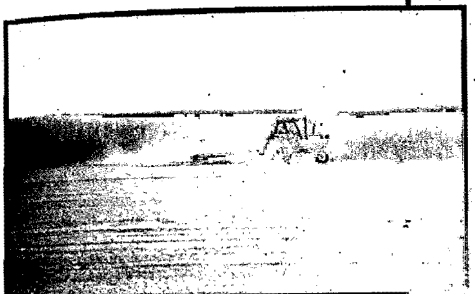
environment WATCH

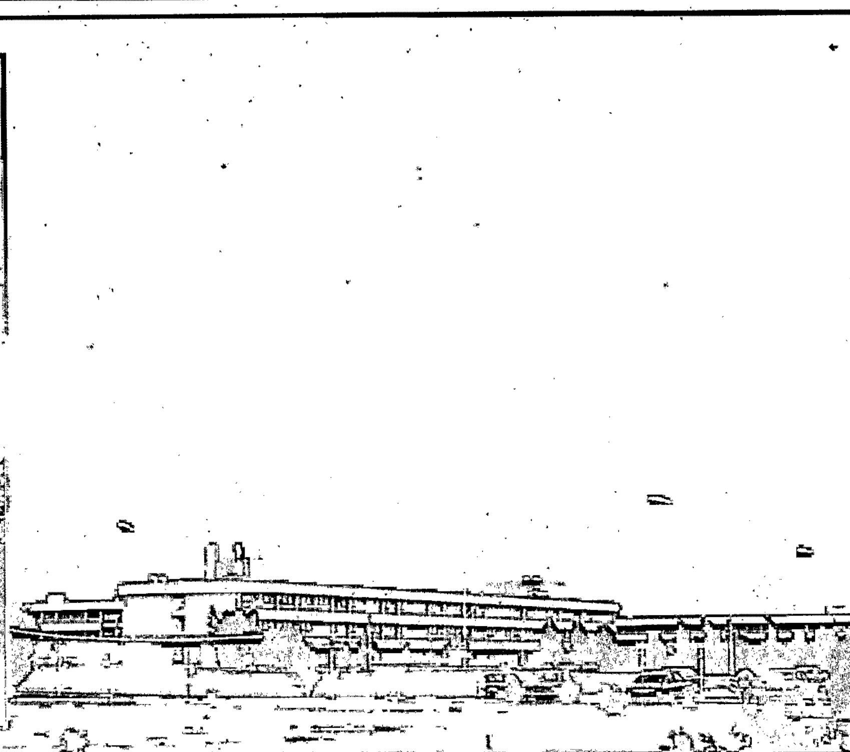


J. WRIGHT

Sixty per cent of mulgaland nutrients have blown away.

J. WRIGHT

We get rather annoyed when dust lands on our clean washing.



G. McTAINSH, ENS, GRIFFITH UNIVERSITY, BRISBANE

Melbourne Airport 1983

The Australian dust bowl

Harry Butler

Many readers will remember the dust storms that swept across Western Australia, South Australia and the western parts of New South Wales and Victoria in May 1994. It is estimated that these storms removed 10-15 million tonnes of topsoil from major farming districts and transported it across much of the continent. Understanding the cause and effect of these major dust events is important, as their economic impact can be considerable, both in Australia, and in other countries where they occur, such as North America and Africa.

To most people dust is merely a nuisance. It gets in our eyes, irritates our noses and ends up on the carpet. New Zealanders complain bitterly, when the red dust of western Queensland and New South Wales discolours the snow on their lovely mountain peaks. It is however, the Australian farmers who suffer the most during dust events.

Dust storms

Dust storms are size selective in the soil particles involved, with only the smallest particles being transported out of the local area. Due to this selective nature and the size of the areas involved (thousands of square kilometres), much of the effects of wind erosion (the erosion process that produces the dust in nature) are difficult to measure.

Effect on rural areas

It is the smallest soil particles (usually less than 50 µm or 0.05 mm) and organic matter that are lost in dust storms. So why are these small soil particles so important? In answer to this question, we need to consider the make up of these small soil particles.

If we look closely at these small mineral and organic particles, we find that many of the major soil nutrients (nitrates or phosphates) are attached to them. As these nutrients are necessary for strong crop growth, their loss can result in a substantial decrease in the production potential (the tonnage yield per hectare) of the wind-affected land. In order to recover some (but not all!) of this loss, it is necessary to apply more fertiliser, thus increasing the cost per tonne of grain produced on wind-affected land. Removal of these fine particles also reduces the moisture storage capacity of the soil.

