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Trend Analysis of annual rainfall over Iran

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Extended abstract

1-Introduction

Identification of heavy rainfall events are important in the design of water-related structures, agriculture, weather modification, policy making and planning and in monitoring climate change. Generally the change in rainfall in the world was examined in both time and space. Hence, much attention has been paid to different methods of analysis of extreme precipitations during recent years.

Karl and Knight (1998), studied the twentieth century trends of precipitation are examined by a variety of methods to more fully describe how precipitation has changed or varied. They believed that since 1910, precipitation has increased by about 10% across the contiguous United States. The increase in precipitation is reflected primarily in the heavy and extreme daily precipitation events. For example, over half 53% of the total increase of precipitation is due to positive trends in the upper 10 percentiles of the precipitation distribution.

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These trends are highly signification, both practically and statistically. The fallowing as a result, there is a signification trend in much of the United States of the highest daily year-month precipitation amount, but with no systematic national trend of the median precipitation amount.

Kunkel (2003) analyzed the extreme precipitation events indicate that there has been a sizable increase in their frequency since the 1920s/1930s in the U.S. This suggests that natural variability of the climate system could be the cause of the recent increase, although anthropogenic forcing due to increasing greenhouse gas concentrations cannot be discounted as another cause.

Liebmann et al (2004) reports that Seasonal linear trends of precipitation from South American station data, which have been averaged onto grids. The results showed that in the period 1976–99, the largest trend south of 20 occurs during the January–March season, is positive, and is centered over southern Brazil. From 1948 to 1975 the trend is also positive, but with less than half the slope. The dynamic causes of the trend are not obvious. It does not appear to be accounted for by an increase in synoptic

wave activity in the region. The precipitation trend is related to a positive sea surface temperature trend in the nearby Atlantic Ocean, but apparently not causally.

Brahmananda et al (2006) believed that there has been an increase in rainfall over northeast Brazil (Nordeste), while over the sub-Saharan region there has been a drought. The correlation coefficients between the 11-yr running means of the rainfall series over the two regions are significant (at the 95% confidence level by a two-sided t test), suggesting that both trends are related. The rainfall variations over the two regions are connected to the position of the intertropical convergence zone (ITCZ) over the Atlantic. A more southward (northward) position of the ITCZ is favorable for higher than normal rainfall over Nordeste (sub-Sahara). The correlation coefficient between the position of the ITCZ over the Atlantic and the rainfall over Nordeste (sub-Sahara) is negative (positive) and highly significant, reaching values over 0.9. Thus, this study suggests that a more southward than normal location of the ITCZ in the Atlantic may be the cause for the recent increasing (decreasing) trend of rainfall over Nordeste (sub-Sahara).

Su et al (2006) studied the extreme temperature and precipitation trends over Yangtze from 1960 to 2002 on the basis of the daily data from 108 meteorological stations. Both the Mann-Kendall (MK) trend test and simple linear regression were utilized to detect monotonic trends in annual and seasonal extremes. Trend test has revealed a significant trend in summer rainfall, no statistically significant change was observed in heavy rain intensity.

Becker et al (2006) studied the Precipitation trends in the Yangtze River catchments (PR China) for the past 50 years by applying the Mann-Kendall trend test. The results showed that significant positive trends at many stations can be observed for the summer months.

Crochet (2007) studied the climatic variability and trends of precipitation in Iceland for the period 1961–2000. He believed that the observed intra- and interannual variations in the precipitation characteristics can be linked to variations in size, location, and occurrence of the large-scale precipitation systems crossing Iceland that are in turn influenced by the strength of the North Atlantic Oscillation, especially in winter.

2- Methodology

Identification of trend or persistence in the rainfall series is essential to present the hydrological information in the condensed form for decision-making in water resources planning of any region. This paper exemplifies a study involving non-parametric statistical method of Mann-Kendall test for identification of existence of trends in annual rainfall series for Iran country. Sen's estimator of slope method was used to compute the change per unit time in a time series having linear trend.

According to the test, the null hypothesis H0 states that the deseasonalized data (x1, x2,........,xn) is a sample of n independent and identically distributed random variables. The alternative hypothesis H1 of a two-sided test is that the distribution of X_k and X_j is not identical for all k, j ≤ n with k ≠ j. The test statistics S is computed from Eqs. (1) and (2) and are given by:

$$S = \sum_{k-1}^{n-1} \sum_{j-k+1}^{n} \operatorname{sgn}(x_j - x_k) \qquad (1)$$

$$\operatorname{sgn}(x_j - x_k) = \begin{cases} +1 & if \quad (x_j - x_k) > 0 \\ 0 & if \quad (x_j - x_k) = 0 \\ -1 & if \quad (x_j - x_k) < 0 \end{cases} \qquad (2)$$

The test statistics S has mean zero and variance of S, computed by:

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_t t(t-1)(2t+5)}{18} \qquad (3)$$

Here t is the extents of any tie and Σt denotes the summation over ties. For the cases that n is larger than 10, the standard normal variants z is computed by using Eq. (4).

$$Z = \begin{cases} \frac{S-1}{\sqrt{Var(S)}} & if \quad S > 0 \\ 0 & if \quad S = 0 \\ \frac{S+1}{\sqrt{Var(S)}} & if \quad S < 0 \end{cases} \qquad (4)$$

Thus, in a two-sided test for trend, the hypothesis H0 should be accepted if $z \leq z\alpha/2$ at the α level of significance. A positive value of S indicates an upward trend and a negative value indicates a downward trend.

3– Discussion

In this study, trends of rainfalls were examined on the basis of measurements of 1437 stations (included synoptic, climatic and rain gage stations) in Iran for the period 40 years (1964-2003). For this purpose, the used statistical methods are the nonparametric Mann-Kendall test for testing the presence of monotonic increasing or decreasing trend of rainfall and nonparametric Sen's method for estimating the slope of a linear trend.

4– Conclusion

For the present study rainfall data in respect of Iran synoptic stations were analyzed to study about the variation in rainfall trend. The results of trend analysis showed that there are not any significant trends in mean of station's rainfall and mean of pixel's rainfall. However, mean of station's rainfall and mean of pixel's rainfall over Iran was respectively 0.64 mm and 0.5 mm for every year.

Key words: Trend analysis, interpolation, Mann-Kendall, Iran's rainfall.

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