Atmospheric Patterns of Heavy and Widespread Rainfall in South Khorasan

Reza Doostan [1]
Assistant Professor of Climatology, Ferdowsi University of Mashhad, Mashhad, Iran

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Extended Abstract

1. Introduction

Iran plateau is located in the desert belt of the earth. The height and elongation of latitude results in weather diversity dominated by dry and semi-dry climates. Rainfall anomalies are an inherent feature of these climates. Humid air masses commonly reach Iran from the Mediterranean, Persian Gulf – Oman, the Black Sea and the Caspian Sea. A major part of rainfalls occurred upon entry and in west, south west, and North West of Iran in Zagros and Alborz heights; meanwhile, east of Iran witnesses reduced humidity in these masses. The positioning form of atmospheric patterns at 500 hectopascal level majorly determines Eastern Mediterranean trough and the path and pace of air mass. Meridian movement and deepening of western winds conflicting with various humidity sources leads to heavy rainfalls and flooding. Naturally, the form of atmospheric patterns of rainfalls in Iran is diverse. Discovering this atmospheric pattern is essential for predicting flooding caused by rainfall as well as planning and risk management. What is this pattern in the east of Iran plateau (South Khorasan Province)?

2. Review of Literatureand Theoretical Framework

Researchers working in the area of climatology are interested in synoptic studies, recognizing atmospheric patterns, and determining pattern behavior and its consequences; because it leads to the position and natural performance of western winds' meridian pattern, low pressure, position of polar jet, subtropical and high pressure, and heavy rainfall. Including in Sweden (Hellstorm, 2005), Greece (Houssos & Bartzokas, 2006), Brazil (Teixeira &Satyamurty, 2007; Oliviera et al., 2017), Mediterranean (Toreti et al., 2010, 2015; Dayan et al., 2015), Indian Peninsula (Nepal) (Bohlinger et al., 2017), Britain (Champion et al., 2018), Western USA (Zahang & Villarini, 2019), Iran (Mohammadi & Masoudian, 2010), (Asakareh et al., 2012; Baghideh et al., 2012; Mostafaei et al., 2015), Chaharmahal and Bakhtiari, Iran (Omidvar and Torki, 2012), Caspian shores of Iran (Halabian & Hosseinali Pourjezi, 2014; Jalali, 2017), Persian Gulf (Ahmadi & Alijani, 2014), Western Iran (Saeidabadi et al., 2015; Mozaffari and Shafiei, 2017) UrmiaLake (Tahaei et al., 2016), Central Zagros (Doostan et al., 2016), and Western Caspian (Halabian, 2016). The climate of South Khorasan with its heights in the north and east and lowlands in south and west is warm, dry, cold, and dry. Heavy rainfalls, floods, and drought are the inherent features of these climate. The purpose of this

1. Corresponding author. E-mail: doostan@um.ac.ir

study is to recognize the atmospheric pattern that leads to heavy rainfalls in this region.

3. Method

To identify the atmospheric patterns of heavy rainfalls in South Khorasan, daily precipitation records of 6 synoptic stations (1987-2018) were used from Iran Meteorological Organization. After qualitative control and data correction, heavy rainfall was defined with an index of 95^{th} percentile and at the same time, synoptic heavy rainfall was defined in 3 stations and higher. The studied numeral window involved 10-70 degrees north and 10-80 degrees east with 725 grade point (29× 25). To indicate atmospheric patterns and conduct synoptic analysis, geo-potential height data at 500 millibar level was selected. Atmospheric patterns were specified using main component analysis method, S array, and clustering). Next, to analyze and adhere to the principle of air package as a whole, map of geo-potential height meter levels of 500, 700, and 850 and sea level pressure (SLP), relative vorticity (10^{-5}), relative humidity (%), flow lines, vector winds in atmospheric layers of 700, 500, 850, 700, 100 and sea level pressure (SLP) were drawn and analyzed.

4. Results and Discussion

Mediterranean Blocking Pattern: located in the meridian movement of western winds, omega blocking in central Mediterranean and cut-off low in Western Siberia and low pressure (1012 mb) in Eastern Iran and South Khorasan and south high pressure in Europe to Western Iran. Humid currents with north directions at Eastern Mediterranean enter Iran by passing over Iraq and Persian Gulf directed towards west and south west.

Trough Pattern of Iran: located in strong cut-off low (5550m) with meridian movement in Central Europe and same height of 5715 meters in the region and simultaneous low pressure (1011 mb) in Eastern Iran and high pressure in higher latitude from Siberia to Europe. At 850 millibar level, cyclone is located in the anticyclone region in Africa, Saudi Arabia, and Oman.

Low Pattern: with the movement of western winds, shallow trough in Central and Eastern Iran are in front of the trough with a height of 5640 meters. They are located in low pressure earth surface on the region (1011mb) and high pressure in Anatolia and Siberia. At 850 level, strong anticyclone currents are present in Northern Africa and Northern India and cyclone in Eastern Iran and Turkmenistan. In general (table 3) atmospheric conditions of heavy rainfall day in South Khorasan is low height (5760, 5700 and 5640 m) and low pressure (1012, 1011 and 1011 mb) in earth surface and weather instability. The direction of most winds are from south west to north east and humid current direction is from Persian Gulf and Oman Sea to the region, and the role of these two seas is obvious in heavy rainfalls of Eastern Iran.

5. Conclusion

Heavy rainfalls of Eastern Iran are related to meridian movement and deep trough of western winds in Eastern Mediterranean. Rainfalls occur as central Mediterranean

blocking and Eastern Europe- Western Russia cut-off low and shallow trough in Central and Eastern Iran take place. Cyclones reach Iran with average pressure of 1011 millibars with the humid Mediterranean current and cyclone movement with a direction more south of Persian Gulf and Oman Sea. These two sources of humidity (Persian Gulf and Oman Sea) play a more significant role in heavy rainfalls of Southern Khorasan, as can be seen in previous studies (Golkar & Mohammadi, 2013). On the other hand, the heights of Eastern Iran with north western- south eastern direction play a role in intensification of mass ascension and precipitation conditions, because the focus of heavy rainfall of over 18 mm is most on high regions in Ghaen, Birjand, and Ferdows. When rainfalls occur, low pressure of dominant pattern in South Western Asia and high pressure of Siberia are weaker. The most intense rainfalls take place in spring and late winter in March and February with the second and third patterns. These flood causing rainfalls require management. Farmers in the past used traditional (experience) method by cultivating bandsari and creating local dams around rivers to control a part of these floods and carried out spring cultivation in the flooded lands.

Keywords: Atmospheric Pattern, Heavy Rainfall, 95 Percentile, South Khorasan

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