Comparative Study Climatic Changes with Contemporary Basin River Changes in Iran

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Abstract

Understanding climatic changes by means of trend determination and study of major climatic parameters, particularly rainfall and temperature, and their comparison with records of climatic changes in the past can reveal patterns of changes. The present study investigates changes in climatic elements such as precipitation, maximum temperature and minimum temperature by Mann-Kendall model in Iran .

Spatial comparison tables were prepared and the changeability of climatic elements was modeled on the basis of the region of highest changes in climatic elements and the zoning of climatic elements by Geostatistic methods. Taking into account the significance of seasonal changes in Iran and the effect of the two seasons of spring and winter on the water resources of the country, changes arising from these two seasons were investigated. Then, using the Cokriging method, the relationships between these changing variables were defined on the basis of the regression model, and the relevant tests were conducted. The models obtained show that Iran should expect a climate which has not been experienced by her at least during the past 50,000 years, and that its changes are not separate from global climatic changes.

Y = -0.59-0.01X (Precipitation changes in spring)

Y = -0.382-0.02X (Precipitation changes in winter)

Y = -0.797-0.007X (Minimum temperature changes in spring)

Y = -0.607+0.019X (Minimum temperature changes in winter)

Y = -0.782-0.016X (Maximum temperature changes in spring)

Y = -0.479-0.04X (Maximum temperature changes in winter)

As northwest Iran experiences higher climatic changes, Uremia Lake basin was investigated as the sample basin. ETM satellite images were used for reconnaissance of surfaces of changes and SRTM satellite images for determining the height of surfaces of changes arising from climatic change. The supervised classification was conducted on the basis of the sampling of lakeside surfaces, which clearly revealed the existence of four surfaces in the lake. Based on the studies conducted on these surfaces and the climatic changes concerned, it was concluded that each surface of the

lake is proof of long-term climatic changes. Smaller and waterside surfaces indicate short-term climatic mutations and variations. Given the results of the study, it can be predicted that water resources in Iran will face more serious problems in a way that the natural strength of Iran to preserve and provide water resources will gradually subside. In other words, water resources in Iran will encounter waste through increase of floods and evaporations.

Keywords: Climatic changes, River basins, Mann-Kendall, Uremia Lake, Iran

1. Introduction

Changing in climate has extra importance in this decade that was given into consideration by many companies in different aspects in the world and growing world wide warming trend is one of the first results of it. so that except 1996 other years in this decade (1996-2005) was the warmest years in the world and in 2005 annual mean temperature level was 0.47 % $c°$ more than annual mean during(1996-2005) period (it means it was warmer 14 $c°$).so 2005 had been the second warm year in registered records since 1850 till now. The warmest year is 1998 with 0.52 % $c°$ annual mean temperature level more than annual mean in30 year's period. (Center of climatology, 2005)

Climate changing is one of the most important problems in management in water sources in Iran. What is the influence of warming in the world on Iran? Accepting that drought appearance in Iran is a result of world wide warming, needs more studies because some researchers expected more wet condition for some part in result of warming in the world (Sellers, 2001).others believe that Iran's more wet climate in the past was coincident with cold or glacial period and relate dry climate and desertification to warm or interglacial period in Iran with notice to past witnesses and changing in Quaternary climate and believe that declining in precipitation, changing in kind of it from snow to rain and increasing in mean of temperature is some of its effects.

2. Method

This study was done for whole of Iran in1:25000 scale so contours and stream networks were extracted from this figure and statistics of 40 synoptic stations from

whole of the country during 1953-2005 were chosen and minimum, maximum and mean of monthly precipitation of them were extracted. For understanding of changes in factors of climate in fluctuation, trend and change abrupt scales, Man-Kendall index was used because of its unparametric characteristic and its relation to time. For the reason that seas and lakes and rivers and down parts of catchments records the effects of changing in climate and it is more common in north west of the country so Urumieh lake was chosen for study of effects of changing of climate. ETM satellite images were prepared from it and were mosaiced. DEM of this catchement was prepared according to topographic figures (it must be mentioned that Lambert's coordinate system that was used in all layers is Lambert).

2.1. Precipitation changes of seasonal and monthly changes in precipitation

During (1996-2005) period that Man-Kendall_index was calculated. Most of the stations show one change in annual precipitation and it was classified until 4 changes so the figure was made for them (if rate of changes was between +-1.96, the changes are leap kind. Increase and decrease in that rate shows increase and decrease in trend of precipitation).

