منتدى الثلاثاء الثقافي

Dust & Sandstorms.
Causes,
Impact, and
Mitigation

What is a Dust storm?

Is a wall of dust and debris that is often blown into an area by strong winds from thunderstorms. The wall of dust can be ***miles long*** and ***several thousand feet high.***
Dust storms happen in many places around the world. Most of the world's dust storms occur over the **Middle East and North Africa**. However, they can also happen anywhere in the United States. In the U.S., dust storms are most common in the Southwest, where they peak in the springtime.

Barren ground and sites with **low coverage by vegetation** (e.g., dunes, soil surfaces, dry lakes, and riverbeds) are the main source areas of sand and dust storms (SDS).

Sand and dust storms (SDS) are common hazards, especially in **semiarid** and **arid** regions

The understanding of **causes**, processes (**abrasion**, **deflation**, **transport**, **deposition**), and **influencing factors** of sandy and dusty particles moving by wind both in the boundary layer and in the atmosphere are basic prerequisites to distinguish between SDS.

Difference between Sandstorm and Dust storm

A Sandstorm is particles of sand carried aloft by strong winds; they are mostly confined to the **lowest ten feet and rarely rise more than fifty feet above the ground**. Sand particles are larger than dust particles, are not launched far and **fall out of the air faster.**

A dust storm is a severe weather condition characterized by strong winds and dust-filled air over an extensive area. The particles in a **dust storm are smaller in size than particles in a sandstorm** and can be launched higher and farther. Dust storms can be broken down into **three categories:**

1- Localized and channelized dust storms,

formed by winds over disturbed areas (i.e. where agricultural crops go fallow) with small scale blinding dust. These are difficult to predict

2- Winter to early spring gradient dust storms

These storms are more widespread and create a cloud causing hazy days.

3- Monsoonal convective dust storms.

*produced from downbursts in **severe thunderstorm** development. This **creates a blast that lifts** dust as high as 5,000 feet generating very large scale, high and dense dust storms. This type of dust storm has been known to be called a haboob. Monsoonal dust storms tend to be the largest and thickest type of dust storms. They can travel as fast as 30 to 60 miles per hour, be as wide as 30 to 100 miles and travel as long as 100 to 200 miles!*

Causes

- Years of inappropriate farming practice,
- Mismanagement of water resources and
- Climate change

Continue to contribute to

* Reduced vegetation coverage,
* Desertification and droughts, which directly contribute to the growing regional SDS problem. *
* Droughts and arid conditions

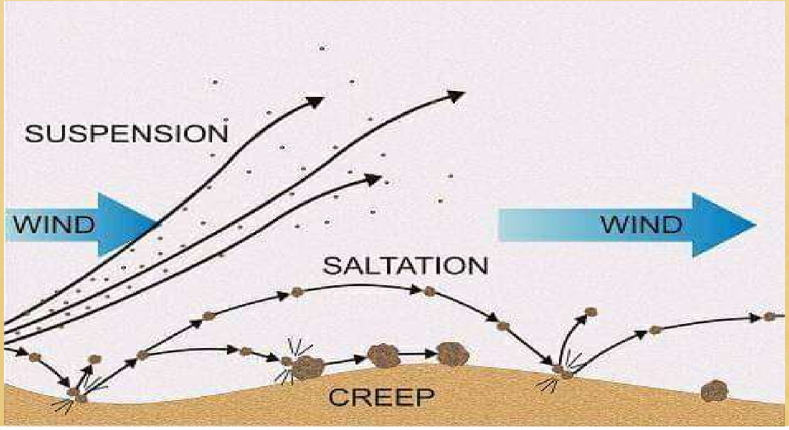
Every year, an estimated 2,000 million tons of dust is emitted into the atmosphere. While much of this is a natural part of the biogeochemical cycles of the Earth, a significant amount is generated by human-induced factors, especially unsustainable land and water management.

Types & Causes

Haze and dust with extreme storms have been documented as high as (10,000 - 12,500). The main cause for developing a dust storm is given "As **the force of wind passing over loosely held particles increases**, particles of sand first start to **vibrate**, then to **saltate** ('leap'). As they repeatedly strike the ground, they loosen and break off smaller particles of dust, which then begin to travel in suspension. At wind speeds above that, which causes the smallest to suspend, there will be a population of dust grains moving by a range of mechanisms: ***suspension***, ***saltation*** and ***creep***". However, SDS is the results of much inter dependent factors,

Vertical downdrafts of **chilled air during thunderstorms** may locally strike the ground with **velocities of (40 - 80) km/hr**. Under such conditions, fine particles may also be swept upwards hundreds or thousands of feet into the air. The average height of a dust storm is (1000 - 2000) m and stronger storms have dust to (2750 - 3500) m.

