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ASSESSMENT AND MONITORING OF NATURAL ATMOSPHERIC HAZARDS (HEAVY RAINFALL) IN THE CITIES OF NORTHWESTERN IRAN USING SATELLITE DATA

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Abstract: Natural hazards are involved in various factors and circumstances, including natural hazards such as heavy rainfall and floods. Various factors and situations are involved in the occurrence of natural hazards. These natural hazards include heavy rainfall and floods. In the present study, in order to evaluate the synoptic conditions for the occurrence of flood-induced rainfall in Khalkhal city, in Ardabil province, first the statistical data of 34 year rainfall was used from 1987- 2020. The most rainfall occurred in date 1991.09.12. The synoptic atmospheric maps of this date at the level of 500 mbar including sea level pressure map, geopotential elevation, wind speed and direction, humidity, temperature, surface rainfall and blocking (omega), using satellite imagery received and reviewed from the NCEP/NCAR database of the US National Oceanic and Atmospheric Administration. In this research, Environmental approach to Circulation method was used. Based on the results of the present research in the study of atmospheric synoptic maps showed that in addition to atmospheric and terrestrial conditions effective in causing heavy rainfall in the study date, the internal situation with an external pattern such as the surrounding seas and neighboring Iran such as the Black Sea and the Mediterranean has had an impact. The amount of monthly rainfall of Khalkhal station as a region in the south of Ardabil province and southwest of the Caspian Sea, with more rainfall in the three months of spring including March (1321.8 mm), April (1716.7 mm) and May (1448.5 mm). The highest natural atmospheric hazards due to heavy rains and floods in the study area were urban, rural, riversides and agricultural damages in the mentioned months. The maximum and minimum rainfall are 51 and 4.5 kg/m^2, respectively, but in the study area, the curve shows the number 20 kg/m^2 and this indicates the formation of super heavy rainfall. The observable temperature values with Kelvin criterion in the study area were significant, the maximum and minimum values are 265 and 245 degrees Kelvin, respectively.

Keywords: Flood, Heavy rainfall, Iran, Monitoring, Natural hazards, Synoptic assessment.

1. INTRODUCTION

One of the natural disasters that causes the most damage is heavy rainfall. Northeast of Iran is sometimes affected by heavy rains and eventually leads to floods and subsequent financial and even loss of life (Ahmadi & Alijani, 2014; Ahmadi & Jafari, 2015; Ahmadian & Shabankari, 2015; Ahmadizadeh et al., 2016). Heavy rainfall is rainfall in which the total daily rainfall is more than 15 mm (Hamdianpour et al., 2010; Masoudian et al., 2014; Javadi et al., 2014). Rainfall is one of the most irregular climatic elements of semi-arid regions, especially special conditions of its occurrence and especially heavy rainfall that often leads to floods (Golkar & Mohammadi, 2014; Masoudian et al., 2014). Perhaps the importance of climate in human life has never been more important in macroeconomic issues than it is today, and even now many macroeconomic decision makers are not very familiar with the impact of this issue (Ataie et al., 2015; Barati et al., 2015; Dostkamian & Yousefizadeh 2015). At present, many experts on political, economic, social and environmental issues raise and predict climate change as one of the most complex and influential issues in various areas of human life. This issue will increasingly bring various problems and consequences for human societies in terms of their economic, social and environmental context, especially in the economic dimension (Yarahmadi & Maryanji, 2012; Fatahi, 2014; Khorshiddoust et al., 2016). Heavy rains are the effects and evidences of climatic anomalies that have faced the planet with various crises such as severe floods, damage in various sectors of transportation and human deaths (Denning et al., 2016; Paredestrejo et al., 2016). Mild or moderate rainfall that falls in an area over a long period of time can strengthen groundwater reservoirs, irrigate crops, strengthen vegetation, and other positive effects in the area, but heavy rainfall that occurs in a short period of time can occur in an area, increase floods and damage in that area (Faraji & Sadeghi, 2016; Rezaeibanafsheh et al., 2016). Among the 45 known natural disasters, flood is one of the most devastating ones that causes a lot of damage and loss of life. Severe synoptic instabilities with high humidity play a major role in flood occurrence. Severe and prolonged droughts along with terrible floods in arid and semi-arid areas have caused irreparable damage so far, Today, science has proven that natural hazards cannot be considered merely natural events and their complex causes cannot be ignored. Most of these causes are attributed to a combination of socio-economic factors, (Aramesh et al,. 2017; Safarzadeh & Mansoorinia, 2017).

Among the researches that have been done in this field in Iran and other countries of the world, the following can be mentioned: Yao & Huang, (2016) analyzed heavy rainfall events during January and March 2010 in eastern China. They concluded that in the first is event, there was a unique upward movement by integrated vertical (300 to1000 hPa) temperature. Moriyama et al., (2016) examined smart rainwater reservoirs as a rain gauge and flood control network. They concluded that a sensor should be installed in the first quarter of 2016, some installed is for pre-drainage water before heavy, detection of heavy rain and sending an order to sort with a pump. Accuracy of heavy rainfall detection has been investigated, but more research is needed for August 2014 alone. Zahiri et al., (2016) examined the area of heavy rainfall in South Africa. They results confirm the existence of a latitude that shows the average annual rainfall and the number of heavy events in Mesos. Classification simulation methods show a clear distinction between local-scale and synoptic events, which are organizational systems on the coast. Qasemifar et al., (2017) have investigated the identification of synoptic patterns of heavy rainfall in western Iran. They concluded that days with omega-negative limited rainfall (from 1000 to 200 hPa with a maximum core of 0.3 Pascals per second) is located on the west of Iran. Jalilian & Ramazi, (2017) have studied the statistical synoptic analysis of heavy and super heavy rains in Ilam province. They concluded that heavy and super heavy rains in November, December, February and March are more likely to occur than other months and at the Ilam station, intensity of rainfall is more than other stations. Christina et al., (2017) have studied a very unusual rainfall event related to the 2015 floods in Jakarta. they concluded that the two-day event more that of Jakarta was unusual in in February 2015, with the highest record of 135 years with a return period of more than 60 years in the current severe monsoon climate with unexpected north winds leading to the event. Land et al., (2017) have studied climate growth analysis using long-standing station parvands on a daily basis focusing on the impact of heavy rainfall events. They concluded that the unique sensitivities to rainfall over the past three to four decades are due to damage from mountaineering, increased sulfur dioxide emissions in the study area (southern Germany), and daily temperature changes. Thus, the climatic reaction for hydrolytic constructions may develop until the 1970s. Siswanto et al., (2017) studied the detection of anthropological incentives for heavy rainfall in September 2013, They concluded that simulations of regional climate models show that human drivers northeastern of Colorado increased by 30% for the wet week in September 2013. Synoptic meteorological studies in Iran do not have a long life and meteorological studies that are done by synoptic method have not been done for climatic parameters in most parts of the country. Therefore, the synoptic analysis of ultra-heavy and heavy rainfall on the selected day of Khalkhal Synoptic Station in Northwestern Iran is a new issue and seems necessary due to the importance of rainfall in the country and Northwestern. In the present study, the synoptic analysis of ultra-heavy and heavy rains in Khalkhal Synoptic Station will be studied and it will be monitored and analyzed the dynamics of heavy rains in a period of 34 years the results will help to better understand the heavy and ultra-heavy rainfall systems in this city and possibly in the region.

