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Propagation of precipitation extremes into discharge extremes in a changing climate

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Mediterranean basins are characterized by high precipitation variability, which presents strong seasonality, large inter-annual fluctuations and spatial variations during single events, and by wide spatial differences of terrain and surface properties. As a consequence, these catchments are often prone to the occurrence of hydro-meteorological extremes, including storms, floods and flash-floods. Several climate projections in this area predict a general exacerbation of intensity and frequency of extreme events, thus requiring further analyses to evaluate their impact at the land surface, especially in relatively small watersheds. In this study, we used climate and hydrologic simulations produced within the Climate Induced Changes on the Hydrology of Mediterranean Basins (CLIMB) research project to analyze how precipitation extremes propagate into discharge extremes under changing climate conditions in the Rio Mannu basin (472.5 km2), an agricultural watershed located in Sardinia, Italy. The basin response to climate forcings in a reference (1971-2000; REF) and a future (2041-2070; FUT) period was simulated by using four combinations of global and regional climate models (CMs), statistical downscaling techniques, and a process based distributed hydrologic model. We first conducted statistical analyses based on the General Extreme Value (GEV) distribution on precipitation annual maxima at different durations (daily and hourly), extracted from the grids of the four selected CMs. Results show high uncertainties in climate projections, with GEV parameters differing among CMs, REF and FUT periods, and time duration. Subsequently, we fitted the GEV distribution to the series of maximum annual discharge data at daily and hourly duration, simulated by the hydrologic model at distributed basin locations. The analyses reveal that sub-basins characterized by lower slope and dominated by more impermeable soils have higher probabilities of extreme event occurrence than steeper sub-basins with loamy soils. Hence, both soil properties and topography play an important role in the basin response to extreme events.