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Monitoring of Climatic Factors Affecting on Dust & Sand Storm in Tehran Province

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ABSTRACT

In this study, according to the objectives and implementation method, climatic factors affecting the dust phenomenon in active meteorological stations in Tehran province for a period of 30 years were studied and analyzed. The results showed that in Mehrabad meteorological station, temperature, humidity, rainfall, evaporation factors were directly related to DSI indices, wind trend and dust storm changes, Lancaster, wind and storm diagrams, SPEI and the increase of drought indices in the statistical period increased with temperature, evaporation and decrease. Rainfall and humidity are proportional. DSI dust storm indexes were compared to 1 and Lancaster drought index was compared to 50 and SPEI index was compared positively and negatively in different years of the statistical period in the region and was classified in terms of drought and wet season. The results of monthly and annual changes in wind trend and dust storms showed that the region has no wind in all months and seasons with a speed of more than 20 meters per second. In terms of wind speed and frequency percentage, the highest wind speed was related to late May and early June, and the lowest wind speed was related to late December and early January. In addition, according to the changes in the wind trend and the documents of the winds and thunderstorms, the prevailing wind direction in the region was from the west.

Keyword: Dust, Climatic Factors, Drought Indices, Desert, Dust and Sand Storm, Tehran Province.

INTRODUCTION

In general, there have been many researches in the world from the past to date with different views and purposes to research about origin, nature, characteristics, displacement paths, existing combinations of dust or dust, effects and consequences of their spread over cities and villages. In fact, deserts and land lakes, which have been transformed to small deserts due to regional climatic changes, are among the most active dust - producing sources. These regions usually have less annual precipitation than 288 to 258 mm and topography is situated in an area of topography. Dust is one of the most important environmental problems in the world that has attracted much attention in recent years. This problem affects all aspects of human life (including human health, influence

on the industries of electricity distribution, the development of desertification, agriculture and ecotourism, etc.). For sustainable management of dust, it has to be done at first and then review all comprehensive management. Internal or external sourcing of dust is important because the necessity of investing within the region or outside of the region will be considered as investor, and comprehensive management will also be emphasized that in the absence of attention to all aspects affecting the origin of dust of sustainable management will not be achieved and therefore all measures have been carried out. The purpose of this study was the study of the system from different aspects such as pedology, geology and meteorology in this regard. As an example of desert in Africa, the largest source of dust in the world is the dust that takes 155 million tons of dust annually. The main sources of this phenomenon in Sahara include Bodeleh pit, western Mali, southern Algeria and eastern Mauritania [1]. More than 78 % of the dust storms are attributed to the storm that come from the Horn of Africa [2]. The study of storms in the country of Mongolia showed that the most frequent occurrence of these storms is in the west of Mongolia, which is affected by the Gabi desert and the Great Lakes of Mongolia. Most of these types of hurricanes occur in the spring, where air and soil are dry[3]. Another studies, about the country's dust storms, is shown to be the cause of the storm, which has operated in northern China, and has been the pressure gradient between the northern China and the Gabi deserts and sand, the south and west of Mongolia [4].
According to the study of the Desert (Sahra) has a huge role in the production of global dust, in northwest Africa. Western China and parts of Mongolia are considered the second major source of desert dust [5]. Middle Eastern storms are mainly divided into a different kind of north, front, and convective forms. The main types of these storm are the northern type that takes place on Iraq, Kuwait and the Arabian Peninsula [6]. In recent years, dust storm in the Middle East and especially in the Saudi Arabia and Iraq have caused significant damage to our country, ranging from its range to major cities. Analysis of flows and investigations of satellite imagery of the Middle East region shows that the world's sandy desert, called " Rub ' al - Khali, is one of the sources of dust phenomena in the Middle East region, which has been established in Saudi Arabia, Yemen, Oman and the United Arab Emirates [5].
Dust storms in Iran, the southeast of Iraq and Syria, the Gulf and southern Saudi Arabia are the most frequent in the summer. The storms in the west of Iraq and Syria, Jordan, Lebanon, northern Saudi Arabia and southern Egypt are mostly in the spring. Whereas in southern Israel and the areas of northern Egypt occur in spring and winter [7]. According to a study of dust storms in the middle east, Iran, Sudan, Iraq, Saudi Arabia and all Gulf states in the first place indicate that the frequency of hurricanes in these regions indicates the fact that the frequency of hurricanes in these countries during the hot period of the year is higher than the rest of the periods [7]. Therefore, it is important that management of the sourcing of dust or internal or external carriers will not be the same. The source of dust in the country is categorized in two phases of source of dust, internal dust, and source of dust or external dust. The main source of dust or external dust in the west and south of Iran is the location of the Euphrates and Euphrates rivers to the Euphrates and the Euphrates (north and northeast of Syria). As the origin of dust or internal dust in Razavi Khorasan province is increased from the north to the south (i.e., dust in the region from the Sistan and Baluchestan region). The results showed that the three important zones of dust in the south west of the country, including the west of Ilam and the border with Iraq, meet the southern borders of Ilam, northern Khozestan and Iraq and the surrounding areas of Horolazim Pond [8].
Satellite images showed have at least a large portion of the dust march Khozestan in the local ponds of the source especially Horolazim pond. The high concentration of dust in Ahvaz, a figure of about one hundredth of g / m3, which recorded a historical record, also indicates the proximity of the dust storm or the recent dust.

