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The effect of intensity and duration of drought on wind situation and wind erosion (case study: Damghan city, Iran)

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Key words: Wind, Precipitation, Evapotranspiration, Temperature, Wind erosion.

Abstract

Wind erosion is a natural disaster that the arid zones in center of Iran are increasingly faced with it. Improper management of natural resources has been many effects on increasing of the phenomenon. Precipitation, temperature and wind are the most important climatic factors that influence the Lack of rainfall, rising temperatures and wind velocity increased evapotranspiration in the region. Therefore, identifying the climatic parameters can be useful for natural resources and agriculture management. Damghan City is prone to wind erosion in the North East of the country. The aim of this paper is to investigate climatic parameters (precipitation, temperature, evapotranspiration and wind) and to determine dry month of area and the effect of it on wind erosion. Based on the results of the average temperature in the month of May to mid-October, the region was dry, so that, June, July, August and September seems to be its greatest extent. The evapotranspiration exceeds rainfall all year, and rainfall is 11 times the amount of evapotranspiration. Occurrence of wind storm and evapotranspiration in May, June and July is more than the other months, also temperature rate is higher than rainfall in these months. The temperature of August and September is more than any other months that drought is severe and rainfall is at its lowest. Therefore, the climatic factors are caused the occurrence of wind erosion in the study area.

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Introduction

The wind erosion process detaches soil particles from the land surface and transports them by wind. It occurs when forces exerted by wind overcome the gravitational and cohesive forces of soil particles on the surface of the ground. This phenomenon is one of the natural disasters in the arid regions. Central Iran is increasingly faced by mismanagement of natural resources, and the rise of this phenomenon has had a large impact. Precipitation, temperature and wind are the most important climatic factors that affect on wind erosion. Iran is located in universal desertification and wind erosion belt (Miri *et al.*, 2009), so that substantial part of its areas (88.6 percent) is dry climate especially 34.8% of the country is occupied by dry land (approximately 5 times the global average) (Fatahi and *et al.*, 2011).

In order to determine the effect of drought severity on wind erosion this phenomenon should be quantitative instead of qualitative and some indices must be introduced. Drought indices are normally continuous functions of rainfall and temperature, river discharge or other measurable variable. Rainfall data alone may not reflect the spectrum of drought- related conditions, but they can serve as a pragmatic solution in data_ poor regions (Safari Shad *et al.*, 2013; Rohina *et al.*, 2013).

The choice of indices for drought monitoring in a specific area should eventually be based on the quantity of climate data available and on the ability of the index to consistently detect spatial and temporal variations during a drought event (Khosravi *et al*, 2013; Dashti Marvili and Dabiri, 2013).

Wind erosion is one of the most important aspects of land degradation in arid and semi-arid areas (koopingr *et al.*, 1991), in which about one-sixth of the world's land area is affected (Skidmore, 2000). Worldwide, about 549 million hectares were degraded by wind erosion (Sabramanyam and Chynapa, 2002) that 296 million hectares are affected by severe wind erosion (Lal, 2003).

Wind erosion is one of the main factors that have limited soil fertility in many parts of the world, including Iran; therefore, it is serious challenge for sustainable production and agricultural land management. One of the most important tools in the development of the country is identifying and existing climatic conditions in different regions of the country. Better planning of human activities such as agriculture, is subject to the understanding of climate and applied climate of each region (Paply Yazdi, 1998).

Wind erosion is usually caused by lack of reasonable management practices on soil and land resources, such as intensification of agricultural practices, overgrazing, deforestation, etc. mentioned practices degrade adhesion properties of soil and it is vulnerable to wind. Damage is slowly caused to decline fine particles of soil and gradually increase sand particles that don't have adhesive and are vulnerable to wind.

The whole country is about 18 million hectares of land under cultivation. It is obvious that 12 million hectares to 10 hectares is under permanent cultivation and the rest in fallow. 47% of the cultivated land is irrigated and the rest of them are non-irrigated. But it should not be neglected is that the exploitation of the land and use systems that is not harm for soil because soil is life capital. Unfortunately, due to the improper use of water and soil resources, 1.5 million hectares in the country added to desert every year (Zehtabiyan and Khosravi, 2009).