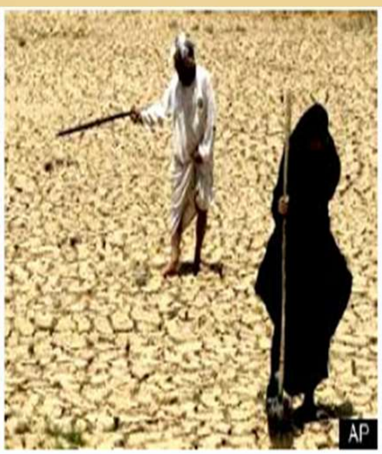
Research has shown that wind does not usually pick up dust-sized particles less than 0.05 mm in diameter along many completely smooth surfaces.



IRAQ

Iraq is one of the most affected countries in the Middle East concerning the occurrences of sand and dust storms. The **frequency of the occurrence** has increased drastically in the **last decade** and it is increasing continuously. The events of sand and dust storms are either **regional** or **local**. The former, however, is more frequent than the latter.

Iraq is affected by the southern and southeasterly wind called “Shargi” (in Arabic language means from the south), which is a dry wind with occasional gusts of 80 Km/hr, occurs from April to early June and again from late September through November. This wind brings with it violent dust storms that may rise to heights of several thousand meters.

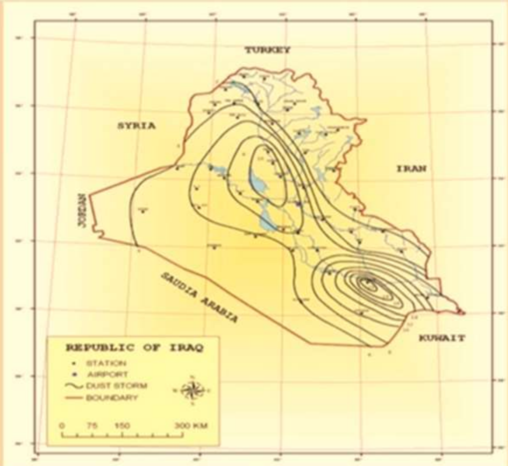


Contour map of dust storms for Mosul, Baghdad and Basra and for the period 1987-2002. Source: Abdulkareem et al. 2013.

Annual total precipitation rate for Iraq for 1970-2008 showing a trend of decreasing rainfall. Source: Crook 2009.

Various remote sensing products are used to track dust storms and to help to identify their sources. The SEVIRI Meteosat second generation (MSG) images are used to monitor the path and spatial scales of dust storms. Their movement is monitored using true colour composite images supplied by Europe's meteorological satellite agency, EUMETSAT.

The concentration of dust can be observed clearly from true colour red-green-blue (RGB) composites from the Moderate Resolution Imaging Spectroradiometer (MODIS) from the Aqua and Terra satellites. The spatial resolution of 250 metres allows identification of point sources.

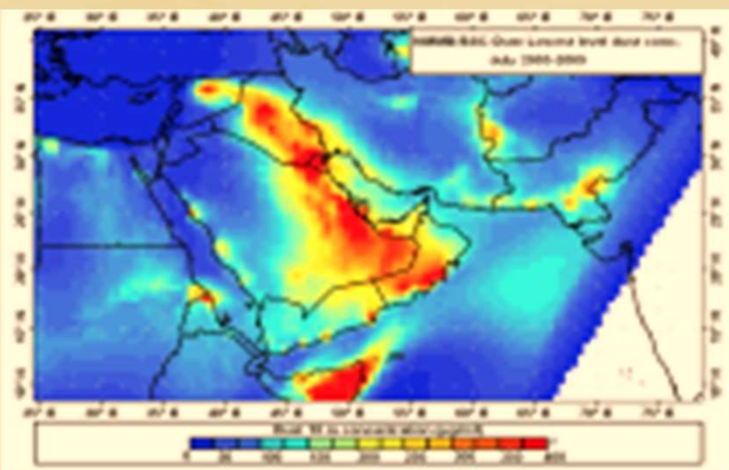


Average annual number of days of dust storms across Iraq, using monthly means for the period 1981-2011 (Iraqi Meteorological Organization 2013).