MATERIAL AND METHODS

In the beginning to prepare the weather data of Mehrabad station, in Tehran, the required action to collect a 30 - year statistical period was conducted. To cover the time of statistical data based on WMO method, the meteorological data of the reconstruction were completed. In the next step, data analysis can be noted that, usually, factors such as shifting the measurement location change of time measurement, replacement of measurement time, replacement of devices and extreme local climate change may result in the heterogeneity in the data, which can be interpreted as a method of double crime curve and through numerical methods to sequence test. In the present study, the annual data homogeneity analysis of the stations was done using sequence test and completed data inhomogeneity.
After reconstruction and completion of statistical gaps, the relationship and annual and seasonal trends between the number of days associated with hurricanes and dust and the studied parameters are examined, in this section the days associated with dust as a dependent variable during the study period with simultaneous data of temperature, evaporation and precipitation and Other required and involved parameters in this phenomenon are compared as independent variables. The results of this part of the study show the relationship between these variables in terms of the effect of climate on the phenomenon of dust. Because changes in the incidence and frequency of extreme events can have more severe effects and damage than Changes in the average have climatic characteristics and climate change in borderline events show themselves better than changes in the average. In this regard, dust storm days in time Shorter and at least monthly studies with limit events of climatic elements have also been reviewed. In order to monitor the phenomenon of climate change, every year we can update the data and provide new zoning maps of the severity of the phenomenon of climate change in Tehran province and differentiate different regions in terms of vulnerability.
In order to study the dry years and its effects on the increase or decrease of days with dust, the status of drought years and periods have been studied using the SPI (Standardized Precipitation Index). This index is obtained based on the difference between precipitation and average for a specific time scale and then dividing it by standard deviation and the only effective factor in calculating this index is the element

of precipitation. This index can be calculated on time scales of 12, 24, 36 and 48 months. In order to study the dry and wet years in this method, the value of the standard annual precipitation index is determined [9] and based on the values of this index in such a way that if its value, A. More than 2, B. 1.50 to 1.99, C. 1.00 to 1.49, D. 0.99 to -0.99, E. -1.00 to -1.49, and F. -1.50 to -1.99, G. Be less than -2.00, respectively, classified as very severe wet season, severe wet season, normal year, normal drought, severe drought, very severe drought.

$$\boldsymbol{SPI} = \frac{\mathrm{P}-\bar{P}}{\mathrm{SD}} \quad (1)$$

In equation (1) SPI is Standard Annual Precipitation Index, P is Annual rainfall (mm), $\overline{\mathrm{P}}$ is Average rainfall during the statistical period (mm), SD is Deviation from the standard annual rainfall values.

However, the study of drought status using SPEI index (Standardized Precipitation Evapotranspiration Index), considering that SPEI index in addition to precipitation, also considers evapotranspiration, so areas with positive temperature anomalies, even in case of proper rainfall, they may be located in drought areas. Therefore, if possible, drought in the study areas has been studied using this index.

$$\boldsymbol{SPEI} = \frac{\mathrm{D}-\bar{D}}{\mathrm{SD}} \quad (2)$$

In equation (2) SPEI is Standard index of annual precipitation, D is Annual rainfall difference with annual modified evapotranspiration (mm), $\overline{\mathrm{D}}$ is Mean rainfall difference with modified evapotranspiration during the statistical period (mm), SD is Standard deviation of D values during the statistical period. Of course, before calculating the SPEI index, the following five equations must be calculated and placed in the SPEI formula. The five required relationships are as follows.

$$\boldsymbol{Im} = \left(\frac{\mathrm{Tm}}{5}\right)^{1.51} \quad (3)$$

In equation (3) Im is Monthly thermal profile, Tm is Average air temperature (Celsius) in the desired month.

$$\boldsymbol{I} = \sum_{n=1}^{12} Im \quad (4)$$

In equation (4) I is Annual thermal profile, I_m is Monthly thermal profile.

$$\boldsymbol{a} = (6.75 \times 10^{-7})I^3 - (7.71 \times 10^{-5})I^2 + (1.792 \times 10^{-2})I + 0.492 \quad (5)$$

In equation (5) a is Annual thermal profile Process.

$$\boldsymbol{PET} = 16\left(\frac{10\mathrm{Tm}}{\mathrm{I}}\right)^{a} \quad (6)$$

In equation (6) PET is Annual thermal profile, Tm is Average air temperature in the desired month, I is Annual thermal profile.

$$\boldsymbol{PET} = 16\mathrm{Nm}\left(\frac{10\mathrm{Tm}}{\mathrm{I}}\right)^{a} \quad (7)$$

In equation (7) PET is Evaporation of modified monthly potential (mm), Nm is Correction factor (according to the number of days and the number of lightings per month), Tm is Average air temperature in the desired month, I is Annual thermal profile.

