City Resilience

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KEY MESSAGES

- Today, as many as 79 African cities rank among the 100 fastest-growing cities in the world, but also fall within the "extreme risk" category of climate hazards. The Rapid Climate Risk Assessment (RCRA) is an approach for urban climate risk assessment developed by the Global Center on Adaptation (GCA) building off a similar approach for climate risk assessment developed by the C40 Cities Climate Leadership Group.
- An RCRA gathers key information on climate hazard and risk, 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.
- In its first round, GCA has implemented RCRAs in Antananarivo, Madagascar; Bizerte, Tunisia; Conakry, Guinea; Dodoma, Tanzania; and Libreville, Gabon. These cities were selected in partnership with the African Development Bank (AfDB).
- Although not meant to be exhaustive, RCRA can often serve as a codified document summarizing

the overall state of climate adaptation within a city, providing a basis for collaborative governance, integration of different knowledge domains across sectors, as well as a consensus-building tool among various interests in a city.

- 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.

> **Doing nothing is not an option. In fact, doing nothing means you lose. Why? Because these new steps in adaptation will lead to the new economies and will lead to the new jobs. And I see that day by day in my port, where 150,000 people are working every day."**
>
> **Ahmed Aboutaleb**
> Mayor of Rotterdam, the Netherlands

INTRODUCTION

Underpinning all climate adaptation solutions—from climate-adaptive planning and infrastructure investment to service delivery, community development, land management, and nature-based solutions (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. It is in this context that the Global Center on Adaptation (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.

The vulnerability of African countries to climate change, relative to their readiness to adapt, ranks them among the lowest on the Notre Dame Global Adaptation Index (ND-GAIN): 16 of the 20 countries ranking lowest in the Index are in Africa.[1] Germanwatch's most recent Global Climate Risk Index shows that in 2019, five of the 10 most affected countries by extreme weather events were African: Mozambique (No. 1), Zimbabwe (No. 2), Malawi (No. 5), South Sudan (No. 8), and Niger (No. 9).[2] And African nations' climate risk is increasingly being concentrated in cities, where rapidly growing proportions of people, assets and economic activity are becoming exposed to climate hazards.

According to the Climate Change Vulnerability Index (CCVI), 79 African cities rank among the 100 fastest-growing cities in the world, but also fall within the "extreme risk" category. A total of 15 African capitals, and many of the continent's key commercial hubs, have significant combined risk factors stemming from rapid population and economic growth and climate risk. Among the most at risk are Addis Ababa (Ethiopia), Luanda (Angola), Dar es Salaam (Tanzania), Kampala (Uganda), and Abuja and Lagos (Nigeria).[3]

These risks take different forms. Flood risk is most prevalent in southwest Africa and countries with large rivers in West Africa, fueled by increasingly extreme hydrometeorological activity and by deforestation and urban encroachment into flood plains. Sea-level rise is of particular concern in low-lying coastal areas, increasing flood frequency and the risk of storm surges. This is of especial concern given that half of the African settlements with 1–5 million inhabitants are located in low-elevation coastal zones, with some estimates projecting that Africa's populations in low-elevation coastal zones (LECZ) will rise at more than double the world's average.[4] The impact of drought is particularly acute in African cities as it manifests itself in reduced water supply, which in turn creates difficult water management issues as urban water utilities often source their water upstream in watersheds that go beyond their municipal jurisdiction. Extreme heat is another pressing concern, as the cities in Africa are often being built without consideration for green space, leading to an increased heat island effect. Tropical cyclones, whereby one singular event can have a globally catastrophic impact, are also of concern. For example, the impacts of Cyclone Idai in March 2019 alone propelled Mozambique, Zimbabwe and Malawi to the Germanwatch top 10 list, due to catastrophic damage and a subsequent humanitarian crisis.[5]

These impacts are experienced most especially among the urban poor, who have the least amount of access to formal means of withstanding the impacts of climate change. A combination of high levels of social vulnerability among Africa's rapidly growing urban poor, coupled with the increasingly recurrent impacts of extreme weather events, is creating an urgent need for adaptation responses.[6]

THE OPPORTUNITY

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) is still in the early stages of urbanization. Climate risk assessments can help decision-makers understand the climate risks associated with current and future urban development, and identify, prioritize, and implement low-cost actions to avoid repeating mistakes made by other regions of the world and locking in risks. 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.

As noted in this State and Trends in Adaptation report 2022, up-to-date knowledge of current and future risks, based on cost-effective data collection, among other elements, is critical in significantly reducing the impact of climate change in African cities. The prioritization of investments based on climate risks and bottlenecks requires an understanding of the general landscape of climate hazard, risk and resilience opportunities. However, given the limited resources of African cities, doing so can be cost-prohibitive if not done in a way that is strategic.

The RCRA is an approach developed by GCA, building off a similar approach for climate risk assessment developed by the C40 Cities Climate Leadership Group, a global network of mayors collaborating to reduce emissions in their cities. An RCRA gathers key information on climate hazard and risk, 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. While RCRAs are by no means meant to serve as all-encompassing studies, they provide the basis upon which more detailed studies for project feasibility, preparation and design can be made. Thus, RCRAs can serve as a critical first step in a longer-term climate resilience—building journey for cities across the continent—by first understanding the current state of climate adaptation locally.

OBJECTIVE AND METHODOLOGY OF CITY RESILIENCE ASSESSMENTS

As a first step in the engagement of cities, GCA implements RCRAs to identify key climate risks and vulnerabilities, and to scope expected impacts in selected cities. The RCRAs also work further to gain a more solid understanding of past and current initiatives in the urban climate adaptation and resilience domain, to help inform a future course of action. For GCA, improved urban climate adaptation and resilience outcomes are characterized by:

- strengthened urban climate risk management in cities and their hinterlands;[7]


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- improved climate-adaptive spatial planning at the municipal and regional levels;[8]
- enhanced urban water resources management for more equitable access to ecosystem benefits;[9]
- enhanced resilience, consistency, inclusiveness and integration of urban drinking water, sanitation and solid waste management services;[10] and,
- improved urban livability and public health from climate risks stemming from heat stress and disease.

An RCRA consists of three parts to be implemented in each city:

Part A: City Scan provides a rapid review of what has been done in the respective city regarding climate hazard and risk assessments, as well as more locally focused assessments of vulnerability and adaptive capacity. It provides a clearer picture of the city's urban climate adaptation and resilience ambitions, strategies, plans and specific priorities.

Part B: Rapid Climate Risk Assessment provides an overview of the key climate hazards and associated risks that a city faces and is intended to inform the decision on whether an in-depth climate risk assessment is required. This part of the RCRA largely builds off the C40 Cities Climate Leadership Group approach for climate risk assessment. Box 1 outlines the differences between the two approaches.

Part C: City Scoping provides insight into past and current initiatives relevant for adaptation and resilience building, identifying key stakeholders and relevant initiatives. This provides the basis for early identification of potential no-regrets climate adaptation measures a city can consider for further analysis.

Box 1. A Comparison of Approaches to Assessing Climate Risk

The C40 Climate Action Planning Framework includes guidance for conducting both climate hazard assessment and climate hazard impact assessment. The former identifies the probability, intensity and timescale of key climate hazards (i.e. short- or long-term meteorological, climatological, hydrological events) in a city. This is done by accounting for historic climate trends and the current situation of a city as well as future climate scenarios derived from available scientific evidence through to 2050 (and beyond, where possible). The latter draws on the former and looks at the potential impact of extreme climate events on people, assets, and service delivery within a city. In addition to identifying (a) potential climate impacts on people and systems (e.g. number of individuals impacted, cost of damages and economic losses due to service delivery disruption), it also provides guidance on how to assess (b) the capacity of an area's population and systems to adapt in the face of climate hazards, and importantly (c) consideration of vulnerable groups within the population, relevant systems, and service sectors (e.g. water, transport, energy, solid waste management). GCA's RCRA methodology—in particular, for Part B: largely aims to achieve the same objectives.