Dust characteristics

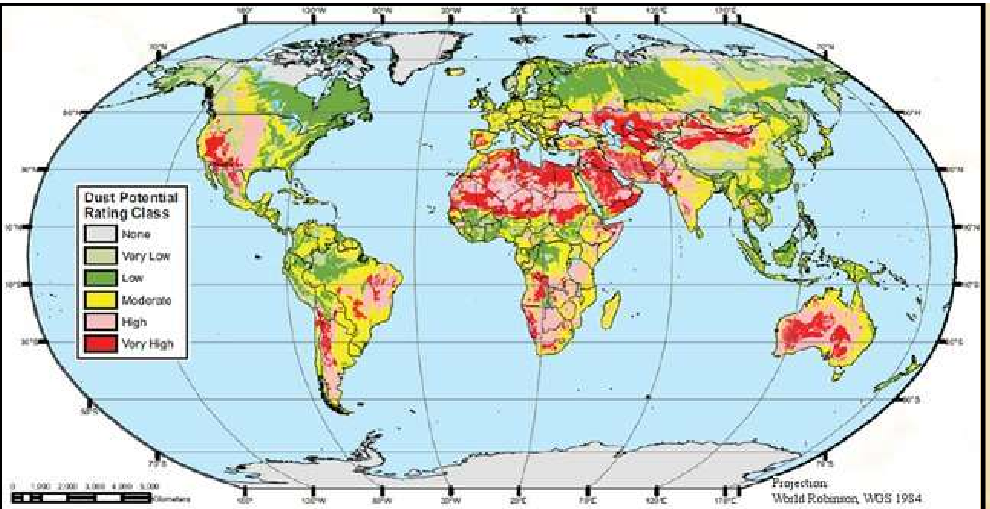
The composition of dust from storms that reached cities in central and southern Iraq was analysed. The total number of studied dust storms was 48 during 2007- 2010, 7 in 2007, 20 in 2008, 11 in 2009, and 10 in 2010.

Analyses of particle size distributions of dust storms provided information on: clay (20 - 71%, mean=55%), silt (18% - 63%, mean= 32%), and sand (8 - 18%, mean=13%) contents. The main texture of most dust samples was sandy silty clay (71.4%), and to lesser extent sandy clayey silt (28.6%), depending on the energy and velocity of the wind from the regional dust storm.



Dust storm corridor in West Asia. Source: Darvishi Boloorani et al. 2014.

Dust storm sources in West Asia, identified as th
main clusters and one subsidiary cluster. Source:
shi Boloorani *et al.* 2014.

