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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Mangroves or sediments?

Why not both? Beginning on page 3, we feature two related articles – one examining the role of mangoves as ecosystem engineers, the other an update on E-SUDS, the next sedimentation super tool.

Mangroves at Paihia, Northland
(For photo credit, see page 2)

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Word from the Chair

Kia ora koutou katoa, and welcome to the final 2023 edition of *Coastal News*.

As we write this, the annual NZ Coastal Society conference in Wellington is only days away. We are really looking forward to coming together with our members and hearing what they have been up to in recent times, both on a social and professional level. Conference time is always a time of reflecting on what NZCS has achieved over the previous year. We have to admit, after an exceptionally busy year last year we have chosen to take things a little more slowly in 2023. However, there has still been plenty going on! We are preparing to initiate production of the sixth *Coastal News* Special Issue, topic to be confirmed. We are seeking ideas for a theme for this issue from our members, so if you have a particular topic area that you would like us to take a deep dive in to, please do get in touch.

Another task the committee have been focusing on is a review of the NZCS strategic direction. We recently had a valuable strategic workshop to explore this topic, facilitated by Source Consulting. One of the tasks emerging from the workshop was the need to review the Society's vision, mission and values (see here: https://www.coastalsociety.org.nz/about-us/who-is-nzcs). We are really keen to get feedback from our members on these matters and we encourage you to engage and provide feedback via our survey monkey[1] to inform

the conversation going forward. We hope to hear from you and look forward to reading your contributions. We hope that our discussions and any changes arising from these will help us to better serve you as our members as we move forward into the future.

In this issue, we have a range of interesting articles traversing research on both ecological and physical coastal processes, as well as interesting updates from the universities and from our regional representatives. Following our previous issue's focus on Cyclone Gabrielle and its impacts, which also feature in this issue, the articles in this issue cover a broad range of coastal hazards, their impacts (direct and indirect) and some possible nature-based mitigation measures. We have news about coastal monitoring initiatives from Auckland and Canterbury, and a discussion of the impacts of 'yet another 2023 storm' on the Waikato region. As we prepare for our annual conference, Joshua Sargeant provides some reflections on the recent 4th Australasian Young Coastal Scientists and Engineers Conference.

We hope you enjoy the issue!

Amy Robinson and Colin Whittaker
NZ Coastal Society Co-Chairs

1 Survey link (*see page 20 for easy access*): https://docs.google.com/forms/d/e/1FAIpQLSfejdJl6EbpV8bjBixXHKRhAL3-c_7Z4dwV5TcKM6y_0gKp9g/viewform?pli=1

About the NZCS

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's mission is to take a leading role in facilitating robust discussion and nationally-coordinated interactions to better manage and learn about our coastal and marine environment. The society currently has over 400 members based in New Zealand and overseas, 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 nzcoastalsociety@gmail.com

***Cover photo:** Mangroves at Paihia, Northland (Photo: MurielBendel (https://commons.wikimedia.org/wiki/File:Avicennia_marina_Mangrove_Paihia_1.jpg), https://creativecommons.org/licenses/by-sa/4.0/legalcode).*

Mangrove ecosystem engineers: How a mangrove forest influences intertidal flat morphology – Insights from numerical modelling

Rik Gijsman[1], Erik Horstman[1], Iain MacDonald[2] and Andrew Swales[2]

Mangrove forests are increasingly recognised as a viable 'nature-based solution' for long-term flood risk reduction and shoreline stabilisation of low-lying coasts (Temmerman et al., 2023). Next to their functioning as storm buffers, mangrove forests also provide a range of other ecosystem services to society (e.g., carbon sequestration, maintenance of biodiversity). In addition, the implementation and maintenance costs of mangroves could be substantially lower in comparison to building hard-engineering infrastructure. However, successful implementation of mangroves in coastal flood-risk reduction strategies does require a well-defined capacity to reduce flood risk (functionality) along with a predictable behaviour over time (persistence) (Gijsman et al., 2021). At present, it remains challenging to implement mangroves in coastal flood-risk reduction projects, largely because the dynamic response of mangrove systems to changing environmental conditions is not yet sufficiently understood to design flood-risk reduction projects with a reasonable level of certainty.