However, the GCA RCRA approach diverges from the C40 approach in its exclusive focus on climate adaptation. Spanning both the climate adaptation and mitigation sides of the climate spectrum can result in an assessment not so different from a general sustainable development assessment of a city, for example. Concentrating on the adaptation side of the climate spectrum can enable a quicker process resulting from a more focused identification of and discussion with government counterparts when conducting GCA RCRA's Part A: City Scan. For example, experience has shown that in all contexts (regardless of level of development), climate change adaptation and mitigation concepts are often confused with each other, resulting in disjointed problem articulation, assumptions and recommendations. In addition, when it comes to identification of no-regrets measures under Part C: City Scoping, a focus on adaptation enables more concrete recommendations on how to strengthen a city's resilience to climate hazards. While actions that demonstrate both adaptation and mitigation co-benefits certainly exist (e.g. effective upstream watershed management can both reduce downstream flood risk and confer greening benefits by increasing absorption of CO_2), this list of actions is relatively limited. Thus, having an adaptation focus may result in a wider menu of actionable options—be it for investment or policy reform.

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In all, RCRAs largely consist of the following key elements:

Figure 1. Key Elements of an RCRA

Introduction: A general overview of the RCRA, including a context section highlighting key development indicators related to urbanization, poverty, and informality.

Governance Structure: A detailed survey of municipal and national policies and institutions relevant to climate adaptation within the city.

Hazard, Impact, and Risk Assessments: Based upon existing data, information and analysis (including freely available global data sets), they assess the climate hazard, impact and risk context of the city. When available, these assessments include existing hazard, impact, and risk maps. While often these maps do not exist due to a lack of localized data, identifying specific neighborhoods and districts that have recently experienced high-impact climate events (including disasters) can provide a rough picture of the climate context within a city, with specifications for further analysis in future investigation, whether in the identification and prioritization of specific infrastructure interventions and/or to inform the planning process.

Past and Planned Investments: A survey of past, current and planned climate adaptation investments within the city, to shed light on the climate adaptation landscape and identify gaps that can be filled in future investment activities.

No-Regrets Measures: Identification of no-regrets climate adaptation measures that can be implemented and result in high impact in strengthening the climate resilience of the municipality. These are items that can be considered by the municipal and national authorities—as well as potential financiers—for future potential project finance, and serve as a first step for more in-depth, future scoping activities.

The key to this approach is the rapid nature in which the climate risk assessment is carried out. In essence, RCRAs are meant to put the finger

on the pulse so as to support decision-making of municipal and national authorities for where further, more in-depth investigation is necessary (which requires more resources and time). And, in an effort to understand the needs of the most vulnerable, the RCRAs aim to understand the informal sector as much as possible, often having to rely on primary information gathering as well as identification of areas for further investigation.

Box 2 offers a comparison of RCRAs with a more detailed climate-risk assessment conducted by GCA in Accra, Ghana.

Box 2. Why Choose an RCRA?

Two kinds of climate-risk assessment are possible: rapid or in-depth. Any assessment that is more comprehensive is obviously more ideal, but the more in-depth the analysis (meaning the inclusion of new quantitative analysis and mapping), the higher the cost involved and the longer the time required to implement it. Determining the level of detail of an assessment, therefore, is contingent on the available budget as well as other factors, such as availability of other assessments or capability, and political will of a city in achieving its climate adaptation ambitions. Table 1 provides an outline of the pros and cons of a rapid versus in-depth climate-risk assessment based upon GCA's experience in implementing both kinds of assessments: RCRAs in five African cities and in-depth assessments in Accra.

While in-depth assessments in every context would be ideal, RCRAs may prove most feasible given that they are relatively quick, cheap and easily deployable—especially when generation of new hazard and exposure data is required, but time- or cost-prohibitive.

In such a situation, even if the end result of an assessment is not as comprehensive as needed, an RCRA can serve as the preliminary legwork that would have still been required for determining the parameters of a more in-depth analysis. An RCRA can serve, then, as a strategic first step in engaging city and country authorities on the importance of considering climate adaptation options, while building the necessary political will needed for embarking on a long-term climate adaptation journey that requires both investment and meaningful policy change.

Table 1. Rapid Versus In-Depth Climate Risk Assessment

Factor	Rapid		In-Depth	
	Advantages	Disadvantages	Advantages	Disadvantages
Methodology	Simple, modular and easily deployable	Limited, particularly the depth of new quantitative analysis	Results in detailed picture of climate risk landscape of a city	Highly specific to local context, requiring preliminary reconnaissance of existing analysis in the city and technical staff to provide quality assurance of outputs (even when fully outsourced)
Cost	Relatively low-cost			Relatively high-cost, especially in data-poor environments
Technology	At a minimum, can be relatively low-tech and deployable in data-poor environments	Likely to result in a broad-brush assessment and mapping of hazard and risk. Unlikely to identify and prioritize specific climate-adaptation investments	Likely to result in a detailed picture of hazard and vulnerability hotspots of a city, resulting in a critical reference when identifying and prioritizing climate-adaptation investments	Highly technical, likely requiring contracting of external analytical (quantitative) expertise
Time Duration	Quick (3–4 months average)			Time-intensive (9–12 months minimum)

Box 3. The Benefits of Batch Procurement Case Study

Batching together the RCRAs into two separate contracts provides a number of benefits.

First, the efficiency gains stemming from batch procurement saves time in recruitment and contracting. Procuring the consultant services of a firm can further offer efficiency gains by placing the onus of hiring multiple expertise on the firm—which can often be quicker in the private sector. This is especially important when considering the diverse expertise required to be deployed in a rapid manner with the RCRA, ranging from climate change, urban development, hazard and risk analysis, social development, and economics. This, in addition to the need to hire local consultants with local knowledge and access to the local communities, institutions and data, has proven especially critical in enabling a quick turnaround.

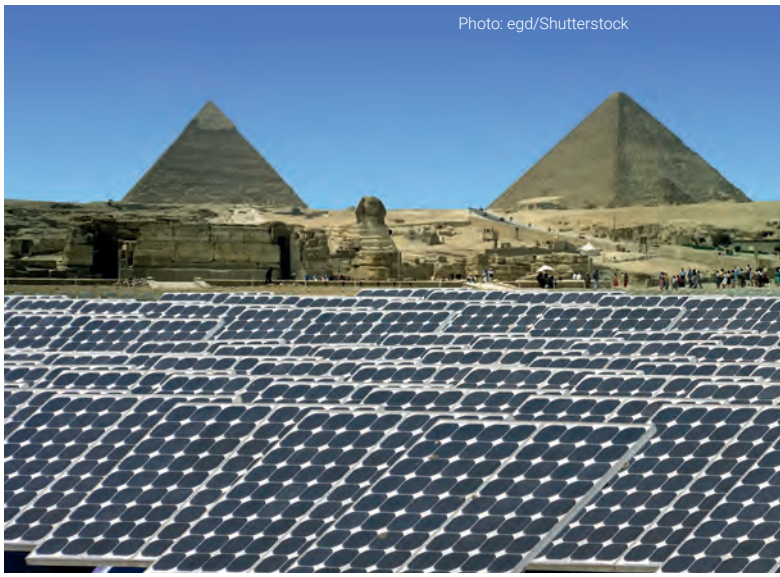
Second, a significant benefit stems from the opportunity to employ a diversity of approaches and to learn from each other's approaches—in a context where there is no single way of conducting an RCRA, even when the questions are clearly laid out. As a plethora of assessment approaches exist, and ways in which to overcome commonly experienced challenges, peer-to-peer exchange among firms proved to be successful in sharing experiences and overcoming common implementation challenges. Enabling this exchange is something in which the contract holder (GCA) can play a strategic role.

