SEI Stockholm Environment Institute

Enhancing the climate resilience of Africa's water and energy infrastructure

SEI Fact sheet
October 2019

Sub-Saharan Africa is not a significant source of greenhouse gas emissions, but it is already feeling the effects of climate change. Extreme weather events – such as floods, droughts and storms – threaten this region's economies, and underscore the need for climate-resilient infrastructure.

SEI evaluated seven major river basins in the region: those of the Congo, Orange, Niger, Nile, Senegal, Volta, and Zambezi rivers. These basins hold strategic significance in terms of hydropower, basic water supply and irrigation potential; together, they account for some 200 gigawatts (GW) of hydropower generation capacity and have the potential to increase irrigation capacity by more than 60%.

For each basin, SEI created a model in its Water Evaluation and Planning (WEAP) system. These models enabled users to estimate streamflow, as well as domestic and agricultural water demands, under various climate futures – and to explore different management strategies and investments under a range of uncertainties. Using these models, SEI:

1. Evaluated a range of climate change impacts on roads, hydropower, domestic water use, and irrigation, in various climate scenarios.
2. Developed and tested a framework for "robust" investment decision-making under a wide range of climate outcomes.
3. Formulated actionable recommendations for decision-makers on how to enhance the climate resilience of infrastructure development.

Motivation:

Africa needs to invest upwards of US$90 billion per year to fill its infrastructure gap.[1] To address this, the Program for Infrastructure Development in Africa – or PIDA – lays out an ambitious long-term plan for closing Africa's infrastructure gap by 2040. This plan not only aims to improve access to water, sanitation, roads and electricity; it also includes increases in hydroelectric power generation and water storage capacity.

Based on PIDA, SEI developed a reference scenario in WEAP for infrastructure investment in Sub-Saharan Africa through 2030, as well as alternative scenarios to increase resilience. Armed with such models, policy-makers were able to articulate the need for investments that reduce vulnerability in basic water supply, food security and hydropower generation.

IMAGE (ABOVE): The Gariep Dam on the Orange River © JANROODE / GETTY

1 http://infrastructureafrica.opendataforafrica.org/yvnqdbf

Methodology:

SEI's approach acknowledged that uncertainty in climate change runs deep. Researchers not only identified which adaptation options were the most robust – and thus the most likely to be resilient under an uncertain climate future – but also emphasized that policy-makers should consider such options during the planning phase of infrastructure. Plans that integrate adaptation can better mitigate the negative effects of climate change, as well as take advantage of any beneficial side effects.

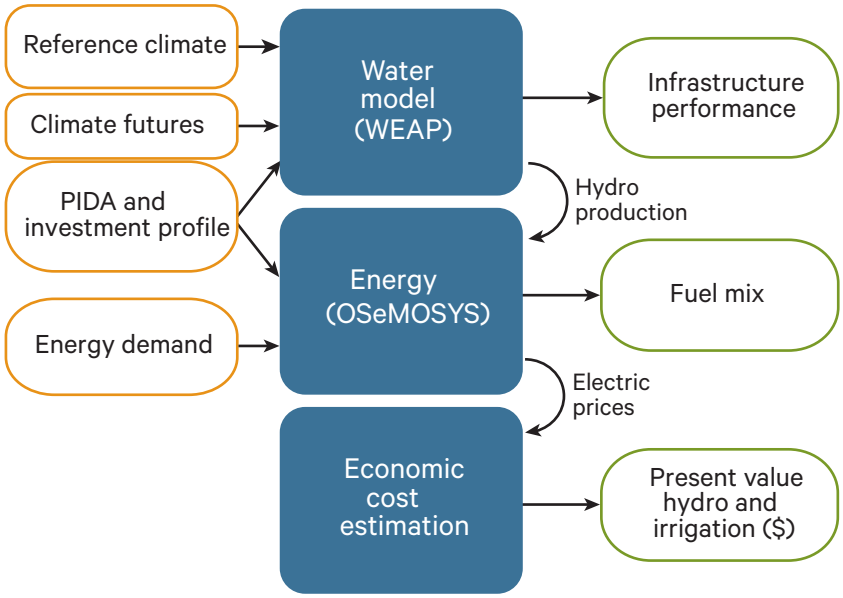
The key elements of the approach included:

1. Setting a reference scenario for infrastructure investment in Sub-Saharan Africa through 2030, based on the Program for Infrastructure Development in Africa (PIDA).
2. Developing a PIDA+ investment scenario that included irrigation investments.
3. Estimating the impacts of a broad range of climate change forecasts on the physical and economic performance of each basin's infrastructure.
4. Identifying a set of potential adaptations to these climate change effects.
5. Identifying a "robust" adaptation alternative that provides resilience to the broadest possible range of forecasted climate change scenarios.

