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MULTI MODEL APPROACH IN FLOOD FORECASTING SYSTEMS AND FLOOD HAZARD MAP PREPARATION AT THE LOCAL AND REGIONAL SCALE

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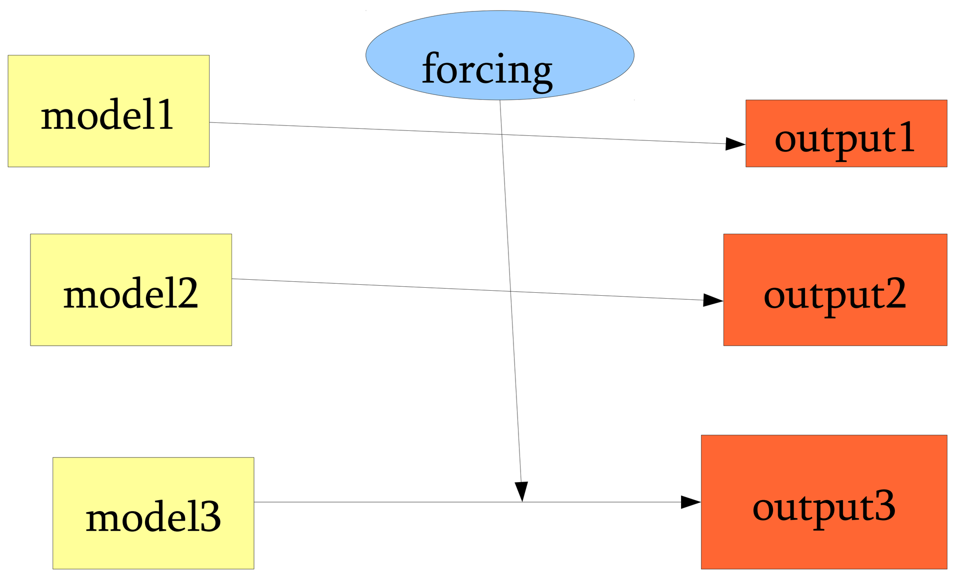
ABSTRACT

As stated by the new EU flood directive "Member States should base their assessments, maps and plans on appropriate 'best practice' and 'best available technologies' ...." From an hydrological point of view this could suggest the use of the 'best model' both in the simulation of prefixed flood scenarios and in flood forecasting systems. Actually plenty of hydrological models were created and applied for this purpose in the past, especially in the last decades, but the definition of an 'optimal model' is still an unresolved problem. The multi model approach, considering a weighted combination of hydrological models to define the most probable response of the basin, might be a suitable solution.

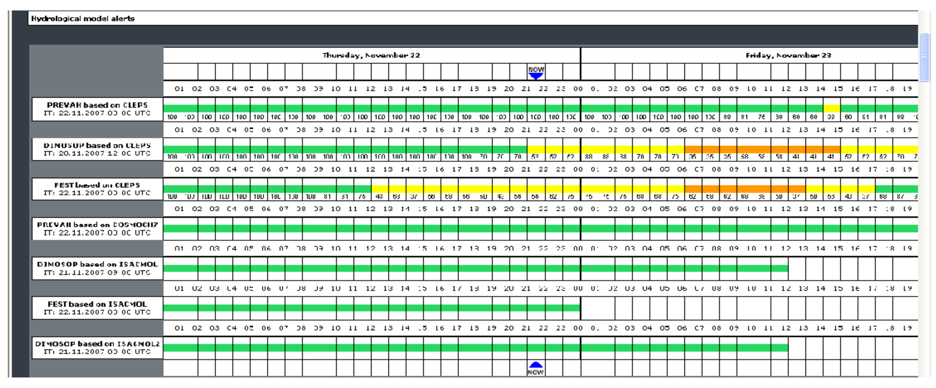
The application of this approach and its advantages were investigated in this work, focusing on the mountain areas of Northern Apennines (Italy), contributing to the Po river. To this aim, the Taro river watershed was selected as a case study. The drained area is about 2´000 km2 wide at the junction with the Po river. In the last decade the basin has been monitored through a dense hydro-meteorological network. Distributed, semi-distributed and lumped hydrological models were used to simulate or hind-cast (using real time meteorological forecasts) the flood events that occurred during the monitoring period and their performance was measured.