After calculating the SPEI to investigate the wind trend, which is an important factor in the occurrence and intensification of dust, first the hourly data recorded in synoptic stations such as time and date of observation, wind direction and speed, field of view and the code of dust phenomena (6, 7, 8, 9, 30, 31,32,33,34 and 35) was taken from the Meteorological Organization. Then, by examining the common statistical period of the selected stations, a common time interval has been selected for data analysis. The number of dusty days in synoptic stations of the study area in different field of view (less than 200 meters, between 200 to 1000 meters and more than 1000 meters) is another necessary calculation and to study the frequency and severity of the phenomenon. Dust Storm Index (DSI) method has been used (relation ...). The DSI index is a suitable method for monitoring wind erosion on a large scale using meteorological records. Is; which calculates the frequency and intensity of dust storms in the area. This index is a combination of three Local Dust Event LDE (MDS Moderate Dust Storm) and Severe Dust Storm SDS (Sever Dust Storm) profiles, based on the number of times the registration of dust phenomenon codes in synoptic stations has been calculated based on the reduction of the field of view due to various factors. The values of the above three indices are extracted and calculated based on the reported codes from the location of synoptic stations in the studied areas of Tehran province based on the following definitions:

$$\boldsymbol{DSI} = \sum_{i=1}^{n}[(5 \times SDS) + MDS + (0.05 \times LDE)]i \quad (8)$$

In equation (8) DSI is Dust Storm Index, SDS is Sever Dust Storm, MDS is Moderate Dust Storm, LDE is Moderate Dust Storm.

In this research, DSI for different stations in the study period has been calculated monthly and annually, and finally the total value of the index for each region has been calculated from the total of estimated indices annually. In order to monitor the trend of changes in the study period, monthly and annual trends have been statistically analyzed. The finally, the mobility of quick sands and climatic variables in sandy areas and sand dunes are investigated.

To study the effect of climate change, especially wind and precipitation on the activity of sands in order to predict the possibility of mobility of sand dunes and sand dunes and the resulting dust by the Lancaster global method Used. This method can be predicted for the coming decades as well. They are all based on two factors, which reduce or increase the mobility of sand dunes. The first factor is the degree of wind (W) This is expressed as the annual percentage of days when the wind speed is higher than the sand threshold speed, and if the wind speed (W) increases, most sand dunes become mobile. The second factor, on which vegetation

growth depends, is expressed as the ratio between the average annual rainfall (P) and the annual potential evaporation (PET). Called. The basis of this model is known as the Lancaster Sand Hills Mobility Index [10]. Based on the developed model of wind erosion, [11]. In this model, the amount of sand mobility (M) is determined from Equation 9. In this regard:

$$\boldsymbol{M} = \frac{W}{P/_{PET}} \quad (9)$$

In equation (9) M is Activity of wind sediments, W is Percentage of winds with speeds higher than the erosion threshold speed in m/s at a height of 10 m above the ground, P is Average annual rainfall in mm, PET is Evapotranspiration of annual potential in millimeters.
The experimental value obtained from it is: **A**. Less than 50, dormant sand dunes and sand surfaces stabilized by vegetation, **B**. Between 50-100, active only in sand dune canopy areas; **C**. Between 100-200, dunes are active, but areas between sand dunes are stabilized by vegetation; And above 200, fully active sand dunes. This index seems to show climatic variables and geomorphic environments well in terms of sand activity. After calculating the sand mobility index for different regions of Tehran province, the values obtained are placed in the graph introduced for this purpose to compare their activity index.
Finally, in order to investigate the possible effect of climate change on the mobility of quicksand and intensification of dust, after calculating the activity of wind sediments, using the sensitivity analysis method, the effectiveness of the output variables from the input variables of the model is determined. In other words, sensitivity analysis is a method to change the inputs of a statistical model in an organized (systematic) way that can predict the effects of these changes on the output of the model. The use of sensitivity analysis is used to determine the relationships between model variables and to determine the priority of the effect of parameters on the output of the model. Due to this issue and since some climatic elements such as rain, wind and evaporation have a significant effect on the mobility of quicksand, so the desired variables are changed in a reasonable range and the effect of these changes in the output of the model is the amount of sand movement. In this way, the sensitivity of sand mobility to increase or decrease of any of the variables is determined and if the amount of rain decreases or increases in the future or global warming issues lead to more evaporation or decrease or increase of wind the probable status of these changes will be determined.

