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ORIGINAL ARTICLE

The Study of Precipitation Trend in Gavkhooni Basin (Iran)

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ABSTRACT
Temperature, humidity and precipitation in an area, are parameters provide influential in the climate of that area, and one should recognize them so that he can determine the climate of that area. Climate fluctuations are of primary importance in climatology, and in recent years, have been of great concern to researchers and even politicians and organizations, for they can play an important role in social, political and economic activities. Even though the real cause of climate fluctuations or their stability is not yet fully recognized, they are a matter of concern to researchers and their importance for countries has prompted them to investigate climate fluctuations in different levels, especially in regional, national and continental level. This issue has less been investigated in our country. However, in recent years, there have been some researches and conferences on climate changes. This study is also in line with such researches and tries to investigate and analyze the trends of precipitation change Gavkhooni basin. Monthly and Annual precipitation 31synoptic and climatology stations in a statistical period of 46 years (1960-2005) in the stations of Gavkhooni basin were analyzed by Mann-Kendall test. The results obtained by data analysis show that precipitation is changes in many part of Gavkhooni basin. In West area the precipitation has a significantly falling trend and in East and South area the precipitation has a significantly rising trend.
Keywords: *Trend, Gavkhooni basin, Man-Kendall test*

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INTRODUCTION

Climate changes during the recent decade have been considered as one of the most important environmental issues in different world's assemblies. The categories such as the weather pollution, reduced power of the soil resources production, natural resources destruction, deforestation and the other similar cases like the global warming issue are of much importance from the view of increasing and accumulating greenhouse gases. The occurrence of such these phenomena may have different impacts on the human's life on the earth including the human settlements, agricultural products and energy and the other related factors uses. For this purpose, the human has always been trying to find the history of evidence, causes and future of the climate changes [1]. The variability of temperature and precipitation is also regarded as the main characteristic of climate, especially the precipitation at different time and spatial scales that is with a lot of changes [2]. A lot of studies have been conducted concerning the study of trend and climatic changes. For instance: Buffoni et al. [3] analyzed the precipitation in Italy. They collected the precipitation data of 32 stations dispersed across Italy and divided them in two climatic homogeneous sets in order to study the seasonal and annual precipitations of Italy for a 164-year period. They applied Mann-Kendall test to study the trend and came to this conclusion that there are a variety of trends in different zones and seasons. Stafford et al. [4] obtained a 50-year trend of temperature and precipitation in Alaska using the data of 25 stations for the period 1949-1998. They utilized the mean, maximum and minimum temperatures, the rate of daily temperature and total precipitation to study linear trends and found that the seasonal and annual mean temperatures have been increased in the whole state and the majority of them seen statistically at the level of 95% or higher. Tumusio et al. [5] studied the winter precipitation variations of 40 rain gauge stations in Italy during 1995-1960. They studied the variability of time series using Mann-Kendall concepts and Pettit test in order to estimate the possibility of trend occurrence and changing points. They found that almost the total stations under study showed a significantly decreasing trend on summer precipitation during this period. Dumunex [6] studied

