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Soil erosion assessment via temporal and spatial high-resolution time-lapse Structure from Motion on rainfall simulation plots

Lea Epple[1], Anne Bienert[2], Oliver Grothum[2], and Anette Eltner[2]
[1]Department of Physical Geography, Friedrich-Schiller-University Jena, Jena, Germany (lea.epple@uni-jena.de)
[2]Department of Geosciences, Technical University Dresden, Dresden, Germany

High-resolution information on the processes and rates of soil erosion, transport, and deposition, offer important knowledge for soil erosion modelling, and the protection and sustainable management of soil. It helps improve the cross-scale understanding on aspects as aggregate breakdown, rill erosion, swelling and shrinking effects, and rill-network evolution. As a non-invasive, high-resolution, and cost as well as time-efficient method, Structure from Motion (SfM) presents a valuable tool to calculate soil loss, depict soil surface change detection, and offer high-resolution information on soil and soil erosion processes. Even though SfM shows in general higher erosion rates, due to the influence of non-erosive processes, the technique is altogether in good agreement with the sampling data at the outlet. We monitor soil erosion on multiple erosional plots and with spatial and temporal high-resolution photogrammetry to assess its feasibility over time.

For this purpose, we conduct 12 rainfall simulations on a three times one metre plot, on different sides, with different vegetation cover, tillage, and initial soil conditions. Seven to ten synchronized time-lapse cameras are set up around the plot, taking pictures every 10-60 seconds. The data thus obtained allow change detection assessment via digital elevation models of difference at least once per minute. The elevation change by SfM is validated via bulk density measurements, and sampling at the plot's outlet assessing runoff, and sediment concentration at minute intervals. During an overflow experiment, we measure flow velocity via video using particle tracer and manually via colour tracer, gaining spatial and temporal distribution information on the flow velocity. Using low-cost sensors, we furthermore monitor the progress of the soil moisture and temperature during the whole rainfall simulation.

We present sampled and photogrammetric results based on a dozen rainfall simulations at the micro-scale with a very high temporal and spatial resolution. This gives an insight into spatial distribution and development of soil erosion processes on a sub-minute resolution. We compare these data to gain knowledge on the feasibility of temporal and spatial high-resolution SfM soil erosion assessment and their usability for the validation and calibration of process-based soil erosion models.