Sand & Dust Storm “Hot Spots” in Iran

Ali Darvishi Boloorani¹ and Farzaneh Moshayedi²

1. RS-GIS Department, University of Tehran, Tehran, Iran
2. Department of the Environment, Center of Researches, Tehran, Iran

Corresponding author: Farzaneh Moshayedi (fmoshayedi@yahoo.com)

Abstract: Dust storms as a challenging issue in environment have brought several harmful effects to WAR. This phenomenon has influenced many countries such as Iran, Jordan, Iraq, Syria, Persian Gulf countries tremendously. For controlling and combating with this event, provision of a comprehensive plan was on the agenda by United Nation Environmental Program- Regional Office of WAR (UNEP-ROWA). During the first meeting in Nairobi and technical meeting in Abu Dhabi, the following report is provided in Islamic Republic of Iran. Regarding the span of the issue, a concise introduction of Iran is presented. Then the selected areas for implementation of pilot projects of UNEP-ROWA in dust source (DS) areas are identified. Based on this, two major clusters in south west and south east of Iran are determined as follows: DS cluster 1: This cluster consists of 4 sources with arid and semi-arid ecosystems and one other source with humid ecosystem (i.e. Hour- Al-Azim) in south west of Iran. DS Cluster 2: This cluster consists of 3 active sources with arid and semi-arid ecosystems in Sistan and Baluchistan and Kerman and one source in humid zone of Hamun (south east of Iran). It should be noted that, in this report, dust sources are primarily introduced. Also, based on a plenty of related information, if complementary and detailed information are required, the GRI of University of Tehran can provide them. Department of Environment (DoE) with cooperation of Geo-Informatics Research Institute (GRI) of the University of Tehran has accomplished this work.

Key words: Dust storm, West Asia, cluster.

1. Introduction

During the last decade, Dust storms have affected WAR Region (WAR) destructively. For controlling and combating with such a phenomenon, it is essential that a comprehensive plan be provided. In order to do this plan, UNEP-ROWA has been preparing a Master Plan for Combating Sand and Dust Storms in WAR Region (MPC-SDS-WAR). Therefore, a meeting was held in Nairobi with the hosting and presence of Iran, Iraq, Jordan, Turkey, and United Arab Emirate. The constitution of a technical meeting about the program agreed to increase the understanding and cooperation of countries. According to this, technical meeting for management of dust storms in WAR was held on 6 and 7 May 2013, in Abu Dhobi. More than 50 representatives from 11 countries from WAR attended as well as UN agencies and regional organizations. In Summary the approvals of that meeting are as follows: Verification of UNEP proposal regarding the cooperation of UN and regional organizations; Determination of Dust Storm Corridor in West Asia Region (DSC-WAR) based on climatologically evaluation of WMO; Additional understanding about SDS-WAR status based on oral reports of countries and WMO reports of present condition; Agreement on a road map consisting of verification of steps by leading committee and meetings of ministries; Agreement on taking action along with documenting of program. So that, it be possible to call it MPC-SDS-WAR; Establishment of a trust fund for the execution of dust storm control and combat projects;
Updating and identifying dust storm active sources in every country by responsible organizations.

According to this, all countries should announce a complete list of dust storms active sources for SDS-WAS to UNEP.

Regarding that, UNEP- WAR-SDS for combating dust storms is seeking an action plan to solve the problem in national and regional scales. In accordance with the request of UNEP in Abu Dhabi meeting, all attended countries were committed to introduce active dust storms to the end of August 2013, M. Haddad [1], IGR [2].

2. Geography of Islamic Republic of Iran

Islamic Republic of Iran in South West Asia has 5,440 km land border with Armenia, Azerbaijan, Turkmenistan, Afghanistan, Pakistan, Iraq and Turkey and 3,180 km shore border with Caspian see, Persian Gulf and Oman see. Iran with 1,648,000 km² area, located between 25 to 39 degrees, latitude and 44 to 63 degrees, longitude (Fig. 1).

According to a general census in 2011, population of Iran is about 75 million whose 71 percent is living in cities and the rest in rural areas. Concentration of population in every km is 45.6 persons and annual average rate of growth is about 1.3%. According to World Economic Forum, Iran is the eighteenth populated country in the world. The fertile plain of Khuzestan province is one of the populated regions where has experienced the max number of dust storms during last decade.

