

A SUMMARY OF INFORMATION OBTAINED FROM THE PHENOMENON OF DUST AND INTRODUCING WAYS TO DEAL WITH IT IN IRAN AND THE WORLD

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Abstract: - A phenomenon that has in several recent years become a permanent feature with the country's provinces is The Dust Phenomena. The phenomenon occurred in the short time of the 1994 in some Southwestern cities of Iran and gradually its severity increased. Various causes such as human interventions in the irrational use of surface and groundwater resources, destruction of vegetation, weakening of Soil due to Agriculture, and frequent use of land and intensification of natural factors such as drought and climate changes have been expressed as a basis for the occurrence of this phenomenon. So these storms are a sign of poor management and bad policy due to the use of traditional technologies regardless of rapid population growth. Because the particles move; effects of this phenomenon is not limited to of region of occurrence but also has an impact on many other terrestrial and aquatic ecosystems of the world. The purpose of this paper is to express a summary of the findings about the dust storms, its effects, and effective factors and ways to confront it worldwide. With the hope that by more cooperation from governments and active investigators in operational studies a day comes that we never witness the occurrence of this phenomenon in our country.

Keywords - Dust phenomena, Factors affecting the occurrence, effects of phenomena, ways of collate

Introduction

Sand and dust storms are natural occurrences that occur widely around the world in arid and semi-arid regions, especially in subtropical latitudes [21]. Iran has an area of about 1/65 million KM² and is situated in Southwest Asia one of the arid zones of the world; it is one of the most of prominent countries that has encountered this phenomenon [17]. Initially the start of a dust storm in Iran was observed between 1984 and 1988. These storms didn't become serious until 2001, but gradually increased in intensity, and towards 2008 covered 18 provinces of the country creating and along with it many problems and losses [19]. Therefore by anticipating any probable heightening of these storms in future, it would be necessary to obtain necessary information and be more aware and understand suitable and appropriate ways for combating and overcoming this.

Sites of dust production in Iran and the World sites of dust production in the World

The biggest and most active regions in world which are the sites for production of dust are found in places where human activities are limited. These regions of dust are linked; starting from the Northwest Africa and after transiting from the Middle East, Central and South Asia reach the mainland of China [6]. Studies have indicated that The Sahara desert is the biggest and main dust producing source in the world when compared to other dry lands such as the Middle East, Southwest Asia,

Central Australia, Southern Africa which are also dust producing sources in the world [21,7]. According to Global estimates dust emissions are between 1000 and 3000 Tg yr⁻¹ Measurements made in The Sahara desert was between 500 and 1000 Tg yr⁻¹ i.e. about half of the total global dust production. Other major source of dust producing sites following this desert is China. The third region is Bodélé depression in North Africa that despite having a small surface area may alone be responsible for 6-18% of global dust emissions [9].

Sites of dust production in Iran

According to evidence available 80% of dust particles caused by these storms in Iran originates from outside sources and is dependent on existing desert conditions in the East Mediterranean to Iran. Between these sources of dust production Iraq, Saudi Arabia and Syrian countries are in the first degree of importance and countries of Qatar, Kuwait, Turkmenistan and some of the countries in North Africa are in the second degree of importance [28].

According to "Fig. (1)", most of the effective regions for occurrence of this phenomenon are in Iraq but these sources are also seen in Khuzestan, Ilam, and Kurdistan provinces. Dust storms originate from countries like Saudi Arabia and North Africa and the dust particles being bigger are deposited quickly, and the storm comes to a standstill after about 24 hours. However, storm particles originating from Iraq, Kuwait, and East Jordan

continue to spread for almost a week due to the fineness of the particles.

Dividing of dust storms

Dust Storms are divided by various methods. One of this ways is on the basic type of particles. Based on this, storms are divided into 2 groups - Sand storms and Dust storms. Sand particles have an approximate size range of 0.6-1 mm, while dust particles <0.6 mm, but only those dust particles below 0.1 mm can be carried by suspension and be manifested in a dust storm and transported long distances but Sand storms due bigger particles move in proximity near the ground surface and are not found in layers above [6]. Hills of Rub' al Khali desert in Saudi Arabia produce sand storms but the storms in North Africa and China are of the second type therefore they transit longer distances to South Europe and the Pacific ocean[9].

Another method is using two indexes - wind velocity and visibility to classify the grade of intensity of sand dust storms. For instance on this basis the sand-dust storms occurring in the Northwest part of India are divided into three groups. [13].

