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An HBV-model based approach for studying the effects of projected climate change on water resources in Slovakia

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Climate change challenges policymakers and river basin authorities to find sustainable management solutions and optimal strategies to avoid undesirable impacts on water resources and the environment. Our study aimed to evaluate the possible impacts of future climate change on water resources in Slovakia. Eight pilot river basins spread throughout the whole territory of Slovakia were selected in this study. To draw more general conclusions, basins were delineated into two different groups, i.e. basins with a mean elevation < 435 m a.s.l. (four basins) and basins with a mean elevation > 435 m a.s.l. (four basins). An HBV bucket-type hydrological model (the TUW model) was used to provide runoff projections. For the model parametrization, we used a cross-calibration strategy based on selecting the most suitable decade in the observation period. The model was calibrated and validated over four periods (1981–1990, 1991–2000, 2001–2010, and 2011–2019) with rainfall, air temperature and potential evapotranspiration as inputs. Then, the parameters that best reflect the current climate (mainly in terms of the mean daily air temperatures) were used to simulate runoff over the baseline (1981–2010) and three future time horizons (2011–2040, 2041–2070, and 2071–2100). For the future runoff projections, the model was driven by the precipitation and air temperatures projected by the KNMI and MPI regional climate models under the A1B (moderate) emission scenario. The model performance during the calibration and validation was assessed using four metrics (the objective function, the logarithmic Nash–Sutcliffe efficiency, the Nash–Sutcliffe efficiency, and the volume error). All model performance metrics and visual inspection of hydrographs indicated that the simulated runoff has a good agreement with the observed values.

Our results indicate that the change in climate variables is expected to be more or less the same for both groups of the river basins. Precipitation shows an increasing pattern during spring, autumn, and winter periods. The regional climate model data suggest that the long-term mean monthly air temperatures will rise with the future time horizons. Compared to the baseline (1981–2010), winter runoff (December–February) is projected to increase, with a maximum increase in the period 2071–2100. In the summer season (June–August), the runoff will react in reverse. The values of maximum annual daily runoff are more prominent in lower elevations (i.e., basins < 435 m a.s.l.) than at higher elevations (i.e., basins > 435 m a.s.l.). Our analysis could help

develop optimal strategies for water resources management and flood control in the studied basins.

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