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Reviews of the Synoptic Patterns of the Most Severe Droughts, Watershed of Urumiyeh Lake

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Abstract:

Drought is a natural disaster that gives a lot of damage every year. This phenomenon occurs as a consequence of high and repeated temporal and spatial anomalies in the atmospheric circulation patterns. Therefore, it is inevitable to study and identify synoptic patterns of the mentioned phenomenon. In this study we have considered the standard time of the annual rainfall of the selected stations of Urumiyeh Lake watershed. 1999 has been established as the pre-determined threshold of the time - spatial precipitation, as being the year of the worst drought at regional level. Then the elevation data, the level of 500 hPa located at the limit between 0 to 70 degrees North latitude and 10 to 70 degrees Eastern longitude is set as a matrix mode S-mode for days of without precipitation. In order to identify and classify the synoptic patterns of drought there were used the Statistical Component Analysis and Cluster Analysis of Advanced Materials, while the Synoptic Analysis was used to prepare composite maps for each cluster. The results show that the event of a most severe drought in the watershed area has had an impact on all four synoptic patterns.

Key words: drought, factor analysis, clustering, ridges and trough, watershed of Urumiyeh Lake

Introduction

Weather is an important aspect of human life that is well known for its effects on human activities. Climatic fluctuations, as drought, are a natural disaster, which take place from time to time, in different regions, and bring great losses in economic, social, political and environmental terms.

Defined according to the agency of environmental studies in Europe, drought is a situation that can happen and repeat in various regions, dependent on each and every seasonal rainfall (Hags and Saunders 2002, 1572). From the viewpoint of climatology, when rains get in a place in a given time period to a lesser extent than the long-term average precipitation, we are faced with drought. Therefore, the threshold quantity of drought in geographic areas varies in terms of temporal and spatial scales (Bhalme and Mooley 1980, 1198).

Iran, in comparison with other countries, due to a variety of environmental conditions has a high ranking in crisis caused by natural disasters. Therefore, of the 40 types of natural disasters around the world, 31 occur in Iran (Mirzakhani 2000, 8). Based on the FAO report, Iran is ranked tenth in the world due to potential natural disasters rise (Shen 2003, 11). Due to the special geographic position, the topography and drainage basin of Lake Urumiyeh, and the fact that one of the main populated areas and one of the poles of strategic crop farming is in the northwest of the country, certain problems result from lack of rain. Since all droughts start with little rain, some analyses of climatic drought as related to precipitation are found in the Synoptic analysis methods. The purpose of this study is the identification and classification of the synoptic pattern of days without rain and with most severe drought, using factor analysis and cluster analysis, thus contributing towards mitigating the effects of drought decision makers.

Materials and Methods

Annual rainfall raw data, the daily pressure surface of Urumiyeh Lake watershed in selected stations, and the statistical distance of 30 years (1976-2005) were obtained from the Meteorology Organization. There was taken into account the distribution of selected stations in the basin, so that they have a long-term statistics, as well as a uniform distribution so that we could have a complete coverage of the entire area.

Table 1: Characteristics of selected meteorological stations located in the catchment area of Lake Urumiyeh

Station	Type	latitude	Longitude	Elevation from sea level	Period
Urumiyeh	Synoptic	N ´ 33°37	E ´ 05°45	1313 M	1976-2005
Saghez	Synoptic	N ´ 14°36	E ´ 16°46	1523 M	1976-2005
Tabriz	Synoptic	N ´ 05°38	E ´ 17°46	1361M	1976-2005
Miyandoab	Synoptic	N ´ 58°36	E ´ 06°46	1314M	1976-2005

