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Synoptic Analysis of Drought in Gilan Province (Iran)

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Abstract. Weather aridity is the special feature of regions with low precipitation and high evaporation and it is unique to some particular areas on the Earth. But, drought is a decrease in average annual precipitation. Drought is a common phenomenon in all parts of the world even in wet regions.
Gilan province is the rainiest area in Iran. Average annual precipitation in Gilan province is 1293 mm. most people are farmers and their lives have a close relationship with agriculture, water and precipitation. A decrease in precipitation causes serious damage to people's lives. We can reduce the damage by timely prediction of drought and proper planning as well as good management in using water recourses. There are different methods in predicting drought.
Any climatic phenomenon has a close relationship with pressure systems and their movement. Drought forecast is possible through detecting the relationship between the occurrence of drought and atmospheric synoptic conditions. Analyzing sea level pressure and geopotential height patterns in low and middle layers of atmosphere show that the occurrence of drought in this region follows particular air patterns. In fact, atmosphere synoptic condition has the greatest role in the occurrence of drought in this region.

Keywords: Air patterns, Synoptic Analysis, Geopotential height

1. Introduction

Most of the processes related to the environmental issues (air pollution, quality and quantity of water, draught, flood and etc) are severely under the influence of atmospheric circulations.

According to the definition, synoptic climatology is a science that examines the relationship between atmospheric circulation and environmental conditions of a region. Since synoptic climatology is after assigning substantial interaction among atmosphere layer, it favors theoretical and scientific value among environmental sciences. In synoptic studies there are 2 tendencies which are named tendency of circulatory to the environment and environment to the circulatory. In tendency of circulatory to the environment, researchers make synoptic categories and examine its relation with a region; on the contrary in environment to circulatory, researcher defines patterns of circulation of atmosphere according to particular environmental condition that happens in the layer. In this aspect, researcher makes criteria for entering circulatory data in categorical process according to environmental conditions. Then, synoptic categories are not able to be examined away from environmental response. [1]

Samadi [2] in a study argued that torrential rains of southern coasts of the Caspian sea is based on the location of a deep through in the north east of Europe which continues its axis on Caspian sea and the outgoing of polar cold weather from north across to Caspian sea.

Moradi [3] in a study about forecasting of the occurrence of torrential rains according to synoptic states in southern coast of Caspian sea, come to the conclusion that occurrence of heavy rainfall in the north of the country with index of 500 hp has the power of piles over black sea, east to centre of Europe, east of Mediterranean sea and presence of deep through in the east of the black sea. This through starts around latitude of 70° North and extends towards south, south east at the end of approximately 40 to 50° of south.

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Reason of more rainfalls in fall of southern shores of Caspian Sea especially the southern part in comparison to winter rainfalls is because of less blowing of cold and dry fall winds of Caspian sea's area in comparison to winter winds that as a result fall winds have more time to take humidity and warmness from the sea [4]

Ghodrati and Dadashi [5] studied draught and decrease in rainfall and provided a solution to the problem in Gilan province and came to the conclusion that time resistance of draughts in some of the stations in this province is 3 years old, but in most stations just rainfall indexes cannot make a clear picture of sequence of the draught time .

Fatahi [6] in a project studied synoptic symbols of widespread draught in Shahrekord and with designing compound maps of pressure of the sea level and level of 500 hp clearly delineated different kinds of rain falls and draughts.

Sadeghi and colleagues [7] in a project with the name of analyzing of synoptic of anticyclones over epidemic draught of Khorasan came to the conclusion that 3 synoptic patterns are effective in the occurrence of draught in Khorasan and among them anticyclones have the most influential role in the occurrence of draught. Around 61.6 % of widespread draughts in Khorasan is because of anticyclones actions. Anticyclones make the air descending and destroy or decrease the cause of ascending of humid weather masses and cause the decreasing and disorganized rainfall have environmental, economical and social consequences.