the precipitation trend in Hungary. He analyzed monthly precipitation time series from Hungary station during 1901-1998 in order to detect long-term changes on precipitation features of 20th century. He has paid a special attention to the changes in the recent decades and their relationship with large-scale climatic changes in Europe and Atlantic ocean.In addition, systematic changes were studied through analyzing the linear trend and Mann-Kendall test and long-term fluctuations described using a ***15-point Gaussian filter*** in time series. Jemrel et al. [7] studied the monthly precipitation trend of China using the data of 160 stations during 1951-2002. They used Mann-Kendall test and could determine the positive and negative monthly precipitation trends at the importance level of %90, %95 and %99. Livada & Asimacopoulos [8] studied the seasonal precipitation in Greece using single seasonal index and then measured the linear correlation of this index with the single seasonal index. In the next phase of research, they conducted a regression analysis of this index and latitude and found a significant reverse linear correlation and finally the study of time series trend of this index showed that no significant change occurred in seasonal precipitation of this zone. Kian & Lin [9] analyzed the regional trend of the recent precipitation indices in China from the daily precipitation data of 494 stations during 1961-2000. Of the sample of these indices, the precipitation percent, precipitation intensity and precipitation duration have been used and their interdecadal differences studied. AminiNia et al. [10] studied and analyzed the precipitation fluctuations of heavy snow in North West of Iran. The studies showed that the precipitation of heavy snow has been with high fluctuations and a decreasing trend in all stations and within the common statistical period. Using Mann-Kendall rank test on the stations holding long-time statistic shows the existence of a descending trend in receiving the precipitation of heavy snow for Tabriz and Urmia stations and the lack of a descending trend for Ardebil and Khoy stations. Parvin [11] studied the climate change of the recent half-century by emphasizing on the North west zone of Iran. In order to study and recognizing the changes of time series, he has utilized t-statistic of Mann-Kendall test and Mann-Kendal rank statistic methods. The results of research show that the assumption of the random-being data is intensively rejected and the trend condition dominated on the data and the graphical-statistical study of **u** and **u**ó components changes of minimum mean temperature and the zonal precipitation have been under the change during the recent half-century. Azizi&Roshani [12] studied the climate change in the southern coasts of Caspian Sea using Mann-Kendall test. The results of their survey indicate climatic elements change during the period (from 1950 to 1990) so that this change is of the short time weather fluctuations type and trend observed in some of the monthly, annual and seasonal series. Feizi et al. [13] studied the climate change in Sistan and Baluchistan province using Mann-Kendall method. The results of the data analysis show that in all of the stations except Zahedan station the temperature parameters show a negative trend during the year. Omidvar & Khosravi [14] studied the change of some climatic elements in Northern coasts of Persian Gulf using Mann-Kendall test. The results of their research show that the mean temperature changes in all stations are similar to the trend of their minimum temperature changes and what caused increased mean temperature of the zone stations has been mostly the minimum temperature. Moreover, the relative humidity has had mostly a significant descending trend or without a significant trend. Concerning the precipitation, the frequency of significant descending trend is seen in the stations under study and no significant rising trend observed in them. Hejam et al. [15] studied the trend analysis of seasonal and annual rainfall changes in some of the selected stations in central basin of Iran using non-parametric Mann-Kendall and Sensestimator slope methods. The results obtained from this research indicate the presence of a significant decreasing trend by two applied tests in some of under study time series, but no significant increasing trend approved jointly by two applied tests. Khordadi et al. [16] studied the meteorology parameters trend in some zones of Iran. Jahanbakhsh et al. [17] studied rainfall and temperature changes in Karkheh basin. The results of research show that the annual rainfall in all sub basins of the zone has a decreasing trend while the existent trend of temperature is rising. With respect to the above matters, in this survey it has been tried to study the importance of weather changes and their impact on zonal and local changes of the precipitation variable having an important role in the weather changes as well as the trend of these changes in Gavkhouni basin.

MATERIAL AND METHOD

In this survey, to study the precipitation changes trend in Gavkhouni basin, annual and monthly precipitation statistics of 31 synoptic and climatology stations across and around the basin have been utilized (Fig.1). The used statistical period has been 46 years from 1960 to 2005. Then, 46 annual precipitation maps and 46 monthly precipitation maps for each month were prepared using interpolation by Kriging method. The size of mapping cells was considered to be at 10 km x 10 km dimensions. The data related to each cell was evaluated and analyzed using Mann-Kendall test.

