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Projection of the climate change fluctuations impacts on the Standardized Precipitation Index of AqQala city in Iran

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ABSTRACT

With the development of communities, the demand for water resources and greenhouse gas emissions are increasing. It is a severe threat to the hydrological cycle. This research studies the projection of the climate change impacts on the Standardized Precipitation Index (SPI) in AqQala urban area in Iran. The monthly climate change fluctuations were investigated using the GFDL-ESM4 model under the (Shared Socio-economic Pathways) SSP5-8.5 scenario for the future period. The 12-month SPI was calculated to evaluate drought in the future compared to the base period in AqQala city. The results indicated that temperature and evapotranspiration will increase, and precipitation will decrease in the future compared to the base period in AqQala city. Moderate drought will occur in different years in this region. The drought will be neutral under the SSP5-8.5 scenario in the future period in AqQala area.

Keywords: Climate Change, CMIP6, SPI, GFDL-ESM4 model.

1 INTRODUCTION

Global warming leads to changes in the hydrological cycle and water resources. It can cause extreme natural hazards like floods, droughts and the reduction of surface and groundwater quality resources (Aladejana et al., 2020) and the economic transformation, welfare, and social conditions. Therefore, the projection of climate change impacts on drought has a significant role in creating an attitude toward the correct exploitation of water resources and the sustainable development of societies. One of the methods to determine drought is the Standardized Precipitation Index (SPI). This index is a good way to determine wet and dry periods. The calculation of it is based on the probability of rainfall for each time scale to monitor droughts. Its values follow a normal distribution (Bonaccorso et al., 2003).

2 MATERIALS AND METHODS

The study area of this research is AqQala city, located in northern Iran. The location AqQala city is shown in Figure 1. Its area is 1763 square kilometers, with an average precipitation of 400 millimeters. The climate of AqQala city is hot and humid. The recorded climatic data from the meteorological stations, including temperature, precipitation, and evapotranspiration for the base period (1987-2021), were used.

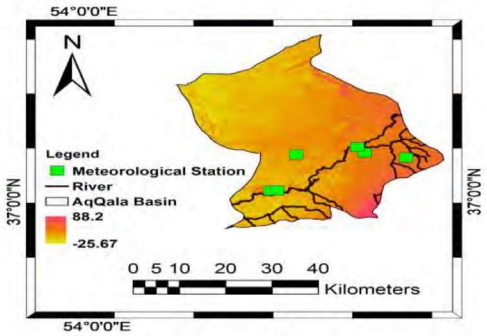

Figure 1. Location of AqQala city

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Also, the daily mentioned data were downloaded using the GFDL-ESM4 model under the SSP5-8.5 scenario for the future period (2022-2054) in the form of netCDF. Since the distribution mapping of precipitation and temperature method has an excellent performance in the bias correction of climatic variables (Enayati et al., 2021), this technique was used to correct the accuracy of the simulations resulting from the micro scaling of GCMs models. In this research, the 12-month SPI was calculated for the base period (1987-2021) and future period (2022-2054).

3 RESULTS AND DISCUSSION

Figure 2 shows the percentage of climatic variables changes for the future (2022–2054) compared to the base period. Based on Figure 1, temperature and evapotranspiration will increase by 2% and 4%, respectively. Precipitation will decrease by 52% in the future compared to the base period using the GFDL-ESM4 model under the SSP5-8.5 scenario. Figure 3 shows the 12-month SPI during base period (1987-2021) and future period (2022-2054). According to Figure 3, there were severe droughts in 1990, 2012, and 2021, and severe drought will occur in 2047. Moderate drought will occur in 2028, 2033, 2034, 2051, and 2053 because of the decrease in rainfall. Extremely wet will occur in 2042. As a result, the drought will be neutral in the future period.

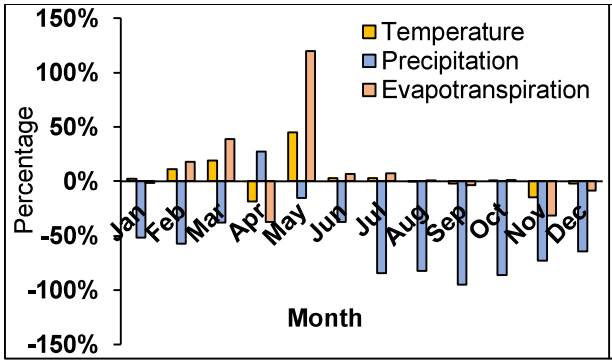

Figure 2. Percentage of climatic variables changes for the future (2022–2054) compared to the base period (1987-2021).

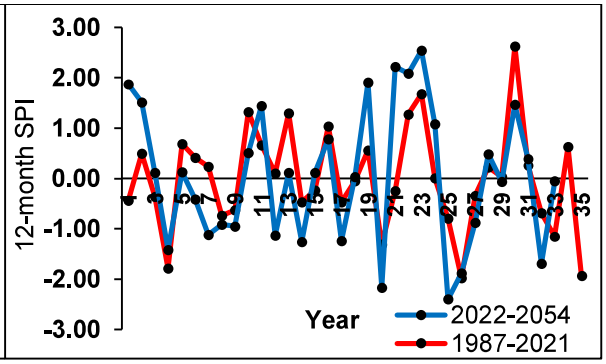

Figure 3. The 12-month SPI during base period (1987-2021) and future period (2022-2054).

4 CONCLUSIONS

Our finding points out that temperature and evapotranspiration will increase, and precipitation will decrease in the future (2022–2054) compared to the base period (1987-2021) under the SSP5-8.5 scenario in AqQala city. Moderate drought will occur in different years in the future. Moreover, the drought will be neutral in this region based on the 12-month SPI calculated under the SSP5-8.5 scenario. The results of this research can be used to adopt suitable strategies for adaptation and reducing the effects of drought.

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