MULTI MODEL APPROACH



A real time flood forecasting system for the target areas 1, 2, 3 and 4 was implemented. The DIMOSOP (DIstributed hydrological MOdel for the Special Observing Period) hydrological model was used to predict flood hydrographs from Numerical Weather Predictions provided by ISACMOL (a deterministic non hydrostatic model) and CLEPS (an ensemble of 16 predictions).

By the end of October 2007 it was possible to compare in real-time the results of up to 7 meteo-hydrological forecasting chains (3 Ensemble+ 4 Deterministic) for the Toce watershed at the Candoglia outlet. The operational chains are listed in fig. 3, showing the operational forecast produced by each chain on two 48 hours time windows: 31st October and 1st November the first, 22nd and 23rd November the second. Different colours referred to different alert levels: no alert (green), alert for an event with a return period of at least 60 days (yellow), of at least 180 days (orange) or of at least 10 years (red).



References

The European Parliament and the Council of the European Union (2007) Directive 2007/60/EC of 23 October 2007 on the assessment and management of flood risks, Official Journal of the European Union, L288, p.27.

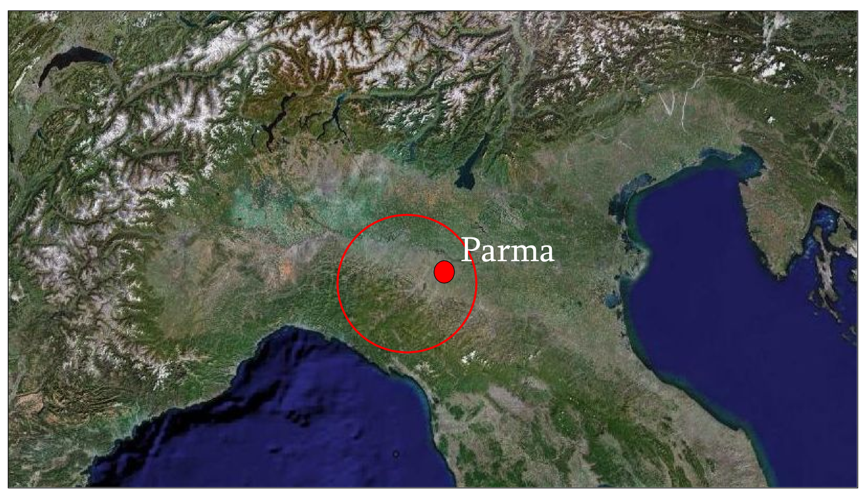
Grossi, G, and N. Kouwen (2004). Intercomparison among hydrologic simulations coupled to meteorological predictions provided by different mesoscale meteorological models, Atti del XXIX Convegno di Idraulica e Costruzioni Idrauliche, Trento, 7-10 Sept. 2004, Editorial Bios, 2, 265-271.

Grossi G. & M.Balistrocchi (2008) Rainfall input spatial characterization for hydrologic simulation, Abs. EGU2008-A-11207, Poster presentation at EGU2008.

