Geophysical Research Abstracts,
Vol. 11, EGU2009-10740, 2009
EGU General Assembly 2009

Flood frequency approach in a Mediterranean Flash Flood basin. A case study in the Besòs catchment

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Flash floods are one of the most devastating natural disasters in the Mediterranean areas. In particular, the region of Catalonia (North-East Spain) is one of the most affected by flash floods in the Iberian Peninsula. The high rainfall intensities generating these events, the specific terrain characteristics giving rise to very fast hydrological responses and the high variability in space and time of both rain and land surface, are the main features of FF and also the main cause of their extreme complexity. Distributed hydrological models have been developed to increase the flow forecast resolution in order to implement effective operational warning systems. Some studies have shown how the distributed-models accuracy is highly sensitive to reduced computational grid scale, so, hydrological model uncertainties must be studied.

In these conditions, an estimation of the modeling uncertainty (whatever the accuracy is) becomes highly valuable information to enhance our ability to predict the occurrence of flash flooding. The statistical-distributed modeling approach (Reed, 2004) is proposed in the present study to simulate floods on a small basin and account for hydrologic modeling uncertainty.

The Besòs catchment (1020 km2), near Barcelona, has been selected in this study to apply the proposed flood frequency methodology. Hydrometeorological data is available for 11 rain-gauges and 6 streamflow gauges in the last 12 years, and a total of 9 flood events have been identified and analyzed in this study. The DiCHiTop hydrological model (Corral, 2004) was developed to fit operational requirements in the Besòs catchment: distributed, robust and easy to implement. It is a grid-based model that works at a given resolution (here at 1×1 km2, the hydrological cell), defining a simplified drainage system at this scale. A loss function is applied at the hydrological cell resolution, provided by a coupled storage model between the SCS model (Mockus, 1957) in urban areas and Topmodel (Beven & Kirkby, 1979) in rural and forested areas.

The distributed hydrological model is calibrated using observed streamflow information from the available events. Simulated peak discharges are then compared to observed discharges in these gauged cells, so the relative forecast errors are estimated for all the events. Flood frequency is introduced in the analysis in order to derive probability functions for relative flow error. The next step consists in the extension of the flood frequency error patterns to the corresponding subbasins so it is possible to characterize the accuracy of the simulation in the uncalibrated cells (typically ungaged basins). As a result, the operational flood simulation at every cell in the Besos catchment can be checked and validated (in a first approach) in terms of occurrence. Thus, the distributed warning system can take advantage of the modeling uncertainties for operational tasks.