LLA holds the promise of unlocking variegated responses to highly localized risks in contexts marked by deficits in formal governance machinery. This chapter highlights the growing momentum toward LLA in Africa. It outlines the rationale for LLA and explains how LLA has been operationalized through different financial delivery mechanisms in Africa. It presents the enabling conditions for LLA, along with notable LLA case studies from across the African continent, before discussing some of the challenges faced in scaling up LLA in Africa. It concludes with lessons for governments, funders and civil society on how they can scale up LLA in Africa.

Over 80 entities spanning international organizations, national governments, multilateral organizations, bilateral institutions, non-governmental organizations, climate funds, private-sector companies and social enterprises have now formally endorsed the Principles for Locally Led Adaptation and committed to operationalizing them in different ways. The LLA Principles are outlined in Table 2.

Table 2. Principles for Locally Led Adaptation

Principle 1: **Devolving decision-making to the lowest appropriate level** ensures that those most affected by climate change have agency over decisions about adaptation finance and programming that will affect them.
Principle 2: **Addressing structural inequalities faced by women, youth, children, people with disabilities, people who are displaced, Indigenous Peoples, and marginalized ethnic groups** entails actively recognizing and redressing the power dynamics, imbalances, and development deficits that create vulnerability, poverty, and marginalization.
Principle 3: **Providing patient and predictable funding that can be accessed more easily** requires that funding mechanisms be simplified, and finance provided over longer, more predictable timescales to enable greater access to funding by local actors, support adaptive management and learning, and adequately strengthen local institutions.
Principle 4: **Investing in local institutions to leave institutional legacies** means building and strengthening local institutions by building capacity to understand climate risks and uncertainties, capacity to generate resilience solutions, capacity to facilitate and manage adaptation initiatives, and capacity for local fiduciary responsibility and management so that these institutions can provide grants and loans to other local actors for local adaptation actions.
Principle 5: **Building a robust understanding of climate risk and uncertainty** supports locally led adaptation by ensuring that interventions reflect understanding of local climate risks, current resilience-building practices, and uncertainties about direct and indirect climate impacts on local communities, as well as provide access to appropriate tools to handle uncertainties.
Principle 6: **Flexible programming and learning** recognizes that it is important to maintain budget and programmatic flexibility as well as space for adaptive management and learning.
Principle 7: **Ensuring transparency and accountability** requires that decision-making and governance structures are made explicit, so it is clear which decisions are made at what level of the organization and by whom. It also should be ensured that financing flows are made transparent and can be publicly tracked, and ultimate accountability should be to local actors themselves.
Principle 8: **Coordinated action and investment** by donors, aid agencies, and governments recognizes the need for multiple levels of coordination, horizontally among communities and across sectors and vertically across levels of government and policy processes.

Challenges

There are several options for deploying LLA on the ground. Broadly, in countries with mature state machinery, strong democratic institutions and institutional structures for devolution, LLA might be best supported by government-led national financing mechanisms, whereas mechanisms that rely on civil society organizations or constituent-based organizations might be more appropriate in fragile contexts.

Transitioning to this mode of adaptation action requires an enabling environment with a few key components. There is a need for capacity building, as local actors often may not have a complete appreciation of the full spectrum of climate risk and can struggle to access, manage and deploy adaptation finance, and for patient institutional support over long timeframes.

Effective LLA also requires institutions that can access climate finance and channel it to relevant programs, projects or investments. Many countries in Africa have strong national institutions to access and/or deliver climate finance, including national funds and government agencies such as Ethiopia's Climate Resilient Green Economy (CRGE) Facility and FONERWA in Rwanda. In countries where these institutions do not exist, international funders should support governments with patient finance to develop them.

Putting local communities in a leadership position within a process of adaptation that tackles structural drivers of risk through strengthening local institutions may indeed be more complex and, in certain cases, have higher upfront costs than top-down, technocratic interventions. However, the evidence on returns on investment from adaptation initiatives that focus on the agency of communities suggests that the benefits far outweigh the costs.

Recommendations

- International funders should provide finance to establish and/or strengthen institutions that can channel adaptation finance at the local level.
- International funders should significantly scale up the volume of climate finance that they deliver through LLA mechanisms.
- International funders—in particular global climate funds—should create channels for providing

finance directly to subnational governments and institutions.

