

Wet Feet: The Coastal Inundation Risks Facing Mangawhai



The Sustainable Mangawhai Project

Mangawhai Matters Inc

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Protecting our Environment, Sustaining our Community

Mangawhai Matters Incorporated (MMI) is a community group committed to maintaining the qualities of Mangawhai. The Sustainable Mangawhai Project aims to assess the physical risks to the harbour and distal spit and the consequences for the environment and community of any damage to them from a more volatile climate. The objective is to provide authoritative evidence to support community and agency cooperation in the preparation and implementation of harbour management and flood hazard reduction policies and guidelines.

This is a short version of a technical report outlining the flooding risks associated with a more volatile climate. That report, *The Coastal Inundation Risks Facing Mangawhai*, is available on the Mangawhai Matters website, along with an inundation visualisation tool and guidelines prepared by Tonkin and Taylor Ltd.

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This report is a synopsis of a technical report setting out and mapping coastal inundation scenarios for Mangawhai which is available on the Mangawhai Matters website. Minor editorial changes have been made to the first version distributed in July 2025.

For further information, visit www.mangawhaimatters.com/sustainabilityproject.

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SUMMARY

The Issue

Mangawhai's coastal spit is a vital natural barrier, protecting the harbour, community, and environment from storm-driven flooding. Tropical cyclones originating northwest of New Zealand, lead to elevated seas, high surf, strong winds, and flooding to low-lying areas. Cyclonic storms are projected to intensify and track further south, increasing the risk of damage to the Mangawhai built and natural environments. With rising sea and air temperatures, these storms are projected to intensify and track further south, increasing the risks for Mangawhai.

Lessons from the Past

A 1978 mid-winter storm breached the spit. Since then, dune stabilisation by planting and fencing and maintaining the harbourside bund wall have protected the spit against similar storms. However, scientific evidence and recent history suggest future storms could overwhelm even these defences. Over the last 35 years, there have been fewer but stronger storms, with 47% classified "major", compared with just 7% in the previous 35 years.

The Risks

Stronger Storms: Warmer oceans are fuelling more intense cyclones. Projections indicating a high probability of storm tides reaching 2m by 2040 and exceeding 2.5m by 2080.

Spit Vulnerability: Over time, sea-level rise will increase the probability of spit erosion and breaching from such storms. Damage to or breaching of the spit will expose the lower harbour coast to increased wave action and inundation from storm tides.

Community and Ecological Impacts: Storm tide surge inundation threatens homes, infrastructure, emergency lifelines, cultural sites, and livelihoods, as well as spit and harbour habitats.

A Call to Action

These risks can be mitigated by an adaptive flood hazard management plan. Such a plan needs to be developed and implemented collaboratively by the regional and local councils and the Department of Conservation. This would mean joint governance by these agencies supported by representatives of mana whenua, Te Uri o Hau and Ngati Manuhiri, and the community.

Measures to consider for incorporation in a plan include:

Soft Engineering: Maintaining the integrity of the spit must be a high priority in any plan aimed at limiting and mitigating the damage from a more volatile climate. Other soft engineering measures include beach nourishment on the open and harbour coasts; and extending and managing wetland buffers adjoining the mid- and upper harbour.

Hard engineering: The construction of seawalls and groynes may be called for to protect, maintain, or extend and elevate harbourside land in vulnerable areas.

Regulatory measures: Land use rules and construction standards in areas vulnerable to inundation can be used to limit exposure of vulnerable areas and structures to flooding risk.

Infrastructure maintenance and development: Increasing and maintaining the resilience of critical infrastructure, including drainage and stormwater systems, roads, and utilities will lift their capacity to withstand flooding and will expedite recovery.

Delaying developing and implementing a plan risks irreversible damage; investing now secures a sustainable future. And, as in any risk management scenario, the cost of prevention is always going to be a fraction of the cost of remediation.

Introduction

Mangawhai's distinctive coastal setting - a harbour sheltered by a dynamic sand spit-- has high environmental and community value. The services it provides, though, are under threat from climate-driven changes, particularly from severe storms causing coastal inundation.

