

10 Coastal Hazards of the Gulf

Key Points

- Significant parts of the Gulf's coastline are susceptible to coastal hazards.
- Coastal erosion, coastal flooding, and climate change impacts are the main coastal hazards.
- Fluctuations in the position of the coastline are a normal and expected process along the Gulf's 'sandy' coastline.
- The most notable sites of coastal erosion and flooding are near the entrance of tidal estuaries, rivers or streams.
- Coastal cliffs, particularly of Waitemata Group sediments, are slowly eroding, average rate of 4-8m/100 years.
- Storm surges are a frequently occurring phenomenon, most of which are insignificant unless they coincide with high tide, in which case low lying areas are typically flooded.
- The longest record of sea level is that recorded in the Waitemata Harbour. The record shows a trend of rising sea level since 1899 of 1.4mm per annum.
- Climate change is expected to influence a number of 'drivers' of coastal change, e.g. winds, waves.
- The predicted sea-level rise of 0.14 –0.18m by 2050 and 0.31-0.49 by 2100 could lead to a landwards retreat of the coastline – possibly by 15-20m along beach environments.
- Limited knowledge of tsunami. Locally generated tsunami are a significant potential coastal hazard.
- Site specific strategies need to be determined and implemented to address coastal hazard issues, and to ensure that other values, such as the natural character of the coastal environment and public access are appropriately provided for.

10.1 Introduction

Coastal hazards arise from the interaction of natural processes with human use, property, and/or infrastructure. Natural processes, such as storms, that drive physical changes in the ocean, along the coastal margin or in the hinterland can lead to a hazard where use and development has concentrated near the coast.

Not only can coastal hazards affect the economy, health, well-being and safety of people and communities, they can also adversely affect vegetation and habitat; public access to and along the coastal environment; visual character; amenity values; recreation; aspects of coastal heritage, such as historic buildings

or structure; and sites of significance to tangata whenua, such as waahi tapu, urupa, middens and other taonga.

There are significant parts of the Gulf which are exposed to coastal hazards: coastal erosion, coastal flooding, extreme weather events, changes in sea-level, and tsunami. Of these the predominant coastal hazards are coastal erosion and coastal flooding.

The Forum has identified a series of strategic issues and objectives relating to coastal hazards in the Gulf (see Box 10-1). In order to avoid future hazard risks and to manage existing hazards, councils, affected property owners and the community must work together.

Box 10-1

Strategic Issues and Objectives

The major issues identified by the Forum relating to coastal hazards in the Gulf are:

- Foreshore erosion threatens private property and community assets such as parks and beaches. Degradation and destruction of wetland ecosystems is a major factor exacerbating coastal erosion.
- There is a lack of understanding of natural coastal processes that create and maintain sandy beaches and the long term and cyclical nature of these processes.
- Lack of public awareness and recognition of existing coastal hazards leads to demand for development in high-risk areas, uncertainty of legal requirements and responsibilities, and demand for physical protection works.
- Continuing inappropriate subdivision and development along the coast places more property at risk from coastal erosion and sea level rise.
- Control of coastal erosion or flooding using physical protection works (e.g., sea walls) can have adverse effects on the natural character of the coastal environment, public access and amenity values, biological diversity, waahi tapu and cultural heritage sites.
- Management of coastal hazards is a joint responsibility of regional and local authorities, which if not effectively integrated, may result in gaps or overlaps in management resulting in inconsistency, confusion and ineffective overall management.
- The potential for oil spills is a major risk to the values of the Gulf.

The Forum identified the following objectives for coastal hazards in the Gulf:

- Consistent and co-operative management of natural hazards between regional councils and territorial authorities.
- Communities and agencies have a greater understanding and respect for natural coastal processes and the need to take the long-term view to allow for natural processes and manage development on the coast accordingly.
- Where protection of coastal development is appropriate it is undertaken in a way that minimises effects on the environment, waahi tapu and cultural heritage sites of tangata whenua, while allowing reasonable use of coastal properties.
- Existing wetlands are maintained, enhanced and protected and where possible areas of wetland are restored.
- The potential for oil spills is minimised through preventative management and recognition of MARPOL regulations.

processes, however, it may result from or be exacerbated by human activities.