Based on the results of studies by Hanifehpur and Jabari (2014) showed that the average temperature in the month of May to mid-October the region was dry, so Once, June, July, August and September seems to be its greatest extent. The evapotranspiration exceeds rainfall all year, and rainfall is 10 times the amount of evapotranspiration. Occurrence of wind storm and evapotranspiration in May, June and July is more than the other months, also temperature rate is higher than rainfall in these months. The temperature of August and September is more than any other months that drought is severe and rainfall is at its lowest. Therefore, the climatic factors are caused the occurrence of wind erosion in the region. The climatic factors examined the conditions for the occurrence of the phenomenon of wind erosion in demand stems

The most important climatic factors that influence the wind erosion are: precipitation, temperature and wind. In this study, we investigated and compared three climatic factors to determine their effect on wind erosion.

Materials and methods

The study area

The study area is located in east south of Damghan city covering an area of 27,000 hectares, so that, about 15,000 hectares of it is agricultural land and orchards. The minimum length of the eastern is 54 degrees 16 minutes to 54 degrees and 29 minutes, and longitude 35 degrees 54 minutes at 36 ° C and 13 min (Fig. 1).

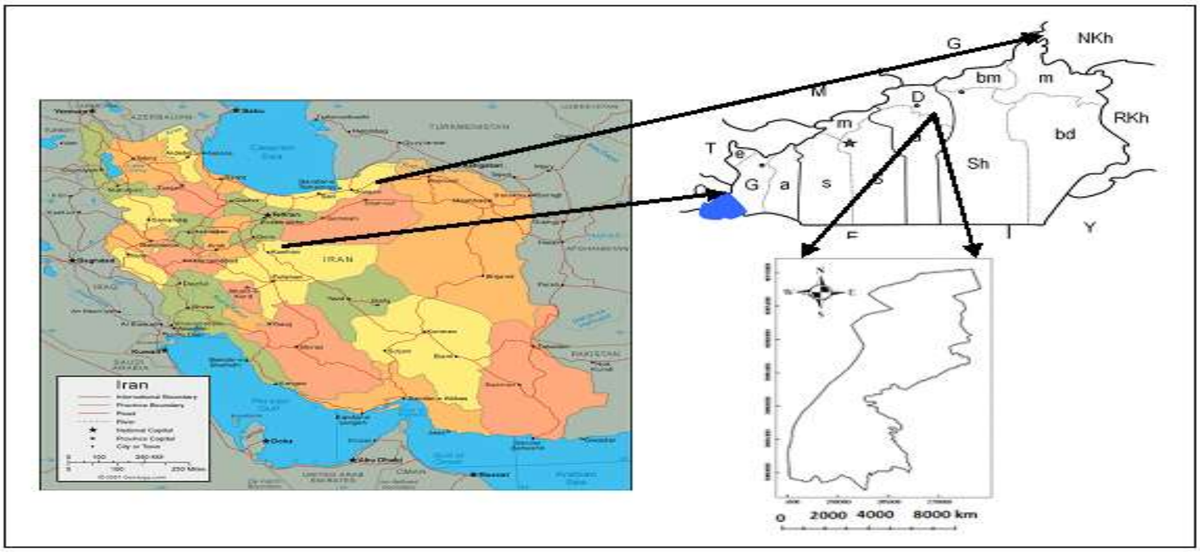

Fig. 1. Location of the study area.

The mean annual rainfall is 120 mm and maximum rainfall is in the spring and the mean annual temperature is 16.3 degrees Celsius. Based on classification of Domarten the study area is dry and cold.

Information of climatology stations of Damghan(located at longitude 54 degrees 19 minutes latitude 36 degrees 9 minutes and altitude 1155 (m) was used to assess the climate and its indicators.

Wind data

In this study, information of wind orientation and speed of Damghan synoptic station was used to analysis of wind conditions, during the past 9 years (2010- 2009).

Software's used

In this study several software including Excel-software -Crop wat - Software Convert- Software, WRPLOT View were used.

Methodology

Investigation of precipitation, temperature, evapotranspiration parameters and Embrothermic curve to determine the dry season in the region.

Embrothermic diagram

Embrothermic diagrams are prepared to identify the dry months in the meteorological stations. The average monthly temperature and rainfall are drawn in a vertical axis in embrothermic diagram. So that, the horizontal axis is the months of the year, the left vertical axis is monthly temperature T (in Celsius) and the right vertical axis is monthly precipitation P (mm). The scale of the precipitation is two times of the scale of temperature, because if precipitation is equal or less than two times of temperature, time is dry (Seydan and Mohammadi, 1998). If the precipitation curve doesn't cut the temperature curve, time is semi-arid and if the curve of precipitations exceeds that of the temperature, it is wet season. The intersection of the curves can be followed on the extremely dry period and the time it takes.