This document summarises a technical report consolidating evidence from historical storm events, climate change scenarios, and coastal modelling.¹ These sources together confirm the likelihood of increased inundation from future storms and enable mapping the flooding that would result. The objective of the study is to inform the community - the people who benefit from living in or visiting Mangawhai - and the agencies responsible for managing the harbour and environs of the risks, and to suggest how the impacts might be mitigated.

A Changing Climate, A Compounding Threat

Inundation results from the elevation of coastal waters by multiple factors under storm conditions. These include:

- Storm surge, which is the temporary elevation of sea levels from the joint influence of the low atmospheric pressure and the fierce winds typical of tropical storms;
- Wave set-up, caused when strong onshore winds pile sea water up towards the shore in the surf zone, further elevating sea level locally; and
- Wave run-up, through which waves erode the beach above the tide line potentially allowing sea water to penetrate the dunes.

Storm tides, which reflect the joint impact of storm surge and the astronomical tide (worst case scenario being a spring tide), give rise to short-term elevation of coastal and harbour waters, while long-term *sea-level rise* (SLR), fuelled by thermal expansion and ice melt, progressively raises the baseline upon which the storm tides build.

Historical Precedent and Lessons Learned

The July 1978 mid-latitude winter storm that breached the Mangawhai spit shows what can happen in intense storms. Storm surge and substantial wave set-up exceeded 1.9 m above mean sea level, resulting in harbour-side flooding. Despite being less intense than Cyclone Gabrielle (2023), the 1978 storm had a bigger impact, breaching the spit at its narrowest point.

The lesser effects of Gabrielle were partly due to protection by the bund wall on the harbour-side of the spit, dune reinforcement, and a wider spit neck, around 450m compared to 1978's 150m. This demonstrates that storm impact is shaped not just by storm strength, but also by spit morphology, beach condition, tides, and recent erosion.

The Mangawhai Harbour Restoration Society's work since 1998, forming and strengthening the bund wall and stabilising dunes, has clearly helped mitigate the damage of major storms since.

The Outlook

Tropical cyclones arising north and northwest of Northland are the major source of severe storms affecting the region. The Solomon and Coral Seas are experiencing significant ocean warming. Scientific analysis suggests that while the number of cyclones originating in these areas may decline, warming means that those that do form will be more intense, with stronger winds, lower central pressure, and heavier rainfall, and will be larger in area.

1 P McDermott (July 2025) *The Coastal Inundation Risks Facing Mangawhai*, Mangawhai Matters

This is consistent with the evidence provided by 70 years of cyclones storms that migrated from the tropics to the seas off Northland. Storm frequency has fallen since around 1988, but intensity has increased. Between 1956 and 1988, three out of 41 storms (7%) were classified *major* in their area of origin (Hurricane Force 3,4, or 5 according to the international Saffir-Simpson wind scale). In the 37 years since, 16 out of 34 storms (47%) met that threshold.

And, while storms numbers may contract, more are expected to track further into the mid-latitudes in coming decades, increasing Northland's exposure to severe winds and storm surge.

Development Pathways and Storm Risk Modelling

Modelling undertaken by Tonin and Taylor to project how storms in the region that could lead to coastal inundation in Mangawhai has been used to inform this study. The modelling is based on Shared Socioeconomic Pathways (SSPs).² These are scenarios used internationally and recommended by the Ministry for the Environment to explore how localities might respond to climate change.

Three scenarios have been applied here:

- **SSP2–4.5: Middle of the Road**, in which adoption globally of green technology, policy directions, and international collaboration reduce emissions and warming stabilises;
- **SSP3–7.0: Regional Rivalry**, in which fragmented geopolitical responses lead to higher emissions and continued warming;
- **SSP5–8.5: Fossil Fuelled Development**, in which intensive industrialisation sustains a high-emissions and an extreme global warming trajectory.