Figure.1.a shows the negative changes abrupt in trend of precipitation in west and east of Iran. Changes in precipitation have a positive trend in central part of Iran. Figure.1.b shows that the changes second series to the first one are in negative trend and the extent of them have some increases and the territory of positive changes are bounded in south and north part. Figure.1.c shows the negative leaps in precipitation in North West and center of Iran and in figure.1.d the decreasing trend was fade in North West and center parts are dwindle to a small region but in the south east the negative trend was increased. Positive trends that were in north and south parts in second series were inclined to center of Iran. This trend are continued in forth trend.

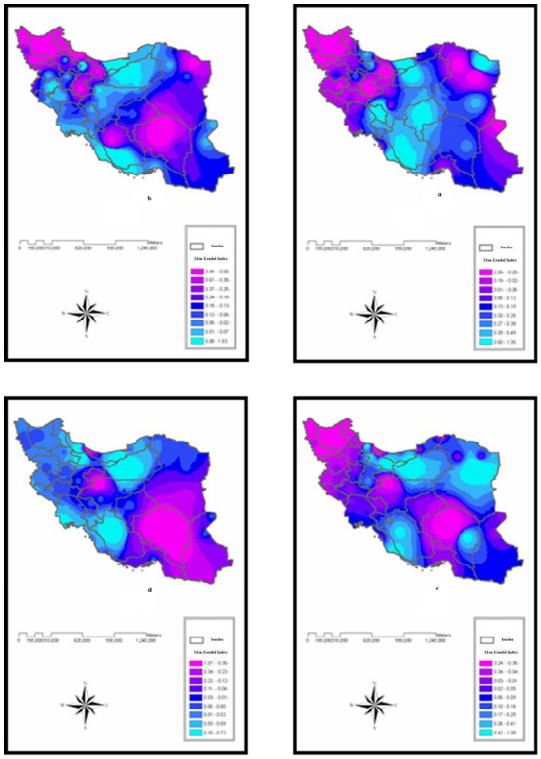

figure.1: spatial distribution in 4 series of precipitation changes in Iran

Precipitation is one of the most important of climatic factors in Iran. Iran receives most of its income in winter. The maximum of wintery precipitation are in north and west parts of Iran.

Consideration in changing in wintery precipitation shows that none of the stations have any changes in this parameter and they just show some increase or decrease leaps (figure.2.a).negative leaps pattern involve north, north west and south east of the country and positive leaps pattern are expanded in north east and south west and some parts of center of Iran.

Entirely it can be understandable that during this statistical period negative leaps of precipitation in winter have north west-south east direction and positive leaps of it have north east -south west direction.Figure.2.b shows that although there is some positive leaps in some parts Best Fit of it shows declining trend.

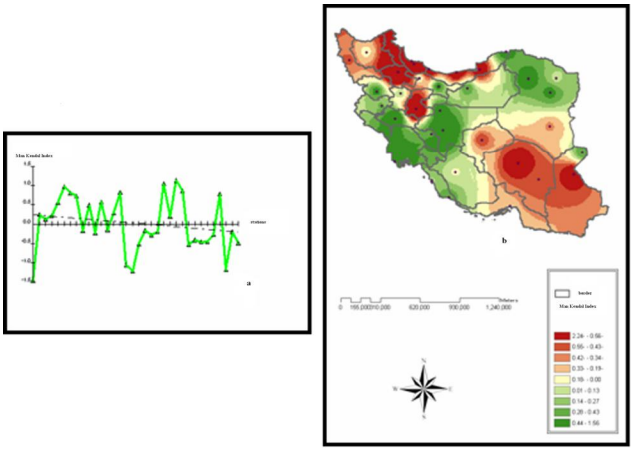

Figure.2: spatial distribution and chart of changing in wintery precipitation

Most of the precipitation in spring is in north and North West of the country and its decline direction is into south and south east.Figure.3.b shows the spring distribution of precipitation. Although the frequency is with negative leaps but its best fit shows the slow trend of increasing in it.Figure.4.a shows the spatial distribution of Man-Kendall index. If this figure compare with changing in wintery precipitation, it will be became distinct that changing in spring precipitation is like to wintery one and north west-south east have negative leaps and north east -south west direction have positive leaps in precipitation.