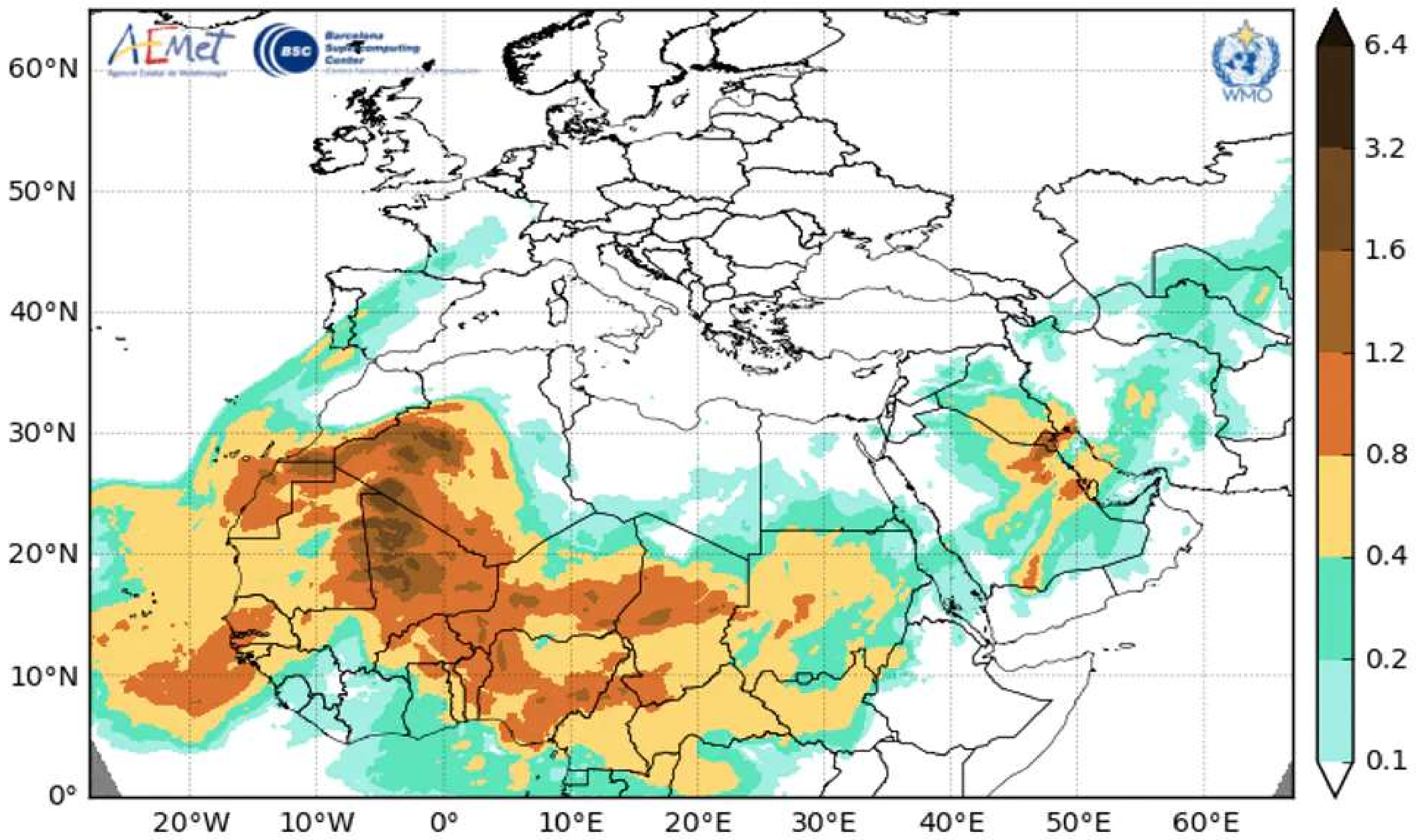


Global Dust Potential Map (After DTF, 2013).

Dust storm in the Iraqi Western Desert, west of Falluja. Compare the height

Governorate	Mean annual rainfall (mm)	Mean annual temperature (°C)	Mean annual dust storms (days)	Dryness index
Baghdad	150 - 200	23	12	20 - 25
Mosul	300 - 600	18 - 20	1 - 4	5 - 10
Basra	75 - 150	24	8 - 24	15 - 20
Erbil	400 - > 800	< 16 - 19	1 - 4	< 5
Suliamaniyah	500 - > 800	< 16 - 18	1 - 2	< 5
Dohuk	600 - > 800	18	1	< 5
Kirkuk	200 - 400	20 - 22	2 - 4	5 - 10
Salah Al-Deen	100 - 300	22 - 23	4 - 12	10 - 20
Diyala	150 - 450	23	4 - 12	15 - 20
Anbar	< 75 - 150	18 - 22	4 - 8	20 - 35
Wasit	150 - 200	23	2 - 6	20 - 25
Misan	150 - 200	23	2 - 8	15 - 25
Babil	100 - 150	23	10 - 12	25 - 30
Karbala	75 - 100	22 - 24	8 - 12	30 - 35
Najaf	75 - 100	22 - 24	8 - 12	30 - 35
DhiQar	100 - 150	24	6 - 12	20 - 30
Qadisiyah	100 - 150	23 - 24	6 - 24	25 - 30
Al-Muthan'na	< 75 - 100	24	12 - 24	25 - 35

*Climatic Atlas of Iraq (1951-1990).



Forecast of the dust content in the atmosphere for February 18 by the MONARCH model developed at the Barcelona Supercomputing Center. The comparison with observations showed that models forecasted well the timing and geographic extension of the dust plume reaching Europe.

Figure 2.1: Particle transportation types. Source: Pye (1987).

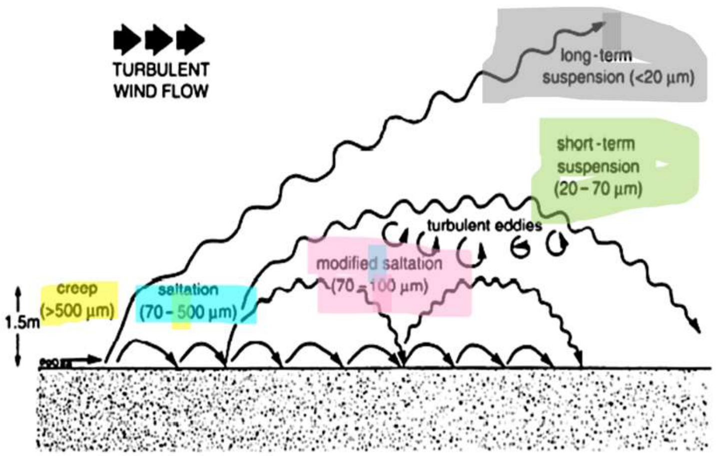


Figure 2.9: Integrated 10 year mean (2000–2010) annual dust emission flux in Tg/year for different regions as simulated in present, past, present climate historical land use (pChL), and historical climate present land use (hCpL). Dark green denotes emissions from agricultural source regions and yellow emissions from natural source regions. Note the use of different axis ranges. Source: Stanelle *et al.* (2014).