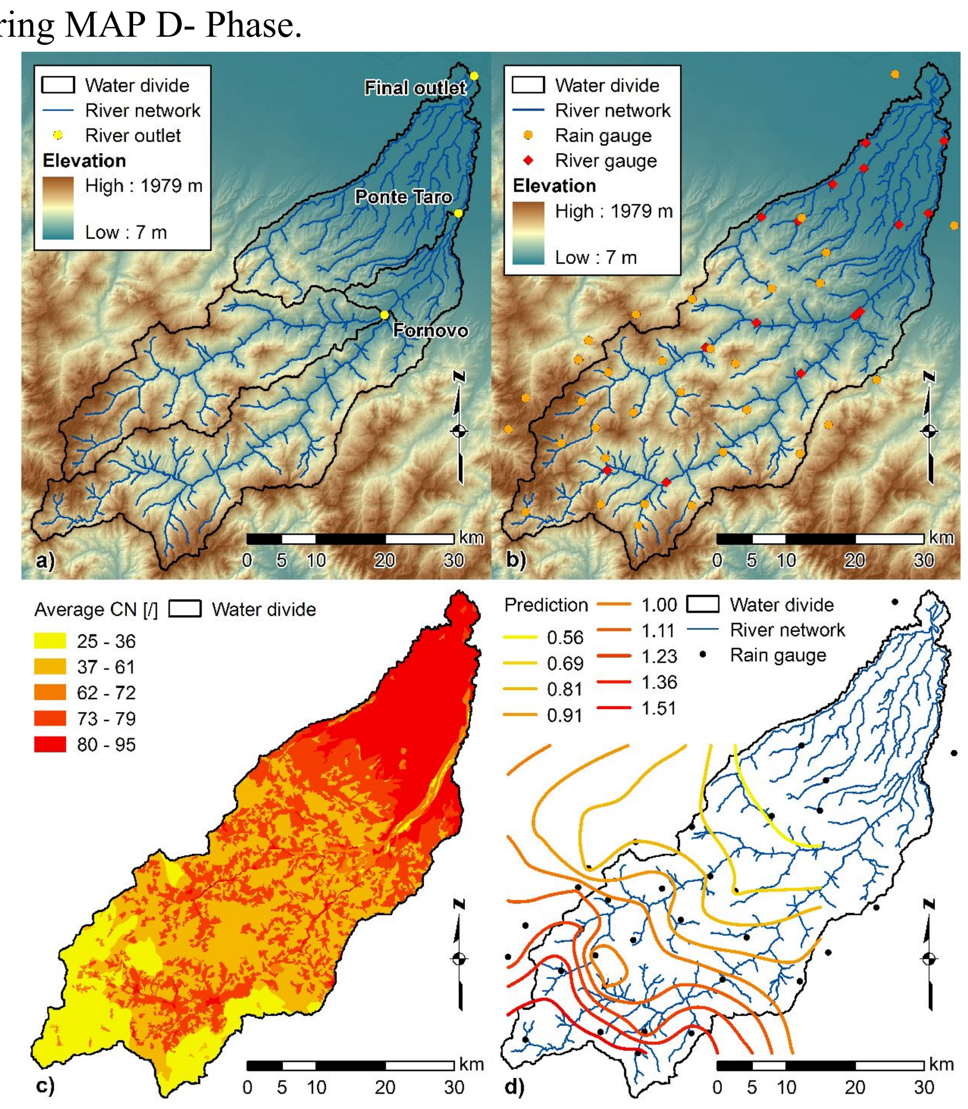
Zappa M, Rotach M.W, Arpagaus M, Dorninger M, Hegg C, Montani A, Ranzi R, Ament F, Germann U, Grossi G., Jaun S, Rossa A, Vogt S, Walser A, Wehrhan J, Wunram C (2008). MAP D-PHASE: real-time demonstration of hydrological ensemble prediction systems. Atmospheric Science Letters; p. 80-87, ISSN: 1530-261X, doi: 10.1002/asl. 183

