Hydrological response with respect to soil characteristics in a context of Mediterranean extreme events

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I. Introduction

In September 2002 a flash flood killed 23 human lives and generated 1.2 billion Euros of damages in less than 24 hours over an area of 20000 km^2 located in the south of France. The Gard river basin was hit by a storm that locally received more than 600 mm in one day (Huet et al., 2003). The Mesoscale Convective System firstly remained stationary for 14 hours then moved West, and finally interacted with a cold front moving East (Delrieu et al., 2005). This storm triggered catastrophic flash floods on many upstream tributaries as well as the most important flood ever reported of the major rivers (Gard, Ceze and Vidourle). Post-event hydrological investigation using interviews of witnesses and river cross-sections surveys allowed estimation of specific peak discharges of 17 watersheds, the size of which ranged from 10 to 100 km2. It was noticeable that most of the estimations gave specific peak discharges of at least 5 m3.s-1.km2 whereas the 10 years return period discharge, in this region, is about 2 m3.s-1.km2 for such catchment sizes. Below the 600 mm rain area, peak discharges even exceed 20 m3.s-1.km2, which was the most important value ever reported for watersheds of similar areas (Delrieu et al., 2005). The prediction of such extreme events remains an open question due to scarcity of observations and the unknown individual hydrological behavior of very small basins. The aggregation of small basins contributions along the river network remains also largely unknown. In order to study runoff generation on these small catchments, we implemented a physically based hydrological model developed under the numerical LIQUID platform (Viallet et al., 2006) on the Cévennes - Vivarais region. The study focused on the variability of the hydrological response with respect to soil properties in order to propose an observation strategy to enhance our understanding of the corresponding hydrological processes.

II. Results and Conclusions

Soil characteristics, including soil depths and hydraulic properties, were described using a regional soil data base and pedo-transfer functions. Using a 1D soil water transfer module (Varado et al., 2006), we performed sensitivity tests in order to highlight the role of soil properties and the soil depth on the hydrological response of the catchments (maximum ponding and time of beginning of runoff in response to a given

rainfall). The results present a regional overview of the main soil properties that favor the flood propagation and of the type of active process (saturation excess or infiltration excess). From the first estimation of the infiltration properties of the soil, the simulations allow to highlight the impact of initial soil moisture and the nature of the soil on the hydrological behavior within the studied catchments. The impact of the pedotransfer function has been studied on the simulated saturation rate profile within the soil. The signature of the structure on the simulated soil moisture profile is visible during a long time after the rainfall event has ceased. Therefore, the simulated amount of water available for runoff will lead to very different hydrological impact.

III. References

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