An Investigation of Sources of Dust Storms in the Southeast and Southwest Regions of Iran

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Abstract:

Dust storm is a devastating climatic phenomenon that happens in different regions of Iran every year and causes many financial losses and health effects. Iran Plateau due to the exposure to the dry belt on the northern hemisphere, poor water supply, low atmospheric precipitation, low soil moisture, and low amount of vegetation (hyper-arid region), is considered to be a prone region for wind erosion. These prone regions are found in the East of Iran (Sistan and Khorasan) and the West (Khuzestan) and they are considered to be the origins of dust storms. But the east's parts contribute more in dust production. In West of the Iran, more than 70% of the dust storms have a foreign origin, and only the small part, have an internal origin. The causes of the foreign origins are some arid lands such as Robalkhali desert, and Huralazim wetland as well as dry parts of Tigris and Euphrates. Long periods of drought and reduction of soil moisture are the causes of internal origin. Whereas the eastern dust storms have an internal origin. 120-day winds of Sistan, Hamoon Lake drought, consecutive droughts and reduction of soil moisture and low precipitation are the causes of eastern dust storms.

Keywords*: Dust storm, Sistan and Baluchestan, Khuzestan, Wind erosion, Huralazim wetland, Robalkhali desert*.

1. Introduction

More than two-thirds of Iran's area includes arid and desert lands, with an estimated 34 million hectares of deserts and sand dunes, 85% the former, and 15% the latter.

According to the Environmental Status Report in 2005, the Iranian plateau due to its location on the arid belt of the northern hemisphere; It has weak water reserves, low rainfall, and low vegetation cover. The poor vegetation allows wind to easily explore the surface of the soil and annually large amounts of surface soil are carried from one point to another.

Hurricane-made dust storms is one of the types of natural disasters that cause a lot of damages each year in the arid and desert areas of the world including Iran. Dust storms involve small particles of soil and may occur on special occasions emitted to a height of several kilometers above the ground. Strong winds blow large amounts of soil from drylands covered lifting them into the air and obscures the atmosphere, reducing the amount of visibility to less than one kilometer. Dust particles carried up to several thousand kilometers by the wind and they are removed from the atmosphere by dry and wet deposition. These dust have detrimental effects on people's health and the environment. Loss of human life, disruption of their economic and social situation, and air pollution are examples of dust harmful impacts. Dust storms not only in Iran but also in other Asian, in African and in American countries cause a lot of financial and human losses.

Iran’s Sand and Desertification Technical Office based on the identification plan of wind erosion centers and determining specific executive priorities determined that 14 provinces in Iran are affected by wind erosion. Among them, Sistan and Baluchestan province (located on the east of Iran) has the highest rank dedicated. The Sistan region in this province has more number of dust storms occurrences, with an average of 54 days of dust storms per year. Khuzestan province (located on the west of Iran) ranked second having dust 45 days of dust storms per year. The purpose of this article is to compare the origin of dust storms in southeastern Iran (Sistan and Baluchestan province) and southwest of the country (Khuzestan province) and to discuss what measures should be taken in these areas to reduce damages.

2. Materials and methods

2.1. Sistan region

Sistan has an area of 15197 square kilometers in the geographical area between 60° 15' to 61° 50' longitude and 30° 5' to 31° 28' latitude is located in southeastern Iran. Annual average for precipitation, temperature, and relative humidity are 59 mm, 22 °C, and 38%, respectively. Also, according to the Dumarten classification obtained 1.9 for drought index making it classified as an arid region.

2.2. Khuzestan region

Khuzestan province with an area of about 64236 square kilometers with the geographical coordinates 47° 41' to 50° 39' longitude and 29° 58' to 33° 4' latitude is located in southwestern Iran. The north and east of Khuzestan are covered by the Zagros mountain range, the heights of which decrease in the southwestern direction changing to the forms of sand dunes in the southern parts. Khuzestan province can be divided into the two mountainous and the plain regions. This province has a different climate across its geographical location: the semi-arid climate in Abadan, Khorramshahr, Mahshahr, Hindijan, Dasht-e Azadegan and Dezful, Behbahan, Ramhormoz, Shushtar and the northern regions of Ahvaz and the arid regions include northern parts of Dezful, Behbahan, Ramhormoz, Shushtar and northern Ahvaz.

