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Interaction between dust concentration and fluctuating seasonal temperature in Khuzestan province

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Abstract

Dust is a mass of solid particles that diffuses in the atmosphere and diminishes the brightness and limits horizontal visibility. One compelling reason would be climate change that has adverse effects on the environment. Increasing in dust concentration during last decades caused more decline in vegetation in the west of Iran. This is an interactive effect on vegetation cover and dust storms in this area that also have some health risks. Researchers showed a remarkable increase in death rate between respiratory patients by escalating in dust concentrations. Iran is located in dry land of the world, especially the Khuzestan province; thus, dust systems are frequently exposed to having internal and external origin. Drying of wetlands in Khuzestan province leads to dust occurrence exacerbated by winds carrying larger amount of dust from Iraq, Saudi Arabia, Kuwait, Jordan and Syria towards to the southwest of Iran and numerous deficiencies. Other reasons are the reduction of air humidity, temperature rise, drought, untapped use of water resources, especially groundwater resources. This study attempts to investigate the trend of changes in dust concentration due to fluctuating seasonal temperature in Khuzestan province during about the 30 years from 1993 to 2015. A comparison between temperature and dust concentrations showed the highest rate of dust concentrations in June and July. According to the adverse effects of suspended particles on health and vegetation, knowing he changes in this phenomenon will help to short, medium and long-term national and regional plans to reduce undesirable effects and eradicate this issue.

Keyword: Dust; Horizontal visibility; Climate change; Khuzestan province; temperature.

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1. Introduction

The human environment is always at risk by natural disasters and one of these natural disasters is dust storms that originate in the deserts of the Persian Gulf and the countries of Iran and Iraq (Razavian and Koshki, 2011). Other than atmospheric instability, dust creation depends on presence or absence of humidity in the air. So that, if unstable atmosphere has enough humidity, precipitation and thunderstorms are created and in the absence of humidity dust storm is created (Alikhani, 1998). These mineral dust particles directly affect weather conditions and indirectly influence absorption and emission of sun light, clouds formations and amount of precipitations (Krueger *et al*., 2004). Dust storms occur when the total annual precipitations is significantly lower than normal precipitations (Ghorbani and Kardovani, 2013). Issues such as atmospheric instability in the deserts of Saudi Arabia, Kuwait, and Syria due to air pressure changes, strong winds, long and repeated droughts, reduced precipitations, and the amount of air and soil humidity, vegetation, soil texture, energy bands (soil adhesion force between soil particles), and earth topography have effects on the formation of dust storms (Xuan *et al.,* 2004; Kianian, 2011). One of the natural sources of the aerosols entry into the atmosphere is the rise and the horizontal motion of the air masses containing fine particles of dusts due to the changes in temperature. These particles may stay in the atmosphere from several days to several weeks (Ederzoli *et al*., 2010). In a study, time variations between the global mean (GMT) and sea surface temperature (SST) in Hormozgan province were investigated and the growing trend of these two data was observed as an alarm to the negative effects of global warming on Persian Gulf environment (Samadianfard *et al*., 2016). The dust's source of the southern and western parts of Iran from 1984 to 1988 were studied by Wilkerson (1991) and 14 single sources of dust storm in the Mesopotamia (Bein-Al-Nahrein) were identified (Bochani and Fazeli, 2011). Using remote sensing techniques, identification and analysis of dust in the western regions of Iran showed that decreasing vegetation and consequently reducing the moisture of the soil and dryness of Hawizeh Marshes Wetland (Hoor-Al-Azim) lead to fine grain production and soil texture alteration, which is the main cause of dust phenomenon in Khuzestan province (Mosavizadeh *et al*., 2011).

