Geophysical Research Abstracts, Vol. 8, 05968, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05968

Using fuzzy systems to integrate soil moisture information into rainfall runoff models

M. Johst (1), M. Casper(1), P. Gemmar(2), O. Gronz(2), M. Stüber (2)
(1) University of Trier, (2) University of Applied Sciences (FH) Trier

Heavy rainfall may cause damaging flash floods in small watersheds. Flood prediction based on upstream water level measurements is common for large rivers but not possible in small catchments for a lack of gauges. Besides the rain intensity, that certainly affects the hydrological response of a catchment strongest, the moisture state is also a very crucial factor concerning the generation of floods. The soil hydraulic properties as well as the actual soil moisture control strongly the runoff generation and the runoff intensity at the plot scale. Therefore, continuous measurements of the soil moisture could give valuable information on the moisture state of the basin and extend the knowledge of runoff generation processes e.g. the extension of saturated areas or the percolation of an infiltration front.

Although there are obvious correlations between soil moisture and discharge, physically based or conceptual models mostly fail to describe this relationship due to the difficulties in scaling up the processes at the plot scale. Instead, the method of Fuzzy Logic that allows for simplifications of system intercorrelations could be a helpful tool. This approach deals with fuzzy variables and linguistically described inferences and consequently allows for the implementation of both unsharp data and scientific expertise. A further advantage of this modelling technique is the transparency of the system showing the influence of all system variables for any system state directly. In the last years, the authors developed successfully various fuzzy systems for data analysis and process modelling, especially for rainfall runoff processes, with high efficiency and accuracy. Based on this experience, a fuzzy system will be built up using soil moisture and rainfall as input variables and runoff as conclusion.

The data base of this project contains timeseries of climate, discharge (4 gauges) and soil moisture (16 soil moisture probes, TDR-approach) over two years for a 7 km2

basin in the Northern Black Forest. The probes were installed on sites where different runoff generation processes occur. Thus the data shows typical patterns of soil moisture behaviour for different sites as well as for different runoff events. Building the fuzzy system the first step is the definition of the fuzzy variables and the fuzzy inference system. Therefore, soil moisture probes were selected that show a well-defined behaviour for a specific moisture state and that correlate highly with the discharge. Consequently, ranges were specified concerning the moisture state and the rainfall characteristics and fuzzy rules were defined. The next step was the optimization of the fuzzy system. This was supported by computer algorithms, so most of the task has been done automatically. Finally, the last step will be the validation and application of the fuzzy-system for up till then not used data. The long-term aim of this project is the development of an advanced flood warning system using online data of soil moisture and short-term rainfall forecasts.