2. MATERIALS AND METHODS

2.1. Study area

Khalkhal is located in the southeast of Ardabil province. Its coordinates are 48° 32′ longitude and 37° 37′ latitude. The average altitude of this city is 1797 meters above sea level. Khalkhal is a mountainous region with a temperate and relatively cold climate. The forested and high Talesh mountain in the east of Khalkhal from north to south is a barrier between the Caspian Sea and Gilan and Ardabil provinces (Fig. 1). Due to the high altitude of Khalkhal city and the collision of rainy masses with these heights, the air masses have cyclonic properties and cause heavy rainfall in these heights. The prevailing rainfall regime in the region is such that the rainiest season of the year is spring and other rainy seasons are autumn and winter, respectively (Ranjbar, 2011; Lashkari & Khazaei, 2014; Masoudian & Karsaz, 2014; Heydari & Hawasi, 2016). Land use change is one of the most important human intervention in the hydrological cycle of watersheds. Lack of observance of land development capability in the selection of land uses and even unprincipled implementation of users, including deforestation and consequently the increase of agricultural lands and increasing urban development increases the peak discharge and frequency of floods (Khorshiddoust et al., 2016). In the studied station, Khalkhal in the south of Ardabil province, which is one of the areas prone to heavy and super heavy rainfall and ready for flooding.

2.2. Research methods

In this study, daily rainfall data of the region was used with statistics of nearly 34 years (1987-2020) in Khalkhal station, which is located in the southern part of Ardabil province. Atmospheric flow and air pressure data was received from NCEP/NCAR database related to the US National Oceanic Administration. In this database, the period from 1980 to the present has been used and for each day, four observations in synchronous hours (0, 6, 12, 18) were covered (Nouri et al., 2013a; Shahmohammadi & Ehsami, 2015; Rahimi & Hatami, 2016; Mostafazadeh et al., 2017; Kalnay et al., 1996). Then, atmospheric maps at the level of 500 millibars including sea level pressure map, geopotential altitude, wind speed and direction, humidity, temperature, surface runoff and blocking (omega) were prepared using satellite images. These maps in terms of atmospheric disturbances from the ground up to the level of 500 hPa in terms of the type of systems affecting the formation of preciholation and the process of its changes from 48 hours before preciholation, to the end of preciholation by environmental approach to circulation (i.e. first in terrestrial environment phenomenon or hazard climates such as droughts, floods, temperature and preciholation extreme occur. Then the its atmospheric cause and effect are investigated) were analyzed.

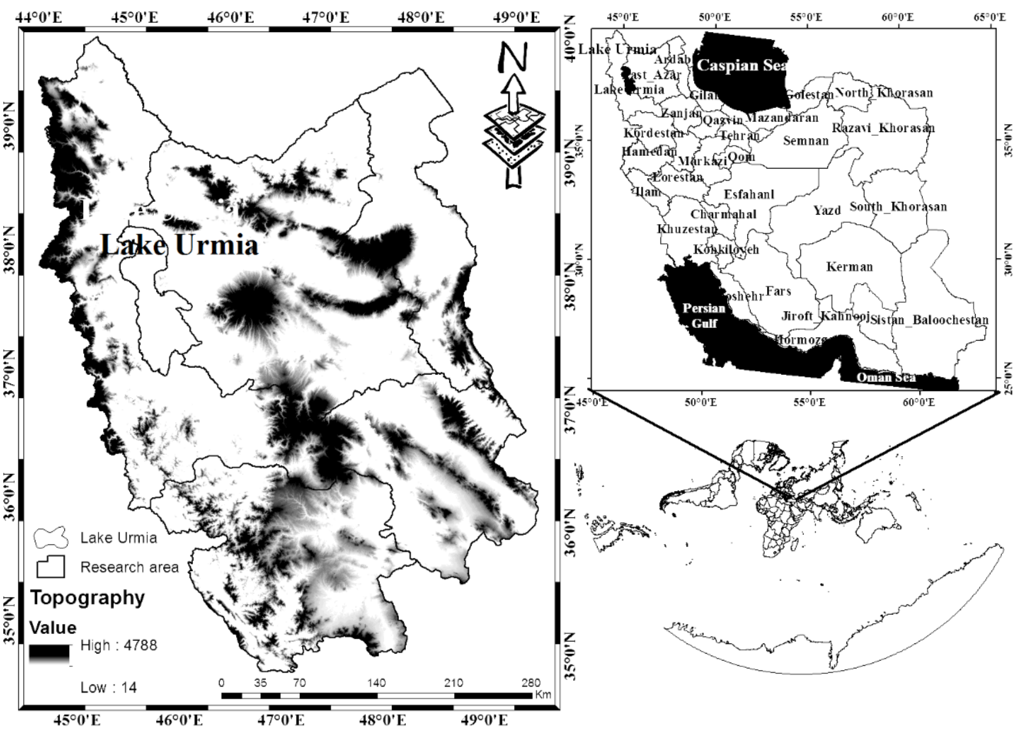

Figure 1. Map of the study area globally.

The steps and procedure are as follows:

1. Available statistical information, a 34-year statistical period (1987- 2020) was selected and received from the website of the Ministry of Roads and Urban Development of the Meteorological Organization.
2. To determine the patterns of showers during the 30-year statistical period, the daily precipitation data of Khalkhal synoptic station in in Ardabil province have been used in order to prepare surface pressure (Slp) and 500 hPa (same height) level maps.
3. Synoptic maps were prepared through the site of Noaa Meteorological Organization from 1987 to 2020.

2.3. Rainfall of the study area in days more than 30 mm

According to Table 1, the amount of heavy rainfall over 30 mm in Khalkhal station is located in the south of Ardabil province. At the study station, which was monitored for 34 years (1987- 2020), about 10,950 days, the 11-day rainfall was more than 30 mm. According to the analysis performed in the studied years, one day with a rainfall of 46 mm on 1991.09.12, has the highest rainfall day of 10,950 days. Table 2 presents flood statistics, which were analyzed using the environmental approach to circulation. All stages of the present research (graphical materials) from the beginning to the last stage were presented in Diagram 1.

3. RESULTS AND DISCUSSION

3.1. Geopotential maps of 500 hPa level

Due to the fact that the 500 mbar level includes atmospheric and terrestrial factors and conditions. In this study, this level was used to analyze the maps. In the geopotential map at Khalkhal station at the time in question, two cold holes in the northern latitudes of the study area, one on the north of Russia with a geopotential height curve of 5300 m and the other center almost north of the Mediterranean Sea with geopotential height curve of 5400 meters that these cold holes,

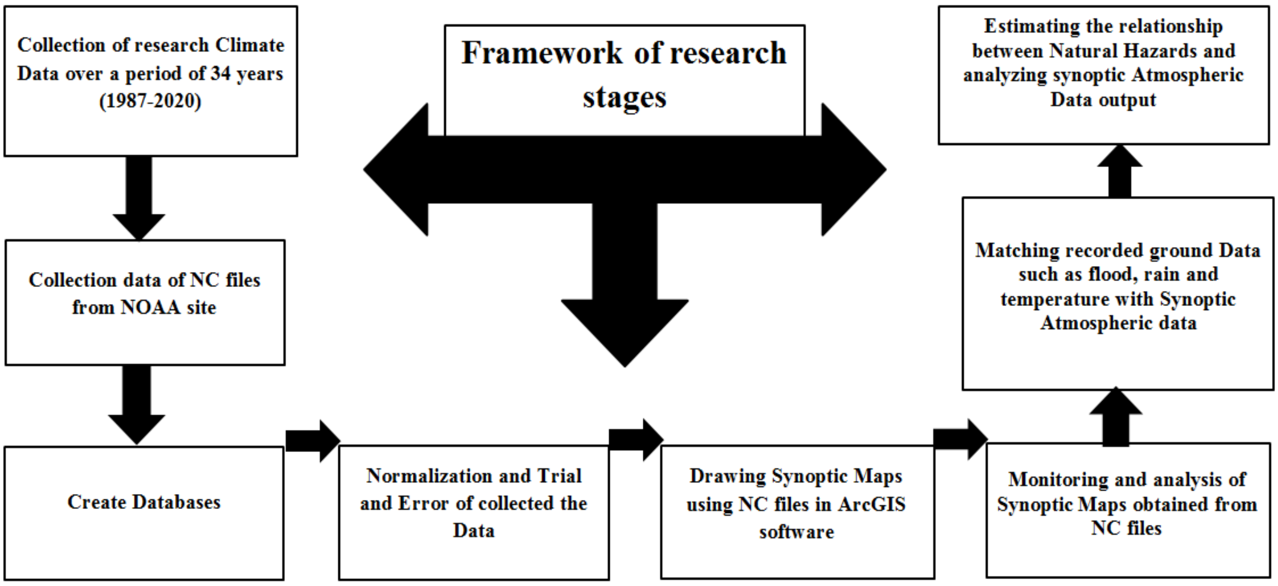

Diagram 1. Steps performed in the present study.