Diverse climate, surface coverage, temperature, humidity, and soil type causes different land uses. Rapid growth of population and limitation of natural resources lead to unbalanced growth in economic activities and unplanned change of land uses. So that, these land use changes and extra use of the lands more than their ecological potentials paved the way for land degradation phenomenon in many regions. In addition to physical, chemical and natural processes which cause land degradation (Fig. 2), human threatening factors are the most effective element in emergence and expansion of dust storms in the country (Fig. 3).

Iran is located in the middle of Apian Himalayan change region which starts from Europe and after passing Turkey, Iran and Afghanistan reach Tibet and

Fig. 1 Iran in WAR.
Fig. 2  Major land degradation processes in Iran.

Fig. 3  The major factors in land degradation.
near Burma and Indonesia. It can be said that Iran is the joint area of two old continents of Eurasia and Gondwana. In geology of Iran, deposits almost are of alluvium, wind and water sediments (salt and clay) which show off in more than half of the country.

Alluvium sediments has the largest portion in Quaternary sediments which are erosive materials expanded from heights to flat plains. Wind deposits of have erosive materials with the same or bigger size than sands. These materials form sand dunes in open and closed zones. Studies and observations show that in harsh climate condition like aridity of land and blowing of winds, deserts and their surrounded are the most susceptible zones for the emergence of dust storms. Alluvial sediments which cover a wide area of country are as flat and low slope lands. They contain the most volume of groundwater resources and also include agricultural, industrial, and residential areas are. Geo-Morphological structures in both aspects of creation and change of atmospheric patterns and presence of susceptible alluviums for erosion are significant. Because of this, most of dust storm sources are related to congested alluvial deposits. Alborz and Zagros as the main mountain chains of Iran are effective in precipitation regime and surface water resources.

In general, a large portion of west and south west of Asia are located in arid and semi-arid regions of the world. Due to climatologically condition, the largest and expanded deserts are located in this region. In tropical regions, the effects of lower latitudes (tropical regions) and mid-latitudes are important which can cause a large amount of spatial-temporal changes in metrological parameters like precipitation and temperature. So that sever changes in precipitation and its distribution, cold and warm waves, long term droughts, inundation, dust storms, air pollution and etc. are considered as characteristics of this region. Regarding the frequency, intensity, duration, time of these events, any one of them can make environmental, economic, social and political challenges within the region. One of the environmental disasters is drought and One of its consequences can be the emergence of dust storms during last years affected a large portion of west and south west of Iran.

Annual average temperature of all important cities in Iran is shown in (Fig. 4). Diversity of climate in WAR, including Iran, is high, i.e., temperature change in winter between warmest and coldest points could reach 50 Celsius degrees. The average temperature in Iran is 18 which is 3 degrees warmer than global average. Average precipitation is one third of the world's average and contrary; the potential evaporation is also higher than global average.

Generally, it is possible to divide Iran into 8 temperature zones: south west warm area, cold hillsides, foot hills, warm shores of Persian Gulf, plains (dasht sar), Caspian temperate, warm plain and cold mountains with averages of 24.7, 14.6, 9.4, 27.0, 17.2, 16.7, 20.2, and 12.1, respectively. Therefore, Iran has different climates, including very arid to very humid areas (Fig. 5). Consequently, there are some areas with about 2,000 mm annual precipitation (e.g. Caspian basin) and areas with less than 100 mm (e.g. central and southern arid areas). Wholly, 90% of country area has less than 200 mm precipitation.

Based on available statistics, 85 to 89.7% of Iran has non-humid and arid climate (Fig. 6). In addition to annual poor precipitation, its spatial distribution is not suitable, i.e. 50% falls within 24 percent of country and the rest within 76 percent. Many fertile fields of country located in arid and desert areas are not suitable for cultivation (even dry farming) due to lack of water. If any agricultural activity happens, in such a climate condition, the cultivated land is susceptible for dust storm.

Based on the amount and time of precipitation, Iran is divided to 4 zones: very low, low, average, and high precipitation. Very low and low precipitation zones with average of 188 mm occupied 83% of country area. All south, east and central parts are within this zone. Central part which takes 25% of Iran includes central
Fig. 4  Annual average temperature of Iran (Celsius).

