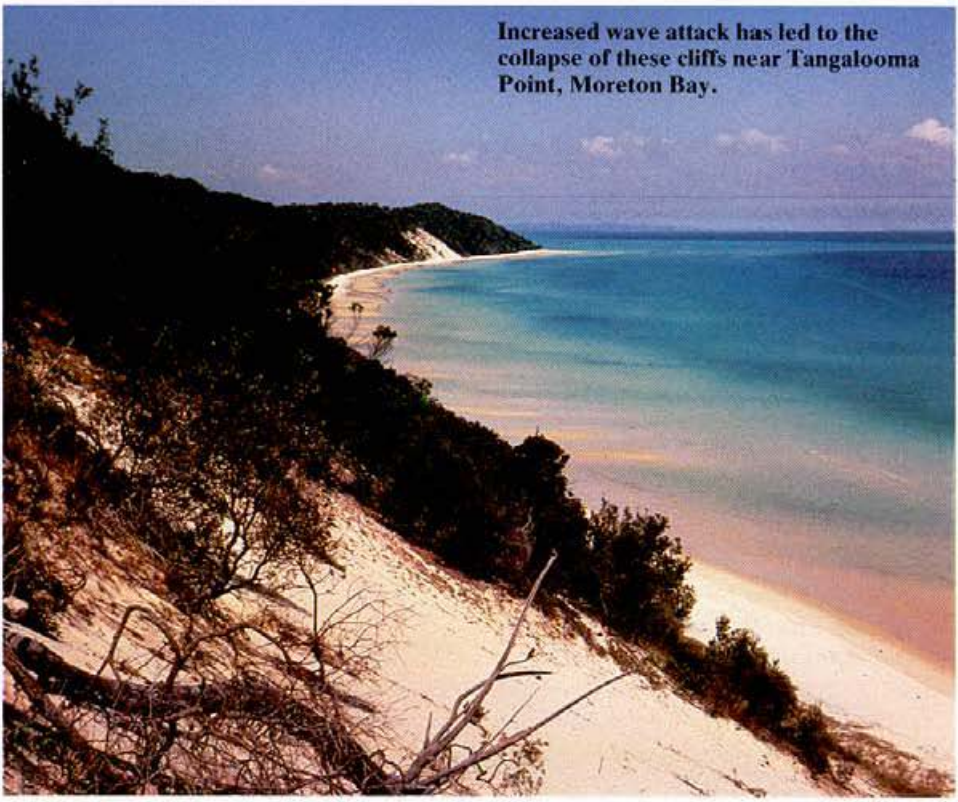
Weather in the sands

The sun shines, the clouds gather, the rain falls, and occasionally frost, snow, and hail blight our day. We take day-to-day weather changes for granted, but what about long-term differences in weather patterns?



Increased wave attack has led to the collapse of these cliffs near Tangalooma Point, Moreton Bay.

Meteorological records show variations from year to year, and these tend to obscure changes to climatic regimes occurring over decades and centuries. Furthermore, reliable records don't date back very far. How, then, can scientists read the weather over long time spans?

Mr Bill Ward of the CSIRO Division of Soils in Brisbane is among those scientists who are unravelling past weather patterns by looking at the evidence of geology. By studying deposits of sand, and the landscapes and soils formed on them, geologists are giving a new perspective to the meteorological record.

Often the best place to do this is at the coast, where depositions and their subsequent development are closely tied to changes in sea level and wind strength. In south-eastern Queensland, in particular, large massed sand dunes and sand islands have formed at times of low sea level, when much of the earth's water was held in huge glaciers during the ice ages. In fact, the sands of this part of Australia preserve one of the longest records of sea level and climatic fluctuations on the planet.

The origins of the smaller masses of blown sand along this coast — such as those at the foreshore on Fraser, Stradbroke, and Moreton Islands — appear to coincide with episodes of windiness and slightly lowered sea level that occurred after the last ice age, which ended about 10 000 years ago. Mr Ward has identified three relatively recent episodes of erosion. The first and second took place before Cook surveyed the coast, for he described the dunes at Sandy Cape that the second episode produced. The latest such episode occurred in the 1930s, the so-called 'dustbowl' era, remembered especially in the south-east of the country.