After calculations, in the present study, for each of the main meteorological stations of Tehran province with statistics, climatic data (hourly, daily, monthly and annual data) are collected, reconstructed, supplemented and extended, respectively. Collected, analysis of collected climatic data, drought and dust phenomenon (SPI index), drought and dust phenomenon (SPEI index), wind trend and dust storm index (DSI index), irritability of quicksand and climatic factors (Lancaster index) as well as the effects of climate change on the excitability of quicksand have been studied and analyzed, which is followed by the necessary explanations for each meteorological station in Tehran province (unfortunately only for one Mehrabad station in Tehran part of the statistics in The required time period has been prepared) separately as follows.

MEHRABAD STATION TEHRAN

At Mehrabad station in Tehran, part of the statistics in the period 1990 to 2020 (30-year period) including temperature, humidity, annual rainfall, evapotranspiration and the number of dusty days is prepared, each of which is compared separately in the form of tables and graphs. Moreover, compared with the predictable dust storm index (DSI index) and sand dune mobility index (Lancaster index).

A: Comparison of changes in temperature, humidity, precipitation, annual evaporation, number of days and dust per year:
As in separate sections, changes in temperature, humidity, precipitation, evaporation and the number of days of dust in the year and in the statistical period of 1990 to 2020 (30-year period) are studied, in this section, all the factors mentioned in a table (Table 1) is centrally compared. According to the table in 1991, 1994, 2000, 2001, 2003, 2008, 2009, 2010, 2011, 2015 the number of dust days per year was high (over 30 days per year) which is compared with the factors of temperature, humidity, precipitation, Evaporation shows that in the mentioned years, the amount of precipitation, low humidity and conversely, the amount of temperature, evaporation shows an almost high number, which indicates the acceptable accuracy of meteorological data at Mehrabad station and the realization of one of the important goals of the present project. That is, the impact of climatic factors on the unexpected incident of fine dust and dust in the region, all cases separately in the form of graphs and based on available statistics with drought and climatic indicators of dust storm (DSI) and mobility of dust and sand fields (Lancaster) has been compared.

Table.1. Comparison Temperature, Humidity, Annual Rainfall, Evaporation, Dust Days amount in Mehrabad Station of Tehran.

No	Year	Temperature. Av	Humidity. Av	Annual Rainfall. Av	Evaporation. Av	Dust Days
1	1991-1990	16.7	61.7	122.6	1927.0	0
2	1992-1991	16.9	41.3	267.2	2063.0	35
3	1993-1992	16.3	41.1	319.8	1827.0	15
4	1994-1993	17.5	42.7	218.3	2072.6	23
5	1995-1994	18.0	40.9	254.1	2063.3	41
6	1996-1995	17.6	43.1	319.4	2191.2	10
7	1997-1996	17.9	40.5	154.4	2644.4	13
8	1998-1997	18.0	42.8	236.5	2672.1	11

9	1999-1998	19.3	39.0	182.8	2641.3	4
10	2000-1999	18.4	43.5	168.4	2495.8	29
11	2001-2000	18.8	57.3	179.6	2531.4	53
12	2002-2001	19.3	40.0	191.9	2623.2	36
13	2003-2002	18.6	39.2	333.4	2366.9	18
14	2004-2003	18.5	40.5	315.7	2030.2	31
15	2005-2004	18.0	43.7	329.1	2040.2	12
16	2006-2005	19.0	38.2	270.9	1989.7	17
17	2007-2006	18.6	42.7	232.6	2176.8	15
18	2008-2007	17.7	41.6	293.4	2333.1	19
19	2009-2008	19.2	31.6	138.3	2396.9	44
20	2010-2009	18.5	36.8	235.4	1618.4	56
21	2011-2010	18.7	33.6	217.1	2308.2	33
22	2012-2011	17.5	36.1	318.0	2343.6	54
23	2013-2012	18.7	35.1	242.0	2641.8	29
24	2014-2013	18.1	34.0	111.6	2635.6	26
25	2015-2014	18.9	33.1	136.5	2513.7	22
26	2016-2015	19.2	33.2	202.4	2508.1	40
27	2017-2016	18.2	33.7	168.0	2540.1	25
28	2018-2017	19.3	31.3	152.7	2474.9	17
29	2019-2018	18.9	35.7	256.0	2379.0	12
30	2020-2019	18.5	36.8	374.0	2318.4	8

B: Wind and dust storm trend changes:

In this section, different wind speeds in the period with statistics for Mehrabad station in Tehran, which had statistics in the form of monthly and annual wind speeds were examined. The investigation process was as follows: all wind events that are recorded at three-hour intervals at Mehrabad station in Tehran are counted and then in five slopes less than 6 meters per second, 6 to 10, 11 to 15, 16 to 20 and more Were classified from 20 m/s (Tables 2 and 3). In this way, it is possible to determine the seasons with a high percentage of wind speed, compare, and analyze the frequency of the number of dust days in different seasons of the year.

