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Identification of Precipitation Changes in the Caspian Sea Basin and its Relationship with Remote Linkage Patterns

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Abstract
Precipitation is one of the most important and variable climatic elements, exhibiting more complex behavior compared to other climatic factors. This element shows significant temporal and spatial variability. The aim of this research is to examine the trend of precipitation changes in the Caspian Sea basin and its relationship with teleconnection patterns. In this context, monthly precipitation data from the ERA-Interim dataset, with a resolution of 2° x 2°, covering the statistical period from 1970 to 2023, were utilized. Given the non-normality of the data, the non-parametric Mann-Kendall test was employed to calculate the trend. The precipitation slope was also determined using the Sen's slope estimator. The results indicated an increasing trend in precipitation during the months of january, february, march, november, december, and to some extent in may and october, while a decreasing trend was observed in other months. The increasing trend in precipitation was most pronounced in february, while the decreasing trend was most significant in june and august. The correlation between precipitation and teleconnection patterns showed that, temporally, correlations were observed in january, february, march, june, august, september, october, and december. The EA.WR pattern exhibited the highest correlation with the basin's precipitation compared to other patterns, followed by the TNA, AMO, and AMOS patterns. Overall, february showed the highest correlation between teleconnection patterns and precipitation, and in terms of pattern type, the EA.WR pattern had the strongest correlation with the basin's precipitation.

Keywords: **Precipitation, Sen's slope, Mann-Kendall, Caspian Sea**

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Extended Abstract

Introduction

Precipitation, as one of the important climatic elements, has certain complexities, and usually precipitation at a point on different time scales does not have simple and symmetrical statistical distributions. A decrease or increase in precipitation affects many other climatic and environmental phenomena such as runoff, flooding, air temperature, humidity, and also many human activities. therefore, changes in precipitation can be one of the signs of climate change. Climate change can also be affected by remote sensing patterns. teleconnection is one of the climate features on a global scale. The Caspian Sea, as the largest closed lake in the world, is of great international importance and plays a significant role in the fields of shipping, commerce, and the national economy, and has a great impact on the climate and climate of the region. This sea has very different climatic conditions due to its climate variability, evaporation rates, and freshwater inflow. Given the importance of this sea, the present study aims to investigate the trend of precipitation changes in the Caspian Sea basin and its relationship with teleconnection patterns.

Data and Method

In this study, monthly precipitation data analyzed by ERAInterim with a resolution of 2 x 2 during the statistical period 1970-2023 were used. The normality of the data was assessed using the Anderson-Darling test. Given the non-normality of the data, the non-parametric Mann-Kendall test was used to calculate the trend. The Sen slope test was also used to obtain the precipitation slope. Given the large volume of precipitation trend and slope values, this information was transferred to Arc Gis software and presented as zoning maps.

Results and Discussion

The study of the precipitation trend shows that an increasing trend in precipitation has been observed in the months of January, February, March, November, December and to a very small extent in May and October; but in other months only a decreasing trend in precipitation has occurred. In the meantime, an increase in precipitation has been observed in February more than in the other mentioned months. In the months when the increase in precipitation has occurred, it has been observed more in the northern parts of the basin located in Russia. The decreasing trends in precipitation have also occurred in the months of June and August more than in other months. It is noteworthy that the decreasing trends in precipitation have also been observed in the north of the basin located in Russia more than in other parts of the basin. The results of the study of the precipitation slope showed that precipitation decreased in the months of June, July and August, and the decrease was greater in the northern parts of the basin. A slight increase in precipitation has also been observed in the cold months of the year, especially April, November and December. The correlation of precipitation and teleconnection patterns indicates that temporal correlations have been observed between precipitation and teleconnection patterns in January, February, March, June, August, September, October, and December. Among them, more correlations have occurred in February, March, June, and December than in other months. In April, May,

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July, and November, none of the teleconnection patterns has been correlated with basin precipitation. Among teleconnection patterns, the EA.WR pattern has been correlated with basin precipitation more than other patterns. After that, the TNA, AMO, and AMOS patterns are located. The NAO, SOI, NOI, AO, and NCP patterns have also not been correlated with basin precipitation in any month.

Conclusion

Global warming, which is occurring in almost most parts of the world, has also occurred in the Caspian Sea basin, and evidence of global warming has been observed in this basin. Another evidence of global warming in this basin is the decrease in precipitation in this basin, which is clearly evident in the precipitation trend zoning maps. As can be seen in these maps, precipitation has a decreasing trend in most months, and very slight increasing trends have been observed in some months. In general, in the precipitation trend zoning maps, the decreasing trend zone is larger than the increasing trend. In terms of time, the highest correlation between the teleconnection patterns and precipitation was observed in February, and in terms of pattern type, the EA.WR pattern also had the highest correlation with the basin precipitation. According to the coefficient of determination obtained in February and September, 58.4 and 51.1 percent of the basin precipitation changes are explained by the remote sensing patterns, which is the highest among the months of the year. The results of linear regression also indicate that the NCP pattern has been more influential than other patterns on the precipitation of the Caspian Sea basin. Understanding precipitation changes and their relationship with teleconnection patterns can be used to advance meteorological and agricultural management programs and operations.

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