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Evaluation of two flash-flood forecasting approaches in mountainous catchments

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The accuracy of flash flood forecasts in mountainous catchments depends on the rainfall forecast resolution and the availability of real-time rainfall observations characterizing the basin wetness state. In this work, two flood forecasting approaches are tested at the outlet of two small mountainous catchments of 121 and 53 km2 located in Sardinia (Italy). Due to their physiographic characteristics, these watersheds have short concentration times and are then prone to flash flooding. Long records ($\sim$50 years) of simultaneous rainfall (two and three rain gages per basin, respectively) and streamflow observations at 5-min resolution are used to compare the two forecasting approaches: (i) the Rainfall Thresholds based on Conceptual Models (RTCM), which is based on event-based lumped models to generate flash flood guidances (i.e. rainfall thresholds above which a flash flood occurs); and (ii) the Runoff and Frequency Thresholds based on Distributed Modelling (RFTDM), which utilizes a physically-based distributed hydrologic model to simulate continuously the hydrological response. Here, RFTDM is based on the TIN based Real Time Integrated Basin Simulator (tRIBS) hydrologic model and is applied through: (a) Direct Method, where the model runs continuously in real-time mode to issue flash-flood predictions based on meteorological forecasts; and (b) Statistical Method, which provides probabilistic flood predictions based on preliminary flood frequency analyses (FFA) of observed and simulated discharges. Results reveal that RTCM exhibits fairly good forecasting performances when the baseflow is low. While a high false alarm rate is usually exhibited, the RTCM can be easily applied in operational mode. In contrast, RFTDM needs long pre-processing but provides a significant reduction of false alarms with respect to RTCM, preserving good prediction skills in different operational conditions. While the Statistical Method does not significantly overperform the Direct method, it has the advantage of generating flash flood alert maps. Our results suggest that, even in cases of fairly small watersheds and a well calibrated hydrologic model, the accuracy of these maps is highly influenced by the density of the rain gauge network used to simulate antecedent basin wetness conditions and to mimic future rainfall forecasts.