Determine the amount of evapotranspiration

Value of potential evapotranspiration was measured by CROPWAT Software Version 8. This software calculates the average amount of energy reflected from the surface and potential evapotranspiration (mm) automatically by import meteorological data such as the average minimum temperature, average maximum temperature, mean relative humidity, average wind speed and average hours of sunshine a day. Finally wind rose and storm rose properties were used to determine the effect of wind on wind erosion.

Results

Precipitation

Based on the results, the mean annual rainfall in the region is 120 mm, according to the statistics of meteorological stations cover (Climatology- synoptic), during the 32 years of data (1981-2012), (Fig. 2). Figure 3 shows mean Annual Precipitation fluctuations and 3, 5 and 7 -year moving average, according to the diagram , the region was wet in 1992 and extremely dry in 1987.

Table 1. Percent distribution of annual classes of wind speed and dry month in the synoptic station of Damghan (wind rose).

Speed classes / Time series	>11.1	8.8-11.1	5.7-8.8	3.6-5.7	2.1-3.6	0.5-2.1	%Calm wind
annually	20.7	7.5	15.6	17.7	12.3	14.3	11.8
May-June-July	34.6	12.5	21.5	15.9	1.6	5.9	3.4
August-September	22.5	9.2	23.4	19.3	10	9.8	5.7
October-November	14.8	5.5	11.7	21.4	14.8	19.9	11.9

Table 2. Percent distribution of annual classes of wind speed and dry month in the synoptic station of Damghan (storm rose).

Speed classes / Time series	>27	23-27	19-23	15-19	13-15	%Calm wind
annually	14.3	4.1	6.5	7.5	6.5	61.2
May-June-July	24.4	6.7	10.6	10.6	8.7	39.1
August-September	14.5	3.9	9.2	10.9	9.8	51.6
October-November	9.7	3.2	5.9	5.1	3.8	72.2

Temperature

According to 32 -year period of meteorological stations of Damghan (1981-2012) the average annual temperature is 16.3 °, mean maximum temperature is 32and minimum temperature is -1.25(Tymoorzadeh 1360) while the statistics show that the average annual temperature in Damghan on the cover of the period (57-75), is equal to 14.3 ° C, mean maximum temperature 34.4 ° C and the average minimum temperature -4.9 C. The statistics implies on climatic changes during the past 55 years in Damghan (Fig. 4).

Evapotranspiration

The potential evapotranspiration is 1165.7 mm and almost 11 times the amount of annual rainfall. While the potential evapotranspiration rate for the period 1957-1975 was 1286.9 mm in Damghan. Comparison of potential evapotranspiration in two time periods reflects the climate changes in the area (Fig. 5).

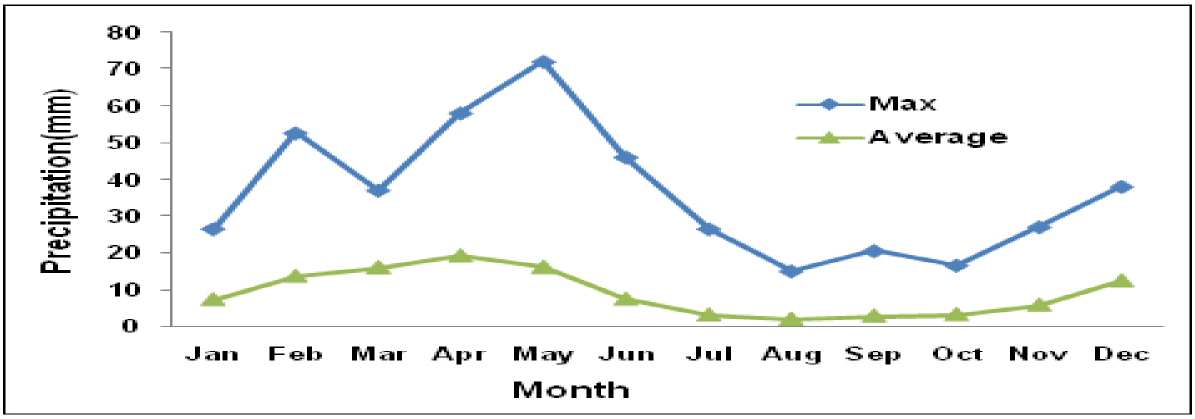

Fig. 2. Monthly rainfall chart of Damghan synoptic station during 32-year statistical period (1981-2012).

