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Hydropower in Sub-Saharan Africa: The Impact of Climate Change and Escalating Conflicts on Shared Water Resources

Author:

Atef Mahmoud Dobal

Researcher in political science

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Introduction

Hydropower represents one of the fundamental pillars of electricity supply in Sub-Saharan Africa, with many countries in the region relying on it almost exclusively to meet their energy needs. Although hydropower is a relatively clean and renewable energy source, such heavy dependence renders hydropower systems particularly vulnerable to the impacts of climate change—especially in the face of increasing extreme weather events and growing variability in water resources. This challenge is further compounded by institutional fragility, aging infrastructure, and transboundary conflicts over shared river basins. Understanding the interrelationship between climate change and the performance of hydropower systems in the region is critical for formulating sustainable and adaptive energy policies. However, anticipating future impacts poses an even greater challenge due to the scarcity of accurate hydrological and climatic data, which adds further uncertainty to long-term strategic planning. The significance of this issue is amplified in light of the region's ambitious plans to expand hydropower reliance, amid growing calls for climate justice and enhanced adaptation financing.

This paper aims to analyze the impact of climate change on hydropower systems in Sub-Saharan Africa by reviewing the regional context, assessing climatic and hydrological challenges, and presenting applied case studies such as the Grand Ethiopian Renaissance Dam (GERD). It further proposes effective adaptation policies that can strengthen the resilience and sustainability of these systems under uncertain climate scenarios.

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Executive Summary

This paper examines the structural and climatic challenges facing the hydropower sector in Sub-Saharan Africa, which serves as a primary source of electricity for many countries in the region, contributing approximately 40% of total generated energy. Despite its renewable nature, the sector's outdated and fragile infrastructure—coupled with excessive dependence—renders hydropower systems highly susceptible to the impacts of climate change, particularly in the context of increasing droughts, fluctuating precipitation patterns, rising evaporation rates, and extreme weather events.

The paper highlights the regional disparities in climate impacts, projecting potential improvements in East Africa, declines in West and Southern Africa, and heightened uncertainty in Central Africa. It warns that many future hydropower expansion plans—despite their importance—are often based on outdated historical data, failing to sufficiently incorporate the realities of a changing climate, thus leading to what is known as the "infrastructure trap."

Through a case study of the Grand Ethiopian Renaissance Dam (GERD), the paper illustrates how climate change complicates the management of shared water resources and acts as a conflict multiplier between upstream and downstream states. It further explores the implications of limited climate finance, the politicization of large-scale energy projects, and the scarcity of reliable climatic and hydrological data, all of which undermine strategic planning and adaptive capacity.

The paper proposes a set of policy recommendations including: integrating climate risk into dam design, upgrading existing infrastructure, diversifying energy sources toward solar and wind, and strengthening regional cooperation in the management of transboundary river basins. It also underscores the need to move beyond rhetorical climate justice toward a pragmatic approach that enables African countries to meet their development needs within a sustainable and inclusive framework.

I. General Context of Hydropower in Sub-Saharan Africa

1. The Prevalence of Dams as a Primary Source of Electricity

Hydropower constitutes the backbone of electricity supply across Sub-Saharan Africa, contributing an average of 40% to the region's total power generation. Its prominence is especially evident in several countries where it accounts for over 90% of electricity production. Currently, Africa's total installed hydropower capacity stands at 42 GW, with a notable addition of 2 GW recorded in 2023 alone. The bulk of this generation capacity is concentrated along three of the world's largest rivers—the Congo, the Zambezi, and the Nile—which also possess substantial untapped potential for future development.

A major challenge facing the sector lies in the aging nature of its infrastructure: 60% of the installed hydropower capacity is over 20 years old, with the average plant age at 33 years. This necessitates urgent rehabilitation efforts, as 4.6 GW has been identified for immediate upgrades, and an additional 10 GW will require modernization investments over the coming decade.