2. Methodology

To determine draught in Gilan province we took advantage of monthly and yearly rainfalls of synoptic and climatology stations of Gilan and other near provinces during 50 years from 1956 to 2005, and occurrence times of draught have been distinguished. Also for studying synoptic condition of atmosphere , daily ,monthly and yearly data related to sea level pressure and geopotential height of different layers of atmosphere were used during alleged times. To determine the relations between draught occurrence in Gilan province and circular patterns of atmosphere ,first time occurrence of draught in Gilan was delineated then environmental patterns of weather condition in indexes of sea and levels of 850,700,500 hp have been made and draught patterns in Gilan province has been recognized.

3. Discussion

Study of precipitation distribution in Gilan shows that, October with average of 205 millimeters is the rainiest month in this province, and then November, September and December are considered as the least rainy month in this province. [8]

Average annual precipitation in this province is 1293 millimetres. Yearly precipitation distribution has varied from 600 millimetres in south east of province to 2100 millimetres in west areas of Anzali lagoon. (Figure 1)

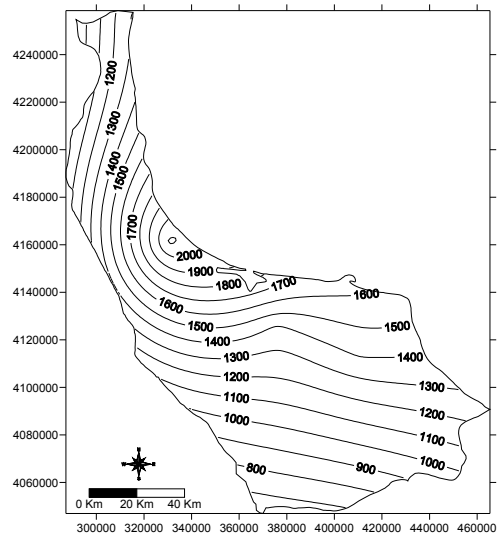

Fig. 1: Annual precipitation distribution in Gilan province.

Study of annual precipitation distribution in Gilan province (Figure 2) shows that in periods of 1956 to 2005, 22 wet years and 26 drought years occurred that of course, intensity of wet years was more than drought years. The rainiest year was 1972 with 1872 millimetres and after it 1982 and 1993 are highlighted. The driest year in this province is 1971 with 911 millimetres, and after it there are 1983 and 1995 respectively.

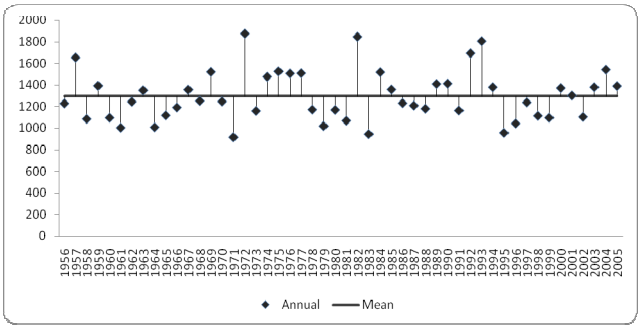

Fig. 2: Average deviation of annual precipitation in Gilan province.

As was stated, in Gilan province, October with the average rainfall of 205 millimeter is the rainiest month and average precipitation circulation of this month is varied from 50 millimeter in south east of Gilan to 350 millimeter in west parts of Anzali lagoon. (Figure 3)

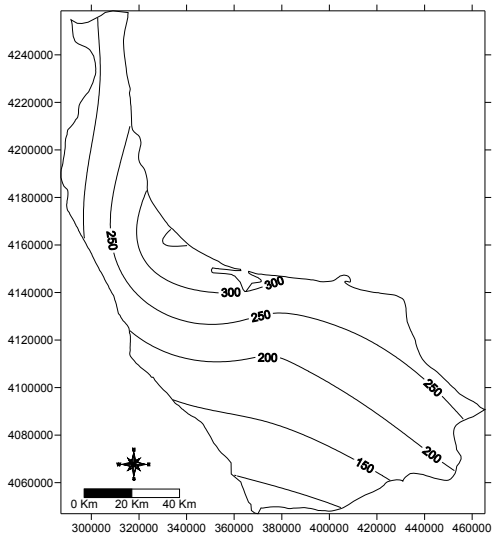

Fig. 3: October Average precipitation in Gilan province.