Third, having two firms also offers the opportunity to standardize methodologies. While initially seeming to be counter intuitive in having two firms (as opposed to one), the batching of cities ensures that the firm develops a modular approach that can be applied to more than one city, rather than having a methodology focused on the minutiae of each individual city. By implementing an RCRA in two or more cities, a firm focuses on developing and delivering on a standardized approach, and moves the climate-risk assessment dialogue closer to a more streamlined methodology globally.

That said, the enabling factor of success in implementing batch procurement is the time taken to design detailed Terms of Reference (TOR) and being as specific as possible in detailing the questions that should be answered by the RCRA. This provides guidance to the firms, but also helps ensure some level of comparability between the two firms' outputs. Going through an open competitive process, with sufficient time dedicated to advertising a Request for Expressions of Interest and Request for Proposal, helps ensure the most appropriate firms are aware of this opportunity. Lastly, a competitive process between two firms helps ensure that certain performance-based standards are met—in particular, the rapidity of delivery. Importantly still, having two firms further helps the contract holder understand whether certain requests detailed in a TOR cannot be met, which is normally made apparent when both firms express the same challenges—allowing the contract holder to collectively brainstorm and decide with the firms on how to modify the requirements.

By gaining a general sense of the current climate landscape in a city offered by an RCRA, decision-makers have a more informed view of where further investigation is needed, such as with conducting more detailed hazard and risk mapping or conducting more in-depth analysis in identifying, prioritizing, siting and designing climate-adaptation investments. This is particularly important given the linkage with the Africa Adaptation Acceleration Program (AAAP), which aims to mobilize US$25 billion in climate adaptation investment in Africa.

Importantly, by bidding the effort out to private firms, the RCRAs leverage the unique expertise and ability to deliver of the private sector.



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A 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. These cities were selected in partnership with the African Development Bank (AfDB). Often, the RCRA represents the first step in a long-term engagement with cities in their climate resilience–building journey. Not only does it assess the climate hazards and risks and identify past, current and planned climate adaptation initiatives, it also provides the premise for forming institutional linkages and connections required for any long-term climate adaptation engagement.

RCRAs are meant to develop an overall picture of the city, including background information of the city and country relevant to expected climate change and its impacts and risks; and they provide a rapid insight into what has been done in the city regarding climate hazard and risk assessments as well as more locally focused assessments of vulnerability and adaptive capacity. They should also provide an overview of the city's urban climate adaptation and resilience ambitions, strategies and plans. They also provide insight into the most significant climate risks across the city and support the identification and preparation of subsequent investment projects. Often, this is where a development partner such as an international financial institution (IFI) or a donor is likely to take the torch, after a general sense of the climate landscape is established by the RCRA, and vulnerable hotspots and in-demand no-regrets measures are identified. A development partner—with project finance—can finance follow-on studies needed for the identification, design, preparation and implementation of climate-adaptation investments (be it a concrete project or policy reform). RCRAs provide the preliminary legwork required for detailed studies to be conducted, as well as help identify cities where there is strong local institutional support and political will to embark on a long-term climate adaptation journey.

The most noteworthy findings from each city resilience assessment, with key takeaways, are summarized in Table 2.

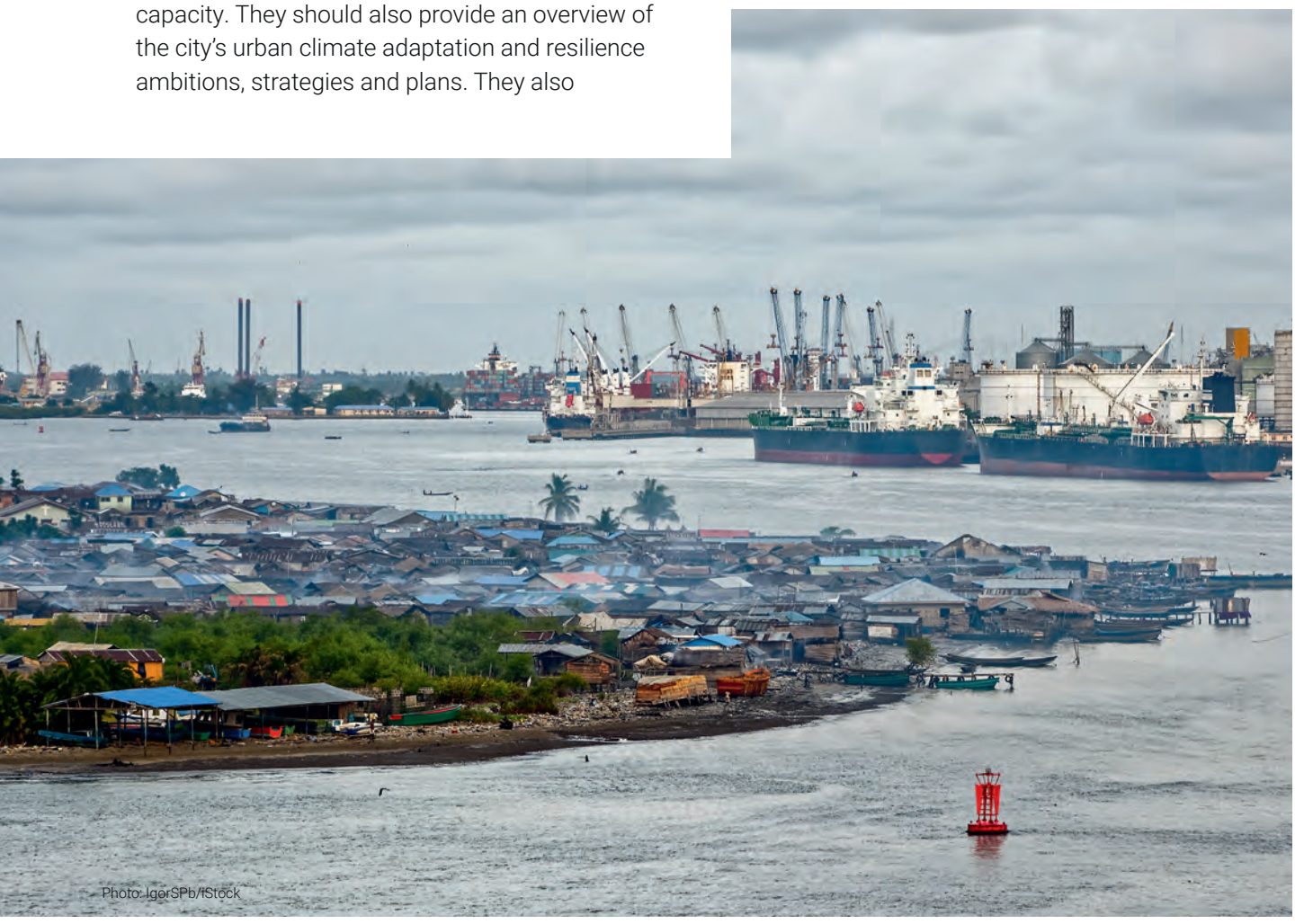


Photo: IgorSPb/iStock

Table 2. Summary Comparison 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; damage 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 water-borne 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

Antananarivo, Madagascar—Increasing Flood Risk in a Fast-Growing City

Rapid population growth (from about 3 million in 2018 to a projected 5.2 million by 2030)[11] is expected to exacerbate social and economic challenges in the capital city of Antananarivo. Almost three-quarters of the Malagasy people lived on less than US$1.90 per day in 2019, and the pandemic devastated urban areas in particular, deepening poverty.[12] Uncontrolled growth in the swampy Betsimitatatra plain, in low-lying areas along three rivers that traverse the city, and into the hills bordering the south and east of the current urban footprint has led to an increased concentration of people and assets in hazard-prone areas. More frequent high-intensity rainfall events fueled by climate change, coupled with deforestation upstream, have increased the flood and landslide risk to urban residents downstream. Currently, nearly one-third of the city consists of flood-prone areas.