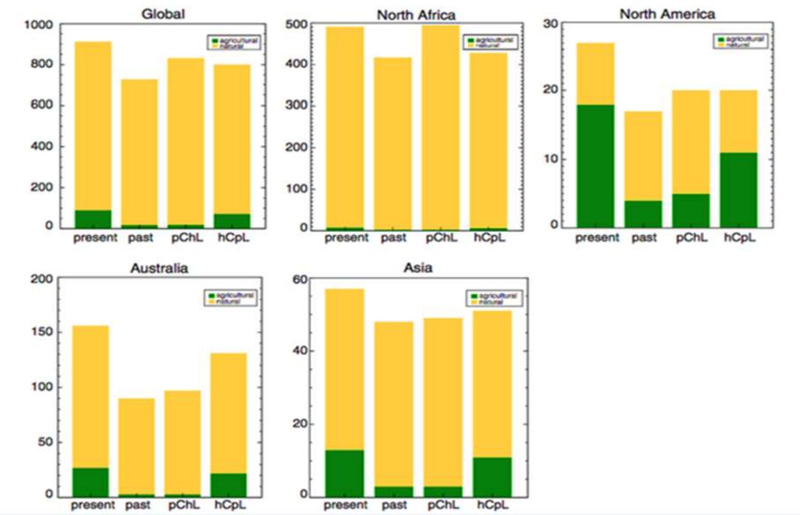


Figure 2.6: Dust – climate feedbacks. The impacts of human activities on atmospheric dust loads and the feedbacks to climate. Source: Arimoto (2001).

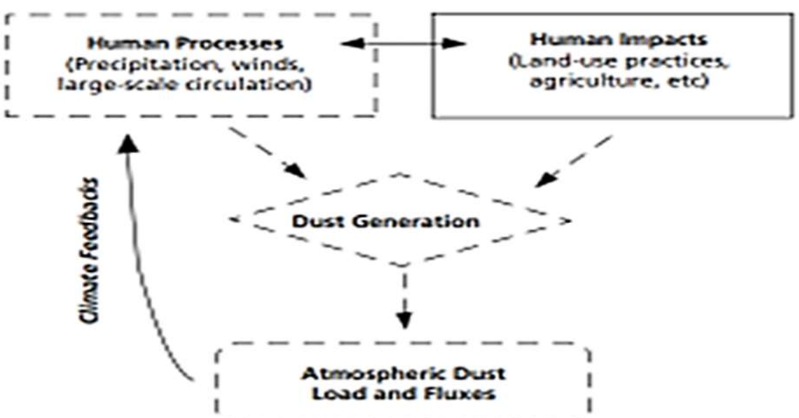
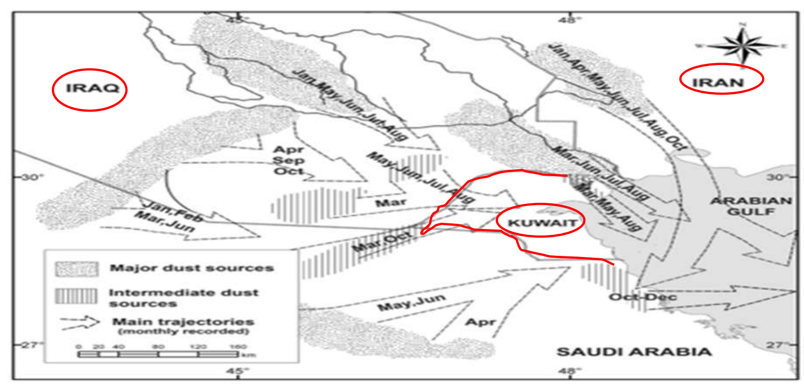
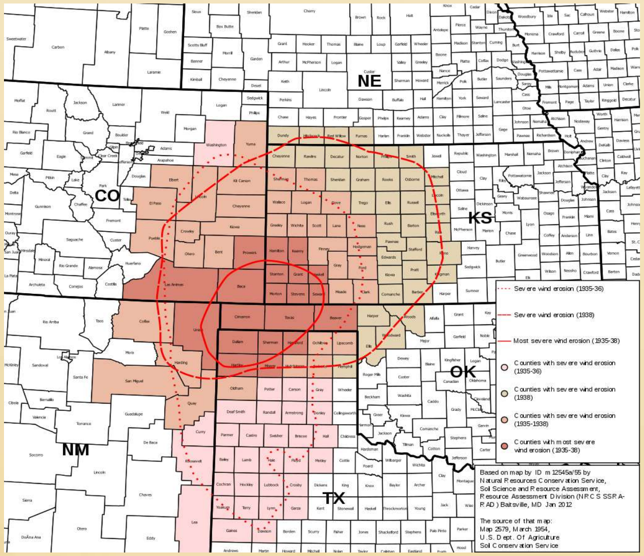


