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Flood alert system based on bayesian techniques

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The problem of floods in the Mediterranean regions is closely linked to the occurrence of torrential storms in dry regions, where even the water supply relies on adequate water management. Like other Mediterranean basins in Southern Spain, the Guadalhorce River Basin is a medium sized watershed (3856 km^2) where recurrent yearly floods occur , mainly in autumn and spring periods, driven by cold front phenomena. The torrential character of the precipitation in such small basins, with a concentration time of less than 12 hours, produces flash flood events with catastrophic effects over the city of Malaga (600000 inhabitants). From this fact arises the need for specific alert tools which can forecast these kinds of phenomena.

Bayesian networks (BN) have been emerging in the last decade as a very useful and reliable computational tool for water resources and for the decision making process. The joint use of Artificial Neural Networks (ANN) and BN have served us to recognize and simulate the two different types of hydrological behaviour in the basin: natural and regulated. This led to the establishment of causal relationships between precipitation, discharge from upstream reservoirs, and water levels at a gauging station. It was seen that a recurrent ANN model working at an hourly scale, considering daily precipitation and the two previous hourly values of reservoir discharge and water level, could provide R^2 values of 0.86. BN's results slightly improve this fit, but contribute with uncertainty to the prediction.

In our current work to Design a Weather Warning Service based on Bayesian techniques the first steps were carried out through an analysis of the correlations between the water level and rainfall at certain representative points in the basin, along with the upstream reservoir discharge. The lower correlation found between precipitation and water level emphasizes the highly regulated condition of the stream. The autocorrelations of the variables were also analyzed, where the water level, with time lags of 12 hours related to the concentration time, was found to be most significant. In short, the fits to the different distribution functions of extremes were unsatisfactory, as the data were of poor quality and scant. This problem with data is not unusual in small and medium sized Mediterranean basins and becomes the real challenge to any prediction system based only on statistical methods.

The aim of the resulting tool is to develop and maintain a numerical short-range weather forecasting system for operational use by the regional water management entities. The development of this tool is also corroborated by recent survey results, which identify the need to develop site specific models for water management in these Mediterranean regions, so prone to flash flood events (NOVIWAM, 2011 Novel Integrated Water Management systems for Southern European Regions, Seventh Framework Programme, EC, 2010-2013).