Urban population growth and expansion have largely outpaced the capacity of existing infrastructure—largely dating from the colonial period, which ended in the 1950s. Water supply, sewerage and drainage

Photo: Tommy Trenchard/Panos Pictures

infrastructures have not been designed to account for current flooding events. Insufficient solid waste management further exacerbates the occurrence of flooding. Catastrophic floods in Greater Antananarivo in January 2015 affected almost 100,000 people, displacing 40,000, and caused damage equivalent to 1.1 percent of GDP.[13]. The majority of those affected are the poorest, who moved into marginal areas that are most exposed to flooding hazard and have least access to urban services. And with 70 percent of the urban workforce employed in low-paying informal sector jobs, there is often little margin to cope with disruptions in urban service delivery. This became particularly apparent during the most recent floods in January 2022 (which occurred during the implementation of the RCRA), in which more than 62,000 people were affected and 6,800 houses were underwater and at risk of flooding or collapsing. More than 35,000 people were forced to take shelter in more than 60 evacuation centers.

To this end, a number of no-regrets measures have been identified to increase the climate-adaptive capacity of Antananarivo and include strengthening disaster evacuation planning, investing in climate resilience of water and sanitation infrastructure, expanding NBS to reduce flood risk and urban heat island effect—all of which are in line with the Antananarivo 2040 action plan. These efforts would complement recent initiatives, which include (a) Integrated Urban Development and Resilience Project (PRODUIRE) (IDA, US$75 million); (b) PIAA-SDAA Urban and Sanitation Master Plan for Antananarivo (AFD and EU, €28 million); (c) Adapt'Action: setting up a national climate adaptation policy and governance framework (AFD, €30 million); (d) SUNREF: mobilizing the financial sector to invest into climate change adaptation (European donors and EIB, €33 million); and (e) Antananarivo Vision 2040 (2025–2040) (AfDB, 2021).

Bizerte, Tunisia—Rising Temperatures and Sea Levels along the Mediterranean Coast

Over the past three decades, the urban built environment has doubled in size in Bizerte. Over the past five decades, average temperatures have steadily increased by 4°C, with projected increases of 4.4°C by 2070; average daily maximum temperature is expected to increase to 43.8°C. By the same token, there have been noticeable decreases in average annual precipitation, with an expected decrease from 365 mm per year to 288 mm per year by 2070. A combination of drought, water scarcity and heatwaves are of concern, having adverse impacts on public health due to the urban heat island effect, water shortages (the Sidi Salem Dam currently functions at 30 percent capacity) and increases in

Figure 2. Bizerte Hazard Map

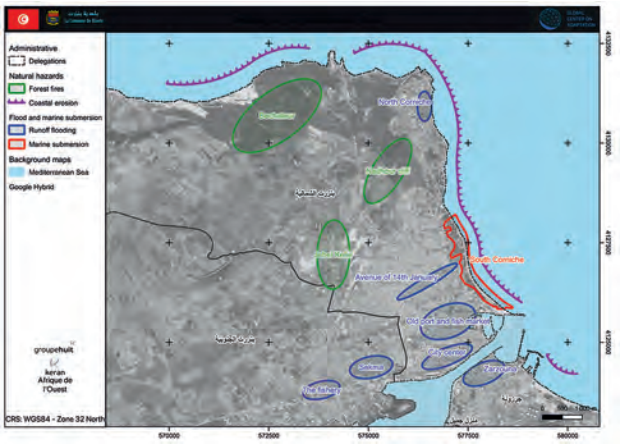


Figure 3. Areas Anticipated to be Submerged with Sea-Level Rise In Bizerte, Largely Limited to Areas around Lake Bizerte and Lake Ichkeul

forest fires. Projected sea-level rise is expected to increase by 0.42 m by 2070 and 0.78 m by 2100, raising concerns of coastal erosion and flooding of low-lying coastal areas (in particular areas built on landfill) as well as salinization of aquifers. The main areas expected to experience impacts include urban economic activities and tourism along the coastline and city center due to coastal inundation and flooding respectively; agriculture due to lower precipitation, salinization of water resources and drought; fisheries due to increased water temperatures; and industrial activities impacted by water shortages and urban floods.

Key physical challenges identified include (a) lack of a properly designed drainage network and hydraulic bottlenecks; (b) expected loss of land, in particular beaches and landfill sites, which are critical for tourism and coastal development. Key institutional challenges identified include (a) lack of knowledge of climate risks and lack of hazard and risk data to guide urban planning practice (e.g. maps of high-risk flood areas); (b) lack of enforcement capacity and ability to ensure risk-sensitive development; (c) lack of municipal-level financial and human resources to manage drainage infrastructure. A new Urban Development Plan (PAU) is currently under development and will guide future urban growth by creating a new urbanization area, but will need to account for climate risk as current planning documents do not.

Current climate adaptation initiatives include (a) Tunisian Coastal Areas Protection Program (Programme de Protection du Littoral Tunisien —PPLT) managed by the Agency for Protection and Planning of the Coastline (Agence pour la Protection et l'Aménagement du Littoral—APAL) to include measures to protect and recreate 7 km of Bizerte coastline, including seawalls and beach renourishment (KfW and other sources, €32 million); (b) Tunisia Disaster Resilience Program-for-Results (P4R), under which Bizerte is one of six municipalities participating in reducing flood risk and enhancing disaster preparedness, among other activities; and (c) new dam construction in south Bizerte slated to be completed by 2023.

Conakry, Guinea—Too Much and Too Little Water Exacerbating Climate Change Vulnerability

Located on a peninsula, Conakry suffers the hydrological challenge of too much salt water and too little consistent freshwater—a challenge further exacerbated by climate change and vulnerability. The projected increase in sea level is expected to be 0.4 m by 2070, which will mean greatly increased coastal flooding. This is intensified by poor waste management, lack of correctly designed drainage, as well as informal construction in flood-prone areas. Coastal recession is reaching 85 cm per year in some places, fueled by increasingly intense storm events