Taro Watershed

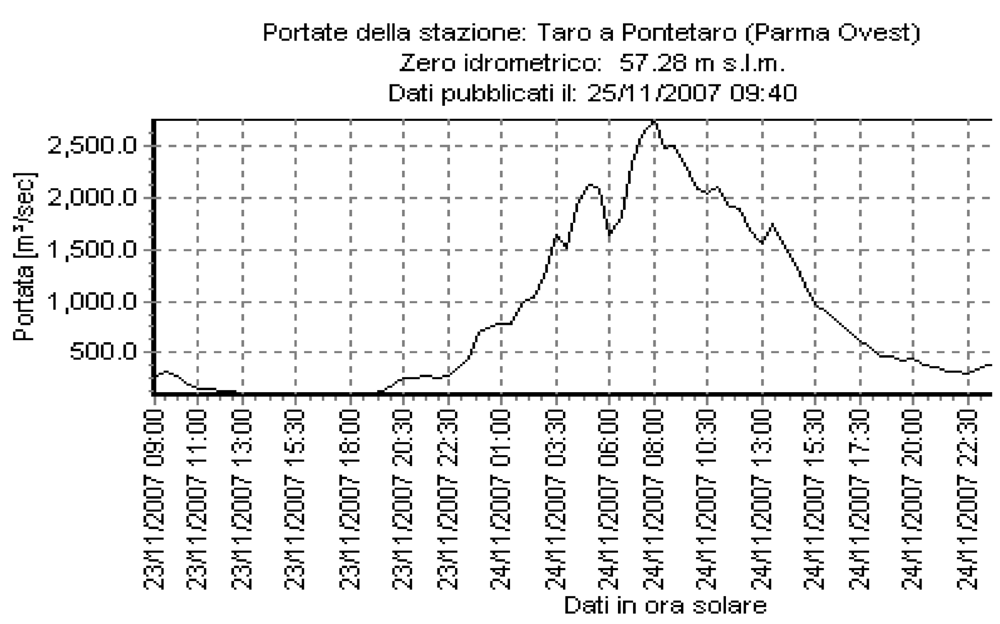
The Taro river watershed located in the Apennine area in Northern Italy (Parma, Regione Emilia Romagna) was selected as a case study. The drained area is about 2000 km2 wide at the junction with the Po river. In the last decade the basin has been monitored through a dense hydro-meteorological network, providing semi-hourly precipitation, air temperature, water level and discharge in several monitoring sites spread both in the mountain area and in the flood plain.



The figure below shows the 28 rain gauges spread over the catchment and the hydrometric station at Pontetaro. Continuous rainfall and discharge observations at 30' time step were available in real time during MAP D- Phase.



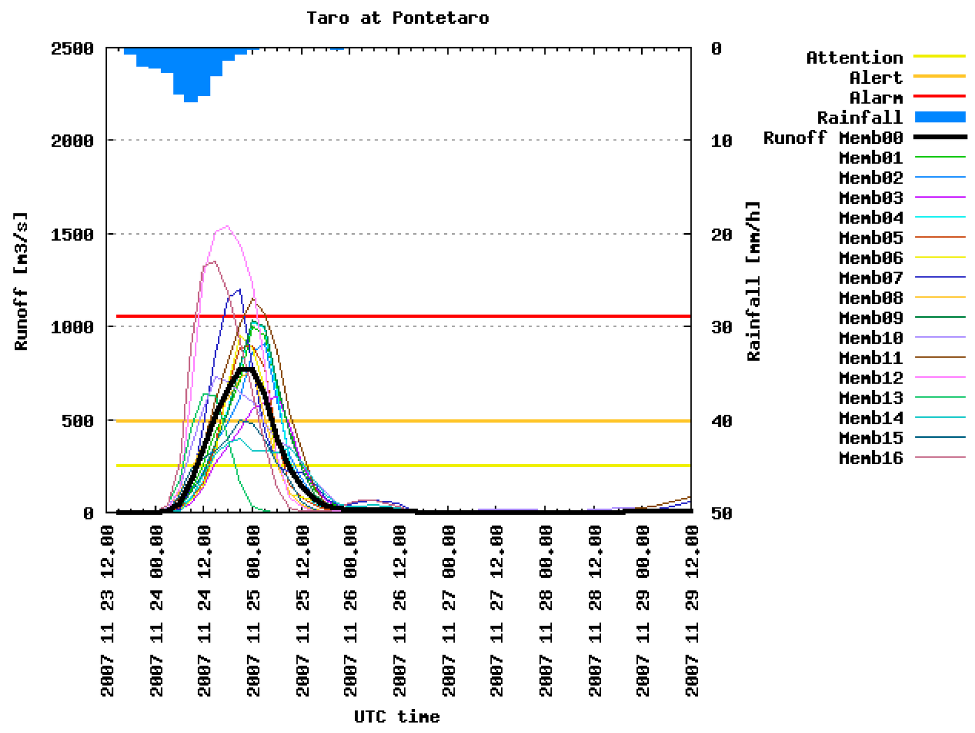
Dealing with flood events it is observed that in most cases they are related to the same 'type' of storm event. Even if the value of the discharge is strongly related to the initial condition of the watershed, the occurrence of the flood event is bound to the occurrence of a particular weather situation: mainly pressure and wind velocity distribution. The particular situation is the cause of the storm event characterized by a precipitation distribution which is similar form event to event. If this is the case than each monitoring site can have a different weight in the reconstruction of the precipitation field: some of them could turn out to be fundamental, others could be actually useless when the detail of the hydrological model is taken into account. This is a very important point in the design of a warning system which should address the question of how much information is actually needed by the hydrological model.

