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Developing the spatial description of river networks included in hydrological forecast models

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Current estimates indicate that the volumetric error of the size of the spring flood in Sweden can be as large as 20%. A significant part of this error derives from simplifications in the spatial descriptions of the hydrology and morphology of the landscape. By developing the spatial description included in hydrological forecast models further, the magnitude and timing of peak floods can be more accurately predicted.

In this study, information about the hydrodynamics, hydromorphology and topography is combined to formulate response functions for the different reaches in the watercourse network. This in turn provides a better understanding of the dynamics that rule the runoff formation.

This study formulates a 1-D compartmental type of runoff model that incorporates both hypsograph information and topographic data describing the watercourse network characteristics. By introducing the hypsograph information expressing how the cross-sectional area, the wetted perimeter and the discharge varies with water level, the model accounts for changes in hydraulic parameters with stream discharge. The modelling is developed in a Matlab environment, linked to a GIS program that deals with the geometrical information of the watercourse network.

The model performance is studied for selected extremely high discharge events. The network model is parameterised in terms of a compartmental type of model that does not explicitly include any information about the hydromorphology. We also investigated the importance of the compartment size – the scaling of model parameters – by studying catchments of different sizes and different sub-catchment divisions.

The model behaviour during high flows was shown to behave better than simpler response functions. The results show that it is essential to account for the geometry of the flooded stream cross sections to obtain correct response times, especially so in more complicated stream networks. The improvement is noted in peak flows as well as in average runoff.

Since hydrological studies show that different future climate scenarios might result in considerably increased flows in the Nordic countries, modelling of peak floods might be an even more important issue in the future.