Africa ‘Climate Infrastructure Trap’ in Energy and Transport Sectors

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1. Context

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

Projections estimate that climate change will cause a 2 percent to 4 percent annual loss in GDP in the region by 2040. The brunt of the impact will be borne by the poor, women, and currently marginalized or excluded populations. Even if international mitigation efforts keep global warming below 2°C, the continent is expected to face climate change adaptation costs of US$ 50

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billion per year by 2050. Meanwhile, the continuing COVID-19 pandemic has been a severe disruption, straining resources in many countries.

Moreover, poor infrastructure continues to hinder economic growth in most African countries and climate risks are affecting infrastructure development strategies and investments. Rising temperatures, changes in rainfall patterns and intensity, and the increasing frequency of extreme weather events are leading to losses in asset values, higher operating costs, and reductions in the economic benefits that infrastructure generates.

Infrastructure systems and their component assets, some of which are decades old, are not planned and built to withstand the impacts of climate change and climate hazards. They are also often distributed over large spatial domains, and inevitably exposed to climate hazards such as droughts, flooding, storms, heatwaves, wildfires, landslides, and sea-level rise. Damage to these assets not only disrupts social services in the short-term, but also exact a significant long-term human and economic toll. Drought-induced power shortages in Zimbabwe and Zambia, for instance, have had cascading impacts on water, health, connectivity, and supply chains and businesses. In Tanzania, businesses lose US$ 101 million, or 0.3 percent of the national GDP, annually due to power outages caused by rain and floods; and US$ 150 million, or 0.4 percent of the GDP annually, due to transport disruptions caused by flooding.³

In the aftermath of climate-related damage, governments are forced to divert what limited public funding there is to rebuild, or in more extreme cases, reconstruct, instead of investing in new infrastructure to make up for existing deficits. This combination creates an “infrastructure trap” – vicious cycles of repeated acute and chronic climate shocks that risk halting economic growth and disrupting or even reversing progress towards achieving the Sustainable Development Goals (SDGs).

Investing in climate-resilient infrastructure is critical to adapting to a warming world. Infrastructure spending and access to infrastructure services is a key contributor to development, economic growth, and poverty alleviation in Africa. Investments in rural infrastructure, in particular, can lead to higher farm and non-farm productivity, employment and income opportunities, and increased availability of wage goods, thereby reducing poverty by raising mean income and consumption.⁴ However, with governments already under pressure, the ability to invest in new infrastructure in Africa is further strained by climate-related impacts and by the repercussions of COVID-19, which slowed down overall GDP growth in Africa to 2.1 percent in 2020, causing the continent’s first recession in half a century.⁵

Current adaptation finance flows to Africa are insufficient to meet growing adaptation needs on the continent. Globally, an annual average of $30 billion in adaptation finance was tracked for 2017 and 2018, mostly provided by public actors (DFIs alone accounted for 67 percent of the total).⁶ Due to data limitations, nearly all flows tracked are from international public finance. Just over $6 billion was tracked in adaptation finance to Africa in that period. If this trend continued through 2030, total finance from 2020–2030 would only amount to $66 billion, far short of the $331 billion (or approximately $30 billion annually) in estimated needs per stated cost estimates

in NDCs. Adaptation finance is therefore scaling up too slowly to narrow the gap, even as the costs of climate impacts rise. Of the $6 billion in adaptation finance tracked, grants and concessional debt accounted for approximately 90% of financial flows to adaptation in Africa. Two sectors—agriculture, forestry, land-use, and natural resource management; and water and wastewater management—combined to receive 62% of total adaptation finance in 2017–18. Most of the finance flowed from Development Finance Institutions (DFIs) both from the region and external to Africa: multilateral, national, and bilateral DFIs contributed and managed 67% of total adaptation finance flows to the region, followed by bilateral government flows at 19%. The most vulnerable countries in Africa have not been recipients of proportionally high volumes of adaptation finance.

