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Method ensemble for quantification of soil erosion processes in the field

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Field experiments are an important tool for geomorphological and soil erosion research. Directly measured field data are used to detect and quantify soil erosion processes as well as for parameterization of soil erosion models. On the other hand, results calculated by models can be validated by field experiments as well. Depending on the soil erosion process to be investigated, various field methods with different focus must be used. Herein we propose a combination of experimental methods and measurements to understand a wide range of soil surface processes at different scales.

The biggest forms caused by soil erosion are gullies. Because of their size, it is not possible to activate measurable processes but it is possible to document the enlargement of these forms by means of large scale aerial photography time series. Under calm conditions, a blimp is used as camera platform, under hard wind conditions two different kites are available and if the wind is too strong for the blimp but too slow for the kites, two different unmanned aerial vehicles (UAV) are used. The UAV-photos can also be used for ploting because the maximum flight level allows overview photos over a whole gully catchment.

For enlarging, gullies need a defined quantity of water which moves as sheetflow or it concentrates in linear forms like rills. Depending on the flow path, different erosion and runoff processes take place that can be quantified by different experimental setups. Sheetflow and the resulting sheeterosion can be simulated with a small portable rainfall simulator. The easy handling allows a large number of repetitions in one test area so that different soil surfaces (crusts, vegetation and rock fragment cover and under different slopes) can be tested in a restricted timetable. In most cases, natural rainfall events are accompanied by wind events (or influenced by wind). By means of the combined wind- and rainfall simulator, the factors wind and rain can be investigated separately and together.

The opposite of runoff generation is the infiltration. The infiltrated quantity of water is not available any more for the surface runoff and, hence, is not available for erosion processes any more. With the single-ring-infiltrometer the maximum infiltration capacity of a test-plot under 5 cm water height can be measured. Main advantages are low operating cost and very easy handling. Concentrated sheetflow or the exceeding of a physical threshold can cause the development of small rills. These rills are runoff collectors, provide a large quantity of eroded material and increase with time to ephemeral gullies and gullies. The runoff and erosion effectivity of rills can be tested with the rill experiments. A given water quantity is induced with constant intensity into a given rill and flow velocities, sediment concentrations, runoff values and different hydraulic parameters can be measured or calculated from the measured values.

Combining the results of all these experiments, it is possible to quantify growth of a gully and the erosion processes in its catchment.