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Dear Readers,

Due to the trans-boundary nature of dust storms, many of us are affected either directly or indirectly. Dust storms are now receiving more attention due to their frequency and intensity. They are often caused or exacerbated by poor environmental management, resulting from a range of factors including: deforestation, degraded rangelands, exhausted cultivated fields, salinized irrigated land, depleted groundwater resources and the shrinking of water bodies such as is the case with Lake Chad and the Aral Sea.

Disruptions and threats from dust storms are a global concern and UNEP continues to develop and network partnerships with others in these fields such as; Asian Development Bank (ADB), Economic and Social Commission for Asia and the Pacific (ESCAP) and United Nations Convention to Combat Desertification (UNCCD) to address the need for prevention, preparedness, response and mitigation of the effects of dust and sand storms.

In this issue, we share with our readers information about what dust and sand storms are, their causes and impacts, methods used for their detection as well as the options available for their mitigation and control.

We wish you informative reading.

What is a dust storm?

A 'dust or sand storm' is a meteorological phenomenon caused by severe weather conditions, specifically high surface winds which pick up loose dust, reducing visibility to less than a kilometre. Severe dust storms can reduce visibility to zero. The average height of a dust storm is from about 900m to 1800m. The images below illustrate the severities of dust storms.

(Beijing) Dust Storm - April 7, 2001
Photo Courtesy of Prof. Zev Levin,
http://www.lakepowell.net/asiandust.htm

Dust storm, west Texas, USA, June 04 2003
http://www.ericsiegmund.com/fireant/archivesmt/cat_local.html

Dust storms originate in arid and semi-arid regions, in particular the Sahara, Middle East, South-West Asia and Mongolia. However, Northwest America and Australia are also source regions of dust. The map below uses satellite data to give a refined view of global dust source regions. The lighter shaded areas are those that produce most dust.