- 1- Weaker dust storm develops when wind velocity is at a force 6 (Beaufort) degrees and visibility varies between 500-1,000 meters
- 2- Stronger dust storms will occur when wind velocity is at force 8 and visibility varies 200-500 meters.
- 3- Strong dust storms will take place when wind velocity is at force 9 and visibility is <200 meters [13].

In China, a sand-dust storm is defined similarly to the above. The only difference is that the category of strong dust storms is defined again into two groups.

- 1- Strong dust storms occur when wind velocity is 50 meters per second (m/s) and visibility is <200 meters.
- 2- Serious dust storm occurs when visibility is 0-50 meters; the sandstorm is termed as Black Devil and sometimes Black Windstorm in other regions (11).

Effective factors in the occurrence of dust storms

It is difficult to show reasons for the occurrence of these phenomena which requires general statistical studies and a long period of time on atmospheric parameters. It is important to separate natural factors from human factors because defining the role of humans in the occurrence of these phenomena can prevent a repetition or intensification of it by suitable management in future [2]. Generally there are two natural and human reasons for the occurrence of these phenomena. In continuation of this a separate study on these reasons has been done.

Natural reasons

One of the most important reasons for the occurrence of dust storms is severe drought, until IPCC (or Intergovernmental Panel on Climate Change) reported in 2007 damage of vast areas of world's dry land due to leakage of rainfall and a high amount of evaporation of moisture from soil [22]. Drought brought about by decrease surface lakes, rivers, marshes and

underground waters has in turn reduced plant cover and has made agriculture more difficult downstream. Therefore reduction in cohesion between individual soil particles supply conditions for wind erosion [7] (Table 1). Additional researches have shown that in period of drought wind increase in velocity that it's the reason for absorption of heat in the environment which if it should continue could help worsen the condition gradually in the future [18]. Therefore the other reasons is wind velocity whereby the higher the velocity of the wind the greater the capacity of dust particles being carried longer distances by wind. Even though, the size of particles has an effect on mass transportation, their influences have been showed in tables 2 and 3. According to table 2 initially, the increase of the water holding rate decreases the erosion rate. When the water-holding rate increases up to a certain percentage (threshold), even a small percentage of soil moisture will cause large-scale reduction of soil erosion rates where the 2% of water-holding content of sandy soil is the threshold. It can be concluded that the higher the water-holding rate, the higher the threshold wind velocity will be while the erode ability of soil is reduced. Table 2 shows similar results too [7].

Human reasons

Management of unsuitable groundwater and surface waters resources

Mesopotamia Marshes between Tigris and Euphrates Rivers had an area about 310 thousand hectares but has decreased nearly 97% of its surface between 1976 and 2000. The reasons for this were transmission of water in the Tigris and Euphrates rivers for the increase agriculture by making rivulets and secondary rivers. This came about because of unsuitable in politics of this country. On the other hand Turkey by constructing of 22 dams and 19 powerhouses has been able to store 17/6 milliard m³ of Tigris River. Iran By creating dams on the Karkheh River has been able to control the loss of water in the last parts of these Marshes mentioned above [15]. In Khuzestan province a third of surface waters of Iran especially Karun, Karkheh, Dez, Jarahi Rivers currently exists. These rivers have been having unsuitable conditions recently. The reason is excessive use of these waters due to unsuitable management by the government. According to the news it has indicated the gradual end of the content of water in Bahmansheer River. The amount of water in the Karun River is alone enough for agriculture in the summer season whereas this river was navigable in past [17].

Destruction of plant covers

Human interferences by widespread and unsuitable agriculture, excessive grazing, unwise collection of firewood, destruction of plant cover is creating risks for life of natural resources in the world, resulting in destruction of more of 13% forests and pastures and has also exposed the danger of more than 30% of the land on Earth changing into deserts[3].

Not forgetting the eight-year Iran-Iraq war has also caused destruction in large areas of the date palm plantations in Abadan and Khorramshahr in Iran and Basra province in Iraq. These plantations played an important role in acting as wind breakers and filters which reduced the volume of dust arose from the Saudi Arabian desert and Arabic neutral zone [18].