Modelling is based on seasonal elevation, storm surge, wave set-up, and freshwater retention within the harbour for storms of different intensities. Intensity is measured by frequency (annual return intervals, or ARI). The results show that over 55 years, sea level rise lifts inundation levels by 0.5m under SSP2-4.5 and by 0.6m under the continued warming scenarios (Table 1). Under all three scenarios, the more immediate risk is the rising intensity of storms which are likely to exceed historic flood levels before 2040.

Table 1: Harbour Inundation Scenarios

Scenario Storm Intensity	Harbour Inundation (metres)			
	2030	2040	2060	2080
SSP2-4.5	Business as Usual			
5-Year ARI	1.7	1.9	2.0	2.2
20-Year ARI	1.9	2.0	2.2	2.4
50-Year ARI	2.1	2.2	2.4	2.6
100-Year ARI	2.3	2.4	2.6	2.8
SSP3-7.0	Regional Rivalry			
5-Year ARI	1.7	1.8	2.0	2.3
20-Year ARI	1.9	2.0	2.2	2.5
50-Year ARI	2.1	2.2	2.4	2.7
100-Year ARI	2.3	2.4	2.6	2.9
SSP5-8.5	Fossil-Fuelled Development			
5-Year ARI	1.7	1.8	2.1	2.3
20-Year ARI	1.9	2.0	2.3	2.5
50-Year ARI	2.1	2.2	2.5	2.7
100-Year ARI	2.3	2.4	2.7	2.9

² Tonkin and Taylor Ltd (2025) *Mangawhai Matters Coastal Inundation Guidance Report* to Mangawhai Matters

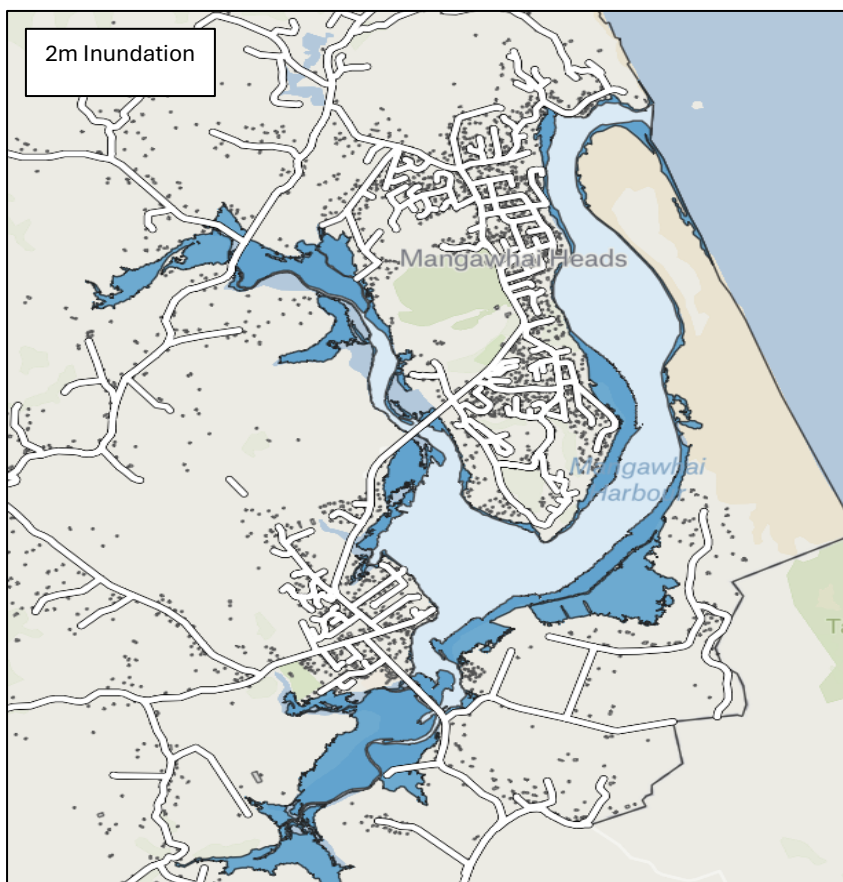
Scoping the Future: Coastal Inundation Scenarios

