Geophysical Research Abstracts
Vol. 13, EGU2011-5745, 2011
EGU General Assembly 2011

Distributed hydrological now-casting for the management of the road network in the Gard Department (France)

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With the development of high spatial and temporal resolution rainfall measurements, distributed hydro-meteorological models can provide useful information to anticipate the local consequences of storm events over a region. Such tools could be of great use for flood event management, especially in regions frequently affected by severe storms with complex spatio-temporal patterns. Nevertheless, the estimation of local consequences through distributed discharge forecasting is not a straightforward purpose: the uncertainties on discharge estimations may be very important in ungauged conditions, and the consequences also highly depend on the local levels of susceptibility to floods.
In this context, a prototype of road inundation warning system (RIWS), providing a rating of road submersion risk every 15 minutes during a storm event, has been developed in the French Mediterranean area, frequently affected by flash floods. Initially tested on areas of limited extension, it has been recently extended to the entire Gard Department: this represents an application area of about 5000 km2, including around 2000 points where roads and stream networks intersect and for which warnings are computed. The RIWS combines distributed rainfall estimates with a spatial resolution of 1km2 and a time resolution of 15-minutes, a distributed rainfall-runoff model calibrated on the few existing gauged watersheds but mostly applied to ungauged areas, and an evaluation of the susceptibility to flooding of each considered intersection to make the connection between the forecasted discharges and the road submersion risk.
The resulting RIWS has been tested on 8 recent severe storm events that caused significant disruptions to the road network. The first simulations performed show that the detection rate of road submersion is close to 80%, and that about 30% of on non-inundated roads may be affected by false alarms. Nevertheless, the detection rate of road submersions varies between storm event with apparently higher scores for high amplitude storms. These results seem to be highly sensitive to the accuracy of road susceptibility assessment and could be improved by the assimilation of post event observations to improve the road susceptibility rating. This specific case study based on highly distributed rainfall-runoff modeling and on a rich set of spatially distributed indirect observations of the flood magnitudes on small ungauged catchments - observed road inundations, also provides an ideal framework to evaluate the usefulness of weather radar products for hydrological applications. In this perspective different types of rainfall inputs have been compared including interpolated rainfall measurements, operational radar QPEs, a posteriori re-calibrated radar QPEs and kriging with external drift. The absence of significant differences between results obtained with different rainfall input data, seems once again underline the importance of the susceptibility assessment which constitutes the next perspective of improvement of the system