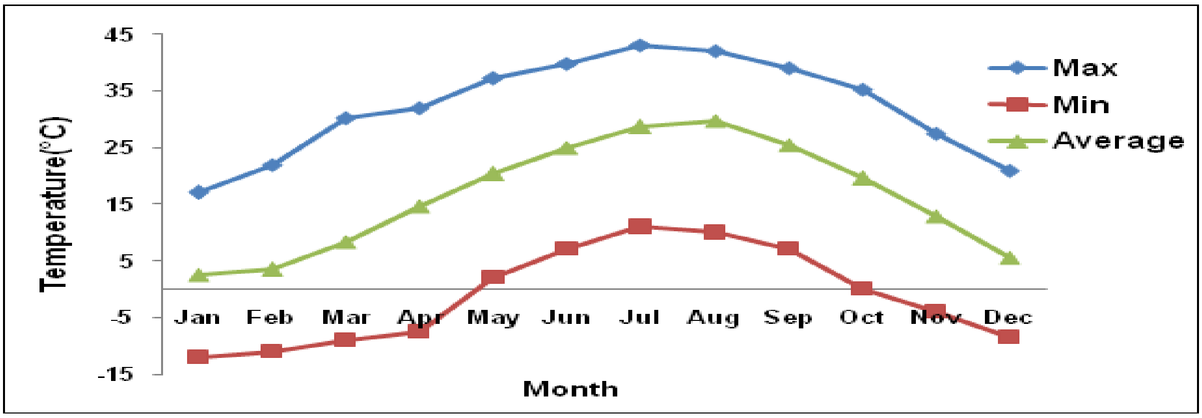

Fig. 4. Temperature charts of Damghan synoptic station during 32-year statistical period (1981-2012).

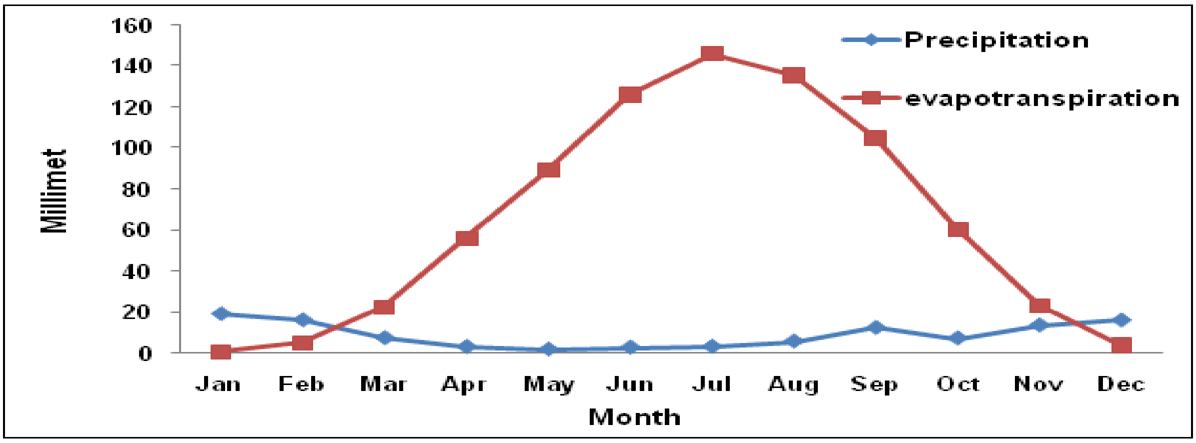

Fig. 5. Water level in the study area based on potential evapotranspiration and precipitation.

Embrothermic Diagram

Embrothermic diagram is provided to enhance two climatic main elements (precipitation- temperature) of Damghan. The chart shows the dry period when the temperature curve is above the precipitation curve. So there are 8 months dry in the year, and sub-humid conditions prevailed for about 4 months of the year in the study station.