Mr Ward's studies indicate that, in past millennia, south-easterly winds were often more important in southern Queensland than they are now. During the ice ages, with their low sea levels, these winds moved large quantities of sand from the coast, then several kilometres to the east of its present location, to build the present-day islands — Fraser, Stradbroke, and Moreton. Brief resurgences of these winds since the end of the last great ice age have caused the subsequent sand movements.

Others, like Dr Ken Pye of Cambridge University, in England, question this view. They relate dune formation to rising sea levels, reasoning that shoreline erosion would then expose sand to the wind. Blowouts, however, frequently show up on high ground, or in exposed places behind inland lakes, and this implies that variations in wind strength are the prime cause.

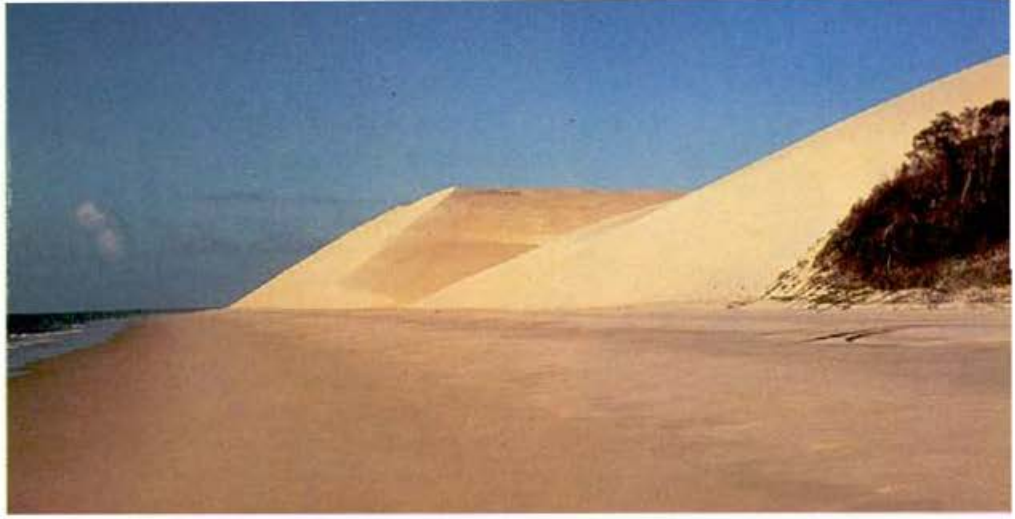
Recent change

A small change in the shape of the Bribie Island shoreline in the 1930s alerted Mr Ward and his colleagues, including Dr John Russell of the Division of Tropical Crops and Pastures, to the likelihood of links between episodes of sand movement and changes in weather patterns. The island's South Point had a stable shoreline until 1928; then the shore rapidly built forward until, by 1942, a complete change in outline, apparent from old RAAF aerial photos, had occurred.

Mr Ward realized that the change could only have been caused by a big switch in wind patterns, and Brisbane meteorological records confirmed that such a change had occurred. During that period, onshore easterly winds increased markedly at the expense of the more usual southerlies. The change was greatest in the winters, but also evident in the summers during the '30s.

Anticyclones (highs) moving east across southern Australia determine the direction of wind in south-eastern Queensland in winter. The wind is south-westerly in Brisbane when anticyclone centres lie in the western part of the Great Australian Bight and swings steadily to the south-east as they move across the eastern Bight, through New South Wales, and into the Tasman Sea. The onshore winds bring rain first to South Australia and western Victoria, then to New South Wales, and finally to coastal Queensland as the anticyclones move across the continent.

