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A robust approach to physically-based rating curve development in remote rivers through UAV imagery

Ivar Abas (1,2), Willem Luxemburg (1), Hubert Samboko (1), Kawawa Banda (3), Hodson Makurira (4), Anais Couasnon (5), Lemmy Namayanga (6), Hessel Winsemius (1,7), and Hubert Savenije (1)

(1) TU Delft, Faculty of Civil Engineering and Geosciences, Water Resources Management, Delft, Netherlands (ivarabas@gmail.com), (2) Witteveen en Bos, Rotterdam, The Netherlands, (3) University of Zambia, School of Mines, Lusaka, Zambia, (4) University of Zimbabwe, Faculty of Civil Engineering, Harare, Zimbabwe, (5) VU Amsterdam, Institute for Environmental Studies, Amsterdam, The Netherlands, (6) Water Resources Management Authority, Lusaka, Zambia, (7) Deltares, Inland Water Systems, Delft, The Netherlands

Development and maintenance of river gauging sites is difficult. This is exemplified by the decline in the world-wide amount of operational river gauging stations. Challenges to maintain such gauging sites and keep rating curves up to date may be related to remoteness, accessibility, rapidly changing geometry due to erosion and sedimentation, and dangers during survey due to debris or wildlife.
In this study, we explore the use of imagery from low-cost Unmanned Aerial Vehicles (UAV), combined with hydraulic simulations to construct rating curves. We applied this in a river section, typically suited for our method, the Luangwa River in Zambia, closely downstream of Luangwa Bridge, close to the Mozambique-Zambia border. We use UAV imagery to establish a 3D reconstruction of the dry part of the river bed and use this to construct a hydraulic model. Only 2 snapshots of on-site observations of flow using an Acoustic Doppler Current Profiler (ADCP) were needed to calibrate the hydraulic model and derive a rating curve reconstruction through sequential simulation of a range of flow boundary conditions. We benchmarked our estimated water levels against observations, taken through extensive historical surveys by the Water Resources Management Authority of Zambia and find the results to be in strong agreement.
Our approach can eventually lead to observations in complex and difficult to access river sections. Because the shape of the rating curve strongly depends on the river geometry, this method can be instrumental to increase the reliability of rating curve extrapolation. This method may facilitate discharge estimates in remote rivers based on satellite observations of inundation extent and flood levels. In particular the upcoming Surface Water and Ocean Topography (SWOT) mission combined with this method, may deliver unprecedented estimates of flows in challenging environments.