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Bathymetric mapping in turbid braided mountain streams using SfM-MVS photogrammetry and statistical approaches

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River bathymetric investigation has a long tradition as river-bed morphology is a crucial geomorphological variable that also has implications for river ecology and sediment management. In one sense, this is becoming more straightforward with the development of UAV platforms and SfM-MVS photogrammetry. Mapping inundated and exposed areas simultaneously has proved possible either by adopting two media refraction correction or by using some form of the Beer-Lambert Law. However, both of these approaches rely upon the bed being visible which becomes restricted to progressively shallower zones as stream turbidity increases. Traditional survey techniques to collect bathymetric data for inundated zones (e.g. total station or differential GPS systems) are time consuming and require a trade-off between point density and the spatial extent of survey. In this study we test a simple hypothesis: it is possible to generalize the likely depth of water in a shallow braided stream from basic planimetric information and use such statistical relationships to reconstruct the bathymetry of inundated zones. This is based upon the principle that a suite of planimetric variables (e.g. distance from stream banks, river channel width, local curvature magnitude and direction, streamline convergence and divergence) can be used to model the spatial distribution of water depths. We attempt to do this for a shallow braided river with high suspended sediment concentrations using orthoimages and DEMs derived from application of SfM-MVS photogrammetry to UAV-based imagery. We develop separate calibration and validation relationships to train and to assess the statistical models developed. These are then applied to the stream to produce bathymetric maps of flow depth for integration with SfM-MVS derived data from exposed areas. The method produces a point specific measure of uncertainty and tests suggest that the associated uncertainties are sufficiently low that after propagation into DEMs of difference reliable data on braided river dynamics and erosion and deposition volumes can be obtained.