The dust storms occur mostly in the spring and summer, and less in the autumn and winter (Ederzoli *et al*., 2010). The worst air quality occurs in July. The reasons of frequent entrance of dust from neighboring countries are the reduction of air humidity, drought, the wasteful use of water resources, the increase of temperature, wind speed and wind direction (Atafar *et al*., 2013). The longest dust phenomenon that lasted for 5 days occurred in July with highest concentration of 2028 μg /m^3 (Shahsavani *et al*., 2012). In this survey during the warm season, especially in July, there was a significant increase in dust and an increasing trend from 2007 to 2015. December also had the minimum dust due to the high rainfall and temperature drop (Tagha *et al*., 2012). The number of stormy days in the last 5 years has reached 366 days. The lowest number of stormy days for all weather stations in Khuzestan province including Abadan, Ahwaz, Omidieh, Dezful, and Masjed Soleyman was observed in the autumn, and the highest ones occurred in the spring for Abadan and Ahwaz stations and

in summer for three other stations.

Actually, at Abadan and Ahwaz stations, the highest stormy days do not correspond to the spring season or to the lowest precipitation (summer), which seems to be due to the difference in the climatic characteristics of the sedimentation and source area (Mehrabi *et al.,* 2015).

In a study conducted by Shahsavani in 2012 on the evaluation of concentrations PM1, PM2.5, and PM10 on dust phenomenon in Ahwaz during the period from April to September 2010, Iraq was reported as the main source of the dust phenomenon in the region and the number of days with dust phenomena was 72 days and 711 hours (Shahsavani *et al*., 2012). In another study, Leon and Legrand (2003) introduced Saudi Arabia as a region producing most severe dust in the world. This difference in determining the origin of the dust storms shows that the diversity of these storms and their temporal and spatial attributes which using 700 weather stations observations during the last 50 years, depends on meteorological factors, especially strong winds, precipitation and humidity in each season (Bochani and Fazeli, 2011). As the distances between Arab countries such as Iraq and Saudi Arabia rises, the source of storm become local and intra provincial (Laili *et al*., 2010).

The number of dust sources in Iraq, Saudi Arabia and Syria increased nearly 3.5 times in the last two decades. The western regions of the country are more exposed to dust systems due to geographical and climatic conditions and proximity to deserts of neighboring countries such as Iraq, Syria and Saudi Arabia, especially since the most atmospheric systems enter the country from northwest, west and southwest. Understanding the chemical and physical constituents of the aerosols and the resulting soil is very necessary to identify the harmful elements and ultimately having policy and planning to eliminate it form regional and foreign policy and cooperation. In areas where dust exists, plant growth reduction and lack of leaf growth can be (Tavakoli *et al*., 2011). This natural phenomenon affects every economic, social, political and biophysical environment, and has caused a lot of negative effects on farmers, so that dust is the cause of a very low vegetation factor in the region between the Saudi and Oman border (Ghorbani and Kardovani, 2013). The main cause of declining the number of Oak trees in the southwest of Iran is also the influence of Arabic dust. Oak trees lose their ability to breathe against the daily invasion of dust, because the Oak leafs are fluffy and can absorb the aerosol. The closure of the ovule of Oak leaves due to the high intensity of aerosol in Zagros; makes these trees no longer have the ability to absorb all of the dust (Bochani and Fazeli, 2011).

Aerosols are of the atmospheric pollutants has adverse effects on the health of the community (Delangizan and Jafari Motlagh, 2012). According to adverse effects of suspended particles on health, awareness of the trend of change, short-term and long-term national and regional planning to address the problem and reduce its effects seems necessary (Atafar *et al*., 2013).

2. Materials and methods

The study area in this survey is Khuzestan province. This area is in particular importance in terms of emissions of possible pollutions and also dust storms, which are the prevailing phenomenon in the southwestern part of the

Figure 1. Khuzestan province, Iran

country (Figure 1). Obviously, it is important to having complete information about this area by knowing the changes in aerosols, dust and temperature. The geographic location of the region is such that the air masses from the southwest and the west can enter the area and have special effects in the distribution of air temperature in this region.

To investigate the effect of dust phenomena with air temperature, observation data of all synoptic stations in Khuzestan province were collected for thirty years. After the verification of data, their time series were drawn up for the past thirty years. For more accurate study two months, June and July for each year were considered. In June and July, the highest probability of dust in the sky was observed. For this purpose, in the region under study, during these two months, the correlation charts, time series, frequency distribution, and air temperature couture lines are compared to determine the relationship between the temperature of the air and the dust phenomenon. The Excel software has been used for statistical analysis and to draw charts and counters.