Fig. 5  Average precipitation map.
deserts, east deserts like Lut, Semnan, Ghom, Yazd, Esfahan and some parts of Kerman and whole Sistan. Average precipitation in this climate is 102 mm which fall from the end of autumn to the mid of spring. Average and high precipitation (average 570 mm) zones cover 17% of whole country.

As mentioned, unbalanced spatial distribution of precipitation made some high potential sources for dust storms. Annually 71% of precipitations are loosened by vapor transpiration of surface, forests, and agricultural fields. In desert areas, also it is possible that 95% of precipitation turns back to atmosphere instantaneously after precipitation (Fig. 6).

Out of 164 million hectare of Iran, 32 million hectare is desert. In accordance with available statistics, 100 million hectare of Iran is jeopardized by desertification. Water and wind erosions are destructive factors as well as salinity (Fig. 7). The total area of active dunes is about 5 million hectare and the total area of sandy soil is about 13 million hectare. While country is confronted with 3 million tons erosion every year, the ratio of desert area to the whole is 61%. The effects of global warming in last century caused 0.76 Celsius degree increases in Iran. As a matter of fact, annual average precipitation is about 440 milliard m$^3$ which during drought, decreases to almost 286 milliard m$^3$.

The analysis of such statistics shows that many parts of Iran have high potential for dust and sand storms.

Considering the amount of precipitation, poor vegetation cover, diverse land cover, and economic activities on land (except mountainous area which has enough precipitation), in many parts, especially inner deserts no significant trace of soil creation could be found. Generally, it is possible to categorize Iran soil types, based on texture, into two classes (Fig. 8).

Those soils where mechanical weathering are more dominant than soil creation factors and undevolved soils with high percentages of gravel and sand. Entisols and Eridisols are in this category. Among all soil types in Iran, Entisols form almost 20% of country area. This kind of soil could be found in west, north, south mountains and central part. Eridisols are a major
portion of desert areas. These soils are the second most
dominant and cover more than 18 percent of country soil. Vegetation covers of these soils are sparse and
nutrients are too low.

Other classes of soil are created from destruction and
dissolution of evaporative formations. These types of
soils, including salt pans and clay flats, are found in
central, eastern and south eastern deserts. Prominent

Fig. 7  Erosion map of soil.

Fig. 8  Soil map of Iran.
characteristic of these soils is their salinity and alkalinity and high percentage of particles in of silt and clay. Such a characteristic paved the way for the emergence of dust storms.

The emergence of dust storms in some countries in WAR like Iran, Iraq, Jordan, Arabia peninsula and Kuwait was common in past but the increase in their temporal frequency, lasting and spatial expansion during last decade have been concerning. Iran is affected by two corridors of dust storm which are different in formation, transportation, deposition, and endurance. As a matter of fact, western part of Iran affected by dust storm dominantly in Dust Storm Corridor in WAR (DSC-WAR). When these kinds of storms which carry tiny suspended particles reach Iran and other countries around Persian Gulf, they lose their speed and last for a long time. There are other active dust storm sources in eastern and south eastern parts of Iran. The activities of these sources are simultaneous with 120 day winds of Sistan and they have more activity in drought time of Helmand river Hamun lakes. Also by the pass of wind over central deserts of Iran, there are always dust storms, dependent to the direction and wind speed. Generally, the highest number of dusty days, during two last decades, belongs to two determined clusters of dust in this report A. Darvishi Boloorani [3] (Fig. 9).

3. UNEP Criteria for Dust Storms Hot Spots

The complexity of dust storm emergence and their diversity and expansion caused determination of a variety of criteria to identify their sources. As a result, in this report, identification and introduction of dust storm hot spots in country are based on the following criteria and some others from experts in the field:

- Dominant mechanisms on dust sources;
- Intensity of dust storm activities (sever, middle and low);
- The hot spot expansion;
- The scope (national or regional);
- Land degradation type;
- Ecosystem type;
- Climate condition;
- Capability in measurement and management of future activities;
- Environmental monitoring abilities;
- Beneficiaries and stakeholders (national or regional);
- Population, economic and social issues;
- Identified areas in order to implement UNEP pilot projects;

Regarding the natural and environmental diversity in Iran, the similarity of determined areas and applying mentioned criteria, dust storm sources are located within humid and arid ecosystems:

For implementing UNEP pilot projects, identified sources are limited to two almost homogeneous zones including south west cluster and south east cluster (Fig. 10). These areas here after will be referred to as dust source clusters, M. Haddad [1].