Table 1. Daily statistics of extensive heavy rainfall over 30 mm in the study area the statistical period (1987-2020)

Row	year . month . Day	Rainfall (mm)
1	1987.6.8	**36**
2	1988.2.2	**31**
3	1988.11.11	**36**
4	1991.12.9	**46**
5	1994.11.5	**37.6**
6	1996.4.13	**34**
7	2000.3.24	**34**
8	2000.10.27	**36**
9	2001.12.30	**37**
10	2005.2.21	**34**
11	2010.4.23	**31**

Table 2. Daily flood statistics during the statistical period (1999-2020), water resources affairs in the study area

Row	Date of occurrence	Discharge (cubic meters per second)	Location of occurrence (please verify)
1	1999.8.18	46	Shahroud Chai
2	1999.8.18	25	Gilvan chai
3	1999.9.26	Not reported	Golgolab chai, Sosahabchai, Damdolchai, kondorghchai
4	2000.7/7	22	Shahroud Chai
5	2000.7.7	102	Herochai
6	2002.7.26	8.84	Mianroodan-Lord
7	2002.7.24	36.6	Tana river
8	2002.7.23	Not reported	Kelarchai
9	2008.8.20	Not reported	Ganzehdarreh watercourse - Malesar Av-darreh between Osbo and Darro village
10	2008.7.20	12	Watercourse leading to Khat-parast village
11	2008.7.23	73.5	Watercourse through the inside and the highway of Mazraeh village
12	2008.7.22	12.7	Watercourse leading to Herochai
13	2009.6.25	14.3	Noralichai (Andbilchai)
14	2010.5.2	18	Khalkhal-Firozabad chai hot-water

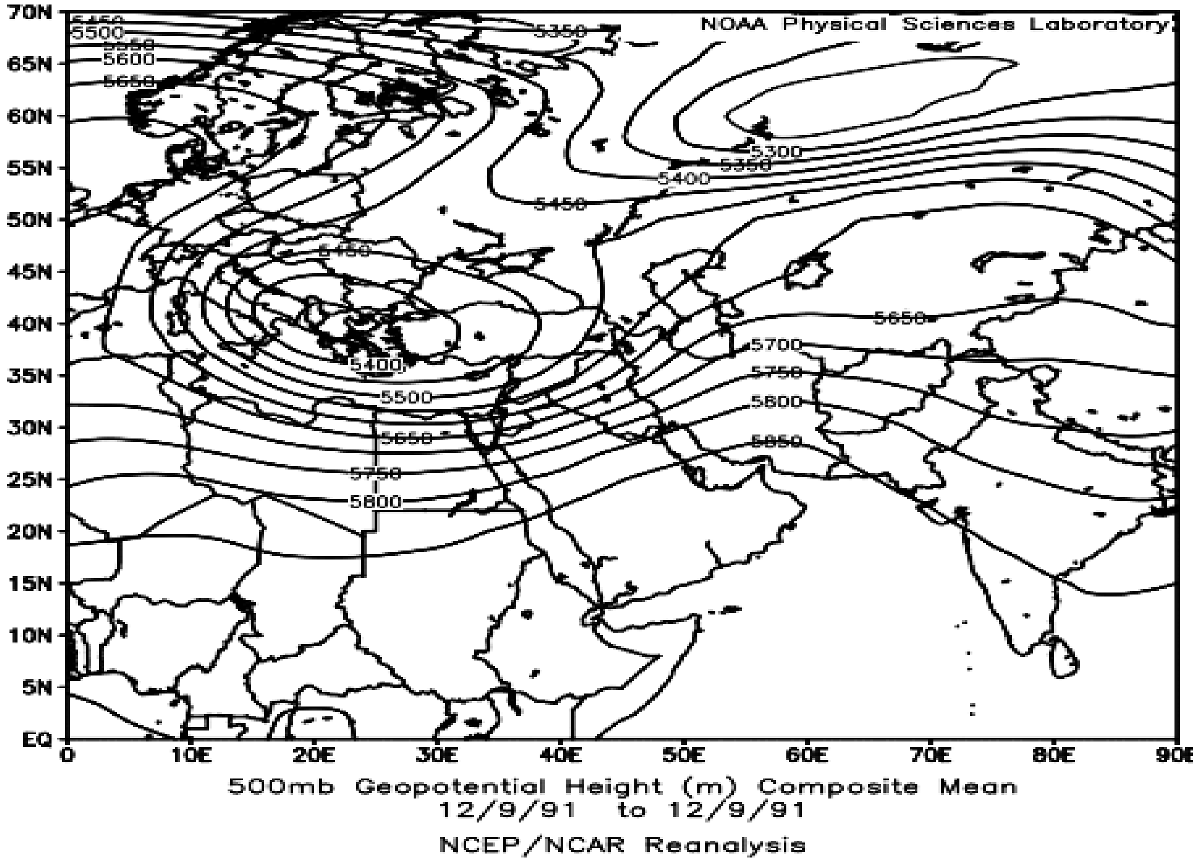

Figure 2. Geopotential height map of 500 hectopascals (meters)

due to their orbital motion, their landing do not affect on the study area and station. It is worth noting that this cold hole that is located in the northern Mediterranean Sea, passes through two water sources, namely the Black Sea and the Mediterranean and carries enough moisture to create a heavy rainfall to the study area. Another point is that when the air mass falls, it causes the temperature to rise and brings sufficient and strong humidity conditions to create a heavy rainfall on 1991.09.12 with a rate of 46 mm. Due to the fact that Khalkhal station during the heavy rainfall is in front of the cold hole of north of the Mediterranean Sea and forms a positive rotation zone PVA (Positive Volubility Area) and includes horizontal and unstable blowing, considering that in in front of the landing NVA (Negative Volubility Area), air moves from the lower latitudes upwards and from the lower layers upwards, creating a dynamic ascent. Therefore because it is under the curve due to the passage of two water sources, the humid Black Sea and the Mediterranean. Therefore it will pregnant with moisture and the 5600 curve of this cold hole passes over the Khalkhal city area, so for the area at the time of the study on 1991.09.12, the humid and precipitating air mass provides the possibility of creating heavy rainfall (Fig. 2).

3.2. Sea level pressure Map

Analysis performed on the surface pressure map dated 1991.09.12 for Khalkhal station in the northern parts of the study area, two low pressure regions, one on the north of Iran with a central value of 1010 millibars on the Caspian Sea and the other on the west and northwestern Iran and centrality of Turkey with a central pressure value of 1012.5 hPa, and given that two low-pressure or high-pressure are never placed together unless the tongue or center of opposite pressure of the two is between them. In this map, between the two low-pressure centers, a high-pressure center is located in Poland with a central value of 1040 hectopascals, and the tabs of this high-pressure center with a value of 1035 millibars are in Ardabil province and the region. Due to the fact that the high pressure in the northern hemisphere has an outward turn clockwise, so the high pressure in the northern latitude of the study area, ie the country of Poland with a value of 1040 mbar and part of It in North is the low pressure that is located on Turkey. The low pressures around the study area are both located on or near the water resources of the Caspian Sea, the Black Sea and the Mediterranean, and can provide moisture to create heavy rainfall in the study area. Brought. On the other hand, because in the hemisphere, the movement of the cyclone is inward and counterclockwise, therefore it plays as an effective factor in causing heavy rainfall at Khalkhal station (Fig. 3).

