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Bathymetric UAS-SfM change detection: The implications of refraction correction, water surface elevations and spatially variable error

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RGB cameras and LiDAR sensors mounted on manned aircraft have permitted temporal monitoring of geomorphic change at spatial resolutions of decimetres to metres within river systems. Monitoring of finer resolutions has typically relied upon traditional in situ field surveys of points or transects. However, these surveys do not provide spatially continuous data and thus may overlook important changes. Recently, we have advanced our capabilities for spatially continuous surveying of geomorphology at finer scales, using imagery acquired from RGB sensors mounted on unmanned aerial systems (UAS) and processed using structure from motion photogrammetry (SfM). The quantification of geomorphic change at these scales is important for a range of applications within river science and management, including sediment budgeting, monitoring river restorations, flood risk monitoring and assessing the impacts of change on physical habitat availability. To date however, few studies have attempted to quantify the success of the UAS-SfM approach for quantifying geomorphic change, especially in the more challenging submerged parts of the river channel where refraction correction is required. In this research, we use two datasets acquired over a 650m reach of the River Teme, UK, to (1) quantify the accuracy and precision of a new methodological development for the bathymetric SfM process, including the implications of different methods for estimating water surface elevations, and (2) identify the sources and impacts of spatially variable error on our ability to detect meaningful geomorphic change, including variations in precision resulting from water depth, local slope, vegetation and the image acquisition and processing routines themselves.