- International funders should significantly increase finance to constituency-governed organizations that provide some of the most locally grounded adaptation solutions.
- Countries with devolved governance systems should establish subnational adaptation planning and investment processes so that climate action is downscaled to local governments.
- In countries without devolved government systems, governments should build the capacity of national climate finance institutions to deliver finance in line with the LLA Principles.
- Where governments deliver local-level development programs with adaptation co-benefits, these should be aligned with the LLA Principles.
- Governments should explore the possibility of creating and/or capacitating subnational climate funds and institutions that can access adaptation finance.
- Civil society organizations should expand the coverage of tried-and-tested LLA delivery mechanisms, while also deepening support so that they are longer-term and more predictable.
- Large-scale NGOs that deliver finance through traditional international financing modalities should aim to mainstream the LLA Principles into programming in order to improve accountability for local constituents.
- The private-sector contribution to LLA remains under-researched and there is a need to better understand how this vitally important group of stakeholders can support LLA.

Education

The relationship between climate change, adaptation and education is complex and bidirectional. Climate change undermines educational attainment in Africa by damaging already fragile infrastructure and increasing the vulnerability of educators and learners, negatively affecting their ability to educate and learn. But education is also a key climate adaptation solution for Africa because it enhances the adaptive capacity of people, and especially children, by building critical green skills for adaptation action.

In Africa, schools and other learning institutions are synonymous with developmental progress. They represent possibilities for children and provide nations with the human capital needed to drive toward a better future–a future under climate

Photo: CECIL BO DZWOWA/Shutterstock

change. Indeed, schools connect people and places and offer hope, shelter and humanitarian assistance in a time of disaster. They are pathways for knowledge, skills and cultural exchange across diverse African communities, and thus they are essential in efforts toward strengthening climate resilience and adaptation.

Despite its strategic importance to adaptation efforts, however, education has been overlooked by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), and more broadly in the formulation of climate and adaptation strategy on all levels. This chapter argues for a greater recognition of the need to adapt education systems themselves, but also to recognize education itself as a critical and central strategy for climate adaptation in Africa. It highlights the challenges faced by the education sector in adapting to climate change impacts and the need for greater investment in education to fully realize its potential as an adaptation solution. It assesses the state of education in Africa today and makes a case for education as an important building block of adaptive capacity. It maps out four strategies to accelerate the project of education for adaptation in Africa.

Challenges

Education is a heavily climate-impacted sector in Africa. It is also a key building block of adaptive capacity. However, investment in education is low in Africa, creating a significant barrier for climate adaptation. Despite growing evidence about the synergies between education and adaptation, education has also not been central to climate and adaptation strategies.

Climate-related disruptions to the education sector have far-reaching negative effects on the adaptive capacity of climate-vulnerable populations in Africa. As many as 25 of the 33 countries where children shoulder extremely high vulnerability to climate shocks are located in Africa. A wide range of impacts of climate change on education infrastructure, educators, and learner outcomes have been identified. The relationship between climate change, vulnerability and education is summarized in Figure 12.

