Geophysical Research Abstracts
Vol. 18, EGU2016-9735-1, 2016
EGU General Assembly 2016

Climate change impacts on water supply: implications for reservoir management in Upper Sabor, northeast Portugal

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Climate change scenarios project warmer temperatures and less precipitation in Mediterranean watersheds. This can aggravate drought conditions, with negative impacts on water supply. Here, reservoirs may play an important role to mitigate these impacts. However, the implications of climate change are not always considered in the reservoir planning and management.

This study aimed to address this issue for the Upper Sabor watershed, northeast Portugal. This is a medium watershed (403km2), part of the Sabor river, a tributary of Douro (one of the major rivers in the Iberian Peninsula). It is a mountainous watershed (up to 1500m), characterized by humid Mediterranean climate, with three dry months in summer. Almost 52% of the area is occupied by shrubland and 18% agriculture. Water supply for about 33 000 people has been based almost exclusively in one reservoir, but constant problems of water supply in dry summers, which coincide with a doubling of population due to summer holidays, led to the construction of a new reservoir in 2015.

The Soil and Water Assessment Tool (SWAT) model was used for a climate change impact assessment, considering the current water supply regime (single reservoir) and the construction of the new reservoir. SWAT was calibrated and validated against daily-observed discharge and reservoir volume, with a good agreement between model predictions and observations. Results from four GCMs (General Circulation Models) for two scenarios (RCP 4.5 and RCP 8.5) were statistically downscaled and bias-corrected with ground observations; climate scenarios for 2021-2040 and 2041-2060 were compared with a control period in 1981-2000. In the future, a general increase of temperatures is expected in the Upper Sabor watershed, especially in the maximum temperature under RCP 8.5 scenario for 2041-2060 (Tmax: +2.88ºC). The change in precipitation is more uncertain, with larger differences according to the selected climate model. Annual precipitation would slightly decrease in RCP 8.5, less than 1% change compared to 1981-2000. However, seasonal changes would be more significant, with more precipitation in winter (+ 6.8%) and much less in spring and summer (-13.2% and -14.9%, respectively). In turn, an annual increase in precipitation is expected under RCP 4.5 for 2021-2040 (+1.8%) and a higher decrease for 2041-2060 (+6.4%), when compared to RCP 8.5.

For hydrological impacts, SWAT results showed a small reduction in river discharge, more pronounced under RCP 8.5 for 2041-2060, for the spring and summer months. Results showed that the existence of two reservoirs will solve the water supply problems in current conditions, but in future conditions the reliability of this solution will decrease, especially under scenario RCP 8.5 for 2041-2060 (reliability of water supply below 80%). Here, the variability given by the different climate models simulated in SWAT brings some uncertainty.

The main conclusion of this study is that the solution for water supply in this region, calculated taking only present-day climate into account, will be inefficient for water supply management under future climates. Taking climate change into account would have avoided the need for further investment in the near future.