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Ground-based structure from motion – multi view stereo (SFM-MVS) for upland soil erosion assessment.

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In upland environments, quantifying soil loss through erosion processes at a high resolution can be time consuming, costly and logistically difficult. In this pilot study 'A cost effective framework for monitoring soil erosion in England and Wales', funded by the UK Department for Environment, Food and Rural Affairs (Defra), we evaluate the use of annually repeated ground-based photography surveys, processed using structure-from-motion and multi-view stereo (SfM-MVS) 3-D reconstruction software (Agisoft Photoscan). The aim is to enable efficient but detailed site-scale studies of erosion forms in inaccessible UK upland environments, in order to quantify dynamic processes, such as erosion and mass movement. The evaluation of the SfM-MVS technique is particularly relevant in upland landscapes, where the remoteness and inaccessibility of field sites may render some of the more established survey techniques impractical.

We present results from 5 upland sites across the UK, acquired over a 2-year period. Erosion features of varying width (3 m to 35 m) and length (20 m to 60 m), representing a range of spatial scales (from 100 m2 to 1000 m2) were surveyed, in upland habitats including bogs, peatland, upland grassland and moorland. For each feature, around 150 to 600 ground-based photographs were taken at oblique angles over a 10 to 20 minute period, using an uncalibrated Canon 600D SLR camera with a 28 mm lens (focal length set to infinity). Camera settings varied based upon light conditions (exposure 100-400 ISO, aperture F4.5 to F8, shutter speed 1/100 to 1/250 second). For inter-survey comparisons, models were geo-referenced using 20 to 30 ground control points (numbered black markers with a white target) placed around and within the feature, with their co-ordinates measured by survey-grade differential GNSS (Trimble R4). Volumetric estimates of soil loss were quantified using digital surface models (DSMs) derived from the repeat survey data and subtracted from a modelled pre-erosion surface (CloudCompare, Golden Software Surfer). We discuss the survey performance achieved in terms of the time required and the precisions delivered, and consider the practical application of SfM-MVS for long-term upland erosion monitoring.