As well as this loss in production from the loss in nutrients and water storage, many young plants are lost to the sand-blasting nature of the process.

In economic terms, these effects are estimated to cost Canada $368 million per annum. The replacement cost in nutrients from the Melbourne dust storm of 1983 is estimated to be about $4 million.

Other effects

As the dust cloud moves downwind, it inevitably passes through populated areas, contributing to urban air pollution.

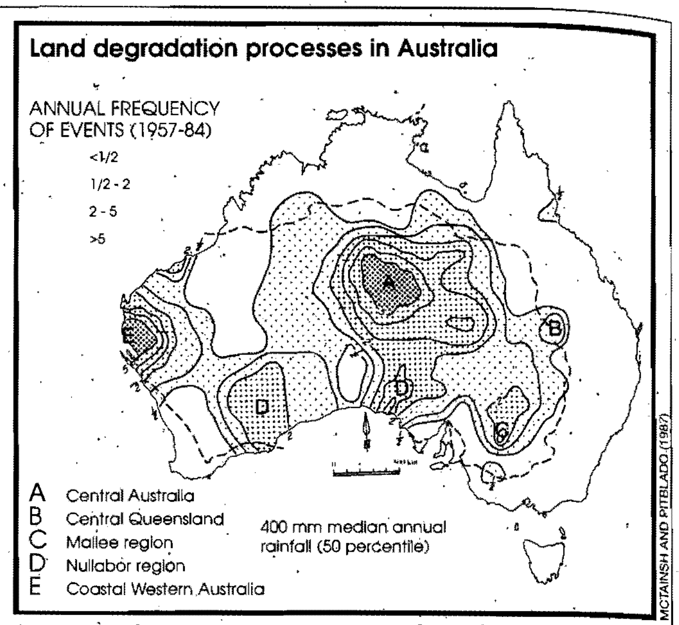
The most noticeable effect is the reduction in visibility. This is dependent on the severity of the dust event and ranges from a slight haze to major dust cloud. In the worst case, visibility could be reduced to only a few metres. This loss of visibility in populated areas can present a major problem for commercial aircraft.

As the dust settles over a populated area and people breathe in these tiny dust particles, people with asthma and similar conditions can be affected. This effect was clearly evident in the Adelaide dust storm of May 1994, with a large increase in asthma-related conditions during the event.

> *It is important that over-grazing be avoided, so that these cover levels can be maintained.*

So far we have only considered what effects the dust storms have on the dust source and populated areas, therefore to complete our analysis of the effects we need to consider how these storms impact on other areas.

As a dust cloud rolls across rural areas where it is no longer entraining (gathering material), a certain amount of dust is deposited on the surface of the land and on plants. This can be quite advantageous depending on the amount that is deposited. A recent NASA study suggests that nutrients transported from the Sahara have a direct effect on the growth rates of parts of the Amazon jungle. This suggests that the dust transport processes form an integral part of the global ecosystem.



Patterns of dust storm occurrence based upon meteorological records in 149 stations (annual averages 1957-84)