Daily surface pressure data, data of 500 hPa on a daily level, days without rain and most severe drought at regional level (1999) in the range 0-70 degrees North latitude and 10-70 degrees east longitude (including 247 points of intersection or elevation) were selected from the website / NCER NCEP. The choice has been made due to the occurrence of the greatest revolutions of 500 hPa in atmospheric level and direct control of environmental conditions by mentioned surface pressure. Moreover, the choice of the mentioned geographical network is also due to the possibility of full self levels of atmospheric synoptic systems, which have caused the most severe drought in the Urumiyeh Lake basin. We used data from the NCEP / NCAR study due to their high accuracy and consistency (Nieto et al. 2004, 372) and because they are widely used by researchers in climatology ((Karl et al. 1982, 1185; Esteban et al. 2005, 321). The data examining changes in surface conditions have been particularly useful in the study of climatic phenomena. However, for more reliable data, daily press station addresses and data reconstitution have been calibrated. After collecting the data and selecting the most severe drought area using the standard score, set elevation data matrix, factor analysis and hierarchical clustering technique were used to classify synoptic patterns influencing the most severe drought in the catchment of Lake Urumiyeh.

In summary, in this study, the factor analysis formula has been based on 247 variables of six factors and can be written as follows:

$$Y_i = \mu_i + \lambda_{i1}F_1 + \lambda_{i2}F_2 + \ldots + \lambda_{i13}F_{13} + e_i \qquad i = 1,2,\ldots,247$$

Where it is assumed that $e_i \approx N(0, \sigma_i^2)$

$Y_i =$ Height, 500 hPa level variables (cross) I

μ_i =Average height of 500 HP intersections I, for 33 days without precipitation

. λ_{ij} = Correlation coefficient the cross i, with factor j

F_j = Factors affecting on variables

e_i = The error terms are assumed to be from each other and from factors existing independently (Farshadfar 2003, 461).

In general, the identification and classification of synoptic patterns were the following: In the first stage of the research, we used the appropriate climatology data, in the form of a widget (button), multiple locations (network convergence NCEP) and frequency (days without precipitation); the second step we have taken into account the matrix data by considering the case of S, or S-mode. Thus, in the matrix of the data, we have used the size of 33 rows (days without precipitation) in the column or variable 247 (500 hPa level). The third step was to calculate the correlation matrix of the data. The outcome of this process was providing a matrix of correlation among coefficients or establishing a variance - covariance between variables.

The correlation matrix, or the covariance is calculated through the following formula:

$$CO_{xy} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N}$$

Before conducting validation, factor analysis was tested by calculating the determinant of the coefficients correlation between the variables and criteria as to Kaiser - Meyer – Olkin (KMO). The fourth step involves the calculation - the matrix load items and the selected factors. In the fifth step we determined the level of 500 hPa synoptic patterns, based on seven factors obtained from factor analysis method.

Discussion

Overall, the results based on the annual rainfall statistics for selected stations of the study area, and calculated at the standard score (Z-Score) time for each station, show that the year 1999 experienced the most severe drought. After setting the data, the value of the statistic $KMO \geq 0.9$ and the output of the correlation matrix, the determinant is equal to zero factor analysis and it is the most suitable .By applying factor analysis on the covariance matrix of elevation data from elevation 500 HP 1999 days without rain, the first five factors were extracted in total, and 94 / 8% of the total data variance was explained. However, with regard to the first factor, this could explain only about 59% of the total variance in the data, and an overview of the extracted correlation matrix also shows the lack of correlation between them, as well as being independent from each other .

Table 2: The total amount of variance explained by each factor

Factor	Initial value		
	Total variance	Percent of variance	The cumulative percentage of variance
1	145/4	58/87	58/87
2	31/4	12/72	71/59
3	27	10/92	82/51
4	22/8	9/23	91/74
5	7/6	3/07	94/81
6	3/9	1/59	96/4

After mapping, each cluster was composed of the following four patterns:

The first pattern: At the 500 hPa level, the prevailing synoptic conditions are on the composite map, in such a way that the first two strong ridges, along the north-west - south-east, the north-eastern Europe and northern West Siberia, have been established, while the other is along the north - south, north of the Black Sea, to the south of the Arabian peninsula. Lake watershed has been affected because the stack falls, the cold high latitude, and the region, the establishment of such conditions on the region causing weather sustainability.