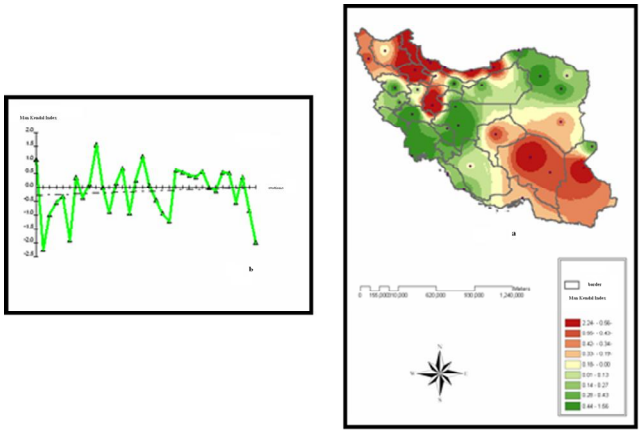

Figure.3: spatial distribution and chart of changing in spring precipitation

2.2. Seasonal and annual changes in temperature

For considering spatial pattern figure.4.a was prepared. This figure shows that the increasing and decreasing trend of changes in minimum of temperature are seen in North West of Iran so that west Azerbaijan show decrease trend and east Azerbaijan and Ardebil show increase trend of minimum of temperature, some parts of north and south of country show some intention to increasing.

During 1996-2005 periods the maximum of temperature in most of stations show increasing changes that in most of them it had increasing trend (figure.4.b). Wherever that shows increasing trend, was separately estimated and graph.4.c was described on their base. So the trend of increasing is defined in stations that are shown in spatial distribution.

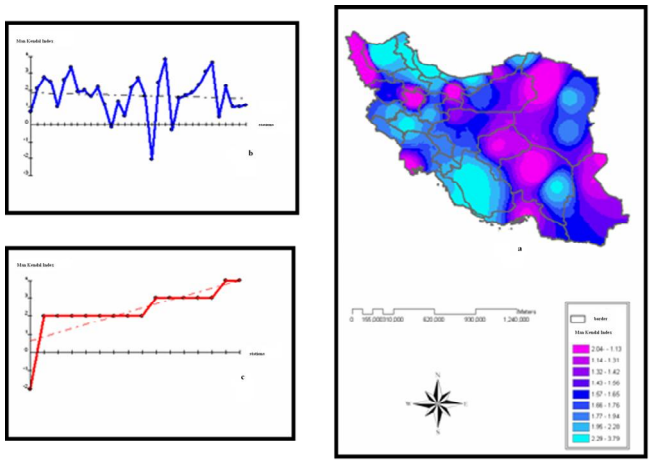

Figure.4: spatial distribution and chart of changing and trend in minimum temperature

The changes of maximum of temperature in most stations show increasing trend and leap. From spatial point of view decreasing leap of maximum of temperature just can see in edge of east and south east of country and other region have increasing leap(figure.5.a).entirely considerations on changes in precipitation and temperature show that the minimum of temperature have increasing trend(figure.5.b).In other word freezing days are decreasing and changing, precipitation are decreasing too and the kind of precipitation is changing from rain to snow because of increasing in minimum temperature and the temperature gradient is toward decreasing.

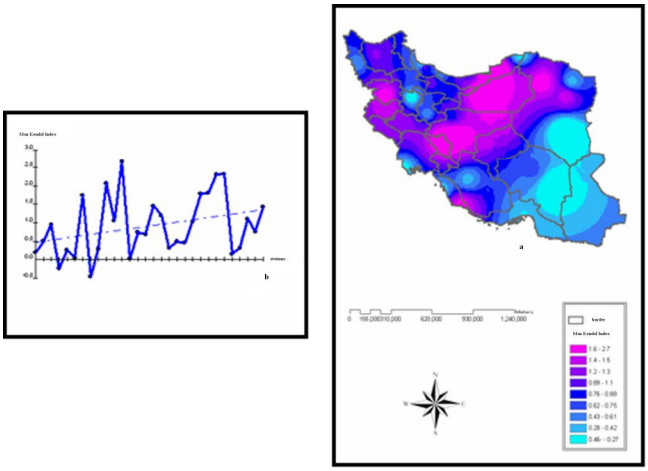

Figure.5: spatial distribution and chart of changing in maximum temperature

2.3. Modeling of changeability of annual and seasonal temperature and precipitation

For modeling of monthly changing in climate between rain layer, maximum and minimum of temperature, changes in precipitation layer, changes in maximum and minimum of temperature, they were spatial corresponded by Cokriging method and each of these layers became changed into a matrix with 45051 records. The result of this consideration was 12 matrixes that each of them is for one of the layers.6 matrixes are related to spring and 6 of them are related to winter. In this part first of all correlation was calculated between layers then the relation among them was described by regression models and the necessary analyst was done.

