A STUDY ON AN INTEGRATED WATER RESOURCES MANAGEMENT PRACTICE FOR SUSTAINABLE TRANSBOUNDARY RIVER BASIN DEVELOPMENT: THE CASE OF THE BLUE NILE BASIN

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SUMMARY

The African region is one of the most vulnerable landmasses to climate change and its variability (Solomon et al., 2007). Climate change is expected to increase the number of people living in water-stressed areas and it is expected to affect water resources and the hydrologic cycle (Bates et al., 2008). In transboundary river basins, climate change poses a substantial risk due to the different economic, political and social interests of the riparian countries. The Nile, known as the world's longest river, embodies the challenges of trans-boundary watershed management. The populations of the Nile basin countries are particularly susceptible to the consequences of climate change on water, food and energy. The construction of water infrastructure, such as the Grand Ethiopian Renaissance Dam (GERD), which is designed to meet the growing energy demand, prompted a complex transboundary situation among upstream and downstream riparian countries (Wheeler et al., 2020). To effectively navigate this challenges, sustainable water management becomes an imperative component of adapting to climate change and pivotal for accomplishing the primary objectives outlined in the United Nations' Sustainable Development Goals (SDGs).

The formulation of improved water resource management policies necessitates the collection of quantitative data on hydro-climatic variables (Hall et al., 2014). For efficient management of water resources and the mitigation of disaster risks, employing robust datasets in hydrological model simulations becomes a fundamental requirement. Nevertheless, the

inadequacy in spatiotemporal hydro-climatic data constrains the efficacy of hazard monitoring and early warning activities in developing regions. Consequently, this study centres on reliable assessment of climate impacts while harnessing globally accessible datasets for climate change adaptation, enhancement of water management practice and comprehensive policymaking within the hydrologic system of the Blue Nile basin. The research strives to address gaps identified in prior studies, aiming for an improved framework for future water resources management and climate change adaptation. Within this study, the basin's current development and status quo are considered to establish well-founded policy recommendation in the Nile basin.

The study assessed climate change impacts on the Blue Nile River using 30-year in situ climate data (1981–2010) and five bias-corrected General Circulation Models (GCMs) for future climate projections (2026-2045). Parametric and non-parametric tests were used to study the trends in the observed climatological datasets. The GCMs were selected based on their performance in the study area, compared with various observed and reanalysis meteorological datasets. An analysis of local and synoptic-scale climate variables in GCMs was also performed to understand the projection uncertainties. To evaluate the hydrological variables, a physically-based distributed model, the Water Energy Budget-based Rainfall-Runoff-Inundation model (WEB-RRI), was developed and validated with observed discharge data. Qualitative indices were used to classify climate change evaluations for ease of decision making.

Both observed historical trends and GCMs precipitation projections show inter-annual and spatial variability, with the most significant increases in the rainy season and a significant decrease in the dry season. The results suggest the probability of an increase in total precipitation, accompanied by an increase in the intensity and frequency of future extreme rainfall events. Analysis of uncertainty in GCMs projection identifies synoptic-scale climate variables such as wind vector dynamics influences on the projected precipitation differences. Moreover, the result of the flow simulation shows a likely increase in total river flow, peak discharges, and flood inundation, which will increase risk of floods. The comparative assessment of changes in observed trends and the results of GCM projections provided in this study enables the qualitative assessment with a high confidence level. Assessments of socio-economic impacts on projected extremes pointed to an increase in the distractive effects of floods on communities, urban area, and agricultural lands in the study area.

Moreover, this study evaluated the performance of near-real-time satellite precipitation products (SPPs) and short-term numerical weather forecasts. The original real-time SPPs comparison in flood events show significant improvement after statistical bias correction and flow simulation. Additionally, the numerical weather forecast provided satisfactory results for shorter lead time forecasts compared to longer lead-time forecast. The result showed that the global datasets are very useful and can provide adequate lead-time for climate change adaptive measures such as real-time flood monitoring, flood early warning, and dam operation to minimize flood damages and improve the power generation in the Nile basin.

This study also finds that the GERD dam, due to its very high storage capacity, is instrumental to accommodate the projected extreme flow volume to smoothen the high and low flow signals and maximize the project's benefit in the entire Nile basin. The policy suggestion of this study point to adaptive measures such as the implementation of informed decision-making on water-related disasters, early warning, and reservoir operation for the enhancing Integrated Water Resource Management (IWRM) practices in the Nile basin.

References

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