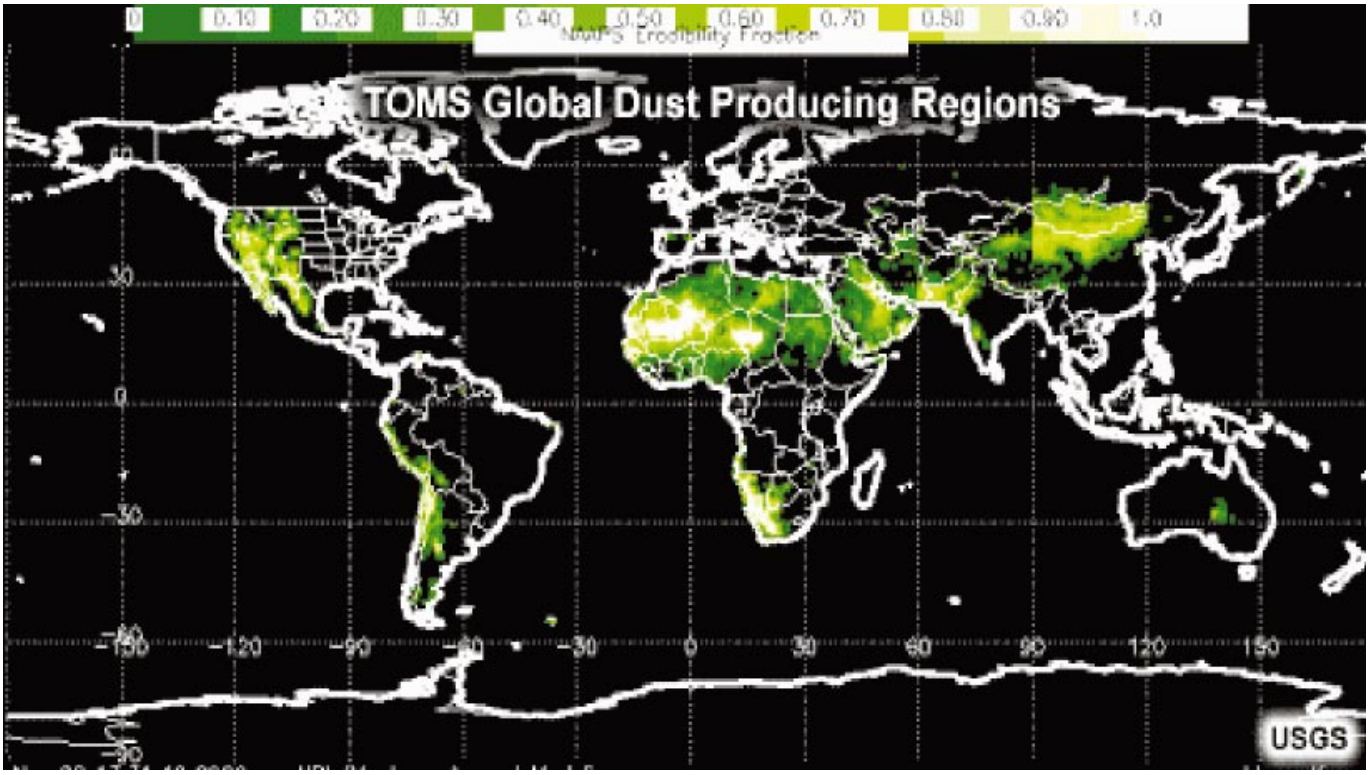
Causes of Dust Storms

Natural Factors

Due to the lack of vegetation cover in dust prone regions, extreme daytime heating of the ground causes the air directly above it to warm up and thus begin to rise. This warm air continues to rise until it meets the higher winds of the troposphere (lowest major atmospheric level) where it mixes in a downward spiral and in so doing causes strong winds at the earth's surface.

Human Factors

Desert surfaces have been stable for thousands of years as they are usually covered with a thin layer of lichen, algae or even gravel (known as the desert pavement). It is believed that desertification continues to breach these surfaces, thus exposing fine sediment to the wind. Desertification is both a symptom and a cause of land degradation. This in turn is caused by a range of factors, such as; deforestation, degraded rangelands, exhausted cultivated fields, salinized irrigated land, depleted groundwater resources and the shrinking of water bodies such as Lake Chad and the Aral Sea. Unsustainable land management practises caused by either inadequate techniques or increasing population pressures have increased the susceptibility of land to desertification and thus to dust storms.



Source: *meted.ucar.edu/mesoprim/dust/print.htm* TOMS refers to Total Ozone Mapping Spectrometer.

Dust storms in Saudi Arabia are known by the word 'Shamal' roughly translated as 'North wind.' The winds can reach speeds as high as 80-95 kilometres per hour. Dust storms common in the Sahara desert and in the dry regions of the Southwest states of the United States of America (Texas, N. Mexico and Arizona) are known as''Haboobs.' They are the large walls of dust and sand that most people think of as strong dust storms. Winds average 60-95 kilometres per hour and they move very fast. In North- East Asia, dust and sandstorms are referred to as''Asian dust' and in Japan as''yellow sand'.

Frequency of dust storms

Over the past 50 years, dust storms originating in the Sahara, where wind can move 65 to 220 million tonnes of fine sediment each year have increased ten fold. Andrew Goudie, of the University of Oxford (New Scientist, 17:48 20 August 2004) claims that up to 3 billion tonnes of dust is blown around the world annually.

Likewise, the Northern half of China is becoming drier. Beijing (China's capital) is now less than 250km from the encroaching desert and has in recent years seen a major increase in the

frequency of sand storms, prompting widespread official alarm. The new decade begun with more than 20 major dust storms in 2000 and 2001 alone. With the dramatic jump in the number, severity, and size of dust storms in 2000–01, the growth of the deserts in China appears to be accelerating. If this annual rate continues throughout the decade, the total will jump to 100—a fourfold increase over the last decade. The table below shows the increased frequency of dust storms by decade.