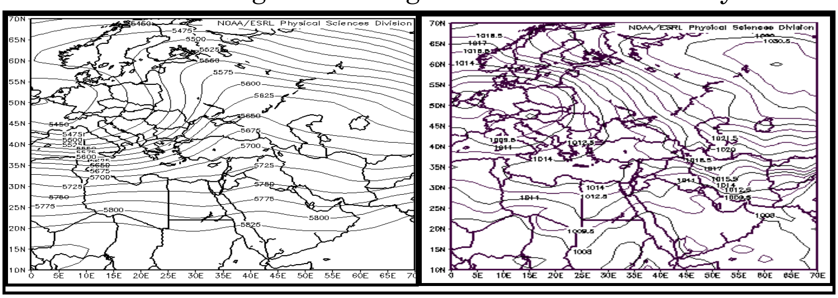

Figure: Map pattern comprising a first surface (right) at the level of 500 hPa (left)

The ground level and the Siberian high-pressure system are the dominant systems in this model. Synoptic conditions prevailing in this model, such as the rotating cell pack hp 1009, has applied all over Europe. So, depending on cell pressure and central pressure of 1030 hPa, thermal Siberia with central Russia, located on the western pressure tabs, has extended influence to Northern Europe. These conditions are prevented from spreading to the Middle East, Europe and the rest of the planet. One can observe that the southern Siberian high-pressure tabs have moved towards a more southern latitude, southern Kazakhstan and the Aral Sea, after crossing into Afghanistan, into Khorasan and then into the West and Central province. The pressure causing loss of cold air over these areas affect the weather conditions and durability.

The second pattern: At the 500 hPa level, the center of geopotential height of 5900 meters is covered, across the South and South-West and North-West of the country and around the Arabian Peninsula and the Persian Gulf and South East Iraq. Synoptic conditions prevailing in this model, suggests that the migratory pressure from Europe is covered with four to five closed cells and a central pressure of 1020 hPa, in the whole of Europe. One can notice the tabs along the southern anticyclone North - South, all within less than 10 degrees to the Sahara Desert; on the other hand, the tabs have moved to the top of the low pressure Sudan, but given the southeastern tab, the migratory pressure, after crossing Turkey, has moved towards the North West Iran, and the situation is prevented from entering the low pressure Sudan to the North West. The result is a loss of cold air across the top on these areas, and it affects air stability.

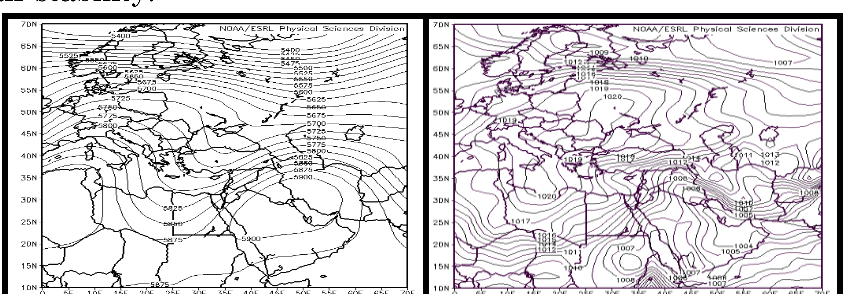

Figure 2: Map of the composite pattern on the surface (right), and the level of 500 hPa (left)