Impacts of dust storms

Transmission into other places

Because dust particles are so small they can be transported over thousands of kilometers and into heights above the atmosphere and is deposited downwind by wet and dry processes, sometimes in appreciable quantities. Therefore its effects are not limited only in the place of its occurrence but its results can be found in far longer distances which have caused the role of desert dust in the global system becoming increasingly apparent. For instance North America dust particles may deposit fine materials on the California Channel Islands and the eastern Pacific Ocean. The Sahara is also a major source of dust deposition into the Mediterranean Sea and neighboring countries while the Ukraine has recently received large quantities of dust from Slovakia. Moreover, Dust particles from the Eyre basin of Australia may accumulate in East Antarctica [9]. Some studies suggest that arid and semi-arid regions around the sea of Oman are one of the principal sources of global dust. Pakistan, India, Iran, and the Arabian Peninsula cause dust deposition in the Oman Sea [21]. Moreover it has been observed that the strength of relationship between African dust outbreaks in the Saharan air layers along with changes in hurricane peak intensity in North Atlantic [9]. These particles during passage via industrial sites are sullied with some toxic chemicals that help in the creation of more problems "Fig. (2)", [26].

Impacts on Climate Changes

Dust particles may affect air temperatures through the absorption and scattering of solar radiation[10,26,12,9,1] on one hand they decrease received energy by light reflection when found in the atmosphere, thereby causing drop in air temperatures, and on the other hand by the formation of a layer on the surface of earth, it traps radio waves and produces territorial heat [21,9]. Moreover these particles can produce finer droplets in clouds resulting in more light reflection and decrease in temperatures "Fig. (3)", [6].

These storms destroy the ozone layer by concentrating the amount of sulfate and Nitrate density in the atmosphere [15]. Moreover, indirectly results in affecting the primary marine productivity especially on the amount carbon dioxide levels. This particles influence sulphur dioxide levels in the atmosphere [9]. These particles are alkali due to having sodium carbonate and calcium carbonate brought from deserts and these decrease effects pernicious of acid rains [7].

However data obtained on climate changes was clearer in 2007 than 2001 in case cooling cause occurrence

these storms, but it is still uncertain about relationship between atmospheric mineral dust aerosol levels and radioactive forcing [9].

Impacts on seas

A recent study indicates dust particles are conveyor of materials and they have positive impacts on seas and ocean of life, which shows that dust transition process is part and parcel of the global ecosystem because most of marine life depends on dust particles. For example Dust fertilization along with elements such as iron, phosphorus, nitrate, and iron could have an effect on life of marine phytoplankton [26,23] or salt dust particles in the China deserts are an important role in the control of the productivity of marine phytoplankton[16,21].

Dust particles deposition on the surface of the glaciers reflects Sunlight that would have effects on the balance of natural ecosystems. Some studies showed that the effects of dust particles on ice sheets retreating [3,9], moreover other studies indicate that the effects of dust emissions from central Asia have prevented the establishment of permanent snow cover in Northern Asia[9,16] and some researchers also suggest that radioactive dust forcing may have dire effects on the asymmetry of glacial cycles[9, 23].

Propagation this particles from a place to another has been said to have effects on transmittal diseases. In Caribbean rocky corals is observed to have positive relationship between times of coral-reef die-off and peak Saharan dust deposition [10].If this storm continued, it probably causes drying of lakes and rivers due to deposition of dust [21], which has a negative effects on the life of the marine organisms.

Impacts on plants growth

On one hand Dust storms disorganize plant growth by influx in stoma of plants and cover of leaves area [19],on the other hand Transferred nutrients carried by dust particles can help plants growing. for example, The output increase and decrease of the area of rain forest in the Amazon are directly related to the enlargement and cut down of the area of the Sahara Desert and the sand transport capacity [21] also is evidenced effects this particles in production the Amazon jungles and forests of South and Central America [21, 2] .but if this particles contain toxic substances, their negative effects on plants can be expected. .Moreover, these particles may also contain salts that effects in plants growth by interfering in photosynthesis and on the particles of salt in the soil affect plant growth[23].

Impacts on deserts

Dust storms correlated to desert geomorphology helps in transporting these surface particles of the desert to other places [9, 2, 5]. Dust storms in Sahara desert can transmit 480,000 tonnes of sand and dust into the Northeast parts of the Amazon Valley which means this storms brought about an accumulation of 190 Kg of sand and dust particles per hectare every year in the region [21], which is effective in the growth of desert plants and

wild animal and negatively effects the natural ecology of area [23].

Impacts on human health

New research has shown that dust particles have dangerous effect on the health of people much more than what was thought [21, 25]. Studies in New York University indicated that prolonged exposure to dust particles is an important factor in causing heart disease and cancer. Breathing polluted air can cause dust particles to penetrate the air sacs that may result in irregularities in heart rate and Heart attack and severe breathing problems and severe headaches and poor eyesight, and skin diseases [15]. Furthermore if these particles contain other materials, such as alkali metals and other pollutants likely to cause more problems[21].In particular , storms taking place in Iran that is consisting of radioactive particulars but It is not reported officially[19].

