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Hydrological Climate Change Impact Analysis for the Figeh-Spring System in Damascus/Syria

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The Figeh spring is one of the worlds largest springs and the major drinking water source for Damascus/Syria serving a population of over 2.9 million. Decreasing precipitation trends observed in various parts of the Eastern Mediterranean region together with recent drought periods increased concerns about drinking water availability for Damascus in changing future climate conditions.

For that purpose first a hydrological model able to describe the observed daily discharge by meteorological driving only was developed for the data sparse and hydro-geologically complex Figeh spring. This was realized by an Artifical Neural Network (ANN) approach. It is the first hydrological model for this important spring that is able to reproduce the observed discharge behavior on a daily scale. We were able to identify the explicit algebraic transfer function of the ANN that allows transferring meteorological driving into discharge.

Second, a set of downscaled climate change data from transient experiments with regional climate models employing the A1B SRES scenario has been used to access the future climate change signal in the area of the Figeh spring system and its potential effects of the future water availability for Damascus. In total, a data ensemble from 9 different regional models (MM5 in 4 different setups, RegCM, COSMO-CLM, CNRM-RM4, RACMO-2, HadRM3) at spatial resolution of 0.25 degree has been investigated for the periods 1961-1990 for present day climate and the periods 2021-2050 and 2070 – 2099 for expected future climate. The focus is on changes to annual, seasonal and monthly surface air temperature and precipitation, and the inter-annual variability.

The potential impact of the climate change on Figeh spring discharge has been assessed by driving the ANN-based hydrological model with daily data of the different RCMs. The investigations show that water supply from the spring might face serious problems under changed climate conditions in the already vulnerable arid and semi-arid environment. Precipitation decrease in order of 11% in winter and 8% in spring together with increased temperatures of up to 1.6°C and significant decrease in snow mass can substantially limit the water recharge potential already in the near future until 2050. In the period 2070 - 2099 the annual precipitation amount is simulated to reduce by 22% and annual mean temperature increase by 4°C compared to the 1961-1990 mean. The ensemble mean of the relative change in mean discharge compared to the control period, reveals a decrease during the peak flow from March to May with values up to -20% in 2021-2050 and almost -50% in the period 2069-2098 both related to the 1961-1990 mean.

All scenario projections depict a decrease in discharge intensity in both investigated periods in the mid and end of the century. In the highly water sensitive region of the Figeh Spring area, this decrease in available water will likely have significant impacts on water security, human living and economy. Adequate water management adaptation measures are therefore highly recommended.