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Quantification of Water Erosion on Subalpine Grassland with Rain Simulators

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Intensive land use and increasing storm events trigger rain erosion, thus its quantification is important. The aim of this study was to asses the influence of the vegetation on runoff and water erosion in an alpine grassland area. Further, we estimated the influence of vegetation on the soil characteristics matrix stability and C/N ratio and assessed the relationship between those parameters as well as the grain size distribution with erosion and runoff rate. To test the above hypotheses a field spray nozzles drop former hybrid simulator, consisting of a full-core Lechler nozzle and a meshed fixed below to improve the rain drop distribution, was used. Prior to the field experiment, we compared this simulator with a drop former simulator in the laboratory at the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) in terms of drop size distribution and kinetic energy. Thereby, we could estimate the accuracy of the field simulator.

The rain drop size distribution and the total kinetic energy of the drops at a rain intensity of 60 mm h^{-1} were measured with a Joss-Waldvogel distrometer. To compare the effect of the two rain simulators as well as the influence of the soil texture on erosion and runoff rate, we used 6 silty soil monoliths and 6 clayish monoliths. To get comparable initial conditions, every soil monolith was irrigated only one time, starting at field capacity. The soil moisture was continuously recorded by TDR probes during the simulation.

The comparison of the two rain simulators showed a close similarity in the drop size distributions. For both simulators, the most frequent drop size class is in the range of 1 mm in diameter. Natural rain typically shows a larger mean drop size at an intensity of 60 mm h^{-1}. In comparison to the natural rain, the total kinetic energy of the simulated rain of both of the simulators was too small as well. These results lead to the conclusion, that the true simulation of a natural rain is hardly realizable.

The sediment load of the laboratory and the field experiment both increased in the first 20 - 60 minutes of raining and reached than a climax. During this period the easily detachable particles got washed out, later on an equilibrium was reached. The sediment load rose exponential with increasing runoff. There were highly significant differences between the sediment load of the clayish soil having good aggregate stability and the silty soil. This demonstrates the clear influence of soil textures on erosion sensitivity. These results show that even though it is very difficult to achieve natural conditions with rain fall simulators, they can be used to study relative differences of the effects of rain erosion on soils with different characteristics. These experiences are very useful for the comparison of different soils, since in laboratory experiences the initial conditions like soil slope and soil water content are freely settable and disturbing factors in the field like wind are negligible.

Nevertheless, field experiments are an essential instrument to assess soil erosion in natural environment. These studies showed that the soil aggregate got more stable with increasing vegetation and the sediment load decreases exponentially. Vegetation coverage of 50% at a 45° slope already leads to a significant decrease of the sediment output through water erosion. However, we could not found a clear relationship between the vegetation coverage and the amount of runoff. For vegetation coverage between 0 and 60% the runoff decreased as the vegetation coverage rose. Opposite, for vegetation coverage between 60 and 100%, runoff increased as vegetation increased. The ratio between the organic carbon and nitrogen decreased linear with the reduction of vegetation coverage. This can be explained mainly by the increased mineralisation caused by the higher temperature on the plot without vegetation and secondarily by erosion.