SEI used a wide range of climate futures for Sub-Saharan Africa – all developed with the same methodology and integrated in WEAP – as well as the latest techniques for interpreting the results of general circulation models. Researchers used both the Water Evaluation and Planning (WEAP) system and the Open Source Energy Modeling System (OSeMOSYS), which is a systems optimization model for long-run energy planning.

SEI researchers linked the WEAP analyses of hydropower production data for the seven basins with the energy models in OSeMOSYS, which then ran an optimization routine to estimate an electric energy price trajectory for the reference case infrastructure. An overview of the process flow for these modeling tools is provided in Figure 1.

Figure 1. Schematic of model interactions to estimate the cost of climate change to infrastructure

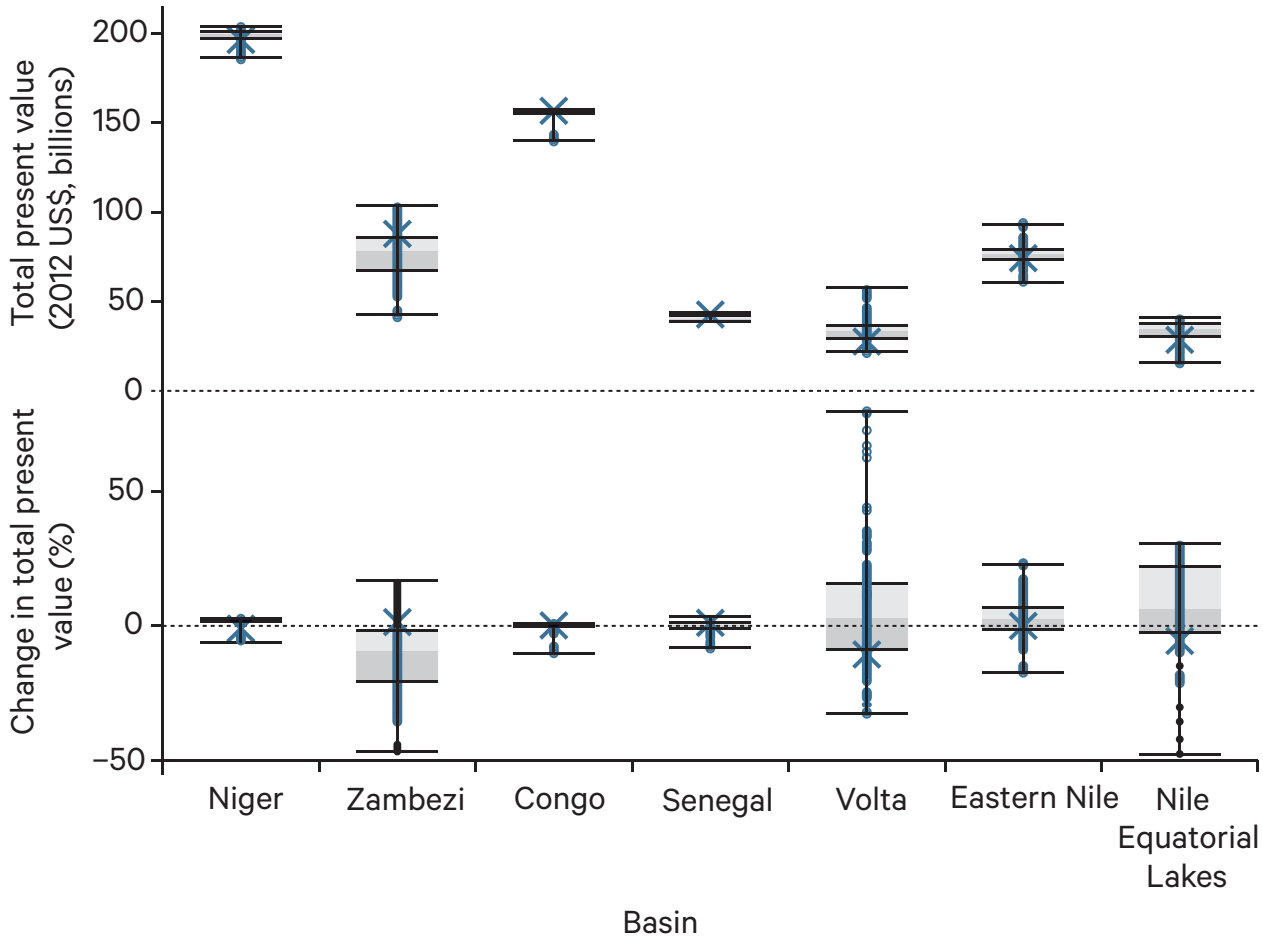


Source: Cervigni, Raffaello; Liden, Rikard; Neumann, James E.; Strzepek, Kenneth M. (2015). *Enhancing the Climate Resilience of Africa's Infrastructure: The Power and Water Sectors.* Africa Development Forum; Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/21875 License: CC BY 3.0 IGO

Results

All basins face significant economic risk, underscoring the need for resilient infrastructure (Figure 2). Among the basins analysed, the Niger River risks the most; climate change impacts could cost as much as $200 billion, if this basin's infrastructure is not made more resilient. But the Zambezi River faces the most uncertain future; climate change could cause impacts on its infrastructure that cost anywhere from $50 billion to $125 billion.

Figure 2. Economic impacts of climate change for all basins, new infrastructure, absent adaptation, in present value, with 3 percent discount rate, 2015–50



Note: The blue x represents the performance for the historical climate. The edges of the boxes indicate the 75th and 25th percentile performance; the edges of the whiskers show the 95th and 5th percentile performance; and the line that separates the light shading from dark shading marks the 50th percentile (median) performance.

Source: Cervigni, Raffaello; Liden, Rikard; Neumann, James E.; Strzepek, Kenneth M. (2015). *Enhancing the Climate Resilience of Africa's Infrastructure: The Power and Water Sectors*. Africa Development Forum. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/21875 License: CC BY 3.0 IGO