In general terms, *short term* coastal erosion is associated with the dynamic coastline fluctuations which occur on all beaches. Averaged over time such fluctuations do not result in permanent coastline retreat, and are regarded as part of the 'dynamic envelope' of the active beach. Evidence suggests that most of the coastal erosion of the Gulf's beaches is in this category.

The most notable sites of coastal erosion and fluctuations in the position of the coastline are near the entrance of tidal estuaries, rivers or streams. These areas can be very dynamic and experience large coastline movements, greater than 100m in places. However the general range of coastline movement for beaches not near estuary, stream or river entrances, are typically in the order of 10 – 40m.

The landward translation of the coastline (generally 20+ years) is termed long term coastal erosion. A few beaches in the Gulf are subject to *long-term* coastal erosion. Generally, average rates of long term erosion are slow, usually less than 0.1 to 0.2m/yr, but some sites have experienced higher rates, e.g. Koputauaki Bay on the western Coromandel coast has experienced an average rate of erosion of 0.3 – 0.4m/yr over the past 90 years.

Erosion along the Gulf's cliffed coastline is common. Rates of erosion are variable, due to the range of controlling factors, e.g. rock properties, aspect, angle of wave approach, groundwater. All cliffs, however, have at least one thing in common, the loss of material is a oneway process. Once the cliff has eroded it does not reform. The effect is a regression of the coastline.

Coastal cliffs in the Waitemata Group sediments (sandstones/siltstones) in general are retreating at an average rate of 4-8m/100 years.

Where rivers and streams have delivered sediment (predominantly gravel) to the coast, low-lying flat areas of land have been developed, such as at Te Puru, in the Firth of Thames. These deltaic fans have been heavily developed, and as they are low lying they are prone to coastal erosion and flooding. There is evidence that such

10.2 State of Coastal Hazards in the Gulf

10.2.1 Coastal Erosion

Fluctuations in the position of the coastline (advance, retreat or dynamic equilibrium) are a normal and expected process on virtually every part of the Gulf's coastline. The change in position of the coastline invariably is the result of natural

landforms might be substantially reworked over periods of 50 – 100 years.

Over 75 percent of all beaches along the Gulf's coastline have, to some extent, been subject to human developments. Such development is in general very close to the sea, for example along the Coromandel Peninsula over 70 percent of all beachfront development is setback less than 100m from the sea. Hence much of this development is susceptible to coastal hazards.

10.2.2 Coastal Flooding

Coastal flooding (the inundation of land by seawater) occurs relatively frequently in low lying areas of the Gulf. The Miranda Plains and the alluvial deltaic fans along the Thames-Coromandel coast are particularly vulnerable to coastal flooding, however, flooding is not restricted to those areas. For example, Whitianga, Tairua, and Maraetai have all been subject to flood events in recent years.

Coastal flooding generally occurs as a result of significant storm events coinciding with periods of high tides, storm surge and high wave energy. Rainfall across catchments that raises river levels, add to the flood risk, particularly in the vicinity of river mouths.

10.2.3 Extreme weather events

Extreme weather events, primarily ex-Tropical Cyclones (1/yr) and subtropical storms, at times generate storm surges. Storm surges can raise the sea level by 0.5 to 0.7m. Typically coastal erosion and coastal flooding of low lying land, are associated with storm-surges. Storm surges, in New Zealand, are mainly driven by atmospheric pressure changes, with winds usually having a relatively minor effect as our weather systems move rapidly across the region, giving the ocean little time to respond before the wind changes direction. This means that storm surges are limited by the change in atmospheric pressure, which typically drops by up to 40hPa in a storm, resulting in water level rises of up to 400mm⁸⁷.