Figure 4. River Flooding and Coastal Erosion/Flooding Hazard Map of Conakry

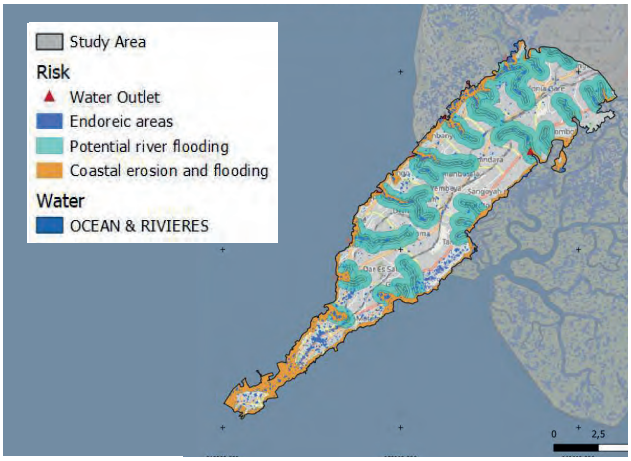
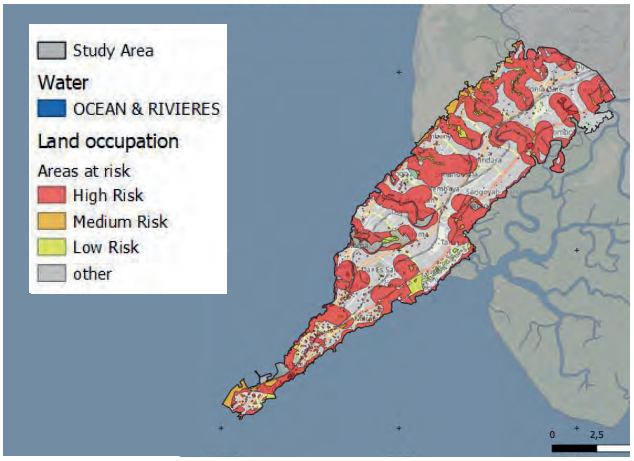


Figure 5. Flood Risk Map of Conakry



and sea-level rise. This is exacerbated by uncontrolled coastal development and destruction of mangroves.

The urban built environment within the city's borders has increased from 89 km^2 in 1990 to 116 km^2 in 2018 (30 percent). Between 1990 and today, the city has lost almost all its natural spaces, which have been replaced by built-up areas (green spaces currently represent 4 percent of the total area, down from 40 percent in 1990). Roughly 30 percent of the urban population in Conakry live below the poverty line, and more than two-thirds live in precariously built housing, greatly vulnerable to climate hazards. People's incomes are vulnerable to climate impacts on economic activities (fishery, agriculture, industries). Drinking water availability is a significant issue for a large part of the population.

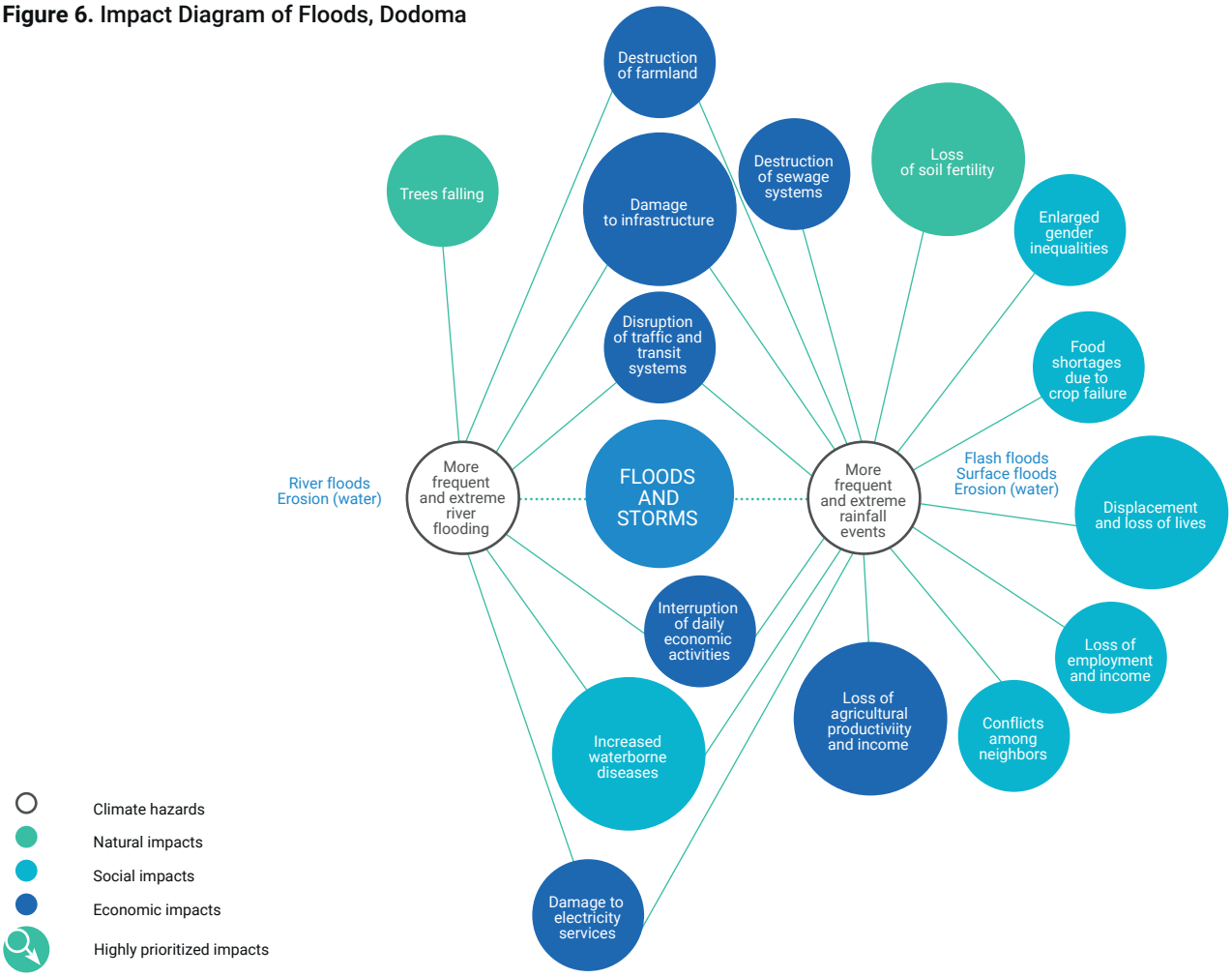
From an institutional perspective, the current urban regulatory framework is not sufficient to address climate change: there is a lack of urban planning and lack of enforcement of existing rules. There is spontaneous urbanization in flood-prone areas, for instance on riverbanks. Earth-filling in wetlands for urban development projects is blocking the natural catchment area of surplus water in case of heavy rainfall. Other activities such as mangrove wood exploitation (only one-fourth of the population are connected to the electricity network, the rest use firewood) and uncontrolled drilling of groundwater are contributing to water scarcity and hazardous conditions (e.g. increased coastal and soil erosion, resulting in increased flooding).

No-regrets measures identified include implementing NBS to reduce floods, heatwaves, erosion, and water-scarcity hazards; improving stormwater management infrastructure; integrating solid waste management and sewerage infrastructure; and limiting the impacts of coastal erosion through beach nourishment and coastal defense infrastructure. While a handful of plans and strategies exist that touch on climate adaptation, there is no project that specifically addresses urban climate adaptation issues, with the exception of the Guinea Urban Water Project (World Bank, US$30 million), which includes (a) expansion of water supply capacity at Grandes Chutes Dam; (b) rehabilitation of distribution network; (c) updated urban water supply masterplan, baseline and hydraulic modeling for Greater Conakry for the 2030 horizon; and (d) strengthening public-sector capacity for water resources management.

