A First Multiscale 2D Hydraulic Model Calibration Over 1740 km of the Main Navigable Reach of the Congo River

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Abstract

Navigating large river systems presents challenges due to the extensive spatial and temporal scales involved. Particularly, in the context of a scarce data environment such as the Congo River. This study addresses these challenges by developing a 2D hydraulic model that spans 1740 km along the middle reach of the Congo River, representing the first model of its kind at this scale. The model's geometry is derived from a combination of ground observation data and remote sensing at various resolutions. The approach involves calibrating the 2D model using continuous in-situ measurements of water surface elevation obtained through GNSS technology in 2019. ensuring close alignment between simulated and observed water surface elevations. The findings are noteworthy, with the root-mean-square error (RMSE) of 0.435, a Kling-Gupta Efficiency (KGE) of 0.994, and a mean bias error (MBE) of -0.072, demonstrating the model's high accuracy and low bias. Additionally, the normality of the error distribution in the final calibration underscores the model's robustness and statistical reliability. Ultimately, the calibrated model serves as a valuable tool for decision-making processes. The simulated depth and velocity results are used for identifying high-risk navigation areas and optimizing navigational waterways, thereby enhancing safety and efficiency while providing essential insights into the navigation river system of this unique and understudied ecosystem.

Keywords: Congo River; 2D hydraulics model; ground observation data; remote sensing; Calibration; navigation river system