



Coastal inundation

Storm inundation is a natural event arising from extreme weather events (storms), in which normally dry, but low-lying coastal land is flooded. Storm-related coastal inundation is caused by high tides (normally during spring or perigean tides), combining with:

- storm surge – the temporary (hours to days) increase in sea level over and above the predicted tide height due to a combination of strong winds and low barometric pressure
- waves, through a combination of wave set-up (an increase in the water levels landward of where waves are breaking) and wave run-up over the upper beach, which can overtop low coastal barriers.

‘Storm tide’ is used to describe the total sea level formed from the combination of tide and storm surge during storm conditions. During storm events, the likelihood and magnitude of coastal inundation is highly dependent on the occurrence or timing of high tides, storm surge and wave conditions. For example, the peak of the storm surge will not always coincide with the highest wave conditions and the time of a high spring tide. Around New Zealand, they will be correlated in some way, owing to the following:

- certain weather conditions, such as the tracking of extra-tropical cyclones or low-pressure systems close to New Zealand’s coast, could produce both high wave conditions and high storm surge. However, as storm surge in New Zealand is relatively modest compared to the astronomical tide, any correlation with extreme wave conditions may not be that high (particularly on the west coast where the tidal range is higher)
- wave heights are limited by water depth in shallow water. In such a case there may well be a high correlation between high water level and higher wave conditions.

The extent and magnitude of inundation also depends on how much the storm tide and wave conditions actually inundate an area (ie, their flow path).

This depends on the physical characteristics and topography of the upper parts of the beach or estuarine shoreline and immediate coastal hinterland.

Typical flow pathways include:

- direct inundation, where the storm-tide level exceeds the level of the land. This typically occurs where waves have not built up a coastal barrier, such as along estuarine and sheltered coastlines or along the margins of rivers and streams
- inundation due to the breaching of a barrier. This may be related to the breaching of a natural barrier such as a gravel ridge or narrow dune field (with low-lying land behind it) or a human-made defence such as a stopbank. Coastal flooding due to breaching of a barrier is more likely to occur on open sections of coast exposed to larger waves
- overtopping of a barrier. Again this may be either a natural barrier such as a gravel ridge or narrow dune field or a human-made defence such as a stopbank. Overtopping typically occurs due to wave or swell conditions during a high tide or storm tide on more exposed open sections of coast.

River flooding of coastal and estuarine margins, and stormwater flooding of low-lying areas, can be exacerbated by high tides or storm tides. In relatively flat, low-lying coastal margins (eg, Lower Heathcote at Christchurch, South Canterbury Plains, Hauraki Plains), land may stay flooded with seawater for several days after an extreme event. This type of inundation has a dramatic effect on vegetation and pasture production, and can sometimes curtail pasture growth for a year or more.



Coastal inundation at East Clive, south of Napier on 16 August 1974 was caused by persistent heavy swell coinciding with high tides. This resulted in the gravel barrier being overtopped and the low-lying land behind being inundated and 200 homes affected.

Source: Ministry of Works and Development collection, Napier.

Human interventions can also exacerbate storm inundation hazards through:

- river engineering works (eg, straightening, stopbanks) that increase river levels at the coast
- poorly designed coastal protection structures that exacerbate loss of the beach adjacent to the structure, or increase wave run-up and overtopping potential
- coastal property development in inundation-prone areas (low-lying estuary margins or shore-front areas without an adequate buffer), or roads or other infrastructure that blocks overland flows
- physical removal, reduction or damage to natural coastal barriers such as sand dunes and gravel barriers (eg, lowering access ways, removing vegetation, trimming or removing dunes)
- permanent modification of coastal margins (eg, by constructing waterways, canals, marinas and boat ramps, and carrying out reclamation).

High tide red alert days

www.niwascience.co.nz/rc/hazards/dates: dates in the present year when high tides reach the highest levels. Hence storm surge or large wave conditions on top of such high tide levels during these dates will likely result in inundation of exposed low-lying coastal areas.