Te Hunga Takutai o Aotearoa
NEW ZEALAND COASTAL SOCIETY

Coastal News

Newsletter of the New Zealand Coastal Society: a Technical Group of Engineering New Zealand

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Clean, green... and stressed?

The coastal marine environment is impacted by multiple human activities, but what if these become overwhelming? For a look at what makes coastal ecosystems resilient to cumulative disturbance and tipping points, see the article beginning on page 3.

Mimiwhangata Marine Park (Photo: Danica Stent, DOC)

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CONTENTS

Contents numbers and blue web links in this pdf are active (clickable).

Word from the Chair

Paul Klinac

Kia ora koutou

As I write this piece, I am reflecting on the year that has been for the New Zealand Coastal Society and how much we have achieved as a society in 2019. Our management committee, regional coordinators, and members have continued to successfully collaborate on a number of well-attended regional events. Our *Coastal News* publications have continued to successfully capture and present both emerging and longstanding coastal management issues, and we have been privileged to present a range of awards and scholarships to very deserving applicants. A huge thanks from me to all of those that have helped and contributed in this respect. It is really appreciated and the society simply wouldn't exist without your continued support and commitment.

This issue of *Coastal News* includes an article on resilient ecosystems that is particularly topical when considering urban growth pressures being experienced in many areas of New Zealand, modelling of coastal hazard exposure, and the use of drones for water quality sampling. Of particular interest is an article from Tom Burkitt on Singapore's coastal reclamation programme and news

Photo: Public domain

from the regions, which confirms it has been a very busy and diverse year for our contributors!

The final event of our year will be the annual conference from the 12th - 15th November in Invercargill. This will be a chance to make new connections and to catch up and network with friends and colleagues during a full programme of presentations and supporting field trips. I really look forward to seeing you there and discussing any ideas or suggestions you may have with respect to the New Zealand Coastal Society as we move into 2020.

Ngā mihi nui.


Stirling Point, Bluff (Pixabay)

NZCS Mission Statement

The New Zealand Coastal Society was inaugurated in 1992 'to promote and advance sustainable management of the coastal environment'. The society provides a forum for those with a genuine interest in the coastal zone to communicate amongst themselves and with the public.

The society currently has over 300 members, including representatives from a wide range of coastal science, engineering and planning disciplines, employed in the consulting industry; local, regional and central government; research centres; and universities.

Membership applications should be sent to the NZCS Administrator Renée Coutts (nzcoastalsociety@gmail.com).

What makes coastal ecosystems resilient to cumulative disturbance and tipping points?

Rebecca Gladstone-Gallagher[1], Conrad Pilditch[2] and Simon Thrush[1]

Cumulative impacts in the marine environment

The coastal marine environment is heavily impacted by multiple human activities that originate on land and in the sea. In New Zealand, land-based sediment and nutrient runoff, and the ecosystem effects of fisheries, are the major stressors/disturbances impacting the coastal environment (New Zealand Ministry for the Environment and Stats NZ, 2019) (Figure 1).

Further exacerbating the impacts of these stressors in coastal ecosystems are the many effects of climate change. The cumulative effects of these stressors can create disturbance regimes that deplete biodiversity, fragment habitats, and lead to a loss of ecosystem functions and services that are essential for societal wellbeing. Recent state of the environment reports highlight the scale and severity of this degradation and broadly recommend some form of ecosystem-based management (EBM) as a solution to solving these pressing problems that challenge our economy, ecology and wellbeing (IPBES 2019; New Zealand Ministry for the Environment and Stats NZ, 2019).

EBM is an inclusive and adaptive way of managing the marine environment that is centred on seven principles, being: collaborative decision making, tailored and place-specific, inclusive of human activities, adaptable, based on multiple knowledge systems, sustainable, and able to foster co-governance (https://sustainableseaschallenge.co.nz/challenge/principles-ecosystem-based-management). An EBM approach is essential because the current marine management methods (e.g. limits-based, single-species management) are often not fit-for-purpose in the context of multiple interacting activities and stressors that degrade ecosystems in an unpredictable way. The tide of change in our coastal ecosystems is going the wrong way, we need to reverse it, and business as usual is not working.

Around the globe, the incidences of tipping points in marine ecosystems are rising. Tipping points are unpredictable, abrupt changes in the state of an ecosystem that are usually accompanied by a loss of the ecosystem services that humans value (e.g. clean water quality, healthy fisheries, connection to nature).

These tipping points occur because multiple activities in the marine environment have cumulative effects. This is a significant social and ecological problem, and one that challenges how we manage and think about ecological change in our coastal environments. We are responding to this challenge and making progress in understanding how and why tipping points occur and what makes ecosystems resilient to cumulative stressors and disturbances. This progress is essential for informing EBM

(1) University of Auckland; (2) University of Waikato.

Figure 1: Common disturbances that impact the coastal marine environment. Some disturbances are associated with activities on land such as urbanisation, forestry, agriculture and horticulture, which increase sediment runoff (top left) and nutrient loading, leading to algal blooms (right). Other disturbances are from activities in the sea, such as the ecosystem effects of fishing (bottom left). Photos: Candida Savage (right), Andrew Lohrer (top left), Conrad Pilditch (bottom left).

of New Zealand coastal ecosystems and for the well-being of our society.

Understanding tipping points from experimental and theoretical studies

There are many examples of tipping points around the world, and these examples tell us that tipping points come as surprises and scientists are so far unsuccessful in predicting them. They come as surprises because they can occur without any obvious increases or changes in stressor loading (e.g. nutrient loads). The unpredictability is because multiple stressors or disturbances interact in complex and often indirect ways. For example, the overfishing of shellfish not only impacts the population itself, but because shellfish filter large volumes of water, overharvesting also reduces the ability of the coastal ecosystem to cope with increased nutrient and sediment loading (thus shellfish contribute to resilience). This is just one example of the multiple interactions and feedbacks that typify the nature of change in coastal ecosystems.

As part of the Sustainable Seas National Science Challenge (https://sustainableseaschallenge.co.nz), a team of researchers from across New Zealand led by Professor Simon Thrush (University of Auckland) has been conducting research to understand how marine ecosystems respond to cumulative change and disturbance, and what factors make those ecosystems resilient. Part of this research has involved a national experiment conducted at 24 sites in 14 estuaries from Northland to Southland (Figures 2 and 3). The national experiment explores the interacting effects of increasing sediment runoff (which makes the water turbid and the seafloor muddy) and nutrient enrichment (which creates eutrophication and harmful algal blooms; Figure 1).

This field-based research tells us that these two stressors radically alter the ecosystem architecture, simplifying interaction pathways and making the ecosystem more vulnerable to change. For example, in estuaries, increasing sediment runoff breaks down the ability of the seafloor ecosystem to process and cope with excess nutrients, because water turbidity impacts key species such as shellfish and the microscopic plants that drive coastal primary productivity and remove the excess nutrients. This means that estuaries already impacted by turbidity will be more vulnerable to eutrophication tipping points from nutrients.

This novel research addresses the network of interactions between different parts of the ecosystem and its response to multiple stressors and is unlike most previous studies which have focused on direct cause and effects of a single stressor or human activity.

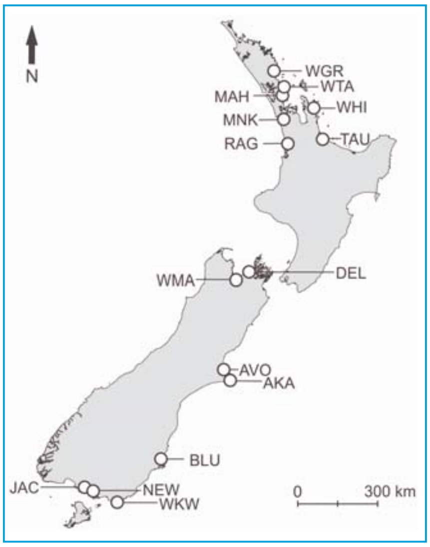

Figure 2: Map of New Zealand marking the 14 estuaries where the national experiment explores the effects of sediment and nutrient runoff on the functioning of coastal marine ecosystems.

Our experiments highlight that the effects of multiple stressors are not simple cause and effect relationships, they are complex, and this means we need to develop new ways of assessing risk, monitoring change, and making decisions about marine futures. Whilst we can't predict the exact thresholds

Figure 3: Photos showing the collaborative field experiment that involved researchers from across New Zealand and investigated the effects of sediment and nutrient runoff on coastal ecosystem function (Photos: The Sustainable Seas Tipping Points project team).

of stress that our ecosystems can cope with before they will cross a tipping point, we can focus on building resilience. We have found that there are certain elements of the ecosystem that we can preserve and improve in order to build resilience and prevent further degradation.

What characterises a resilient seafloor community?

The biodiversity of the seafloor underpins many of the ecosystem functions and services in coastal marine habitats. Some key species can also increase the resilience of ecosystems to cope with stress. Thus, preventing the future loss of functions and services requires a certain level of biodiversity to be conserved. In a recent article published in *Trends in Ecology and Evolution*, we have identified the factors that characterise a resilient seafloor community to different types of disturbances (Figure 1). Our paper presents a new way of applying concepts of resilience from the individual species tolerances to disturbance, to the community's ability to recover after a disturbance.