The increased south-easterly and easterly winds in the mid '30s suggest that in these years the anticyclones stayed longer over the Tasman Sea than in previous or subsequent years. Rainfall records for the period since 1895, which Dr John Russell has studied, provide support for this conclusion: above-average winter rain enjoyed by the east coast in the early '30s implies well-developed anticyclones over the Tasman Sea, and below-average rains in South Australia, New South Wales, and coastal Victoria before 1935 suggest that anticyclonic conditions persisted longer over eastern Australia than they had further west.



South-easterly winds formed these dunes before Cook sighted them in May 1770. He wrote, 'I have named *Sandy Cape* on account of two very large white patches of sand upon it'.

Geologists are giving a new perspective to the meteorological record.

This evidence from Bribie Island is the first to indicate that the disastrous dust storms of the 1930s owed their origin to natural changes in the climate, rather than to overgrazing, rabbits, and intensive agriculture.

A past etched in dunes

The coast of south-eastern Queensland between Brisbane and Fraser Island is formed mostly of dunes, sandy plains, and peaty swamps lying between a few headlands of hard rock. In the south, beach ridges lie between the present shore and the margin of an older landscape a kilometre or so to the west. The dunes on the mainland and on the high sand islands further north generally have the 'blowout' shape characteristic of moving sands impeded by vegetation. The alignment of the blowouts shows the direction of the sand-moving winds, and geologists can use subsurface features to recognize this where erosion has disguised the dune form.

The great thickness of sand deposits, the changes in shoreline position, the evident changes of sea level, the extent of weathering, and the advanced stage of degradation of the older sands all indicate that sand accumulation began a very long time ago.

Earlier studies have shown that eight successive stages of sand accumulation are preserved on Fraser Island, all of them built up by south-easterly winds at times of low sea level. These are identified by the relations of dunes to one another and to former shorelines, by different stages of erosional development, and by marked differences in the soils on the successive deposits.

The youngest dunes lie upwind of older ones and often partially cover them. On Fraser Island, the directions of movement recorded by the bedding in the sands indicate that the older dunes formed from areas now hidden by the sea. Only the three youngest sets of dunes lie close to their sources — broad sandy beaches. These have apparently developed since the end of the last ice age.

Some of the dune sands extend far below the waterline. Beach deposits lie between them close to the present sea level, showing that seas as high as the current one alternated with episodes of blowing when sea levels were low.

Few of the periods of sand accumulation can be dated directly. But former sea shores of one locality can be related to those of another, where dates do exist. The CSIRO team indirectly estimated the age of the Fraser Island shorelines by comparing them with reference shorelines in Gippsland, Victoria. The beach record there is almost

The bleached white sands of these cliffs at Hervey Bay overlie older sands, yellowed by humus washed through the white sands from the topsoil above.

The change in wind direction and strength in south-eastern Queensland in the 1930s added new sand to South Point on Bribie Island. The line on the photo — taken in 1972 — shows the position of the old beach before 1928. Most of the new coastline appeared before 1942.

complete because slow uplift of the land has ensured that former beaches have been saved from wave attack.

The comparison of the stranded shorelines of Fraser Island and Gippsland rests on three premises. One is that any changes in sea level occur globally. The second is that any present differences in elevation of former beaches of the same age result from the steady movement of one area relative to the other, so differences in elevation are proportional to shoreline age. The third is that times of high seas coincide with dates of warmer-water stages recorded in deep-sea sediment cores. Dr Ward has calculated that some of the oldest soil accumulations on Fraser Island date back 500 000 to a million years ago.

Fossil beach

Just south of Fraser Island, on the mainland, lies a stretch of coast called Rainbow Beach. At high-tide level, thick black sandrock forms low cliffs, which reveal the edge of a buried 'fossil' beach comprising boulders of pale sandrock, broken plates of sandy ironstone, and driftwood.

Carbon dating of the driftwood indicates that the beach's age is more than 40 000 years. The ancient beach lies 3 m above the present ocean beach and is probably a remnant of the earth's warmest period in the last 2 million years.