An important aspect of mangrove forests' capacity to reduce flood risk is that mangroves influence their physical environment and enable ecosystem development (also referred to as 'ecosystem engineering'). While submerged, the aerial roots, stems and the canopies of mangrove trees induce drag, attenuating energy from (tidal) currents and (storm) waves. Mangrove roots also reduce the susceptibility of intertidal flats to erosion by increased soil binding. These processes influence sedimentation patterns and mangrove seedling recruitment. These traits allow mangroves to enhance shoreline stability, recover from episodic storm impacts, and adapt to longer-term changes in environmental conditions, such as sea level rise.

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2 NIWA, Hamilton.

Understanding of mangrove forest functionality and persistence for coastal flood risk reduction is being advanced by research conducted over the past three years by the University of Twente (Netherlands) and NIWA. Specifically, biogeomorphological modelling has been performed, informed by a unique set of hydrodynamic, sediment transport, and morphological response data from the southern Firth of Thames (Figure 1; e.g., Swales et al., 2015, 2019; Lovett, 2017; Montgomery et al., 2018; Tablada Torres, 2020). The process-based mangrove forest dynamics model developed in the Delft3D modelling suite of Deltares includes interactions between hydrodynamics (tides and waves), sediment transport, morphodynamics, and mangrove seedling recruitment and forest development. The calibrated model predicts realistic sediment accretion patterns in the dynamic forest fringe that resemble longer-term observations (Figure 2). Sediment accretion rates that were measured during the year 2020 by acoustic surface elevation

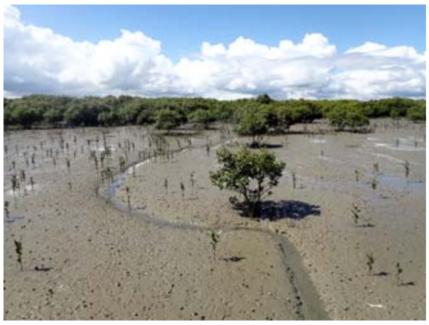

Figure 1: Firth of Thames mangrove forest fringe providing a natural mechanism to reduce energy from (storm) waves and reduce flood risk. Young mangrove seedlings have established in the area seaward of the existing forest (Photo: R Gijsman, December 2022).

dynamics (A-SED) sensors from the NIOZ Royal Netherlands Institute for Sea Research were also predicted with a good accuracy (Figure 2).

Model simulations were manipulated to isolate the impacts of the various bio-physical interactions on sediment accretion on the

