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Rainfall Simulation: methods, research questions and challenges

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In erosion research, rainfall simulations are used for the improvement of process knowledge as well as in the field for the assessment of overland flow generation, infiltration, and erosion rates. In all these fields of research, rainfall experiments have become an indispensable part of the research methods. In this context, small portable rainfall simulators with small test-plot sizes of one square-meter or even less, and devices of low weight and water consumption are in demand. Accordingly, devices with manageable technical effort like nozzle-type simulators seem to prevail against larger simulators. The reasons are obvious: lower costs and less time consumption needed for mounting enable a higher repetition rate. Regarding the high number of research questions, of different fields of application, and not least also due to the great technical creativity of our research staff, a large number of different experimental setups is available. Each of the devices produces a different rainfall, leading to different kinetic energy amounts influencing the soil surface and accordingly, producing different erosion results. Hence, important questions contain the definition, the comparability, the measurement and the simulation of natural rainfall and the problem of comparability in general. Another important discussion topic will be the finding of an agreement on an appropriate calibration method for the simulated rainfalls, in order to enable a comparison of the results of different rainfall simulator set-ups. In most of the publications, only the following „nice“ sentence can be read: "Our rainfall simulator generates a rainfall spectrum that is similar to natural rainfall!". The most substantial and critical properties of a simulated rainfall are the drop-size distribution, the fall velocities of the drops, and the spatial distribution of the rainfall on the plot-area. In a comparison of the most important methods, the Laser Distrometer turned out to be the most up-to-date and the best measurement method for drop-spectra and drop fall velocities. The measured rainfall amounts resulting from the different methods differ by two orders of magnitude, due to the different exposure times and measuring areas, and thus the efficiency also ranges between 0.2 and 108 %. This also shows that a standardized method for the calibration of simulated rainfall should be determined.
As a third point, the three major challenges for the experimental soil erosion research of the Physical Geography Department in Trier will be presented: 1) Influence of land-use and treatments, 2) Influence of Sheep (goat) trampling and 3) Influence of wind-driven rain. The presented results indicate increases of the sediment yields due to wind influence between 113 % and at the maximum even 1100 %, that equals one order of magnitude.
The main conclusions are:
Rainfall simulations are an adequate tool for soil erosion studies with different experimental set-ups.
A calibration of the simulated rainfall is necessary, and an appropriate method should be found.
Rainfall simulations with small portable simulators show discriminative results depending on land-cover types and treatments.
Wind-driven rain increases the soil erosion rate, while the runoff stays almost unaffected. This fact has to be considered for the interpretation of rainfall simulation results gained excluding wind influence, as it is usually the case.