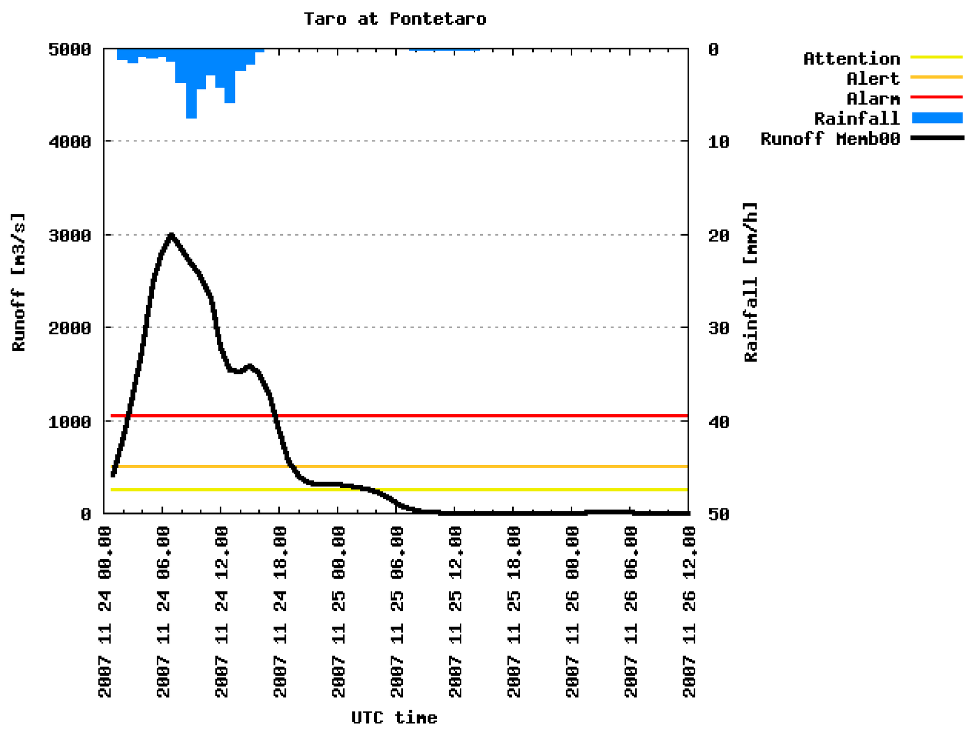


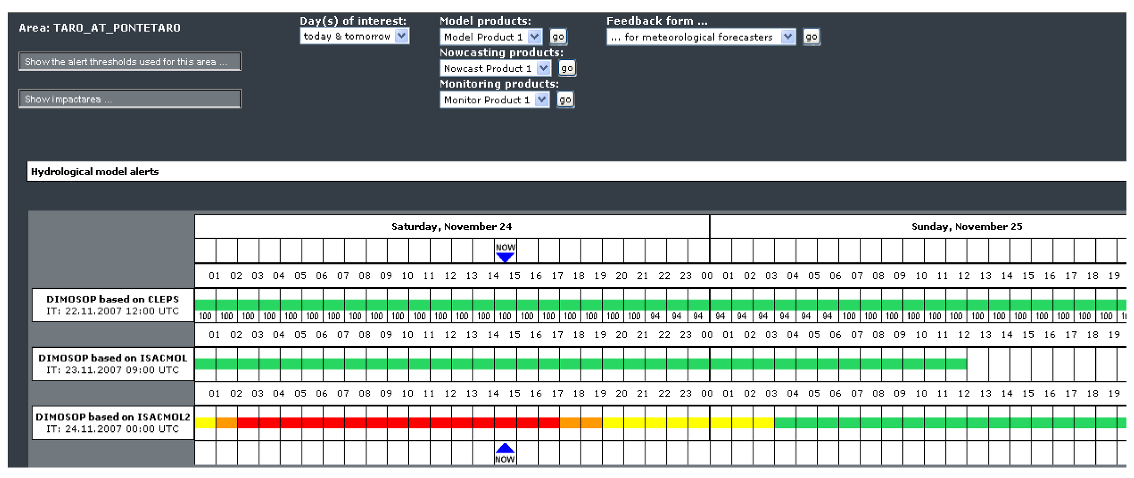
The Map D-Phase event (21-25/11/2007- see Fig. 6) provided a peak discharge value of 2696 m3/s, corresponding to a specific discharge of about 1.8 m3/s/km2. The peak discharge was recorded at 7:00 UTC of the 24th November.

RESULTS

Two operational forecasts obtained with the DIMOSOP models and the CLEPS (on the left) and ISACMOL (on the right) predictions for the Taro River during the MAP D-Phase experiment.

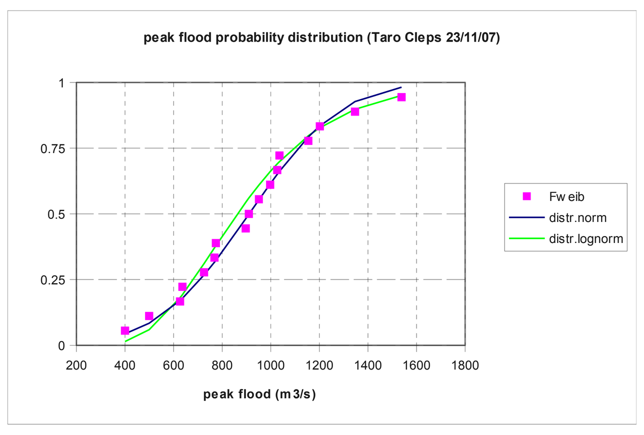






A visualization of the operational flood forecasting chains for the Taro River during the MAP D-Phase experiment. Different colours refer to different alert levels: no alert (green), alert for an event with a return period of at least 60 days (yellow), of at least 180 days (orange) or of at least 10 years (red).

If a probability distribution function is fitted to the sample of 17 peak discharges (16 members+ensemble mean), the values associated with a fixed level of probability can be estimated. In this case a lognormal distribution was fitted to the available sample, its mean and its standard deviation were found to be 911 and 298 m3/s respectively. A peak discharge value of 863 m3/s was estimated for 50% of exceedance probability, 1159 m3/s was estimated for 80%, 1353 m3/s was estimated for 90%.



CONCLUSIONS

1) "hydrological supervision" is necessary
2) The analysis of the spatial variability of the rainfall field, as well as of the soil hydrological properties can be useful for both the analysis of the most sever events and the selection of the most representative monitoring gauges.
3) Considering the potentials of uptodate meteo-hydrological modelling chains aimed at real time flood forecasting, distributed hydrological modelling might not be necessary if the flood peak and the time to peak are the only pieces of information needed.
4) Results are site specific but the procedure could be adopted for other case studies.

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