Harnessing groundwater resources for sustainable development in east Africa

Supervisor: Jonathan Paul

Project Description:

East Africa is one of the most hydrologically complex and conflicted regions in the world. The twin pressures of the Climate Emergency and unplanned, rapid population growth have precipitated a new crisis in freshwater provision, which, coupled with geopolitical conflict, led to the UN declaring water security as "the major unresolved obstacle in Africa for the 21st Century". Recently, the value of unilateral, top-down approaches – such as Integrated Water Resources Management – in combating dwindling water supplies has been questioned. Instead, a new paradigm has recently emerged: community-led, polycentric water management that not only ensures sustainable water use for drinking and irrigation, but also educates and empowers local stakeholders regarding their immediate environment.

This is especially relevant (and ripe for development) in countries with weak institutional infrastructure like Tanzania, where the current groundwater use of 1.3 Mm³/day constitutes barely 12% of available resources. Current hydrogeological knowledge is fragmentary, while interest in hitherto untapped groundwater reserves in crystalline basement rocks has grown rapidly following the 2019 drilling of 12 groundwater wells by UNICEF. These were designed to mitigate against recent extended periods of low rainfall and aquifer recharge, and high evapotranspiration due to weakening of the Indian Ocean Dipole (IOD).

This project will focus on the development of regional hydrogeological maps and a local groundwater model for central Tanzania. First, the student will employ Independent Component Analysis to localise GRACE gravity-derived groundwater fluctuations and their link to climatic indices like IOD. Secondly, by interrogating multiple remote datasets – such as Landsat, GPM precipitation, and ASTER data – the student will construct a high-resolution geological map, which will allow for the modelling and estimation of local hydrogeological indices like aquifer transmissivity and potential borehole yield.

New technologies such as smartphone apps and low-cost off-the-shelf sensors have made it possible for non-scientifically trained personnel to monitor water resources in real time. In a final step, the student will spend one week at an existing field site (established by JP and WWF-Tanzania in 2017) at Mngeta, central Tanzania, to install a suite of such sensors that will facilitate community monitoring of potential groundwater quality and quantity. These data will not only validate the modelling results, but also allow for assessments of the potential for groundwater-irrigated agriculture. Such assessments will be critical to the sustainable, local management of the region's groundwater resources and appropriate/informed policy formulation.

The student will ideally be numerate, with a Physical Science or Engineering degree, and will be willing to conduct field and modelling experiments. Experience in electronics (e.g. soldering) is beneficial but not essential. The student will be trained and gain skills in Earth observation (GIS), field-based hydrological measurement campaigns (in a developmental context), remote geological mapping and community work, and hydrological modelling.
References:


*Please contact the lead supervisor directly for further details*

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