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Integrating hydrological modelling, post-event surveys and morphometric analyses for flash flood investigation

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Flooding is the most common environmental hazard worldwide, flash floods, in particular, represent a major natural threat, and their investigation is usually challenging due to the rapid temporal evolution and the severe but localized spatial dynamics. In order to grab such spatial and temporal dynamics, detailed investigations are necessary: in this framework, post-event monitoring of flash floods represents a key step toward improved assessment of both hazard and vulnerability. In this study, we present a methodology for an enhanced characterization of flash flood dynamics and related instabilities phenomena, focusing on a flash flood occurred on Aug 5-6 2017 over a 100-km^2 catchment of the eastern Italian Alps. The analyzed flash flood caused important damages to structures and business activities and posed a particular threat to human lives due to the concurrent triggering of slope instability phenomena (e.g., debris flows). The examined dataset encompasses calibrated radar rainfall records, the flood hydrograph recorded near the outlet of the basin, peak discharge estimates from post-flood surveys of ungauged cross sections, and LiDAR terrain data and satellite/aerial imagery. The methodological framework of the hydrological analysis embraces rainfall and peak discharge analysis, application of a spatially distributed flood response model and its cross-validation with peak discharges from post-flood surveys and the assessment of related geomorphic effects. The application of a morphometric index of sediment connectivity has allowed investigating the topographic potential for sediment to be routed downstream and analyzing spatial connectivity patterns at high resolution for all the sub catchments. The analysis of available (pre- and post-flood) satellite and aerial imagery and, above all, the valuable disposal of pre- and post-flood high-resolution LiDAR DTMs has permitted the assessment of erosion and deposition patterns in the study area together with volume uncertainty estimation. Preliminary results depict the dynamics of the event as characterized by high spatial and temporal variability and show consistency between simulated discharge and post-flood surveys. Sediment connectivity pattern proved to be an important factor controlling the severity of the response at the analyzed catchments. In particular, the integration of geomorphic analysis with input forcing severity has allowed for a more precise recognition of the gravest conditions in terms of sediment availability, sediment connectivity, and storm severity. Finally, the geomorphic change detection via multitemporal LiDAR analysis has permitted to investigate and quantify the relation between the hydrological processes leading to flash flood occurrence and sediment transfer processes.