Some species have characteristics that give them a capacity to cope with specific stresses or disturbance. For example, suspension-feeding shellfish are sensitive to increasing mud from the land because their gill structures get clogged, whereas other species that don't have sensitive gill structures are more tolerant to mud.

However, resilience also involves how species reproduce and recolonise disturbed areas. Moreover, having a high diversity of different types of species within ecological communities can also increase resilience, as this diversity provides some insurance for the maintenance of ecosystem function even when the biodiversity is declining.

For EBM we need to know what attributes or components of an ecosystem provide resilience so that we can focus on preserving and restoring those components to insure against further degradation and loss of ecosystem services. Our paper highlights new and integrative thinking about change. This knowledge helps us to not only understand the nature of change, but also what actions we can take to enhance resilience to offer some insurance against tipping points.

Preserving ecosystem function and services by building resilience

Our ecological research paints a holistic picture of how coastal ecosystems respond to stress and disturbance, but also how they can resist change. This broadens our thinking and the opportunity to manage for the maintenance of ecosystem function by thinking about, and acting on, not only the environmental drivers of change, but also the capacity of the ecosystem to respond to change (i.e. resilience). This knowledge is essential for EBM. One of the challenges in marine ecosystem management is bridging the gap between research and decision making, and we are also making progress in this space.

Our recently published article in *Frontiers in Marine Science* highlights the value of building models based on expert opinion to bridge this gap. These models can be used to produce decision-making scenarios that are focused on building resilience. Expert opinion can fill in the holes in data, which is often cited as a challenge in managing the marine environment for multiple and cumulative disturbances. An example of this would be to build a model where experts (including people from various sectors of society: governments, scientists, stake-holders, iwi and hapū) characterise vulnerability of an estuary to eutrophication based on the biophysical properties (e.g. flushing rate, hydrodynamics, depth, habitat types) and the human activities that are occurring in the catchment. Experts can also characterise the actions and attributes of the ecosystem that would increase resilience, for example restoring species and habitat diversity that support nutrient removal from the ecosystem (e.g. shellfish beds).

Our collective research highlights the need for new engagement and actions to save coastal ecosystems. We need to fully recognise the real, complex nature of these ecosystems, and the reality of cumulative effects. This recognition is the key to finding solutions to our environmental management crisis. A focus on identifying decisions that build ecological resilience in times of escalating change is critical.

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Contributing to *Coastal News*

We welcome contributions for forthcoming issues of *Coastal News*. Please contact the Editor, Charles Hendtlass, at cellwairmonk@gmail.com if you'd like to submit an article, contribute a news item, have content suggestions or a photo to share, or to give some feedback on the newsletter.

The submission deadline for the next issue is 31 January 2020.

A Contributor's Guide is available for download from the Society's website at www.coastalsociety.org.nz (under the 'Publications' tab). This provides information on the style and format requirements when writing for NZCS publications. An index of articles previously published is also available for download.

Modelling coastal hazard exposure in Tauranga Harbour

Scott Stephens[1], Tom Shand[2], Mark Ivamy[3], Sanjay Wadhwa[1], Rebekah Haughey[2], Ben Popovich[1]

Introduction

Coastal flooding and erosion are major hazards in coastal cities where development of buildings and infrastructure has occurred next to the sea. Our cities are vulnerable to extreme sea-level events (Figure 1), but also to increasing nuisance flooding (Figure 2) and eventually permanent inundation after sea level rise (SLR). Coastal erosion will continue along the base of coastal cliffs, causing cliffs to become oversteepened and eventually collapse (Figure 3). Communities, councils, emergency managers and infrastructure operators need to understand and plan for flooding and erosion hazards now and in the future after substantial sea-level rise.

But our focus should not just be on large sea-level rise. Some places experience erosion already, or flooding during large tides (Figure 2), and especially if a storm-driven surge coincides with large spring tides (Figure 1). Other places will begin to feel the effects of small 0.1-0.2 m increments of sea-level rise long before SLR reaches 1 m or more (Figure 4) (PCE 2014; Stephens et al., 2018).

Models are used to predict where, how big and how often the flooding and erosion could be. We show the results of coastal flood and erosion mapping in Tauranga Harbour to demonstrate the impacts of future sea-level rise on the area of land flooded and number of buildings impacted by flooding and erosion. The modelling was undertaken by NIWA and T+T for a partnership of councils: Western Bay of Plenty District Council, Tauranga City Council, and Bay of Plenty Regional Council. The councils will use the information to educate landowners of the potential risks, in regulatory processes such as the Building Act and subdivision process (and future plan changes processes), and plan for adaptation to SLR.

(1) NIWA; (2) Tonkin + Taylor; (3) BOPRC.

Figure 1 (top left): Flooding of low-lying coastal land during the high storm-tide on 5 February 2018. The sea level reached on this date has about a 3% chance of occurring in any year at present-day mean sea level (Photo: Mike Tyler). Figure 2 (top right): Full tide at a property bordering Waimapu Estuary in Tauranga Harbour, 10:30, 30th April 2017 (Photo: Kate Enright). Figure 3 (bottom left): A land coastal landslip in Omokaroa resulted in more than 1 ha of land lost. The landslip material at the toe is now becoming vegetated, but will continue to be eroded and removed until the erosion of the cliff toe resumes (Photo: Tonkin + Taylor). Figure 4 (bottom right): Full tide at the Bay St Reserve, which borders the Matua Estuary, on 17 November 2016 (Photo: Jim McMaster).

Hazard scenarios modelled

We compared the results of a coastal flooding assessment (https://gisapps.tauranga.govt.nz/harbourinundation) and a coastal erosion assessment (http://taurangacc.maps.arcgis.com/apps/opsdashboard/index.html#/b0ed36770617404f9f216495fe1d7797) in Tauranga Harbour.

For coastal flooding, we modelled how likely it is to get very high sea levels, and we modelled how the frequency of high sea levels will increase with SLR. We compared the impacts of two sea-level events at present-day mean sea level: a) an 'extreme' 1% annual exceedance probability (AEP) sea level and b) a mean high-water springs (MHWS) sea level. To both these events we then added small increments of SLR up to a total of 1.6 m above Moturiki Vertical Datum 1953 (MVD-53). Mean sea level (MSL) is presently about 0.1 m MVD-53. The line of MHWS effectively defines areas that would be legally defined as 'in the sea' now and in future after SLR. The 'extreme' sea level was chosen as a large and rare sea-level with only a 1% chance of occurring in any year at present-day mean sea level – it is about 0.3 m higher than the sea level that caused extensive flooding on 5 January 2018 (Figure 1), which had about a 3% AEP (Stephens, 2017; Reeve et al., 2018).

For coastal erosion, 32 high risk sites around the harbour were selected for assessment. These included lengths of coast where significant assets were located near the coastal edge or development was planned in the future. The areas susceptible to coastal erosion and instability were assessed probabilistically based on the stable angle of cliff or bank response, historical long-term erosion trends, and the potential change in future erosion due to sea level rise. The likely (66% chance of occurring) and very unlikely (5% chance of occurring) erosion and instability extents were mapped for a range of timeframes and sea level rise scenarios ranging up to 1.6 m over a 100 year time frame.

Coastal-flooding exposure in Tauranga Harbour

The hydrodynamic model shows that there is about 25 km^2 of land already exposed to flooding of ≥ 0.3 m in an extreme 1% AEP sea-level event. This will rise to about 60 km^2 at 1.6 m MSL and the increase in exposure is approximately linear with SLR (Figure 5).

Likewise, there are presently about 230 buildings exposed to flooding in an extreme 1% AEP sea-level event, and this will rise to about 3,200 buildings at 1.6 m MVD-53 (Figure 6). We translated the 1% AEP results to estimate the number of buildings affected by a 20% AEP sea-level event (occurs about once every five years) – after 0.14 m SLR there would be about 230 buildings exposed to 20% AEP flooding, and this would rise to about 1000 buildings being flooded every five years or so after about 0.6 m SLR.

Presently there are no buildings seaward of the line of MHWS, but this will change with SLR. The land on which any such building sits would effectively be 'in the sea' from a legal perspective and would experience regular flooding at least every fortnight over the spring tides. Nineteen buildings would be located 'in the sea' when MSL reaches 0.6 m MVD-53, 88 buildings at 0.8 m MSL, and almost 1000 buildings at 1.6 m MSL (Figures 6 and 7). Adaptation must occur before buildings end up 'in the sea', and probably also before 20% AEP flood risk occurs.

It is possible to recover from a rare extreme flooding event, but it is important to note that for the 230 buildings presently exposed to the rare chance of a 1% AEP event, the frequency of flooding will increase dramatically in future with SLR (Figure 6). We expect those 230 buildings to flood about once every two years after 0.2 m SLR, and about three times per year after 0.3 m of SLR (0.4 m MVD-53), which will occur sometime between 2045-2070 (MfE 2017).

