Formation and function of sand dunes

In its natural state, the coastal land area adjacent to the beach berm is generally characterised by sand dunes. To understand the development of these areas we need to look back in time. Between 17,000 and 7,000 years ago the melting ice caps caused sea levels to rise. Large amounts of sand moved onshore and alongside to build barrier spits and dune ridge sequences. This deposit, referred to as the Holocene barrier, generally stopped developing about 2,000 years ago when the transport of sand from the continental shelf ceased.

Coastal processes

Wind, waves, currents, tides and floods, collectively termed coastal processes, influence the distribution of sediments and thus the shape of the coastline. Along the Bay of Plenty coastline, tectonic warping or plate tectonic movements have also influenced the formation of coastal lands.

Wind, the primary source, generates waves which can cause direct changes to the coastline by:

- stirring up sand from the seabed
- creating currents
- eroding or building up beaches and dunes depending on the wave conditions.

The combination of waves and currents can move large volumes of sediment in various directions:

- onshore under the direct action of waves
- offshore by rip currents
- along shore by longshore currents.

Beach changes are cyclical in nature:

- storm waves move significant quantities of sand from the beach and dune to build offshore storm bars
- subsequent calm weather and offshore winds favour onshore movement of the sand to re-establish the beach
- onshore winds blow sand back into a dune system where it can be trapped by surface vegetation.

The short term fluctuations of the shoreline are often very large and may mask the long term accretion or recession.

Importance of offshore sandbars

We are only just beginning to understand the importance of offshore storm/sand bars to sand dunes. It seems sandbars that form along the coastline are important during storms to break waves offshore, reducing the wave energy impacting on beaches and dunes.

It seems these offshore bars are formed during the first high tide of a storm. Sand is removed from the dunes by backwash to help create the offshore sand/storm bars. Waves breaking on these bars spill about 50 percent of their energy each time they break, and sometimes two to three storm bars can form. (Work out the likely effect of two to three storm bars on storm waves running towards the shore, then check out the sea during the next storm!) These natural and relocatable wave dissipating devices can significantly reduce the impact of storm waves on a beach and dune system.

Less swash energy = reduced backwash

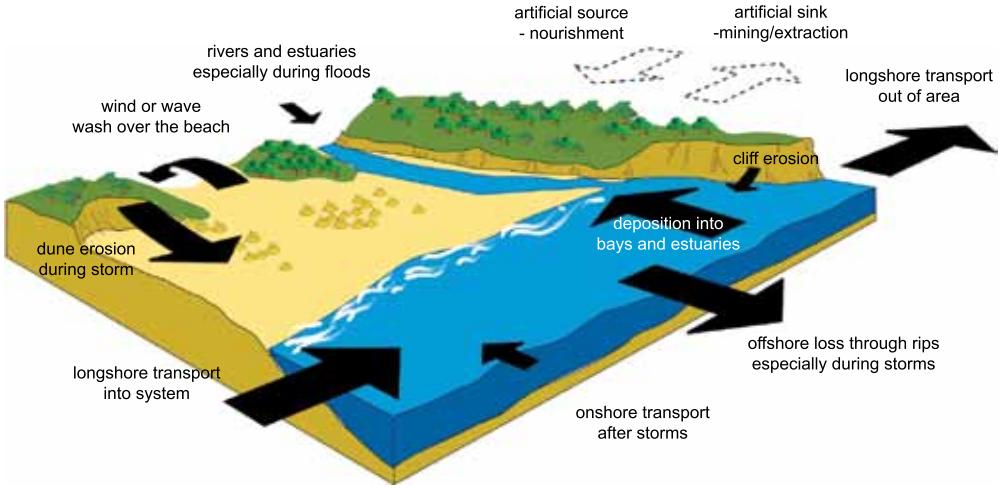
But this natural protection mechanism is only available on beaches with enough sand, and the best place to store sand is in a sand dune. But the sand dune needs to be wide enough to cope. Houses, roads and gardens must not limit the growth of the native dune plants whose function is to trap and hold sand between storms in this natural reservoir. It's a continual cycle of sand movement. Can you think of a better way than this to protect sand dunes?

"The natural role of these frontal dunes acting as a reservoir of sand for rare but severe storms... and their enhancement needs to be adopted as a cornerstone of coastal management."

Prof. Terry Healy, Coastal Marine Group, University of Waikato. 1993

As there is little additional sand being fed to the coast, only a finite amount of sand is available to form beaches and dunes. Many west coast dunes and some along the Bay of Plenty coastline have been modified by wind action. This forms transgressive blowouts and parabolic dunes. This has been particularly prevalent around the New Zealand coast during the last 160 years, due to the destruction of natural dune vegetation during the colonial farming period.

Sand budget - showing sources and losses of sand for a beach



Transgressive and blowout dunes

Without the stabilising effect of vegetation, sand can be easily moved by the wind, resulting in wind erosion and sand drift. When a whole dune is moving by this action it is know as a transgressive dune system.

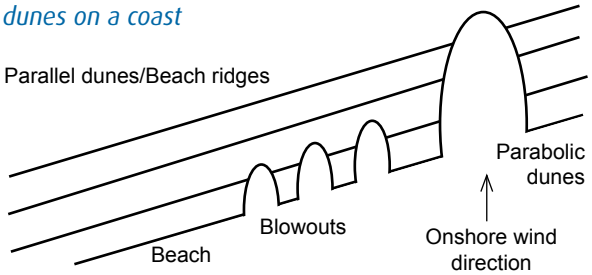
When this process affects only part of a dune it is called a "blowout". They are usually "U" shaped and aligned away from the direction of strong winds.

The wind blows through the gap in the dunes, sweeping sand from the beach and the dune in an inland direction. Consequently the blowout becomes deeper and wider, and can increase into a significant feature. A series of consecutive blowouts in an unstable foredune system often develop into parabolic dunes.

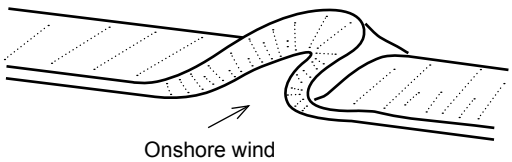
With the influence of prevailing winds, an advancing nose of loose sand can cause parabolic dunes (see diagram above). In this way the blowout develops into a parabolic or U-shaped dune.

Farming on coastal dunes and development pressures have resulted in dune systems being partially or completely modified. This restricts the amount of sand freely available to the beach system/buffer zone between land and sea. Using dunes for recreational purposes such as horse and bike riding have also impacted upon the dune vegetation and structure.

Blowouts and parabolic dunes interrupting parallel dunes on a coast



Parabolic dune



Te ngaunga a Hine-moana

The biting and gnawing of Hine-moana
the sea – forever biting the land

Find out more

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coastcare
Tiaki takutai

Bay of Plenty Regional Council in partnership with Tauranga City Council; Whakatāne, Western Bay of Plenty, and Ōpōtiki District Councils; and the Department of Conservation.