Figure 12. The Relationship Between Climate Change, Vulnerability and Education

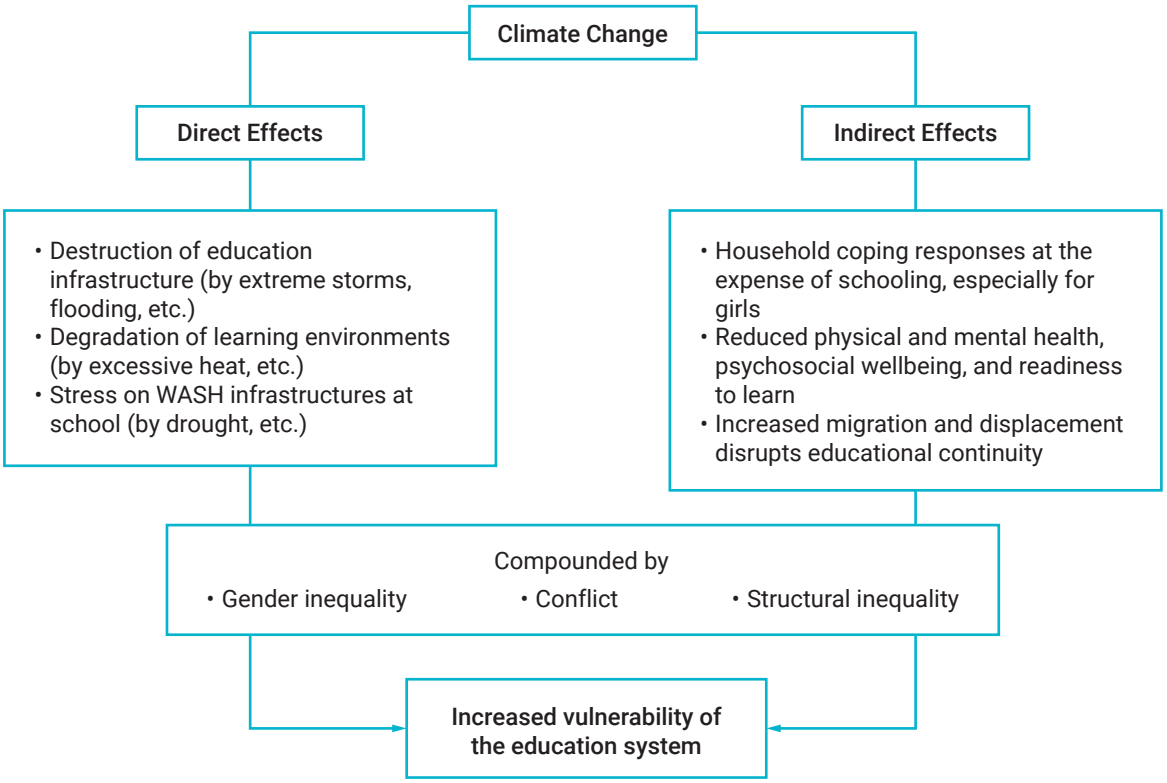


Photo: Dietmar Temps/Shutterstock

The direct impact that climate change has on African education systems is most visibly manifested in the destruction of education infrastructure by sudden-onset climate-related disasters like extreme storms and flooding. The indirect impacts of climate change impair educational attainment, especially for girls. The Malala Fund estimates that climate disruptions will mark an abrupt end to schooling for at least 12.5 million girls every year globally.

Recommendations

Making education systems climate-adapted and ensuring that investments in education can in turn drive adaptation will require action across four distinct areas.

- Data, diagnosis, and improved planning must underpin greater integration of education in adaptation strategies.
- Education infrastructure must be adapted to be more resilient itself and to act as a driver of resilience.
- The education workforce must be supported and strengthened to play its role in educating young people and preparing them to be the climate-adapted workforce of the future.
- Education content and pedagogy must be oriented toward instilling climate literacy and a breadth of green skills for adaptation in all learners.

To make progress on the four levers described in the previous section, a regional effort in the form of an "Education for Adaptation Activator (E4AA)" Alliance is urgently needed. The proposed objectives of the Alliance would be threefold: to bring stakeholders together to establish an irresistible case for education for adaptation; to support countries to identify and activate effective education for adaptation efforts across the four areas identified above that could be localized and scaled; and to build a global movement that champions education for adaptation. Africa, as the continent with the fastest-growing youth population, could lead this Alliance.

Building on existing education, workforce, and climate science datasets, the E4AA Alliance should not only work to fill critical data gaps on education for adaptation, but also create a first-of-its-kind model for calculating the transformative potential of education in building the specific and adaptive capacities for climate resilience. By 2025, the E4AA Alliance could work with 10 of the most vulnerable

countries (members of the Climate Vulnerable Forum, with an initial focus on Africa) to ensure adaptation education and adapted education systems are a key part of their NAPs.

Again, by 2025, the Alliance could work with 10 education providers with community reach and expertise across Africa and a coalition of youth in Africa to develop localized adaptation education tools and content based on climate change education design principles and indigenous knowledge. The E4AA should develop global climate resilience and adaptation education tools that can be localized to support implementation of education for adaptation.

Institutional Arrangements For Adaptation

The 2015 Paris Agreement put forward a global goal of "enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change" (Article 7.1). This chapter first describes and highlights the utility of toolkits for assessing institutional arrangements, namely the World Bank's Climate Change Institutional Assessment (CCIA) and the Capacity for Disaster Reduction Initiative's Digital Tool for Disaster Risk Reduction Capacity Diagnosis and Planning. It presents an analysis of the institutional arrangements described in 10 selected African country NDCs or NAPs. It also highlights the benefits of embedding disaster risk reduction (DRR) and disaster risk management (DRM) into a country's institutional framework.