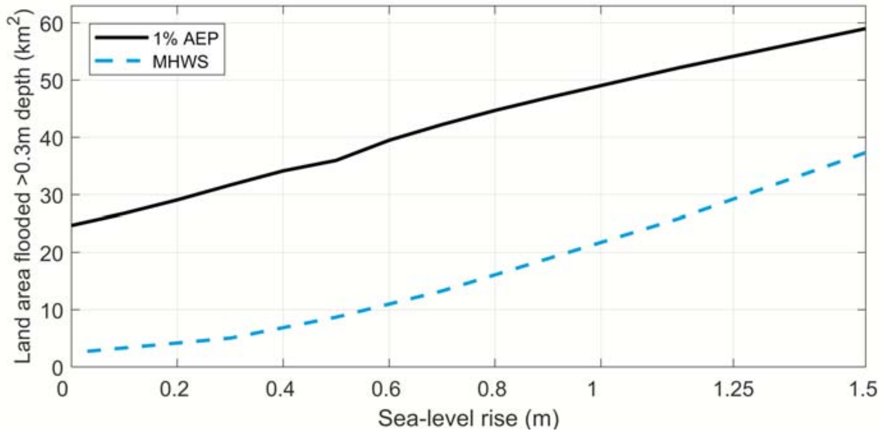

Figure 5: Comparison of land area flooded to a depth ≥ 0.3 m by a) an 'extreme' 1% AEP sea level and b) a typical high spring tide, for sea-level rise up to 1.5 m above present.

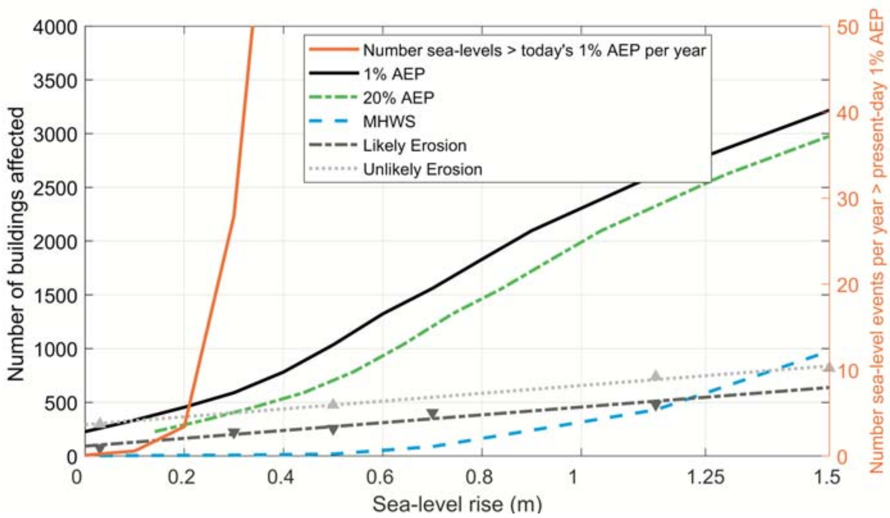

Figure 6: Comparison of hydrodynamic and static bathtub models of the number of buildings affected by an 'extreme' 1% AEP sea level, a 10% AEP sea level and a typical high spring tide, for sea-level rise up to 1.5 m above present. Also shown is the 'likely' (66% probable) and 'very unlikely' (5% probable) coastal erosion. The 20% AEP scenario was not modelled, but is a horizontal translation of the 1% AEP curve by 0.14 m, which is the elevation difference between a 1% and 20% AEP event.

At > 0.3 m SLR those buildings will be flooded many times per year.

Coastal-erosion exposure in Tauranga Harbour

There are about 75 buildings within the present-day 'likely' area susceptible to coastal erosion, and this will rise to about 640 buildings at 1.6 m MVD-53 (Figure 7). If erosion is worse than expected (i.e. under the unlikely scenario), then more than 800 buildings could be affected after 1.5 m SLR.

Comparison of coastal erosion and flooding

Buildings can be repaired after rare extreme flooding events like 1% AEP – insurance companies presently cover that risk. But continual repair of damaged buildings is unlikely if it occurs frequently – Figures 6 and 7 show the (approximate) 20% AEP curve, which is the number of buildings flooded every five years on average and these buildings are unlikely to be sustainable without adaptation. Likewise, buildings are no longer usable if the land on which they sit is eroded. Figures 6 and 7 indicate that coastal erosion affects more buildings right now. But as sea level starts to rise, coastal flooding will soon affect many more buildings than coastal erosion. It is important to examine both hazards since they can affect different locations, e.g. buildings on coastal cliffs may be safe from flooding but vulnerable to erosion and land instability.

Summary

The coastal flooding and erosion modelling provided the councils with accurate high-resolution maps at 1 m spatial resolution. The use of 0.1-0.2 m increments of SLR shows emerging hazard exposure to facilitate both short-term and long-term landuse management and adaptation planning. Coastal erosion affects the most buildings right now, but will soon be overtaken by coastal flooding as sea levels continue to rise, although some properties will remain safe from flooding but be impacted by erosion. Tauranga City and Western Bay of Plenty District have a large area of land and about 230 buildings presently exposed to flooding during a 1% AEP extreme sea level. Flooding from sea levels of this height can be expected about once every two years after only 0.2 m SLR in the next few decades, so the pressure to make adaptive plans is urgent. Many more buildings will be exposed after future SLR. Without adaptation, dozens – and eventually thousands – of buildings will be exposed to fortnightly flooding and will effectively be 'in the sea'.

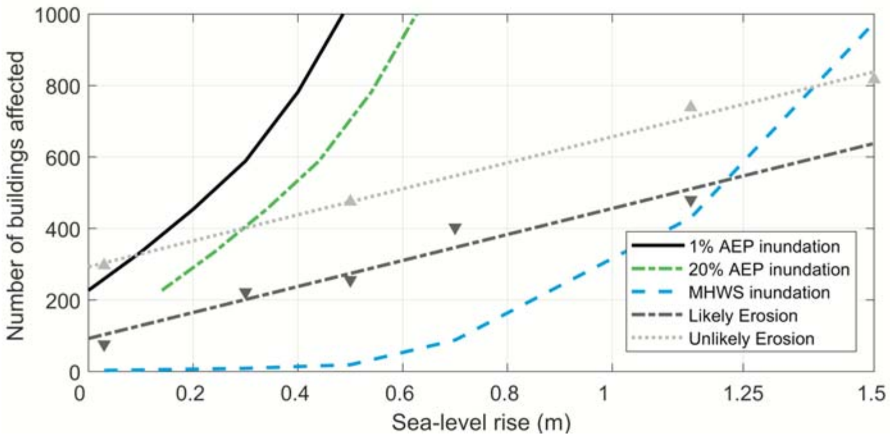

Figure 7: Comparison of the number of buildings affected by a 1% and 20% AEP sea level and a typical high spring tide, and the 'likely' (66% probable) and 'very unlikely' (5% probable) coastal erosion, for sea-level rise up to 1.5 m above present.

This article is an output of the 'Weather-related coastal impacts to climate change project' funded by the Natural Hazards Platform.

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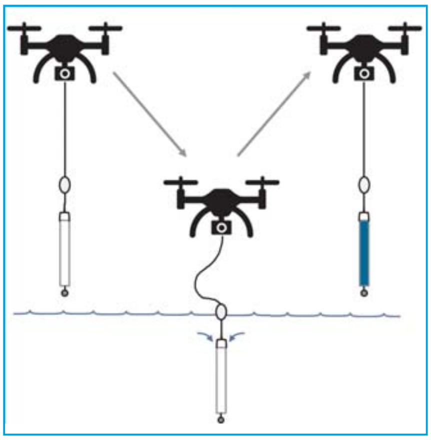
Water quality sampling using drones

Thom Gower, Pattle Delamore Partners Ltd and Tom Porter, Auckland Council

Water quality sampling at a range of offshore distances is important for understanding coastal water quality issues and risks to human health from contamination such as wastewater overflows. In Auckland this high-profile issue is particularly relevant given the popularity of marine swimming events and other water sports at beaches around the region. Auckland Council's Safeswim website, which provides real-time forecasts of water quality at swimming beaches across the region, also relies on sampling to validate the models behind its predictions.

However, traditional offshore sampling methods, including using boats and helicopters, involve significant hazards (e.g. drowning), incur substantial cost, and are difficult to deploy rapidly enough to capture the impacts of weather-related pollution events.

To address these challenges, Pattle Delamore Partners Ltd (PDP) developed an innovative method for collecting water samples with a drone. Combining the relatively inexpensive waterproof Splashdrone with lightweight HydraSleeve samplers, PDP can collect samples from up to one kilometre offshore. The drone lowers the weighted HydraSleeve into the water and it fills when raised through the water column. A float controls the depth from which the sample is taken. With a maximum payload of one kilogram, the drone can carry more than enough water to test for enterococci, the main bacterial indicator of faecal contamination in seawater.