Number of Major Dust Storms in China, by Decade, 1950-99, with Projection to 2009	
Decade	**Number**
1950-1959	5
1960-1969	8
1970-1979	13
1980-1989	14
1990-1999	23
2000-2009	100*

*Preliminary estimate for decade based on more than 20 storms during 2000 and 2001.

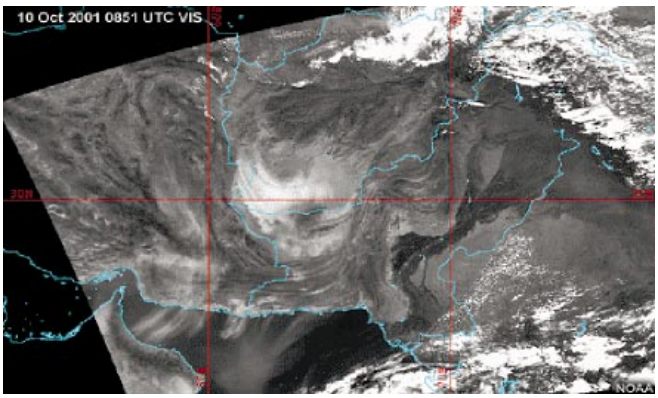
Source: China Meteorological Administration, cited in "Grapes of Wrath in Inner Mongolia," report from the U.S. Embassy in Beijing, May 2001

Methods used for the detection and monitoring of dust storms

Satellite based Imaging

The satellite systems used for dust detection and monitoring include: Geostationary Operational Environment Satellite (GOES), Landsat Thematic Mapper (TM), Wide Field-of-view Sensor (WiFS), the Sea viewing Wide Field-of-view Sensor (SeaWiFS), Advanced Very High Resolution Radiometer (AVHRR), and the Moderate Resolution Imaging Spectroradiometer (MODIS).

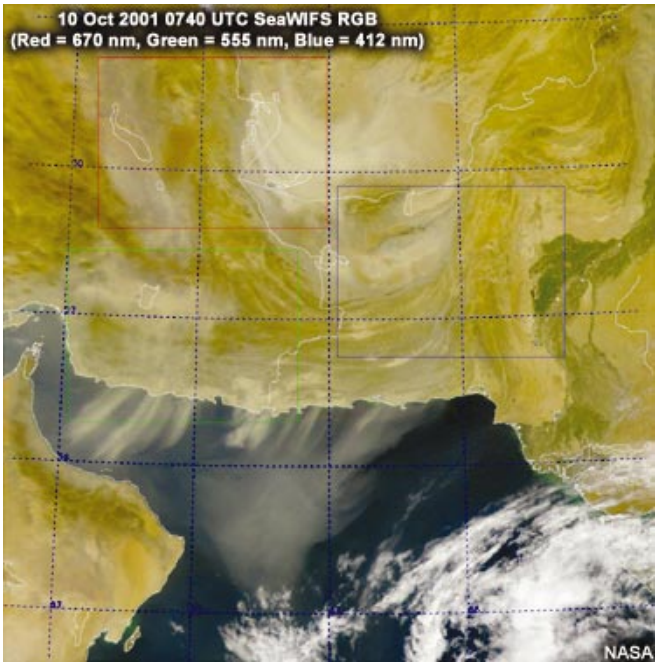
Each of the systems mentioned above has its merits and de-merits. To understand how the different images collected by these systems help in dust detection and monitoring, it is worth comparing the following images:



Source: meted.ucar.edu/mesoprim/dust/print.htm

The AVHRR image on the left shows a dust storm over central Asia. There are two areas covered by the dust storm, one over water and the other over land. It is difficult to identify the two areas, but comparison with the SeaWiFS image on the top right will clarify the regions affected by dust.

The SeaWiFS image below was taken the same time as the AVHRR pass and is better and clearer at illustrating the dust storm over land and over water. For example, dust can be distinguished from the cloud on the bottom right side of the picture. Thus SeaWiFS is more useful in dust identification than the AVHRR system.