It is crucial that climate adaptation finances increase substantially and investments in infrastructure in Africa are sustainable and resilient. This requires a fundamental systemic transformation. A revolution in the planning, design, financing, and delivery of infrastructure is urgently needed to meet the acute needs of warming Africa. Climate-resilient infrastructure planning needs to begin ‘upstream’ in the early planning stages; be integrated across sectors and activities at a strategic level; make use of better analytical tools to understand climate risk at a systems level; and prioritize resources for building resilience. In addition, nature-based solutions for adaptation should be promoted, and engineering standards improved to enhance resilience of individual assets.

This viewpoint analyzes how climate change impacts infrastructure in Africa, with a focus on the energy and transport sectors, with sobering implications across social, economic, environmental, and development outcomes. It is based on the 2021 flagship Global Center on Adaptation (GCA) State and Trends in Adaptation Report 2021: Africa.

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

2. Understanding the impacts of climate change on infrastructure in Africa

The impacts of climate change on infrastructure can be acute or chronic. Acute climate impacts cause a sudden shock to the system, often from an extreme event such as a flood. The event may have widespread impacts (like coastal flooding) or may be very localized (as in a landslide). Chronic impacts of climate change can build up over time. Higher temperatures, for instance, can lower the generation efficiency of power grids over the years, increase losses in transmission and distribution, and decrease the lifetime of key equipment. High temperatures can also shift demand for certain types of infrastructure, for instance by creating additional demand for energy for cooling and air conditioning. While the demand for such infrastructure and the value it generates will increase with climate change, investing in climate resilient infrastructure will bring economic benefits and a range of other socio-economic gains.

Disruptions in critical services

The disruptions caused by climate-related damage to infrastructure can cascade into major societal and economic disruption. For instance, flooding of road networks has significant implications for access to healthcare infrastructure. Climate impacts on infrastructure also pose significant barriers to the connectivity of supply chains. In 2000, flooding in south Mozambique destroyed road links between the capital city, Maputo, and the rest of the country for almost one year, including the rail line to Zimbabwe. This reportedly led to Mozambique’s per capita
economic growth to decline to 1 percent in 2000 – the lowest level in two decades. Several coastal African countries rely almost exclusively on maritime transport for imports and exports, many from a single port, and could suffer crippling disruptions in trade due to sea level rise and flooding. Guinea, Liberia, Mauritania, and Sierra Leone, for example, transfer more than 97 percent of all imported goods through ports.\(^7\)

**Long-term socio-economic impacts**

Disruptions in energy and transport infrastructure can quickly cascade into unforeseen disruptions on wider socio-economic development, including in key sectors like healthcare (SDG 3), education (SDG 4) and agriculture (SDG 2). They can exacerbate and further entrench existing barriers to Africa’s integration and competitiveness in global markets. Seemingly minor disruptions can have significant repercussions on supply chains. Critically, the cost of repairing and building back assets after they are hit by climate hazards diverts funding from building forward.

**Investments fall short of need**

The benefits of investing in climate adaptation and resilience are increasingly becoming clear. Research from the Global Center on Adaptation (CCA) finds that making infrastructure more climate resilient will have additional upfront costs of 3 percent, but returns can be four times the initial investment.\(^8\) In addition to quantitative economic returns, these investments also have important social returns, influencing the attainment of most of the SDGs.

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

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\(^8\) GCA (2019). *Adapt Now: A global call for leadership on climate resilience*. Global Centre on Adaptation, Rotterdam.

Existing investments in making infrastructure climate resilient also hide significant regional and socio-economic disparities, exacerbating gaps in access to basic infrastructure services. A comparison of the total flow of global funding for adaptation for the transport and energy sectors with the vulnerability of infrastructure calculated by the Notre Dame Global Adaptation Initiative (ND-GAIN) index highlights that the most vulnerable countries received the least investments (Figure 2).

3. Key considerations for making infrastructure resilient

As African governments take on the daunting task of building resilience into infrastructure, they will face many difficult decisions and challenges.

*Begin at the beginning*

The best opportunity for managing climate risks is when infrastructure projects are being conceived. Adaptation and resilience should be proactively embedded throughout the life cycle.