This study is based on the library method and a comparative aspect is discussed.

3. Discussion

3.1. Sistan and Baluchestan Dust Sources

We will first discuss the southeastern region (Sistan and Baluchestan). This region's analysis using Gusen method identify it as a desert area, and similar analysis using Kupen method recognized this area as a dry area. The important climatic characteristics of this area causing drought include the average number of annual sunny days more than 260 days, high sunlight, high range of day and night temperature differences, low annual average rainfall with disperse vegetation, high winds. The combination of these factors has caused this region to have the highest annual potential evaporation rate of 4000-5000 mm per year.

The Zabul region (located in Sistan and Baluchestan) is far away from the seas and oceans, and only has Hammon Lake like a belt on its north. When the precipitation is high, it affects the humidity and temperature of the Zabul plain. The only source of water in the Sistan plain is the Hirmand River which originates from the Hindu Kush and Baba Yaghma Mountains in northwestern Kabul and, after traveling 1,050 km, reaches Hamoon Lake. It covers an area of 4,000 square kilometers. The amount of water that enters Sistan (originating from Hirmand River) is 50 cubic meters per second and this is when the water subsides and reaches the lowest level, but in normal cases, there is a flood with flow rate of 1500 to 2000 cubic meters per second.

One of the noticeable features of this region is the occurrence of 120-day winds, which is as a result of pressure gradient occurs between the mountains of Afghanistan and Sistan plain. The winds start almost in June and continue for about 4 months and ending in mid-September in Zabol plain. Sistan's 120-day wind is the most powerful wind in Iran, with a wind speed of 120 kilometers per hour. The source of the wind is from the Pamir and Sahara plateaus of Herat and enters Iran from the western border of Afghanistan. These winds enhance evaporation from Hamon Lake, reservoirs, and agricultural lands. The mountains and the lake in the north of Sistan

and the desert areas in the southern region has caused high temperatures gradient which brings 120-day winds with high intensities.

Results from synoptic station for the period of 1962-2004 displays the prevailing southwards wind in Zabol region. Analyses of these data (from synoptic station) also show the average of the dusty days in this area is 54 annually.

Studies indicate that after 2001 the numbers of dust storms in Zabol region increased up to 74 days in a year. This indicates the successive droughts in the aggravation of desert conditions and increase of wind and dust storms in the Sistan plain. Also, the complete cut-off of the Hirmand River and the sharp decrease in rainfall in the region caused the most parts of the Hamoon Lake to be completely dried out. Following with a sharp decrease in the amount of precipitation, the vegetation cover in the region reached its minimum, also due to the fact that the soil is sensitive to erosion (due to e.g. no proper construction, no sandy texture, no soil stabilizers, and no cementitious materials); it is easily removed from surface and is transferred to other places. The winds in this area sometimes reach speeds of more than 100 kilometers per hour; remove large amounts of sediment from the surface of the dried lake and deposit that dust or sand falls on the city of Zabol and the surrounding villages. Therefore, Hamoon Lake, it is another major factor in the formation of dust storms.

The analysis of synoptic station data showed an Increase in frequency of dust storms after the 1999 drought is as a result of a decrease in vegetation coverage and soil moisture in Sistan plain, especially the Hamoon Lake bed.

On the other hand, due to the lack of sufficient moisture on the soil surface, soil particles do not have the required adhesion to withstand wind. Therefore, as soon as the wind speed increases, the soil particles are easily suspended in the air and the horizontal visibility decreases rapidly.

