Modelling the Bathymetry and Hydraulics of the Congo's Main Stem Through the Cuvette Centrale

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1. Introduction

A scarcity of river bathymetry data along the middle reach of the Congo presents a major challenge for river hydraulic research and in particular numerical hydraulic modelling. In this study we conducted a hydraulic survey of a 70km study reach (shown in Figure 1 & Figure 2) in order to investigate the middle reach bathymetry and its influence on hydraulics.

Figure 1: Hydraulic Survey of Study Reach on CRuHM Fieldtrip

Obtaining full bathymetry of the Congo's massive multichannel main stem is not feasible, even on a discrete study reach. We have therefore developed a bespoke bathymetry modelling methodology suitable for sparse sonar data on a multichannel river. The results of the bathymetry model (BM) are presented in the form of a bathymetric Digital Elevation Model (DEM).

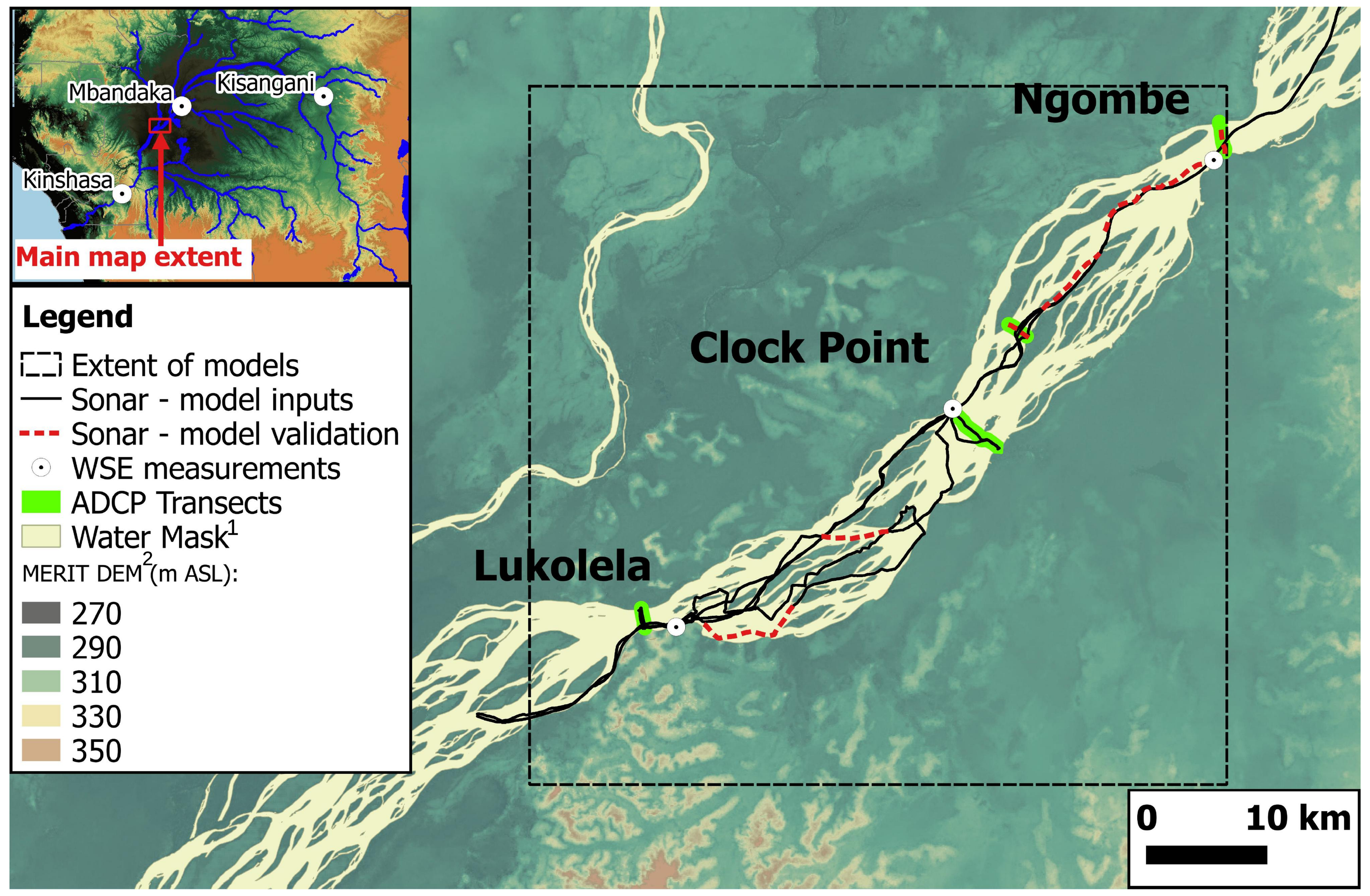


Figure 2: Map of CRuHM fieldtrip hydraulic survey with annotations

2. Methods

- The bathymetry modelling process is described in Figure 3. All calculations are performed in the QGIS open source software.
- Geometric validation of the completed Bathymetric DEM (Section 3) was carried out by comparing it against a validation dataset comprising five sections of sonar data.
- The bathymetric DEM was then fed into a hydraulic model using LISFLOOD-FP[3] (Section 4). Steady state simulations were run using the discharge collected during the field trip, and modelled velocities were validated against ADCP measurements.