Investigation and evaluation of the frequency of different winds in a period of 30 years in Mehrabad station of Tehran showed that the region in terms of monthly:

- The area has no wind with a speed of more than 20 meters per second.
- The highest wind speed of 3.56 meters per second was related to late May and early June.
- The lowest wind speed of 1.70 meters per second was related to late December and early January.
- In terms of frequency in all months of the year, wind speeds of less than 6 meters per second have been predominant.
- In terms of frequency in all months of the year, wind speed values between 16 to 20 meters per second had the lowest values.

In addition, the study and evaluation of the percentage of frequency of different winds in a period of 30 years in Mehrabad station of Tehran showed that the region is also seasonal:

- The area has no wind with a speed of more than 20 meters per second.
- The highest wind speed of 3.40 meters per second was related to spring.
- The lowest wind speed of 1.90 meters per second was related to autumn.
- In terms of frequency in all seasons of the year, wind speeds of less than 6 meters per second have been predominant.
- In terms of frequency in all seasons of the year, wind speed values between 16 to 20 meters per second had the lowest values.
- In all seasons of the year, the wind has been dominant in the west.

Table.2. Percentage of monthly frequency of wind speed classes in Mehrabad station of Tehran

No	Month	Frequency of wind speed classification (%)					Average wind speed (m/s)
		Less 6	6-10	11-15	16-20	More 20	
1	Jan	91.1	8.1	0.8	0.0	0.0	1.98
2	Feb	86.6	11.9	1.4	0.0	0.0	2.72
3	Mar	81.9	15.7	2.4	0.0	0.0	3.18
4	Apr	79.7	17.8	2.4	0.2	0.0	3.43
5	May	79.5	17.8	2.5	0.2	0.0	3.56
6	Jun	85.3	13.5	1.1	0.1	0.0	3.26
7	Jul	91.9	8.0	0.2	0.0	0.0	2.88
8	Aug	95.5	4.4	0.1	0.0	0.0	2.44

9	Sep	93.8	5.8	0.4	0.0	0.0	2.35
10	Oct	91.5	7.7	0.8	0.0	0.0	2.24
11	Nov	93.2	6.0	0.8	0.0	0.0	1.87
12	Dec	93.8	5.6	0.5	0.0	0.0	1.70

Table.3. Percentage of annual frequency of wind speed classes in Mehrabad station of Tehran

No	Season	Frequency of wind speed classification (%)					Average wind speed (m/s)	dominant wind
		Less 6	6-10	11-15	16-20	More 20		
1	Winter	86.5	11.9	1.6	0.0	0.0	2.6	W
2	Spring	81.5	16.4	2.0	0.1	0.0	3.4	W
3	Summer	93.7	6.1	0.2	0.0	0.0	2.6	W
4	Autumn	92.8	6.4	0.7	0.0	0.0	1.9	W

Wind and Dust Rose in Mehrabad station of Tehran:
Graphs and diagrams of annual winds rose in Mehrabad station of Tehran showed that the prevailing wind blows from the west to the station, although in summer, especially winds with less speed and frequency from the south and southeast, affect this station. However, the station's storms rose showed that they were blowing from the west in all seasons. According to the mentioned explanations, its documents are shown in Figures 1 and 2 in the form of frequency and trend of annual wind and dust rose in Mehrabad station of Tehran.

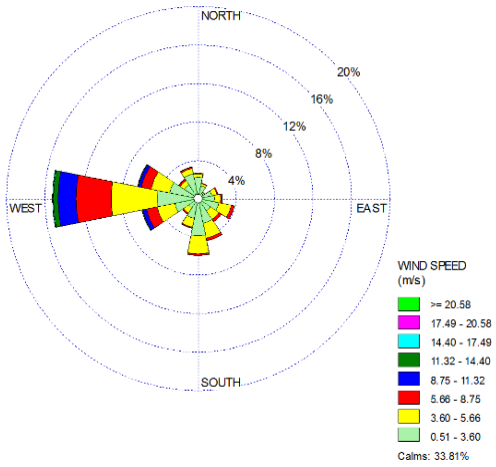

Fig.1. Wind Diagram Rose in Mehrabad Station of Tehran

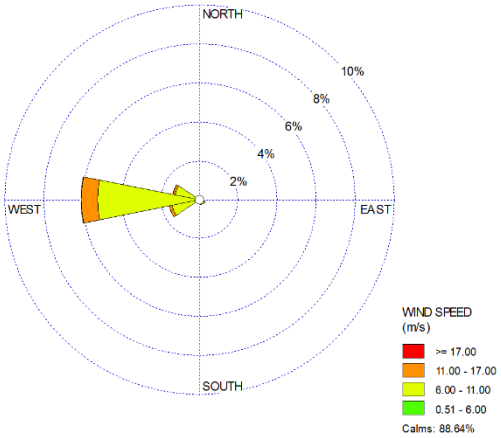

Fig.2. Dust Diagram Rose in Mehrabad Station of Tehran

C: Comparison of changes in DSI, Lancaster and SPEI index based on available statistics:

1. Dust Storm Index (DSI):
In equation number 8, for the years with statistics in Mehrabad station of Tehran, the values of dust storm index were examined and displayed in the form of table number 4. The above table shows that in the years 1992, 1996, 1999, 2000, 2001, 2002, 2004, 2011, 2012, 2013, 2014, the dust storm index (DSI index) shows almost a high body and above the number one, it is noteworthy that in most of the mentioned years, temperature and evaporation values are high and precipitation and humidity values are relatively low, which shows the direct relationship between dust storm index (DSI index) and meteorological factors and data in Mehrabad station of Tehran. Be.