3. Results

After correction of the air temperature data using the correlation line equation, the time series charts of air temperature, evaporation, radiation and sunshine duration were plotted with horizontal visibility. Since the highest and most significant effect of dust is on the horizontal visibility, it is used for comparison. The analysis of the data shows that there is indirect and somehow complete correlation between the horizontal visibility, water surface temperature and air temperature. But the correlation between horizontal visibility and evaporation, sunshine duration and radiation is indirectly weak.

Air temperature has weak correlation with wind and parameters such as evaporation and sunshine duration, and this is due to the fact that the influence of several parameters of air on the temperature depends on each other, and sometimes the effect of one removes the other's effect. In order to determine and compare the changes of air temperature, horizontal visibility, wind, evaporation, radiation and sunshine duration in the last thirty years in Khuzestan

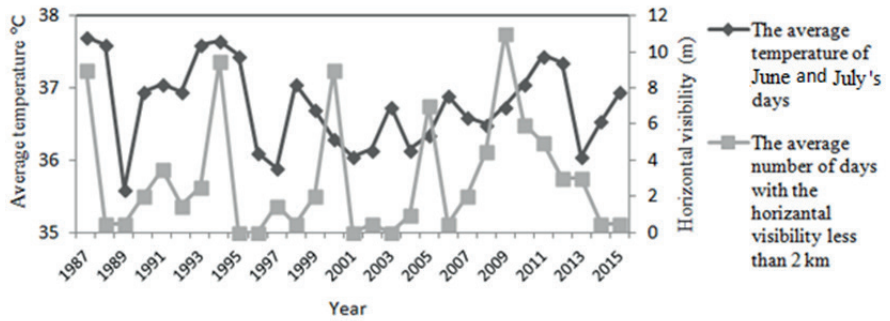

Figure 2. Temperature changes in Bandar-e Mahshar station during 1987-2015

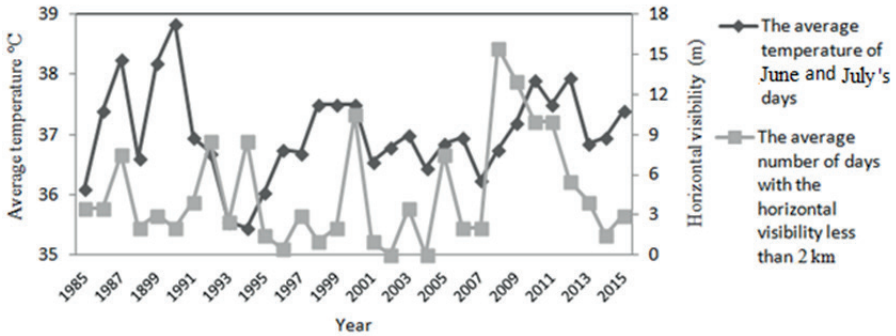

Figure 3. Temperature changes in Abadan station during 1987-2015

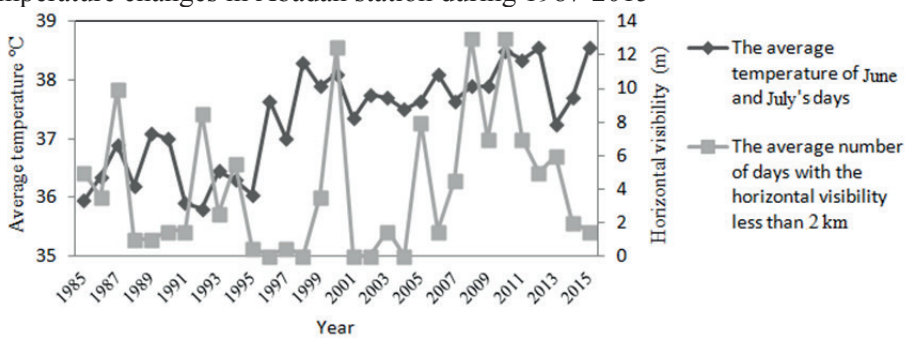