Source: Meted.ucar.edu/mesoprim/dust/print.htm

People in China protecting themeselves against the dust. Source:*http://news.bbc.co.uk/1/hi/world/asia-pacific/1887000.stm*

Ground based digital camera

Photographs from a digital camera station can provide images of dust events during cloudy days, something satellite-imaging systems fail to do. Compared with satellite images, the ground-based digital photographs allow more precise identification of the dust-source locations and provide information about the frequency, size and duration of dust storms not captured by satellite systems. The ground-based photographs also contain information about local sand transport patterns and emission rates when analysed in conjunction with wind speeds required to suspend dust at these locations.

Impacts of dust storms

Environmental

Coincidental with the decline of Caribbean coral reefs over the past 25 years, there has been a sharp increase in the transport of African dust to the western Atlantic. With the long-term drought in Africa, combined with overgrazing in many areas, the amount of dust carried across the oceans has been increasing and is now estimated at several hundred million tons annually. Thus sediment picked up and carried away by trade winds from the Sahara may explain why a variety of new diseases such as white plague and black bland are threatening sea urchins and a diversity of coral species in this area. *Aspergillus*, a fungus that affects corals known as sea fans throughout the Caribbean is found on land and does not reproduce in seawater. One theory is that wind-blown sediment deposits the *Aspergillus* fungi in the seawater, from where it infects the corals.

In the spring of 2001, two robotic carbon explorers recorded the rapid growth of phytoplankton in the upper layers of the North Pacific Ocean, after a passing storm had deposited iron-rich dust from the Gobi desert in China. This is the first direct observation of wind blown terrestrial dust fertilising the growth of aquatic plant life. This would be potentially useful in slowing global warming, though future research needs to confirm this

Social

Dust storms can result in injuries and deaths, for example dust storms that occurred in 2003, in California, New Mexico, Arizona, Oregon, Washington, Utah, Texas and Nevada caused 2 deaths and 91 injuries. Wind blown dust, carrying small particulates of smoke and various chemicals have been linked to respiratory illnesses and premature deaths in dust-affected areas. The United States Environmental Protection Agency (USEPA) implemented air quality standards in 2001 predicting that the stringent requirements would result in a reduction of premature deaths by about 15 000 a year and serious respiratory problems in children by about 250 000 cases annually in the United States. Dust storms result in closure of schools, cancelled airline flights, injured livestock, destroys electricity facilities, cuts off water supply, distorts television signals and overruns clinics with people struggling with breathing. In South Australia, up to 60 days of severe dust can be experienced in a year with major costs relating to health issues, particularly asthma and respiratory illnesses.

Economic

Dust related asthma is costing Australia between $10 and $50 million a year, chiefly lost in absenteeism from work and school. Australian householders spend a further $3m a year, which is used in extra maintenance and cleanup after sandstorms. Dust and sand storms inflicted US$6-billion in costs to China in 2003. Rural areas are more vulnerable to dust storms than urban areas. The damage of crops, soil erosion, and pollution associated with dust storms can easily destroy the economy of a rural community, and this effect may last several years even after the occurrence of the storm.

Approaches to prevent and control dust storms

Biological approaches

Biological measures are the key solutions to fight dust storms. An example of such measures includes the establishment of wind/sand breaks and revegetation of degraded rangeland in China. More than 300,000 hectares of farmland on ground sloping more than 25 degrees will be returned to forest or grasses[1]. Further measures include the development of ecological barriers like forest shelters, which halt the progress of desert encroachment and drifting sands.

Mechanical approaches

Mechanical measures include the 'straw checkerboard', which is a sand dune fixation technique, built in the shape of a checkerboard by using straws of wheat, rice or reed and is remarkably effective in stabilising dunes. (See photograph on the right). It is one such mechanical solution used in both China and Turkmenistan to control sand movement and stabilise mobile dunes along railways, highways and mining plots.

Engineering approaches

In arid provinces of China, the wire fencing system is widely adopted in densely populated zones to protect pasture and rangeland from overgrazing. Air seeding (the use of 'fluffy seed' where the surface of the soil is lightly ploughed by tractor disk, and a mixture of seed and fertiliser placed below the soil surface) is also used to revegetate arid and semi-arid areas in Asia.