Challenges

Setting up an institutional framework for climate governance is crucial to plan, legislate and manage the implementation of adaptation actions in a country. For Africa, progress has been made in setting up the institutional arrangements, but challenges remain when it comes to setting clear roles, mainstreaming finance and disaster disk reduction considerations throughout the process, and having a monitoring system in place for measuring progress and contributing to transparency, among others.

The NDCs enhancement mechanism provides an important opportunity for African countries to establish clear institutional arrangements to support the successful implementation of adaptation actions and to increase the transparency of their climate adaptation communication. Nevertheless, some countries still state the need for capacity building and finance to support the process.

Seven African countries have submitted an INDC and 46 have submitted updated NDCs. Of these, 25 describe their institutional and governance framework in a more detailed manner, 11 do not explicitly mention an institutional framework in place, and 17 signal the intent of developing, adapting, or reinforcing an existing one that is not described with details.

Joint responsibility between the leading institution of climate change adaptation activities and finance ministries can reinforce alignment with national budget frameworks and help to attract international climate finance. For Africa, finance ministries are generally included in some parts of NDC/NAP institutional arrangements as budget holders and financing procurement institutions rather than as co-leads.

Tools for Assessing Institutional Arrangements

The World Bank has developed the CCIA as a tool to identify the strengths and weaknesses of a country's institutional framework for addressing the governance challenges that climate change poses. The assessment tool is for government officials participating in policy, planning, implementation, and finance. It can be used by governments at any stage of the development of their climate change institutional framework. The CCIA is being used in the World Bank's new Country Climate and Development Reports (CCDRs). These are new core diagnostic reports that integrate climate change and development considerations that will help countries prioritize the most impactful actions that reduce GHG emissions and boost adaptation.

The CCIA focuses on five pillars crucial to consider when designing and planning the institutional arrangements for climate governance of a country, which are: organization; planning; public finance; subnational governments and state-owned enterprises; and accountability.

The World Bank emphasizes that the government institutions should coordinate to carry out climate change policy based on medium- and long-term plans and goals. Additionally, vertical and horizontal intergovernmental coordination arrangements, alignment of national policy with international

commitments, and a solid accountability system are crucial factors for a well-structured institutional framework.

Recommendations

- The climate adaptation institutional frameworks in Africa have, for the most part, set up institutional arrangements. There is still work to be done on mainstreaming finance and disaster-risk reduction considerations throughout the process. It is also important to clarify roles of different agencies. As African countries improve their NDCs, clarifying the institutional arrangements would be an important area.
- Ensuring joint responsibility between the lead institution of climate change adaptation activities and finance ministries can strengthen alignment with national budget frameworks. Integrating climate strategies, plans, and policies into the fiscal and public financial management systems can allow countries to maximize resource expenditure and their impact.
- An effective Monitoring, Reporting and Verification (MRV) system is crucial for NDC transparency and accountability. It is a necessary tool for countries to successfully implement adaptation measures, to monitor their effectiveness, and for attracting and facilitating access to climate finance.
- Strengthening the five CCIA pillars when designing and planning the institutional arrangements for climate governance can help to establish clear institutional arrangements to support the implementation of adaptation actions.
- Aligning disaster-risk policy frameworks with climate adaptation institutions and frameworks instruments is imperative, especially for African countries, which are hardest hit by climate-related disasters.

Youth and Entrepreneurship

MSMEs are leading engines of job creation in Africa and account for a large part of economic output for the continent. SMEs constitute 95 percent of Africa's private sector and provide an estimated 80 percent of jobs across the continent. At least 44 million formal MSMEs existed in Sub-Saharan Africa alone in 2018. Their growth, however, is considerably constrained by a lack of access to finance and markets, with 51 percent of the businesses requiring more finance than they have access to. Climate change also poses a threat to business growth and employment in Africa, with negative impacts already seen in the form of job losses, destruction to business assets, forced migration, disruptions to transportation routes and access to markets, risks to occupational safety and health affecting labor productivity, and reduced demand resulting from economic shocks.

Climate adaptation responses can, however, protect existing jobs, drive green job creation for adaptation, support the provision of other employment-related benefits such as healthcare and social protection, and provide opportunities for new economic activity and investments.

There is a considerable opportunity in mobilizing private-sector actors for adaptation efforts in Africa. Collaboration and partnerships within the private sector (and with other stakeholders) can not only build resilience within the private sector, but can generate adaptation and resilience benefits for society at large. This is especially true of MSMEs, given that they make up a significant part of the

Photo: Tommy Trenchard/Panos Pictures

continent's private sector. Further, MSMEs are uniquely positioned to develop locally relevant and effective adaptation solutions, which in turn can significantly build the resilience of the communities in which they operate. Identifying potential business opportunities, incentivizing MSMEs, and promoting local entrepreneurship is thus crucial for creating employment opportunities and generating economic and social output in Africa.