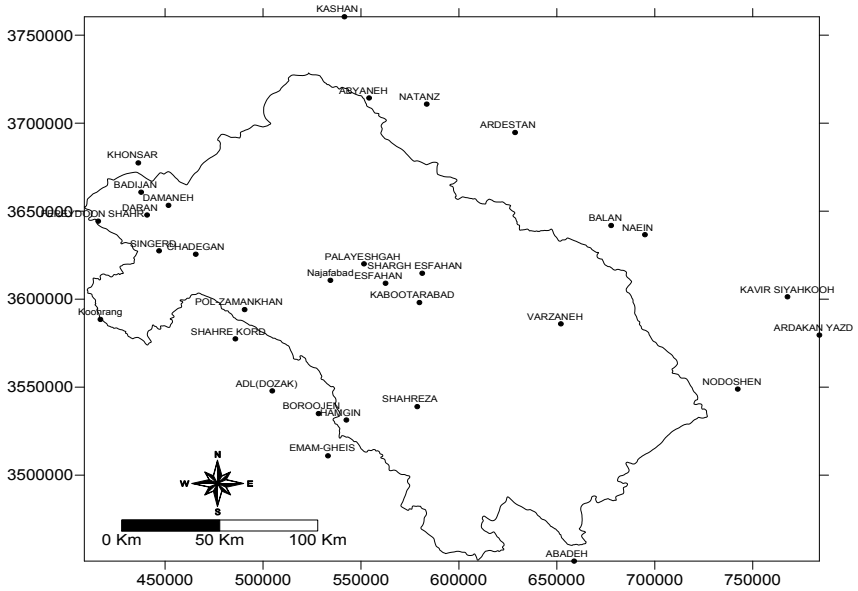

Fig. 1: Synoptic and Climatological Station in and Around Gavkhooni Basin

Mann-Kendall method is applied commonly and widespread to analyze hydrological and meteorological series [18]. One advantage of this method may be its suitable application to time series not following a specific statistical distribution and the other is the negligible effectiveness of this method from extreme values observed in some of the time series [19]. In a specified series of the data, to determine their being random the following relation is used:

$$T = \frac{4P}{n(n-1)} \quad (1$$

Where :t is Kendall statistic and p the sum of the ranks number bigger than n1 row placed after that and is obtained from relation (2) :

$$P = \sum_{i=1}^{n} ni \quad (2$$

Inthis relation, n indicates the total number of the statistical years. For a random set, mathematical expected value of t is zero and variance is obtained from the following relation: $Var(r) = \frac{2(2n+5)}{9n(n-1)}$ (3

Kendall test defines a standard normal variable named N obtained from the following relation. This relation is applied to determine the significance of t statistic:

$$N = \frac{r}{var(r)^5} \quad (4$$

When the number of the data is increased, N(n) will be converged toward a standard normal distribution rapidly. If n absolute value is higher than na/2 (at 5% significant level using normal distribution table, it is 1.96) the data series has a significant trend. If n value is negative, the distribution will have a decreasing trend and if between 1.96 and -1.96, the data series will be without a specific trend [16].

RESULTS AND DISCUSSION

Zayandehroodriver and Gavkhouni basins are the sub basins of Iran's central basin. The main source of providing water for this basin is Zard-Kuh Bakhtiari Mountains in Chaharmahal and Bakhtiari province and western heights of Isfahan province. In the recent years, by inter basin transfer of the water through Kuhrang tunnel some water of Karun head branches has been added to this basin. The water resulted from this river provides the water for drinking, industries and agriculture in surrounding areas of the river. In the recent years, the water shortage in this basin and Zayandehroodriver and Gavkhouni drought caused the incidence of environmental destructive problems for the river beneficiaries, surrounding cities, agricultural industries and especially, Gavkhouni lagoon. The administrators of Isfahan and Chaharmahal and Bakhtiari provinces think that this is due to the droughts resulted from the climate change and decreased precipitation over the basin. In this research, it has been tried to study and analyze the trend of rainfall changes in this basin in order to recognize if this shortage has been due to decreased rainfall or other factors such as the more roles of human and management in this case. Based on the conducted studies in this survey, annual mean precipitation across Gavkhouni basin is around 208 mm. The lowest annual mean precipitation is around 75 mm and is related to the eastern areas of basin and the highest around 1350 mm related to the western areas (Fig.2). Studying the time series of annual mean precipitation across Gavkhouni basin (Fig.3) shows that the highest annual precipitation across the basin

is around 320 mm related to 1986 A.D. The lowest rate of precipitation is around 125 mm related to 1385 A.D. During these 46 years, three drought periods and two rainfall periods are observed over the basin. The duration of drought periods has been longer than the rainfall periods, but the intensity of rainfalls higher than droughts. Studying the trend of annual precipitation changes in the basin show that the mean precipitation hasnot had a significant increase or decrease trends and in fact , the hypothesis of decreased rainfalls in the basin is rejected.