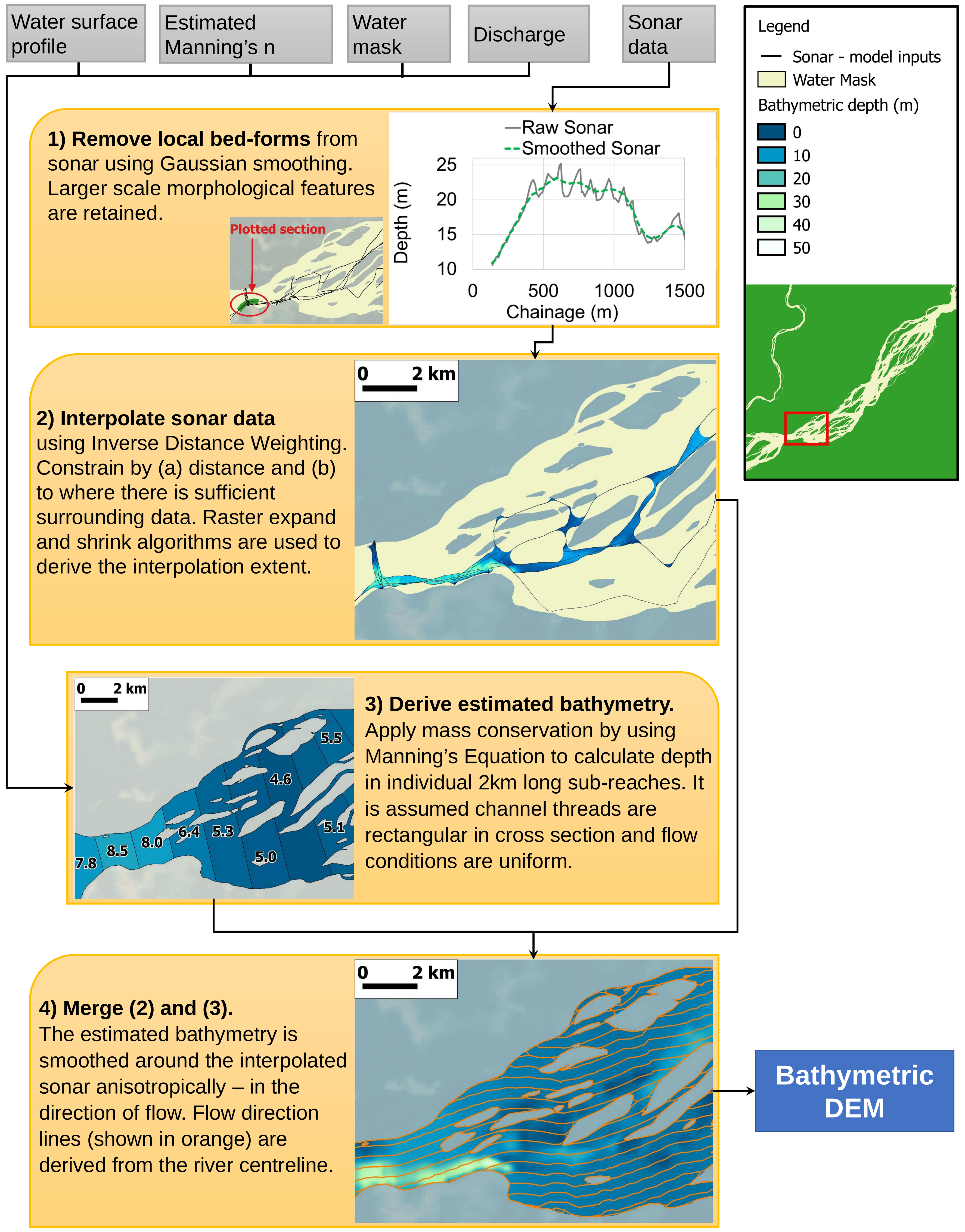
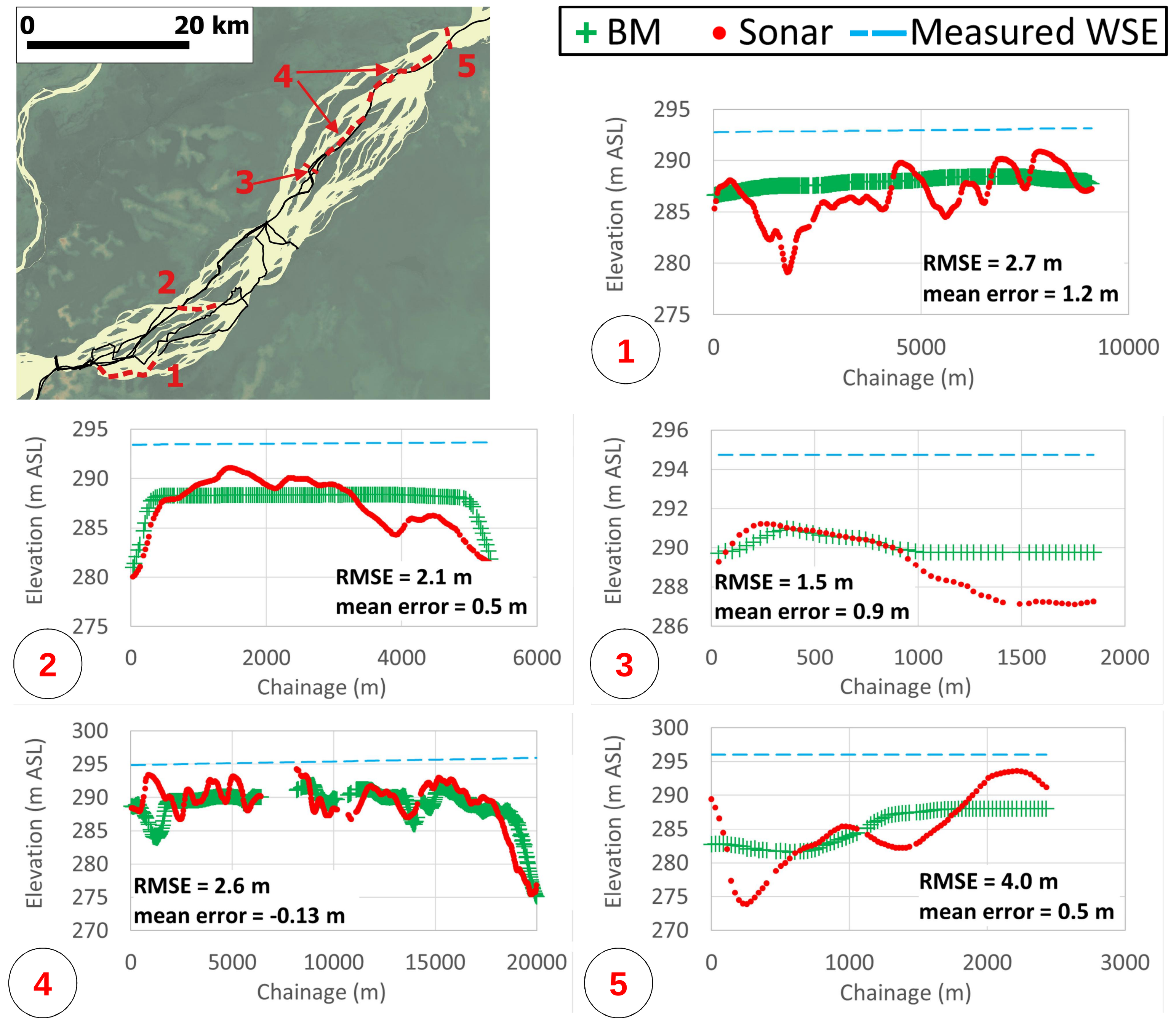


Figure 3: Flow Diagram Showing the Bathymetry Model (BM) Process

3. Results – Geometric Validation



4. Results – Hydraulic Validation

Using the LISFLOOD-FP 2D Inertial Formulation, a spatially uniform Manning's n value of 0.028 was assigned following adjustment to match the modelled water surface profile to the observed. A 25m cell size was used. The resulting cross sectional average velocities were compared against the ADCP measurements, the results are summarized below.

	Velocity (m/s)		
Location	**Hydraulic Model**	**ADCP Measurement**	**% error**
Ngombe	0.84	0.77	9
Clockpoint	0.69	0.82	-16
singlethread section	1.05	0.86	22

5. Conclusions and Future Work

- The Bathymetry model (BM) presented derives a physically realistic bathymetric DEM of a large and complex multichannel river. The BM requires sparse observations of river depth only. Other required inputs can be obtained from publically available satellite data.
- Geometric validation detected a tendency for the BM to under predict depth. Adjustment of the Manning's n input into the BM could reduce this under prediction. Hydraulic validation showed velocities predicted by the BM to be both above and below observed values.
- Future work includes applying the BM to a larger part of the Congo's middle reach, and automation of the BM to enable rapid adjustment of BM parameters such as Manning's n, and smoothing parameters.

References

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