3.3. Wind speed map at the level of 500 millibar (meters per second)

Examination of the wind speed and direction map at the level of 500 mbar, available for Khalkhal station in Ardabil province on the study date shows three speed cores, one on Kazakhstan with a value of 35 m/s, the second on the sea and Norway with a core

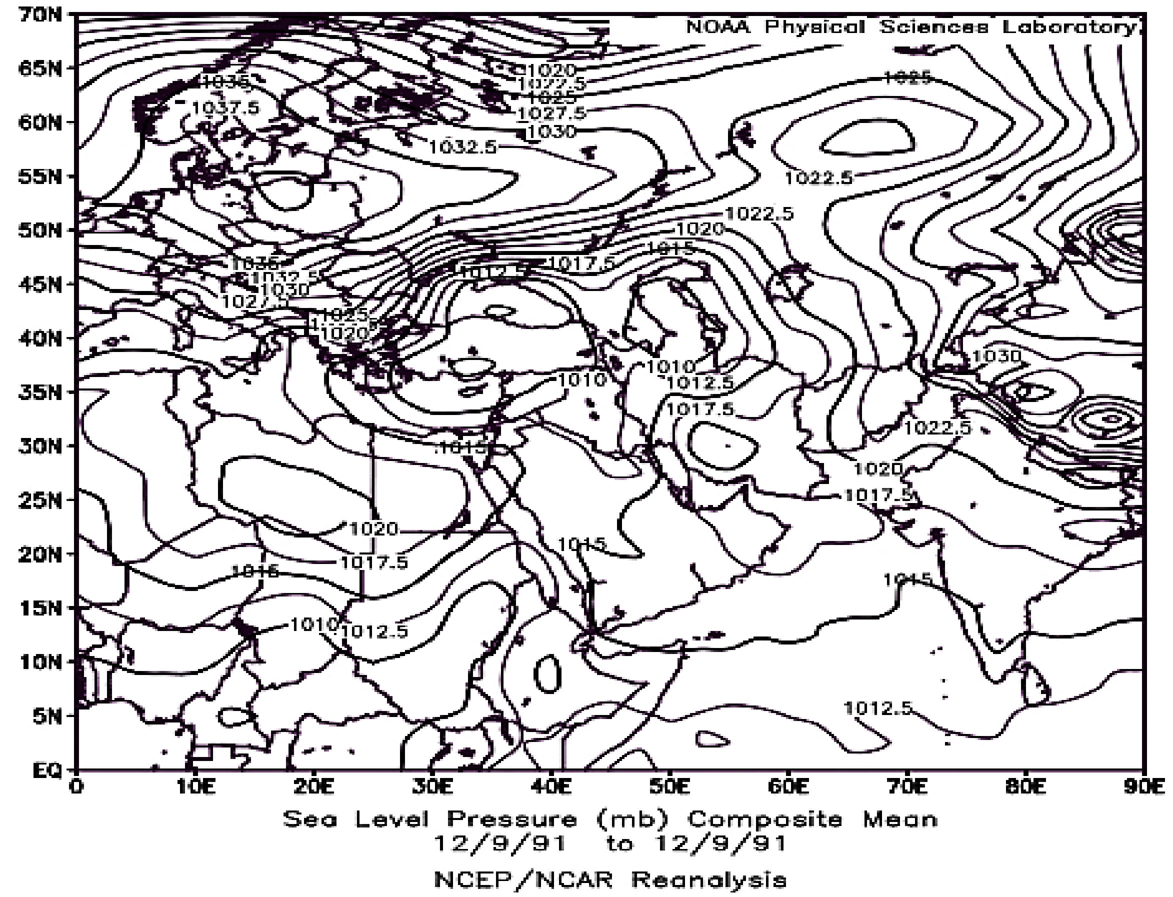

Figure 3. Sea level pressure map

speed of 33 m/s and the last wind speed core with a large core on several countries (Syria, Turkey and the western margin of Iran) and the sea (Mediterranean, Red and Caspian) in the western part of Iran. In (Fig. 4), wind speed diagram (knot) at Khalkhal station is presented on a monthly basis and the value of the coefficient of determination is equal to $R^2 = 0.0023$. The true direction of the wind is at a point above ground level in the northern hemisphere, on land is about 60 degrees and at sea about 75 degrees to the right in direction of the pressure changes gradiant, so that the angle of the wind direction with isobar lines, in lands is between about 30 degrees and in the seas reach about 15 degrees (Nouri et al., 2013b; Kaviani & Alijani, 2015). Due to the fact that the winds in the northern hemisphere are clockwise, in the study area, it is also clockwise. The tongue of this core reaches a wind speed of 31 meters per second on the study area and because the curves are compressed around the area. It has strengthened the instability in Khalkhal station. Also, because it uses the water source of 3 seas, it has brought moisture to the existing system and has caused heavy rainfall in Khalkhal station on 1991.09.12 (Fig. 5).

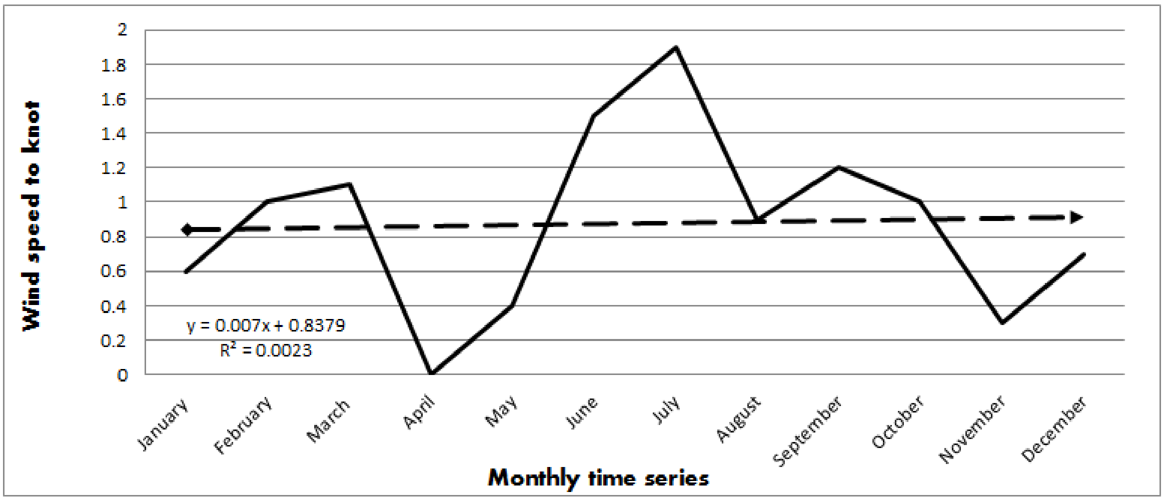

Figure 4. Monthly wind speed diagram of the study area in the statistical period (1987-2014)