Rural Poverty

Such storms damages the farms and farmers in different ways, and therefore damages the agriculture which have negative effects on the economy of the country [19].Deposition of dust particles on land surface causes the burial of agricultural farms, therefore following the huge volume of sand decrease possible agricultural and is left this lands . In addition to this storms with desiccation of lakes and soil surfaces by inter-basin water transfers and ground water depletion [9], Reduce in the quality of agricultural water [7] , transition of disease in plant are effective in reducing agricultural production, insofar as outbreak of the severe storm in Iran caused great damage on agricultural products and date trees [17] .

Moreover, this phenomenon has caused damages to the industries of bee keeping [24] and also caused the death of livestock. In China a storm took place on 5th May 1993 which killed more than 29 thousand livestock [21] and also it cause damages to the farms and vegetation which resulted in less place for grazing and therefore poverty in the villages and immigration of the villagers towards the cities and then the following more difficulties.

Impacts on transportation

Dust storm effects the visibility of the amount of this effect which depends on the severity of occurrence of the storm, which in the worst case it will be less than one meter and it can cause problems in moving of the vehicles and interference in management of the country[21,13] .

Contrasting ways

Mulching

The first step is usually settling areas of erosion by wind by Mulching. But results obtained from recent studies have caused doubt in use of this method.

Research shows that ground temperatures rise due to the high temperature coefficient of mulch and causes the plants to dry. This material loses its stabilizing effects

after 3 to 4 years but their contaminating effects remain for years. Mulch prevents water infiltrating the soil and its accumulation in the hole and then it will evaporate and causes lots of damage to the water tables in these areas. Moreover since mulch is fragile and Motion on that causes frangibility and reduces its effects. Mulch is very expensive and high technology is needed for using it and it isn't also cost effective [29].

Because there are many problems in the use of mulch, professor Parviz kardavani has suggested the methods of sand ballasting which is the first of its kind in the world instead of Mulching. Using sand is not harmful to plants and also it is not sensitive to traffic. It is very resistant and remains intact for years. Sandy surface does not harm the groundwater aquifers. In addition, its raw materials exist in abundance in Iran and incur less cost by using it and require no complex equipment [29].

Another way is to use biomulch. Its origin is plant which does not harm the environment but due to high costs and high technology implementing it in practice it is not widespread in the desert [29].

Protection of natural resources and afforestation

According to table 4, preventing effects of the vegetation can be classified into three categories. When vegetation coverage is higher than 60%, then slight erosion or zero erosion, when vegetation cover is 20 to 60%, erosion is medium and when the vegetation is less than 20%, there is severe erosion [7]. This matter is important for forest conservation and afforestation for preventing dust storms and wind erosion of soil.

Therefore the establishment of the natural guards in the desert, lakes and wetlands which have dried is an immediate action to prevent wind erosion, spread of deserts, destruction of vegetation and faster plant coverage recovery in region. For example, in 2000, China did more than 10 projects in the West to prevent the occurrence this kind of storm by stopping dry farming and starting forestation and protection and preventing damage to regional plant cover [2]. The settlement of *Populus euphratica* species in Ejinna province of West Mongolia in China had a major role in restoring the damaged surfaces or protecting of species of *Tamarix* and *Reaumuria* in China causing stability in more than 30% of the moving sand dunes.

In Iran extensive aforestation has been conducted to prevent further expansion of these storms in future, however more actions are needed [7]. Other measures such as leaving agricultural crops in the soil and leaving crops such as wheat straw in the direction perpendicular to prevailing wind to reduce soil erosion [20]. Artificially charged clouds to create artificial rain in the deserts are the methods that has been done in some countries to prevent wind erosion, but this method is very expensive and is not common [14].

Conclusion

Wide Research efforts have been conducted on the dust storms for the past five decades in various countries that have showed good results, but experience has shown

that without support and using appropriate policies the government can't be contrasted with this phenomenon. Because if it did not use the methods proposed, increase in intensity of this phenomenon could occur in the future. Therefore responsible organizations must make greater efforts to understand and solve problems related to this phenomenon. We hope a day comes when we can end the occurrence of this phenomenon in the world.