Above map shows the location of these clusters, right map shows south east cluster and the left one is the south west cluster. Yellow color demonstrates sources within arid region and green ones are within the humid regions.

4. South West Clusters (DS-Sources in Khuzestan and Ilam Provinces)

4.1 Ecologic, Economic and Social Condition

This cluster includes some parts of Khuzestan and Elam provinces. Khuzestan plain accommodated 3 sources out of 4 ones of this cluster (Fig. 10, D-2, C-2, and B-2). This plain is comprised of different parts and structural zone of Abadan platform. In geological perspective Abadan plain as a portion of Mesopotamia is the north part of Arabia platform. Beneath the young alluviums of this area, there are deposits of first and second period which are folded smoothly from north to south (Arabian trend). Aghajari formation can be regarded as the main source of sand and small particle deposits in whole Khuzestan plain. These sandy areas can be found as wavy and brkhan in north, northwest
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IRAN Dusty Days (20 years)

Fig. 9 Dusty days in last 20 years.

Fig. 10 Dust storm hot spots for the UNEP pilot projects in Islamic Republic of Iran. Lower left map is South West dust sources cluster. Lower right map is South East dust sources cluster. Dust Source (DS).
and west of Ahvaz, Dasht-e Azadegan and coastal areas of Khuzestan plain. The main source of precipitation in this region is the entering systems from south west. Such systems sometimes are too unstable which cause precipitation on low level lands in Khuzestan plain. In temperature point of view, this area has a tropical climate and is regarded as the hottest areas in Iran. Average temperature is 26 and due to extra humidity, the temperature difference between day and night (and annual max and min temperatures) is not considerable in contrast with other areas. The soils of southern and southwestern parts of the province are almost salty and alkaline. In these soils, plenty of Sodium causes soil particles to be dispersed and as a result be ready for distribution. In addition, along with high distribution potential in these soils, they do not have suitable structure. Also the effect of sodium in these parts can have toxic effect on plants. As a result, as well as high vulnerability of these soils for dust storm formation, low vegetation cover is another intensifying factor. Toward east and south east of this province gradually we witness the presence of lime Lithosol consisting of gypsies and salty Marls. Despite that soils of this area are salty but in contrast with salty and calcareous lithosols they are less salty and can be good pastures.

Southern part of Elam province which is the northwest part of this cluster, contains the largest source (Fig. 10, A-2). This part located in folded or outer section of Zagros which by subordinating of general trend has a north west -south east direction. Generally, existing stones in this province belong to second and third geological periods and the new deposits can be observed in different parts. Marl stones are so weak against erosion and forms a large portion of deposits.

Western and southwestern parts of province have about 200 mm precipitation annually. Poor pastures and desert areas are in Elam, Mehran, Dehloran, and Abdanan.

4.2 Land Degradation and Erosion Factors

(1) Natural factors
- Drought (within 1998 and 2001 and also the most sever one in 2008)
- Desertification and soil erosion
- Climate change and temperature increase
- Evaporation increase
- Humidity reduction and vegetation loss

(2) Human factors
- Soil erosion caused by mal-agriculture activities specially in sloping lands
- Presence of a population 3 times more than ecological potential and pasture potentials
- deforestation and land use changes resulted by development projects
- Population increase and settlements.
- unsuitable cultivation pattern in arid and semi-arid lands
- Land degradation resulted from the war between Iran and Iraq.
- Cutting trees and bushes for fuel
- change of lands to swampy and salty ones
- Leaving the agricultural lands

4.3 Activities Related to Dust Storms in South West Cluster

This cluster consists of 4 sources (Fig. 10, areas A, B, C, and D ) in arid areas and semi-arid areas and another one in humid zone (i.e. Hour Al Azim marshland) in southern border with Iraq (Fig. 10, area A-1). A major portion of soils in this cluster are small particle clay and gypsum.