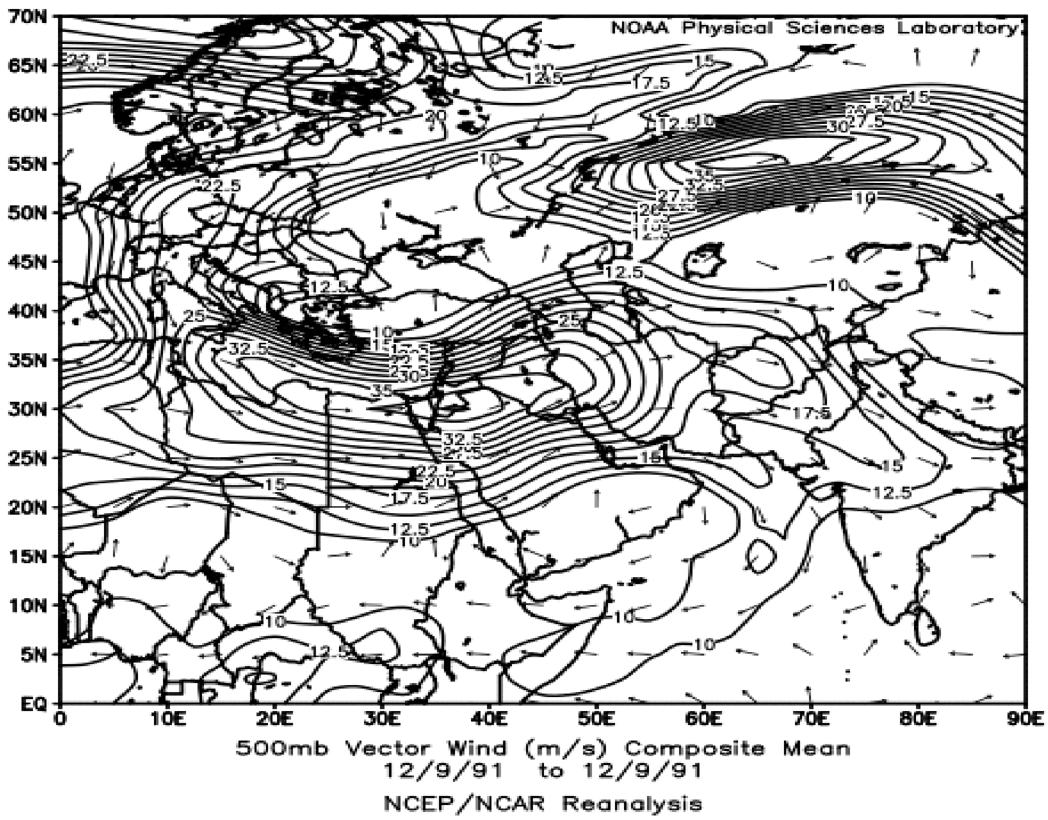

Figure 5. Wind speed map at 500 hPa (m/s)

3.4. Temperature map at the level of 500 millibars (Kelvin)

The available temperature map for Khalkhal station for 1991.09.12 at the level of 500 hPa The observed temperature values with Kelvin criterion in the study area of Khalkhal have been impressive. Then its maximum and minimum values are 265 and 245 degrees Kelvin, respectively. In Figure 6, the monthly temperature (°C) of Khalkhal station in the statistical period of 2014-1987 is given and the value of the coefficient of determination is equal to R^2 = 0.0961. The combination of hot and humid currents that lead to rising ground temperatures and low surface temperatures of 500 has caused this phenomenon. Awareness and knowledge of this situation can help predict the likelihood of this harmful phenomenon (Dargahian, 2015). Due to the fact that the formation of precipitation on the ground requires a temperature above zero to ascend and the formation of clouds and raindrops, these conditions at Khalkhal station at the time of study and conditions for instability, but at a high level to reach the nuclei to the dew point requires a temperature below zero, which in the study place and time shows the temperature curve of 255 degrees Kelvin. Therefore, the necessary conditions and the existence of low-pressure cores are provided to generate heavy and super-heavy rainfall at the time under study (Fig. 7).

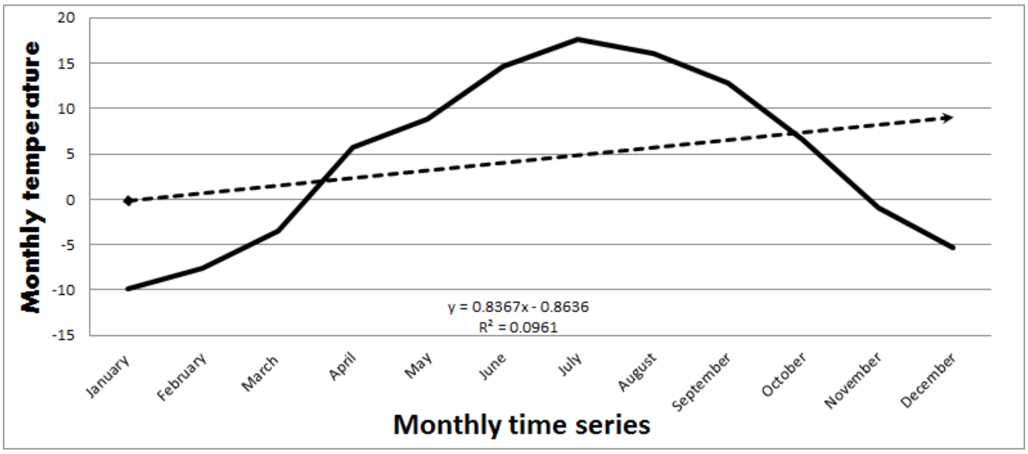

Figure 6. Monthly temperature chart of the study area in the statistical period (1987-2014).

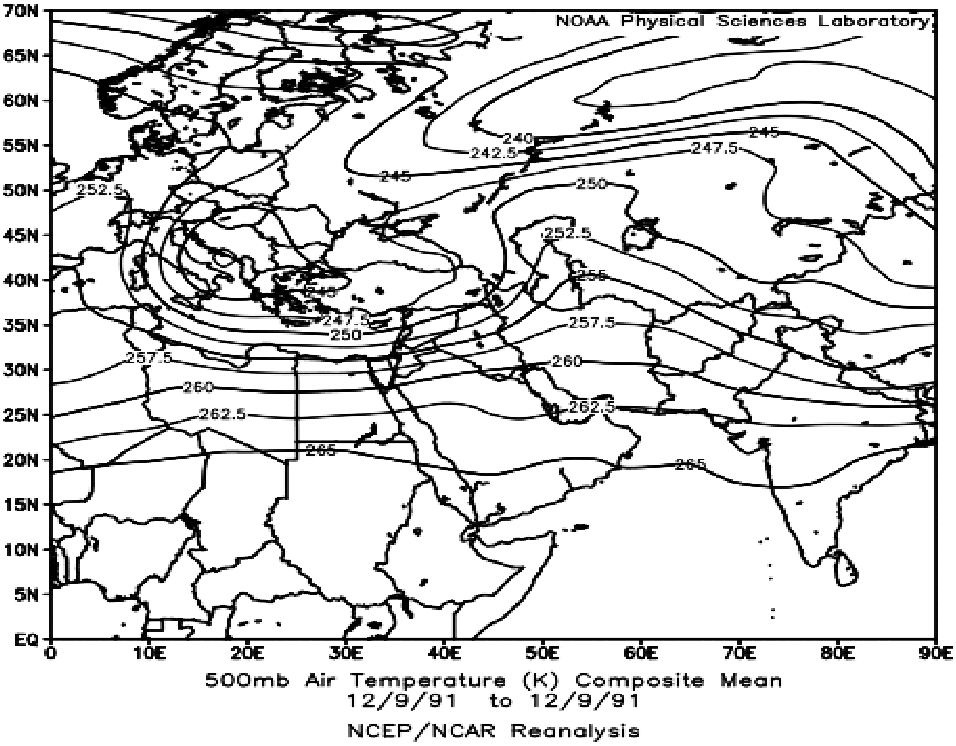

Figure 7. Map of air temperature at 500 hPa (Kelvin)

3.5. Omega map at 500 millibars (Pascal per second)

Omega factor is a component that explains the amount of vertical movement of air in the atmosphere, since the pressure decreases with increasing altitude, so in each level, negative values of vertical velocity indicate the rise of air and positive values indicate the descent of air. (Dargahian, 2015). Analysis of the existing map for omega at a level of 500 millibars on 1991.09.12 indicates the existence of several negative omega nuclei are scattered in the north and northwest and west of Iran, but two of these nuclei are strong. One is in the northeast of Kazakhstan with a value of -0.25 and the other is in parts of the northwest and west of Iran and parts of Turkey and Iraq with a value of -0.25. Omega nucleus, which is located in the west and northwest of Iran, affects the study area. The omega nucleus and the -0.05 curve on the Khalkhal station in Ardabil province have been studied in history at that time. According to the map Geopotentiol Height map that is located in front of the landing, and indicate that in -0.05 Pascal decreases from pressure every second, indicating instability in the study area and heavy rainfall (Fig. 8).