Wind rose

According to Embrothermic diagram (Figure 6) the dry season begins in May and continues until November wind was studied. Figure (7) shows Seasonal and annual wind roses of Damghan synoptic station and the general situation prevailing wind direction and speed and frequency of wind in the study area. Table 1. Shows percent distribution of annual classes of wind speed in the region, according to embrothermic diagram (Fig. 6) with a moderate to high dry condition. The annual wind rose of the area shows that the prevailing wind direction is from the east north (292.5 to 337.5) and about 20.7% of the prevailing winds in the region have over 11 meters per second speed and frequency of calm winds with less than one knot (0.54 meters per second) is about 12.

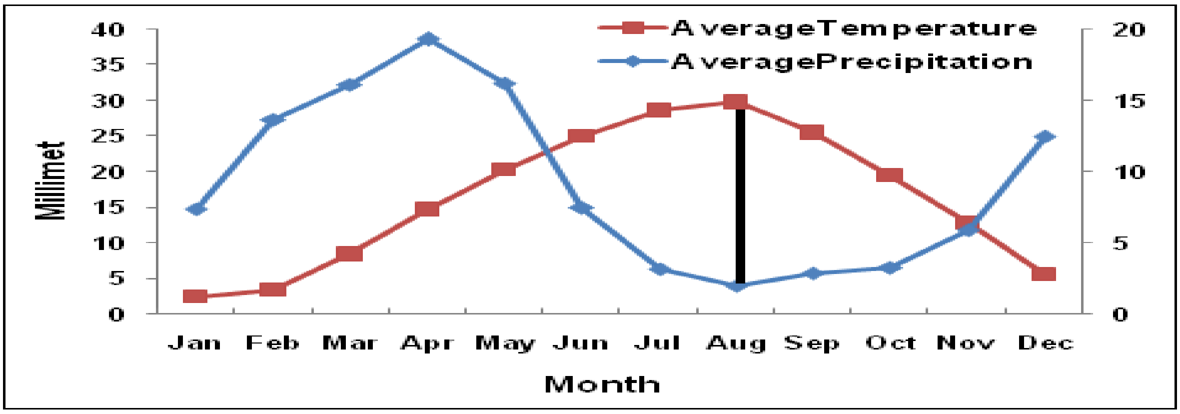

Fig. 6. Embrothermic diagram of Damghan city.