Dodoma, Tanzania—Heating Up in the Nation's Young Capital

Serving as the country's official capital since 1996, Dodoma is a relatively small city (approximately 580,000 residents) with low population density. Nearly 54 percent of the city's territory comprises scattered settlements and farming land as well as open space set aside for nature reserves and recreation. The City Master Plan of 2019 proposes a 20-year zoning and development plan to guide future urban development to accommodate a population that is expected to nearly triple (1.7 million residents) by 2040. Agriculture represents an estimated 39 percent of economic activity, followed by consumer services (29 percent) largely provided by the informal sector (food stalls, beauty salons, tailoring,

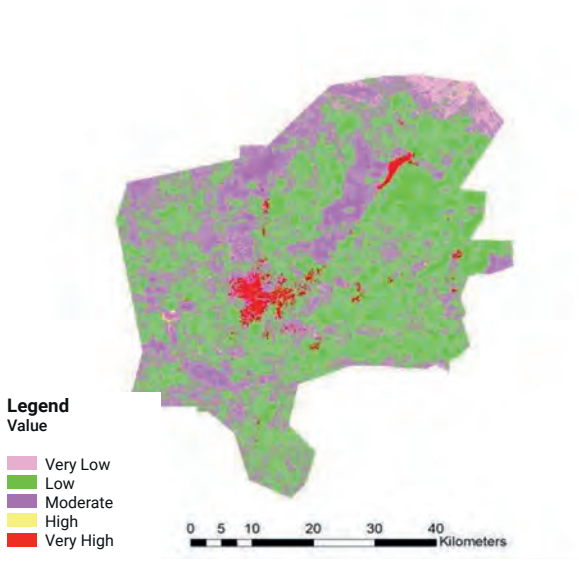
Figure 6. Impact Diagram of Floods, Dodoma



automobile repair) and industry (wood, foodstuffs, household consumer goods).

Located on high-elevation, semi-arid plains, with poor soil permeability of surface water, Dodoma is increasingly affected by heat, drought and water scarcity. This is particularly concerning given the high proportion of the population dependent on agriculture. To a lesser extent, floods and storms are an issue. By current estimates, average maximum temperature is expected to increase by 1.3–1.8°C by 2050, with an almost nine-fold increase in total number of very hot days (>35°C), from 9 days currently to 87 days in 2050. This is particularly concerning as the city's economic production is heavily reliant on agriculture; this will also significantly impact water availability. Within the city as well, increases in very hot days are likely to result in an urban heat island effect, which is expected to impact the poor and most vulnerable living in informal

Figure 7. Flood Hazard Map, Dodoma



Source: Drainage and Sanitation Development Plan, Dodomo City, 2019

settlements and possessing the least financial means of being able to afford cooling equipment.

A series of no-regrets measures identified include promotion of climate-resilient farming practices (including drought-tolerant seed varieties and technologies), increasing large-scale water storage capacity to relieve pressure on dwindling groundwater resources, and promoting city greening initiatives to reduce heat island effect. These efforts would complement recent initiatives that include (a) Eco-Village Adaptation to Climate Change in Central Tanzania—Dodoma (European Commission, US$2.2 million); and (b) various sub-projects implemented under the Tanzania Strategic Cities Project (TSCP) involving climate-resilient drainage and sewerage infrastructure, solid waste management (World Bank, ~US$11 million); (c) construction of a new Farkwa dam to augment water supply (AfDB); and (d) an urban greening initiative, Make Dodoma Green, to reduce urban heat island effect and improve urban livability and public health (City of Dodoma resources).

Figure 8. Libreville Hazard Map

Libreville, Gabon—Assessing Climate Risk in a Young but Data-Poor City

With more than a third of the country's population living in Libreville (and nearly 80 percent of the population living in the top four cities), Gabon maintains one of the highest urbanization rates in Africa. Much of this urban growth is recent, with Libreville's population increasing 20-fold since Gabon's independence in 1960 to nearly 900,000 in 2022. With this rapid growth came a change in demographics, landscape and governance structure. Currently, more than half the city is under the age of 25, with nearly 87 percent below the age of 50 years. 80 percent of urban inhabitants live in "under-integrated districts," which are characterized by informality, uncertain tenure and insufficient urban service delivery. Green cover has reduced from 75 percent of Libreville city center to 5 percent in 1996. Most of the municipal budget is dedicated toward staffing, leaving little left for future investment or even maintenance of existing infrastructure.

There is hilly terrain in the city's center, and flat plains in the city's north and northeast. Wealthier neighborhoods are concentrated on the hilltops and the oceanfront, while lower-income neighborhoods are concentrated in the valley. Flood risk affects more than 37 percent of the population and more than 42 percent of the city's surface area, exacerbated by insufficient solid waste management and high

prevalence of littering and dumping. And while a national statute stipulates that municipalities are responsible for management of sanitation and drainage, transfer of powers and responsibilities has yet to take place, resulting in national ministries (Ministry of Public Works, Equipment and Infrastructure; Ministry of Energy and Hydraulic Resources) being still responsible for the provision of such services. Land is managed under a combination of civil land law and customary law. Such traditional governance is particularly prevalent in the old Libreville districts as well as informal communities.

Given these challenges, the RCRA relied heavily on primary research and field surveys of public perception in the city's first, third and fifth districts, to make up for the relative dearth of urban information. (For example, there is only one meteorological station in Libreville at the airport—one of only three in the entire country). Rainfall stations date from 1974, and are currently out of service. Existing projections are largely at the national scale from global models, with virtually no downscaled information available for the local level. In inquiring about flood and storm risk to the city, the primary impacts are felt in the destruction of urban infrastructure and housing, public health, access to drinking water and jobs. Given the high degree of informal development in Libreville, many of the no-regrets measures identified align closely with sustainable urban development that is climate-resilient and include improving solid waste management, land-use planning, roads, drainage and flood defense as well as water supply. Planned climate-adaptation projects include (a) stormwater drainage construction project (Development Bank of the Central African States, ~US$115 million); (b) stormwater management and sanitation infrastructure under Local Infrastructure Development Project—Phase II (World Bank, US$100 million).

RECOMMENDATIONS

This section offers common recommendations and lessons learned from implementing the RCRAs across five cities, followed by next steps.

1. **Recognize the value of qualitative data:** Often, when we think of climate risk assessments, we think of hazard and risk mapping. Without doubt this is a critical aspect of an assessment, but it does not always have to be quantitative. Since RCRAs are meant to be quick and cost-effective, there often is not enough time or resources to develop a full quantitative picture of a situation on the ground. Qualitative information has its value as well, especially in environments that are data-poor. And when seeking to address the needs encountered among informal communities and the poor, qualitative mapping and information can sometimes be equally, if not more, informative and cost-effective. This is true especially where the predominance of the informal market in cities means that there is likely to be no quantitative data at all—whether regarding service delivery and provision or land and housing markets. Employing field surveys to gain perception data can be a start that will inform future quantitative work, as was done in Libreville.

   RCRAs acknowledge and recognize that generating any kind of data 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.

2. **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.

   Investment decision-makers often sit within line ministries that have line budgets (as opposed to climate change agencies, which often serve

more of a coordination function and do not actually make decisions related to investment). Often municipalities rely on national ministries for securing investment within cities, which further became apparent during the RCRA process, whereby national ministries are involved in local infrastructure planning, investment, implementation and upgrade. To this end, while the primary locus of interaction is the municipality, national line ministries will inevitably have to be involved when talking about future climate investments. It is therefore an advantageous opportunity to utilize the RCRA process to bring such decision-makers into the process early—at the very least to ensure their needs, incentives and challenges are reflected in the final assessment.

3. **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 itself is interested in seeking climate adaptation investment (and it is clear that the RCRA process is a first step in getting to there). 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.

   Importantly, a strong local champion within the municipality can also help in the generation of data. In Libreville, for example, the firm involved local municipal authorities in the enumeration and surveying, accompanied by a training session on key concepts regarding climate adaptation and resilience. Not only did the municipal civil servants become more familiarized with climate change concepts, they also received a learning-by-doing training in primary research methods when implementing the questionnaire with the firm—which can be used for other future activities.

