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Estimation of climate change impact on the runoff from a small alpine watershed in Austria

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The hydrologic regime in alpine watersheds is affected by changing climate conditions. Studies on impacts of climate change on the runoff of small mountain streams are rare, mainly due to difficulties of local climate projection and/or the lack of discharge data. The aim of this study is to estimate the impact of climate change on future flood hydrographs on the exemplary model region, the Wartschenbach catchment in Eastern Tyrol/Austria. An ensemble of five climate change projections, based on the meteorological station in Lienz, was used to simulate the climate of the mid-21st-century scenario period (2021-2050). A one-hour design rainfall event with a return period of 100 years was calculated using a standard engineering approach for past rainfall data and for the different scenarios. A conceptual rainfall-runoff model was setup based on daily and hourly discharge and rainfall data. To quantify possible changes the calibrated hydrologic model was driven by five future design rainfall events and the design event under current conditions. Additionally three scenarios (best, worst, and average) according to different antecedent moisture conditions were investigated. All five model ensembles indicated an increase in 100-year hourly rainfall intensities, whereas three out of five changes are significant. Accordingly, all future flood hydrographs indicated an increase in hourly peak discharges, with a multi-model ensemble average between 18% and 28% under different soil moisture conditions. The results highlight the importance of investigating the impact of climate change for a sustainable secure dimensioning of protection measures and hazard zones. The uncertainty range that originates with each additional model application is high. Nonetheless, the projected signals represent a possible and probable evolution of the future climate towards higher peak floods, whereas the exact magnitude of the expected increase is highly uncertain.