Figure 3.7: Major and intermediate source areas and trajectories for dust storms in the north-western areas of Persian Gulf based on dust storm days in Kuwait and satellite images from 2000 to 2010. Source: Al-Dousari and Al-Awadhi (2012).



Dust Bowl /USA-Canada

The Dust Bowl was a period of severe dust storms that greatly damaged the ecology and agriculture of the **American and Canadian prairies** during the 1930s; severe drought and a failure to apply dryland farming methods to prevent the aeolian processes (wind erosion) caused the phenomenon. The drought came in three waves: 1934, 1936, and 1939–1940, but some regions of the High Plains experienced drought conditions for **as many as eight years.**



During President Franklin D. Roosevelt's first 100 days in office in 1933, his administration quickly initiated programs to conserve soil and restore the ecological balance of the nation. Interior Secretary Harold L. Ickes established the **Soil Erosion Service in August 1933** . In 1935, it was transferred and reorganized under the **Department of Agriculture** and renamed **the Soil Conservation Service**. It is now known as the **Natural Resources Conservation Service (NRCS).**

Mitigation

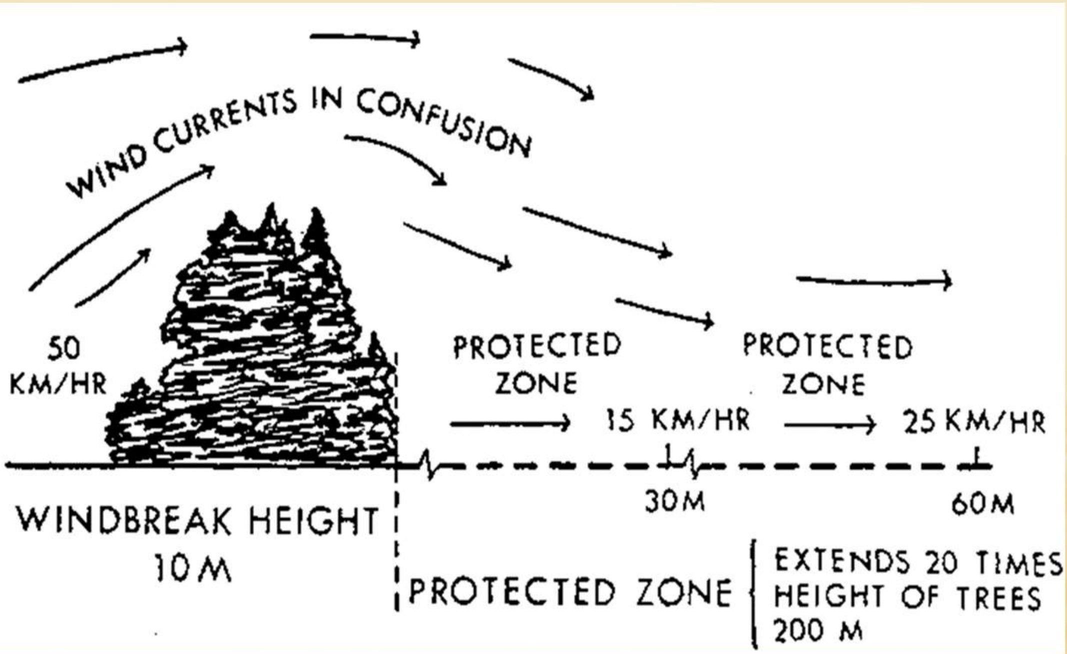
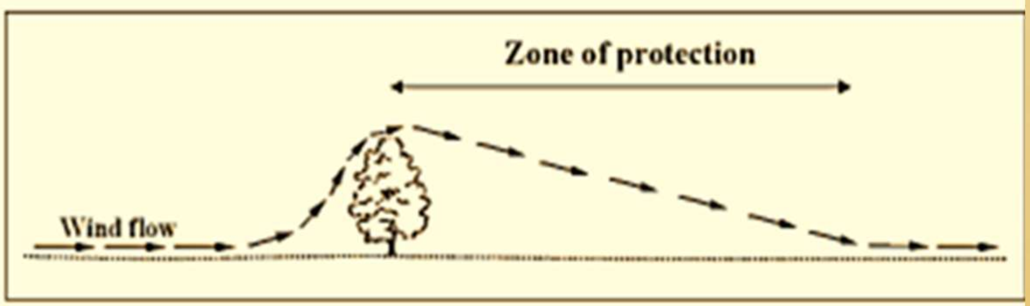