Skin soils and quaternary deposits from Elam city to south of Dehloran, mostly affected by weathered and transported deposits from Aghajari formation. These soils have fine texture and are salty and do not have a robust structure to resist against erosion. Some hills could be found especially in Dasht-e Shadegan and west of Omidiye with suitable wind condition, lead the dust to move toward inner parts of lower cities and
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Persian Gulf (Fig. 11). The other source is a zone expanded along the border of Iran and Iraq from Dehloran to north of Ahvaz and include Bostan, Dasht Azadegan, Hoveizeh, Moosian (south of Dehloran), Soosangerd, Shoosh, Ahvaz and hamidiyeh cities. These areas affected especially by DSC-WAR cause a huge amount of dust with a north west-south east direction. As an example satellite images (Figs. 11 and 12) demonstrate the activity of dust storms in this cluster and its expansion over neighboring regions.

Regarding the pattern of regional atmospheric cycle (both in cold and warm periods) and in comparison with Iraq, Syria, and Arabia sources, the role of this cluster is not very prominent. On the other hand, the effect of Khuzastan-Ilam sources is more significant in local than regional scale. Despite this, if atmospheric patterns transfer waves of dust from west toward south west of Iran (such patterns are more dominant in winter and beginning of spring), these sources will act as subsidiary ones and will affect a broad regional scale. Meanwhile, in warm period of year, due to the general dominancy of north wind (extension of wind blow from North West to south east) this source can only affect lower lands in Khuzestan. Even in more serious cases, it can influence western parts of Persian Gulf. Considering the air stream pattern, the path of dust transport mostly affects Kuwait and Bahrain in regional scale.

4.4 Management, Monitoring and Solutions

Capacity building, training the users of agricultural lands and natural resources;
Reforming the criteria of sustainable cultivation and agriculture;
Increasing the efficiency of water resources up to two times more than current situation in pilot sites;
Achieving to a balance between livestock and pastures and also offering alternate suitable living styles;
Using new energy sources to prevent cutting the trees and shrubs;
Boosting local associations for protection of environment;
Establishing monitoring and early warning systems;
Establishing an informing and training system;
Conducting research to determine appropriate solutions to adapt with harmful damages of climate change.

4.5 Beneficiaries and Stakeholders

The following associations can help to implement pilot projects: Nomads (Ashayer), hunters, farmers, ranchers and other urban and rural societies. Also, different coordinating and planning assemblies within this cluster including executives and decision makers can provide a suitable pavement toward the mentioned goals.

![Dust storm in Southwest cluster in regional scale, Sea-WiFS satellite image 12/20/2004.](image)
4.6 Monitoring and Evaluating Indices

At the present time, changes of main indices like vegetation cover, water, soil, land use, climate, agricultural products and etc. are monitored and evaluated by responsible organizations. In this respect, regarding the existence of research, academic and scientific centers and professional associations, the monitoring and evaluation can be conducted to an acceptable accuracy. Establishment of a comprehensive monitoring system for analyzing dust storm phenomenon is the most required action. In addition this system can help to evaluate the obtained results from pilot projects.

5. South East Cluster of Iran (Sources Located in Sistan and Baluchistan and Karman Provinces)

5.1 Ecologic, Economic and Social Condition

South east cluster of country includes Sistan and Baluchistan and Kerman provinces. Jazmoryan hole is regarded as the largest source in arid zone of this cluster where is located in boundary of two mentioned provinces (Fig. 10, region 2-E). In addition, the two other sources of this cluster are also located in arid zones of Sistan and Baluchistan (Fig.10, region 2-E) which are the active dust sources in the cluster. The last source of this cluster is the dried parts of the Hamun basin (Fig.10, region 1-B).