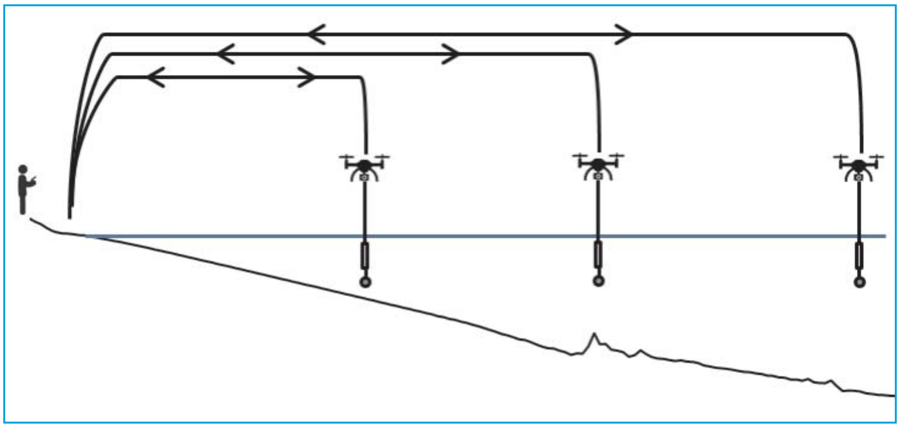


HydraSleeves fill only when raised, allowing for control of the depth at which samples are taken (Graphic: Thom Gower).

One of the PDP team attaching an empty sample sleeve while the drone hovers above the beach (Photo: Thom Gower).

Crucially, the method allows for rapid deployment and sampling in response to the heavy rain events that sometimes overwhelm Auckland's wastewater network —a task that has proven difficult in the past when sampling from boats. This means data is captured when it is needed most. The drone-based approach also eliminates hazards to staff associated with working over deep water, as the entire operation can be conducted from the safety of dry land. As an added benefit, the cost to the council is also reduced, with the monitoring at six popular beaches (including Takapuna and Mission Bay) coming in at around 30 per cent cheaper than when using traditional techniques.

(Top photo) Sampling off Kohimarama Beach, Auckland; (Bottom photo) Sampling off Takapuna Beach, Auckland (Photos: Thom Gower).



Multiple samples are collected in each flight, with the number dependent on the distance to be covered (Graphic: Thom Gower).

Singapore's coastal resilience: Notes from an expat coastal scientist

Tom Burkitt

Singapore is an extraordinary place. The scale, speed, and ambition of its urban transformation since independence in 1965 is truly remarkable, and it remains the premier hub in Southeast Asia for commerce and shipping.

Cities in Southeast Asia compete for economic relevance, and Singapore is a country determined to be relevant and as productive in 150 years as it is now despite the inevitable impacts of climate change and rising seas. Unlike many countries and cities, it has the ambition and resources to achieve its goals.

I moved there with my family in early 2015 to take on a project management role on a national coastal adaptation study; the first of its kind for a major city in Asia. The government of Singapore wanted to know how exposed their country is to sea level rise and inundation, with the intention of investing in adaptive pathways for long-term protection for the next 100 years and beyond.

A diverse and ever-changing coast

Sitting at the southern tip of the Malay Peninsula with only 800 m separating it from Malaysia and only 10 km to Indonesia, Singapore is truly at the heart of Southeast Asia. It is hot, with a climate characterised by two monsoons, a low energy and sheltered coastal environment, and the dubious reputation of being the record holder for lightning strikes in a year. But none of that detracts. The storms are exhilarating, and the city knows how to deal with large amounts of water.

Singapore is a city that is used to adapting and changing. Over the years, its coastline has changed dramatically as the government invests in reclaiming and creating a huge amount of new land to support industrial expansion, and the creation of affordable and desirable housing for its 6 million inhabitants.

The Urban Regeneration Authority (URA) leads the master-planning for the city, and Figure 2 shows how much change there has been as Singapore expands its land area. To the west, the 'fingers' are a new site for the Tuas Mega Port, a huge undertaking that extends Singapore's capacity for shipping, and allows the coastal frontage of the east of the island to be transformed as the current port operations shift west.

Figure 1: Singapore's varied coastline, clockwise from top left: Marina Bay; the Pungol Reserve; the causeway to Sentosa recreational island; and overlooking Keppel Port, which will be transferred to the west of the island by 2030 to create more space for commerce, residential developments and recreation (Photo source: Deposit Photos).

In New Zealand, we have our Garden City, Christchurch. Lee Kwan Yu, the revered founding father of Singapore, coined the phrase 'City in a Garden' to describe his aspiration vision for the city, and despite its rapid development, his vision has been realised through careful and considered master-planning. Biodiversity and coastal habitats have certainly been greatly depleted and only a fraction of the original mangrove persists. However, looking ahead this small and wealthy city state has an ambition to be the world's greenest nation, and the city is investing in coral and seagrass habitat restoration and recovery.

Strategies for coastal protection

The government of Singapore firmly believes that sea level rise and increasing storm frequency poses an existential threat to the country and its prosperity. Prime Minister Lee Hsien Loong recently announced his country's commitment to coastal protection and hard coastal defences, including polders.

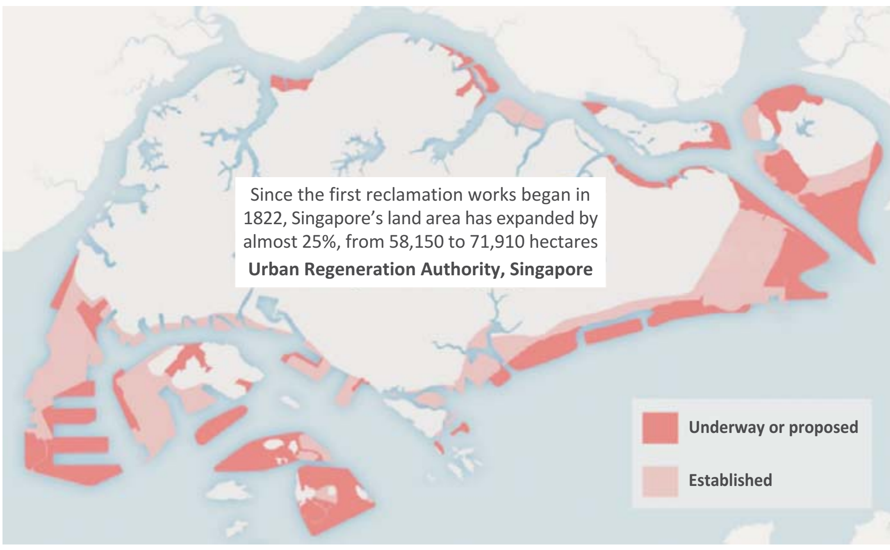


Figure 2: Singapore's reclamation programme has transformed the island state (Source: URA Singapore).

Protection against rising seas will cost Singapore probably 100 billion Singapore dollars over 100 years. "Because it is a 50-100-year problem, we can implement a 50 to 100-year solution. That way we can afford it, and when we need it, we will have it ready", said PM Lee.

PM Lee said that Singapore "must start now and sustain the effort" to address the threat of rising seas. His administration has publicly stated that there is a 20% chance of there being a 2 m rise in sea level by 2120, and his government intends to implement adaptable protection options that can be enhanced in future as the need arises.

> "Climate change defences should be treated with utmost seriousness, just like the Singapore Armed Forces."
>
> *Prime Minister Lee Hsien Loong*

However, this is not coastal protection as we know it from New Zealand, and there is no option for retreat. Singapore aims to 'attack' and 'defend' on a large scale. They will do so with ambitious land reclamation that creates much needed water reservoirs, new land for commercial development, and raising the coastal land for coastal defence.

Singapore's risk appetite is low. This is understandable given the criticality of its infrastructure and the exposure of its commercial 'engine room' and of its financial and industrial hinterland. The first step for the government was to determine to what level the coastal protection should be built, and Singapore borrowed heavily from the Dutch experience. In fact, given the shortage of sand to reclaim and raise land, Singapore is introducing polders, also known as dikes, to create industrial land and protect their assets from inundation.

Like many countries, Singapore is already exposed to infrequent (low probability) large-scale storm and inundation events. This exposure is increasing over time as a result of climate change, and this shifting risk can be measured in terms of expected losses and an aggregate of the Average Annual Losses (AAL) expected year-on-year over the planning horizon of 100 years.

Interventions can be introduced over time to offset as much of the risk as possible, and the reduction in expected losses can be compared to the cost of intervention to build the business case for what to do and when in time. The approach is systematic and quantitative, and the general steps taken on the project to select preferred pathways are listed in the box to the right.

The project I stepped in to was challenging, but immensely rewarding, and I am proud to have been part of it. Singapore now has a complete and costed set of dynamic and adaptive pathways necessary to protect Singapore from rising seas and storm inundation long in to the future. The coastal protection pathways will be refined under the forthcoming coastal masterplan, and the adaptive planning framework in place now allows agencies to collaborate effectively to achieve the desired protection level, whilst maximising other co-benefits like recreation, additional amenities, or the creation of new land.