Therefore, it can be concluded, however, in the Sistan region, dust storms existed due to the presence of 120-day winds and the presence of sensitive soil, they have been intensified after recent drought and wind erosion and dust storms have formed and have reached their maximum intensity.

3.2. Khuzestan Dust Sources

Now we explain the dust storms sources in southwestern Iran (Khuzestan region). According to the data of synoptic stations of Khuzestan province in 1996, the absolute minimum temperature is -2°C degree Celsius and the absolute maximum temperature is reported to be 45 °C degrees Celsius in Ahvaz. Khuzestan province is affected by three types of winds: the first wind, the cold current of mountainous areas and the second wind is the hot current and moisture from the Persian Gulf that blows towards the plain. The third wind blows from Saudi Arabia and there is always some sand and dirt moisture comes with it.

3.2.1 Dust Storms with foreign origin

Due to the influx of foreign flows or drastic changes in pressure between the Sahara, Saudi Arabia, Yemen, the United Arab Emirates, Oman, and Iraq, severe storms and severe wind erosion in these areas are blown towards west of Iran (Khuzestan region) which mainly causes sandy soils removal from surface with sizes of less than 0.05 mm into the air. Therefore, southwestern part of Iran is strongly affected by these dust flows.

According to past studies, the main cause of this phenomenon is the largest sandy desert of the world, Rab al-Khali, located in the countries of Saudi Arabia, Yemen and the United Arab Emirates. This desert is covered with sand dunes and its area is about 64 million hectares.

This desert is completely devoid of vegetation and due to low annual rainfall only has dispersed one-year plant cover on its surface. In the last two or three years, due to the drought, this dispersed one-year plants coverage has decreased and subsequently the amount of dust has increased. Therefore, it can be said that the main cause of dust in the southwestern regions of Iran is due to strong winds from the area of Rab al-Khali.

Most importantly, there is a large body of research conducted mineral dust identification for western part of Iran. These studies suggested that the sources of western regions' airborne dust could be the desert areas located in neighboring countries. Removal and transportation of mineral dust from one place and its deposition into another place is a phenomenon that commonly occur around the world.

3.2.2. Dust Storms with internal (local) origin

About 40% of the areas in Khuzestan province are affected by wind erosion distributed in Ramhormoz, Ahvaz, Omidiyeh and Shush. However, intra-provincial wind erosion has played a very small role in creating dust because of the size of the sand particles which is larger than 180 μm (Aghajari and Bakhtiari geologic formations), which only have saltation or creeping movements. Local dust comprises only 27% of the total dust in the area, which is one of the six main sources of dust originated from Khuzestan province.

4. Conclusion

Therefore, the rate of wind and dust erosion in the eastern part of Iran (54 days) is higher than the western part (45 days) and this rate dust in both areas is rising due to increased drought. Also, dust in the eastern regions of the country has internal origin. Due to strong 120-day winds in the Sistan region, the dry Hamoon Lake, consecutive droughts, as well as declining soil moisture and declining rainfall, all have increased dust generation.

In contrast, in the west of the country (Khuzestan region), more than 70% of the dust generated has foreign origin and only a small part has an internal origin. Dust of foreign origin has been created due to the existence of dry and waterless deserts in the neighboring countries (e.g.

Yemen) that is exacerbated by prolonged droughts. Similarly, internal dust in the area is due to water shortage and long-term drought.

Since wind erosion control operations should be carried out in source areas, to control and decrease wind erosion in desert areas, there is a need to consult with neighboring countries.

However, in order to reduce dust in areas of internal origin, many preventive measures can be taken, including:

- Soil protection in desert areas by livestock grazing management.
- Cultivation of native plants including: Stipagrostis, Haloxylon, Atripelex, Tamarix, Sasola, Citrullus.
- Creation of green space belt designs and natural windbreaks in order to reduce the rate of erosive winds.
- Improving the cultivation pattern and water resources management.
- Observing the privacy of villages, airports, roads and railways to reduce traffic in the area which destroys land cover.

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