2. Structural Vulnerabilities Due to Overdependence

The deep reliance on hydropower makes many Sub-Saharan countries exceptionally vulnerable to climatic fluctuations and changes in water availability. This overdependence directly undermines supply reliability, especially in light of the increasing frequency and intensity of extreme weather events in the region. The scale of this vulnerability is significant: around 160 million grid-connected electricity consumers in Sub-Saharan Africa live in countries where hydropower constitutes more than 50% of total energy supply.

3. Variations in Storage and Hydrological Capacity

The effects of climate change on hydropower potential are not uniform across Sub-Saharan Africa; rather, they exhibit considerable variation across regions. Forecasts suggest potential improvements in East Africa, negative impacts in West and Southern Africa, and high levels of uncertainty in Central Africa. This regional disparity underscores the ineffectiveness of "one-size-fits-all" adaptation strategies. Instead, responses must be carefully tailored to reflect specific local hydrological conditions, prevailing climate projections, and the unique socio-economic contexts of each basin or country.

1 Africa adds 2GW hydropower capacity in 2023 but stark gap remains, accessed June 22, 2025, https://www.hydropower.org/news/africa-adds-2gw-hydropower-capacity-in-2023-but-stark-gap-remains

2 The impact of climate change on hydropower in Africa | Oxford Policy Management, accessed June 22, 2025, https://www.opml.co.uk/insights/impact-climate-change-hydropower-africa

3 Dams, Development, and Dilemmas: The Complex Reality of African Hydropower, accessed June 22, 2025,https://energyforgrowth.org/article/dams-development-and-dilemmas-the-complex-reality-of-african-hydropower/

4 Hydropower dependency and climate change in sub-Saharan Africa: A nexus framework and evidence-based review - EarthArXiv, accessed June 22, 2025, https://eartharxiv.org/repository/view/698/

4. Planned Expansion Despite Climatic Risks

Despite the inherent climate risks, Africa is planning a significant expansion of hydropower capacity, with an estimated 80 GW of additional capacity in the pipeline. Major focus areas include the Nile Basin (28 GW) and the Zambezi Basin (13 GW). The Programme for Infrastructure Development in Africa (PIDA) has allocated roughly one-third of its priority budget—amounting to USD 21 billion—to hydropower projects.
However, a critical concern is that many of these large-scale planned developments fail to adequately incorporate growing climate variability into their design and planning processes, often relying on outdated historical hydrological records. This approach not only reinforces current dependence but also significantly heightens future risks. The cost of new, large-scale hydropower plants in Africa has risen sharply—by 32% between the periods 2010–2015 and 2016–2023.

This situation gives rise to what has been termed the "infrastructure trap" and path dependency. The power sector in Sub-Saharan Africa is characterized by its heavy reliance on aging hydropower infrastructure alongside ambitious plans for large-scale new projects. A critical flaw in these expansion strategies lies in the insufficient integration of future climate risks into design and operational frameworks. As a result, new investments are being made based on historical assumptions that may no longer hold in a changing climate. The region's historical dependence on hydropower, coupled with expansion strategies that inadequately consider climate change, risks locking Sub-Saharan Africa into a cycle of vulnerability. Instead of building climate-resilient infrastructure, limited financial resources are repeatedly diverted toward repairing and rebuilding damaged assets. This perpetuates a cycle of acute and chronic climate shocks, threatening to stall economic growth and reverse development gains.

II. Climate Change Dynamics in the Region and Their Impact on Water Resources

1. Changing Rainfall Patterns and Increasing Droughts

Climate change projections for Sub-Saharan Africa consistently point toward a clear trend of warming, increased frequency of extreme heat events, intensifying drought conditions, and significant changes in regional rainfall patterns. More specifically, studies forecast a decline in total precipitation across northern and central Sub-Saharan Africa, accompanied by a reduction in consecutive wet days and a noticeable increase in consecutive dry days . This shift indicates a pattern of more intense but less frequent rainfall events.
Geographically, Southern Africa is expected to experience a particularly sharp decrease in rainfall, whereas Eastern Africa may see increased precipitation. For example, the Horn of Africa has already endured its longest recorded drought, resulting in widespread water scarcity and the reported drying of approximately 90% of water wells in the affected areas. These complex shifts in precipitation and temperature are influenced by major global climate variability patterns.

