An evaluation of low-cost terrestrial LiDAR sensors for assessing geomorphic change

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For process geomorphologists, accurate topographic data acquired at appropriate spatio-temporal resolution is often the cornerstone of research. Recent decades have seen advances in our ability to generate highly accurate topographic data, primarily through the application of remote sensing techniques. Structure from Motion Multi View Stereo (SfM-MVS) and LiDAR have revolutionised the spatial resolution of surveys across large spatial extents. Continuing technological developments have led to commercialisation of small form LiDAR sensors that are suited to deployment on both mobile (e.g. uncrewed aerial systems), and in fixed semi-permanent installations. Whilst the former has been adopted (e.g. DJI Zenmuse L1), the potential for the latter to generate data suitable for geomorphic investigations has yet to be assessed. We address this gap here in the context of a three-month deployment where channel change is assessed in an adjusting fluvial system. We find that the small form sensors generate change detection products comparable to those generated using an industry-grade LiDAR system (Riegl VZ-4000). Areas of no geomorphic change are adequately characterised as such (mean 3D change of 0.014m compared with 0.0014m for the Riegl), with differences in median change estimates in eroding sections of between 0.01-0.03m. We illustrate that this data enables accurate characterisation of river channel adjustments through extraction of bank long-profiles, the assessment of bank retreat patterns which help elucidate failure mechanics, and for the extraction of water surface elevations. Deployment of this emerging, new technology will enable better process understanding across a variety of geomorphic systems as data can be captured in 4D with near real-time processing.