As the most educated generation ever in Africa, African youth today have high economic ambitions and provide an untapped potential to build resilience through their innovativeness, energy, and entrepreneurship. Indeed, Africa's large and growing young population, estimated at over 1.4 billion in 2022, is one of the continent's most valuable assets for growth. Unlocking the untapped potential of youth in Africa to build resilience through innovative solutions and entrepreneurship can drive transformation adaptation at scale across Africa. It is important to engage and support young people in key investments and adaptation policies, increase accessibility of financial instruments, increase the visibility of private-sector adaptation action in Africa, and to incentivize MSMEs through policies and by creating an enabling environment for entrepreneurship.

The Youth Adaptation Solutions Challenge

The Youth Adaptation Solutions Challenge is an annual competition and awards program for youth-led enterprises jointly organized by GCA and AfDB under the YouthADAPT pillar of the AAAP framework. The competition targets young entrepreneurs between the ages of 15 and 35 and MSMEs in Africa that have demonstrated proof of concept, offer innovative solutions to climate adaptation and resilience, and have been operational for at least two years with a potential to scale up operations. The first winners of the Youth Adaptation Solutions Challenge were presented at COP26 during a dedicated award ceremony for the challenge. Over 2,000 applications were received from which 10 winners were awarded. Winners receive seed funding of up to US$100,000 to develop their innovation and receive tailored business development training through a 12-month incubation and acceleration program.

The awarded enterprises target crucial environmental, social, and economic sectors affected by climate change and present clear value propositions to scale up for higher impact as well as to create employment opportunities across Africa. The challenge also has a strong focus on women, with at least 50 percent of selected businesses being women-owned.

The Accelerator Program

A comprehensive gap analysis of each of the winning enterprises was undertaken by the Kenya Climate Innovation Center (KCIC), with the collaboration of GCA and AfDB, to identify individual needs and provide targeted incubation and mentorship support. The gap analysis was done by conducting interviews, reviewing business plans, and using KCIC and AfDB gap analysis and climate adaptation tools. Some of the most frequently mentioned needs included making the businesses ready to attract investors, the need for digital marketing, and climate-risk management.

During the implementation phase, training is provided as a bundled service, allowing for networking and information sharing among the enterprises on the best practices with a pan-African view, which then integrates into their respective business processes. To provide the entrepreneurs with the necessary tools for scaling up their businesses, training workshops were given on the topics of cash flow management, budgeting, fundraising, and digital marketing. Later, to mainstream adaptation into their businesses, training workshops were conducted on understanding climate change, adaptation fundamentals, adapting SMEs to a changing climate, and the adaptation finance landscape.

The Accelerator program is implemented alongside grant provisions released in tranches determined by milestones achieved. The Youth Challenge provides the winners with a sustainable funding model and an expert mentorship component—allowing them to access funding and training to support their short-term goals while also creating an environment for accessing funds that will help them unlock their long-term goals.

Business Challenges

The YouthADAPT challenge has helped the winners address some of the challenges they have faced since the inception of their enterprises. The grant, training sessions, and mentorship have all contributed to unlocking new possibilities for scaling up their businesses and impacting the lives of more people in their communities. The three main ways the YouthADAPT Accelerator program has helped them are: funding for scaling up, training for impact, and investor readiness. The main challenges that young entrepreneurs face while launching and growing their businesses are:

Limited financial resources and difficulties in accessing and securing funding. Access to finance is essential to be able to fund adaptation innovations. Young entrepreneurs had difficulty navigating loan systems that require collateral at levels that are unfeasible for them.

Need for business development and operational skills. Winners expressed the need for in-house capacity building for business development skills such as project management, financial management, tracking daily activities, bookkeeping, budgeting, writing, implementing company policies and procedures, and marketing, to name a few.

Knowledge gaps. Several entrepreneurs expressed the need for climate experts trained on adaptation and resilience strategies, which would help them disseminate climate knowledge to their customers, smallholder farmers, local municipalities, and the wider community.