Because of the importance of climatic changes and the necessity of its restoration for rain layer, changes in it and changes in maximum and minimum of precipitation, the table of spatial cross tab was prepared and joint cells between these 4 layer were extracted and analyzed by regression model as follows:

PC=Y= changes in precipitation

Precipitation = P=X

PC = a+bP

A (constant) and b (slope) were calculated by these formulas:

$b= \sum (Xi- \bar{X}) (Yi- \bar{Y}) / (N-1) S^2x$

$a= \bar{Y}-bX$

Obtained formulas are as follows:

1- First order models, the predict of the changes in precipitation according to precipitation

(Changes in precipitation)PC=-0.436+ (0.001*P)

Because there were just 28 percent of changes in precipitation were justifiable by above model and also the graph of distribution between these two variables was second order and nonlinear, so the second degree model was used for anticipated the rate changes in precipitation according to precipitation.

2- Second order model, the predict of changes in precipitation according to precipitation

(Changes in precipitation)PC=-0.922P^2+0.005P-0.6

3-the anticipation of the changes in precipitation according to maximum and minimum of temperature

For calculating the polynomial regression for anticipation of the changes in precipitation according to maximum and minimum of temperature, changes in precipitation as related variation and maximum and minimum of temperature as independent variation were taken into consideration

(Changes in precipitation) PC= -.891+0.001P+0.313MaxT+0.165MinT

4- The changes in precipitate in spring and winter

The necessary analyst was done and obtained model are as follows:

Y=-0.59-0.01X changes in precipitate in spring

Changes in precipitate in winter Y=-0.382 -0.02X

5-the changes of minimum of temperature in spring and winter

Changes of minimum of temperature in spring Y=-0.797 -0.007X

Changes of minimum of temperature in winter Y=-0.607+0.019X

6--the changes of maximum of temperature in spring and winter

The changes of maximum of temperature in spring Y=-0.782 -0.016X

The changes of maximum of temperature in winter Y=-0.479 -0.04X

3. Study of geomorphologic witnesses of changing in climate in catchement of Uromieh Lake

Uromieh Lake is the biggest permanent lake in Iran that it is salty and the level of it is now 1275 meter above sea level, the area of its catchement is about 52700 square

meters that is equal to 3.21 percent of the area of whole country (Geographic Organization of army forces, Geographic dictionary of rivers of Iran,2001).

Uremia is one of the pluvial lakes of Iran that was created after the last ice age and it is very young (Kehl,*et al*. 2005) so the effects and witnesses around it, are showed the climate changes. Researchers emphasized on the presence of some terraces that their height shows the changes of lake level. For recognizing the rate of changes, the ETM satellite images and DEM of this catchement were used to determine the height of changes in lake level resulting from climate changing. For this purpose the bands No1 to 5 and band No7 of ETM sensor were compounded (Ghohroudi, 2005a). For detecting the level of around of the lake, the increased in contrast method and Histogram Equalization were used. In this method the digital number is determined for showing levels according to frequency of values. Histogram Equalization makes an image with high contrast between bright and dark region. With pay attention to climatic inheritance that researchers gave an opinion according them about ancient border of Uromieh Lake, it was determined with DEM on the satellite image .the figure 6 shows it.

