Geophysical Research Abstracts
Vol. 14, EGU2012-4406, 2012
EGU General Assembly 2012

Forecasting the impact of global changes on the water resources of a mountainous catchment in the Chilean Andes

D. Ruelland (1), C. Campéon (2), A. Dezetter (2), and H. Jourde (3)

(1) CNRS, HydroSciences, Montpellier, France (denis.ruelland@um2.fr), (2) IRD, HydroSciences, Montpellier, France, (3) UM2, HydroSciences Montpellier, France

This study aims to simulate the complex interrelationships between climate forcing, human pressure and dynamics of groundwater and surface water of the upper Elqui catchment (5 660 km^2) in the Chilean Andes. The water resources of this mountainous, semi-arid catchment has been undergoing a growing pressure because of high climate variability and of the economic mutations of various sectors (agriculture, tourism), which have impacted water availability of the area. Due to the agriculture-based development in the region, water scarcity is thus a matter of great concern for this basin.

Hydrological simulations were performed with a conceptual model that takes into account a shallow reservoir supplied by precipitation and feeding evapotranspiration, surface/sub-surface runoff and infiltration, and (ii) a deep reservoir fed by infiltration and generating the baseflow. A third reservoir, in which fluxes are controlled by temperature, has been introduced to account for the snowmelt regime of the catchment. A 30-year period (1979–2008) was chosen to capture long-term hydro-climatic variability due to alternating ENSO and LNSO events. Then water uses (dam functioning, agricultural and domestic withdrawals) were integrated into the model. The model was calibrated and validated with streamflow data on the basis of a multi-objective function that aggregates a variety of goodness-of-fit criteria. Prospective climatic and anthropogenic scenarios were finally elaborated and forced into the model in order to propose midterm (2050 horizon) simulations.

The model correctly reproduces the observed discharge at the basin outlet. Depending on the modelling complexity, NSE coefficients are about 0.82–0.90 over the calibration period (1979–1990) and 0.78–0.84 over the validation period (1991–2008). The volume error between observation and simulation is lower than 15% over the whole period studied. The dynamics of both the water level in the deep conceptual reservoir and the water table in a piezometer at the basin outlet are also in good agreement. The model thus provides encouraging simulations of groundwater and surface water dynamics when applied to various climatic conditions. Simulations are improved when a dam located in the upstream catchment is considered into the model. In contrast, integrating agricultural and domestic water withdrawals does not improve significantly the simulations. However, it allows assessing the ability of water resources to supply water demands by computing a water allocation index.

The climatic scenarios forecast an increase in temperature of about 1–2°C and a 20–30% reduction in precipitation by the 2050 horizon. According to the hydrological simulations, the mean annual discharge of the upper Elqui River may decline by 30–40%, and the seasonal peak flow would occur earlier than in current conditions. As a result, the agricultural demands (90% of the water uses) may not be always satisfied, especially during the summer season, as shown by the future trends in the water allocation index. This calls for evaluating the efficiency of adaptation strategies consisting in an improvement of the irrigation system and of water management, which is the subject of ongoing research.