5 Climate change impacts in Sub-Saharan Africa: from physical changes to their social repercussions, accessed June 22, 2025, https://climateanalytics.org/publications/climate-change-impacts-in-sub-saharan-africa-from-physical-changes-to-their-social-repercussions

6 Spatio-Temporal Characteristics of Climate Extremes in Sub-Saharan Africa and Potential Impact of Oceanic Teleconnections - MDPI, accessed June 22, 2025, https://www.mdpi.com/2073-4433/16/1/86

7 In Sub-Saharan Africa, Nature-Based Solutions Take Root - World Resources Institute, accessed June 22, 2025, https://www.wri.org/insights/nature-based-climate-solutions-sub-saharan-africa

2. Variability of Blue Nile Flows

The future impact of climate change on rainfall—and thus river flows—in the Nile Basin remains largely uncertain, as climate models project a wide range of potential outcomes. Nonetheless, most scenarios indicate a possible increase in rainfall. However, there is strong agreement across models regarding temperature trends, all pointing to rising temperatures throughout the basin. This warming will inevitably lead to greater evaporation from water bodies and landscapes, thereby reducing overall water availability.

The Blue Nile is a critical contributor, supplying approximately 20% of the Nile's total volume. Its flow is marked by high seasonal variability, with significant surges during the Ethiopian highlands' rainy season (June to November), causing soil loss and flooding in downstream regions. At the same time, up to half of its flow is lost to evaporation in eastern Sudan during the hot summer months.

3. Future Climate Modeling Studies and Implications for Hydropower Production

Assessing the precise future impacts of climate change on hydropower potential is inherently challenging due to the complexity of the climate system and the divergent outcomes produced by different climate models. This challenge is further exacerbated in Africa by a widespread lack of historical observational data, which is essential for validating and refining these models.

Despite these uncertainties, there is a general consensus among models regarding regional trends: potential positive effects on hydropower in Eastern Africa, negative impacts in Western and Southern Africa, and considerable uncertainty for Central Africa. The regional average hydropower capacity factor is projected to decline steadily through 2100 under both "below 2°C" and "around 3°C" warming scenarios assuming moderate emissions.

The cumulative loss in energy production attributed to climate change over the remainder of the 21st century is estimated at approximately 130 TWh—a figure equivalent to the current total annual output of all African hydropower plants. A critical flaw in current planning lies in the heavy reliance of hydropower designs on historical hydrological data—typically from the past 30 to 50 years—which is fundamentally inadequate for long-term climate planning for infrastructure with life spans ranging from 50 to 100 years.

The combination of inherent climatic uncertainty, the long-term nature of hydropower assets, and conventional planning methodologies gives rise to what is known as the "uncertainty imperative." This means that policymakers cannot afford to delay planning until perfect climate data becomes available.

8 The Nile Basin: climate change, water and future cooperation - CASCADES, accessed June 22, 2025, https://www.cascades.eu/publication/the-nile-basin-climate-change-water-and-future-cooperation/

9 Nile River ecosystem | EBSCO Research Starters, accessed June 22, 2025, https://www.ebsco.com/research-starters/science/nile-river-ecosystem

10 Climate impacts on African hydropower - IEA, accessed June 22, 2025, https://www.iea.org/reports/climate-impacts-on-african-hydropower/climate-impacts-on-african-hydropower

11 Climate variability and change over the Volta River Basin - Taylor & Francis eBooks, accessed June 22, 2025, https://api-uat.taylorfrancis.com/content/chapters/edit/download?identifierName=doi&identifierValue=10.4324/9781315707334-16&type=chapterpdf

12 Climate Impacts on African Hydropower – Analysis - IEA, accessed June 22, 2025, https://www.iea.org/reports/climate-impacts-on-african-hydropower

III. The Grand Ethiopian Renaissance Dam (GERD) as a Case Study

Ethiopia's hydropower development strategy is heavily centered on the Blue Nile, particularly through the construction of the Grand Ethiopian Renaissance Dam (GERD). This mega-project—with an estimated capacity exceeding 6,000 megawatts and a cost of USD 4 billion—is pivotal to Ethiopia's economic growth and industrialization ambitions.

