The Role of Subtropical Jet-Stream in Daily Precipitation More Than 10 mm in Zayanderood Basin

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Introduction

Zayanderood basin is one of the major internal river basins in the central Iran, where Zayanderood River is the only permanent river. Fluctuations in rainfall in recent years have affected different areas of Iran. Because of the dependence of the provinces of Isfahan, Yazd, and Kerman on water resources of this basin, changes and fluctuations in precipitation within this watershed have had many social and economic consequences with bad outcomes in regional, national and international dimensions. Therefore, knowledge of mechanisms governing the procurement and availability of water resources in the basin can be helpful to develop strategies to deal with social and economic stresses. This can happen with more confidence, planning and proper management of water resources in the basin.

Due to the importance of rainfall as a component of water supply in arid countries such as Iran, much research effort has been focused on understanding the rainfall mechanisms and its adverse effects. Among researches conducted in this field, we can note Moradi (1996: 54), J. cream (1999: 130), Nasir Ghaemi (1999: 184), J. and Zulfikar (2005: 234), B. et al (2012: 85), and Light and Ayldrmy (2012: 197). This study aimed at identifying the synoptic patterns of precipitation of more than 10 mm as an effective kind of rainfall to provide water supply and understand the origin and characteristics of precipitation patterns contributing to more rainfall. This would lead to a better planning process that could facilitate the optimal utilization of water resources in this basin.

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Materials and Methods

The research method is an inductive and synoptic method on environmental circulation. The daily rainfall data were obtained from synoptic, climatological and rain gauge stations in the watershed basin within the period of 1987-2011. The days during which at least two stations had more than 10 mm of rainfall were recorded and extracted and then the daily precipitation values in the basin stations were grouped. Finally, the days were up to 266. The data file maps of geopotential heights at 1000, 500 and 300 mb levels and orbital wind (U-wind) data from were extracted. After storing the data within the time period, theywere taken and sorted to be processed by Excel using writing macros. It should be mentioned that the digital data were produced for mapping in the form of latitude X, longitude Y, and Z geopotential heights for 365 or 366 days per year. The advantage of this method, compared to other methods, was that during 365 days of one year, length, width and related components could be available as a kind of Excel file. The data were filtered in the study day for each year. Thus, based on daily precipitation of more than 10 mm in the basin, data maps of 266 days were prepared. For the purpose of getting the weather patterns, the **S** method along with Synoptic and Principal Components Analysis (PCA) without rotation was used for classification. As the last step, cluster analysis with Ward method was carried out on factor loadings and 266 days were classified into 4 groups. The Ward method was used for the determination of the clusters and the Squared Euclidean Distance was used to determine the distance between clusters.

Results and Discussion

Based on the results of Principal Component Analysis, 266 days in a year were summarized in 9 factors. The first factor alone would explain 38.1 percent of variation in the data and a total of 3 factors could explain 86.1 percent of variation in the data. Therefore, by dividing the days into four groups, the maximum correlations within the group and the highest diffraction between groups were obtained. Thus, these four patterns of rainfall were found to cause river basin rainfall of more than 10 mm.

Pattern 1: Dept trough Siberian - Eastern Mediterranean Sea; the geopotential height maps at 500 mb load in pattern 1 showed a curved trough in North- East, South West, which had been stuck on the Black Sea and East Mediterranean. According to this model, Zayanderood basin was located in the Eastern side of the trough. This process led to the ascent of air over Zayanderood basin and the occurrence of rainfall in the region. In this model, Zayanderood basin was placed on the left of the air rising in the east-west of the axis of Jetstream and associated with the creation of precipitation.

Pattern 2: Mediterranean pattern; This model could explain (21.4%) conditions in the upper, middle and ground surface levels of the atmosphere for the occurrence of precipitation of more than ten millimeters in Zayanderood basin. In other words, the typical pattern of occurrence of this precipitation belongs to the Mediterranean pattern. In this model, the alignment of Jetstream with little curving to north-east was located between the Red Sea and Persian Gulf towards the center-left output of Jet stream axis. This influences air advection ascent on the East axis of Western wind wave. The location of trough axis in the central Mediterranean Sea was associated with the core center position of subtropical Jetstream.

Pattern 3: Red Sea - Black Sea trough pattern; the average holding position of the trough on this model was located on the Red Sea and the average holding position of Jetstream was located between the Black Sea and the Persian Gulf on the Arabian Peninsula. Adaptation of the left output to axis Jetstream on air advection ascent in the East-West axis wind led to increased instability of waves and heavy precipitation in this model. The most typical pattern was the Sudanese form in this pattern.

Pattern 4: Trough of Turkey – Red Sea; on the map with the height of 500 mb, we observed that a trough was located on the Turkey – Red Sea in the West of Iran. This was converted to the stack in the more northern latitudes of Russia. The transition region from the trough to stack was located in the North West of Caspian Sea. A very low core speed at the level of 200 mb was obvious above this area.

Conclusion

The subtropical jet-Stream on daily precipitation of more than 10 mm and more than ten mm affected the water supply in Zayanderood basin. These were analyzed to come to a good understanding of the effective systems of this precipitation. By using Factor Component Analysis and hierarchical clustering techniques, daily maps with precipitation of more than ten mm were classified into four patterns in Zayanderood basin. Our study indicated that East Europe with trough East Mediterranean and the Red Sea had comparatively heavier precipitation in the basin. Furthermore, the location of the center of the low height in 1000 mb level played a key role in the suction of Mediterranean and Red Sea moisture to low pressure systems of precipitation. On the other hand, the core position of subtropical Jet-stream in the creation of the ten mm rainfall was very effective in Zayanderood basin. This was especially the case when Subtropical jet stream core speed coincided with the core speed of the polar front Jet-stream. In this situation, it was found to have more influence on the creation of an effective rainfall. All models, as determined by means of maps, showed that overlaying of the left output of subtropical jet stream core on the upwelling of westerly winds wave in the left position of trough was very effective in increasing positive vortices and intensifying instability. Our review also revealed that compliance of the trough axis with the mid-latitude trough in the Western Iran was more important in enhancement and creation of instability and precipitation in comparison to the adaptation level of 500 mb of synoptic conditions with the surface pressure. Other results also showed that the influence of the mid-latitude trough was associated with subtropical jet stream. This can lead to the establishment, development and expansion of the low pressure of Red Sea. Strengthening of the subtropical jet in the Red Sea was mainly because of the influence of mid-latitude trough in the East Mediterranean. These factors could increase the pressure gradient over the region.

Keywords: factor analysis, precipitation, subtropical jet-stream, Zayanderood Basin.