2. Sand dunes mobility index (Lancaster index):
Using the mentioned formulas for the years with statistics in Mehrabad station of Tehran, the values of sand mobility index (Lancaster index) were examined in the form of table number 4. The above table show that in the years 1990, 1995, 1997, 1999, 2000, 2001, 2002, 2009, 2010, 2011, 2013, 2014, 2015, 2016, 2017 sand hills mobility index (Lancaster index is almost high and shows above fifty. It is noteworthy that in most of these years, the values of temperature and evaporation are high and the values of precipitation and humidity are relatively low, which shows the direct relationship between the hill mobility indexes. Sand dunes (Lancaster index) with meteorological factors and data in Mehrabad station of Tehran.

3. Drought and dust phenomenon index (SPEI index):
In order to evaluate the dry and wet years and its effects on the increase or decrease of days with dust, using SPEI index, the status of drought years and periods is examined and considering that SPEI index in addition to rainfall, also considers evapotranspiration, so areas with positive temperature anomalies, even with adequate rainfall, may be within drought areas. On this basis, drought was studied in the study areas using this index. In this section, through the mentioned formulas for years with statistics in Mehrabad station of Tehran, the values of dust storm index in the form of tables 4 and 5 were examined and exhibited. The table show that in 1992, 1993, 1994, 1996, 1998, 2003, 2004, 2005, 2006, 2007, 2011, 2012, the drought index and the dust phenomenon were positive values and in 1990, 1995, 1996, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2013, 2014, 2015, 2016 Drought index and dust phenomenon Negative values and also in 1996 and 2016 SPEI index were the highest (1.86) and the lowest (1.50), respectively. Has shown the amount in the years under review. As a result, Tehran (Mehrabad station) according to Table 5 experienced a severe year in 1996 and a severe drought in 2016.

4. Drought situation analysis based on SPEI index:
As mentioned in the SPEI index, in addition to precipitation, it also takes into account evapotranspiration factors, so areas with positive temperature anomalies may be within drought zones, even with adequate rainfall. Therefore, the study of drought in Tehran province using this index is of particular importance. Based on the mentioned index and relying on the classification of table number 4 and 5 of Tehran province in 2016, intense drought, in 1990, 2001, 2008, 2010, 2014, general drought, in 1993, 1994, 1995, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006, 2009, 2013, 2015, normal condition, in 1991, 1992, 2012, normal wet year and finally in 1996, 2007, 2011 wet year Has been severely encountered. So, as mentioned in the paragraph above, Tehran (Mehrabad station) according to Table 5 had a severe year in 1996 and a severe drought in 2016.

Table.4. Comparison Dsi and Lancaster and Spei Indexes amounts and there is Averages in During the Statistical Period in Mehrabad Station of Tehran.

No	Year	DSi. Amount	Dsi. Av	Lancaster. Amount	Lancaster. Av	Spei.amount	Spei. Av
1	1991-1990	0.4	0.93	76.39	59.30	-1.14	0.02
2	1992-1991	0.3	0.93	39.61	59.30	1.28	0.02
3	1993-1992	1.65	0.93	40.38	59.30	1.03	0.02
4	1994-1993	0.45	0.93	42.76	59.30	0.77	0.02
5	1995-1994	0.45	0.93	38.49	59.30	0.89	0.02
6	1996-1995	0.9	0.93	77.92	59.30	-0.89	0.02
7	1997-1996	1.35	0.93	27.08	59.30	1.86	0.02
8	1998-1997	0.5	0.93	83.74	59.30	-0.91	0.02
9	1999-1998	0.85	0.93	39.50	59.30	0.08	0.02
10	2000-1999	1.05	0.93	67.55	59.30	-0.72	0.02
11	2001-2000	1.2	0.93	63.21	59.30	-0.33	0.02
12	2002-2001	1.75	0.93	69.22	59.30	-1.38	0.02
13	2003-2002	1.1	0.93	50.63	59.30	0.19	0.02
14	2004-2003	0.75	0.93	43.22	59.30	0.77	0.02
15	2005-2004	0.85	0.93	40.34	59.30	0.99	0.02
16	2006-2005	1.1	0.93	47.56	59.30	-0.05	0.02
17	2007-2006	1.2	0.93	47.57	59.30	0.28	0.02
18	2008-2007	0.15	0.93	36.01	59.30	1.36	0.02
19	2009-2008	0.3	0.93	84.04	59.30	-1.44	0.02
20	2010-2009	0.15	0.93	60.81	59.30	-0.01	0.02
21	2011-2010	0.85	0.93	67.30	59.30	-1.21	0.02
22	2012-2011	1.55	0.93	33.37	59.30	1.21	0.02
23	2013-2012	2.15	0.93	49.55	59.30	0.85	0.02
24	2014-2013	2.30	0.93	82.38	59.30	-0.82	0.02
25	2015-2014	0.75	0.93	127.35	59.30	-1.34	0.02
26	2016-2015	0.50	0.93	67.39	59.30	-0.50	0.02
27	2017-2016	0.55	0.93	97.85	59.30	-1.50	0.02
28	2018-2017	---	---	---	---	---	---
29	2019-2018	---	---	---	---	---	---
30	2020-2019	---	---	---	---	---	---

