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Comparing model performance of the HBV and VIC models in the Rhine basin

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It is expected that climate change will have major implications on the discharge regime of the Rhine basin. Seasonal streamflow is projected to shift to more discharge in winter and less discharge in summer and the frequency and severity of floods and droughts are expected to increase.

Although basin wide hydrological models such as HBV (Hydrologiska Byråns Vattenbalansavdelning) are available, much uncertainty remains in modelling feedback processes between the soil and the atmosphere. They are of major importance for the simulation of timing and magnitude of extreme flood events. These processes are not well developed in HBV; groundwater recharge and actual evaporation are simple functions of actual water storage in a soil box and runoff formation is represented by three simple linear reservoir equations. Therefore, a basin-wide VIC (Variable Infiltration Capacity) model has been developed. VIC is a distributed, physically based, macro scale hydrologic model that allows sub-grid scale variation in vegetation and infiltration capacity and which solves both the water and energy balance. It is assumed that the representation of land surface processes is improved in VIC as compared to HBV with the aim to improve the hydrologic predictability based on changes in both climate variables or land surface characteristics in the catchment.

However, there is an ongoing debate in hydrological research on the sense of using more complex distributed models that aim to describe all physical processes, including soil-atmosphere feedback processes, in rainfall-runoff modelling. The general idea of distributed modelling is that it represents reality better than lumped model approaches

as it takes into account spatial information and -more important- it uses physical law (mass balance and energy equatio! ns) to describe the hydrological processes. It is, however, well recognized that the available approaches are often still far from providing a satisfactory representation of rainfall-runoff transformation and that more complex modelling does not always lead to better results.

In this paper the hydrological models HBV and VIC were compared for the Rhine basin by testing their performance for simulating runoff. Overall, the semi-distributed lumped conceptual HBV model performed much better than the distributed physically based VIC model. It is argued here that even for a well documented river basin as the Rhine, the available approaches are still far from providing a satisfactory representation of rainfall-runoff transformation and that more complex modelling does not always lead to better results. Moreover, it is concluded that deviations between observed and simulated discharge in many cases seem not to result from a structural problem in model definition, but from errors or deviations in forcing data.