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The SfM-monitored rill experiment, a tool to detect decisive processes?

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The initiation of rill erosion marks the transition from sheet to linear erosion. With this transition, the relevant processes change and therefore, the observation method needs to be changed too: from observing rainfall induced drop impacts to hydraulic observations.
For us, the investigation of the decisive processes in eroding rills resulted in a constantly revised and updated rill erosion experiment, that has been used for several years. Within this experiment the sediment transport behavior of rills is simulated and examined. To make the experiment repeatable and replicable, several key-variables have to be kept constant, i.e. water quantity (1000 L), test duration (approx. 4 min.) and the length of the tested rill section (20 m). For each tested rill, the topographic background is determined i.e. catchment area, aspect, slope, position and height of existing knick-points and three cross-sections. After the initial assessment, the rill is flushed with water (250 L min -1) twice in order to determine the modifications of the rill caused by the flowing water. Within these approx. 4 minutes of "controlled destruction" the velocity of the turbulently flowing water at the beginning of the erosional event and after one and two minutes is determined and the corresponding water depth is recorded using three gauges at selected measuring points. At the end of the tested rill segment, the discharge is constantly monitored.
Unfortunately, the results of this rill experiment do not directly show the modifications caused by the artificial waterflow. A way out of this knowledge gap is offered by combining this experimental measurement method with a technique already used in different scientific disciplines in more large-scale applications.
Structure-from-Motion technology offers the opportunity to get a different, more detailed view inside the erosion rills. A static multi-camera-array and a dynamically moved digital video-frame camera are now used to obtain three-dimensional models of the rills before and after the experiment. These 3-D-models allow, in close connection with the time-controlled sampling, to point out the spatial and temporal distribution of erosion and accumulation hotspots. Furthermore it becomes possible to strike the erosion/accumulation-balance and get a glimpse at the hot-spots of side-wall-failure and rill bed-incision.
The combination of both approaches – rill experiment and 3D modells – results in a more comprehensive insight: What happens in the rill? They allow for the detailed observation of the position, magnitude and furthermore the identification of the relevant erosion process. Eventually, the increased knowledge will assist to describe the processes accurately in a mathematical-physical way.