Figure 6.2: Protection effect of wind barriers. Source: Tatarko (2016).

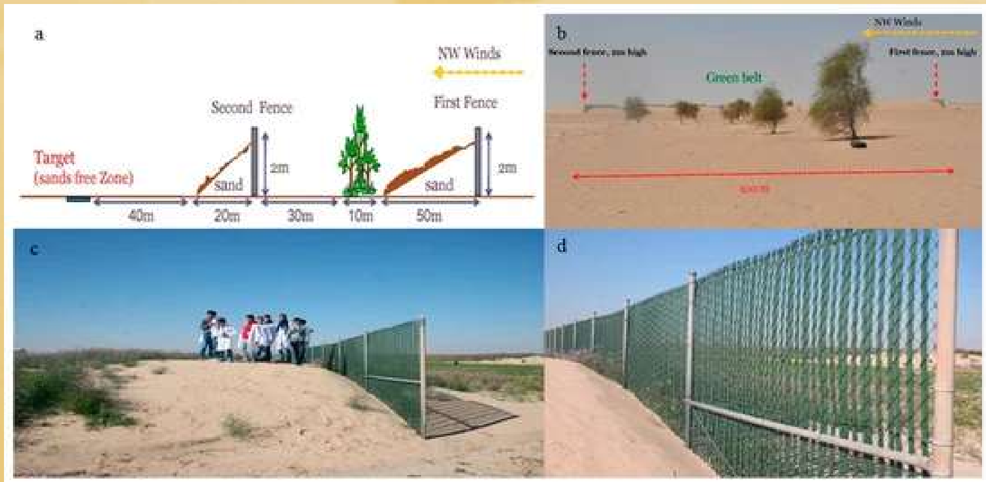


Impact mitigation

- Integrated early warning and monitoring
- Risk / impact assessment
- Vulnerability mapping of population and infrastructure

Source mitigation

- Sustainable land management
- Integrated landscape management
- Integrated water management



Windbreaks and shelterbelts

Shelterbelts and windbreaks protecting crop land in large fields. Sourc

Trees used to stabilize sand dune encroaching on an irrigation scheme on the Nile flood plain. Source: UNEP.

Sand dune stabilization

Canal-side plantation

River-bank plantations

Tillage

Clod forming tillage produces aggregates or clods that are large enough to resist the wind force and trap smaller moving particles, and resist breakdown by abrasion throughout the wind erosion season. Source: Tarataka (2016).

Reduced and mulch tillage systems providing soil protection from wind erosion in the USA. Source: Tarataka (2016).

Global Assessment of Sand and Dust Storms United nation Environmental program

To reduce anthropogenic sources of sand and dust storms, the Assessment **recommends** ***integrated strategies that promote sustainable land and water management in cropland, rangelands, deserts and urban areas, and climate change mitigation.*** The report proposes a consolidated and coordinated global policy: for responding to sand and dust storms,

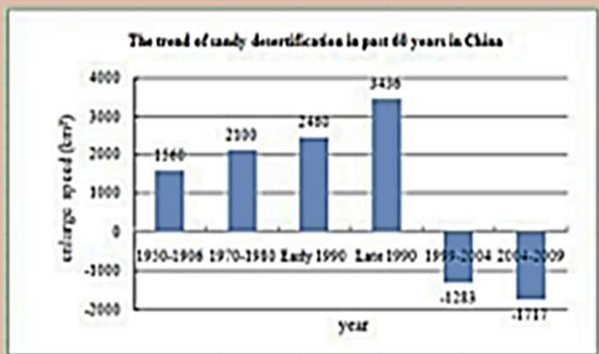
Key questions that are important to answer for policy decision making include:

- Have dust storms got worse (more frequent and severe) in recent decades?
- To what degree are SDS a result of human activity?
- What can be done to prevent them and protect ourselves from their impact?