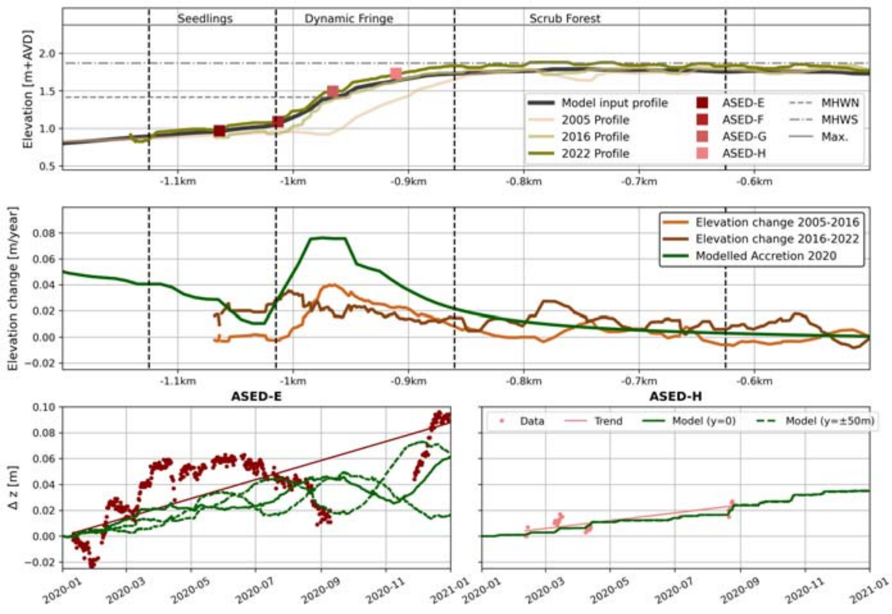

Figure 2: Observed longer-term bed level change and observed and simulated surface accretion in the Firth of Thames. The location of bed level measurements using acoustic A-SED sensors is shown in the top-most panel (adapted from Gijsman et al., under review).

upper intertidal flat. Comparing model runs with and without the presence of mangroves showed a difference in accretion rates across forest zones (i.e., from the unvegetated intertidal flat to the relict fringe forest at landward boundary, Figure 3). The mangrove forest presence resulted in increased sediment accretion in the dynamic fringe, relative to the unvegetated case, while sediment accretion rates were reduced in the areas landward (i.e., scrub and relict fringe forest) and areas seaward of the mangrove forest (seedling zone and intertidal flat). These findings support previous findings on the longer-term evolution of the characteristic platform formation and development in the Firth of Thames (Figure 2; Swales et al., 2019).

The model simulations also showed that the existing morphology of the upper intertidal area is largely responsible for the accretion of sediment in the mangrove forest dynamic fringe. The sediment is delivered to these higher elevated areas during periods when high spring tides are coupled with onshore winds and resulting sediment resuspension by waves (Swales et al., 2019). The drying of the upper intertidal flat due to its longer aerial exposure times induces enhanced bed stability and sediment accretion (Nguyen et al., 2020). The mangrove forest presence further adds to sediment accretion in two ways: (1) by inducing drag to tidal flows and waves, and (2) by further increasing the stability of the bed with below-ground roots systems. However, the contribution of the latter two processes was found to be substantially smaller than the contribution of the aerial exposure (Figure 4).

The findings of our study imply that the presence of mangrove forests may increase the morphological resilience of upper intertidal areas to erosion and sea level rise, by stimulating the development of wider vegetated upper intertidal platforms (Figure 4). This ecosystem engineering function in the upper-intertidal zone may also influence the conditions for the establishment of mangrove seedlings in the dynamic fringe and on the intertidal flat immediately seaward of the forest. The next phase of the study will consider mangrove ecosystem engineering effects on the delivery, dispersal and initial growth of mangrove seedlings, providing key insights for future management of mangrove forest ecosystems as nature-based solutions to long-term coastal flood risk reduction.

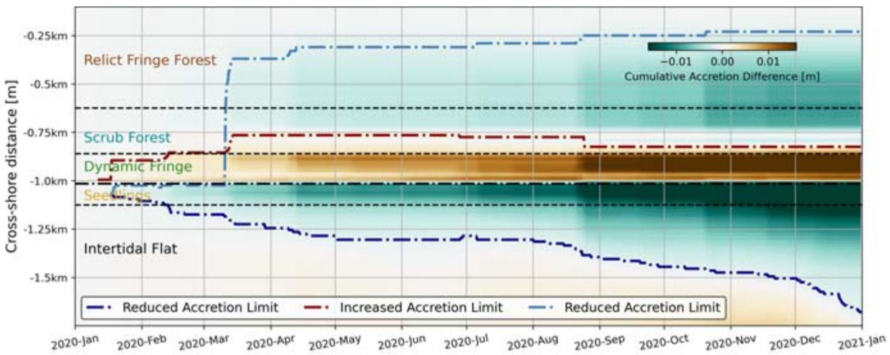

Figure 3: Surface accretion difference between the simulation with mangroves and without mangroves (adapted from Gijsman et al., under review).