4. **Informality represents a significant portion of urban economies in the developing world and must be understood if climate adaptation activities are to be effective:** Getting information on the informal economy often requires qualitative data gathering, further underscoring the importance of having a local city advisor with familiarity with local communities and local stakeholders (e.g. community officers).However, this requires significant money, time and resources as often there is limited literature on the informal economy within the city, and understanding this sector will require new knowledge generation.

   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 helpful in answering questions pertaining to informality or making the contacts needed to gain this perspective. A

Photo: Tommy Trenchard/Panos Pictures

semi-structured interview with a well-informed set of socially focused counterparts can serve as a critical input to an RCRA—to at 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).

Still, understanding everything about the informal sector (in the context of climate and climate adaptation) is hard to accomplish under an RCRA process alone. RCRAs can serve as an initial review of what items of the informal sector and economy are worthy of being understood (in the context of urban climate adaptation) for follow-on research and investigation. This can be done through a combination of semi-structured interviews, analysis, and desk review.

5. **Dedicate time and space for reflective learning and experience exchange:** As a major incentive for implementing RCRAs stems from a long-term goal of identifying climate adaptation investments and policy reforms, the generation of assessments can easily become supply-driven (or perceived simply as a step toward an end). Still, it is important to also appreciate the collaborative nature of the RCRA process in itself, by which common understanding is developed and joint knowledge created. An RCRA can often serve as a codified document summarizing the overall state of climate adaptation within a city, providing a basis for collaborative governance, integration of different knowledge domains across sectors, as well as a consensus-building tool among various interests in a city. In all, RCRAs provide opportunity for reflective learning—a critical component of resilience planning.

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-regrets 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.

Opportunities for reflective learning include through collaborative platforms such as the GCA Water Adaptation Community (WAC) (Box 4). The WAC has been promoting the RCRAs and inviting comments and engagement with the wider community of practice on risk assessments. This enables tapping into the existing body of experience from past risk assessments at a global level and the lessons learned from them. It also provides feedback on the right course of action. For the RCRAs described in this paper, the WAC will host a discussion webinar inviting key actors from the cities and firms involved, discussing the outcomes of the assessments—including the methodology, process and lessons learned.

Moving forward, the GCA RCRA methodology has been further fine-tuned based upon implementation experience shared by both the supervision team and firms, taking into account what items worked, what did not work, and what could be improved. These changes will be reflected in the implementation of GCA RCRA methodology in a second batch of African cities. The GCA RCRA methodology is subject to continuous improvement based upon additional acquired implementation experience and implementors' dialogues and knowledge exchanges (as detailed in Box 4).

With continued experience and more cities included, it will become possible to work out what ideas can be scaled up, drawn from the unique challenges of individual cities. For example, in the second batch of cities, an RCRA will be implemented specifically in a large informal section of a major African city—to not only understand the climate risk context, but to also gain experience in overcoming common

Box 4. The WAC as a Reflective Learning Tool

The WAC is a global multi-stakeholder platform for knowledge and action with an overarching goal to scale up and to accelerate water adaptation. It aims to support collaboration, learning, and practical action for water adaptation and resilience. It acts as a broker between solution seekers and solution providers in the water cycle. It has as one of its focus areas urban adaptations, to support urban actors to adapt to climate impacts through risk assessment and learning about urban adaptation solutions. WAC supports practical action and peer-to-peer learning through exchanges and Communities of Practice (CoP), including NGOs, scientists, experts, policymakers and decision-makers. It collects, consolidates, and supports knowledge brokering and innovation through stories, case studies, blogs, webinars and e-learning.

WAC works off the belief that climate adaptation actions, in general, require cross-sectoral knowledge integration. For this purpose, all around the world, platforms for knowledge exchange and learning such as WAC are becoming more important in urban areas, which can involve multiple actors, with different types of knowledge, bringing together knowledge relevant for cross-cutting actions. Knowledge integration also works to create innovations. Learning can be incremental, which is the most common and easy type of learning and involves adjusting established actions. However, there is also a need, from time to time, to allow for more bold learning, for example, when new practices are needed, such as NBS. Here, it is difficult to build on established actions, but fundamental principles of the work need addressing, which may feel challenging to the owners or stewards of established practices. For example, today many NBS are being brought in to complement drainage pipes, but they come with a whole set of different policy, financial and organizational requirements, which demand active changes by the local management, and sometimes also at the national level. To enable such changes, an ongoing dialogue is needed, to improve existing actions that we know are working, and at the same time have the capacity to embrace innovation and change.

implementation challenges such as gathering information using research methods that involve local community members. Recommendations and lessons learned will be distilled and tabulated so as to provide tips-of-the-trade to other actors implementing climate risk assessments in similar contexts.

Photo: Tim Dirven/Panos Pictures Pictures

Adaptation in the Desert to Power Program

Photo: Pascal Maitre/Panos Pictures

The need to invest in the resilience of energy production and distribution networks to climate change is becoming increasingly critical as the global energy and climate crises expose vulnerabilities in existing systems across the world and in Africa. Designing and operating the physical components of these energy networks to reflect climate change impacts is an important measure in building resilience into energy systems. In addition to energy production, it is important to also address climate risk for the supporting infrastructure—particularly the transmission and distribution systems—that transfer power to consumers and generate revenue.

The Sahel region is already highly exposed to the impacts of climate change. The Global Center for Adaptation's (GCA) climate hazard profile for the region, illustrated in Figure 1, reveals that historical and projected climate trends of the West Africa Sahel indicate an increase in the average temperature of 0.6° to 0.8°C higher than the global average between 1970 and 2010; by 2100, the region can expect an average temperature rise of 3° to 6°C. Droughts in the region are becoming increasingly intense, with temperatures rising 1.5 times faster than in the rest of the world. At the same time, climate change is also causing heavier precipitation, leading to destructive floods, such as in Mali and Niger in 2019. These hazards represent a severe threat to the livelihoods of more than 80 percent of the population, particularly in rural areas. Despite these risks, infrastructure assets, which provide critical services for people and the economy, are not currently being designed and operated to withstand climate risks and hazards.

While climate-related hazards are a concern for the region, the Sahel also provides opportunities to generate power through its tremendous renewable energy potential. The African Development Bank (AfDB), along with the Green Climate Fund, is leading efforts to tap into this potential through

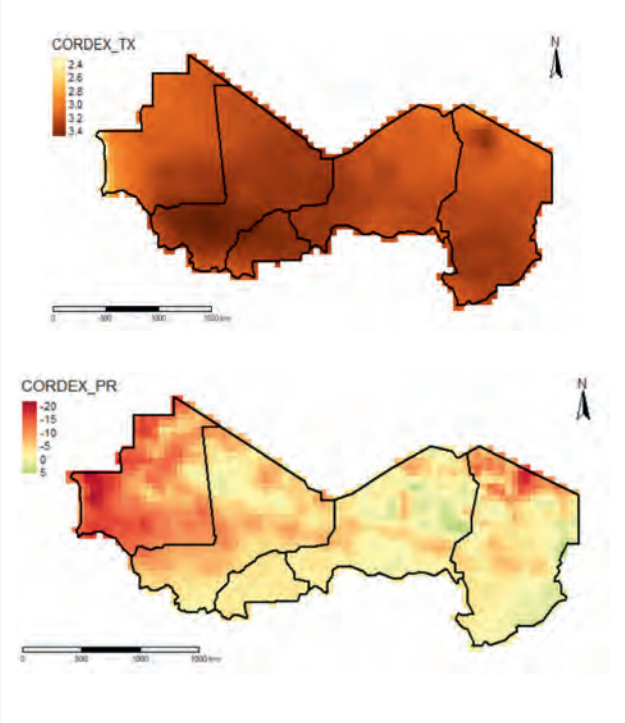
the flagship US$966.7 million Desert to Power G5 Sahel Financing Facility. This program, covering the countries of the G5 Sahel (Burkina Faso, Chad, Mali, Mauritania, and Niger), falls under the broader Desert to Power Initiative of the AfDB, which aims to support the achievement of the Sustainable Development Goals (SDGs) by installing 10GW of renewable energy–generation capacity and providing electricity access to over 250 million people across 11 African countries.

