Assessment of regional precipitation trend in the Lake Urmia basin

Mohsen Ghaderpour
Master Graduate, Faculty of Natural Resources, Urmia University, Urmia, Iran
Hirad Abghari*
Associate Professor, Faculty of Natural Resources, Urmia University, Urmia, Iran
Hossein Tabari
Researcher at Hydraulics Division, Department of Civil Engineering, KU Leuven, Belgium

Received: 14 / 04 / 2016 Accepted: 11 / 08 / 2016

Extended Abstract

Introduction

Recent global warming has led to a change in the global hydrological cycle and an increase in extreme events such as flood and drought at the global and continental scales. However, at the regional scale, the magnitude of warming and the resulting changes in water resources are different from one region to another. Unlike air temperature whose increase is evident throughout the world, there is no unique and defined pattern for global precipitation changes. In recent years, climatic changes and precipitation can decrease in water level of the Lake Urmia. Extension of salt flats near the lake has caused many adverse environmental and economic effects. This necessitates the analysis of precipitation changes as the main input of the lake and one of the possible reasons for the water level decrease. Most of the previous studies on precipitation trends have been performed using data from sparse synoptic stations. Therefore, this study analyzed precipitation time series from a dense rain gauge network in the Urmia Lake basin at the annual and seasonal scales.

Materials and Methods

The Mann-Kendall test is one of the most common non-parametric tests for trend analysis of hydrological and meteorological variables. The main advantage of this test is that it doesn't need the data to be normally distributed. The Z statistic of the Mann-Kendall test for different series can be summed in the framework of a multivariate Mann-Kendall test. The multivariate Mann-Kendall test was used in this study for trend detection in the precipitation time series of the study area. The non-parametric Theil-Sen method was also applied for estimation of the trend magnitude. The existence of serial correlation in hydro-meteorological time series is one of the difficulties of performing a meaningful trend analysis. The effect of serial correlation in the precipitation time series on the trend results was limited in this study. After analyzing the

* E-mail: h.abghari@urmia.ac.ir Tel: +98 91480719001

trends using the aforementioned methods, the results were shown on interpolation maps prepared by the Inverse Distance Weighting (IDW) method in the ArcGIS environment.

Results and Discussion

The analysis of the annual precipitation time series using the multivariate Mann-Kendall test showed that most of the stations had an increasing trend. The Z statistic of the multivariate Mann-Kendall test revealed that all of the significant precipitation trends were found to be increasing. The precipitation decrease of 30% was observed in the central, eastern and southern parts of the basin, while in the western, northeastern, southwestern and most eastern parts an increase in precipitation was found. Most of the spring precipitation trends (about 60% of the stations) were found to be decreasing. Based on the results of the statistical tests, almost all of the decreasing trends in spring were statistically insignificant. The only significant (increasing) trend at the 95% confidence level was detected at Tamr station. For summer precipitation, the number of increasing trends was very larger than that of decreasing trends. Nevertheless, only nine stations showed a significant increasing trend in summer precipitation. According to the obtained results, there was a good agreement between the trend results of spring and autumn precipitation. The autumn precipitation time series revealed a decreasing trend at 33 out of the 37 study stations and an increasing trend for the remaining stations. The decreasing trends were found to be significant only at five stations, whereas the increasing trends were not statistically significant. For winter precipitation, an increasing (decreasing) trend was observed at 23 (14) stations. The statistical analysis confirmed the significance of only four increasing trends, while the decreasing trends were not significant.

Conclusion

In this research, the multivariate Mann-Kendall test and the Theil-Sen approach were used to detect spatial and temporal trends in precipitation at 37 stations in the Lake Urmia basin at the annual and seasonal scales. The results showed an increasing trend in annual precipitation at 54% of the stations. Seasonal and monthly trends provided a more detailed picture on temporal changes in precipitation time series at the basin. The majority of the trends in spring precipitation at the surveyed stations were found to be decreasing. The spring precipitation decrease in the southern part of the basin (between 20% and 30% or more) was more noticeable compared with the eastern part. As for the summer season, precipitation increased during the last 3 decades from 10% in the west to 20-30% in the east and south of the region. It is worthy to note that the obtained significant trends in summer precipitation series are not so reliable due to the existence of numerous zero values in these series in the study region. In the case of autumn precipitation, a decreasing trend was observed in the whole basin, ranging from 10% in the south to more than 30% in the eastern part of the lake. Winter precipitation had a moderate slope in most of the basin, with a slight decrease in the east and central parts.

Keywords: Lake Urmia basin, precipitation, regional trend, statistical tests, trend magnitude.