UNIVERSITY OF NAIROBI

WYSS ACADEMY FOR NATURE

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Wyss Academy PhD Research Project: Search for Candidate

Assessment of the Ewaso Ng'iro North River Basin hydrological dynamics using a multi-model approach

Synopsis

The Ewaso Ng'iro North River Basin is one of Kenya's most vital yet vulnerable river systems. Spanning from the high-altitude montane forests of central Kenya to the northern arid lowlands of Isiolo, Samburu, Wajir and Garissa, this basin supports a wide variety of ecosystems and millions of people. Its main artery, the Ewaso Ng'iro North River, is nourished by two significant water towers: Mount Kenya and the Aberdare Range. They receive high annual rainfall and play a crucial role in capturing moisture, reducing surface runoff, and facilitating groundwater recharge. As the river moves northward, the climate transitions from humid to semi-arid and eventually arid, making the basin highly dependent on the continuity of flow sustained by these upland sources.

Groundwater plays an increasingly vital role, especially downstream, where it sustains water supplies and provides water security for people, livestock and wildlife during dry seasons when surface flows decreases. However, this system is under growing stress from deforestation, land use change, and infrastructure development in the upper catchment. Simultaneously, rising water demands, poorly regulated abstraction, and climate change weaken the basin's resilience. These pressures interact to shape the hydrological cycle in complex and often unpredictable ways, which threatens recharge processes and intensifies water scarcity, calling for an integrated understanding of the basin's hydrological dynamics. Only with such insights can we begin to plan for sustainable water use, design targeted conservation actions, and explore financial mechanisms such as Payment for Ecosystem Services to support the guardians of these critical highland ecosystems.

Hydrological modelling approach

Hydrological modelling is essential for understanding how water moves through the landscape – how it flows on the surface, how it infiltrates the ground, how it is stored, and how it is extracted. Traditional monitoring tools, such as weather stations, borehole data and discharge gauges, provide crucial point-based measurements but offer limited insight, due to the lack of spatial continuity and data consistency, especially in capturing subsurface processes. They also cannot provide future scenarios, such as the impacts of land use

change or prolonged droughts, making hydrological models adequate tools for forward-looking water planning.

To address this, the study will compare two models:

- **SWAT (Soil and Water Assessment Tool)**: Widely used and data-intensive, SWAT simulates long-term surface and shallow groundwater processes, sediment transport and nutrient cycling, but has limited dryland and deep-aquifer capabilities.
- **CUWALID (Climate into Useful Water and Land Information in Drylands)**: A newer, Python-based model designed under the EU-funded DOWN2EARTH project and specifically developed to address limitations of traditional models in drylands. It handles limited datasets well and emphasizes deep infiltration, spatially distributed recharge and percolation, and the spatial variability typical of arid zones.

The models will be applied using harmonized inputs to assess their performance in simulating key hydrological variables such as runoff, evapotranspiration, groundwater recharge, and aquifer storage. Usability, calibration needs, and suitability for planning will also be compared. Such a comparison is necessary. Both models have potential, but their relative strengths and limitations must be understood in the specific biophysical and institutional setting of the Ewaso Ng'iro basin. The study will initially target the following questions: Which model better captures the reality of aquifer recharge beneath the Mount Kenya and Aberdare forests? Which tool can provide usable outputs for water planners with limited data and time? Which model aligns better with the needs of local Water Resource User Associations (WRUAs), county governments, and conservation partners? By the end of the analysis, the research will not only highlight the technical accuracy of each model but also their practical relevance—helping stakeholders make informed choices on which tool to use for different planning tasks. The comparative approach will thus serve a dual purpose: strengthening scientific understanding of groundwater systems in the basin, and supporting more effective, evidence-based decision-making in landscape restoration, water allocation, and conservation finance.

Research Focus and Tasks

The proposed PhD study adopts a basin-wide approach, combining surface and groundwater analysis with spatial and institutional mapping. Its first year will be dedicated to sub-catchment data collection and processing for model calibration (land use/land cover, delineated watershed and hydrological response units, climate, soil layers), identification of critical recharge zones and land use influences on surface water movement (including aquifer mapping and abstraction surveys), and stakeholder engagement (local water users, county institutions, and conservation partners) to understand their needs, facilitate collaboration and data access, and ensure outputs are relevant and actionable.

Following this initial phase, the research will scale up to address the pressing need for integrated water resource assessments that can guide policy, conservation investment, and long-term water security planning. Unlike many existing studies that focus primarily on surface hydrology and borehole records, this project will construct a comprehensive hydrological framework that links surface water processes (runoff, evapotranspiration, infiltration) with subsurface dynamics (percolation, aquifer recharge, water table fluctuation). In doing so, the study will fill a major knowledge gap in understanding how much water is stored in the basin's aquifers, how fast it is recharged, and how much is being abstracted under current land use and climate conditions.

The PhD study will focus on the following core components:

- Mapping and volumetric estimation of aquifers using model outputs, borehole data, and remote sensing.
- Quantifying recharge from various land covers, with a focus on Mount Kenya and Aberdare Range highland ecosystems.
- Modelling seasonal and long-term groundwater dynamics under changing climate and land use.
- Analyzing groundwater abstraction for domestic, agricultural, and conservation needs.
- Estimating the basin's groundwater balance to assess sustainability.
- Developing decision-support tools: recharge maps, scenario dashboards, and water-use projections.

The research aims to bridge science and policy, particularly by informing the design of Payment for Ecosystem Services schemes that link upstream conservation with downstream water security. Collaborations with WRUAs, county governments, and NGOs will be central to the project, ensuring the models and outputs are contextually relevant and actionable.

Requirements

- MSc degree in hydrology/hydrometeorology, hydrogeology, geosciences, geography or environmental sciences.
- Good understanding of hydrological processes; understanding dryland processes is an advantage.
- Experience with hydrological models (SWAT or CUWALID is an advantage).
- Experience in data processing and analysis (e.g. Python or R); experience with remote sensing; experience with model data is an advantage.
- Excellent English writing and speaking.

Location

The student will be based at the Wyss Academy Hub East Africa in Nanyuki. This project is part of the Interdisciplinary Water Scarcity project in collaboration

with the University of Nairobi. The student will therefore be part of an interdisciplinary research team in climate and biodiversity sciences.

Funding
This PhD position is funded through the Interdisciplinary Water Scarcity project of the Wyss Academy for Nature at the University of Bern, Switzerland.

Main supervisor
Professor Alfred Opere, Department of Earth and Climate Sciences, University of Nairobi, Kenya.

Application Information
Interested applicants are invited to apply with an application containing 1) a one-page motivation letter, 2) a CV summarizing academic and professional experience, and publications, if any (maximum four pages), and 3) contact information of two referees. **The application deadline is midnight 24th August 2025**.

Applications should be sent to icca@uonbi.ac.ke with the subject heading: "**Wyss Academy PhD research project: Search for Candidate – Groundwater Study"** and should be copied to marie-estelle.demory@wyssacademy.org**.**

Important Note! The motivation letter, CV and contact information of two referees should be compiled in one pdf.

Women are strongly encouraged to apply.

For further information, please contact icca@uonbi.ac.ke.