Steps for comparing proposed adaptation pathways

1. Estimate AAL 'Do nothing' to 2120 allowing for projections in changing productivity and land use.
2. Introduce a variety of pathways (sequences) of interventions (hard and soft measures) to avert risk.
3. Estimate costs of pathways (the cost of 'Do something').
4. Rerun assessments of each pathway to measure averted risk (the benefit of 'Do something').
5. Calculate Cost:Benefit ratio of each pathway and compare.
6. Optimise the timing and costs of interventions to maximise benefit and minimise the residual risk (economic and human).
7. Stress test with 'what if' deterministic scenarios for planning purposes.
8. Use multi-criteria decision analysis to agree on preferred pathways.

University news

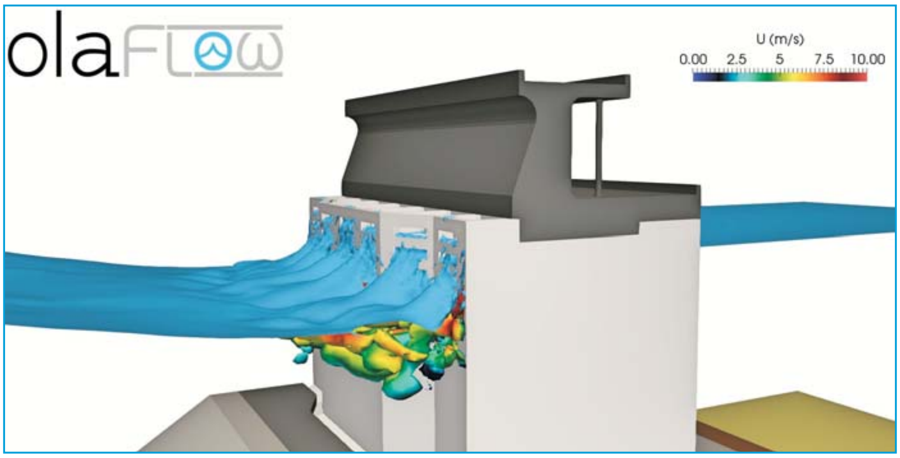
Coastal engineering at the University of Auckland

The Department of Civil and Environmental Engineering at the University of Auckland is pleased to announce the expansion of our Coastal Engineering offering. This is being driven by the recent arrival of new academic staff members including Dr Pablo Higuera, a specialist in the application of Computational Fluid Dynamics (CFD) to coastal problems, and Dr Tom Shand, who is joining the faculty part-time from industry with a strong focus on applied coastal engineering problems and physical modelling. They will join Dr Colin Whittaker, a specialist in destructive wave mechanics and tsunamis, to deliver new courses and research focusing on the coastal engineering issues facing New Zealand.

The new offering includes postgraduate-level courses on Coastal Engineering Dynamics and Coastal Engineering Structures in 2020. These courses cover coastal hydrodynamics and processes, coastal hazards, design of coastal structures, and assessment of coastal effects. The University of Auckland Fluid Mechanics Laboratory also provides world class facilities in which to study coastal and ocean processes. These facilities include wave, tsunami and sediment transport flumes and tanks.

The team will also engage in collaborative research on mitigation of wave overtopping, wave-structure interactions, swash-zone processes, tsunami impacts on structures, and infrastructure resilience to hazards posed by rising sea levels.

(Top) Coastal engineering students from the University of Auckland on a field trip to Auckland's urban beaches (Photo: Colin Whittaker); (right) Scale modelling of wave overtopping of a real world structure within the University of Auckland wave flume (Photo: Tom Shand).



Example of CDF being used to investigate wave-structure interactions using olaFlow (Image: Pablo Higuera).

Dr Pablo Higuera

Pablo Higuera is a Spanish researcher who has just joined the University of Auckland as a Lecturer in Coastal Engineering. His research field involves the application of Computational Fluid Dynamics (CFD) to coastal problems such as wave-structure interaction, hydraulics and environmental flows, and he is currently developing the open-source CFD model olaFlow within OpenFOAM. In his free time, Pablo enjoys travelling to discover new places and foods, taking photographs, listening to progressive rock/metal and jazz music, and sailing or walking by the coast.

Dr Colin Whittaker

Colin Whittaker is a lecturer in Civil Engineering Hydraulics at the University of Auckland. His teaching spans the civil engineering curriculum, from basic fluid mechanics and hydraulics through to coastal and water resources engineering. His research and professional work is primarily experimental, and includes the generation, propagation and impacts of tsunamis and extreme (rogue) waves, and the mitigation of coastal and fluvial flood events. He has also undertaken recent research in particle transport beneath wave groups, with applications to the ocean transport of microplastics.

Dr Tom Shand

Tom joined the University of Auckland in a part-time capacity as a Senior Lecturer in Coastal Engineering. His research interests include wave breaking and wave-structure interactions, innovative coastal protection, and remote sensing of coastal processes. His background in industry enables real-world and applied expertise to be brought into teaching and research, including the strategic development of the overall coastal engineering curriculum.

NZCS 2019 award winners

Each year, the New Zealand Coastal Society presents awards to some of its members to recognise their efforts and to give financial support for their work. These are the recipients of the 2019 awards.

Josie Crawshaw
NZCS Professional Development Award

Josie is a coastal environmental scientist at the Bay of Plenty Regional Council where she has been based post PhD studies since July 2018. Her core responsibilities include the design and implementation of environmental monitoring programmes, synthesis and reporting on coastal environmental programmes, scientific support to policy makers, and communication of scientific information to the public, industry and council committees.

She has been granted a professional development award to attend the Coastal and Estuarine Research Federation (CERF) 25th biennial conference in Mobile, Alabama, USA in early November. The theme of the conference this year is 'Responsive, Relevant, Ready'. The five-day conference brings together a worldwide contingent of academics, government employees and consultants to discuss current and emerging issues for sustainable management of the marine environment.

The Bay of Plenty region faces a range of conflicting stressors in the marine environment, and large work programmes are underway creating policy to implement our responsibility to sustainably manage and enhance the marine environment.

A range of talk themes at the CERF conference will be highly relevant to support her scientific input into these processes/ programmes, including some chosen topics on:

- Advancing environmental flow assessments for estuaries
- CMECS: A common language for coastal habitat mapping
- Ocean acidification in a multiple climate change stressors context: science-based tools for management
- Outreach and engagement of our estuaries, coasts and oceans
- Setting ecologically relevant targets for management of marine plant habitats.

The attendance at this conference will provide up-to-date international science and management strategies to ensure our programmes are in line with international colleagues. The information and new knowledge gained by attendance at this conference will be communicated back to BOPRC through a range of presentations and workshops to interested parties across the governance, policy, science teams, and wider organisation. Her reflections of the conference will also be shared at the next Coastal Special Interest Group meeting and in the next edition of the *Coastal News*. The attendance at the workshops and conference will enhance her skills as a coastal scientist and support her in her role to ensure sustainable environmental management in the Bay of Plenty.

Deirdre Hart
NZCS Professional Development Award

Deirdre is a coastal scientist at the University of Canterbury. Her work concerns the interface of coastal science and management, oceanography, lifelines engineering, and multi-hazards (https://researchprofile.canterbury.ac.nz/Researcher.aspx?Researcherid=521456).

Multi-hazards occur where two or more hazards interact in space and/or time such that the sum of their interactions produces different effects to the combined effects of the same hazards operating independently. In simple terms, hazard assessments produce different results when performed independently (a traditional hazards approach), compared to when the results of one type of hazard event are input into another hazard assessment, and vice versa (a multi-hazards approach). For example, future inundation predictions can vary depending on if baseline shorelines are used that do/do not incorporate future erosion scenarios. Inundation assessments can vary further when likely interactions are considered with the effects of wildfires, atmospheric extremes, seismic disturbances, pollution events, ecosystem perturbations, and infrastructure damage, to name a few possible multi-hazards. Experiences from recent earthquakes in New Zealand and elsewhere indicate that, compared to multi-hazard approaches, multiple independent hazard analyses can both under- and over-estimate hazard effects, leading to misplaced prioritisation of efforts to increase coastal settlement resilience.

Deirdre will use the NZCS Professional Development Award to explore the intersection and methodological gaps between (a) multi-hazard interactions, and (b) coastal hazards, including sea level and climate changes. She hopes to advance the way we perceive and assess the risks associated with managing coastal environments through a multi-hazards review of coastal hazard assessment practices, including analysis of offerings at the International Coastal Symposium (ICS) in Seville, in April 2020. Herein lies an opportunity to explore the potential intersection of multi-hazards theory, coastal hazard assessment practices, and statistical methods, to improve scenario realism and provide a robust basis for communities to employ in climate change adaptation planning stages.

Raphael Krier-Mariani
Student Research PhD Scholarship

New approach to define wave transformation on rocky shore platform

Raphael's research focuses on wave dynamics over intertidal rocky shore platforms (wave breaking, wave propagation and wave energy dissipation). Intertidal shore platforms act as natural buffers dissipating wave energy in rocky shore environments. The understanding of wave transformation represents a first step toward the characterisation of rocky shore erosion mechanisms. Unlike sandy beaches,

Raphael Krier-Mariani

Will Pinfold

Maddy Glover

characterised by a seasonal or inter-annual erosion/accretion cycle, cliff erosion is an irreversible process threatening rocky shorelines that represent 80% of the world's coastline and 23% of New Zealand's coastline.