Tonkin + Taylor Ltd applied the scenario projections to detailed land elevation data to map potential inundation from the sea around Mangawhai Harbour. This report focuses on two threshold levels that have high probabilities of occurring within 55 years:

- **2.0 m:** Expected within 15 years or thereabouts, even under an optimistic SSP2-4.5 in the event of a 20-year ARI (Average Return Interval) storm, earlier under more intense storms;
- **2.5 m:** Plausible by 2080, even under SSP2-4.5, earlier under the high emissions scenarios.

Another way of looking at it: 2.0 m sea elevation corresponds broadly with the 1978 storm and Cyclone Gabrielle and can be considered a strong prospect by 2060. Moreover, 2.5m is a strong possibility within 40 years, unless warming slows within the next 10 years (SSP2-4.5), while 3m is a possibility around 2080 if the current rate of warming continues (SSP3-7.0 and SSP5—8.5).

Inundation with 2m Harbour Elevation



The bulk of Mangawhai lies over 4m above Mean Sea Level and will avoid the direct impacts of inundation. There are, though, significant areas of reserve and settlement at lower levels which will flood at 2m. Overtopping low lying areas in the upper harbour tributaries is also likely, threatening urban edge subdivision, rural dwellings, and roads and bridges.

The northern tip of the spit would suffer erosion from high sea levels, possibly leading to internal flooding and reducing its defences against more serious or subsequent storms.

At 2.5m the flooded area would expand significantly. Equally important, water would be deeper on roads, flooding reserves, stormwater, and wastewater systems, causing both short-term disruption and long-term damage.

In short, storms exceeding historical flood levels are likely by 2040 regardless of pathway. Inundation beyond 2m would be a major threat to the integrity of the sandspit and the role it plays in sheltering the harbour and its environs. Within our 55-year horizon, continuing strong storms and sea level rise can be expected to cause severe damage.

The Barrier Spit: Mangawhai's Natural Defence

The spit is the linchpin of Mangawhai's character, the first line of defence for the harbour and dependent activities. The 2.5m coastal inundation scenario demonstrated the risks, especially

Is More Severe Flooding Likely?

Eight reasons are set out below as to why we can expect more coastal inundation and why the development of a flood hazard reduction plan to counter the risks to Mangawhai is justified.

1. All scenarios see significant lifts in flood levels over the next 15 years, primarily in response to increased storm activity arising from current levels of atmospheric and oceanic warming.
2. The prospect is for increasing RSLR raising inundation levels in and beyond the middle of the century if global warming does is not moderate in the short term.³
3. Extreme ex-cyclonic storms have been uncommon off the Northland coast in the recorded past, but the scientific literature indicates they are likely to be more common in the future.
4. Experience on the coast since the 1960s is consistent with this prognosis.
5. Any shift from a Middle of the Road to a Regional Rivalries development path brings the prospect of more damaging inundation forward. Accelerated warming would raise the likelihood of 2.5m storm tides well within 50 years (and 3m by the turn of the century).
6. The assumptions regarding seasonal elevation, freshwater retention, and wave setup used in the modelling used here are reasonable. They are grounded in historical storms, but potentially conservative under the more extreme wind and rain conditions anticipated.
7. The bathtub model used to assess inundation prospects makes no provision for the cumulative erosive effect of a succession of storms, which, as 1978 demonstrated, is likely to increase vulnerability of the spit to over-wash or breach.
8. The scenarios do not provide for the contribution to freshwater flooding from major storms other than through elevating harbour water levels. Direct flooding by runoff from the catchment will compound inundation from the sea in low lying areas.

