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Flash floods in arid areas: characteristics and modelling

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One third of the world can be classified as arid or semi-arid. Localized convective rainfall and poor soil development make flash floods a major hazard in these areas, with characteristics that are noticeably different from other climates. However, these areas are often sparsely populated, and data with appropriate resolution to study flash floods phenomena are lacking. Because of the lack of information, the hydrological models applied for flood studies are often unspecific for these areas, resulting in a poor representation of the driving processes. The objective of this work is to gain insights on the distinctive properties of rainfall and runoff in arid as compared to Mediterranean areas. From this comparison we can draw guidelines for the specific model requirements for flash flood modelling in arid climate.

A unique database composed of stream gauge measurements and about 23 years of corrected and gauge adjusted radar rainfall estimations at 5 minutes and 1 km2 resolution is available for the Eastern Mediterranean, including arid and Mediterranean climates. The database is mostly homogenous among the two climatic regions, allowing a direct comparison of the flood characteristics between 14 Mediterranean and 25 arid basins of sizes 11-1200 km2. While the two areas show some similarity, the comparison highlights strong differences in rainfall-runoff processes. In Mediterranean areas floods are longer and with more total rainfall. In this climate regime, high runoff coefficients are related to basins with higher annual rainfall, long events and wet antecedent conditions. In arid areas, on the other hand, rainfall is much more localized, high runoff coefficients are present also for low rainfall, and are related to short events in drier basins. A hydrological model (KINEROS2) is then applied to 6 arid basins within a probabilistic framework (GLUE), to examine the model structure required to better capture the unique properties of arid flash floods. Model performances are evaluated in relation with multiple model setups. The application shows that the quality of simulations in arid areas improves with distributed rainfall infiltration, local rainfall bias correction, and with the inclusion of transmission losses. Antecedent conditions and lower surface infiltration are not found to significantly improve simulation results.