The third pattern: The level of 500 hPa shows that the synoptic conditions prevailing in the cluster spin have spread from northern Europe to within 50 degrees. This is considered stack located along the north – south of Turkey-Iraq, which has been affected the North West of Iran, too. This stack is prevented from entering the high-latitude cyclone on Iran and the situation has caused loss of cold air on land and in air on the mentioned watershed. At ground level, the dominant system in this model is a high-pressure system, migrant from Europe. In terms of the prevailing synoptic pattern, it shows a spin center, with a central pressure of 1002 hPa, and is located along the east – west of the Gulf of Butene and Finland tabs. The center of the spin is located in and along the East - West, North, Central, and East Europe; the center of the spin has no influence on Iran. On the other hand the anticyclone has been closed with four to five cells and a central pressure of 1024 hPa, on the North-East of Turkey, east of the anticyclonic center tab, after crossing the Caspian Sea in Azerbaijan and the North West into the watershed, this situation being due to the pour cold weather in the North West and air stability.

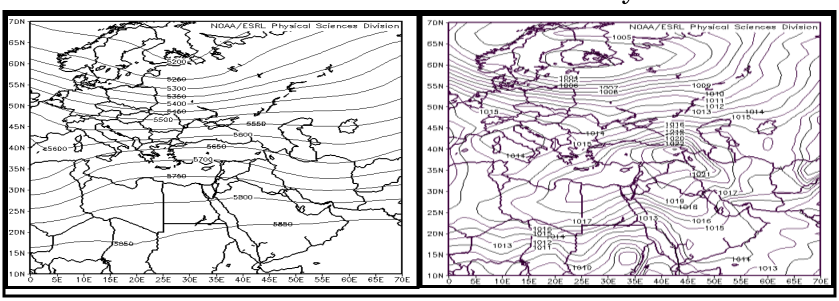

Figure 3: Composite Map of the third model, the surface (right) and at the level of 500 hPa (left)

The fourth pattern: The level of 500 hPa, the synoptic conditions, and the composite map of the cluster, suggest that the center of the low - high altitude, with a central pressure of 5350, potential geo-and four-cell pack under its control, has, of all Europe, the axis moved south. the anticyclone, the width of the bottom, causing the meter in the East has led to the creation of a strong ridge that stretches from the North - South desert of Siberia, to the North of the Arabian Peninsula. It can be seen that all Iran, especially in the North-West and West of the country, has been affected by the stack of these conditions, which will result in the creation of stable weather and lack of rainfall in the study area. At ground level the dominant system in this model is a high-pressure system in Saudi Arabia. So the spin, the center line the pressure of 1008 hPa is located in Italy, France and North West Mediterranean area. The thermal pressure in Siberia too, has affected all the Siberian desert. It can be seen that the Arabian anticyclone, with a central pressure of 1018 hPa, located on the the Arabian Peninsula, and the tabs to the top establish the conditions that prevent the entering of the cyclone from Europe to Iran and the watershed resulting in a stable dry air dominating on the West and North West of Iran.

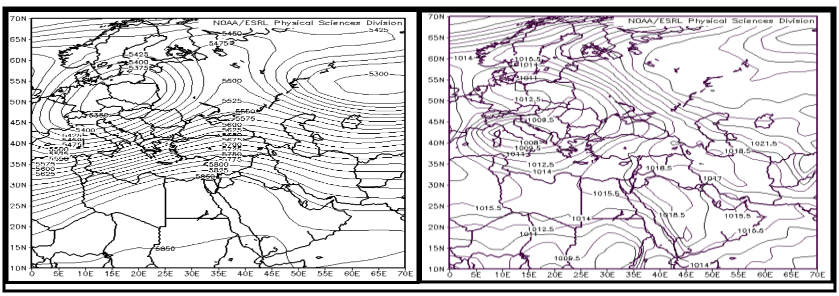

Figure 4: Map of compound IV pattern, at ground level (right) and at the level of 500 hPa (left)

Suggestions

After identifying the four synoptic patterns at the level of 500 hPa effective severe drought at the lake watershed, in order to manage and reduce damaging severe droughts, it is suggested that the relevant experts should base on the synoptic patterns identified to design an early warning system related to drought at the level of the catchment basin of Urumiyeh Lake and thus to be able to forecast and establish preventive measures.

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