Storm surges around New Zealand have had an upper limit of approximately 1m above the predicted tide. The highest recorded storm surge was 0.9m at the Port

of Tauranga during the 'Wahine' storm in 1968. Historical storm-surges in NZ have not produced extensive flooding, except on the Hauraki Plains. A storm-surge in 1938 flooded about 35 000 ha, extending inland as far as Ngatea, 7.5km from the coast. The total elevation for this event, including tide, storm-surge and wave set-up was 3.0m above mean sea level. A smaller storm-surge (2.5m) on 14 July 1995 caused more than \$3 million of damage in Thames.

Storm surges are a frequently occurring phenomenon. New Zealand experiences approximately 20 significant storm surge events a year. These can be significant when they coincide with large tides.

10.2.4 Changes in Sea Level

In terms of coastal hazards, it is the trend in *relative* sea-level rise that is important (i.e. the change in sea-level relative to the local landmass).

The last major change in sea-level (about 6000 years BP) established the position of our present coastline. There is substantial evidence of historical sea-level rise on a world wide scale, and an often cited consequence of climate warming is sea-level rise. The longest sea-level record in New Zealand is that for the Port of Auckland (Waitemata Harbour). That record shows a trend of rising sea-level since 1899 of 1.4mm per year (or 0.14m per century). In comparison the NZ average has been slightly higher at 1.7mm/yr, and the global average over the 20th Century was a rise of between 0.1m – 0.2m.

Global warming is projected to cause an acceleration of sea level rise, mainly through thermal expansion of a warming ocean, and to a lesser extent meltwater from glaciers and non-polar ice caps. To-date there is no discernible evidence of an increase or acceleration in the rate of sea-level rise. However, a sea-level record contains a spectrum of responses of the ocean to the various physical driving forces, e.g. storm surges, tides, changing atmospheric pressure, effects of the Southern Oscillation, and a recently discovered phenomenon called the Interdecadal Pacific Oscillation (IPO) which operates across the Pacific Ocean at 20-30 years cycles, meaning identifying a

⁸⁷ Using the inverted barometer relationship which says that when pressure drops by 1 hPa, sea level will rise by 10mm

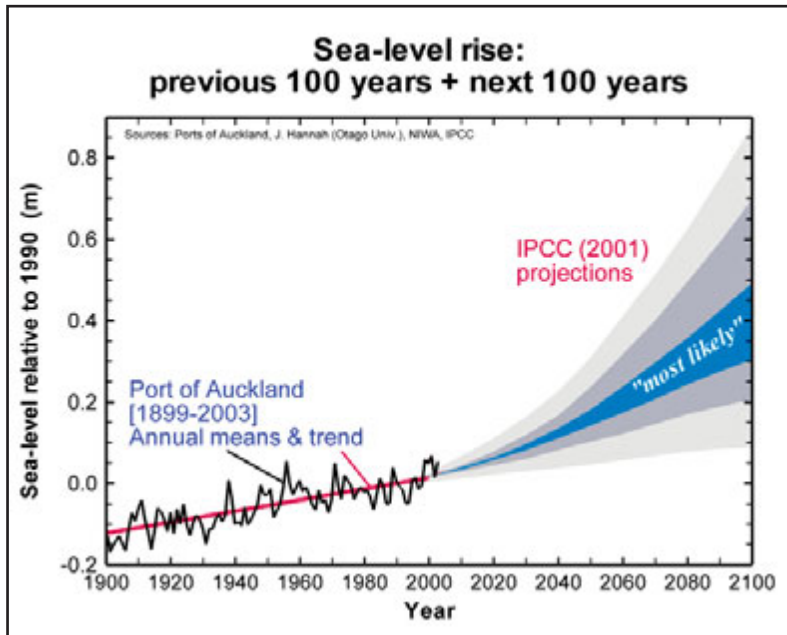


Figure 10.1 Sea level rise in the Waitamata Harbour since 1899.

change that is measured in millimetres will be difficult to discern.

The sea-level record shown in Figure 10.1 has distinct fluctuations at timescales of a few decades that appear to match with the 20-30 year cycle of the IPO. It is notable that when the IPO is in its negative phase, sea-level rises faster than when IPO is positive. The graph shows that the IPO appears to have shifted to a negative phase around 1998. Therefore over the next 20-30 years sea-levels round NZ will probably rise faster than the average trend.

