HYDROLOGICAL SOIL MAPPING LOWER AUSTRIA

AN APPROACH FOR HYDROLOGICAL SOIL CLASSIFICATION AND RUNOFF ASSESSMENT

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INTRODUCTION

Besides rainfall characteristics, the generation of storm runoff is mainly influenced by the spatial distribution of landscape forming parameters. Geomorphology, vegetation, land use, soil and geology determine the processes of runoff generation. Especially soil properties like pore volume, storage capacity and (saturated) hydraulic conductivity may accelerate or decrease the amounts of surface or interflow runoff.

Most common assessment approaches and hydrological models use both soil and land use / land cover information. Different concepts were developed for this purpose e.g. the Curve Number procedure (US Department of Agriculture, 1972) or the HOST method (Boorman et al., 1995). To delimit areas with accelerated response to rainfall, decision schemes indicating the dominant runoff process were developed (Peschke et al., 1999; Schmocker-Fackel et al., 2007).

The study area comprises the whole of Lower Austria with a surrounding 1-km buffer, covering a total area of about 20.400 km². To obtain information about the hydrological response of soils to rainfall events, a stepwise procedure with the final result of site specific hydrological soil and response types was developed, based on established concepts, but also including new schemes.

PROCEDURE

All available prior information about soil, geology, land cover or land use, forestry, etc. was assembled from various environmental offices, forest services and forest enterprises. The information was harmonised and homogenous areal and site specific data sets were generated. One of the results was a highly detailed, up-to-date map of land use, which was compiled from the digital cadastral map, aerial photography and the European Integrated Administration and Control System (IACS). The geological map was classified to a manageable number of substrate-classes. Furthermore terrain parameters were extracted from the digital elevation model in order to improve the spatial prediction of the required soil variables.

One main problem was the inhomogeneous level of soil information for i) agricultural areas, ii) forests and high altitude regions and iii) the Czech part of the buffer area. A high quality digital soil map only exists for agricultural regions. The information for unmapped areas had to be generated from site specific datasets. For this purpose the profile-related data (sand, silt, clay, organic carbon and solum depth) from different forest investigation programs were regionalised with statistical and geostatistical methods. The hydrological parameters such as saturated hydraulic conductivity, pore volume and field capacity were derived from these regionalised variables by a Pedo-Transfer Function (PTF). In addition, the soil storage capacity was calculated as product of pore volume and solum depth.

Both the regionalisation of soil properties and the derivation of secondary information by the PTF generate major uncertainties in the work flow. To assess the accuracy of the produced maps, an error analysis for each obtained hydrological parameter was performed separately for the regions with high and low quality soil information. For the agricultural areas as well as the Czech area the bandwidth of the soil parameters within the soil mapping units was evaluated. For forests and high altitude regions the hydrological parameters were additionally calculated for the profile sites and compared with the regionalised data. The median of the overall percentage error is highest for the saturated hydraulic

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conductivity and ranges from 19% for agricultural areas to 80% for forests and high altitude regions. Significantly lower errors were determined for pore volume and field capacity (2 - 12%).

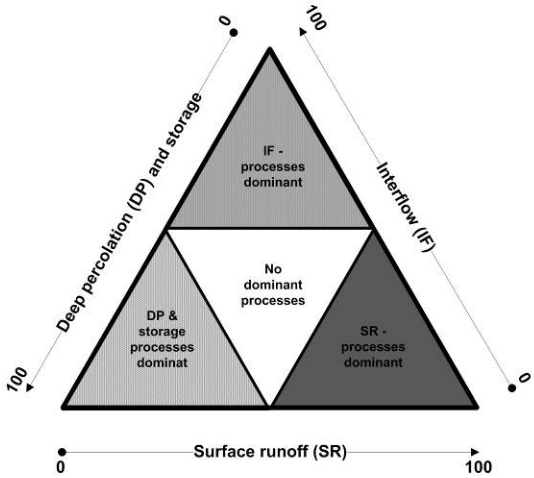

Fig.1 Classification of dominant runoff processes

In the next step a simple model was developed to classify the hydrological response units. The decision scheme is based on the soil storage capacity as well as on the saturated hydraulic conductivity for the different soil layers. Additional inputs for the model are the degree of surface sealing from the land cover / land use map, the slope and the permeability of the underlying geology. The infiltration capacity of the surface soil layer was modified on agricultural areas with a high tendency to siltation.

The derived hydrological response units describe the reaction of the soil/land use complex to main runoff processes, e.g. surface runoff, interflow and deep percolation, for different types of rainfall events (Fig. 1).

Depending on the soil properties and the topographic conditions (slope), a more complex classification of the hydrological reaction (e.g. fast or delayed saturation overland flow) is possible.

For four scenarios, a short time rainfall event (duration one hour) and a 12-hour event, both calculated with and without siltation, the dominant runoff processes were evaluated (Fig. 2).

In addition to the homogeneously generated hydrological soil parameters including well known values of accuracy, critical areas for runoff generation in Lower Austria can be identified.

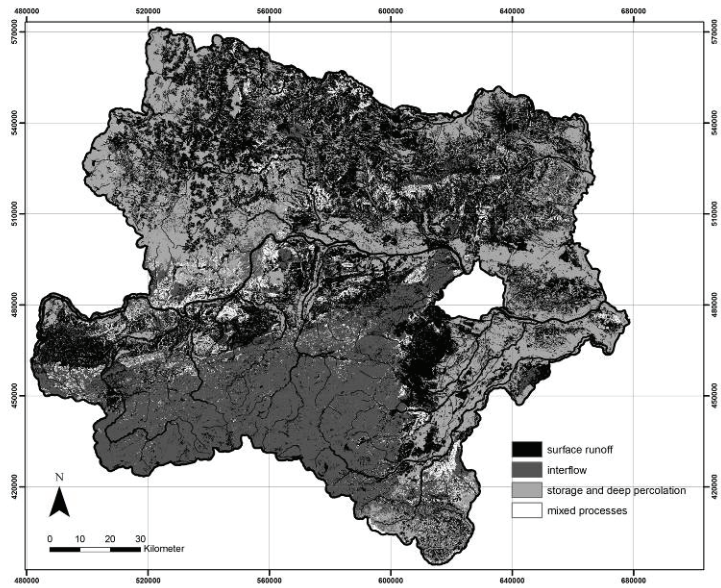

Fig.2 Dominant runoff processes in Lower Austria

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