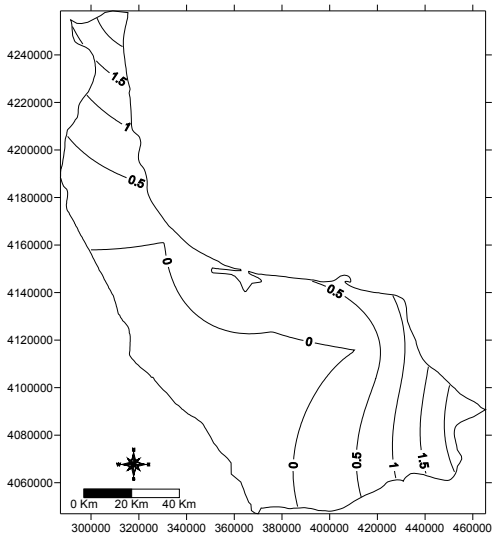

Fig. 4: Distribution of precipitation in October 1974.

In order to study air synoptic status during drought's occurrence in Gilan province, first dry and less rainy months have been recognized especially some months of the year that must have the rainiest time, for example, in 1974 in October with the highest average precipitation, there was no rain. And according to statistics during 50 years, this is the only year that in October there's no precipitation. (Figure 4); on the contrary we must refer to October 1982 with the most precipitation during the intended time and the average precipitation of province in this month was 475 millimetres that was varied from 100 millimetres from south east regions to 1000 millimetres to west regions of Anzali lagoon. (Figure 5)

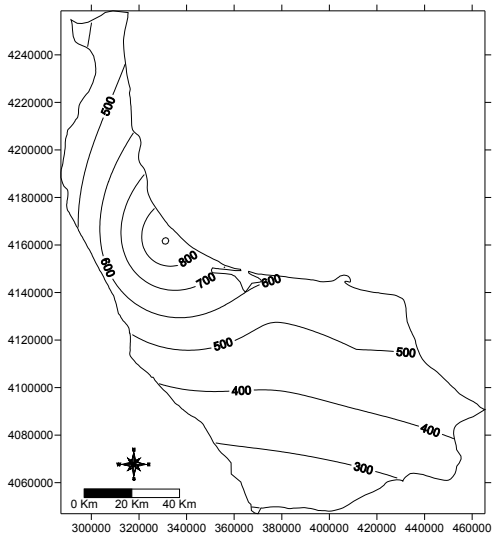

Fig. 5: Distribution of precipitation in October 1982.

For this reason related maps to October 1974 were studied and analyzed and compared with the maps of this month in October 1982 having more precipitation.

Studying map of sea level pressure in October 1974 (Figure 6) showed that in most of the days of this month, a high pressure centre with the core pressure of 1026 hp is located over Caspian Sea and its northern cost and effects of this high pressure center are widespread over south coast of Caspian Sea and all over Gilan.

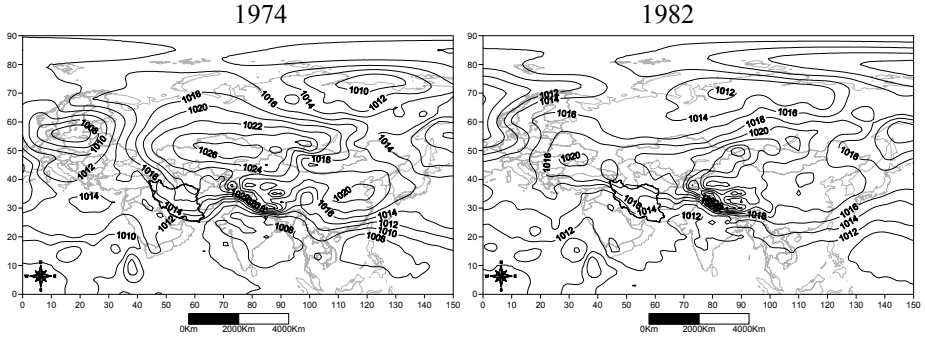

Fig. 6: Sea level pressure Patterns in October 1974 & 1982.

