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Water resources model shows how climate change poses risks to future water availability in Malawi

The UMFULA (Uncertainty Reduction in Models for Understanding Development Applications) research group, that is part of the programme Future Climate for Africa, have been investigating how future climate change will affect water resources in Malawi. The UMFULA research team has developed a water resources model to project future water availability in Malawi under a changing climate. The findings focus on potential future changes in Lake Malawi water levels and subsequent flows in the Shire River basin. Results indicate a range of potential futures, which illustrates the important role that adaptive decision-making approaches that are robust to uncertainty can play in supporting improved water management and infrastructure development in Malawi. This tool is being shared with decision makers across various sectors, including water resources, hydropower, agriculture, and environment. There is potential for this tool to then be used by planners and decision-makers in Malawi to derive useful insights about the range of possible hydrological futures that will enable them to take decisions that are more robust in the face of uncertain future changes.

Current and future water, energy and food security depends heavily on water resources in the Lake Malawi and the Shire River Basin. The outflows from Lake Malawi go into the Shire river that run Malawi's hydropower stations, providing over 90% of the country's electricity. This water is also vital for agriculture, industry, domestic use and sustaining the ecosystem services provided by the downstream wetlands.

Water availability is under stress because: water demands are increasing to meet the needs of a growing population; increased and competing demands from hydropower, irrigation, domestic water supply and environment sectors; and the impacts of a changing climate. Understanding future climate projections and their potential impacts on the dynamics of water availability and demand in the Lake Malawi Shire River Basin is important to inform future water management, infrastructure planning, and the socio-economic development of the country.

Dr Ajay Bhave (Research fellow, University of Leeds) led the UMFULA modelling team on this innovative research and adapted the water resources model known as WEAP (Water Evaluation and Planning) for the Lake Malawi Shire River Basin to investigate the impact that climate change could have on Malawi's water resources. Key to the successful application of this WEAP model was the active engagement of stakeholders from different sectors. Stakeholders contributed to the development of the model by providing knowledge of current water management practices, plans for future water management, and insight into future infrastructure plans. This also involved identifying key features that should be included in the model to increase its application potential. Ajay indicates that, *"iterative consultation with stakeholders helped enhance interest, gain acceptability and trust, and develop a shared understanding of the model and its uses between researchers and stakeholders."*

Three possible groups of futures were projected by the model for the water availability between 2021 - 2050. The three plausible futures illustrate the range of climate impacts that may be felt in the future due to the fluctuating water levels of Lake Malawi.

1. Future one, there is an increase in lake levels leading to increased water flows into the Shire river resulting in increased risk of flooding.

2. Future two, the lake level would remain similar to the current state where the lake level will only maintain levels just high enough to flow into the Shire river, resulting in limited downstream water supply which may impact the performance of hydropower and irrigated agriculture.
3. Future three, there is a decrease in lake levels and decreased inflow of water to the Shire river basin due to reduced rainfall. A few of the models projected such low levels in Lake Malawi that it resulted in no flow of water into the Shire river, which changed it from a perennial to seasonal river.

Uncertainty over the future water availability in Malawi illustrates the need to include Decision Making under Uncertainty approaches: identifying decisions that are robust across the range of plausible water futures, whether there will be either a projected increase or decrease in water levels of Lake Malawi and how these would affect trade-offs between hydropower, agriculture and sustaining the environment. The WEAP model will now be available for use as a tool by decision-makers and planners to test a range of scenarios in order to ensure robust climate change decision-making for Malawi.

According to Dr David Mkwambisi (Head of Industrial Research Centre, Malawi University of Science and Technology), the WEAP model is an ideal policy planning tool that will support several partners in future investments and will further help in building the resilience of the communities in the Lower Shire. *"The WEAP model will help to understand the type of investments to address future climate challenges and support the National Planning Commission to consider water scenarios in their economic blocks."* Dr Mkwambisi further said that the engagement of the Ministry of Agriculture, Irrigation and Water Development to participate in the application of the model will provide the required information to critical sectors in the Lower Shire including fisheries, wildlife, agriculture, forestry and irrigation. *"It is expected that through the involvement of the Malawi University of Science and Technology, the WEAP model will be locally adapted and proper capacity building mechanisms will be put in place"* Said Dr Mkwambisi.

Ajay notes, *"Managing water resources under uncertain future climate change is important for Malawi's sustainable and resilient development. The underlying philosophy of the UMFULA project's modelling approach in Malawi has been to develop and share a model that can be used to generate more decision relevant information, support in-country assessments and decisions, and lead to more robust planning to facilitate development in an uncertain future."*

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UMFULA (Uncertainty Reduction in Models for Understanding Development Applications) is a four-year research project that aims to improve climate information for decision-making in central and southern Africa, with a particular focus on Tanzania and Malawi. The team is generating new insights and more reliable information about climate processes and extreme weather events in the region and their impacts on water, energy and agriculture, with the aim to support long-term (5 to 40 years) planning decisions around resource use, infrastructure investment and cross-sectoral growth priorities.

The UMFULA partners involved in this research are: University of Leeds, University of KwaZulu Natal, London School of Economics and Political Science, University of Sussex, and Malawi University of Science and Technology

Future Climate for Africa aims to generate fundamentally new climate science focused on Africa, and to ensure that this science has an impact on human development across the continent. For more information please visit the website: www.futureclimateafrica.org.

Selected Outputs from the Research:

Bhave, A.G., Bulcock, L., Dessai, S., Conway, D., Jewitt, G., Dougill, A.J., Kolusu, S.R. and Mkwambisi, D. Lake Malawi's threshold behaviour: A stakeholder-informed model to simulate sensitivity to climate change, Submitted to Journal of Hydrology.

Download the brief on Projecting future water availability in Lake Malawi and the Shire River basin here.

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