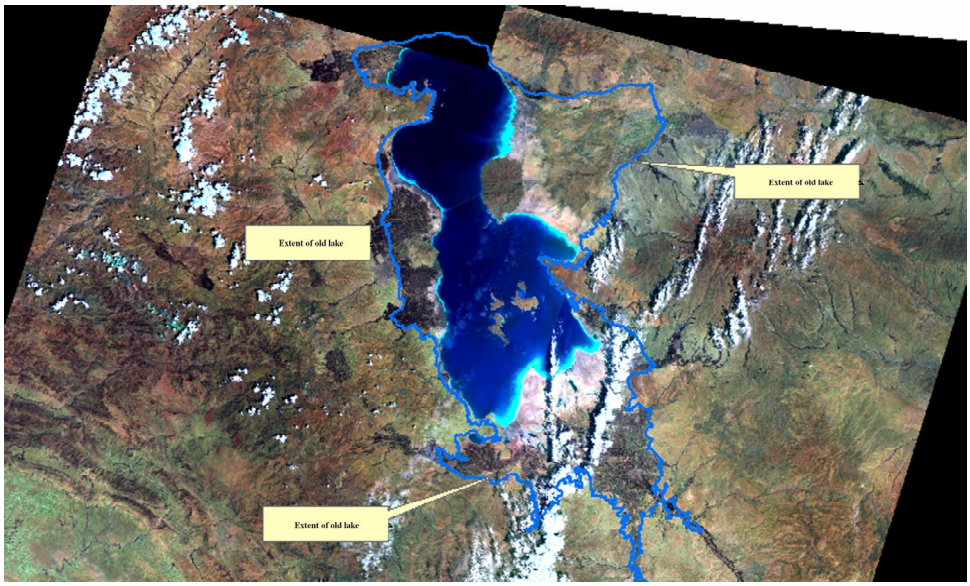

Figure 6: probable extent of Uromieh Lake in late Pliocene

4. Discussion and Conclusion

Climate change is the most important issue in this decade and its dimension involve different part of world so that experts of various fields have studied this phenomenon.

In this study changes in climatic factor in Iran were considered and zoning by Cokriging method. With pay attention to the extent of maximum of changes in climatic factor and zonation of them the spatial cross tab by Geostatistic methods and the changeability of climatic factors was modeling and showed the results of the most leaps for spring and winter. So that increasing leaps of precipitation are in the center parts of country in winter whereas the decreasing leaps are located in south east and west of the country. Lout desert, Kavir desert, Siyah kouh catchments and parts of Gav khoni have increasing leaps in their precipitation whereas parts of Karun, Karkhe, Hamun's Hirmand and jarrahi catchments showed decreasing leaps in their precipitation. The catchments that have decreasing leap in winter are face to increasing leap in spring. Of course some parts in center of Iran that has increasing leap in winter have such this increases in spring. The increasing leaps are more expanded in spring and involved the great parts of Chalus, Talesh, Sefid rood, Talar-Babol rood, Gorgan rood catchments and some parts of Namak Lake and Lout desert. The most expanded changes in this period are related to increasing leaps for minimum of temperature and involve the most of Iran's catchments. Decreasing leaps involve a few regions in Iran. The intentions of increasing in temperature starts from winter to spring and also in it with little spatial changing leaps are increasing in increase of temperature direction. Even some catchments that increasing leaps were not shown the minimum of temperature in winter, were faced to intention of increasing in temperature in spring. But the decreasing leaps in minimum of temperature are shown in small area in Iran. Increasing leaps in maximum of temperature involve the west, center, east and south east of catchments. Simineh rood, Zarineh rood, parts of Sefid rood, Karkhe, Hele, Mond, Hamun's Hirmand, Khaf salt desert, Lout desert and some parts of Central desert were faced to increasing of maximum temperature. This is in the condition that the decreasing leaps are shown just in some small parts of Iran. The expansion of increasing leaps loses their relation in spring and dragged to north west and south east. So that all parts of Uromieh Lake is faced to increasing in temperature and Hamun's Hirmand, Hamun's Moshkil and some parts of east catchments of Iran are faced to increasing leaps of temperature.

Because the importance of precipitation in climate changes and necessity of restoration of this changes, for precipitation layer, changing of it, changing in maximum and minimum of temperature the spatial cross tab was prepared and the

joint cells between 4 above layer were extracted and was analyzed and studied by statistics methods. The models are as follows:

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With notice to obtained models and examined analysis this result obtain that although the seasonal and annually changes are present, the intention of changes in precipitation and temperature are present too so that it can be expect that precipitation have inclination to reduce its presence in winter and more appears in spring and leads its trends of changing from rain to snow. Minimum of temperature has increased tendency and with a little changes this condition is shown in maximum temperature.

The minimum of temperature in most part of Country have increasing leap that in some parts appears to increasing trend. Accepting the increased trend of minimum temperature, can form a new method in management in water sources. In other word it can show this result that the capacity of snow resources is decreasing. Iran is a mountainous country and water sources in most catchments supplied by snow resources in spring and summer .in result the management in water sources must be looking for possibility of saving of spring flood on the other hand the maximum

temperature is shown increasing leap so lost of water will be increased in spring and summer by evaporation. Also decreasing in leap of precipitation is in some region that have more wet climate like north and north west coasts of Iran. In result it can be expected that the surface of lakes will be smaller and because the base level goes down therefore rivers must eroded more to reach to base level then the capacity of sediment in behind the dams will be increased. Rising in temperature can make biologic changing and plant spices will face to increasing in water requirement and the vegetation cover will be decreased so that the penetration of soil will be more less and the capacity of underground water will be decreased and because of changing in type of precipitation so the expectation of destroyed flood will be increased and... Which phenomenon will impose Iran because of increasing temperature? It can be studied from different aspects.

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