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Basis for a flood early-warning system approach in fast-flow Mediterranean catchments: The case study of Cala reservoir (Spain)

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An optimal operation criteria in Mediterranean dams is specially required to prevent damages associated with flood and drought events, which are common and directly connected with the intrinsic seasonal and annual climate variability over these regions. That need is clear in multipurpose dams, that usually include hydropower systems in these catchments. These systems must guarantee an equilibrium between an optimum storage for production and the capacity needed for flood abatement. Specially relevant are torrential flooding events, in which quick decisions need to be taken to prevent not only the associated damages, but also the energy production losses connected to a conservative approach. Those facts are translated into a huge range of possibilities that difficulties the optimization of decision making processes. On the one hand, several meteorological forecasting systems at different spatiotemporal scales are currently available. However, the greater uncertainty linked to the rapid response time of these catchments limits their use. On the other hand, the insufficient number of control points with available real time measurements (i.e., precipitation gauges and water level controls) challenges the creation of early warning systems with an appropriate uncertainty quantification.

This study proposes the basis for the definition of an early warning system based on a limited number of real time in situ measurements in a characteristic Mediterranean catchment. The Cala dam (59 hm^3), located in the Rivera de Cala river, was chosen as an example. Cala dam is mainly used for hydroelectric production, but also for irrigation and leisure activities. Their upstream catchment (535 km^2) is characterized by agroforestry uses and a quick response to intense precipitation due to steep slopes, shallow soils and groundwater redistribution, which does not favour the lamination of water. In situ historical information from, stations with available real time data in the watershed is used to: (a) define driver indicators of key streamflow states (i.e., a threshold in the cumulative precipitation since the beginning of the hydrological year or precipitation intensity over certain months); and, (b) caracterize and cluster precipitation-runoff events over the catchment. The three resulting most significant three types of events were validated during the last period of the observed data. This information was translated into a decision tree using a conditional structure, constituting the basis of the designed early warning system This scheme allows to identify the potential occurrence of a warning situation, which is fixed by the normal operational rules of the reservoir. Once the flood event is underway, the use of real time information about the water volume stored in the reservoir and the estimated

probability of occurrence of an discharge event in the next hour based on antecedents precipitation, are the hydrological indicators to base the decision on together with the generation thresholds and requirements of the hydropower system. The approach is also validated based on historical information within a hindcast process during the validation period.