SEI Stockholm Environment Institute

A water-resilient economy

Hydro-macroeconomic and climate change analysis in Rwanda

SEI policy brief
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2030 Water Resources Group | HOSTED BY WORLD BANK GROUP Water

IMAGE (ABOVE): The Virunga Mountains, Rwanda © GUENTERGUNI / GETTY

Key messages:

- **Rwanda's economy is vulnerable to water supply fluctuations exacerbated by climate change.**
- **Rwanda's dependence on run-of-river hydropower contributes to the economic vulnerability.**
- **Using a diversified portfolio of water storage and demand efficiency strategies, Rwanda can achieve a water-resilient economy.**

Background and objectives

Rwanda's economy is inextricably linked to its water supply, with agriculture employing nearly 70% of its population and making up half of the country's export revenue. It aspires to become an upper-middle-income country by 2035, and a high-income country by 2050. But rising temperatures and more prolonged dry spells threaten crop production and strain water supply.

Rwanda's Vision 2050 policy details the country's long-term goals and provides the planning blueprint to guide Rwanda's development. But such growth, coupled with climate change, will profoundly affect its water supply and demands. Gaining a clearer understanding of the changing water supply and demand, as well as the nexus between water, energy, and food production, is critical to Rwanda's success.

The Water Resources Group (2030 WRG) is a public-private-civil society partnership hosted by the World Bank to help governments balance water security with long-term development and economic growth. The recently established Rwanda Water Resources Board (RWB), the Ministry of Agriculture and Animal Resources, and Ministry of Environment tasked the 2030 WRG in 2020 with performing a Hydro-Economic and Climate Change Analysis (HECCA), with the following directives:

1. Conduct a strategic assessment of the water sector that demonstrates how water and the economy are inter-linked;
2. Recommend concrete actions toward sustainable water resources management; and
3. Support a dialogue to identify and align joint initiatives among sectors, both public and private, towards sustainable water resources management, and enable long-term economic growth through 2050.

2. Overview of the methods

The central question is: *How can Vision 2050 be achieved, given the projected water constraints and their impacts on GDP?*

We used the following methods to reach our findings:

WEAP: Supply-demand gap analysis

We used Stockholm Environment Institute's Water Evaluation and Planning (WEAP) tool to model the assessment's water scenarios. WEAP represents current water conditions in a given area and explores a wide range of options for balancing environment and development objectives. The 2020 Water Users and Uses Assessment in Rwanda provided the basis for estimating water demands in WEAP.

Macro-economic analysis

WEAP simulations detailing water allocation options throughout Rwanda were complemented with a macroeconomic analysis of each scenario. The analysis focused on the links between economic sectors, showing how water-constrained production in one sector can cascade across the economy. The resulting model, WEAP-MACRO, was used to estimate water constraints' impact on GDP. We then estimated costs of inaction by comparing GDP under a production scenario aligned with Vision 2050, but with and without water storage.

Scenario descriptions

WEAP and the macro-economic analyses explored three scenarios, each including 121 climate projections, to identify which investments and policies lead to the greatest water resilience. We compared our scenario results with baseline economic assumptions and historical climate.

- **Baseline** – No new policies or public infrastructure expansion enacted, unless already underway with funding. This represents business as usual and allows decision-makers a contrast with other planning options.

- **Vision 2050** – This explores the possibility of achieving the water-related goals of Vision 2050, accounting for population growth, urbanization, land use and economic aims, among other factors.

- **Water Resilient Vision 2050 (WRes2050)** – This scenario identified pathways that achieve Vision 2050, but factor in potential impacts of climate change on water availability. This scenario includes Rwanda's own adaptation goals, such as more efficient irrigation and water management, and mitigation options, such as varying levels of hydropower as a share of the overall electricity mix.

3. Brief overview of key findings

The HECCA shows that even under Baseline conditions, Rwanda's economy is vulnerable to climate change, indicating a need for supply-side measures economic stability. The Vision 2050 scenario sets out a very ambitious growth trajectory for Rwanda, with large population shifts from rural to urban areas, vast expansion of irrigated agriculture, and increased industrial and hydropower production, among other dramatic changes. All of these will affect water, human welfare and the economy.

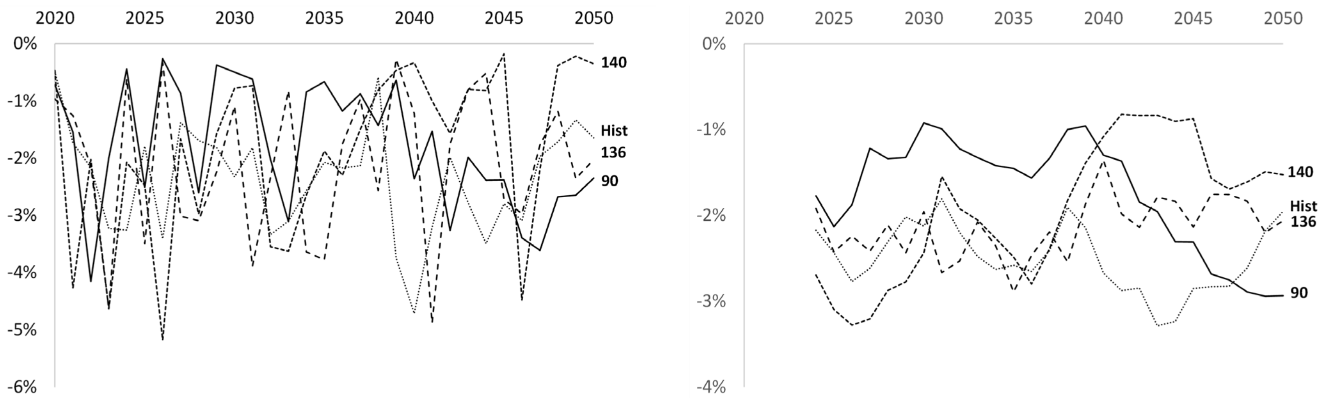
Domestic use and irrigated agriculture make up over 90% of current total water demand. However, relative to its current size, industrial water demand is assumed to expand significantly, from 9 million cubic meters (MCM) to about 25 MCM per year in the Vision 2050 scenarios, or 23 MCM in the WRes2050 scenarios achieved with increased industrial water efficiency.

