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Structure-from-Motion as a method to quantify erosion volumes and to identify sediment sources in eroding rills

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One particular problem in the study of rill erosion is the lack of information about sediment sources. So far, the sediment sources can only be identified by observation during the event or the experiment. Furthermore, only large and clear visible changes are considered and observations do not allow the quantification of erosion rates. A solution to this problem can be provided by 3D-modeling using the Structure from Motion (SfM)technique.
Digital elevation models (DEM) from terrestrial and aircraft based images have been produced for many years; however, traditional photogrammetric analysis techniques require considerable expertise both for imaging and for data processing. The recent development of SfM providing for geoscientific applications the potential and greatly facilitated conditions for creating accurate 3D models from terrestrial and aerial photographs that were recorded by standard, non-metric cameras.
Before and after the rill erosion experiments, coherent and largely overlapping terrestrial photos have been acquired. Afterwards, VisualSfM constructs 3D models by searching unique features in single images, searching for common features in image pairs and by triangulation of camera and feature positions using these pairs. The results are point clouds with x-, y- and z-coordinates, which are the basis for the preparation of the 3D-digital elevation models or volumetric surface models.
The before and after models are all in their own, arbitrary coordinate systems and therefore they need to be superimposed and scaled. From the point clouds, surface models are created and via difference calculations of the before and after models, sediment sources can be detected, and erosion volumes can be quantified.
Until now, the volume deviations between the 3D models and reference volumes do not exceed 10%. The noise of the 3D models in the worst dimension (z-axis) does not exceed the pixel spacing times 4-5.
The results show that VisualSfM is a good, easy to apply and economic alternative to other imaging systems like laser scanning or standard software like Leica Photogrammetry Suite.