

Title: Monitoring and modelling of hydrological flows under current and future land-use and climate change scenarios in the Kasai River sub-basin within the Congo Basin

(Oral)

Ngandu Jean-Felly¹, Tshimanga Raphael¹, Kitambo Benjamin^{1,2}, Mark Trigg³

1. *Regional School of Water/ University of Kinshasa, DR Congo*
2. *University of Lubumbashi, DR Congo*
3. *University of Leeds, United Kingdom*

*jf.ngandu@unikin.ac.cd

The Kasai sub-basin is one of the hydrological pillars of the Congo River basin, storing approximately 43% of the basin's total drainable water (Tourian et al., 2023). Despite this central role, scientific knowledge remains fragmented, largely due to the lack of continuous observations and operational hydrometric networks (Tshimanga et al., 2022). This data gap is occurring at a time when the basin is experiencing intensified pressures from land-use change and mining activities, which have driven an observed increase in sediment fluxes since 1984 (Mushi et al., 2019; Mushi et al., 2022), compounded by the impacts of climate change. This context highlights a critical shortage of data required for hydrological forecasting and evidence-based decision-making for the sustainable management of water resources in the Kasai River sub-basin.

The primary objective of this doctoral research is to improve understanding of the hydrological processes in this sub-basin through the integration of multi-source observations (in-situ and satellite), hydrological modelling, and forward-looking analysis of future scenarios. More specifically, the research aims to design and deploy an optimal hydrological monitoring network combining in-situ stations and virtual altimetry stations to ensure continuous data acquisition; to identify, map, and quantify water storage compartments and hydrological flows in the sub-basin, and analyse their spatio-temporal interactions; and to assess the impacts of climate and land-use scenarios and propose robust, realistic adaptation options.

The methodology combines field hydrometric measurements (ADCP, automatic hydro-climatic stations), spatial altimetry (Sentinel-3, SWOT, ICESat-2; Kitambo et al., 2023), optical and radar remote sensing (Sentinel-1/2, MOD16; McFeeters, 1996; Xu, 2006), and hydrological modelling using PITMAN/ SPATSIM model (Hughes & Forsyth, 2006). Rating curves will be recalibrated using a hierarchical Bayesian approach (Le Coz et al., 2014) and model ensemble selection (WAIC; Mansanarez et al., 2016). Future scenarios will incorporate CMIP6 projections under SSP2-4.5 and SSP5-8.5 (O'Neill et al., 2016), combined with land-cover trajectories including conservation, agricultural intensification, or reforestation.

Expected outcomes include an operational hydrological monitoring network, an integrated map of storage compartments (surface water, groundwater, floodplains), an updated rating-curve database with reduced uncertainty, and a calibrated and validated model capable of estimating seasonal flows, hydrological extremes (Q5, Q95), and exchanges between compartments (Getirana et al., 2019). Prospective simulations will identify critical zones, estimate future changes in water availability across the sub-basin, and prioritise management options using the Analytic Hierarchy Process (AHP) multicriteria analysis (Saaty, 1980).

This study will therefore strengthen hydrological monitoring capacity and guide the sustainable management of water resources in the region. Future steps include producing a hydrological atlas of the study sub-basin, publishing at least three scientific articles, and integrating the results into decision-support tools.

Keywords: Hydrology – Kasai – Climate change – Congo Basin