Uncertainty of climate impacts. The winners have already experienced negative impacts of climate risks on their business, both directly and indirectly. There is great uncertainty surrounding how climate risks will impact their businesses in the future. This is particularly true for young entrepreneurs in the agriculture sector, which in Africa is predominantly rain-dependent and highly vulnerable to climate impacts. This makes the implementation of adaptation strategies even more critical.

Changing farming and customer behavior. Being agents of behavioral change is challenging in itself. Some winners reported initial reluctance from the communities in which they operate in first accepting and then implementing new behaviors, such as adopting new technologies. Sustaining long-term behavioral change is another challenge requiring interventions and strategies that maintain motivation.

Operational context. Other contextual conditions that posed challenges for the winners to launch and grow their businesses include receiving little help from local municipalities, lack of infrastructure such as poorly constructed roads and unreliable access to electricity, difficulties obtaining the necessary certificates and licensing, government regulations such as on drone usage, and not having structured markets.

Recommendations

Reflecting on the challenges and barriers they have faced in launching and growing their businesses, the winners provided their insights into how African governments can support young entrepreneurs through policy actions and programs. There are three main recommendations:

- **Access to funding:** Make access to financial capital easier for young entrepreneurs. This includes simplified loan systems and processes; making grant and funding opportunities more visible; lowered interest rates that are

flexible and adjusted according to revenue at different periods; and more flexible and feasible collateral requirements.

- **Create tax incentives:** Encourage youth entrepreneurship by lowering tax barriers that severely inhibit growth. This could include providing early-stage tax cuts until the company starts making a profit; offering adaptation tax rebates; reduced or zero-rate taxes on farm inputs such as seeds and equipment; and tax holidays or exemptions.
- **Facilitate access to knowledge and capacity building:** Equip young people with tools to successfully implement their adaptation innovations through training and mentorship programs; business incubators; training in digital technologies; access to networks of young entrepreneurs around the world; knowledge exchange between young businesses and established companies; vocational training programs; and climate change awareness-raising campaigns. Create synergies between government, NGOs, and the private sector.

Security

Climate change impacts create novel security threats and also interact with existing social, political, and economic conditions and vulnerabilities. Climate-security analysis seeks to understand these risks as well as identify opportunities to prepare for and to prevent complex climate-related security risks. This chapter presents a climate-security adaptation framework to better understand the climate and security nexus and support the "security-proofing" of climate adaptation planning. The framework consists of five steps:

1. Identify areas of climate-security risk through an analysis of climate-conflict pathways.
2. Assess climate-security risk through forecasting and EWS that combine security and climate risks.
3. Develop conflict-proof adaptation planning.
4. Translate climate-security risk assessments into localized action.
5. Climate-proof the role of local security sectors.

Photo: Yuzu2020/iStock

Challenges

The security landscape in Africa is evolving in response to rapidly shifting climate conditions. Integrating climate and security action is critical for adapting to the unprecedented challenges of a climate-changed world.

Up to half of all African countries have been identified to be vulnerable to climate change and are regarded as very fragile. Currently, eight of the top 10 countries impacted by climate change are in Africa, six of which are also currently experiencing armed conflict. Overall, the Sahel and Horn of Africa regions as well as the countries to the south of these regions are most vulnerable to climate-induced risks as they already have a precarious starting point through state fragility and ethnic fractionalization.

Access to water, food, and energy is threatened by climate change trends like decreased rainfall, rising temperatures, and extreme weather events, leading to a loss of crop productivity, and leaving the continent exposed to further unrest. Multiple regions in Africa have seen an increase in conflict between herders and farmers as climate-induced changes through droughts, wildfires and heatwaves decrease grazing lands and available natural resources.

Photo: Amors photos/Shutterstock

Recommendations

- Developing a conflict-sensitive climate adaptation strategy and a climate-sensitive security strategy requires a deep understanding of the climate-security nexus and of the ways in which this applies to the local context. Research on the climate-security nexus has identified several pathways by which climate change impacts can produce social, political and economic conflict. Many of these pathways have a direct application to Africa, and specific combinations of them can be identified in particular regions. Understanding these pathways and identifying vulnerable regions can facilitate the development of more specific data tools to predict and anticipate climate-security risks in Africa.
- The design and deployment of EWS is an indispensable part of dealing with climate-security risk. Based on triangulated research methods involving local communities and climate-security practitioners, an effective EWS can be developed that informs the development of adaptation programs to address climate-security risks. EWS should rely on local actors and their knowledge in order to prevent maladaptation and to not enhance or exacerbate existing vulnerabilities of local and marginalized communities. Any action informed by EWS must be carefully evaluated to avoid unsustainable choices, unintended consequences for local communities, or escalations of humanitarian crises.
- Regional institutions in Africa have begun to integrate climate-security risks into their policy frameworks, but urgency is required in translating those frameworks into action, especially by building on the strengths of local security actors. The United Nations Office for West Africa and the Sahel (UNOWAS) and the African Union have both demonstrated strengths in the development of EWS and policy frameworks to understand climate-security risks. However, it is important for regional institutions to move from assessment into action to ensure adaptation for communities in practice.