3.6. Map of rainwater at ground level (kg per square meter)

The high rainy arae of the subtropical region correspond to the path of subtropical cyclones. However, the amount of rain in all of these paths does not reach as much as the amount of rain around the tropical convergence belt (Kaviani & Alijani, 2015, 270). By analyzing the synoptic map of rainwater and the map of the amount of rainfall on the ground, it showed that in the map of the study station on 1991.09.12 of this study, the maximum and minimum columns of rainfall can be equal to 50 and 5 kg per square meter, but in the study area shows a curve of 20 and this indicates the formation of rainfall in Khalkhal station, and it is worth noting that the synoptic map of rainwater shows how much water vapor per square meter of land there is in the mentioned unit that can be converted into rainwater (Fig. 9).

3.7. Humidity map (percent)

According to the analysis of the relative humidity map on the study date for Khalkhal station in Ardabil province, it shows that in the existing map, the maximum surface moisture in the surveyed maps

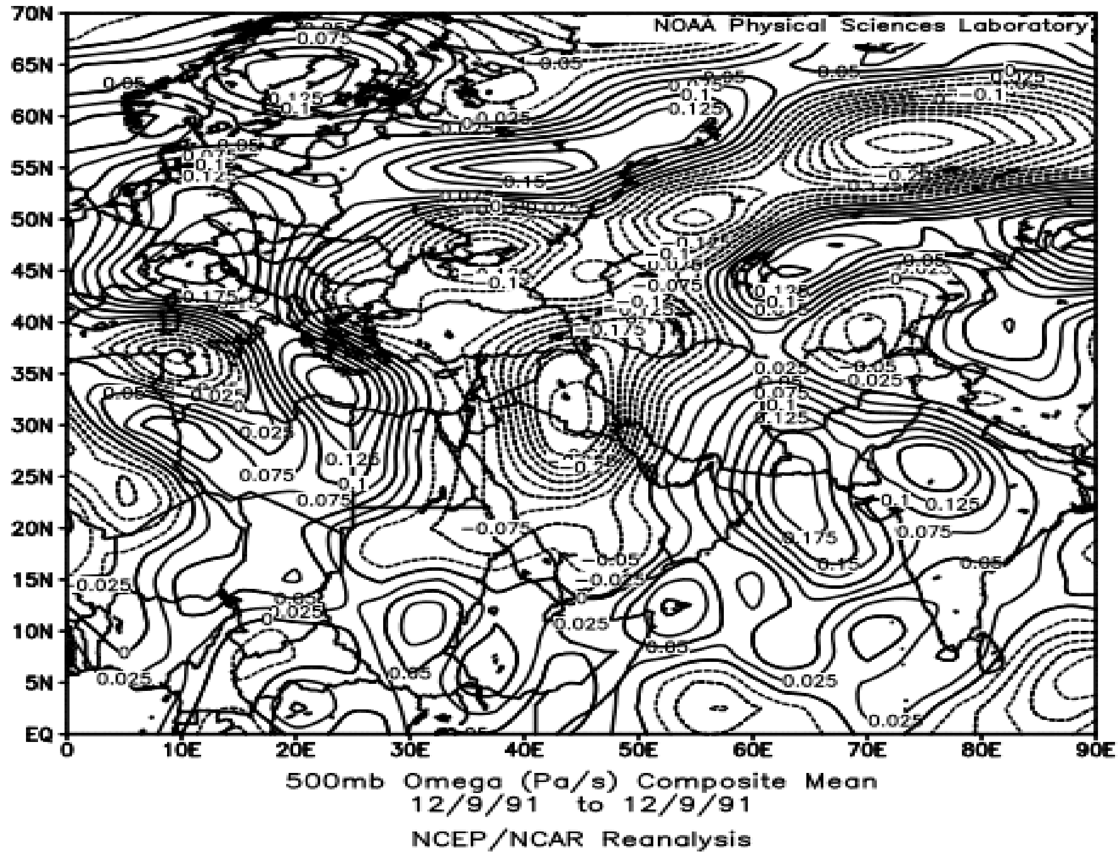

Figure 8. Omega map at 500 millibars (Pascals per second)

correspond 90% in the countries and seas of north and northwest of Iran, including Romania, Ukraine, Turkey and parts of northern Iran and the Caspian and Black Seas and other regions and at least 10% around Iran, north of the Aral Sea and the Indian Ocean, Australia and other regions and in the study area in Ardabil province is 72% that provides the conditions for heavy rainfall (Fig. 10). When the air gets warmer, more humidity is needed for the air to approach saturation, because relative humidity expresses the air conditions for approaching saturation (Dargahian, 2015).

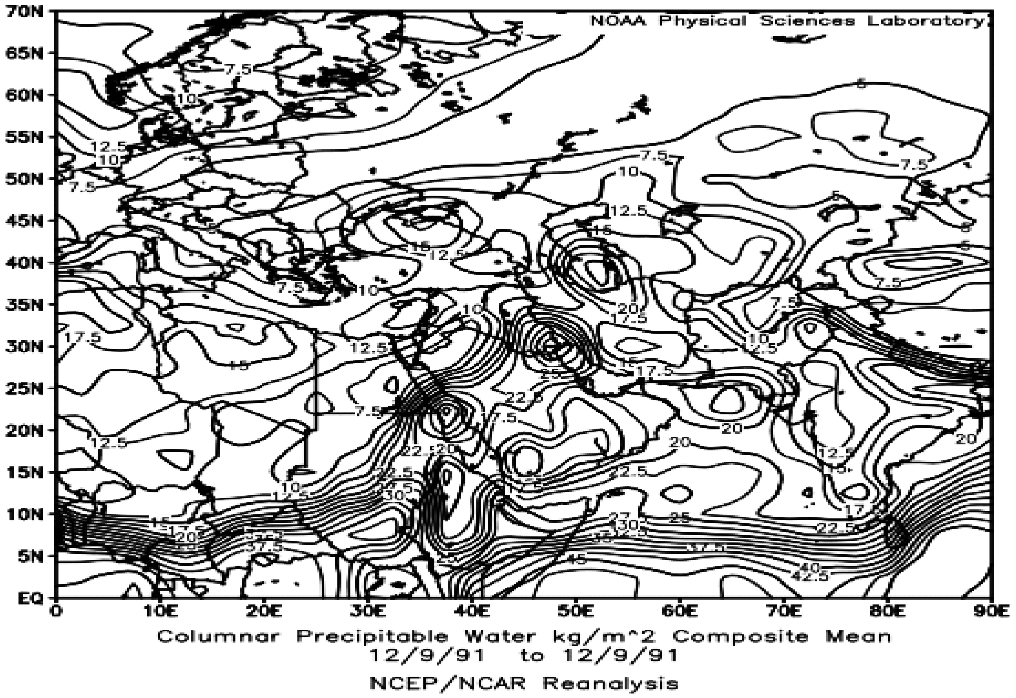

Figure 9. Map of rainwater at ground surface (kg/m^2).