GERD has become a focal point in the intense geopolitical debates and tensions between Ethiopia, Egypt, and Sudan. These longstanding disputes are significantly exacerbated by the growing impacts of climate change, especially concerns over future water scarcity. Uncoordinated dam operations, particularly during prolonged multi-year droughts, pose a serious threat to downstream countries such as Egypt and Sudan, which are critically dependent on the Nile for their freshwater supplies.

The future hydrological regime of the Nile Basin under climate change remains highly uncertain, with projections ranging from increased to decreased precipitation, alongside rising temperatures that will intensify evaporation. This inherent variability complicates the long-term management of GERD, especially given the water scarcity challenges facing downstream states. The potential for conflict remains a serious concern, underscoring the urgent need for binding agreements and cooperative management mechanisms.

Climate change, by intensifying water stress and increasing hydrological unpredictability, acts as a "conflict multiplier" in transboundary river basins such as the Nile. It amplifies existing geopolitical tensions over shared water resources, making cooperative management both more necessary and more difficult. While economic incentives may discourage overtly hostile dam operations, climate-induced water stress creates fertile ground for disputes to escalate into broader instability—highlighting the critical need for robust, legally binding agreements and sustained diplomatic engagement.

13 Experts warn climate crisis could exacerbate Nile dam tensions, accessed June 22, 2025, https://www.trtworld.com/magazine/experts-warn-climate-crisis-could-exacerbate-nile-dam-tensions-61469

IV. Adaptation Responses and Proposed Policies

1. Strengthening Hydrological Early Warning Systems

Enhancing monitoring, forecasting, and early warning systems for hydrological hazards such as floods and droughts is a fundamental adaptation strategy. These systems are critical for effective risk management, as they provide communities and energy operators with crucial lead time to prepare and mitigate impacts. Effective early warning systems must integrate advanced technological innovations, including Internet of Things (IoT) sensors, Long Short-Term Memory (LSTM) models for real-time data processing and forecasting, and satellite-based remote sensing data. Equally important is the incorporation of strong community engagement and the utilization of traditional local knowledge to improve both effectiveness and public trust.

2. Integrating Climate Risks into Future Dam Design

It is essential to systematically integrate the projected impacts of climate change into the planning and design stages of all new hydropower installations. Given the exceptionally long operational lifespan of hydropower infrastructure (50–100 years) and the substantial challenges involved in retrofitting once built, proactive climate-proofing is far more cost-effective than reactive measures. Specific engineering and operational adaptation tools include enhancing reservoir capacity to manage variability, modifying turbine types to accommodate expected flow rates, constructing upstream sediment control facilities to extend reservoir lifespan, and reinforcing dam embankments to withstand extreme events.

3. Expanding Solar and Wind Power as Resilient Alternatives

Diversifying the national energy mix away from over-reliance on hydropower is a critical adaptation strategy, particularly for countries located within river basins projected to face negative climate impacts on hydropower potential. Africa possesses vast untapped potential in solar and wind energy, holding 60% of the world's best solar resources while utilizing only 1% of its current installed photovoltaic (PV) capacity. Solar PV is already the cheapest energy source in many parts of Africa and is expected to outcompete all others across the continent by 2030. Renewable energy sources—solar, wind, hydropower, and geothermal—could account for over 80% of new power generation capacity by 2030. Integrating solar and wind with hydropower can offer a synergistic solution, whereby hydropower's storage capacity and operational flexibility help balance the inherent intermittency of solar and wind, enhancing grid stability and reliability. This integration not only reduces vulnerability to climate change but also accelerates the clean energy transition, reducing the need for extensive fossil fuel-based expansion.