Local security actors can play an important role in the application of adaptation strategies on the ground, as they are often the first and best equipped to respond to increasing climate risks.

- Translating climate-security assessment into action requires participatory engagement through, for instance scenarios exercises, training and dialogue, and co-creation with local communities. These tools can help to eliminate gaps in data dissemination and climate adaptation action, especially for vulnerable and/or disconnected communities.
- Local communities should have a leadership role in responding to EWS. Robust systems for information sharing exist at the local level, yet they are often misunderstood or underappreciated by regional or state institutions. However, when those local information-sharing systems are utilized, they can be very effective at mobilizing communities to action and doing so at a low cost. Therefore, another starting point for more security-proof adaptation policies is Local Adaptation Plans of Action (LAPAs), which can then help to shape broader NAPs.

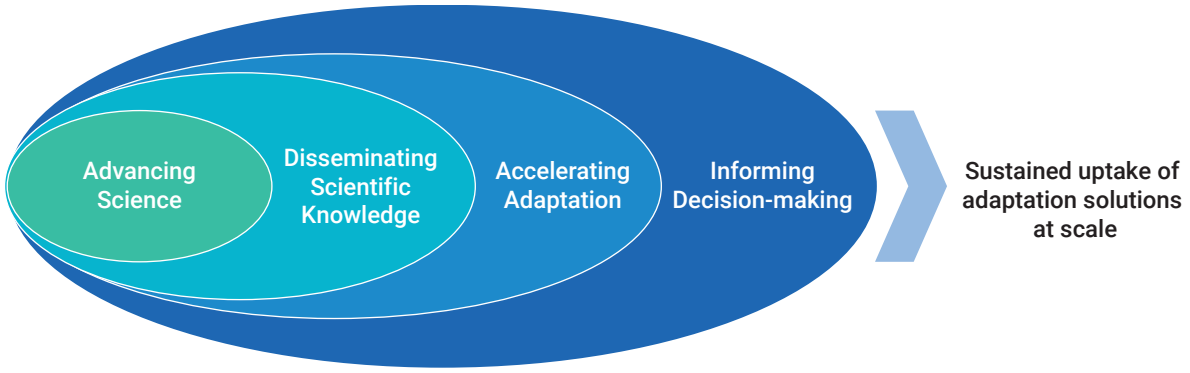
The Unfinished Research Agenda In Adaptation

Countries in Sub-Saharan Africa are particularly vulnerable to climate change because multiple biophysical, political, and socioeconomic stresses interact to heighten the region's susceptibility and constrain its adaptive capacity. Adaptation, defined by the IPCC as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities," is needed to manage current climate impacts and will be increasingly vital as the world continues to warm. Adaptation can take place at a number of scales, from local to global, addressing climate-related problems at that particular level, and making use of capacities available to that particular group of actors.

Progress in adaptation planning and implementation has been observed across all sectors and regions, generating multiple benefits. However, adaptation progress is unevenly distributed with observed adaptation gaps. Also, many initiatives prioritize immediate and near-term climate-risk reduction. To increase the efficiency and effectiveness of adaptation, integrated, multisectoral solutions that address social inequities, differentiate responses based on climate risk, and cut across systems are vital.

Adaptation is a complex and multifaceted subject that is evolving rapidly as climate change impacts the world in ever more challenging ways. Hence there is a large research agenda to fill in present and future knowledge gaps on adaptation, spanning the disciplines of climate science, economics, psychology, and other social sciences. However, adaptation research needs to go beyond assessing risks and identifying impacts and instead take a problem-focused and systems-oriented approach, pursuing user-centered solutions with a clear line of sight between research and its application. Figure 13 visualizes the theory of change of adaptation research for impact.