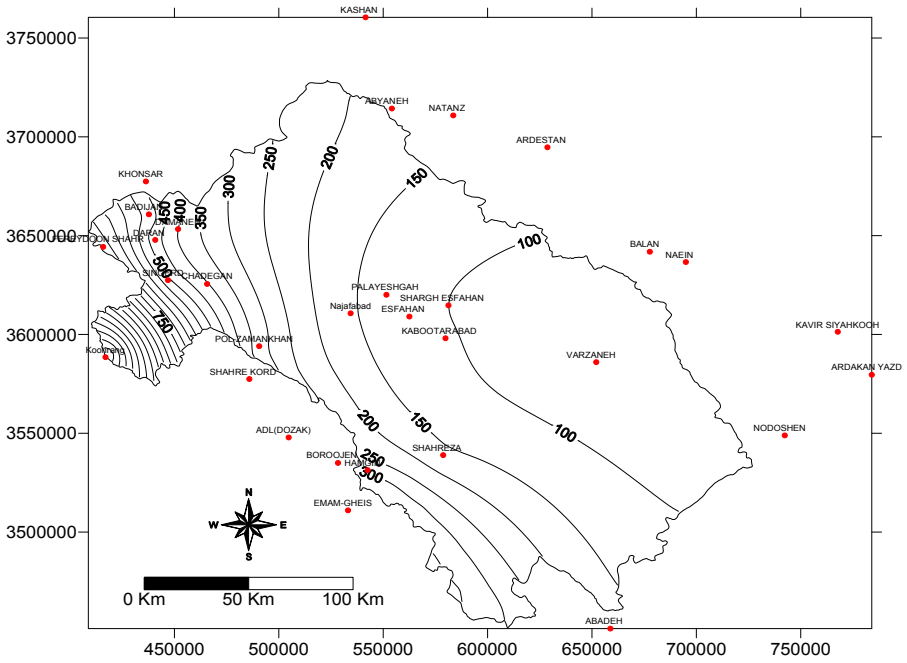

Fig. 2: Precipitation Distribution in Gavkhooni Basin

In order to detect the trend of precipitation changes in different parts of basin, Mann-Kendall test was performed on 46-year data related to each cell. The results showed that in some parts of the basin significant changes are observed in the precipitation rate (Fig.5) so that in some western parts of the basin the precipitation has had a significant decreasing trend. This decreased rainfall is observed in western towns of Isfahan province including Feridan, fereidunShahr and Chadegan, especially in areas around Zayandehrood dam reservoir. The studies also showed that in some western and southern areas of the basin, the precipitation has had a significant increasing trend. This increasing trend is observed in Naeen, Shahreza and Dehaghan.

