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Towards a regional distributed hydrological modelling for flash-flood risk assessment

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Flash floods result from the combination of meteorological and hydrological conditions. Recognition of the coupled meteorological / hydrological nature of flash floods is now evident in interpretative studies and in the development of predictive models. There is a real need for research to improve the understanding of the major atmospheric and hydrologic factors leading to extreme flood events, especially those affecting small to medium ungauged basins.

The paper presents a regional distributed hydrological modeling approach aiming at providing useful information for flash-flood understanding and risk assessment, especially in small ungauged basins. The analysis of the September 2002 event in the south-east of France has shown that these small ungauged catchments are the most vulnerable to flask floods, with a large number of casualties (Ruin et al., 2008).

The model discretization is based on the concept of hydro-landscapes proposed by Dehotin and Braud (2008). In a first approach, only sub-catchments and the soil units derived from an existing soil data base were used to delineate the hydro-landscapes. In order to study the feasibility of the regional approach, a first model, implemented within the LIQUID numerical modelling platform (Viallet et al., 2006) was set up in the Cévennes – Vivarais region. It is based on the 1D Richards equation for the simulation of infiltration and water redistribution within the hydro-landscapes (including the representation of the vertical soil heterogeneity). The ponding was routed to the closest river reach using a simple flux formulation and the routing through the river performed using the kinematic wave approximation of the St-Venant equation. The model was forced with 5 minutes radar images with a 1km2 resolution and used without any calibration phase. A verification of the results was conducted at the regional scale, based on distributed post-flood estimation of maximum peak discharge from the September 2002 event and showed promising results (Manus et al., 2009). The modelling approach was used for sensitivity study on two catchments of about 100 km2 in order to assess the impact of the spatial variability, spatial and temporal aggregation of rainfall on the hydrological response. The sensitivity to the soil description was also conducted. The results show that, in terms of peak discharges, both factors are equally sensitive, when the soils are not fully saturated. The impact of boundary conditions was also important and the permeability of the bedrock should be studied in more details. The use of high resolution radar rainfall estimates proved to be of great importance for the correct simulation of small catchments peak discharge. The hydrological response in terms of processes (infiltration excess, saturation excess) was also analysed on some small catchments, based on model results. The impact of the soil vertical heterogeneity and soil depths was highlighted (Manus et al., 2009). The sensitivity to initial conditions was tackled through the addition of an evapotranspiration module to the existing model based on Varado et al. (2006).

The results of such a study are interesting in terms of field experiment planning as they allow to assess functioning hypothesis and highlight sensitive factors. The results are currently used to set up field experiments in the framework of the HyMex project. In terms of warning and risk assessment, the idea is to extend the approach to larger catchments and determine the most sensitive areas for a given rainfall amount.

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