Geophysical Research Abstracts
Vol. 16, EGU2014-7709-1, 2014
EGU General Assembly 2014

Comparing and combining terrestrial laser scanning with ground-and UAV-based imaging for national-level assessment of soil erosion

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3D topographic or surface models are increasingly being utilised for a wide range of applications and are established tools in geomorphological research. 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 compare methods of collecting topographic measurements via remote sensing for detailed studies of dynamic processes such as erosion and mass movement. The techniques assessed are terrestrial laser scanning (TLS), and unmanned aerial vehicle (UAV) photography and ground-based photography, processed using structure-from-motion (SfM) 3D reconstruction software. The methods will be applied in regions of different land use, including arable and horticultural, upland and semi natural habitats, and grassland, to quantify visible erosion pathways at the site scale. Volumetric estimates of soil loss will be quantified using the digital surface models (DSMs) provided by each technique and a modelled pre-erosion surface.

Visible erosion and severity will be independently established through each technique, with their results compared and combined effectiveness assessed. A fixed delta-wing UAV (QuestUAV, http://www.questuav.com/) captures photos from a range of altitudes and angles over the study area, with automated SfM-based processing enabling rapid orthophoto production to support ground-based data acquisition. At sites with suitable scale erosion features, UAV data will also provide a DSM for volume loss measurement. Terrestrial laser scanning will provide detailed, accurate, high density measurements of the ground surface over long (100s m) distances. Ground-based photography is anticipated to be most useful for characterising small and difficult to view features. By using a consumer-grade digital camera and an SfM-based approach (using Agisoft Photoscan version 1.0.0, http://www.agisoft.ru/products/photoscan/), less expertise and fewer control measurements are required compared with traditional photogrammetry, and image processing is automated. Differential GPS data will be used to georeference the models to facilitate comparison.

The relative advantages, limitations and cost-effectiveness of each approach will be established, and which technique, or combination of techniques, is most appropriate to monitor, model and estimate soil erosion at the national scale, determined.