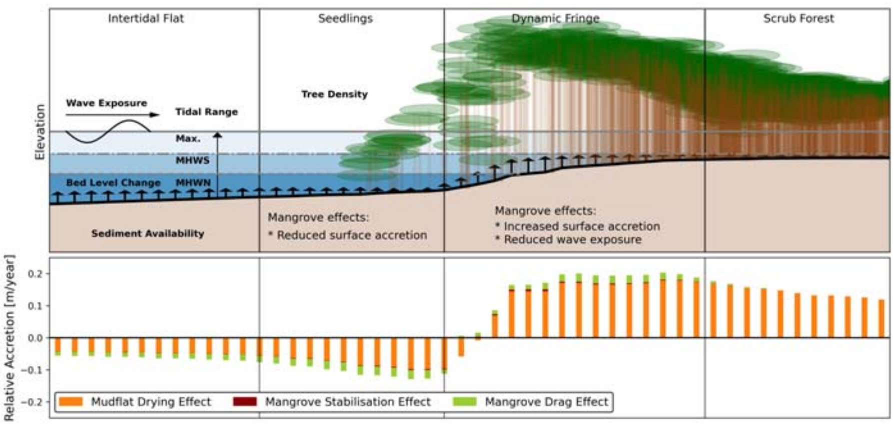

Figure 4: Mangrove ecosystem engineering effects on sediment accretion. Important processes indicated. The effects of bed stabilisation by mudflat drying, bed stabilisation by mangroves and mangrove drag are shown (Gijsman et al., under review).

Acknowledgements

This study is part of the Mangrove-RESCUE project funded by the Dutch Research Council (NWO grant 15899). The research is supported by the MBIE Strategic Science Investment Fund (NIWA Catchments to Estuaries Programme, contracts FWCE2104, FWCE2204, CECE2304).

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E-SUDS – The next sedimentation super tool

Samantha Parkes, Iain MacDonald, Richard Yates and Andrew Swales, NIWA Hamilton

The ecosystem services provided by coastal wetlands, such as saltmarshes and mangroves, play a significant role in mitigating the effects of land use activities. For example, carbon sequestration by mangroves, per unit area, substantially exceeds that of terrestrial forests (Bimrah et al., 2022; Adame et al., 2021) and their ability to act as major sinks for contemporary and legacy fine sediments eroded from the land (Swales et al., 2020).

In addition, mangroves are increasingly recognised for their ability to enhance the resilience of low-lying areas to inundation and erosion by storm surges (Montgomery et al., 2019; Gijsman et al., 2021; Temmerman et al., 2023).

Coastal wetlands are, however, being threatened by rising sea levels and their future resilience will largely depend on their capacity to accrete sediments at a rate sufficient to keep up with sea level rise (SLR). The supply of fluvial sediment from catchments to maintain coastal wetlands will be a key factor (Swales et al., 2020). Research has highlighted the transitional region between the mangrove fringe forest and mudflat as a hotspot for change and complex hydro-sediment dynamics (Mullarney et al., 2017; Lovett, 2017; Haughey, 2017).

Managing coastal wetland adaption to SLR will depend on our ability to predict how these systems will respond under a range of relative SLR and sediment supply scenarios. Future decisions will need to be guided by robust models underpinned by quantitative measurements of sediment dynamics and geomorphic response in sedimentation hotspots.

NIWA research being conducted in the southern Firth of Thames is informing model development to predict the bio-geomorphic evolution of intertidal habitats over event- to decadal-scales. The study is a collaboration with researchers from the University of Twente, Netherlands, led by Dr Erik Horstman (Mangrove-RESCUE), and Waikato Regional Council (Dr Stephen Hunt).

A key component of this work has been the arrays of acoustic sensors and cameras continuously measuring sedimentation and erosion of the tidal flat and fringing mangrove forest. Sensors include the Estuary-Surface Ultrasonic Distance Sensor (E-SUDS), developed by NIWA and making continuous measurements since late 2019. A unique capability of E-SUDs are high frequency measurements of both water levels and tidal-flat elevations (when sites are exposed) (Figure 1).