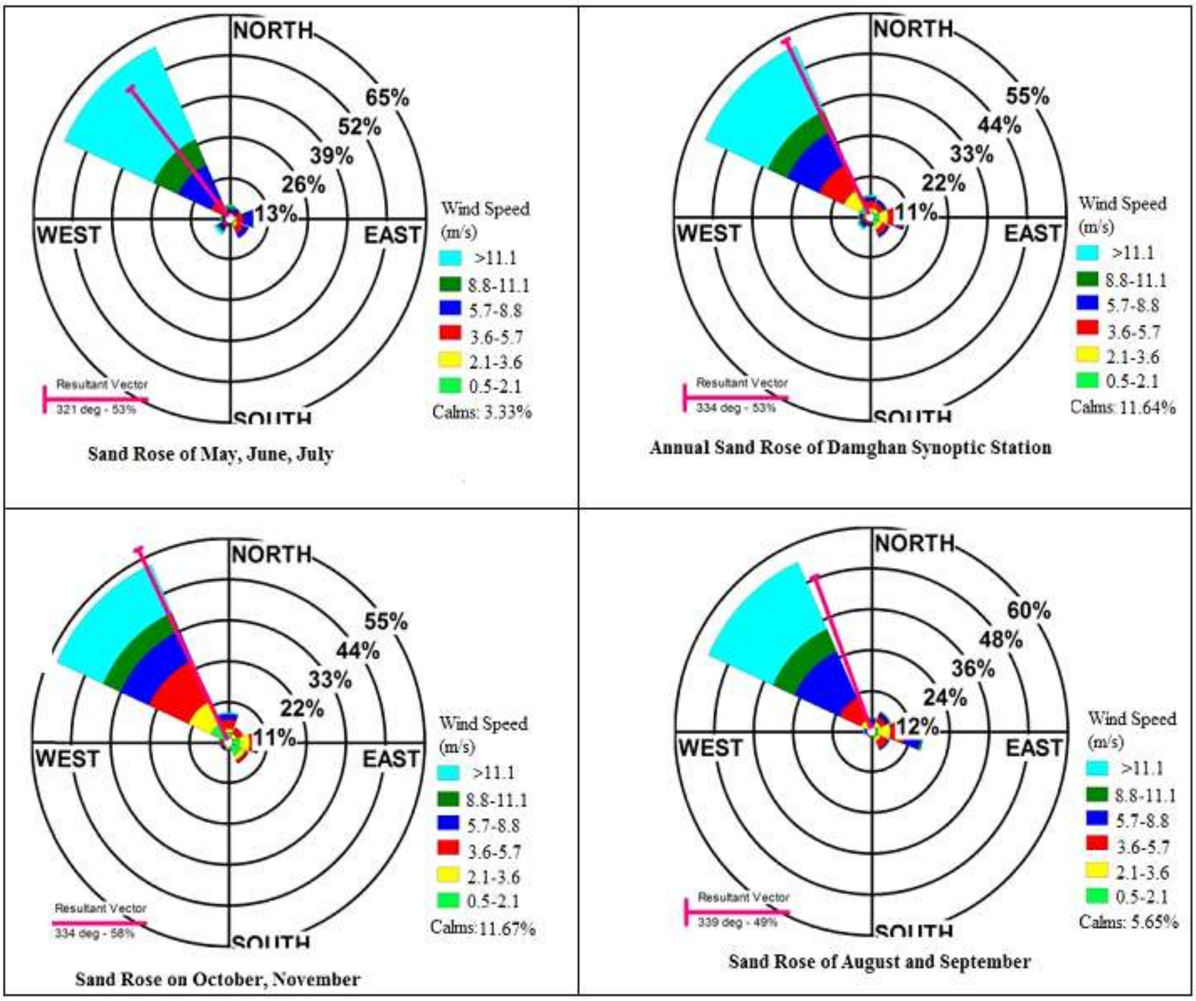

Fig. 7. Annually and monthly wind roses of Damghan synoptic station.

Storm rose

To analyze storm rose, the storm rose with the lowest threshold velocity of wind erosion at a height of 10 meters (6.5 meters per second) was used and according to it the erosive winds condition were investigated in the region. The orientation of erosive winds, with speeds in excess of 6.5 meters per second in all seasons is west north (292.5 to 337.5) (Fig. 8). According to Table 2, the frequency of winds with a velocity less than the threshold velocity of wind erosion is 61.2%. This indicates that the storm winds and causing dust are about 40% of the total area.