Wave transformation on rocky shore platforms has mostly been studied over linear transects, which limited previous observations to two dimensions. The aim of Raphael's research is to redefine shore platform hydrodynamic processes in three dimensions and assess the effects of platform morphology on wave transformation. This will allow him to establish conceptual models coupling morphology and hydrodynamics. These types of models are currently lacking in rocky shore environments and the information they provide can be useful to assess the level of hydrodynamic forcing acting on different rocky shores and, subsequently, cliff erosion rates.

Understanding cliff erosion rates and mechanisms has strong implications in coastal management plans, not only in urban regions facing ongoing cliff erosion issues (e.g. Coal Mine Bay, Auckland), but also in rural regions where sites of high cultural importance are threatened (e.g. Urupā in Mahia Peninsula, Hawke's Bay). Raphael's work focused on a section of coastline where cliff erosion was threatening one of the main road accesses to Kakanui (Otago). Most recently, after considering coastal issues mentioned by ko te komiti Maori o Mahia, his work aimed to provide local iwi in Mahia information on coastal processes occurring on their coastline.

Will Pinfold
Māori/Pacific Island Student Research Scholarship

Quantifying an invasive seaweed Undaria pinnatifida using underwater videography

First discovered in New Zealand in 1987, *Undaria pinnatifida* is an invasive kelp native to North East Asia, now well established at most ports nationwide. Its potential to spread quickly, displace native biota, and alter ecosystem structure has earnt it a place in the most 100 invasive species in the world.

Will's study aims to develop a more efficient method of gathering valuable information about underwater seaweed assemblages, which can be used to better manage our coastal ecosystems. Will plans to do this through constructing a filming setup to enable more time- and cost-effective sampling of areas of interest, a great advantage given the challenging local weather and sea conditions.

He will first construct and assess the accuracy of his sampling method vs. the traditional time-consuming method of manually counting organisms along a transect line. He then plans to use this technique to assess the effect *Undaria* is having on native seaweed assemblages around Otago and other parts of the South Island using existing habitat maps. He also plans to study areas before and after harvest of *Undaria* as part of a hapū (Kāti Huriapa ki Puketeraki) led control programme to determine how native species and *Undaria* regenerate after being harvested.

As a result, Will hopes his research can be used to protect coastal marine ecosystems, that are not only valuable economically and recreationally, but are also culturally significant for iwi.

Maddy Glover
Student Research MSc Scholarship

The lost kelp forest: Habitat mapping of Macrocystis pyrifera *along southern coastal Otago, New Zealand*

Macrocystis pyrifera is an ecosystem engineer, providing both food and a three dimensional habitat to coastal ecosystems. *M.pyrifera* is declining globally due to multiple stressors in different eco-regions.

Anecdotal evidence from the living memory of residents and fishers along the Otago coast describe *M.pyrifera* coverage being far more extensive in past decades. The kelp forest once supported many commercially and culturally important species such as pāua, New Zealand rock lobster, blue cod, kina and butterfish.

Maddy's research aims to investigate the historic and current extent of *M.pyrifera* along coastal Otago through semi-structured snowball sampling interviews of local stakeholders. Following surveys, areas identified as once supporting *M.pyrifera* will be investigated with multibeam echosounder and dive surveys to determine if suitable kelp habitat still remains.

This research has local and global benefits. By understanding the extent and drivers of loss, we are better informed to restore these once productive ecosystems. This research forms the basis for restoration efforts and is important to local stakeholders who will benefit first-hand if these ecosystems can be restored.

Additionally, this work will add to understanding in the wider context of global marine ecosystem changes.

Maddy is supervised by Associate Professor Chris Hepburn, Dr Matt Desmond, Emily Tidey, and Dr Anne-Marie Jackson (University of Otago).

Newsletter archive & downloads

Back issues of *Coastal News* (from 1996 onwards) are available to download from the Society's website at www.coastalsociety.org.nz (under the 'Publications' tab). Also available for download are author and article indexes for issues 1 to 65 (these will be updated each year), a Contributor's Guide to writing articles for *Coastal News*, and copies of the three NZCS Special publications – *Rena: Lessons learnt* (2014); *Adapting to the consequences of climate change* (2016); and *Shaky shores: Coastal impacts & responses to the 2016 Kaikōura earthquakes* (2018).

News from the regions

Auckland

Lara Clark, Greg Munford, Colin Whittaker and Matthew McNeil, Regional Representatives

Stanmore Bay restoration project

Stanmore Bay is a sandy beach located on the Whangaparaoa Peninsula. Following significant erosion resulting from a storm event in January 2018, a soft solution approach was applied to a 100 m length of affected reserve edge. This involved removal of outflanked rock armouring, reprofiling and realigning the sandy reserve edge landward, and installing planted dune cells.

Given the success of the 2018 works to date, a second and final stage of this project was undertaken in August 2019. This involved removal of a further 100 m length of rock armouring to the immediate east. The remaining sandy reserve edge was then reprofiled, with the crest realigned landward by 2-3 m as dictated by adjacent pohutukawa trees. Dune cells were created using rope and timber bollards to match the 2018 work. Approximately 1000 dune grasses (spinifex and pingao) were planted within the new dune cells.

Stanmore Bay, pre (top) and post (bottom) 2019 works (Photos: Matthew McNeil).

To date the project has been successful, despite community pressure to 'hold the line' by constructing a new rock revetment.

Sandspit Beach enhancement project

Earlier this year Auckland Council completed the Sandspit Beach enhancement project in the Waiuku Estuary, southern Manukau Harbour.

An existing 60 year old concrete seawall that armoured the reserve had significantly deteriorated. In 2016, undermining of the seawall resulted in the collapse of several large sections of the wall and concrete promenade.

Consent was obtained for an integrated erosion management solution for the wider Sandspit Beach area that would provide an enhanced beach buffer to the reserve, minimise disturbance to a stand of scheduled pohutukawa trees, and improve public access to and along the coastal marine area.

The beach was replenished with 6,600 m^3 of Waikato River sand sourced from Tuakau quarry, with associated control structures (jetty headland, a boat ramp access, and combined stormwater outfall rock groyne) installed. A new boardwalk was constructed along the coastal edge.

The erosion management and beach upgrade works have greatly enhanced the recreational and amenity values of the reserve, and improved access to public open space along the coastline.

Sandspit Beach, pre (top) and post (bottom) 2019 works (Photos: Jo Morriss, Auckland Council).

Shelly Beach foreshore upgrade

The Shelly Beach foreshore upgrade project on the southern Kaipara Harbour was completed in August 2019.

This involved construction of a stabilised sediment backstop seawall, and stabilised sediment groynes. Typical cement content used in the structures varied between 150 to 250 kg/m^3.

Approximately 2,500 m^3 of sand sourced from the northern Kaipara Harbour was placed between the groynes to replenish the beach. Performance of the stabilised sediment structures and replenished beach will be monitored over time.

The aim of the Auckland Council project was to address beach erosion, and to improve amenity values for beach and reserve users.

Shelly Beach, stabilised sediment backstop seawall and imported sand being placed (Photo: Christoph Soltau, Auckland Council).

Waikato

Christin Atchinson and Jacqui Bell, Regional Representatives

Waikato District Council held a community meeting in Port Waikato on Saturday 5 October to talk to the community about coastal erosion on the Sunset Beach coast.

A huge turnout, about 150 people, turned up to call for some sort of protection against erosion, whether that be in the form of giant sandbags, a sea wall, or groynes.

The meeting was called after a particularly rapid bout of erosion took place during storm surges about a month ago. This caused Waikato District Council to take action with the community hall there and it has since been demolished.

Coastal scientist Jim Dahm explained to the audience that protection against erosion on the west coast was extremely difficult.

He highlighted that it would be very expensive and likely to fail in an environment as dynamic as Port Waikato. He told them that while managed retreat was the least popular option in all communities he's engaged with over the years, it was the best solution for the future in Port Waikato.

Four years ago, consultants were called in to recommend a strategy for community assets in Port Waikato after the rate of erosion since 2010 had started to accelerate – their advice to Waikato District Council was also managed retreat. But now some private property on Ocean View Road is perilously close to the dune/cliff edge and the immediacy of the problem has the community very worried about their future and the future of their investments.

If the community meeting achieved anything, it was that it made it clear that the Port Waikato situation, which Mr Dahm labelled as in the top five in New Zealand in terms of the seriousness of coastal erosion there, would require a multi-agency response from central, regional and district government.

Sunset Beach (Port Waikato) coastal erosion (Photos: Waikato District Council).

