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Forest influence on runoff generation assessed in a nested approach at four scales

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On December 26th 1999 the storm Lothar caused severe damage in large parts of central Europe, including Switzerland. In the Sperbelgraben, a small forested basin in the Swiss Emmental where hydrologic measurements began in 1903, the storm generated a favourable situation for research. In one of two neighbouring sub-catchments, with an area of about 2 ha each, more than two third of the trees were overthrown or broken whereas in the other one slightly over 20 % of the trees were damaged. Thus, WSL carried out a research project about the general influence of forests and specifically of this deforestation on runoff generation. The study was financed by the Swiss agency for forest, environment and landscape (SAFEL).

Runoff generation processes in the Sperbelgraben were investigated on four scales. On the profile level, 14 soil profiles were analysed. Irrigation experiments have been carried out immediately above 11 profiles. On the plot scale, surface runoff has been measured on 19 plots with an area between 50 and 110 m2. On two plots subsurface runoff on a less permeable layer in a depth of about 70 cm has been measured too. In both sub-catchments a gauging station was installed. The entire Sperbelgraben (0.5 km2) represents the uppermost level of our nesting approach.

For up- and downscaling of dominating runoff processes, information distributed on soil properties is needed. In the Sperbelgraben this information was assessed through profiles analysis and irrigation experiments. For the up-scaling of the finding we adopted a so called forest site type map, available for all forests in Switzerland. Specific hydrological processes were assigned to the classes available in the forest site map and qualitatively verified by plot measurements if and modelling.

The results show that storm damage has only little influence on runoff and also on

erosion in the Sperbelgraben. This is mainly due to the fact that the key factor determining hydrologic reaction, the soil, was only slightly influenced by the storm. Comparing the observations on profile and plot scale showed that on both scales similar hydrologic reactions can be detected. On gleyic soils high surface runoff coefficients were observed and on cambisols no or only little surface runoff due to a hydrophobic reaction of an organic layer at the beginning of a rainfall event was measured. The forest site type map suits for an identification of the dominating hydrologic processes in the Sperbelgraben.

For application of the findings on the sub-catchment and catchment level additional information, e.g. channel density and connectivity of areas producing surface runoff to the channel, have to be considered. The analysis confirmed the widespread lack of knowledge on subsurface processes that many authors cite in their studies. For this purpose the authors are planning to carry out irrigation experiments on artificial slopes of 3 * 5 m with the indoor rainfall simulator of WSL. We expect to improve the interpretation of field knowledge on how permeability, macropores, roots etc. influence the lateral flow in the soil with well target-oriented laboratory experiments.

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