14 Hydromet Services and Early Warning Systems | GFDRR, accessed June 22, 2025, https://www.gfdrr.org/en/hydromet-services-and-early-warning-systems

15 FLOOD EARLY WARNING SYSTEMS (FEWS) IN ENHANCING DISASTER RISK REDUCTION AND COMMUNITY RESILIENCE: A SYSTEMATIC REVIEW, accessed June 22, 2025, https://gaexcellence.com/ijlgc/article/download/5352/4933/18373

16 POLICY BRIEF: Using climate information for large-scale hydropower planning in sub-Saharan Africa, accessed June 22, 2025, https://cdkn.org/resource/climate-change-data-hydropower-planning-sub-saharan-africa

17 Measures to enhance the resilience of African hydropower - IEA, accessed June 22, 2025, https://www.iea.org/reports/climate-impacts-on-african-hydropower/measures-to-enhance-the-resilience-of-african-hydropower

18 Renewable energy transition in sub-Saharan Africa, accessed June 22, 2025, https://ca1-clm.edcdn.com/assets/renewable_energy_transition_in_sub-saharan_africa.pdf

19 Key findings – Africa Energy Outlook 2022 – Analysis - IEA, accessed June 22, 2025, https://www.iea.org/reports/africa-energy-outlook-2022/key-findings

4. Regional Cooperation on Transboundary Water Resource Management

Given that over 90% of Africa's surface water resources lie within transboundary river basins , regional cooperation in water management is crucial for adapting to climate change and ensuring energy security. Climate change can exacerbate tensions over shared water resources, as seen in the Nile Basin. However, effective cooperation can result in:

- **Improved water management:** Through the exchange of hydrometric data (e.g., river flow, precipitation), treated as public goods, countries can improve the accuracy of hydrological forecasting and enhance water resource planning.

- **Coordinated adaptation strategies:** States can jointly develop and implement climate change adaptation strategies, reducing risks from floods and droughts.

- **Enhanced energy security:** Joint hydropower projects can generate shared electricity and revenues, boosting regional energy security. Regional power grids can also enable electricity exchange between countries with available capacity, offsetting climate-induced supply shortages.

- **Institutional capacity building:** Programs such as the Regional Climate Resilience Program (RCRP) and the Cooperation in International Waters in Africa (CIWA) initiative support the strengthening of national systems and the development of human capacity in water management, leading to improved flood forecasting and resource governance.

20 Forging efforts to promote transboundary water cooperation to address climate change impacts and reduce conflict risks, accessed June 22, 2025, https://www.uneca.org/stories/forging-efforts-to-promote-transboundary-water-cooperation-to-address-climate-change-impacts

21 Transboundary Natural Resources Management in a Changing ..., accessed June 22, 2025, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Transboundary%20Natural%20Resources%20Management%20in%20a%20Changing%20Climate%20%E2%80%93%20The%20Case%20of%20Shared%20Watersheds%20in%20Africa%20-%20%20CoP%C2%AD%E2%80%9018%20Side%20Event%20Concept%20Note.pdf

22 Keys to Successful Transboundary Water Cooperation in Africa, accessed June 22, 2025, https://blogs.worldbank.org/en/water/three-keys-to-successful-transboundary-water-cooperation-in-afri

23 Policy brief Climate risks to hydropower supply in eastern and southern Africa, accessed June 22, 2025, https://www.cc-cep.ac.uk/wp-content/uploads/2018/08/Climate-risks-to-hydropower-supply-in-eastern-and-southern-Africa_Conway-et-al.pdf

V. Challenges and Barriers

1. Weak Climate Financing for Energy

Attracting sufficient climate financing for energy infrastructure in Sub-Saharan Africa faces significant challenges. Despite contributing less than 4% of global greenhouse gas emissions, Africa is one of the regions most vulnerable to climate change. However, the region receives less than 3% of global climate finance, highlighting a large financing gap. Key barriers include:

• High Debt Burden and Economic Challenges: Many African countries face high debt burdens and overall economic difficulties, limiting available funds for climate initiatives.