Bay of Plenty

Jonathan Clarke, Kieran Miller and Josie Crawshaw, Regional Representatives

Kaituna River re-diversion

The Kaituna River re-diversion project is getting close to completion. Construction started in June 2018, and is scheduled for completion this summer (2019/20). As of September 2019 the project is 80% complete, with over 42,750 worker hours completed

The Kaituna River re-diversion project (Graphic: BOPRC)

so far. The main earthworks are complete and culvert gate testing is underway (see photo). Recent actions include the completion of the salinity block, creation of a new diversion channel, deepening the river loop, and the construction of new boat moorings. The Te Pa Ika wetland construction has been completed and a large planting programme is now underway.

Fifteen kilometres of Tauranga's coastline to have tsunami sirens within two years

Tauranga City Council will install sirens with voice-over capability along the coastline from near Mount Maunganui Primary School to Papamoa East, covering approximately 15 km with 10 to 12 sirens. The communities along this stretch of coastline are those in the highest flood (inundation) risk zone from a tsunami compared with other coastal areas of Tauranga.

The project will be rolled out in two stages. For stage one, council approved the installation of six to eight voice-over sirens along the Omanu – Papamoa coast down to Wairakei, which is approximately a 12 km stretch of coast. This strip has the widest tsunami inundation areas, the furthest to travel to safe areas, and contains the largest population. Stage two will add sirens along the 3 km from Mount Maunganui Primary School to Omanu. This area has a large daytime population, including schools.

Planning for the final location of each siren is already underway and their installation will be completed before the end of 2021. Sirens with voice-over capability are more effective than those with alerting tones only as voice messages are able to help drive actions and reduce confusion. Once the sirens are in place, council will launch a community campaign, including testing, so that everyone knows what to expect and what to do when they hear the sirens. Further work needs to be done to understand whether additional siren sites are required for the remaining tsunami hazard areas in Tauranga, including Mount North, Matua, and Welcome Bay. This assessment would allow for further budget consideration in council's next long-term plan.

Draft coastal structures policy adopted for consultation

In August, Tauranga City Council's Policy Committee adopted a draft Coastal Structures Policy for public consultation later this year. The role of this policy is to guide decisions on how council manages and maintains public coastal structures (e.g. seawalls, jetties, wharves and rock revetments) on public land. The policy includes criteria for determining when council will maintain or stop maintaining a structure. The policy also guides the way council prioritises the annual budget to manage these structures.

The proposed changes will help prioritise attention to the coastal structures that protect from erosion (like seawalls), and give less priority to structures built for recreational purposes (like jetties). The draft policy focuses on protecting three waters infrastructure (water supply, wastewater and stormwater), essential transportation infrastructure, and public access to the coast.

Inner harbour inundation study outcomes

Tauranga City Council continues to invest in mapping and planning for natural hazards on behalf of the community. In mid-August, council released a new set of data and updated maps that illustrate the potential inundation levels for low-lying areas around the Tauranga harbour. Letters were sent to the owners of approximately 5500 properties that lie within the areas identified as susceptible to inundation around the harbour.

The National Institute of Water and Atmospheric Research (NIWA) carried out this latest study on harbour inundation, which considers a range of storm events and potential sea level rise scenarios out to the year 2130. The updated information is now available at www.tauranga.govt.nz/harbourinundation – the website includes a map viewer that allows people to explore the outcomes of the modelled inundation for different locations, and consider the extent of inundation for various storm events and changes in sea level rise. Council will also use the new information when considering resource and building consent applications, and future planning processes.

Hawke's Bay

José Beyá, Regional Representative

Napier City

Hawke's Bay Regional Council (HBRC) and Napier City Council (NCC) started their yearly Westshore nourishment contract in September 2019. A total of 15,800 m^3 of gravel will be placed on a gravel embankment between the surf club and the Whakariri Ave rock revetment. Of the total volume, 13,900 m^3 are of pea metal (small gravel) and the rest river gravel from the Tutaekuri River. The construction cost of this operation is estimated at $320,000.

Figure 1: Westshore nourishment (Photo: Napier City Council).

Hawke's Bay seabed mapping

NIWA is defining key ecological areas for Hawke's Bay, combining information from the Department of Conservation (DOC) and HBRC with a Zonation software. This process will identify sites that meet criteria of ecological significance. The project will provide a robust rationale for prioritising marine environments and ensure HBRC is adequately monitoring key ecological areas.

Cape Kidnappers landslide *(update from last edition)*

The second survey has been recently completed and a final QRA (Quantitative Risk Assessment) report is expected by the end of October.

Environmental trends

The State of the Environment (SoE) reports are five-yearly updates on environmental monitoring trends. In general, coastal water quality in Hawke's Bay is within the national standards with the usual peaks in suspended sediments and nutrient levels after heavy rains in the region.

The Hawke's Bay Water Quality Information (HAWQi) buoy has records since 2012 and identified, in Hawke's Bay, the magnitude of the nation-wide marine heat wave in 2017/18. A heat wave is defined as a period of five or more days with temperatures greater than the 90th percentile for the last 30 years (see Figure 2). Heat waves are expected to increase in frequency and duration under climate change predictions with potential impacts on marine communities.

The Ahuriri estuary is high in nutrient levels and further work is needed to understand whether these levels are naturally occurring or due to human activities. The infaunal communities of several estuaries in the region are experiencing sediment stress due to an increase in muddier sediments. Sandy beach infaunal communities in the region are patchy and variable, but species assemblages have remained similar over time.

In Napier, intertidal algal cover is the lowest of all sites, at least 24% less than northern and southern sites. The invasive seaweed, *Undaria pinnatifida*, continues to thrive, but is still not present at other sites.

One promising trend is that the intertidal seagrass beds on the south coast could be recovering with steady increases since 2011 (see Figure 3). Because of the ecological importance of sea grass beds, HBRC is

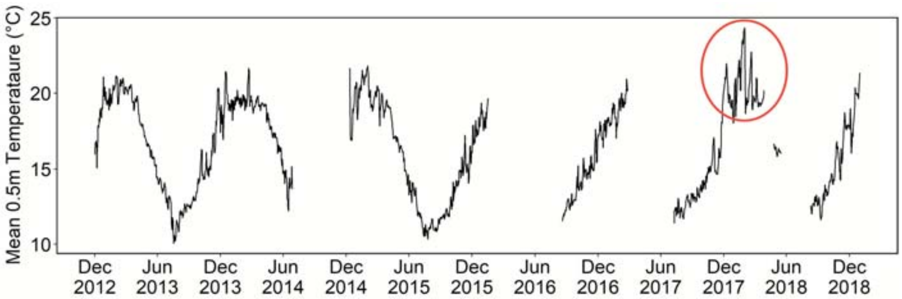


Figure 2: Surface temperature recorded by the HAWQi buoy.

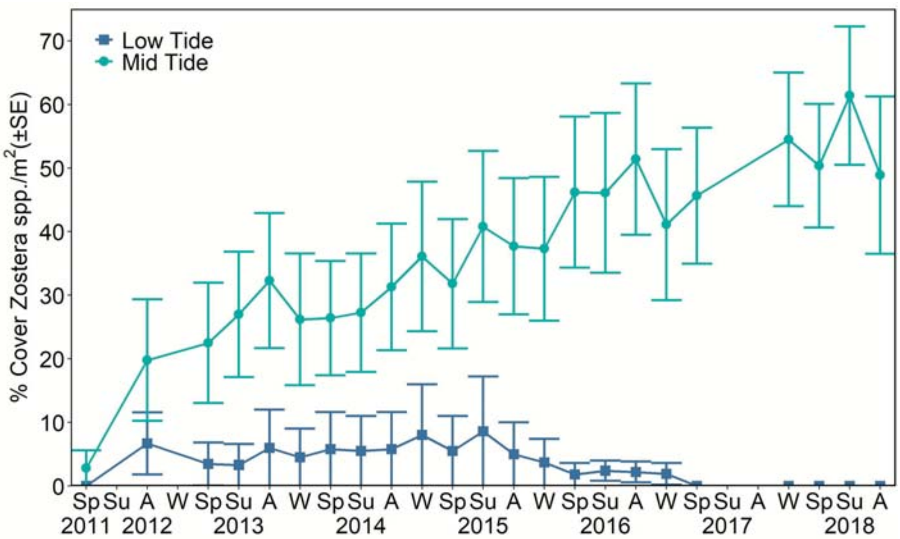


Figure 3: Zostera coverage in the southern Hawke's Bay coast.

re-evaluating their monitoring strategy to include larger areas.

Pollution response

An old dumping ground at Clifton motorcamp has been uncovered by coastal erosion. Tree trunks and demolition debris, including asbestos and vehicle wrecks, are part of what is believed to be a post-1931 earthquake infill in an area that has experienced nearly 30 m of coastal erosion since the 1970s (see Figure 4). A coastal clean-up is being organised by HBRC.

Figure 4: Old dumping ground uncovered by erosion at Clifton motorcamp (Photo: Napier City Council).

NIWA mapping Clive Hard *(update from last edition)*

The Clive Hard mapping area suffered a delay due to instrument issues. The mapping vessel, *Ikatere*, just arrived back in Hawke's Bay in September and is finishing mapping the Clive Hard and surrounding areas.

