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Rapid streamflow monitoring with drones

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Accurate and reliable streamflow monitoring data are urgently needed for many new locations to tackle the on-going climate emergency, where we now see increasingly severe impacts on society from extreme flows. Yet, traditional river monitoring methods depend on empirical rating-curve methods for which it typically takes many years or decades to obtain reliable data, in particular for extreme flows. This gap between increasing needs and current monitoring capabilities calls for new methods to be developed.

Drones provide an unprecedented ability to measure both the physical and hydraulic characteristics of a river in an efficient manner. Topography, water surface slope, surface water velocity and even bathymetry can be derived from drone images and drone lidar data. We exploited this potential by incorporating drone data into the framework for Rating curve Uncertainty estimation using Hydraulic Modelling (RUHM). The RUHM framework combines a one-dimensional hydraulic model with Bayesian inference and together with drone data it allows us to efficiently estimate a reliable rating curve and its associated uncertainty based on as few as three gaugings.

We present our results from applying RUHM to Swedish gauging stations where we model rating curves and streamflow based on drone data. We primarily used low-cost camera drones to collect both the input (DEM, vegetation, bathymetry) and calibration data (water surface slope, surface velocity) for the hydraulic model, but also tested the capabilities of drone lidar data. Our aim was to estimate reliable rating curves with RUHM based only on data from the drone flights. We assessed the uncertainty in the drone-derived model input and calibration data compared to traditional fieldwork techniques, as well as their impact on the RUHM-modelled rating curves and streamflow results.

We find that careful planning of when to fly the drone is important for obtaining good-quality model input and calibration data. Using a combination of drone camera and drone lidar data we were able to obtain all the data needed for RUHM from the drone flights. Extreme low and high flows were reliably modelled with RUHM with constrained uncertainty based on as few as three low and middle flow gaugings, without the need for gauging extreme flows. We conclude that using RUHM with drone data is an efficient and promising alternative to traditional streamflow

monitoring methods, being much less time-consuming and costly, as well as involving fewer risks to field staff.