Cyclone Gabrielle, February 2023



³ Recent evidence points to higher levels of sea level rise than previously projected. See, for example, James E. Hansen, et al. (2025) "Global Warming Has Accelerated: Are the United Nations and the Public Well-Informed? *Environment: Science and Policy for Sustainable Development*, 67:1, 6-44,

The Risk-Regret Trade-Off

The decision whether to invest in a plan to increase protection from the effects of more severe storms and increase the capacity to mitigate their impacts can be placed in a risk- regret framework (below). Doing nothing has minimal short-term costs, but if major flooding occurs, it will affect homes, households, and lives, recreation, business, infrastructure, and ecosystems. Key cultural sites and habitats may be lost.

We conclude that the likelihood of more intense storms and their potential impact supports a strong case for investment in mitigation.

Table 2: The Risk-Regret Matrix: A Call to Action

	<i>Minimal Action</i>	<i>Proactive Mitigation</i>
No major flood event	No cost incurred	Moderate upfront & ongoing investment
Major coastal inundation	Significant damage & losses, Prolonged recovery, high costs	Protected assets - lower costs, resilient infrastructure - quick recovery

Investing early spreads costs out over time. Even if severe flooding does not happen soon, the community gains resilience and protection as sea levels rise. If scenarios like SSP3-7.0 or SSP5-8.5 become probable, early investment becomes even more compelling.

Managing the Risk: Adaptive Coastal Planning

Mitigation can be pursued in a planned manner, investing early in flexible, cost-effective defensive measures and in the medium term in building resilience. An adaptive coastal plan can identify the appropriate measures, the order in which they should be taken, and who is responsible for their implementation and their funding.

Such a plan should operate under a governance structure that represents the interests of the communities through the agencies that represent them; and a management structure to coordinate operations. This would involve participation by the Northland Regional Council, the Kaipara District Council, and, as managers of the Mangawhai Spit Wildlife Reserve, the Department of Conservation. Te Uri o Hau and Ngati Manihere as representatives of Mana Whenua should be included, with provision for direct community input.

Management should reflect the objectives of the plan, managed by arrangement among the agencies responsible for its implementation. This includes the councils and DoC, as well as the Mangawhai Harbour Restoration Society which is currently responsible for the integrity of the harbour and spit on behalf of the ratepaying community.

A policy toolbox from which a plan for can draw should include four types of measure:

1. **Soft engineering:** Continue dune reinforcement and advance beach nourishment. Target the spit's vulnerable points for strengthening. Undertake wetland restoration and extension.
2. **Hard infrastructure:** Consider seawalls, groynes, and raised roadways at critical pinch points. Reinforce vulnerable infrastructure corridors.
3. **Network resilience:** Audit and upgrade drainage, water, power, and communication systems to withstand projected flood levels and ensure continuity of essential services. These needs should be incorporated into central, regional, and local government long-term financial plans.

4. **Regulation:** Introduce district and regional plan provisions to restrict activities in high-risk areas, impose standards in areas at lower levels of risk, and enforce appropriate stormwater and design standards in new developments.

Whatever measures are adopted, a plan should identify the objectives of each measure and their order of priority within an adaptive programme. It should also identify the agency or party the responsible for their implementation.

Adaptation calls for flexibility so that measures can be advanced, delayed, or varied according to changes in the state of the coastal environment. The plan should therefore incorporate a commitment to monitor indicators of increasing (or diminishing) risk. They might cover:

- Trends in regional oceanic and atmospheric temperatures;
- Storm frequency and intensity across the South Pacific;
- Morphological changes in the spit and harbour dunes;
- Tide and inundation levels during peak storm events;
- Effectiveness of existing infrastructure under duress.

Conclusion

The evidence supports a clear proposition: Mangawhai faces a growing risk of coastal inundation from increasingly intense storms which will be exacerbated over time by rising sea levels. The consequences—economic, social, and ecological—are likely to escalate if preventive measures are delayed.

Through scientifically grounded and practical planning, collaborative governance, and staged investment, the threats from severe storms can be mitigated, preserving the health of the harbour critical to Mangawhai's community and its natural environment.

The agencies and tools exist to ensure that this is done in an efficient and effective manner. The challenge now is to bring them together.