Table.5. Drought status classification based on SPEI index in Mehrabad station of Tehran

Category	Spei Amount	Drought Situation
1	More 2.00	very intense Wet year
2	1.50-1.99	Intense Wet year
3	1.00-1.49	General Wet year
4	0.99- -0.99	Normal Year
5	-1.00- -1.49	General Drought year
6	-1.50- -1.99	Intense Drought year
7	Less -2.00	very intense Drought year

DISCUSSION

Studies and evaluations of research have shown that the earth is gradually warming and the spread of drought in the coming years is not far from expectation, among which drought is one of the most important factors in climate change, followed by changes in temperature and It will be accompanied by rain. Extensive arid and semi-arid climate of Iran and neighboring countries and improper exploitation of water and soil resources have intensified wind erosion and the occurrence of dust and quicksand, so that every year population and industrial centers, agricultural lands and Affects infrastructure structures.

Since the phenomenon of dust and the movement of quicksand is considered as one of the important processes of land degradation and a serious challenge in Iran and climatic factors also play an important role in this phenomenon, so in this study These factors were studied and recognized in terms of their impact on the occurrence and intensification of dust and mobility of quicksand. To investigate climatic factors such as temperature, rainfall, humidity, changes in wind regime, drought indicators, dust storms, irritability of quicksand, etc. affecting the phenomenon of dust inside and outside the climate of Iran, significant research activities were performed. Which has been mentioned in the resource review section and in each case different results have been obtained from the impact of climatic factors affecting the dust phenomenon.

Discussion of origin, nature, characteristics, routes of movement, existing compositions of dust storms, effects and consequences of their spread over cities and villages Various activities have been carried out in the world. Dust source areas in the world usually have an annual rainfall of less than 288 to 258 mm and are located in the lowlands in terms of topography. Among the most active sources of dust production in the world can be deserts and dry lakes that He pointed out that the cause of regional climate change has turned into small deserts. Dust is one of the most important environmental problems in the world, which has attracted a lot of attention in recent years.

This problem affects all aspects of human daily life (such as human health, impact on the electricity distribution industry, development of desertification, agriculture and ecotourism, etc. For sustainable dust management, it should first be sourced and then comprehensive management should be considered. Internal or external dust source is important because it will consider the need for investment inside or outside the region, and comprehensive management is emphasized because if not all aspects are considered. The impact on the source of dust will not be achieved through sustainable management, and as a result, all actions taken will be ineffective. Multilateral solutions and while studying the ecosystem from various aspects such as soil science, geology and climatology in this view have been considered by researchers. As mentioned, the storms in the Middle East are mainly divided into different types of northern, frontal and convective. The main type of these storms is the northern type, which occurs in Iraq, Kuwait and the Arabian Peninsula. In recent years, dust storms in the Middle East, especially in the deserts of Saudi Arabia and Iraq, have had many harmful effects on our country, which has spread to major cities. Analysis of currents and satellite imagery studies in the Middle East show that the world's sandy desert called "Rabi al-Khali", due to its lack of rangeland and recent droughts, is one of the sources of dust in the eastern part of the Middle East, Oman and the United Arab Emirates.

For example, researchers have listed the most important foreign sources of infiltration dust into Iran as follows: three in Syria, one on the Syrian-Iraqi border, four in northern Iraq and the Euphrates River basin, and one in central Iraq. Other sources point to the eastern and southeastern plains of Saudi Arabia, parts of the United Arab Emirates, Yemen, and Kuwait, as well as North Africa, as foreign sources of dust in Iran. Together, these hotspots cause dust storms known as Arabian dust storms, which have affected the mentioned conditions in Tehran province as well as in different places.

Discussion and Analysis In studies that examined the incidence of dust in the southwestern region of Iran in a 10-year period from 1998 to 2007 in 10 different cities, researchers observed that in this 10-year period, in total in the cities There were 4552 days of dust study in which the source of dust in 3285 days (72%) was the deserts of neighboring countries of Khuzestan province such as Iraq, Syria and Saudi Arabia and only in 1264 cases (28%), the source of this dust was itself. Khuzestan province has been the reason why, according to researchers, dry and devoid of vegetation in a large part of the Khuzestan plain, especially in its central areas has been mentioned.