Jazmoryan hole has the tectonic characteristic with east-west direction where it is separated from Lut desert by Bazman volcano. Bashagard Mountains limit its southern border. This source is regarded as one of four independent tectonic states of Makran area. Southern and western heights of this hole consisted of Ophiolitic and metamorphic stones. In it’s east borders, there are fault rocks in Miocene period. These rocks mostly are in the forms of hills and composite Karsts features. Hills and fans of this region are drained off by Bampoor River and are considered as the main sources of evaporative and lime deposits of Jazmoryan Lake. The min, max and average height of water shed are 325, 4000, 600 m above sea level, respectively. In precipitation perspective, except northern heights which receive 200 mm annually, other regions are in arid and hyper arid conditions i.e. in south western part of the hole annual precipitation is less than 100 mm. At the middle of Jazmoryan, marshy lands are about 3,800 km² which are fed from east by Bampor River and from North West by Halil River. The bottom of marsh is constituted by clay and silt deposits which due to low permeability, a large portion of marshy lands remained as permanent lakes. Sandy hills are the most prominent features of hole in south and south east of hole which
shows off as extended barkhans and linear and compressed features. It seems that those winds which come from North West and west have a great effect on their formation.

Second area of this cluster is in boundary of Iran with Afghanistan in closed basin of Sistan which is one of the most arid ones in the world. Hamun Lake, as another source of dust (humid) is located in 31.5 degrees of north and 61 degrees of east in Zabol plain in east of Iran. The area of lake during its high water period reaches more than 5,600 km² whose 3,800 km² is in Iran. The main water of this lake is provided by Hirmand River which comes from Hindu Kush Mountains in center of Afghanistan.

Hamun Lake consists of three parts: Pozak Hamun in north east, Saberi Hamun in north and North West and Hirman Hamun in west and south west of Sistan. Except spring, in other seasons three Hamuns are separated from each other. These water bodies and have a decreasing trend due to the reduction of Hirmand River because of expansion of irrigation. Marsh lands surrounded the lakes like a strip. Large clay plates are very important in this area which are dominant in lake and marsh lands and (their area is as two fold as marsh lands). Whole lake with the storage of 15 milliard m³ of fresh water has a substantial role in ecosystem protection in Sistan basin.

Other sources of this cluster are located in Zabol plain (Fig. 10, region 2-G). These sources are a small part of Dari Rud of central Afghanistan which are separated by Harirood fault form east Iran's Falish zone. In North West, there are Neogen falishi deposits. Geophysical analyses also verify the north- south direction of plain and it’s 2500 m quaternary thickness deposits. Totally this area can be regarded as extra arid regions with warm summer and cold winter. Air temperature in it’s max, sometimes reach 52 Celsius degree while in cold nights of winter decrease less than 10 Celsius degree below zero. Average annual precipitation less than 60 mm along with potential extra evaporation 4,800 mm, clarify the aridity of this region.

Blowing of winds called “120 day winds” which starts from May and continue to the beginning of September is an important factor in removal of humidity from soil surface and intensification of aridity. On the other hand, along with depth drying it causes a significant decrease in Hamuns water surfaces (less than one third of Hamuns normal area). Based on announced statistics on behalf of Food and Agriculture Organization (FAO), the desertification process around the world at the present time is 36 m² per second, while this trend in Sistan and Baluchestan reaches 50 m² per second. Among 60 metrological stations of country, Zabol station has experienced the highest frequency and wind speed. Also, this region with average of 80.7 of dusty days in year, in a 5 year period from 1990 to 1995 has the second rate in sand and dust storm occurrence in Asia.

5.2 Main Reasons of Land Degradation and Soil Erosion

(1) Natural Factors

Drought causes water resource and vegetation cover loss in the region. The soil deposits of dried lakes and rivers including clay, sand and Lime, with humidity loss are very susceptible for wind erosion. Also it important to note that, this lake is located in north part of region where the winds starts. Therefore, a suitable condition for dust storm formation is provided.

Undoubtedly, the most important factor of the wind erosion occurrence in the region is the 120 days winds in Sistan. These speed of these winds reach 70 and sometimes 100 km per hour in short intervals and even in some cases they continually blow more than 6 months with lower speed. During last years, drought not only intensified the occurrence of these winds but also reduced their intervals, so that, even in spring in some cases they happen. The emergence of drought in the region, vegetation loss and topographic situation of region (being flat) has intensified the occurrence of these winds. Therefore reduction of surface roughness and presence of erodible soils in the region have paved the way for dust storm.
Sistan plain soils are mostly the deposits from rivers and contain silt, sand, loam and powders, without structure. These kinds of soils are so sensible to wind transportation. In this region, there is no trace of pebbles or are so scares. As we know, the pebbles larger than 2 mm are less susceptible to wind erosion. On the other hand they resist against movement. Besides the absence of these particles in surface, the soil of this region suffers from the lack of particles needed for soil structure which cause the increase in the activity of dust storms and their sensitivity to wind erosion.