This assessment aims to shed light on these question

Abdulkareem A. A. Mohammed. Ministry of Science and Technology, Baghdad, Republic of Iraq; ,
Moutaz Al-Dabbas. College of Science, University of Baghdad,

After 20 years hard work in combating desertification, the pattern of national desertification has reversed since 2004 and 1,280 – 1,720 km² of desertified land has been controlled. As a result, desertification severity has reduced significantly in recent years. This is a significant achievement towards implementing the UNCCD LDN initiative.



Trend of sandy desertification in China over the past 60 years.

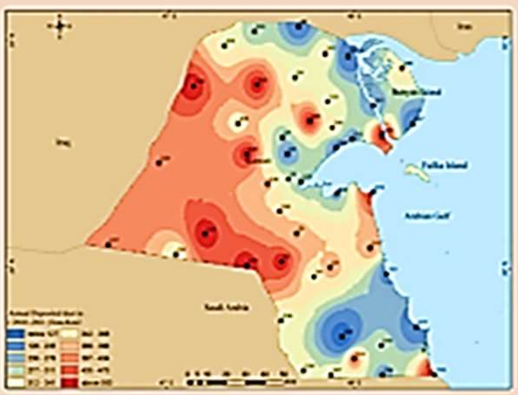
China is moving on with a new vision to extend its greening initiatives along the Silk Route, with an aim to plant 1.3 billion trees in ecologically vulnerable regions over the next 10 years. A Green Silk Road Fund was launched through public-private partnership in China.

Source: SFA (2013)

The location of the planned Africa Great Green Wall.

Box 8.7: Impact of preserved areas, farms and green belts on dust deposition in Kuwait.

Kuwait has high depositional rates of dust in its western, southern and northeastern regions as shown in the map below (Al-Dousari *et al.* 2016).



Annual dust fallout in Kuwait 2010-2011

Control measures that have been tested include protected areas of native plants arranged in green belts, consisting of lines of tress of Prosopis and Tamarix species. In two preserved areas dust deposition was 40% to 76% less in downwind areas than in upwind areas. Farm areas reduced deposition by 88%. Green belts reduced dust by 26%. Native vegetation, green belts, and well-managed farms are recommended as the most practical method to mitigate dust problems in the region (Al-Dousari *et al.* in press).

Box 8.10: Iranian agreements on sand and dust storms (continued)

SDS remedies in Iran. Top-left: area planted with Haloxylon trees. Top-right: bio-mechanical measures for rain water harvesting and runoff control and seeding. Bottom-left: sand dune fixation.

Source: UNEP (2014).

REFERENCES

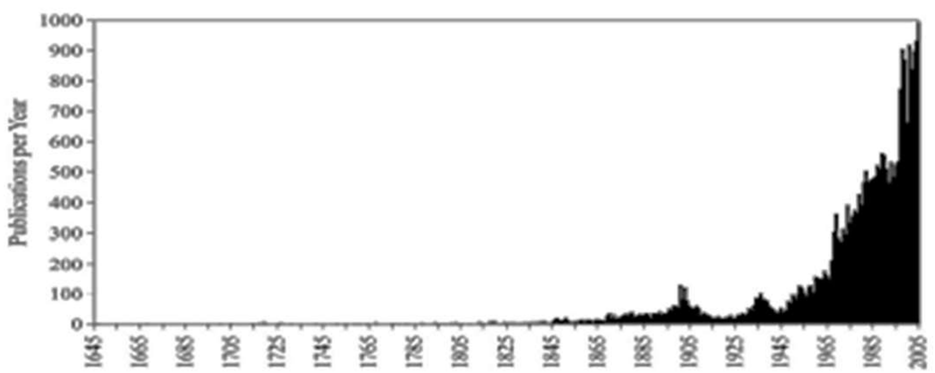
1- J. Risk Financial Manag. **2021**, 14(7), 326; https://doi.org/10.3390/jrfm14070326

2- Sand and dust storm events in Iraq. Vol.5, No.10, 1084-1094 (**2013**)

3- Global assessment of Sand and Dust Storms. 14-12-**2016**

4- Economic Impact and Risk assessment of sand and dust storms…. *Sustainability, 11. (200), 1-19*. January **2019**

Figure 1.2: Time trends in publications on sand and dust storms derived from Google Scholar.
Source: Stout *et al.* (2009).



Q&A