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The importance of soil moisture in forecasting characteristics of flood events

Peter Chifflard (1), Julius Kranl (2), Georg zur Strassen (3), and Harald Zepp (2)

(1) Philipps-University Marburg, Department of Geography, Marburg, Germany (peter.chifflard@geo.uni-marburg.de), (2) Department of Geography, Ruhr- University Bochum, Bochum, Germany, (3) Ruhrverband, Essen, Germany

Accurate runoff prediction is of vital interest for any integrated management of water resources and for controlling reservoirs. This calls for reliable functions describing how rainfall is transformed into creek and river discharge depending on the properties of the catchment. The prediction is aggravated by the fact that runoff generation is a highly nonlinear process and threshold processes are observed in many catchments due to the initial conditions. Thus, information describing the wetness of a catchment prior to a flood event is increasingly being introduced into flood warning tools. In this study the feasibility and added value of upscaling point data of soil moisture from a small- to a mesoscale catchment for the purpose of single-event flood prediction will be examined. Further the hypothesis that in a given catchment, the present soil moisture status is a key factor governing peak discharge, flow volume and flood duration will be tested. Multiple regression analyses of rainfall, pre-event discharge, single point soil moisture profiles from representative locations and peak discharge, discharge duration, discharge volume are discussed.

The used soil moisture profiles are selected along a convergent slope connected to the groundwater in flood plain within the small-scale catchment Husten (2.6 km^2), which is a headwater catchment of the larger Hüppcherhammer catchment (47.2 km^2, Germany). Results show that the number of explanatory variables in the regression models is higher in summer (up to 8 variables) than in winter (up to 3 variables) and higher in the meso-scale catchment than in the small-scale catchment (up to 2 variables). Soil moisture data from selected key locations in the small catchment improves the quality of regression models established for the meso-scale catchment.

The results show that for the different target variables peak discharge, discharge duration and discharge volume the adding of the soil moisture from the flood plain and the lower slope as explanatory variable improves the quality of the regression model by 15%, 20% and 10%, respectively, especially during the summer season. In the winter season the improvement is smaller (up to 6%) and the regression models mainly include rainfall characteristics as explanatory variables. The appearance of the soil moisture variables in the stepwise regression indicates their varying importance, depending on which characteristics of the discharge are focused on. Thus, we conclude that point data for soil moisture in functional landscape elements describe the catchments' initial conditions very well and may yield valuable information for flood prediction and warning systems.