This article updates a previous *Coastal News* item introducing the E-SUDS instrument system (Eager et al., 2021). E-SUDS utilises ultra-sonic technology to measure distances from a downward-facing transducer mounted above the water surface/seabed. High-frequency measurements (6 Hz) are made at 10-minute intervals, with data telemetered to a server. The high sampling rates and solar power supply allows for continuous measurement of dynamic intertidal processes across multiple time scales (seconds to years).

Distance from the sensor to the water surface or exposed intertidal flat is calculated from ultrasonic returns from a footprint that varies in size (i.e., decimetres) with sensor height. To determine this footprint, laboratory experiments were undertaken using various sized targets (e.g., wood dowels, plywood circles of varying diameter) and mimicking different substrate types (i.e., bare sand with and without ripples, different areal densities of pneumatophores). For a sensor height of 2.1 m above the bed (as deployed in the field) we found that the acoustic footprint was closer to 10 cm in diameter. Interestingly, E-SUDS was able to detect a single 1 cm diameter dowl, protruding 10 cm above a flat sand bed.

These experiments provided confidence in the accuracy of the field measurements and the ability of the instrument to integrate measurements to remove effects of small-scale bed variations (such as pneumatophores and ripples).

E-SUDS were deployed in the southern Firth of Thames at four sites along a cross-shore transect in the upper intertidal zone. Habitats range from mudflat and through the mangrove fringe forest (Figure 2). The mudflat (Site 1) is the most dynamic environment, being exposed to waves generated by northerly winds. E-SUDS was able to accurately measure water depth and significant wave heights (Figures 3A-B, D and E) and comparison of E-SUDS data with measurements of water depth from RBR pressure sensors demonstrate strikingly similar results (Figure 3A).

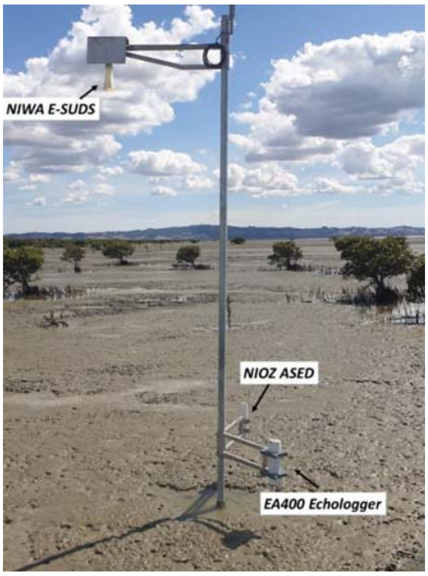

Figure 1: NIWA E-SUDS and Echologger and ASED acoustic sensors deployed on the intertidal mudflat, southern Firth of Thames.

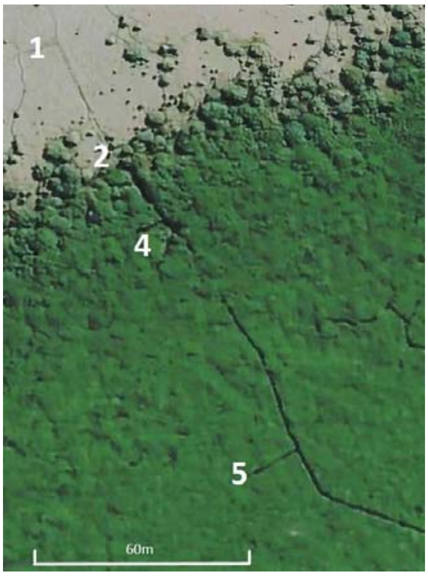

Figure 2: Location of E-SUDS in mangrove fringe forest and mudflat, Southern Firth of Thames.