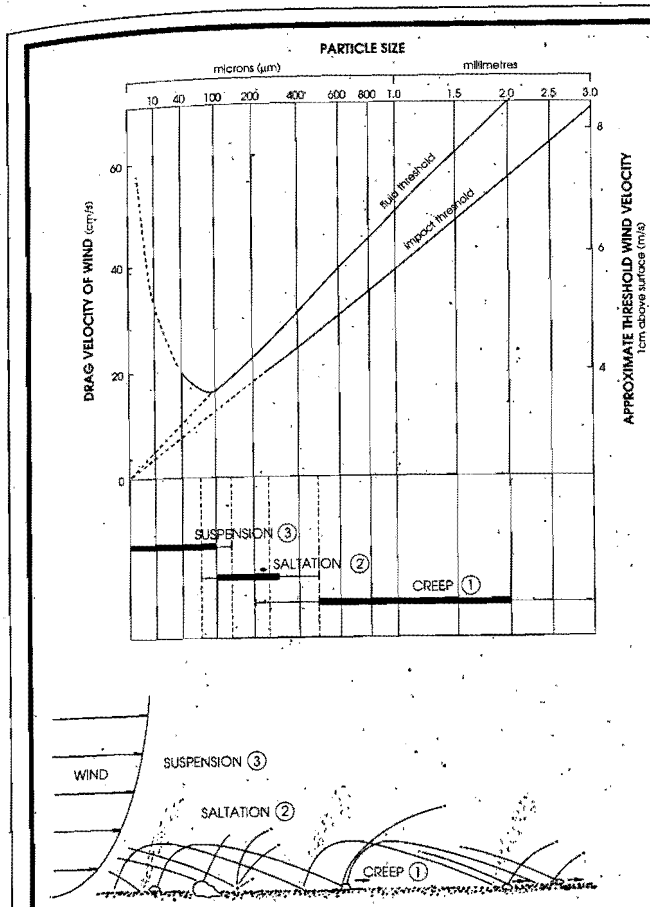
Blowing in the wind

Consider a surface made up of separate particles which are held in place by their own weight and some interparticle bonding. Across this we will apply a low speed wind, which we will gradually increase. Initially there will be no indication of motion, but at an increased wind speed, a number of particles will begin to vibrate. Increasing the wind speed further will result in a number of particles being ejected from the surface into the air flow. When these ejected particles impact back upon the surface, more particles are ejected, thus starting an avalanche effect.

Once ejected, these particles move in one of three modes of transport, depending on *size*, *shape* and *density* of the particle. These modes are *suspension*, *saltation* and *creep*.

The suspension mode (or dust mode) is generally made up of particles less than 0.1 mm (or 100 μm) in diameter. Particles in this mode may be transported at altitudes up to six kilometres and over distances of up to 6000 km.

Saltating particles (between 0.1 mm and 0.5 mm in diameter) leave the surface, but are too large to be suspended in the air flow and quickly return to the soil surface. As these particles impact upon the surface, they initiate movement of other particles (in a similar way to a moving billiard ball: hitting a stationary ball initiates its motion). About 50 to 80 per cent of all the soil being transported is carried in this mode. Due to the nature of this mode, transport heights are generally less than 30 cm, with distances traversed being of order of a few hundred metres.



Bagnold's fluid and impact threshold relationships between wind velocity and soil particle size. Particle size ranges of three modes of sediment transport – creep, saltation and suspension.

The remaining particles (larger than 0.5 mm) are transported in the creep mode. These particles are too large to be ejected from the surface and are therefore rolled along by the wind and impacting particles. The distance covered by these particles rarely exceeds a few metres before they are trapped by surface obstructions.

Conservation techniques

There are two basic ways of controlling wind erosion – reducing the erosivity of the wind (the capacity of the wind to erode) or decreasing the erodibility of the soil (vulnerability of the soil to erosion).

There are a number of techniques available for achieving a combination of these two conditions. Let us now consider some of the more common techniques in detail.

Cover management

In this technique, cover (such as stubble from a wheat crop) is allowed to remain on the surface after a paddock has been cultivated. This leaves the surface of the paddock with a protective cover, thus reducing the wind erosion. There is however, a critical amount of cover that is required for maximum protection. This critical cover level can now be determined from either empirical data or from mathematical models.

This technique can also be applied to grazing areas, where a good amount of ground cover is required to prevent wind erosion. Thus from the graziers' point of view, it is important that over-grazing be avoided, so that these cover levels can be maintained.

Wind breaks

This is a common method of wind control in areas of intensive agriculture and horticulture. Wind breaks work by reducing the wind speed and the wind fetch (unobstructed upwind distance from a particular point). However as winds can come from any direction, these barriers require careful planning to be effective.

Strip cropping

In this technique farm land is divided into strips perpendicular to the erosive wind direction. This reduces the wind fetch, and thus reduces the erosive strength of the wind. Also the cropped area may trap some saltating particles, preventing their escape from the paddock. This method is uncommon in Australia, due to the mixed farming conditions (grazing and cropping together) that exist in Australia. It is also a common practice for water erosion control.

Current research

In the past ten years our knowledge of wind erosion and natural dust processes has increased significantly. However, advances have been slow when compared with those seen in water erosion processes. This has been largely due to the difficulty in obtaining experimental results from simulated events. However, with new measurement technology, it is now possible to get better experimental results from actual events. These techniques are enabling scientists to examine wind erosion and dust transport in more detail.

The majority of these new experiments are designed to increase our knowledge of where wind erosion fits into the global ecosystem. As a result of these experiments, better models are being developed, to predict the amount of dust transported, and its final resting place.

While these models are mainly predictive, they can also be used to gain an understanding of the environmental processes that shaped the Earth during the Quarternary Era, 2.4 million years ago. As a result of these studies our New Zealand friends may have to change their opinion about Australian dust.

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