Clifton to Tangoio 2120 Coastal Hazards Strategy *(update from last edition)*

The concept design of the Clifton to Tangoio 2120 Coastal Strategy – Stage 4 is planned to be completed by October 2019 with costing information from contractors still on the way. No significant progress has been made in the other workstreams. Local government elections will see a change in the Joint Committee members with the Chair Peter Bevan retiring. This is expected to result in a delay in the strategy as the new councillors familiarise themselves with the work carried out since 2014.

Port ownership *(update from last edition)*

Napier Port was listed on the New Zealand Stock Exchange on 22 August, after an IPO raised $234 million. The money raised will enable the Port to invest in its future growth, while protecting ratepayers from the costs, diversifying the Council's income streams, and maintaining majority ownership and control. The Port is currently planning the development of a new wharf, which is estimated to cost between $173 - $190 million.

Work with the community

Sustainable Coastlines has recently begun working with several Hawke's Bay groups on coastal litter surveys. Their normal cycle includes four surveys in a year. The Regional Council supports this initiative and looks forward to analysing the data. In June, as part of a week long Matariki Celebration at Waitangi Regional Park, Sustainable Coastlines supported wetland planting as part of their Love Your Water campaign. School groups right across Hawke's Bay regularly undertake restoration planting to reduce coastal erosion.

Napier Port

A Marine Cultural Health Programme is being developed by the port and mana whenua to protect, monitor and report on the cultural and ecological health of the Ahuriri marine area as the port begins plans to build a new 350 metre long wharf. The area contains taonga of cultural value for hapū and is the home of Pania Reef – a site of cultural significance as the emobodiment of the sea maiden Pania and an important site for gathering kai moana.

Napier Port plans to start its construction and dredging programme for the new wharf in February next year and complete it in 2022 so it can support customer and regional growth. As part of the project and a wider 6 Wharf Avian Management Plan, the port is developing an on-port sanctuary for the kororā or little blue penguin. The sanctuary, which is now operational , will be a protected breeding, monitoring and research centre for the kororā that nest in and around the port's sea walls (Figure 5).

The port has also recently installed three settlement plates in the inner harbour to monitor for marine pests. Other biosecurity measures in its Wharf Biosecurity Management Plan include inspecting the dredges and support vessels that will be used during the dredging programme.

Figure 5: Kororā or little blue penguin at the Napier Port rock revetment (Photo: Napier City Council).

Taranaki

Thomas McElroy, Regional Representative

The Coastal Plan review continues to proceed. Following a comprehensive consultative and engagement process, including the extra steps of consulting on the Draft Proposed Coastal Plan, the Council publicly notified its Proposed Coastal Plan on 24 February 2018. Sixty-one initial submissions were received on the Proposed Coastal Plan, with a further 25 submissions received in support or opposition of the initial submissions.

Since then a hearing of submissions has been held and, at its Ordinary meeting of 1 October 2019, the Council made its decisions and publicly notified and served notice of its decisions on 5 October 2019. Submitters will have until about 18 November 2019 in which to lodge any appeals.

In brief, through submissions, pre-hearing meetings, and the hearing, a number of small but important changes have been made to the Proposed Plan, which should ensure that the Council builds on its efforts to promote sustainable management in the coastal environment. Other changes have also been recommended to improve the readability or clarify policy intent in relation to many plan provisions.

West Coast

Don Neale, Regional Representative

Natural hazards continue to be the biggest coastal issue on the West Coast, with several locations still recovering from the impact of ex-Cyclones Fehi and Gita in 2018, and a number of storms and erosion events since then.

Operation Tidy Fox – the cleanup of the Fox River landfill incident in South Westland – was wrapped up in August after an intensive 60 days that involved over 1000 volunteers, dozens of DOC and Defence Force personnel, the equivalent of 14,500 domestic bags of rubbish collected, and a total response cost yet to be counted, but well over $1 million. Over 13 km^2 of riverbed and 64 km of coastline was cleared of all visible rubbish, but 15,000 m^3 of waste remains in the vulnerable landfill and unrecoverable volumes are buried in the river bed or lost out to sea.

At Hector township in the northern Buller, an old waste dump became more exposed by continuing beach erosion in July, and hazardous materials are a significant concern. Rockworks have been installed as an interim solution. At Hokitika, a line of rocks is being used as a temporary measure to try to arrest recent beach erosion at the northern end of the township. Also at Hokitika, work has begun on an ocean outfall for Westland Milk Products, to replace the existing Hokitika River discharge.

At Okarito village, an assessment of the effects of the 2018 ex-Cyclone Fehi by NIWA's Murray Hicks has documented the parts of the settlement that were affected and the flow directions of the wave inundation. The report proposes some solutions to mitigate future risks of storm surge events, including a stopbank set back from the active beach to help reduce and divert the flows.

In the Karamea area, the Otumahana Estuary has undergone some enormous natural changes in recent years, as the channels and outlets of the estuary and the Karamea River migrate alongshore.

Two species of critically endangered coastal lizards – the cobble skink from northern Buller and the Chesterfield skink from central Westland – continue to be bred in captivity at Auckland Zoo. The bulk of their populations were evacuated from their natural habitats by DOC staff in 2018, after they succumbed to major storms and beach erosion.

Otago

Tom Simons-Smith, Regional Representative

In August 2019, a series of storms resulted in significant dune cut-back and foreshore lowering of more than two metres along a 200 m length of Middle Beach, Dunedin.

As a result of this erosion and oversteepening of the dune, sections of capping material fell out of the dune face onto the beach. Further erosion and the progressive relaxation of the dune face posed a risk that further capping material and potentially the inland landfill could be exposed.

In response, the Dunedin City Council commissioned the installation of a temporary sand bag barrier across a 100 m section of the worst affected area. The barrier was put in place to limit the impact of wave run-up on the dune, and reduce the likelihood that building and demolition materials (capping) located in the dune face would be exposed and eroded. The sand bag option provided an opportunity to test a temporary and targeted method of protection, helping council understand the suitability of the option as a storm response. The approach also helped to avoid lock-in to longer-term protection while council and the community work together to develop a long-term plan for this valued coastline. Since the installation, favourable conditions have resulted in the complete burial of the bags.

Temporary sand bag barrier on Middle Beach (Photo: Tom Simons-Smith, DCC).

NZCS Regional Representatives

Every region has a NZCS Regional Representative who is available to help you with any queries about NZCS activities or coastal issues in your local area. If you are interested in becoming involved as a regional representative, please get in touch with Paul Klinac (paul.klinac@aucklandcouncil.govt.nz).

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Central government news

Amy Robinson, Central Government Representative

New Zealand Coastal Policy Statement effectiveness review

In 2016 and 2017 the Department of Conservation (DOC) carried out a review of the effectiveness of the New Zealand Coastal Policy Statement 2010 (the NZCPS 2010) on RMA decision making. The two reports on this review are available online:

- Part 1 – Overview and key findings (https://www.doc.govt.nz/Documents/conservation/marine-and-coastal/coastal-management/review-of-effect-of-nzcps-2010-on-rma-part-one.pdf)
- Part 2 – Background information (https://www.doc.govt.nz/Documents/conservation/marine-and-coastal/coastal-management/review-of-effect-of-nzcps-2010-on-rma-part-two.pdf).

Following consideration of the effectiveness review reports, the Minister of Conservation decided that there would be no changes made to the NZCPS 2010 and requested that DOC focus on improving the implementation of the NZCPS 2010 through the development of implementation guidance for councils.

New Zealand Coastal Policy Statement guidance

The roll out of the guidance for the NZCPS 2010 is now complete. DOC worked with the regional councils' Coastal Special Interest Group (CSIG), the Ministry for the Environment, the Ministry for Primary Industries, and other agencies to produce guidance on the policies contained in the NZCPS 2010. The guidance can be viewed at: https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/

The new guidance that has been completed since the last *Coastal News* article on the NZCPS 2010 is Policy 12 Harmful aquatic organisms (https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/policy-12.pdf).

There is now a full set of guidance on DOC's website at www.doc.govt.nz (see the above link). The guidance for NZCPS 2010 policies 13 (Preservation of natural character) and 15 (Natural features and natural landscapes) was last reviewed in 2013 and is currently being refreshed in light of the implementation experience following the *King Salmon* Environment Court case and guidance being developed by the New Zealand Institute of Landscape Architects.

For further information, contact Karen Bell at kbell@doc.govt.nz or 027 5570 579.

About the authors

Tom Burkitt is a Risk, Resilience, and Adaptation Consultant with WSP in New Zealand (www.wsp.com). Whilst in Singapore he worked with DHI Water & Environmental and collaborated with Surbana-Jurong on the project. He has worked in over 18 countries and is committed to helping coastal communities understand and manage the risks posed by climate change.

Rebecca Gladstone-Gallagher is a Rutherford Foundation Post-doctoral Research Fellow at the University of Auckland and specialises in marine ecology, biodiversity and ecosystem function. Her research focuses on how marine ecosystems respond to disturbances and stress created by human activities, and what makes them resilient to change.

Scott Stephens is a coastal scientist and assistant regional manager at NIWA Hamilton. He is interested in extreme-value and joint-probability modelling, and the problems of coastal inundation and sea-level rise.

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