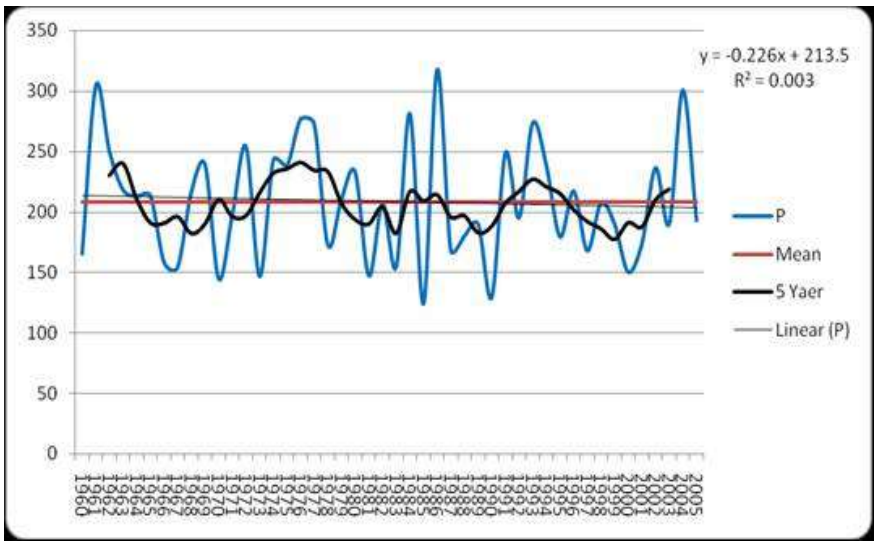

Fig. 3: Annual Precipitation Trend in Gavkhooni Basin

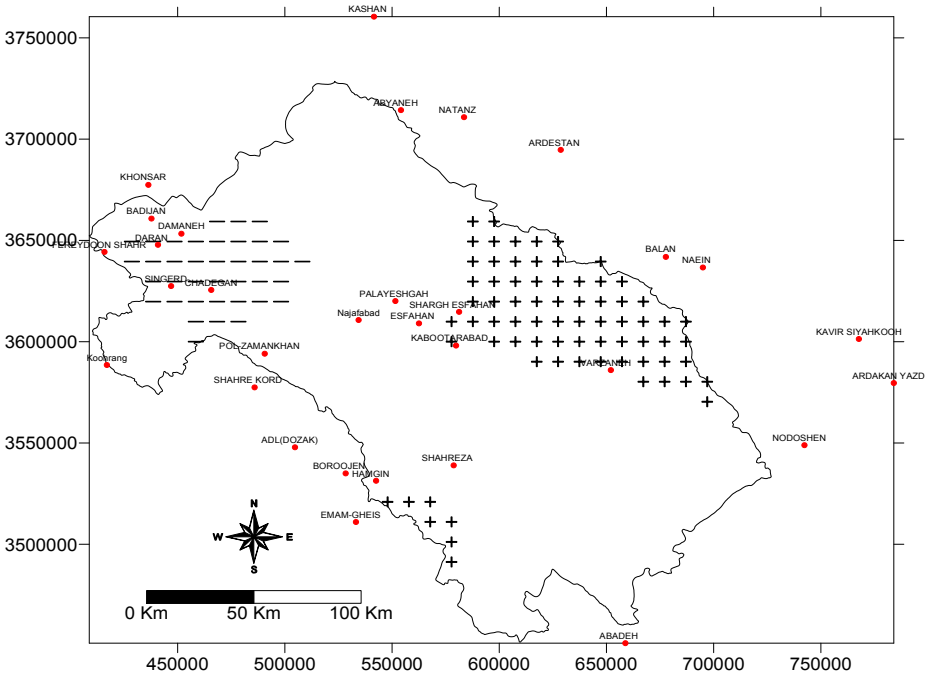

Fig. 4: Precipitation Trend in Gavkhooni Basin

CONCLUSION

Studying annual precipitation time series in Gavkhouni basin during 1960-2005 A.D shows that there is no significant increasing or decreasing trend in annual mean temperature of this basin. But, analysis of the precipitation data on cells 10 km x 10 km resulted from mapping annual isohyets show that in some areas of the basin there has been significant increasing or decreasing trend. In western areas of the precipitation basin a significant decreasing trend and in eastern and western areas a decreasing trend is observed. In general, it may be stated that the claim of decreased rainfall over the basin and occurrence of the water drought in Zayandehrood and Gavkhouni are not accepted due to the climate change and decreased precipitation and in fact, the annual rate of precipitation in this basin hasn't been reduced but ineffective management and lack of adequate distribution of the water in different parts of the basin caused this problem.

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