EXPLORING HIGH-RESOLUTION OPERATIONAL WEATHER FORECASTS FOR FLASH FLOOD PREDICTION

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1. INTRODUCTION

In Mediterranean Europe, flash flooding is one of the most devastating hazards in terms of human life loss and infrastructures. Over the last two decades, flash floods brought losses of a billion Euros of damage in France alone. The objective of this study is to investigate if operationally available short-range numerical weather forecasts together with a rainfall-runoff model can be used as early indication for the occurrence of flash floods.

The study is focussed on the Cévennes-Vivarais region (Fig.1), Southeast of the Massif Central, France, which is often prone to flash flood. The main objective aims at evaluating the hydrometeorological chain for the forecasting of one of the main flash flood event that took place in this region in September 2002 (Delrieu et al., 2005). During the 8 and 9 September, more than 700 mm were recorded; the flash flood took 24 lives and the economical damages were evaluated at 1.2 billions euros (Huet et al., 2003).

The short range weather forecasts are derived from the Lokalmodell of the Deutscher Wetterdienst, the German national weather service, and is available twice a day, at 00:00 and at 12:00 on a grid spacing of 7 km and an hourly temporal resolution. The outputs are driving the hydrological rainfall-runoff model LISFLOOD (van der Knijff, 2007, de Roo et al., 2000). It is set-up for the whole study area comprising several smaller river basins on a grid spacing of 1 km and runs with an hourly time step for the flood predictions.

One of the challenges in flash flood forecasting is that the watersheds are typically small and good observational networks of both rainfall and discharge are rare. Therefore, hydrological models are difficult to calibrate and the simulated river discharges cannot always be compared with ground truth. The miss of observation in most flash flood prone basins, therefore, leads to develop a method where the excess of the simulated discharge above a critical threshold can provide the forecast. A model consistent approach is then proposed based on the evaluation of discharge threshold values obtained with the simulation of long-time series. Then, the forecasted discharges, for a given event, are compared against these thresholds, available at every pixel. The major advantage of this approach is that any systematic over- or under-prediction of the model is compensated for. If the model tends to overestimate discharges in a given river reach, either because of a non-optimised parameterization or lack of processes such irrigation or reservoir operations, this would be reflected in the thresholds as well as in the forecasts.

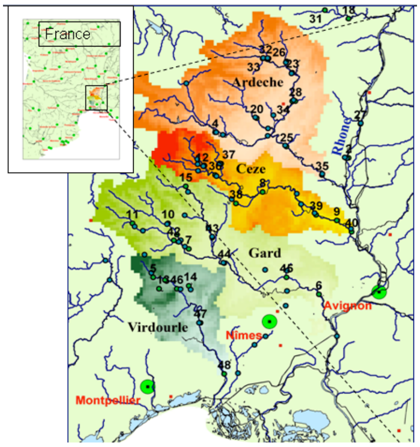

FIG. 1: The study area, location of stream gauging stations (green points) and meteorological gauging stations (red points) used to calculate the meteorological fields for this study

2. RESULTS AND CONCLUSIONS

For this study, the long time series simulations are based on observed daily meteorological data derived from observed meteorological stations for the time period 1990-2003. From the daily hydrological simulations critical thresholds have been derived as well as the starting conditions for the flood forecasts. The flood forecasts were driven by the 48h DWD weather forecasts starting on 20020906 00:00 and then in 12h intervals the next weather forecasts until 20020910 12:00 o'clock forecast. The initial conditions were always taken from the 00:00 forecasts. Both the 00:00 and 12:00 forecasts from the same day start with the same initial conditions.

Fig. 2 presents the results of the simulations at Generargues in the Gard river (n°41 Fig.1). Below the hydrograph of the observed discharge, the block diagram proposes a visualization of the dynamics of the simulated excess above the given thresholds. The threshold levels are color coded and represent severe flood threshold (purple), high flood threshold (red), medium flood threshold (yellow) and the low flood threshold (green). The thresholds are derived from long-term simulations based on observed data. The first line corresponds to the simulation forced with the radar observations (Boudevillain et al., 2006) which are the best rain estimations available for this event. We therefore use this chronogram as the reference.

It appears that the forecast from the 7th at 12:00 exceeds in fact the severe and high flood thresholds, indicating a possibility for a severe flood within the coming 2 days. This time is required for the civil protection to organize the warning of the territory and to prepare the eventual rescues. The later forecasts confirm the severity of the flood.

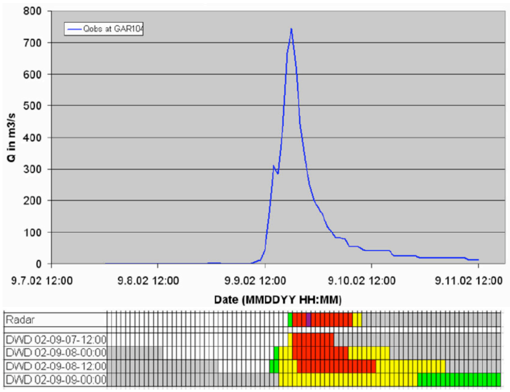

FIG. 2 : (top) Observed discharge in m3/s from 20020908 to 20020911 at station Generargues. At the bottom the corresponding exceeded threshold levels based on the DWD weather forecasts from 20020907 12:00, 200200908 00:00, 20020908 12:00 and 20020909 00:00.

In order to provide a regional view of the simulations, Fig. 3 illustrates the spatial distribution of flood alerts. It is obvious that the whole region is simulated at risk of flooding and that particularly the area around the Gard and Virdourle is at particular risk.

3. REFERENCES

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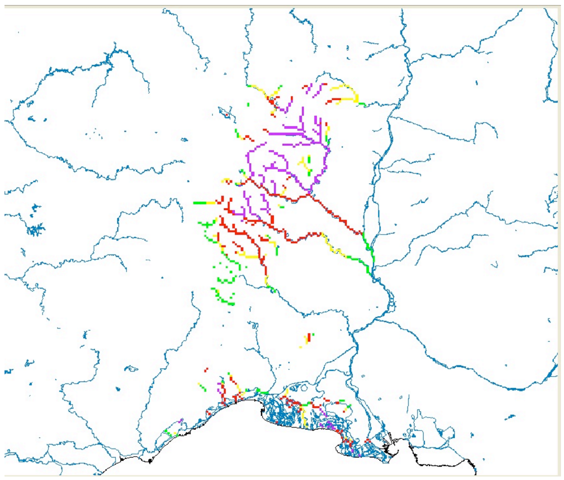

FIG. 3: Spatial overview of forecasted flood threshold excess where the purple, red, yellow and green colour indicate that the severe, high, medium and low flood thresholds have been exceeded.