Figure 4. Temperature changes in Ahwaz station during 1987-2015

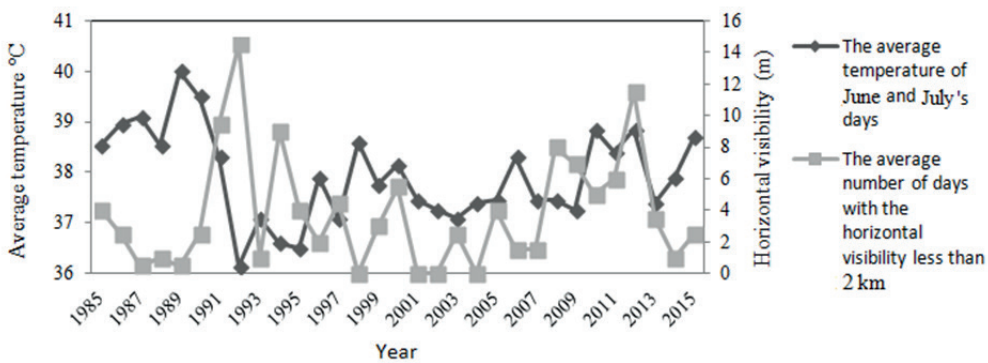

Figure 5. Temperature changes in Masjed Soleyman station during 1987-2015

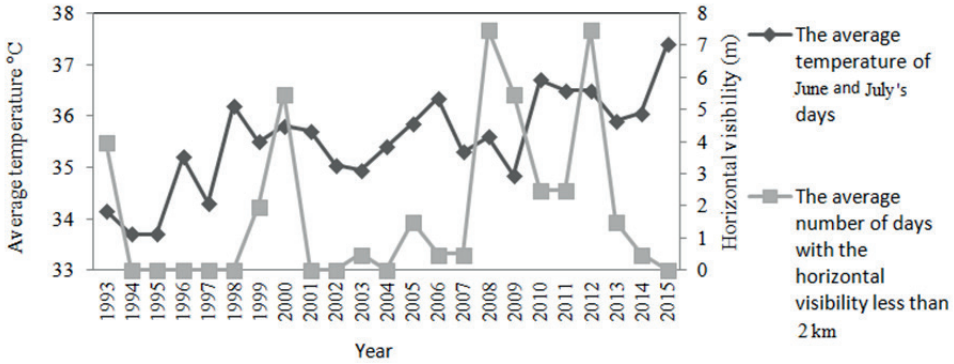

Figure 6. Temperature changes in Izeh station during 1993-2015

province, after the validation of data, the time series charts were drawn (Figures 2 to 6). The purpose was to analyze the variations of these parameters during the months with dusty days. In this study, the temperature trend was analyzed in the six meteorological stations in Khuzestan province, where long term data for 30 years were available and concluded that the average incremental temperature rate was 0.18 °C.

An increasing temperature trend were observed in Ahwaz, Mahshahr, Abadan, Izeh, Masjed Soleyman and Shooshtar stations, which respectively were 0.12, 0.16, 0.09, 0.15, 0.17 and 0.4 in°C.

The trend of average number of dusty days during 22 years was investigated for the six stations and the correlation coefficient was obtained 0.23 for Abadan station, 0.18 for Ahwaz, 0.14 for Bandar Mahshahr, 0.22 for Masjed Soleyman, 0.24 for Izeh (Figure 7, as a sample), and 0.04 for Shushtar.

It is clear that for all stations in the Khuzestan province, the trend of days with dust had been increasing in recent years. This trend was calculated 0.17 over the past thirty years.

