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Rain simulation experiments and the tortuous way to runoff values in alpine catchments

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At the Austrian Institute for Avalanche and Torrent Research in the last decade about 135 representative plots have been irrigated by means of a transportable spray irrigation installation for large plots (50 up to 400 m^2) and more than 250 rain simulation experiments were carried out for analysis of runoff processes on different alpine soil vegetation complexes. During such experiments also a lot of other aspects, like vegetation characteristics, way and intensity of cultivation, soil physical properties, soil moisture content and others are investigated in detail. Monitoring of soil moisture by use of TDR-probes shall allow the observation of changes in soil moisture conditions and the advance of the wetting front in the soil. On some plots runoff velocity is measured by use of salt and dye tracer.

Already during the experiment the first problems occur, such as non-uniform distribution of rain due to side wind or loss of runoff at the gauging unit.

The rain simulation studies usually are carried out in torrent catchments, on mountainous soils, mostly rich in skeleton, where measurement techniques which normally are functioning well in the lowlands come to their limit. So TDR-probes often show reliable soil water content at the beginning of the experiment but change to not reproducible values during the irrigation. In addition significance of soil physical properties derived from soil cores of 200 cm^3 bulk volume is limited for alpine soils, due to their extreme heterogeneity. So it's possible to get nearly dry cores and totally wetted cores after several hours of irrigation within distances smaller than one meter. These effects result from high differences in antecedent moisture content and changes in infiltration characteristics within a small area.

Also a lot of questions occur during the interpretation process, for example, as Govers (2000) says: Our knowledge of the effect of soil roughness on hydrological and erosion processes is far from complete. Normally there is a strong relationship between overland flow velocity and surface roughness, especially if water merely runs at the surface. When runoff covers also the upper soil (near surface runoff) flow velocity strongly increases – an effect which can often be observed for forest soils – but to which extent it is an effect of vegetation, the humic layer or the mineral soil?

Each research plot, every rain simulation experiment has its own characteristics, this makes standardization of the generated data, comparison of results from different plots or different catchments and the extrapolation of these results on wider areas very difficult. Pure statistical analysis of the data in our case does not lead to satisfactory results. So a combination of statistical and detailed empirical analysis has been used for the development of a simple code of practice for assessment of surface runoff coefficients in alpine catchments in torrential rain. Since 2004 these instructions form an essential basis for runoff modelling by practitioners in Austria.