Together with Mr Ian Little and Mr Cliff Thompson, also of the Division, Mr Ward found several lines of evidence suggesting that the fossil beach is hundreds of thousands of years old. It lies below sands reduced almost to pure quartz by weathering, and below a soil whose well-developed surface and subsurface layers denote a considerable age.

The scientists found no sign of any shore above the 3-m beach, so it appears to be the highest level that the Pleistocene sea reached on the coast of south-eastern Queensland. Higher fossil shorelines exist on other coasts in Australia, but local earth movements may account for them. Deep sea sediments reveal prominent warm periods 430 000 and 480 000 years ago, and this era's relatively high sea level is also recorded in Hawaii. It is likely that the fossil beach dates back to that time.

Man's impact

Further south, offshore from Brisbane, sits Moreton Island. On its western shore lies Tangalooma Point, adjacent to an area of Moreton Bay called Middle Banks, recently the source of sandfill for the Brisbane Airport extension. With the exception of rocky Cape Moreton, the island is formed entirely of dune sands rising above 50 m, often more than 250 m above sea level. Although consisting of loose sands, the coast near Tangalooma Point has been stable since its formation, a few thousand years ago.

Now this coast shows evidence of erosion, partly due to the effect of wrecks lying on the shore, but mostly due to changes in wave action induced by variations in wind frequency and direction on Moreton Bay — from the easterlies that frequently gave shelter to the Bay in the '30s to the south-westerlies predominant today. The cliffs in particular have been buffeted by waves that these weather changes have caused. Mr Ward concluded that, if these conditions continue, most of the cliffs will soon crumble into bare sand.

Concern for the fate of Tangalooma Point after sand excavation at Middle Banks led to Mr Ward's study of the area. He found that Tangalooma Point was formed by sand blowing from the south-east and spilling into Moreton Bay. And, even though Middle Banks existed during the Point's formation, no evidence exists of a connection between the Banks and the Point. Conclusion: sand-dredging at Middle Banks will not affect Tangalooma Point and the nearby resort.

What of the possible effects of human activity on Fraser Island? This island has many areas of sand vulnerable to wind erosion, some of them well inland on high ground, with bush on the seaward side. Aborigines lived on the island before its occupation by European man, and one theory proposes that burning and trampling of the vegetation by Aborigines caused these blowouts.

Mr Ward accepts this as an explanation for some of the nearshore blowouts, but not for the main inland 'blows', which existed before Aboriginal man reached Australia.

In recent years, the active sand blows have contracted after a period of greater extension in the 1930s. Dr Eric Bird of the University of Melbourne believes that the agent of this extension was European man, who has cleared and burnt some of the dune vegetation and introduced grazing animals. But Mr Ward disagrees, noting that the island has few settlers, no rabbits, and no goats. He believes the blowouts were extended by wind changes and are merely the latest of a long series that began before the advent of man in Australia.

At present the risk of further sand blowouts on Fraser Island is low. Wind erosion is largely limited to a narrow coastal strip and to the shoreline near the entrances to bays, where tidal channels swinging against the coast have dumped new sand deposits on the beach.

Some erosion is occurring where frontal dunes have been assaulted by people and vehicles. But such erosion can be expected from tourist activity, and coastal management authorities are moving to effectively control the damage.

Mary Lou Considine

More about the topic

Winds in south-east Queensland and rain in Australia and their possible long-term relationship with sunspot number. W.T. Ward and J.S. Russell. In 'Climatic Change', vol. 3. (D. Reidel Publishing Co: Dordrecht, Holland 1980.)

Soil formation on coastal lands and the effects of sea-level changes. W.T. Ward and W.M. McArthur. In 'Soils: an Australian Viewpoint'. (CSIRO: Melbourne/Academic Press: London 1983.)

The Holocene marine transgression as a forcing function in episodic dune activity on the eastern Australian coast. K. Pye and G.M. Bowman. In 'Coastal Geomorphology in Australia'. (Academic Press: Sydney 1984.)