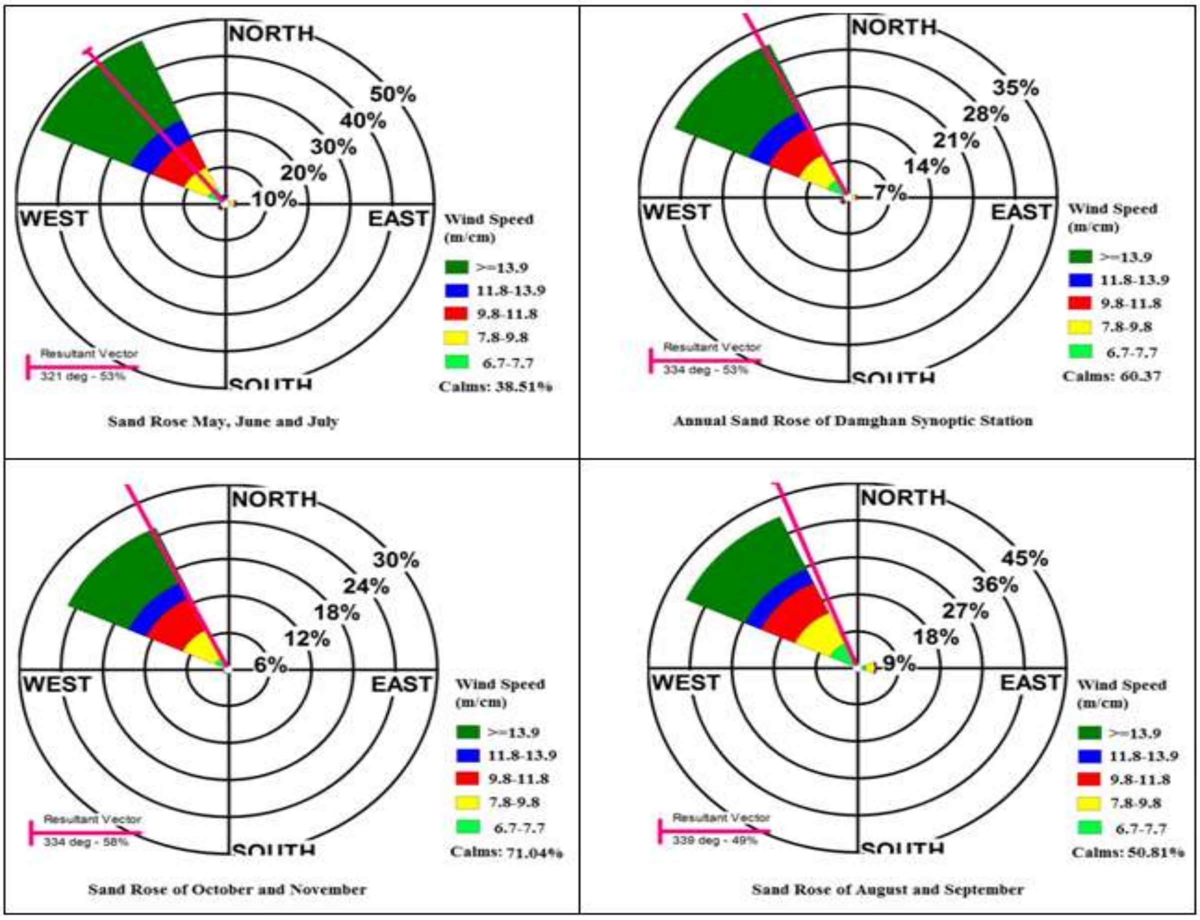

Fig. 8. Seasonal and annual storm rose of synoptic station of Damghan.

Discussion

According to Embrothermic diagram (Fig. 6), the average temperature in August is expected to peak at the station and in this month, total rainfall is the lowest value. May to mid-October is dry, so that, July, August and September seems to be its greatest extent. Based on the diagram (5) the amount of evapotranspiration exceeds rainfall throughout the year and the amount of precipitation is 11 times the potential evapotranspiration.

Results from the storm roses of the region show, the percentage of calm winds (less than 6.5 meters per second) is less than 40% in May, June and July. Therefore, the percentage of the storm winds is more than 60 percent in these months.

According to the figure 9, the percentage of the storm winds and evapotranspiration are more than the other months in May, June and July.

As well the temperature is higher than rainfall. In August and September, temperature is more than the other months that based on Embrothermic diagram (Fig. 6) at the height of the drought and rainfall is at its lowest.

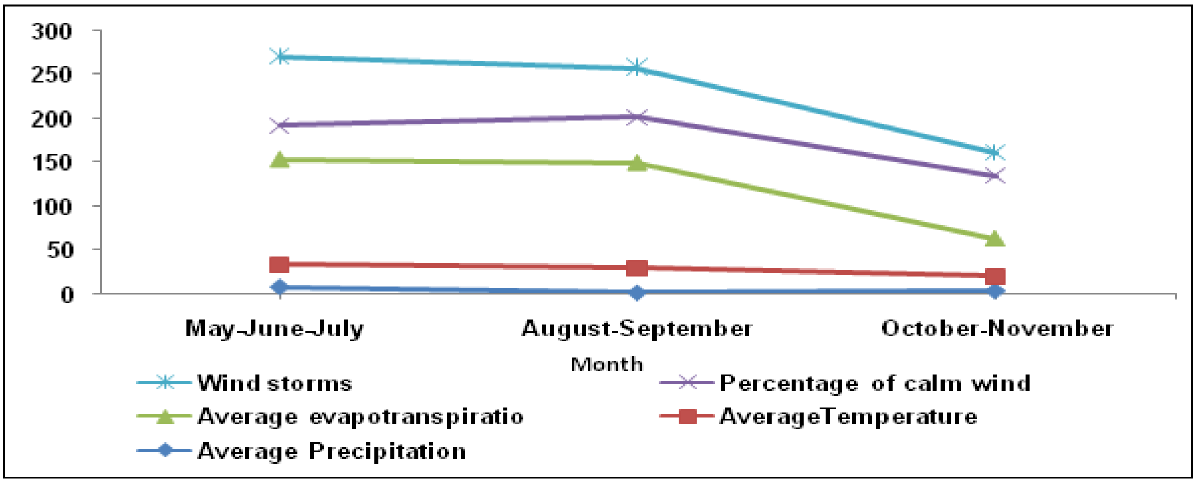

Fig. 9. Climate diagram of the study area.

