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Assessing hydrological regime sensitivity to climate change in a convective rainfall environment: a case study of medium-sized eastern Mediterranean catchments

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A modeling framework is formulated and applied to assess the sensitivity of the hydrological regime of catchments with respect to projected climate change. The study uses likely rainfall scenarios with high spatiotemporal resolution that are dependent on projected changes in the driving regional meteorological synoptic systems. The framework was applied to a case study in two medium-sized Mediterranean catchments in Israel, affected by convective rainfall, by combining the HiReS-WG rainfall generator and the SACSMA hydrological model. The projected climate change impact on the hydrological regime was examined for the RCP4.5 and RCP8.5 emission scenarios, comparing the beginning of the 21st century and the mid-21st-century periods from General Circulation Models simulations available from CMIP5. Focusing on changes in the occurrence frequency of regional synoptic systems and their impact on rainfall and streamflow patterns, we find that the mean annual rainfall over the catchments is projected to be reduced by 15% (outer range 2–23%) and 18% (7–25%) for the RCP4.5 sand RCP8.5 emission scenarios, respectively. The mean annual streamflow volumes are projected to be reduced by 45% (10–60%) and 47% (16–66%). Moreover, the streamflow season in these ephemeral streams is projected to be shorter by 22% and 26–28% for the RCP4.5 and RCP8.5, respectively. The amplification in reduction of streamflow volumes relative to rainfall amounts is related to the projected reduction in soil moisture, as a result of fewer rainfall events and longer dry spells between rainfall events during the wet season. The dominant factors for the projected reduction in rainfall amount were the reduction in occurrence of wet synoptic systems and the shortening of the wet synoptic systems durations. Changes in the occurrence frequency of the two dominant types of the regional wet synoptic systems (Active Red Sea Trough and Mediterranean low) were found to have a minor impact on the total rainfall.