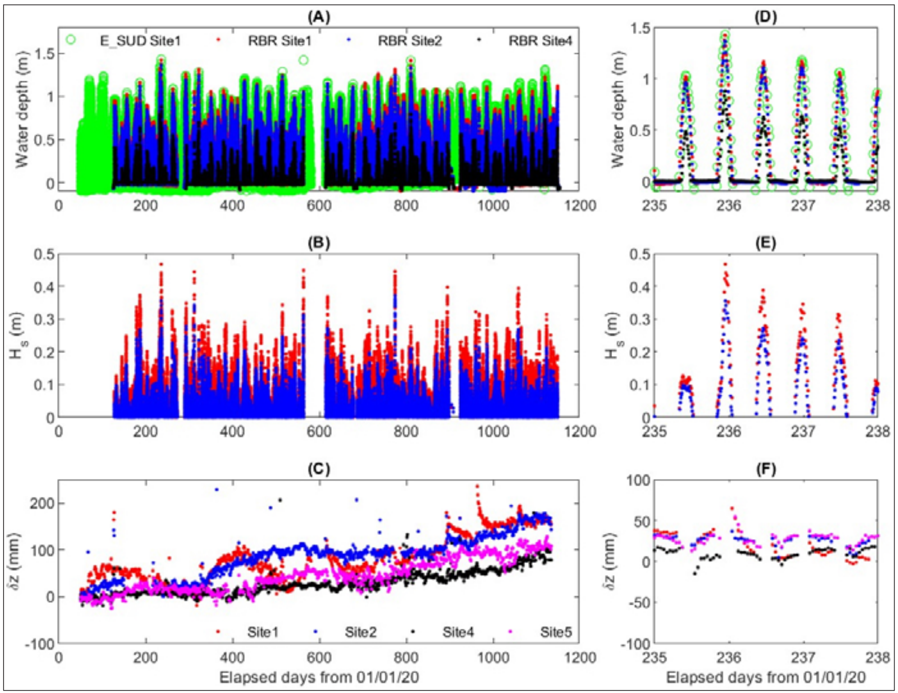

Figure 3: Three years of 12 hour averaged data showing (A) changes in water depth, (B) significant wave height, and (C) changes in vertical distance between the sensor and seabed surface. Figures 3D-F shows a zoomed in portion of the plots to demonstrate the E-SUDS ability to capture small scale events.

The E-SUDS captured seasonal and interannual cycles of mudflat accretion and erosion over the three years of continuous measurements. Net average rates of sediment accretion varied from ~6 cm/yr on the mudflat to ~3 cm/yr in the upper intertidal mangrove forest. Variability in bed level within the mangrove forest is less pronounced in comparison to the mudflat, which is consistent with a progressive reduction in sediment disturbance and sedimentation due to wave height attenuation and distance from the mudflat sediment source. The upper intertidal platform (Site 5) is only inundated by spring tides with resulting limited hydroperiod for sediment delivery and low wave exposure. This results in a less variable and lower rate of sediment accretion (Figure 3C).

Our three-year field experiment has also highlighted the capability of E-SUDS to capture small-scale morphological changes during episodic large wave events driven by strong onshore winds (Figures 3D - F). These formative events are not detected by more traditional methods of bed level monitoring, such as sediment accretion plates. As we complete these experiments, our impression is that E-SUDS can provide a cost-effective, reliable, and user-friendly tool, linking acoustic sensors and cameras, for real-time monitoring of New Zealand's estuaries.

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Marine offsetting and compensation – review, findings and recommendations

Megan Oliver[1] and Pete Wilson[2]

Development along New Zealand's coastlines often results in poor outcomes for indigenous marine habitats and biodiversity. We need to find a balance between providing for and protecting human interests along the coast, and preserving and giving resilience to the marine environment. History and experience show that with many developments in the marine environment (e.g., reclamations for marinas, ports, transport infrastructure) there is a net loss of biodiversity, and cumulative impacts on coastal habitats and ecosystem function.