According to the results of the climate graphs, wind rose and storm rose of the region can be concluded that occurrence of dust storm and erosion is before the peak temperature and rainfall; therefore, examined climatic factors are caused wind erosion.
Based on the results of the effect of the severity and duration of drought on wind erosion in Tehran ((Hanifepour and Jabbari, 2014); studied climatic factors including temperature, evaporation, precipitation and wind provide conditions for creating the phenomenon of wind erosion in Tehran. The study of Hanifepour and *et al.* (2014) in studying the effects of the severity and duration of drought on wind erosion in Kashan showed that the studied climate factors create conditions for occurrence of wind erosion in the study. So, in desert area lack of rainfall and relative humidity leads to increased evapotranspiration and the temperature that provides condition for wind occurrence and soil displacement.

References

Coppinger KD, Reiners WA, Burke IC, Olson RK. 1991. Net erosion on a sagebrush steppe landscape as determined by cesium 137 distribution. Soil Science Society of America Journal **55**, 254-258.

Dashti Marvili M, Dabiri D. 2013. Study of drought in northern Karun watershed. International journal of Advanced Biological and Biomedical Research **1,** 487-492.

Fatahi MA, Darvish M, Javidkia HR, Adnani SM. 2010. Assessment and mapping of desertification total risk using FAO-UNEP method (Case study: Qomroud watershed). Iranian Journal of Range and Desert Research **17,** 575-588.

Hanifepour M, Jabari B. 2013. The impact of drought intensity and duration on wind and wind erosion, 3rd National Conference on *Wind* Erosion and Dust Storms, Yazd, Iran.

Hanifepour M, Mashhadi N, Khosravi H. 2014. The impact of drought intensity and duration on wind and wind erosion, 1nd International Conference on *Engineering Environment* Tehran, Iran.

Khosravi K, Mirzai H, Saleh I. 2013. Assessment of Empirical Methods of Runoff Estimation by Statistical test (Case study: BanadakSadat Watershed, Yazd Province), International journal of Advanced Biological and Biomedical Research **1,** 285-301.

Lal R. 2003. Soil erosion and global carbon budget”. International Environment **29,** 437-450.

McTainsh GH, Leys JF, O'Loingsigh T. 2011. Strong CL. Wind Erosionand Land Management in Australia during 1940–1949 and 2000–2009. Report prepared for the Australian Government Department of Sustain- ability, Environment, Water, Population and Communities on behalf of the State of the Environment Committee. DSEWPaC: Canberra.

Miri A, Pahlavanravi A, Moghaddamnia A. 2008. Assessment of dust storms occurrence in the Sistan region following the occurrence of periodic droughts, Iranian Journal of Range and Desert Research **16,** 329-342.

Papoli Yazdi M H, Labaf Khaniki M, Jalali A, Vosoghi F. 2010. The Qasabeh`s Qanat of Gonabad a Myth, Khorasan Razavi Press, 294p.

Rohina A, Baharanifard A, Kazemi N, Abadi K, Mohammadi A. 2013. Evaluating empirical methods of flood flow rate estimation in Bakhtegan watershed-Iran. International journal of Advanced Biological and Biomedical Research **1,** 450-458.

Safari Shad M, Dashti Marviliand M, Allahbakhshian Farsani P. 2013. Zoning droughts by standardized precipitation index in Esfahan province (IRAN). International journal of Advanced Biological and Biomedical Research **1,** 477-481.

Sing J. 1934. Translated by Koucheki A, Dehghanian S, Kolahi Ahari A. 2008, Introduction to Agricultural geography, Ferdowsi University Press, 304 p.

Skidmore EL. 2000. Air, soil, and water quality as influenced by wind erosion and strategies for mitigation, Second International Symposium of New Technologies for Environmental Monitoring and Agro-Applications Proceedings, Tekirdag, Turkey, 216-221.

Subramaniam N, Chinappa GP. 2002. Remote sensing and GIS techniques for land degradation assessment due to water erosion, 17th WCSS, Thailand, 815-819.

Zehtabian GH, Khosravi H. 2009. Optimizing agricultural activities in order to arrive to sustainable development, Report to Center of Excellence for Sustainable Watersheds Management, Faculty of Natural Resources, University of Tehran, 88 p.