Ministry for the Environment
Manatū Mō Te Taiao

Factsheet 4

Waves

Waves around New Zealand's open coast derive from two sources:

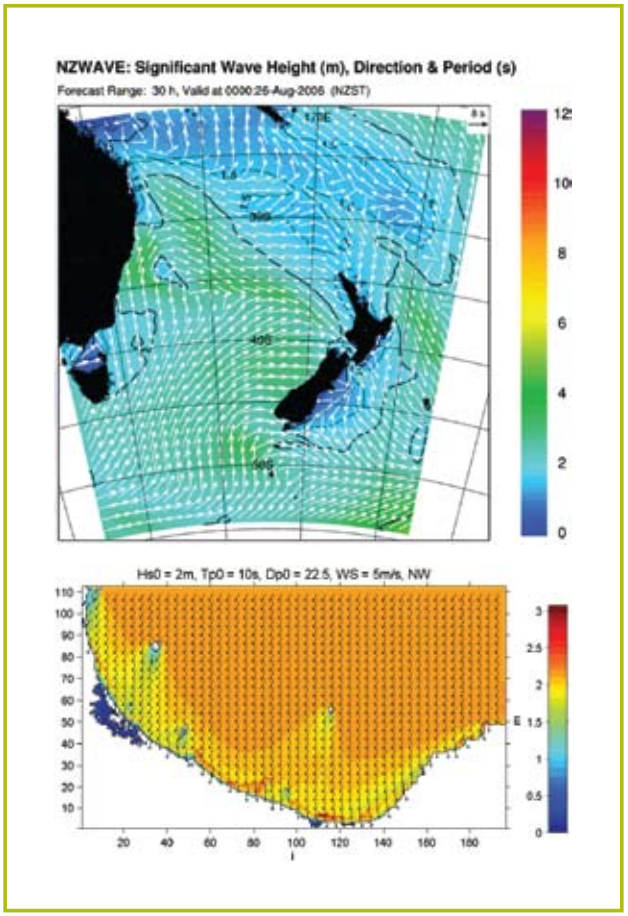
- locally generated waves caused by local winds
- distantly generated (swell) waves formed within the wider Pacific Ocean or Southern Ocean.

Waves tend to be defined by their *significant wave height*, which is the average height of the highest 33 per cent of waves over a certain period; the *wave period*, which is the average time between successive waves; and the wave direction.

In estuaries and harbours, waves are mostly generated by local winds and their height is limited by the wind fetch and the depth of water. Fetch is the distance downwind of continuous open water, with long fetches allowing the wind to build up larger waves. Wind waves in estuaries and harbours can still cause erosion and inundation hazards, particularly during very high tides or storm tides.

Very little monitoring of wave conditions has been carried out around New Zealand. Consequently, to assess wave climate and derive probabilities of extreme wave conditions, use is made of computer models to *hindcast* wave conditions from past wind conditions over a sufficient period of time (decades). Two types of model are typically used:

- deepwater wave models that simulate oceanic wave conditions over a large part of the Southern and Southwest Pacific oceans (see right, upper figure) based on global wind fields
- nearshore wave models that simulate the changes in deepwater wave conditions as the waves approach the shore brought about by wave refraction, diffraction and shoaling. These models cover a small regional area and are driven by deepwater wave conditions on the offshore boundary and local winds over the region being modelled (eg, see below, lower figure for the Bay of Plenty).



New Zealand Government

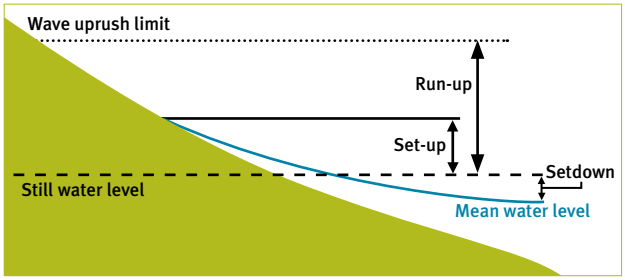
Wave set-up, run-up and overtopping

Waves contribute to coastal inundation hazards by three consecutive processes:

- wave set-up – after incoming waves break, the average level of the water inside the surf zone to the beach is set up higher than the sea level offshore from the breaker zone
- wave run-up (also referred to as wave uprush limit) – the extra height that broken waves reach as they run up the beach and adjacent coastal barriers (natural or artificial), until the wave energy is finally expended by friction and gravity

Wave run-up over the beach crest at East Clive in Hawkes' Bay. *Photo courtesy of Doug Ramsay.*

- overtopping – the spill-over of waves as they reach the crest of the coastal barrier or defence structure, resulting in flooding of the land and properties behind the barrier. Depending on the overtopping flow and character of the barrier, the barrier may breach, increasing the potential for further inundation. Wave spray or splash over a coastal defence structure can be hazardous for transport networks, but inundation volumes are relatively small.



Wave set-up and run-up.

Wave set-up is influenced by the offshore wave height and wave period, together with the nearshore seabed slope. These factors may be similar over large stretches of coast in the district, which is why wave set-up is sometimes included in the storm-tide level.

Wave set-down is a depression in the mean water surface below the still water level that occurs offshore prior to where waves break.

Wave run-up and overtopping at any coastal locality is usually quite site-specific, depending on factors such as beach slope, roughness of the beach (sand, gravel or large rocks), wave height, exposure to ocean swell, how close inshore waves can penetrate before breaking, and the characteristics of the land above the beach (eg, dunes, seawall, low cliffs).

Waves also play a major role in causing coastal erosion, by:

- the run-up of high-energy storm waves resulting in erosion of the dune or cliff toe
- large quantities of sediment being de-stabilised and moved back and forth between the beach and nearshore bars. Gentle swell and more quiescent waves following a storm usually assist in 're-stocking' a beach by slowly combing sediment back onto the beach, helping the beach to recover. Sequencing of moderate to severe storms that generate high wave activity is also an important factor in the susceptibility of a beach or cliff to severe coastal erosion
- variations in the rate of longshore movement of sediment (the movement is due to waves approaching the coast at an angle to the shoreline). Erosion can occur in this situation, especially if the drift is predominantly in one direction when any structure or natural feature traps sediment behind it, 'starving' the down-drift coast.

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