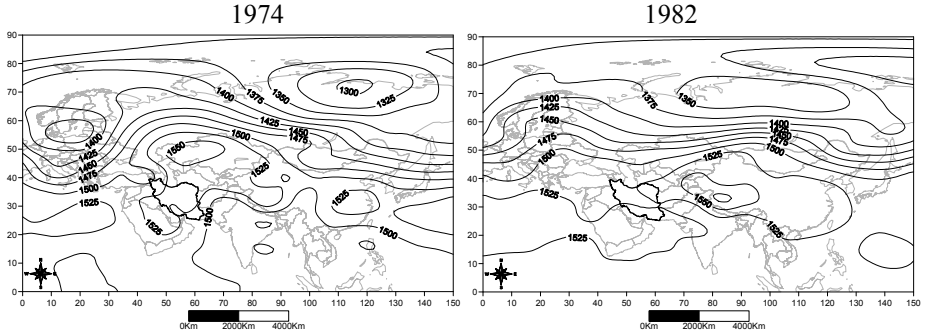

Fig. 7: 850 hp geopotential height Patterns in October 1974 & 1982.

However, study of sea level pressure pattern in October 1982 shows that, at this time Caspian Sea and its South coast's are among 2 high pressure centers which are located over Eastern Europe and Central Asia and more affected from low pressure center of pole that its effects are widespread over Caspian Sea and pressure rate over this Sea decreased to 1018 hp. In fact, in October 1974 location of a high pressure center over Caspian Sea prohibited air elevation and this static air did not have any precipitation. But in October 1982 decrease in pressure of this region caused air elevation and precipitation.

Study of air patterns in 850 hp (Figure 7) shows that at this air layer in October 1974 a high altitude center with height of geopotential of 1550 meter is located over Caspian Sea and its effects covered all Southern coast of Caspian Sea in Gilan, however in this layer in October 1982, the presence of Southern shallow deep down can be seen and parallel lines with the same altitude in this layer are a sign for blowing of Western winds in this layer.

The most obvious difference in intermediate layers is in 500 and 700 hp (Figure 10 and 11). In these 2 layers in October 1974 location of high altitude center has been seen. At this time, at these 2 layers the presence of high Mediterranean altitude can be seen. The presence of this pattern at this time causes decrease and relative calm of air on the ground and this causes prevention of raining, but in October 1982 the location of high through of near pole over Caspian Sea and its South coast can be seen. The movement of air in this through and especially air elevation in this system cause precipitation in this area.

4. Conclusion

Evaluations of such studies shows that the occurrence of draught in Gilan province has a close relation with sea level pressure and lower and intermediate layers of atmosphere so that the location of high pressure in air over Caspian Sea level and also location of high altitude center in lower and intermediate layers cause air stagnation and the prevention of elevation. This phenomenon both causes dry air with no precipitation and draught in the region. If a high pressure center is created over the sea level and in intermediate layers of atmosphere, the effects of high West through are established, the air of sea level will be elevated and substantial rain is caused.

Studies show that in October 1974 a deep down over Caspian Sea and its surrounding region is made among intermediate layers of atmosphere. The presence of this air pattern causes descending of air into ground and consequently causes stability and stagnation of air. The result of this phenomenon is dry weather and no rain. But in most of the October's times of 1982 a deep down over Caspian Sea's area and its surroundings at intermediate layers of atmosphere is established .The Location of this pattern causes air elevation and unstable weather and precipitation. It should be noted that at this time because of warm weather before that; there was enough humidity for rainfall.

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