Chemical approaches

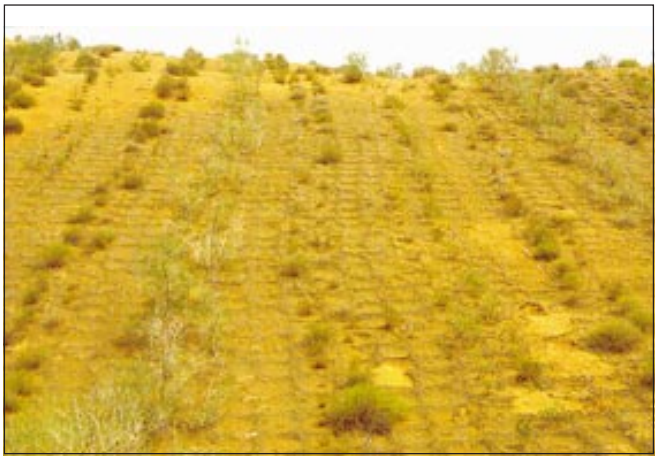
In the Islamic Republic of Iran, waste oil materials are used to arrest the further movement of drifting sands and stabilises mobile dunes. Likewise, in China, the use of chemical materials and plastic mulching[2] in dryland regions are alternatives that halt sand movement. However, chemical approaches are unfriendly to the environment, soil and ground water, though they are extremely effective in controlling sand movement.

Socio-economic approaches

Socio-economic approaches have concentrated on mainstreaming land management issues, including policy reforms, land reforms, poverty reduction strategies and water-use efficiency. Measures taken in isolation of one another cannot solve the dust and sandstorm problems; rather an integrated approach with multi stakeholder partnerships is needed. This would address the long-range, transboundary environmental problems caused by the dust and sandstorms. This was the initiative adopted in December 2002 by the Regional Technical Assistance (RETA 6068,) for prevention and control of dust and sandstorms in North-East Asia. It is a collaborative initiative of ADB, ESCAP, UNEP and UNCCD. China, Japan, Mongolia and the Republic of Korea are the four participating countries that have agreed to promote the establishment of a regional cooperation mechanism among stakeholders, including Governments, international agencies, the private sector and civil society to address the transboundary dimensions of dust storms in North-East Asia.

[1] Multi stakeholder partnership in promoting sustainable development in Asia and the Pacific: Prevention and control of dust storms, ESCAP, 29/11/04

[2] Any substance spread or allowed to remain on the soil surface to conserve soil moisture and shield soil particles from the erosive forces of raindrops and runoff.



A sand dune stabilized in 1981 with straw checkerboards in Ningxia Province, China
Source: www.weru.ksu.edu/symposium/proceedings/mitchell.pdf

Selected websites related to dust storms

1. National Geographic (June 1, 2001): Reggie Royston, '*China's Dust Storms Raise Fears of Impending Catastrophe*'' http://news.nationalgeographic.com/news/2001/06/0601_chinadust.html
2. Geology News (July 12, 2000) '*Tie me topsoil down*''http://www.geolsoc.org.uk/template.cfm?name=Winderosion
3. Erosion Control (Sept/Oct 2001): Greg Northcutt, '*Some Downwind Costs of Upwind Erosion*''http://www.forester.net/ec_0109_toc.html
4. Arid lands Newsletter (No.51, May/June 2002): Chavez et al: '*Monitoring dust storms and mapping landscape vulnerability to wind erosion using satellite and ground-based digital images*''www://ag.Arizona.edu/OALS/ALN/aln51/chavez.html
4. Prevention and control of dust and sandstorms in North-East Asia - United Nations Economic and Social Council. Multi-stakeholder partnership in promoting sustainable development in Asia and the Pacific: Prevention and control of dust and sandstorms.http://www.asiansandstorm.org/

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