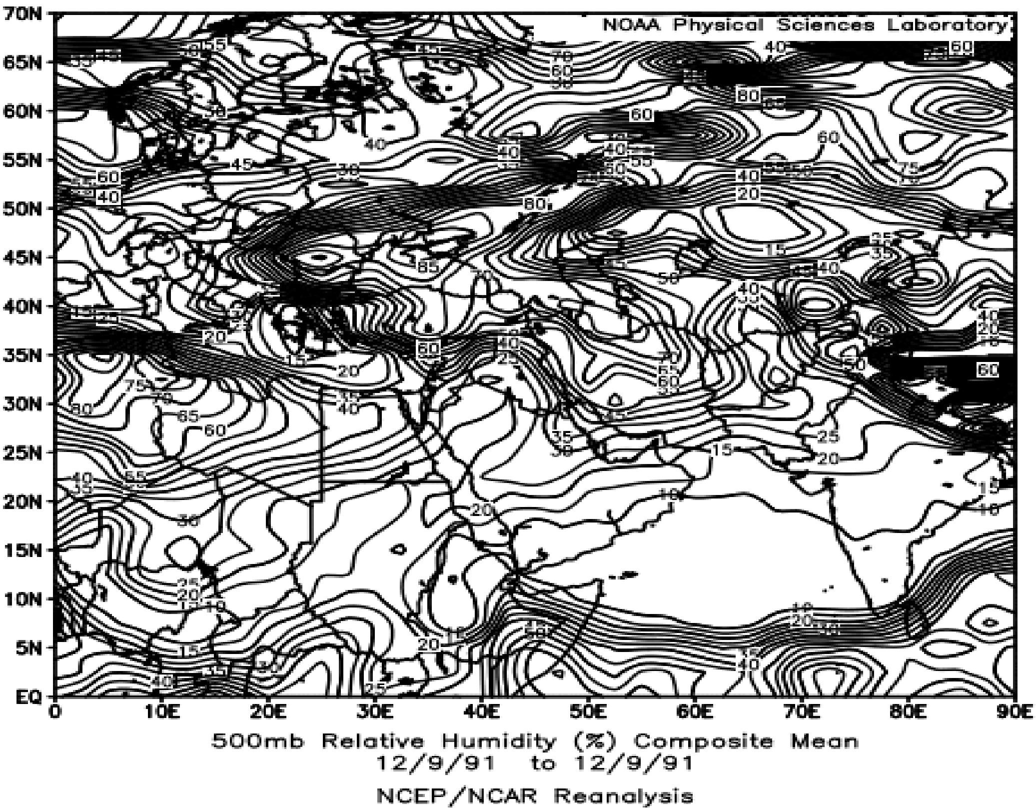

Figure 10. Moisture map at 500 millibars (percent).

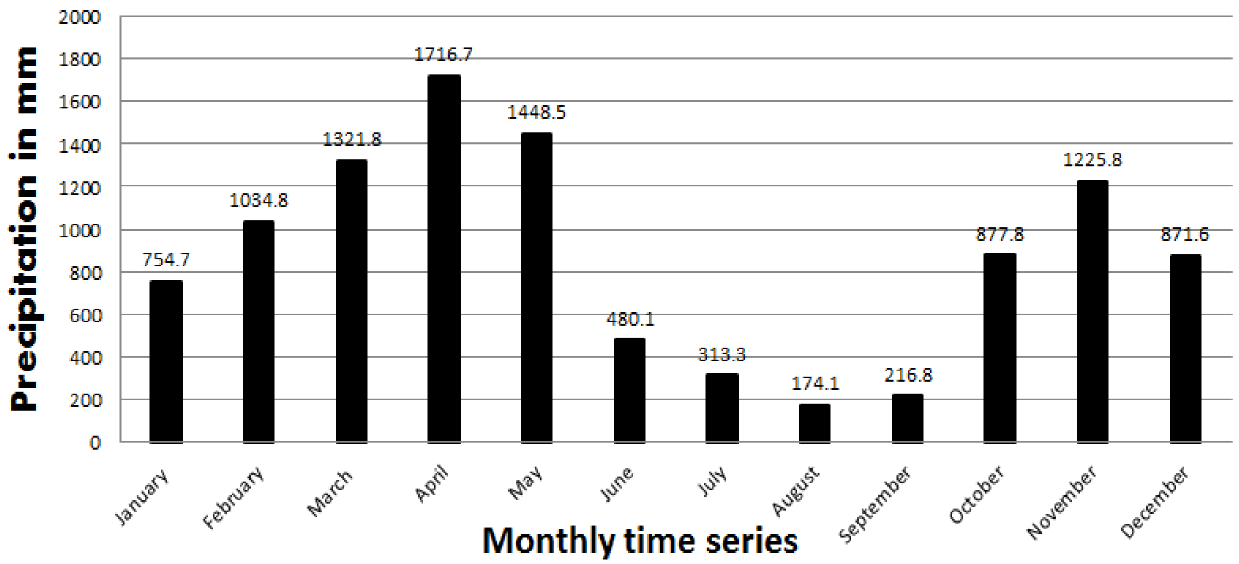

Figure 11. Monthly rainfall diagram of the study area in the statistical period (1987-2020).

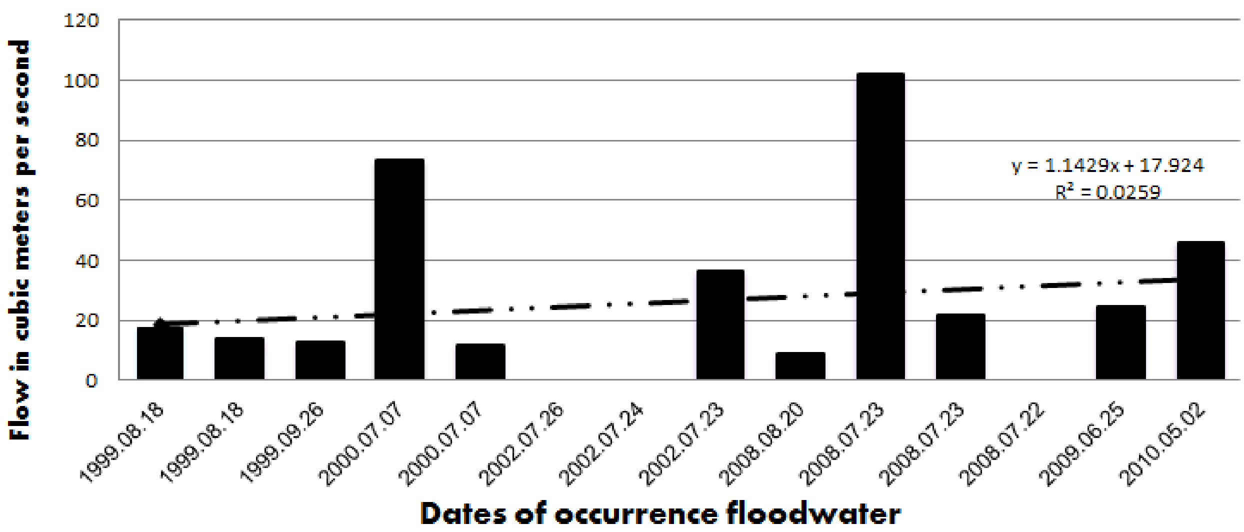

Figure 12. Diagram of daily flood statistics with the date of occurrence during the statistical period (1999-2020)

3.8. Monthly rainfall in the study area

The amount of monthly rainfall in Khalkhal station as a station in the south of Ardabil province and southwest of the Caspian Sea, in the three months of spring has more rainfall that includes March (1321.8), April (1716.7) and May (1448.5) mm, which according to (Fig. 11), the most natural weather hazards, including urban damage, agriculture, etc. in this city, has been done in the same months and the value of the coefficient of determination is equal to R^2 = 0.0259 table 3 and after May the rainfall in this city with a gentle slope is decreasing (Fig. 12).