Another effective factor in wind erosion in the region is the increase of salinity which causes the soil dispersion. In these soils there is another problem reinforcing wind erosion which is dispersal of soil particles due to the presence of sodium minerals. This event causes soil particles be separated from each other and be carried by wind easily.

(2) Human factors

Human factors have significant impacts on wind erosion and dust storm activities in the region and include the following issues:

Social, economic, and cultural condition of residents;
Nonstandard methods of cultivation;
Extra grazing of livestock;
Cutting bushes and trees for fuel;
Mismanagement in exploitation of pastures;
Removal of natural species like Gaz, Tagh and Atriplex and other ones;
The obstruction of water entering to the Hamun Lake by Afghanistan due to dam construction.

5.3 Related Activities to Dust Storms in the Southeast Cluster of Country

In Fig. 13 Satellite image show eastern, western, and southern arid and exposed margins of Jazmoryan Hole as one of the main sources of dust storm. The most activity is due to north-south winds to the extent that, dust storms covering whole south east of Iran. It also immerses the Strait of Hormoza shore, to Oman Sea and Persian Gulf countries, in a dense dust (Fig. 13).

Climate and metrological analysis of this region show that more than 75% of dust storms in Sistan region happened during warm period of year from May to October. Also it has been verified that, the formation of dust storms in Sistan plain during this period of year is related to formation, duration, and frequency of regional winds. Formation and continuance of an air circulation in regional scale in east of Iran' plateau in warm period of year is along with remarkable temperature differences. Also this circulation causes large slope of pressure difference between Sistan plain in lower lands and Afghanistan and Khorasan mountains in upper lands. As a result one of the most frequent and sever local winds in east of Iran's plateau happens. In the most north part of wind blowing region of Sistan (due to the nature and type of soil and surface coverage) dust storms are not much frequent. During passing of wind over upper lakes of Sistan (Hamun lakes) most of dust storm are appeared in WAR.

According to the previous studies, this region had the most frequency of dust storms in WAR and Iran. Diversion and removal of water in Hirmand River in recent years have caused an unprecedented drought and shrinking in Hamun Lake and it’s marsh lands. The Effects of such event can be found in the increase of days with visibility of less than 2 km in last years. In addition, whole lake has experienced vanishing trend since last 30 years especially during last climatic and
hydrologic droughts. Also at the present time the surface of lake has been changed to a source for soil and sand removal (Fig. 14).

In most cases the expansion of this source can be recognized by satellite images in dusty days which cover Sistan plain in both Iran and Afghanistan and some western parts of Pakistan. But it is notable that, in many cases if wind reinforces the event, the expansion of these dusts reaches Oman Sea and Oman and also North West of India. Also their expansion range from west can affect Zahedan city and some parts like Saravan and Mirjaveh (Fig. 15) [2-4].

6. Conclusions

Sand and Dust Storms (SDS) in the West Asia region have escalated in scale, geographic spread, intensity and frequency to a level that it became a true impediment to development and human well-being across several countries in the Region. In March and May 2012, the region was hit with probably the worst
dust storms in history; schools and airports were closed, traffic paralyzed, hospitals congested with cases of respiratory diseases and almost all aspects of people’s daily life and needs were disrupted. Sand and Dust Storms have also had impacts on land productivity and increased rate of desertification and land degradation ultimately affecting the already fragile ecosystems and livelihood of people and their well-being.

A number of countries in the Near East are experiencing the negative impacts of sand and dust storms, and have held a number of discussions and consultation regarding this, including a cooperation meeting held between Iran, Iraq, Syria and Turkey in Ankara in April 2010, resulting in the Ankara Ministerial Declaration and commitment to form a Task Force to address the SDS issue. Within the Declaration the Ministers committed to further develop cooperation in the area of environment and meteorology and proposed the development of a project with the aim of reducing environmental pollution with special emphasis on the mitigation of SDS, taking measures on dust formation, improving the meteorological monitoring and forecasting, controlling the wind and soil erosion and developing regional cooperation projects in these areas [2, 5].

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