Figure 13. Theory of Change of Adaptation Research for Impact



Adaptation Research: Insights and Recommendations

For adaptation to be effective, it requires knowledge of current and future climate-related risks. However, there is a dearth of climate-risk data and models for actors seeking to invest in adaptation, particularly at a more granular level. Conducting vulnerability assessments and providing local climate projections can help formulate a clear climate rationale and identify where adaptation is needed the most. Informality characterizes a significant portion of urban and rural economies across the African continent and must be understood if climate adaptation activities are to be effective.

One of the most important but difficult challenges is to gain a better understanding of adaptation to more extreme forms of climate change, such as those associated with 3 to 4°C of mean surface warming. It is clear that those higher levels of warming could be extremely disruptive and adaptation strategies would have to change, perhaps fundamentally so. Empirical analysis is by design restricted to the relatively modest levels of climate variation observed in the recent past. Artificial intelligence is increasingly being used to expand the realm of future climate scenarios.

Researchers need to ensure that scientific knowledge is packaged in a comprehensible manner and disseminated to the broader public. Knowledge sharing among different stakeholders will help reduce transaction and information costs and involve the public and private sectors in identifying vulnerabilities as well as adaptation solutions. Data collection and analysis can also be empowering. Involvement of communities in data gathering and geographic information system mapping can help them to understand and articulate their needs and challenges better, and to negotiate more effectively with governments.

The effectiveness of strategies for adapting to climate change depends on the social acceptability of options for adaptation, the institutional constraints on adaptation, and the place of adaptation in the wider landscape of economic development and social evolution. Research needs to contribute to an understanding of all three.

Collective action is at the heart of many decisions regarding the management of natural resources, which are a key locus of adaptation. Greater insight can be gleaned on how collective action is central to adaptive capacity at various scales by case-specific research.

Making adaptation decisions can be complex, requiring careful consideration of multiple factors and perspectives, and balancing different priorities over different timescales. Societies are said to only be at the start of a learning process that will continue for decades. Decisions on adaptation are made by individuals, groups within society, organizations and governments on behalf of society. But all decisions privilege one set of interests over another and create winners and losers. Mainstreaming adaptation refers to the process whereby climate change concerns become an integral part of decision-making and influence the ways in which actors perceive the problem and consider climate change in their day-to-day activities.

At the macroeconomic level, successful adaptation policy would reduce tradeoffs across sectors and promote synergies; reduce under- and overreaction by departments, organizations, or ministries in response to climate change impacts; prevent inefficient investments of (scarce) resources; and promote coherence and consistency in implementing actions on the ground.

For decision-makers to be able to move from predict-to-act to risk-of-policy approaches, researchers need to assess the effectiveness of adaptation policies at the sector level, including the performance of adaptation measures under different climate scenarios, and then integrate these results in economy-wide models where they can also make linkages to the mitigation agenda. Such economy-wide models would also allow policymakers to assess impacts of adaptation strategies on poverty reduction and employment generation, which are important considerations from an equity point of view. The Comprehensive Africa Agriculture Development Program (CAADP) provides a good guide for the risk-of-policy approach.

At the local level, adaptation preferences have been found to be rather heterogeneous and conditioned by a host of social factors across the African continent. Case studies reveal that local preferences consistently supported the need for both autonomous and planned adaptation; a mix of hard and soft measures; and awareness of the

importance of pursuing both collective and individual adaptation measures.

In addition, the adaptation strategies perceived to be most effective were those that addressed underlying drivers of vulnerability, rather than those that focused on climate change alone. Further research is required on adaptive behavior at the local level, for example the farm household, so that simulations run on that level can inform and predict the workings of the overall economy. Insights in adaptive behavior could also inform policy measures designed to build adaptive capacity of the more vulnerable.

Decision-making for scaling or replication of adaptation actions needs to be informed by learnings from adaptation actions on the ground. Several projects have already introduced adaptation solutions, for example a climate-smart adaptation technique or providing weather index-based insurance to farmers, but an intervention bias, the pilot or experimental nature of such initiatives, and a lack of methodologically sound impact studies, makes it difficult to draw lessons from these. Impact evaluation, which includes identifying impact pathways of adaptation actions, would shed light on the limits to adaptation and reduce the risk of maladaptation pathways.

To summarize, to achieve sustained uptake of adaptation solutions at scale, research efforts need to produce and ensure dissemination of comprehensive and disaggregated information on climate risks, to identify context-relevant adaptation solutions with high potential for uptake, and to develop decision-making tools that enable scaling. What is more, these various elements need to speak to each other.

Photo: Simon Townsley/Panos Pictures