However, despite the fact that experts have mentioned the share of foreign centers in the production of dust more than 70%, the results of research show that there are several areas inside our country that are able to play a role in the production of dust storms. To be. Among these, dried wetlands such as Hur al-Azim or Hur al-Hawizeh wetlands, which is one of the most important centers of dust, are mentioned.

However, only one third of the Hur al-Azim wetland is located in our country and the other two thirds are in Iraq.

Some sources also refer to the Abadan Delta and its sand dunes as areas prone to dust production.
Discussion and analysis in another comprehensive study conducted by our country's researchers in order to identify dust centers, using a combined study of meteorological and satellite data, days with dust along with horizontal visibility of synoptic stations in Khuzestan and Ilam provinces in one A relatively long period of time from 1990 to 2013 has been studied. The result of this study was to identify 62 different points as internal sources of dust that were classified in three general areas: Zone 1 located in the west of Ilam and the border of this province with Iraq, Zone 2 including the south of Ilam, North Khuzestan and their intersection with the border. Iraq and finally Region 3, including the areas around Hur al-Azim Wetland. According to the results of this research, dust created from region 1 often does not enter the territory of our country. However, regions 2 and 3 are the main causes of dust in Khuzestan province, the first of which completely affects the north, north of Khuzestan and the other west and southwest of this province.
But Tehran province (along with Alborz province) about 74,000 hectares of land in the south, southwest and east of Tehran province are prone to dust, which from this area according to the characteristics and conditions and soil location of the area near the city of Varamin (to Special area of Charmshahr) and Rey city (southeastern and western areas of Rey) is more than other cities of the province, in general, most of the area around Garmsar-Qom highway (especially in the southern areas of the road) in Tehran province with the center Are accompanied by dust. (Director General of Environment of Tehran Province), in Tehran Province, uncontrolled extraction of groundwater and sand mines, development of water-based industries (such as steel), increasing the level of water evaporation (with the construction of dams), etc. are among the factors that They have created dust centers on the outskirts of cities in Tehran province.

COCLUSION

As mentioned in the discussion section of the present study, the vast arid and semi-arid climate of Iran and neighboring countries and improper use of water and soil resources have intensified wind erosion and the occurrence of dust and quicksand. Every year, population and industrial centers, agricultural lands and infrastructure structures are affected. Since the phenomenon of dust and the movement of quicksand is considered as one of the important processes of land degradation and a serious challenge in Iran and climatic factors also play an important role in this phenomenon, so study and identify These factors have a special place in terms of their impact on the occurrence and intensification of dust and mobility of quicksand. In this study, the relationship and annual trend of days with dust as a dependent variable with simultaneous temperature, evaporation and precipitation data as independent variables during the study period were studied and compared.

The results of this part of the study showed that the number of days with dust in Mehrabad station in Tehran in the 30-year period has increased and in the last decade has been higher than the average in all years. Further investigation showed that the station in the last decade was affected by trans-local dust and most of the dust days in Mehrabad station occurred in summer and then in spring.
A. From all the parameters of air and climate, rainfall, temperature and evaporation can be mentioned as three important and influential factors on the climatic situation of each region. The study of long-term average annual rainfall, temperature and evaporation showed a significant increase in temperature and evaporation and a decrease in rainfall during the statistical period in Tehran province.
B. Since dust usually occurs in conditions where the wind speed is higher than the erosion threshold, the wind speeds higher than the erosion threshold for the stations were calculated during the study years. From the point of view of changes in wind regime and dust storm in the region in the form of monthly and annual wind speeds, the maximum and minimum wind speeds in the months and seasons of each year during the statistical period have been determined separately.
C. Calculation of long-term dust storm index (DSI) at Tehran station showed that the general trend of dust storm index at the station, although not significant, is increasing. The results of the dust index in the same period of ten years leading up to 2016 for Tehran station was 21.95 dust index.
D. Winds that are strong enough to move the sand; Also lack of vegetation to stabilize the sand. Depending on the relative balance of these three variables, different types of hills may be formed.
E. Drought and risk of desertification: Usually, changes in the activity index of sand dunes reflect natural factors such as climate change, which show themselves in the process of desertification of an area (desertification due to the movement of sand). Examination of the relationship between land index and Lancaster index at Tehran Mehrabad airport station showed that there is an almost high (Equal to %98) linear relationship.
F. In order to evaluate the dry and wet years and its effects on the increase or decrease of days with dust, using SPEI index, the status of drought years and periods has been studied and has been determined separately in different years.
G. As stated in different parts of the research report in Tehran province, which is the focus of the present research sub-project of the macro plan "monitoring of climatic factors affecting the phenomenon of dust and quicksand in the country" in the lands south, southwest and east are prone to the phenomenon And there was dust, which from this area due to the characteristics and conditions and soil position of the area around Varamin city (especially Charmshahr area) and Rey city (southeast and west Rey areas) was more than other cities in the province.

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