3.9. Rainfall runoff map (kg/m^2)

In recent years, it has been newsworthy damages of agricultural and urban areas, village and river banks. The surface runoff map was also investigated. In the mentioned map, which was analyzed on 1991.09.12, water flow rates in this region in less than 1.75 hours after the onset of rain increased from 2 to 4 cubic meters per second, mostly due to the mountainous slopy nature of the city and due to the destruction of vegetation and the great impact of human factors, etc., the runoff has flowed at a high speed and the discharge has reached its maximum. Such conditions are a factor in causing floods and natural hazards in the study area (Fig. 13).

In this study, evaluation and investigation of synoptic conditions for the occurrence of precipitation leading to floods in Khalkhal city, Ardabil province on 1991.09.12 was performed. In most studies, this method is a suitable method for monitoring, analysis

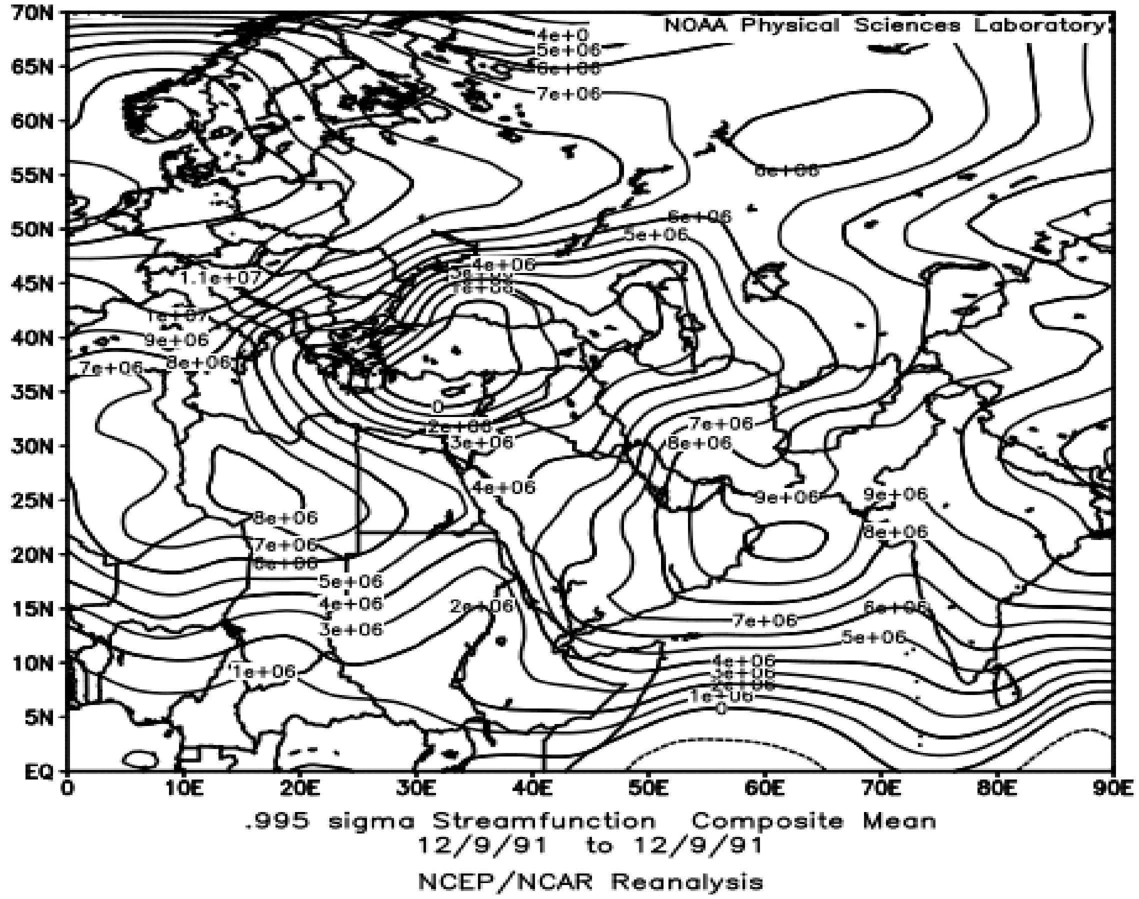

Figure 13. Map of discharge rate and areas where rainfall has flowed in the form of runoff (kg/m^2).

and comparison, including Qasemifar et al., (2017) Identification of synoptic patterns of floods in western Iran; Aramesh et al., (2017) Synoptic analysis Floods in Sarbaz watershed; Jalali et al., (2017) Identification of synoptic patterns of heavy summer rainfall on the southern shores of the Caspian Sea; as well as Jalilian & Ramazi (2017) approved acceptable accuracy of environmental to circulation approach in the synoptic analysis of heavy and super-heavy floods. Also, this model has acceptable performance in the present study. The indirect effects of rainfall (drought), which are more widespread and imperceptible, are related to its social and economic damage. Reduction of rainfall (drought) in the study area, agricultural economy has had a greater impact on the four important contexts of changes in agricultural cultivation, production stagnation, poverty and increasing farmers' debt, respectively.

4. CONCLUSION

In this study, by synoptic analysis, evaluation and study of synoptic conditions of rainfall leading to floods from 1987 to 2020, Khalkhal city in Ardabil province was presented. First, the statistical characteristics of rainy days, which was about 10,950 days, of which 11 days had a rainfall of more than 30 mm, and then, using atmospheric components and parameters, a rainy day of more than 30 mm, which was 46 mm on 1991.09.12, monitored, evaluated synoptic conditions with an environmental approach to circulation, which finally in addition to internal conditions, external factors or patterns such as the conditions of the surrounding seas and neighboring Iran such as the Black Sea and The Mediterranean has been effective in the rain this day. This station has more rainfall in the three months of spring, which is in March (1321.8), April (1716.7) and May (1448.5) mm according to table 2 and is affected by dynamic systems of the west wind wave and the mechanical system of the local mountains, as well as the convection factor which all of them have caused precipitation in this area. According to Figure 11, seasonal rainfall in Khalkhal station as a station located in the region in the south of Ardabil province, in spring has a total amount of 4483 mm that is more than other seasons. Next season after spring is winter with December (the total rainfall of 871.6 mm, January (754.7 mm) and February (1034.8 mm) and after winter is autumn with November (with a total amount of 1225.8 mm, it is the rainiest month of this season) and finally, the low-rainy season of the year is summer at June being the most rainy month of the season with 480.1. The storage capacity of air humidity is less than the amount of available humidity, therefore density begin and clouds and rain are created (Mostafazadeh et al., 2017). By evaluating and examining the synoptic map of rainwater and the map of the amount of rainfall on the ground, it showed that in the map at the station under study at the date of this study, the maximum and minimum rainfall are 51 and 4.5 kg/m^2, respectively, but in the study area, the curve shows a number of 20, in which indicates the formation of rainfall at Khalkhal station. It is worth noting that the synoptic map of rainwater shows how much water vapor there is in one square meter of land in the mentioned unit, which can be converted into rainwater. Given that the level of 500 millibars includes atmospheric and terrestrial factors and conditions. In this study, a level of 500 mbar was used to analyze the maps. In the northern parts of the study area, there are two low-pressure regions, one on the north of Iran with a central value of 1010 millibars on the Caspian Sea and the other on the west and northwest of Iran to the centerality of Turkey with a central pressure of 1012.5 hectopascals. The costs of agricultural production in the years after the drought have been high and very high. Due to the decrease in rainfall due to drought in the study area, the area under cultivation has decreased. In the wind speed and direction map, there are three speed cores, one on Kazakhstan with 35 m/s, the other on the sea and Norway country with core speed of 33 m/s and the last wind speed core with large core in the western part of Iran. The observed temperature values by Kelvin criterion in the study area of Khalkhal were significant. The maximum and minimum values are 265 and 245 degrees Kelvin, respectively. According to the monitoring and analysis, effective atmospheric and terrestrial factors and conditions have been provided for heavy rainfall on the day, date and place of study area.

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