10.2.5 Tsunami

Tsunami can be loosely grouped into those that are generated beyond the continental margins (distant or teletsunami), and those generated on or within the continental margins (local tsunami). There is limited knowledge of the Gulf's vulnerability to tsunami, particularly for locally sourced tsunami that represent the greatest potential hazard.

Distant tsunami are estimated to have a maximum height of 3.6m above mean sea level. Since the 1800s distant tsunami have generally reached 1-3m in height along the NZ coast. There is evidence that there has been at least four 'moderate', distant tsunami recorded along the eastern

Coromandel coast over the past 120 years. The most recent, in May 1960, was generated off the South America coast and caused minor flooding in low lying areas, including Whitianga. It has been calculated that potentially damaging teletsunami have a moderately high return period (~75 years).

Local tsunami are generated by seismic activity (earthquakes) and volcanic activity. Seismically generated tsunami are likely to be in the order of 2.5-3m above mean high sea level. It is unlikely that tsunami generated by volcanic activity will be larger than teletsunami or local, seismically generated tsunami.

10.3 Pressures on, and from Coastal Hazards

Fluctuations in the position of the coastline (advance, retreat or dynamic equilibrium) and coastal flooding is a normal and expected process on the Gulf's coastline. The fluctuation of the coastline and/or flooding is not generally a problem, except where valued assets and infrastructure are located along a retreating or low-lying coastline. The close proximity of development along the Gulf coastline and the damage caused to natural dune systems, e.g. the lowering of dunes to improve sea views, has resulted in widespread coastal hazard problems in the Gulf, with many houses and properties threatened by coastal erosion and flooding.

The potential for coastal hazards to become of greater concern over the next 50-100 years, and beyond, is considerable. The likelihood is that ongoing subdivision and development of coastal areas, particularly intensification of existing beachfront development, and sea level rise and other changes, e.g. increased frequency and intensity of storms, that may accompany global warming will increase the incidence and risk of coastal hazards. Similarly, development in close proximity to the sea has a high likelihood of detracting from the natural character of the coastal

environment, and having adverse effects on amenity, cultural, recreational, and public access values.

10.3.1 Climate Change

Global warming is likely to affect most of the physical processes that drive changes along coastal margins. The drivers of coastal change are:

- Winds – extreme storms and prevailing windiness
- Waves – extreme storms and prevailing wave climate
- Sea-level variability – seasonal, interannual ENSO and interdecadal IPO cycles
- River flow – extreme storms and baseflows
- Storms and cyclones – incidence, intensity, tracks, storm surge
- Ocean and coastal currents
- Sediment supply to the coast.

It is anticipated that the coastal response to climate change will be a mix of change to these drivers, rather than a simple response dictated mainly by the rise in sea level.

10.3.2 Sea Level

The effects of sea-level rise will vary by location and depend on a range of physical, and biological characteristics, as well as socio-economic factors. The primary effects will be physical changes to the environment. Probable changes will include the following hazards.

Coastal erosion:

The predicted sea level rise (0.14 – 0.18m by 2050 and 0.31 – 0.49m by 2100) could lead to a landwards retreat of the coastline of 15 – 20m at beaches along the Gulf's coastline over the next century. However, predicting coastline response to changes in sea-level is a complex matter. Simple conceptual models of coastline response based mainly on sea-level rise (such as the often cited Bruun Rule) are at best indicative. The potential effects of sea-level rise on beaches that have historically exhibited a trend of erosion will be continued erosion, but at a faster rate. Dynamically stable beaches (fluctuate round a stable position) are likely to show a bias towards erosion, unless the supply of sand balances the rise in sea-level.

Accreting beaches are likely to continue to accrete, but more slowly – again the supply of sediment being a major factor. Erosion of cliffs comprising of sedimentary rocks and clays/silts will continue, at similar rates. Estuarine coastlines are likely to erode.

