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Modelling current and future trends in water availability for agriculture on a semi-arid and mountainous Chilean catchment

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Abstract This study aims to develop an integrated modelling approach to assess current and future trends in water availability for agricultural purposes on the upper Elqui basin (Chile). A hydrological model including a snow reservoir was combined with an agricultural water demand model to provide an index of the capacity to meet water needs. Particular account has been taken of flow regulation via a storage-dam by modelling the reservoir water balance and its operating rules, and by dividing the basin into two sub-basins located respectively upstream and downstream of the dam. The modelling chain was applied and tested over a long reference period (1979–2008) and then run over 2041–2060 under the constraint of four climate scenarios statistically downscaled from various GCMs. Simulations of the basin outlet discharge show a fair degree of realism over the reference period, despite a reproduction of peak flows which tends to deteriorate in validation. Although the dam model and the agricultural water demand model could be improved in the future, they already provide reliable simulations with regard to observed dam releases on the one hand, and to withdrawal authorizations for irrigation on the other. In spite of significant discrepancies, the climate scenarios all lead to a decrease in the capacity to meet water needs at the height of the irrigation period (from December to March). This can be notably explained by less abundant precipitation (–22 to 48%) according to three of the four climate scenarios and by earlier peak flows for two scenarios due to the impact of higher temperatures (+1.7 to 2.1°C) on the snowmelt regime. This study is a first step towards improving the efficiency of the different models and assessing the propagation of uncertainties through the modelling chain.

Key words climate change impacts; hydrological modelling; snowmelt regime; agricultural water demand; water reservoir modelling; Elqui River