Aerial view of the Zambezi © GOLERO / GETTY

Main messages

Proper consideration of climate change impacts in the planning and design of infrastructure investments can considerably reduce the risk that climate change poses to hydropower and irrigation systems. This will require a shift in current practices to integrate the expertise of multidisciplinary professionals. For this to happen, the study recommended that policy-makers:

1. Develop technical guidelines for climate-sensitive sectors on the integration of climate change in the planning and design of infrastructure.
2. Promote an open-data knowledge repository for climate-resilient infrastructure development.
3. Establish a facility that helps in the preparation of climate resilience projects, catering to sectoral needs for infrastructure development, providing climate-resilient infrastructure master plans, and helping with the integration of climate resilience into individual projects.
4. Launch training programs for climate-resilient infrastructure professionals.
5. Set up an observatory on climate-resilient infrastructure development in Africa.

SEI Stockholm Environment Institute

Published by
Stockholm Environment Institute
US Center, California office
400 F Street
Davis, CA 95616
Tel: +1 530 753-3035

Author contact
Annette Huber-Lee
Annette.huber-lee@sei.org

Media contact
emily.yehle@sei.org

Visit us: sei.org
Twitter: @SEIresearch
@SEIclimate

Stockholm Environment Institute is an international non-profit research and policy organization that tackles environment and development challenges. We connect science and decision-making to develop solutions for a sustainable future for all.

Our approach is highly collaborative: stakeholder involvement is at the heart of our efforts to build capacity, strengthen institutions, and equip partners for the long term.

Our work spans climate, water, air, and land-use issues, and integrates evidence and perspectives on governance, the economy, gender and human health.

Across our eight centres in Europe, Asia, Africa and the Americas, we engage with policy processes, development action and business practice throughout the world.