Coastal flooding

Sea level rise will result in more frequent coastal flooding. This will include inundation of low-lying coastal areas by extreme tides and storm surge, and permanent tidal inundation of low-lying coastal margins. The implications of this include a landward shift of the coastline along undeveloped low-lying areas and consequent damage to assets located in those areas. On developed coastal margins, especially within estuaries and harbours, where the coast is fixed in position by seawalls, a rising sea level is likely to reduce the extent of intertidal area, and a potential loss of habitat. The loss of intertidal habitats may affect the gathering of kaimoana/seafood, and have consequences for estuarine ecosystems in general. Potential effects include salinisation of coastal wetlands, lower reaches of rivers, aquifers and soils from incursion up rivers or seepage of seawater. Increasing salinisation of coastal margins will have an effect on their flora and fauna.

10.4 Responses to Pressure on and from Coastal Hazards

Current development trends, natural variability and climate change impacts are likely to exacerbate existing coastal hazards, and present new ones. The potential is for property to be damaged and human safety to be put at risk, and/or the environment to be degraded as a result of people's response to the issue, e.g. eventual loss of some beaches, coastal wetlands, or estuary intertidal areas.

Success in avoiding, remedying and/or mitigating coastal hazards requires a comprehensive understanding of the areas susceptible to those hazards, an understanding of the frequency and magnitude of those hazards, and an understanding of the effects of undertaking

activities within areas susceptible to coastal hazards.

In order to successfully manage coastal hazards the HGF determined the need for the following actions:

Progress on Forum Action

- **Co-ordinate and promote opportunities for learning such as visiting speaker, conferences and reports that are relevant to the issues faced by several parties.**

To date the Forum has ensured that actions undertaken by its constituent parties have been made available to all Forum parties.

Other Progress

10.4.1 Co-ordinated development of educational materials.

Coastal hazards are generally manifested at a specific locality, e.g. coastal erosion at Cooks Beach, though the physical process that in part creates the hazard, e.g. Cyclone Drena, may affect more than one locality. Generic information about coastal hazards is therefore useful, however implementing proactive and/or reactive responses requires site specific understanding as a basis for determining the appropriate response and to enable community buy-in. Further, within a particular community it is usually necessary to particularly raise the awareness and understanding of coastal hazards for sea-front property owners.

Therefore educational materials of a site specific nature, for example the Browns Bay Coastal Hazard Management Strategy developed by the North Shore City Council and ARC is usually required to determine appropriate outcomes.

Site specific educational material generally adds to and builds upon the more generic educational material, such as the ARC's Coastal Erosion Management Manual (CEMM) and EW's Coromandel Beaches: Coastal Hazards and Development Setback Recommendations, and the NZ Climate Change Programme's publication, Planning for Climate Change Effects on Coastal Margins.

The challenge for resource managers is to achieve community buy-in to long-term planning for coastal margins.

10.4.2 Planning to avoid the damage or destruction of waahi tapu and cultural heritage sites by physical protection works.

There are many areas of special interest to Maori, such as sites of urupa, middens, waahi tapu and marae, along the Gulf's coastline that are or may be subject to coastal hazards. Some, but not all, are provided a level of recognition and protection as they have been identified as sites worthy of protection within statutory plans, for example the Stone working area/midden known as the Sunde Site on Motutapu Island which is included in Schedule 1: Cultural Heritage Sites for Preservation, of the Proposed Auckland Regional Plan: Coastal. However, the majority of cultural heritage sites are not identified in statutory plans and how they are protected in terms of coastal hazards is generally determined on a case-by-case basis, and subject to the level of priority accorded to that matter via the annual planning process.

10.4.3 Joint coastal hazards assessments.

A number of joint coastal hazard assessments have been undertaken round the Gulf, including for Browns Bay (NSCC/ARC), Onetangi Beach and Huruhi Bay, which are both on Waiheke Island (ACC/ARC), Maraetai Beach (MCC/ARC), Buffalo Beach/Whitianga, Cooks Beach and Tararu (TCDC/EW). These projects have improved our knowledge of coastal hazards in the Gulf, and provide good working examples of coastal hazard assessments, including the identification of appropriate management options.