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10 The ND-GAIN Index indicates countries’ vulnerability to climate change in combination with readiness to improve resilience. The data used for this analysis presents the vulnerability (exposure, sensitivity, and adaptive capacity) of the infrastructure sector for countries in Africa for the year of 2018.
of infrastructure planning, project preparation, finance, design, delivery, operation, and maintenance. This requires a strong commitment from governments (national, city, and local), who play leading roles in steering the provision of infrastructure, and in mainstreaming sustainability through adaptation.

Such ‘proactive adaptation’ in the energy and transport sectors in response to climate change is a no-regret option. Energy supply in low-income African countries is particularly vulnerable due to their higher dependence on hydroelectricity and biomass energy supplies. According to the World Bank, the early integration of resilience in hydropower infrastructure, considering the river basin level and predicted changes in rainfall patterns in the pre-feasibility, planning and design stages, can considerably reduce and mitigate future climate risks in a cost-effective manner.  

**Account for uncertainty**

Investment decisions need to account for the significant uncertainty and local variability associated with climate change in Africa. The impacts and nature of climate change will not be equally distributed across Africa. Zambia, for instance, is projected to experience more extreme climate events than neighboring Malawi and Mozambique. Countries such as Angola, Nigeria, Botswana, Togo, South Sudan, Mozambique, Benin, and Cameroon will be exposed to significant precipitation-related disruption even from moderate climate changes. These geographic differences have implications for the design of adaptation responses.

**Consider indirect costs**

Investments in proactive adaptation (which anticipates climate change and incorporates upstream resilience into the design, construction, and rehabilitation of infrastructure) often don’t seem justifiable. In Nigeria and the Democratic Republic of the Congo, for example, proactive adaptation for key bridges is likely to be economically justifiable because they provide critical links within the countries, and there are no alternative routes. The first step is to understand these wider, indirect impacts and costs. Ghana is taking the lead in assessing systemic risk by enhancing capacity to assess how climate change will impact existing and planned energy, transport, and water infrastructure systems and services.

**Integrate ‘green’ with ‘grey’**

The integration of nature-based solutions (NbS) in infrastructure planning and decision-making – including the restoration, protection, management, or creation of natural and semi-natural terrestrial and marine ecosystems – can make infrastructure more sustainable and resilient. In the energy sector, NbS can safeguard the storage capacity of hydropower reservoirs during droughts or high temperatures by regulating and storing water, recharging groundwater supplies, and reducing sedimentation. The degradation of catchments in Kenya, for instance, has already led to high sedimentation of two hydropower reservoirs along the Tana River, and reduced total


reservoir storage capacity by as much as 10-15 percent within the last three decades. NbS can also help regulate water flow to reservoirs during high rainfall events and reduce the frequency at which dams need to be discharged. In Ghana, for instance, the Atewa Forest regulates water flow to the Weija Dam, reducing the need for discharge, and preserving downstream infrastructure and communities. In the transport sector, NbS can increase the resilience of assets by shading and cooling. This slows the deterioration of streets and pavements, decreases maintenance, and provides additional benefits such as improved water management and more productive use of land. Green spaces, green roofs, and green walls can safeguard roads in African cities by improving stormwater management, and at the same time reduce the need and costs of engineered solutions such as stormwater drains.

Leverage public-private partnerships

Leveraging public-private partnerships (PPPs) for climate-resilient infrastructure can help countries in Africa to mobilize funds to bridge the existing infrastructure gap, while accounting for climate change. The incentive structure of PPPs provides opportunity to establish project requirements that include resilient and adaptive assets or services.

While African governments are increasingly turning to PPPs to attract private capital for infrastructure projects, the World Bank’s Private Participation in Infrastructure (PPI) database shows that Africa has secured less than 7 percent, or only US$ 74.8 billion, of global PPP investments over the last decade. In sub-Saharan Africa, PPP investments between 2010 and 2020 amount US$ 59.3 billion, directed to 275 projects mainly related to electricity, ports, and information and communications technology. Only seven of these PPPs were for road networks. If the PPPs integrate climate resilience and adaptation considerations, they could contribute to bridging the existing infrastructure gap in Africa.

