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Inverse modelling of subsurface flow permeability values

Bernhard Kohl, Veronika Lechner, Gerhard Markart, and Herbert Pirkl

Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), Department of Natural Hazards, Innsbruck, Austria (bernhard.kohl@uibk.ac.at)

Most hydrological models require information about hydrogeological permeability to calculate subsurface runoff processes in the soil and geological substrate. This information is commonly represented as k-values (subsurface storm flow permeability values). Permeability values from literature can be used only if the transfer to specific hydrogeological units is provided. Several classification schemes exist for qualitative differentiation of k-values (e.g. Hölting, 1996).
However extensive data on distance velocities or rather transport velocities are existing from field investigations (rain simulation experiments with accompanying measurement of the water movement via geolectrics or tracers). Bandwidths of shallow interflow velocities for different substrates have been derived from such experiments (e.g. by Markart et al. 2014). The derivation of k-values for hydrologic modeling from this data represents a not negligible challenge. For the presented solution approach, inverse modeling was used to determine subsurface k- values.
Hydrogeological mapping was carried out comprehensively for East Tyrol (2.000 km^3) by H. Pirkl in 2012. The existing substrates were assigned to 13 classes, differing in their hydrogeological behavior. In addition, Pirkl did a series of simultaneous discharge measurements at representative springs and brooks. Based on this data set bandwidths of interflow velocities for the different hydrogeological response classes were defined. These bandwidths were complemented and verified with the above-mentioned data from literature and other field experiments.
For the inverse modeling of subsurface k-values the Izzard's formula was used to estimate subsurface flow velocities assuming comparability in subsurface flow and overland flow behavior. (considering the analogy with overland flow.) Overland flow length downstream and mean slope of the flow path were calculated, both equated with interflow simplistically. A design rainfall event was defined with an intensity of 100 mm/h. For each k-value by Hölting (1996) theoretical distance velocities were calculated for the project area. Comparing these results of distance velocities with the previously presented collected data of subsurface flow velocities, reliable k-values for each hydrogeological response unit could be determined. These k-values were successfully verified in several torrent catchments.