The Desert to Power G5 Sahel Financing Facility is designed to leverage and attract private-sector financing to facilitate up to 500MW of solar energy–generation capacity through Independent Power Producers by providing favorable loan conditions coupled with partial risk guarantees. It also complements investments made by the World Bank and the International Finance Corporation (IFC). The investment program is also a key pillar of the Great Green Wall Initiative. It aims to transform the desert region into an opportunity to address Africa's energy needs and to use clean technologies to deliver adaptation benefits, mobilize private-sector investments in solar projects, and develop institutional capacity in the Sahel countries to ensure long-term sustainability of their renewable energy programs.

The GCA is working with the AfDB and client governments in the region to ensure that assets and networks financed under the Desert to Power Initiative are resilient to projected climate change. GCA will provide upstream climate risk and vulnerability analytics to ensure that investments are designed to optimize the financial and operational performance of assets under projected climate-hazard and risk scenarios. GCA will also screen projects for climate-risk vulnerability assessment and provide practical risk management and climate-adaptation options to climate-proof investments in assets and the services they provide.

GCA's support for Desert to Power investments brings a new perspective on renewable energy investments as a core intervention for climate adaptation and resilience. Diversifying away from fossil fuels not only reduces carbon emissions but

Figure 1. Projected Climate Change by 2100 in the G5 Sahel Region



Source: GCA with data from WMO and CORDEX

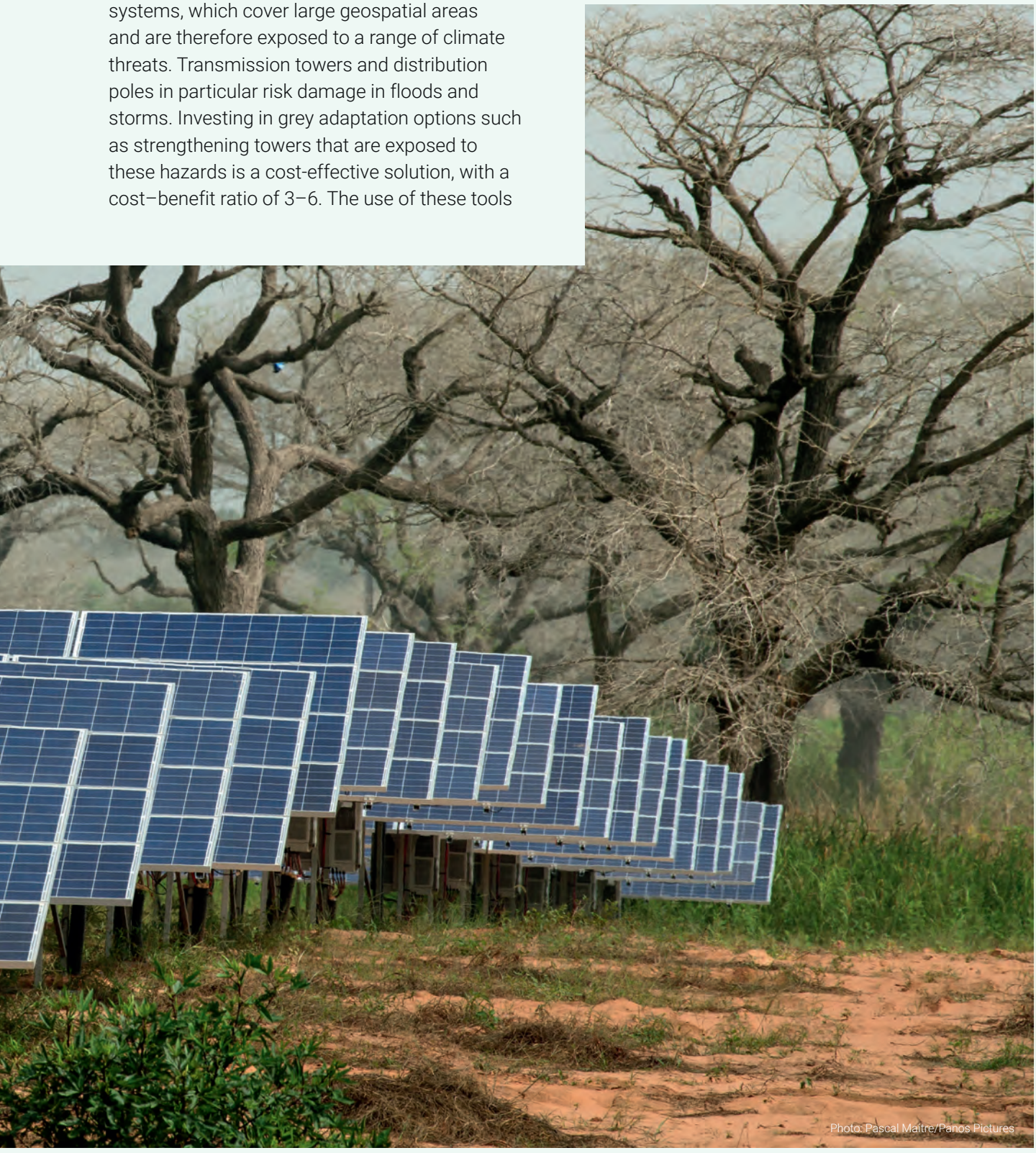
can also help build the resilience of energy systems that support people and the economy. In addition, designing and operating these physical assets to reflect climate-related hazards is an important measure in ensuring that climate-related damages to physical assets are minimized.

GCA is developing a Climate Hazard Geospatial Screening Tool to help client countries to optimize site locations of the solar plants and other key assets to avoid climate hotspots where possible. Solar photovoltaic panels, for example, are vulnerable to extreme heat and lose efficiency and risk burning out above 45°C. At the same time, floods can damage installations. Integrating grey and green solutions, such as elevating key assets, building flood walls, adjusting asset management protocols, and developing natural solutions to cool the systems, can have a cost–benefit ratio of 5–10, indicating a positive net present value.

GCA's support to develop climate-adaptation investment appraisals will leverage these returns by quantifying climate risk for solar generation assets and proposing cost-effective adaptation design solutions. In addition to informing the sovereign lending operations under the project, this data-driven approach to identifying and quantifying climate risk will be critical in informing the design of public–private partnership (PPP) components of the investment program. GCA will apply the principles and recommendations developed under

the Toolkit for Climate Resilient Infrastructure PPPs to mainstream adaptation in the PPP transaction structure and design.

In addition to energy-generation assets such as solar panels, the screening tool will be used to assess climate risk for critical supporting infrastructure, particularly the transmission and distribution systems, which cover large geospatial areas and are therefore exposed to a range of climate threats. Transmission towers and distribution poles in particular risk damage in floods and storms. Investing in grey adaptation options such as strengthening towers that are exposed to these hazards is a cost-effective solution, with a cost–benefit ratio of 3–6. The use of these tools in designing the Desert to Power investments will be mainstreamed through Climate Risk Dialogues and through an innovative Masterclass on Climate-Resilient Infrastructure with Senegal's Cheikh Anta Diop University (UCAD) to help build upstream capacity within the G5 Sahel countries.



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