This issue is exacerbated by limited guidance and evidence for the efficacy of marine offset and compensation efforts; a consequence of having limited baseline information, the complexity of interactions in the marine environment, and large gaps in our ecological knowledge of marine species, habitats, ecosystems, and related processes.

Stocktake and guidance

Following earlier articles on this topic (Allestro & Bell, *Coastal News* 76; Steer & Oliver, *Coastal News* 77), we commenced work across councils and consultancies to produce a report highlighting current knowledge and tools relating to marine mitigation, offsetting, and compensation, and identifying gaps where they exist. The aim was to drive consistency in our collective approaches to offsetting and compensation, and to ensure that key words and concepts are clearly defined so that they are used and understood with the same intent by consent applicants and decision makers.

The final report provides: (1) an overview of the policy setting for offsetting and compensation, and principles to be applied; (2) discussion on how to determine the ecological value of coastal habitats and species that may be adversely affected by a development and that may be proposed as mitigation, offsetting, and/or compensation; (3) guidance on how the quantum of offsetting or compensation might be determined in the marine environment, including limitations that may apply; and (4) examples of practical measures and case studies of offsetting and compensating for biodiversity loss in marine ecosystems. We expect this report to be available in late 2023 but want to share some of the key findings with you below.

Offsetting in the marine environment

Offsetting aims to redress the residual adverse effects after applying measures to avoid, minimise, and/or remedy (collectively 'mitigation'). If adverse effects are not able to be sufficiently mitigated, serious consideration should be given to whether it is appropriate for the project to proceed. Offsetting and compensation should be treated as a last resort to manage adverse ecological effects.

For an approach to be considered as offsetting, it must be like-for-like and result in at least no net loss. Some guidance also suggests that like-for-better or 'trading up' is a form of offsetting[3]. Trading up has the potential to provide better environmental outcomes than like-for-like and may be preferable to environmental compensation. Considering the narrow scope for offsetting in the marine environment, opportunities to improve other impacted habitats should also be explored.

As an example, if a seagrass bed within a construction area is adversely affected, another seagrass bed could be enhanced or restored nearby to an appropriate standard to achieve a no net loss and ideally a net gain in seagrass area or biomass. However, in most cases, restoring or recreating habitats will be severely restricted by our fundamental lack of information on the biophysical requirements of habitat forming species, or even their reproductive ecology. Wellington Harbour, for example, contains high value horse mussel beds, red algae (*Adamsiella*) meadows, sponge gardens, and polychaete fields, but we lack basic information on how to manage or restore them in the event they are impacted by coastal development.

Proposed offsetting methods should, therefore, have a relatively high level of confidence of success and a low risk of failure or unanticipated adverse effects. Based on our review of offsetting and compensation conducted in New Zealand, this is likely to be difficult to demonstrate as many projects are recent and lack robust monitoring results and evidence of outcomes. Is it also important to note that there are limits to offsetting and that biodiversity offsets are not appropriate in situations where biodiversity values cannot be offset to achieve at least a no net loss outcome.

Compensation in the marine environment

In many cases compensation is likely the only viable means of redressing residual adverse effects in the marine environment. We therefore suggest that the standard for compensation in the marine environment should be high. Like offsetting, compensation should be conducted as close to the affected area as possible, but existing guidance suggests it can include approaches that do not meet the requirements for offsetting (e.g., like-for-like or like-for-better). Technically, it includes all other approaches for managing residual adverse effects that are likely to result in overall positive environmental outcomes. Compensation should be designed following best-practice design principles and endeavour to achieve the highest value ecological outcomes possible. Like offsetting, compensation actions should be accompanied by robust monitoring and adaptive management.

Compensation packages could include actions such as restoring shellfish beds, creating artificial reefs, casting textures into seawalls to create habitat, installing rock pools and textured pile sleeves, or catchment-based actions to improve water quality entering the coastal marine

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2 Principal Coastal and Water Quality Scientist, SLR Consulting.