4. Discussion and Conclusion

Khuzestan province, which is a part of first grade drainage basin of the Persian Gulf and Oman Sea, is composed of second grade drainage basins, the Great Karoon, West border Karkheh and Zohreh-jarahi. These areas are part of the large and cross border of Arvand River, which is common between Turkey, Iraq, Syria, Iran and Saudi Arabia. The drainage

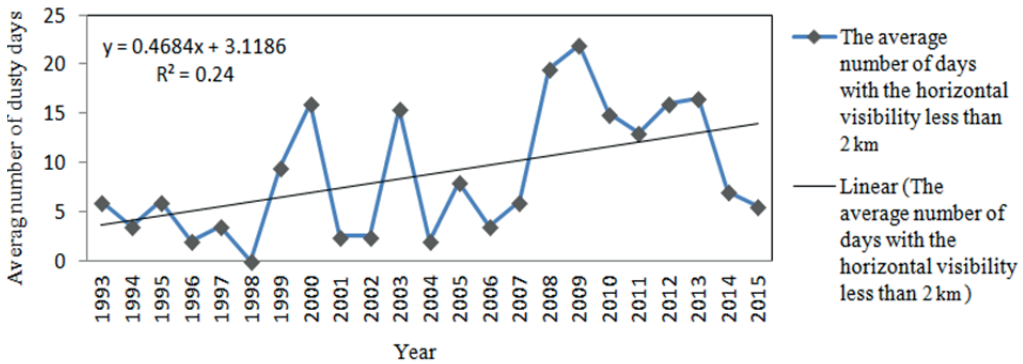

Figure 7. The trend of days with dust in Izeh station during 22 years (1993-2015)

basin of Arvand River is composed of the Dajleh (Tigris) and Forat (Euphrates) drainage basin.

Due to climate change and droughts, this drainage basin has been highly warmed in recent years, so that over the past 15 years, the average temperature in this region growth 0.96 °C. Annual precipitation also decreased by about 27% compared to the long-term average. Dust storm phenomenon in this region has long history, and most of it happened in the dry seasons (summer and early autumn). Due to the ascent of thick dust to the higher layers of atmosphere and its entering into the clouds, the precipitation is extremely cut or reduced.

As a result, dust production causes a lack of suitable precipitation and low or no precipitation causes droughts and development of the dust and storm in the Khuzestan province.

A look at the process of decreasing the precipitation and increasing the temperature in the rainy season at different stations indicated that the average of total winter precipitation in the last five years in the Ahwaz, Bandar Mahshahr, Abadan, Bostan and Dehloran stations decreased to 39.3, 38.2, 38.5, 30.6, and 35.9 in °C, respectively.

Also, the mean temperature in winter has increased in the last five years by about 0.7, 0.7, 0.5, 0.1, and 0.1 in °C, respectively. This result is very significant and shows drought in this region, which is a natural cause of dust storms. The occurrence of local and intermittent droughts is a natural component of the hydrological cycle, and has an historical background. The period and duration of the drought varies depending on its severity. Changes in climate on a global scale can also be considered to cause dust storms.

Since the main cause of climate change is the producing greenhouse gases into the earth's atmosphere by humans, this factor also has been a human made component in global scale. Although most of the dust storms that affect the western provinces of Iran have foreign origin, in recent years, the dust storms in the Khuzestan with domestic origin sources has been increased.

In recent years, many studies have been conducted on the identification of foreign origin of the dust storms. Most of these studies are based on the satellite data and remote sensing techniques. On this basis the main origins of dust storm are as follows:

Region 1**:** Northwest of Iraq and Syria, both side of Forat River (Euphrates),

Region 2: Wetlands and dry land in the southern Iraq (Mesopotamia),

Region 3: Lands nearby and north of Tartar Lake in Iraq,

Region 4: The lands of western Iraq (Anbar province) and eastern Syria (Homs province),

Region 5**:** The border areas of northern Arabia and east of Jordan, the domestic origin of dust expands from the east and south-east of Ahwaz to the east of Hendijan in southeast of province. The west of the province is also the dried parts of the Hoor-al-Azim wetland in the west of and its Hoveyaze surrounding areas, and also parts of the north of Khorramshahr, which are part of the origin area. Typically, Khuzestan dust storms are both widespread and local. Dust storms, as one of the most common natural disasters in the last century have multiple negative effects on ecosystems. Dust storms in the Khuzestan province become local by moving from the west to the east.

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