• Perceived Risks by Foreign Investors: Foreign investors view Africa as a high-risk region, despite the enormous opportunities for climate projects. Key concerns include political and economic instability, weak infrastructure, currency volatility, and depreciation. For instance, a solar project in Nigeria can cost three times as much as a similar project in Madrid.

• Inadequate Commitment from Wealthy Countries: Despite pledges, wealthy countries have not translated their commitments to support developing countries in adaptation and climate transition into sufficient tangible actions. The financing gap for Sub-Saharan Africa to achieve sustainable energy access goals is estimated between USD 35 billion and USD 50 billion annually.

24 Africa's energy trilemma: Security, equity, sustainability | World ..., accessed June 22, 2025, https://www.weforum.org/stories/2025/05/africa-energy-trilemma-security-equity-sustainability/

25 Attracting Climate Finance to Africa Through the Development of ..., accessed June 22, 2025,https://sdgfinance.undp.org/news-events/attracting-climate-finance-africa-through-development-bankable-project-pipelines

26 How can we finance a fair energy transition in Africa? - Clean Air Task Force, accessed June 22, 2025, https://www.catf.us/2025/06/how-can-we-finance-a-fair-energy-transition-in-africa/

2. Fragility of Infrastructure in Some Countries

Energy infrastructure in Sub-Saharan Africa is fragile, increasing its vulnerability to the impacts of climate change. Much of the region's energy infrastructure is outdated, a trend exacerbated by a lack of investment in new power stations, transmission systems, and maintenance technology. The manifestations of this fragility and the impacts of climate change include:

• Aging and Lack of Resilience: Many infrastructure assets, some dating back decades, were not planned or built to withstand the effects of climate change and related risks.

• Acute and Chronic Impacts: Acute climate impacts, such as floods, result in sudden shocks to the system. For example, energy shortages caused by droughts in Zimbabwe and Zambia led to cascading effects on water supply, health, communication, supply chains, and businesses. Chronic impacts, such as rising temperatures, can reduce the efficiency of power generation networks over time, increase transmission and distribution losses, and shorten the lifespan of key equipment.

27 An Evaluation of the World Bank Group's Support to Electricity Access in Sub-Saharan Africa, 2015–24, accessed June 22, 2025, https://ieg.worldbankgroup.org/reports/evaluation-world-bank-groups-support-electricity-access-sub-saharan-africa-2015-24-approach

28 Africa 'Climate Infrastructure Trap' in Energy and Transport Sectors, accessed June 22, 2025, https://www.mines.edu/global-energy-future/wp-content/uploads/sites/361/2022/10/Payne-Institute-Commentary-Africa-%E2%80%98Climate-Infrastructure-Trap-in-Energy-and-Transport-Sectors3.pdf

29 State and Trends in Adaptation Report 2021: Africa: Transport and Energy, accessed June 22, 2025, https://gca.org/wp-content/uploads/2021/10/GCA_STA21_-Sect2_TRANSPORT-ENERGY.pdf

• Infrastructure Trap: Governments are often forced to divert limited public funding toward rebuilding or repairing climate-damaged infrastructure, rather than investing in new infrastructure to address the existing gap. This creates an "infrastructure trap," where recurring climate shocks hinder economic growth and impede progress toward sustainable development goals.

• Heavy Reliance on Hydropower: The significant reliance on hydropower in many countries increases vulnerability to energy supply shortages, as any decrease in river flows due to drought directly results in energy deficits.

3. Limited Climate and Hydrological Data

The lack of historical climate and hydrological monitoring data is a significant challenge in Sub-Saharan Africa, hindering accurate assessment of climate change impacts and effective hydropower planning. Key challenges include:

• Planning Based on Outdated Data: Many hydropower projects still rely on historical hydrological records (from 30 to 50 years ago), which do not reflect the future climate variability expected over the long lifespan of these facilities.