Optimize lifecycle costs

Investments with lower up-front costs are attractive for countries that need to bridge infrastructure access gaps within significant financial constraints. However, this can result in higher lifecycle costs due to climate change, where countries must spend large amounts to repair and maintain infrastructure.

Mainstream adaptation in infrastructure networks

Various agencies hold different responsibilities across the infrastructure lifecycle for data collection, sharing and management resulting in disconnected solutions across the sectors. The technical nature of climate change impacts requires specialized knowledge, understanding, and skills in developing targeted solutions for infrastructure resilience development and management. Transport and energy sectors will require new tools and approaches that allow climate and disaster risks to be systematically identified, prioritized, and built into investment planning and decision-making processes. These range from upstream sectoral assessment and spatial planning to post disaster risk and recovery support; and from infrastructure system solutions and support, to building an enabling environment.

4. Charting the way forward

The scale and multi-sectoral scope of interventions to increase infrastructure adaptation and resilience creates a complexity that is difficult to navigate. Together with African governments, many private and public investors are already exploring – or have committed to – major new infrastructure projects over the next decade. Africa’s current pipeline of infrastructure projects includes US$ 2.5 trillion worth of projects estimated to be completed by 2025, across all asset classes. Over 50 percent of these projects are still in the early feasibility stages, and while not all of them are expected to succeed, will a critical mass of the projects that move from feasibility to completion be resilient to climate change? The answer to this question will determine whether Africa will progress in closing its infrastructure gap, and climate-proof these investments to make them sustainable and resilient. The following recommendations help chart the way forward:

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

• **Invest in integrated systems to generate data for investment planning.** To bring down the cost of the analysis needed to integrate climate considerations into energy and transport development, and to mainstream systemic risk and resilience, significant amounts of data on climate, infrastructure assets, supply chains, the environment, economic activities, and other socioeconomic aspects is needed. Most African countries and their development partners already have existing systems and projects that generate the required data, but these systems are siloed and mostly disconnected from decision-making processes. While data alone will not increase infrastructure adaptation and resilience, it is a vital entry point for putting in place the building blocks for climate-smart investments in infrastructure. African countries should focus on two priorities: Climate data and Infrastructure asset data. This will also improve assessments of key vulnerabilities of infrastructure when used with the climate data and will help to prioritize investments.

• **Invest in tools and methodologies to quantify energy, transport, and infrastructure-related ecosystem services provided through natural assets.** NbS, implemented on a large scale, could reduce costs by 90 percent for the same level of adaptation benefits. There is a need to ensure sharing of research within and across sectors, and to standardize methodologies and approaches for integrating NbS in infrastructure planning and implementation where appropriate, while recognizing the context-specificity of NbS projects.

• **Leverage PPP frameworks that promote incentives for climate resilience and adaptation of infrastructure projects.** While PPPs represent a relatively small proportion of infrastructure investments in Africa, they provide a clear entry point for integrating adaptation and resilience into infrastructure design and asset management. A robust PPP framework is imperative to attract private capital for infrastructure, particularly in Africa where market conditions are more sensitive, given the complexity of PPP projects, contract size, and risk exposure.

• **Governments must drive reforms for improved operations and maintenance asset management.** Planning, designing, and financing climate-smart infrastructure represents only

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one portion of the infrastructure lifecycle. Asset management is often ignored or de-prioritized in the drive to finance and increase infrastructure capacity in Africa. Countries must enhance fundamentals of climate-smart infrastructure governance by reflecting climate change in asset management practices through clearly defined system performance metrics and levels of service. Specific recommendations to integrate climate change into asset management practices include: defining requirements; assessing climate impacts on the asset base; developing climate-smart capital works strategies; integrating climate risk in financial plans; and integrating climate change and hazard data in management information systems (MIS).
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