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Impact of climate change on water availability in Tropical Andean catchments: a case study in the Vilcanota catchment, Peru

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Water scarcity is increasingly becoming a problem in many regions of the world. On the one hand, this can be attributed to changes in precipitation conditions due to climate change. On the other hand, this is also due to population growth and changes in consumer behaviour. In this study, an analysis is carried out for the highly glaciated Vilcanota River catchment (9808 km^2 – 1.2% glacier area) in the Cusco region (Peru). Possible climatic and socioeconomic scenarios up to 2050 were developed including the interests from different water sectors, i.e. agriculture, domestic and energy.

The analysis consists of the hydrological simulation at a monthly time step from September 2043 to August 2050 using a simple glacio-hydrological model. For historic conditions (1990 to 2006) a combination of gridded data (PISCO precipitation) and weather stations was used. Future scenario simulations were based on three different climate models for both RCP 2.6 and 8.5. Different glacier outlines were used to simulate changes in glacier surface through the time for both historic (from satellite data) and future (from existing literature) scenarios. Furthermore, future water demand simulations were based on the SSP1 and SSP3 scenarios.

Results from all scenarios suggest an average monthly runoff of about 130 m^3/s for the Vilcanota catchment between 2043 and 2050. This represents a change of about +5% compared to the historical monthly runoff of about 123 m^3/s. The reason for the increase in runoff is related to the precipitation data from the selected climate models. However, an average monthly deficit of up to 50 m^3/s was estimated between April and November with a peak in September. The seasonal deficit is related to the seasonal change in precipitation, while the water demand seems to have a less important influence.

Due to the great uncertainty of the modelling and changes in the socioeconomic situation, the data should be continuously updated. In order to construct a locally sustainable water management system, the modelling needs to be further downscaled to the different subcatchments in the Vilcanota catchment. To address the projected water deficit, a new dam could partially compensate for the decreasing storage capacity of the melting glaciers. However, the construction of the dam could meet resistance from the local population if they cannot be promised and communicated multiple uses of the new dam. Sustainable water management requires the cooperation of all stakeholders and all stakeholders should be able to benefit from it so that they will support future projects.