At the regional scale, Environment Waikato has identified the coastal hazard at Coromandel beaches and the ARC has identified the areas susceptible to coastal hazards for its entire region (Technical Reports in print).

The safe management of coastal hazards will require the dissemination of this information (areas susceptible to coastal hazards) and collective determination of

how it can be used to appropriately manage coastal hazards. This component of work is planned for 2004/05.

In addition to the aforementioned, various projects are undertaken that contribute to our understanding and management of coastal hazards, including:

- Investigations and monitoring programmes of physical coastal changes. For example Councils undertake beach profile monitoring programmes. Generally these are co-ordinated to extend the usefulness of the datasets, and/or are collaborative programmes, and information is shared.
- Determination of the wave climate. The ARC has run a 5-6 year programme focused primarily on the Auckland Region, but including the Firth of Thames.
- Public perception surveys—contribution to GNS survey.
- Contribution to Coastal Dune Vegetation Network.
- Support and collaboration in associated projects, e.g. NIWA's national sea level monitoring programme.

10.4.4 Promotion of consistent policy direction and management of coastal hazards.

Coastal hazards affect peoples' lives, lifestyles and properties. By their very nature, coastal hazards can have devastating effects on people and communities. Resource managers and communities will need to make some very tough decisions on the future of some areas.

As stated by the Intergovernmental Panel on Climate Change in 1996, *'The challenge is not to find the best policy today for the next 100 years, but to select a prudent strategy and to adjust it overtime in light of new information'*.

Local authorities have developed a good understanding of the spatial and temporal extent of coastal hazards throughout the Gulf. Current statutory direction needs to be reviewed in light of this information and in light of overall coastal management objectives. A key issue here is a need for a truly integrated approach.

10.4.5 A consistent approach on approaches to the management of coastal erosion

Historically coastal hazards, such as coastal erosion, have typically been managed by adopting an engineering approach, e.g. construction of a seawall, as evident by the large number of coastline armouring devices that line the Gulf's coastline. However, as almost universally accepted now, it has been recognised that there are usually severe consequences of adopting a 'simple' engineering approach. Rather it is recognised that the appropriate approach to coastal hazard management requires a consideration of the three main types of response to manage coastal hazards:

- Planned retreat: moving away from the coastline.
- Adaptation/accommodation: includes altering the use of land, and adaptive responses such as the elevation of buildings and roads etc, and enhancing natural 'protection systems', e.g. dunes.
- Protection/defence: involves maintaining the coastline in a 'fixed' position, either by 'hard' solutions, e.g. seawalls, or 'soft' solutions, e.g. beach nourishment.

Invariably the most appropriate response at any particular site is a combination of 2 or more of the aforementioned categories.

It is arguable whether a consistent approach has been adopted across the various management agencies. Any management approach should demonstrate that each of the following steps have been properly considered:

- Confirmation that there is a problem. For example, is coastal erosion occurring, at what rate, and what will the consequences of that erosion be?
- Determine the cause (or causes) of the problem – a prerequisite for determining the appropriate management response.
- Understand the environmental context, i.e., the key values and uses of that particular part of the coast.
- Identify the range of management options.
- Select appropriate management approach(es).

- Assess the potential environmental effects of the management options.
- Select preferred approach.

This approach is consistent with various statutory policies, but perhaps none-more-so than Policy 3.4.6 of the NZCPS. This approach is set out in the ARC's CEMM, and has been the basis for the previously mentioned coastal hazard management plans (developed by the ARC in partnership with TLAs of the Auckland region).

There is a new imperative for integrated coastal management, and a recognition that greater direction is required than what the various statutory plans currently provide. Over the next 5 years greater consistency and direction will be provided. That direction and consistency is likely to be achieved through the development of Coastal Compartment Plans, and/or changes to the various city/district/regional plans.

References

EW Technical Report 02/06 - Coromandel Beaches: Coastal Hazards and Development Setback Recommendations, April 2002.