An Integrated Multi-Satellite Altimetry and Field-Measurement Approach to Estimating Water Surface Slope in the Congo River Main Stem and Adjacent Wetlands

Génie Spirou K. Lutonadio[1,2*], Mark A. Trigg[2], Raphael M. Tshimanga[2], Mark Smith[3]

[1]School of Civil Engineering, University of Leeds, Leeds, United Kingdom
[2]Congo Basin Water Resources Research Centre and Regional School of Water, University of Kinshasa, Kinshasa, Democratic Republic of Congo
[3]School of Geography, University of Leeds, Leeds, United Kingdom

**Corresponding author: kgmv0565@leeds.ac.uk*

ABSTRACT

Cuvette Centrale wetlands, covering approximately 360,000 km², comprise one of the world's largest tropical peatlands, and play a key role for global climate mitigation. However, these ecosystems, which depend on permanent inundation, face increasing threats from climate and land-use change, which are likely to alter the hydrological functioning of these ecosystems. This hydrological functioning is controlled by various factors, including the seasonal morphological changes, generally shaped by low and high flows. The water surface slope (WSS), the spatial gradient of the water surface elevation (WSE), is one of the key hydraulic parameters, essential for understanding hydrological connectivity between the Congo River main stem and its adjacent wetlands. Nevertheless, WSS remains poorly constrained due to the scarcity of in situ observations in this remote and sparsely instrumented region. Here, we present an integrated approach based on multi-satellite altimetry, with in situ water level measurements to more accurately quantify spatiotemporal variations of WSE and WSS within the Congo river wetland system. We will combine complementary observations from CryoSat-2, Global Ecosystem Dynamics Investigation (GEDI), Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) and Surface Water and Ocean Topography (SWOT), overcoming the spatial and temporal constraints of individual satellites and delivering a continuous dataset of WSE dynamics for the Congo River wetland system. Our field campaign, guided by satellite altimetry will involve installing the water level loggers at selected locations along the main stem and in its wetlands, co-located with altimetry virtual stations. These in situ locations include Wendji (Mbandaka), Irebu (Lake Tumba), Djoundou (Oubangui), Liranga and Lukolela. These loggers, will be temporally synchronized by using Trimble Global Navigation Satellite System (GNSS), and will record water level dynamics (timing, direction and magnitude of the flood pulse) during both dry and rainy seasons. These instantaneous WSE will help to calibrate and validate satellite-derived WSE observations. WSS will be computed as the WSE difference between paired stations divided by their longitudinal distance. The multi-satellite altimetry and in situ observations will generate longitudinal WSE profiles and high resolution WSS estimate. This will allow the detection of key hydrodynamic signatures, including backwater effects, flow reversals and seasonal changes in upstream-downstream controls. These resulting high resolution WSS will advance understanding of Congo River main stem-wetland exchanges, and support future hydrodynamic modelling and vulnerability assessments of this globally significant wetland system to future climate and land-use changes.

Keywords: Multi-satellite altimetry; Field measurements; Water Surface Slope; Water Surface Elevation; Congo River wetland system