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Erosion research with a digital camera: the structure from motion method used in gully monitoring - field experiments from southern Morocco

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ABSTRACT

From a geoscientific view arid or semiarid landscapes are often associated with soil degrading erosion processes and thus active geomorphology. In this regard gully incision represents one of the most important influences on surface dynamics. Established approaches to monitor and quantify soil loss require costly and labor-intensive measuring methods: terrestrial or airborne LiDAR scans to create digital elevation models and unmanned airborne vehicles for image acquisition provide adequate tools for geomorphological surveying. Despite their ever advancing abilities, they are finite with their applicability in detailed recordings of complex surfaces. Especially undercuttings and plunge pools in the headcut area of gully systems are invisible or cause shadowing effects.

The presented work aims to apply and advance an adequate tool to avoid the above mentioned obstacles and weaknesses of the established methods. The emerging structure from motion-based high resolution 3D-visualisation not only proved to be useful in gully erosion. Moreover, it provides a solid ground for additional applications in geosciences such as surface roughness measurements, quantification of gravitational mass movements or capturing stream connectivity.

During field campaigns in semiarid southern Morocco a commercial DSLR camera was used, to produce images that served as input data for software based point cloud and mesh generation. Thus, complex land surfaces could be reconstructed entirely in high resolution by photographing the object from different perspectives. In different scales the resulting 3D-mesh represents a holistic reconstruction of the actual shape complexity with its limits set only by computing capacity. Analysis and visualization of time series of different erosion-related events illustrate the additional benefit of the method. It opens new perspectives on process understanding that can be exploited by open source and commercial software.

Results depicted a soil loss of 5,28 t for a 3,5 m^2 area at a headcut retreat of 1,95 m after two heavy rain events. At a different site in the Souss region the depression line of a gully was lowered after channel flow and a hollow appeared while the headcut remained stable. The latter is usually interpreted as a hint for an inactive system.

While formerly precise differences in volumes could only be estimated based on aerial imagery or LiDAR scans, the presented methodology allows assumptions of high quality and precision. Not only in erosion research the structure from motion-method serves as a useful, flexible and cheap means to increase detail and work efficiency.