Overall, the Baseline scenarios projected water demands would grow 83% from 2020 to 2050. But the full realization of Vision 2050 would increase water demand by 1140%, with major jumps in the agricultural sector. The WRes2050 scenario that combines reduced hydropower dependence and more efficient agricultural water use still results in a 740% growth in water demand. However, the strategies incorporated in the WRes2050 scenarios significantly reduced the overall water demands to achieve Vision 2050.

Both Vision 2050 and WRes2050 assume significant increases in water storage. While water storage is a critical to achieving such economic growth, storage alone is insufficient, leaving the country with a near-annual shortfall from June to October. The overall economic dependence on hydropower poses a significant risk to economic growth. By combining a reduction in hydropower dependence from 40 to 20%, and a balance of supply- and demand-side interventions, the WRes2050 scenario shows lower losses of GDP related to water constraints, while maintaining overall GDP growth rates consistent with Vision 2050.

Briefly, the results, both on an annual basis and as a 5-year running average, show the percent drop below potential GDP caused by water constraints (Figure 1).

Figure 1: Deviation of GDP from estimated potential under the baseline scenario due to water constraints, comparing various climate projections from wet to dry, annual (left) and five-year running average (right)



On the whole, water storage reduces fluctuations in water availability and water-linked economic output. Our results show that investing in storage results in avoided GDP loss ranging up to 5 percent. Alternatively, the cost of inaction is that Rwanda does not develop as much as it hopes to and it will remain vulnerable to fluctuating rainfall patterns.

Existing planned investments for irrigation, drinking water and sanitation, and industrial water use informed this analysis.

Key policy recommendations

The HECCA shows that Rwanda's economy is vulnerable to water constraints through 2050 under each of the three scenarios considered. We propose measures to improve both water quantity and quality:

6.1. Supply-side policy measures

- **Multi-scale storage:** Ensure national water security by expanding water storage three-fold from 100 to 300 MCM. This could be complemented with water conservation practices, wetlands restoration, greater water efficiency, and the use of multipurpose dams.
- **Groundwater access**: Support groundwater's ability to meet water supply gaps by investing in sand and surface dams, groundwater recharge facilities and a variety of smart agricultural soil and water management interventions.
- **Supplemental irrigation**: Provide supplemental irrigation that can bridge dry spells for rain-fed agriculture. This can be done by collecting rainfall in small storage structures.
- **Source water protection and payment for ecosystem services**: Establish Payments for Ecosystem Services (PES), which compensates individuals or communities for taking actions that support their local ecosystem. In addition to preserving water, such a program could boost rural incomes.
- **Wastewater treatment and reuse**: Incentivize the private sector using subsidies or tariffs to treat and reuse wastewater, with adequate monitoring to enforce safety standards.
- **Flood protection and erosion control**: Invest in flood-mitigating infrastructure to protect the 90% of the population that lives in flood-prone areas.

6.2. Demand-side measures

- **Increased irrigation efficiency:** Use water pricing incentives or subsidies and small loans to encourage the use of water-efficient technologies (e.g. drip irrigation). Selecting less water-intensive crops can also aid this effort. Authorities can help control water use by issuing permits with total water use limits.
- **Reduction of non-revenue water losses:** Reduce physical water losses, such as leaky pipes, with investments in infrastructure. Recoup water-related revenue losses by implementing the use of water meters and automatic billing.
- **Economic incentives**: Foster public buy-in on the efficient use of water by adopting taxes and fees for water use. Levy additional taxes and fees on water discharges into the environment.
- **Reduced water pollution**: Protect source water to address soil erosion and provide sanitation to improve public health.

6.3. Legal, regulatory and institutional strengthening

- **Safeguard investments:** For supply-side and demand-side interventions to succeed, effective legal, regulatory, and institutional mechanisms must be in place. This can help prevent aforementioned new infrastructure from falling into neglect.
- **Multi-Stakeholder Platform:** Foster a mutually beneficial partnership between the public and private sectors through the Multi-Stakeholder Platform established by the WRG 2030. Such cooperation can unite technological innovation and national goals in a joint effort to expand sustainable development by protecting water.

As the HECCA shows, the benefits of water storage outweigh the costs at the aggregate macro-economic scale. However, a diversified portfolio of supply-side and demand-side interventions can lead to a more water-secure future for Rwanda.

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