• Uncertainty in Projections: Mixed signals from climate projections make it difficult for decision-makers to plan and adapt appropriately, with a significant risk of "misadaptation".

• Lack of Integration Capacity: There is a lack of capacity to systematically generate, analyze, and integrate climate forecasts into long-term planning and investment processes.

• Impact of Human Intervention: River flow data in heavily managed basins are often influenced by reservoir operations and water withdrawals, making it difficult to use these data directly for calibrating hydrological models.

To address these challenges, it is recommended to establish a shared data source for exchanging climate scenarios and hydrological information, possibly hosted by African institutions, to reduce the cost of analysis for each country and energy provider.

4. Politicization of Large-Scale Energy Projects

The politicization of large-scale energy projects in Africa is a complex issue, often creating tension between the realistic needs of low- and middle-income countries and the idealism of climate advocates. Challenges and tensions include:

• Energy Poverty vs. Climate Goals: Many African countries continue to suffer from widespread energy poverty, necessitating the expansion of energy access to support economic development and job creation. However, this often conflicts with pressure from climate advocates in developmental finance institutions and civil society in Europe and North America to immediately and completely abandon natural resources.

• Financing Gaps and Constraints: The annual financing gap of USD 400 billion until 2030 to meet the UN Sustainable Development Goals presents a significant barrier to expanding energy production in African countries. Access to capital for large-scale energy projects has been constrained by environmental activism, political concerns, weak investment climates, and conflicting agendas from international funders.

• "Climate Colonialism": Some frustrated observers describe these well-intentioned but overly coercive and contextually disconnected demands as a new form of climate colonialism.

These tensions hinder adaptation efforts by making securing necessary funding and developing major projects more difficult, affecting Africa's ability to build resilient energy systems.

30 How African Countries Can Harness the Global Policy Reframe from Energy Transition to Energy Security | Carnegie Endowment for International Peace, accessed June 22, 2025, https://carnegieendowment.org/research/2025/05/africa-energy-security-transition?lang=en

31 (PDF) From Data Scarcity to Solutions: Hydrological and Water Management Modeling in a Highly Managed River Basin - ResearchGate, accessed June 22, 2025, https://www.researchgate.net/publication/389830777_From_Data-_Scarcity_to_Solutions_Hydrological_and_Water_Management_Modeling_in_a_Highly_Managed_River_Basin

32 Will climate change undermine the potential for hydropower in Africa?, accessed June 22, 2025, https://www.opml.co.uk/files/2021-10/eeg-energy-insight-climate-change-and-hydropower.pdf?noredirect=1

Conclusion

This paper has demonstrated that the heavy reliance on hydropower in Sub-Saharan Africa—amid aging infrastructure and highly climate-sensitive water resources—has led to a growing pattern of structural fragility in energy systems. Intensified by climate change, severe droughts and floods now threaten the stability of electricity supplies and exacerbate socio-economic crises. This dynamic reinforces the "infrastructure trap," in which scarce resources are repeatedly allocated to reconstruction rather than proactive modernization. The study underscores that the impacts of climate change extend beyond environmental and hydrological dimensions, acting as a conflict multiplier—particularly in shared river basins like the Nile, where increasing water stress and hydrological uncertainty amplify the risk of geopolitical escalation. Despite variations among climate models, they collectively point to a more volatile future, with declining hydropower efficiency across much of the continent—except for potentially positive effects in parts of East Africa.

In light of these findings, the paper stresses the urgent need for a paradigm shift in energy planning. This involves integrating climate risk into infrastructure design, upgrading existing systems, diversifying energy sources by expanding solar and wind alternatives, and strengthening regional cooperation in water resource governance. It also highlights the imperative of closing the climate finance gap and ensuring climate justice by enforcing industrialized nations' commitments to support adaptation efforts in the Global South. Building resilient energy systems in Sub-Saharan Africa requires not only technical and engineering solutions but also transformative shifts in policy, governance, and investment priorities—anchored in cross-border cooperation and international climate solidarity.