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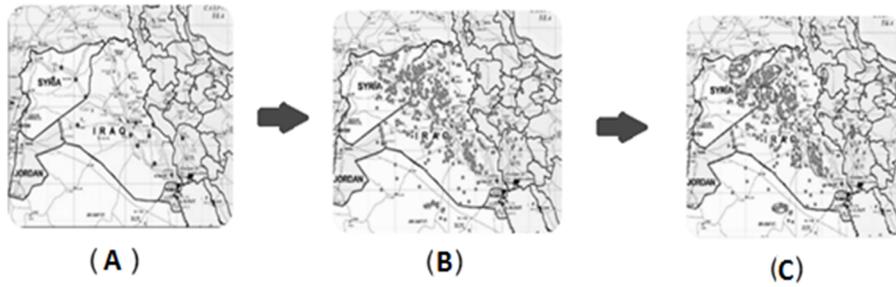


Fig. 1- Is a map of the vast distribution and existence of the sources of dust storms in Mesopotamia zone between 1989 (A) to 2008 (B). Although distribution at these points are random, we can divide them into several zones and introduce those for sources of production dust storms in Iran Country (C) .According to this figure increases very much number of these resources during about 20 year[27].

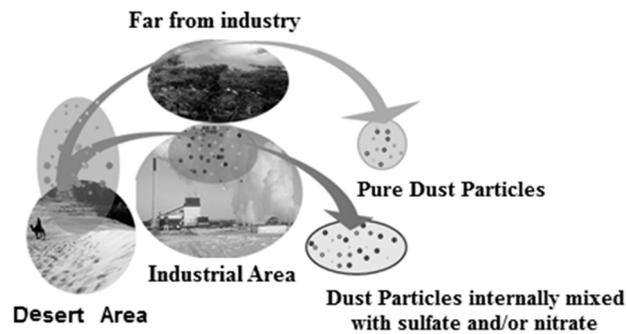


Fig. 2-Pollution of dust particles during passage of industrial areas [26].

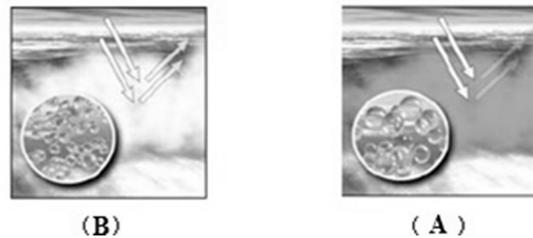


Fig. 3-Effects of dust particles on formation globes of clouds, part A indicate clouds contain more suspense particles present, therefore larger globes, and less globes number [6].

Table1- Relationship between wind erosion rates and water-holding capacity of soil under different wind velocities [7].

Water-holding capacity (%)	Erosion rate g/min under different wind velocity			
	10 m/s	15 m/s	20 m/s	25 m/s
2.67	73.04	761.96	1582.32	2480
4.14	66.19	210.86	881.32	1568.69
5.2	24.72	145.82	239.42	390.59
5.69	12.94	81.86	172.26	280.42
6.2	0.10	52.03	107.03	224.04
7.13	0	27.79	53.53	158.47
7.87	0	10.45	47.06	133.92
8.18	0	8.76	42.65	90.26
9.59	0	5.01	22.83	50.06

Table 2- Wind tunnel experiment and sand blowing rate on alluvial Gobi desert in Gansu Province China [8].

Wind velocity(m/s)	10	20	30	40	0
Sand blowing rate (kg·m ⁻¹ ·min ⁻¹)	0.0021	0.038	0.0504	0.0866	0.1357

Table 3- Movement of soil particles under a wind force of 15/meters/second [21].

Particle size (mm)	Period of suspension (time)	Comment
0.1	0.3-3 seconds	Fine sand
0.01	0.83 – 8/3 seconds	Dust. Can go up to 700 m high
0.001	0.95-9.5 years	Fine clay can go up to 77 km high

Table 4- shows the relationship between percentage of vegetation cover and soil erosion . Erosion rate decreases with increase of vegetation [7].

group	Veg Cover%	Threshold velocity (m/s)	Wind velocity (m/s)	Erosion (kg)	Wind erosion modeling	
					g / cm.m	t / mm.h
1	69/7	10/23	14	0/14	0/020	8
			21/6	0/49	0/070	28
			24	0/82	0/117	46
2	58/5	8/7	14/4	0/25	0/050	20
			19/6	0/88	0/176	70
			22/4	0/90	0/180	72
3	27/4	8/27	23/6	2/28	0/425	182/4
			10/2	0/07	0/008	3/2
			16/7	0/87	0/095	38
4	10/8	7/84	20/6	1/95	0/214	85/6
			24/4	4/93	0/540	216
			10/6	0/43	0/050	20
			15/5	1/77	0/208	83/2
			21/5	2/36	0/287	111/2
			24/9	4/56	0/538	215/2