3 For example, Maseyk et al (2018), section 3.1.2.

Artificial rock pools (left) and textured sea walls (right) recently installed as part of coastal development in Wellington Harbour (Photos: Annie Graham, GWRC, left; Shelley McMurtrie, EOS Ecology, right).

environment, including treating stormwater to a high standard to remove urban contaminants.

Monitoring and adaptive management

All offsetting and compensation approaches should have measurable biodiversity outcomes and/or metrics. These should be clearly identified in a monitoring plan, including the outcomes/metric of success, how these will be measured, and an appropriate timeframe over which the success of the offsetting approach should be realised. Offsetting and compensation approaches may also require ongoing maintenance or management to ensure the estimated ecological value is realised. These should be clearly defined and include appropriate frequencies and timeframes. If an offsetting or compensation approach does not meet the outcomes or metrics of success (i.e., it is unsuccessful within the designated timeframes) it is expected that an alternative or 'back up' form of compensation is applied. These alternatives should be identified at the project outset and form part of a robust adaptive management plan.

The application of adaptive management to offsetting in the marine environment requires a staged approach. It may be appropriate to stage various offsetting and/or compensation components based on the findings from robust monitoring. For example, an offsetting approach may be implemented in a restricted form initially but done so with robust monitoring and clear objectives and timeframes in which the benefits should be realised. If the monitoring demonstrates success of the approach, it could be expanded. Alternatively, if the monitoring indicates that the approach is unsuccessful, alternative approaches forming part of an offsetting/compensation package could then be enacted.

Valuing marine habitats and quantifying loss

Perhaps the largest, and potentially most controversial, gaps in our knowledge and implementation of offsetting and compensation relate to how we value the marine environment and how we assess the quantum of loss and the quantum of offsetting or compensation required.

Determining the level of effect is dependent on the value of the species, habitats and ecosystems that could be affected by an activity and currently there are no robust tools to determine the ecological value of marine habitats. The current edition of the Ecological Institute of Australia and New Zealand's (EIANZ) *Ecological impact assessment guidelines* (EcIA; https://www.eianz.org/document/item/4447) does not include an approach for valuing marine habitats. Instead, the approach to evaluate ecological values of terrestrial and freshwater habitats found there has been informally adapted over time for use with marine habitats, but these have not been peer-reviewed and are often not applied consistently for determining the value of the habitat and, in turn, the scale of impact. Having these guidelines reviewed and expanded to include the marine environment would go a long way to ensuring consistent assessment of marine values and improving outcomes for coastal ecosystems.

Calculating the quantum of loss – be that biodiversity loss, ecosystem service loss, or some other measure – and in turn being able to determine the quantity of offsetting or compensation that should be undertaken, is a multi-faceted challenge. This process should be transparent and able to be understood and reviewed by others. In many cases, quantifying residual adverse effects, and the offset or compensation measures to manage them, has relied on 'expert judgement', which can be challenged due to a lack of transparency and a reliance on ad-hoc approaches such as a 'multiplier' (e.g., the loss of 5 m^2 of seagrass is offset by the creation of 10 m^2 nearby). Support tools to assist with quantifying offsets and compensation, such as biodiversity compensation models, are not widely used in New Zealand for the marine domain. Where biodiversity compensation models have been used in the marine context, they have typically been based on the ecological values identified using the EIANZ approach.

We desperately need additional or revised tools to quantify what is being lost and the area or habitat needed to offset or compensate for that loss where there are residual adverse effects of development.

Gaps and recommendations

Examples of offsetting or compensation implemented in New Zealand are all relatively recent and there is very little evidence of the success of the approaches used. Accordingly, outcomes for offsetting and compensation approaches must be clearly articulated and robust measures put in place to monitor progress. There should be clear objectives about what a successful outcome will look like and this should also include appropriate timeframes within which these benefits are realised. Adaptive management will be a key tool to manage the complexity and uncertainty of implementing untested methods in the marine environment and ensuring that an acceptable level of offsetting or compensation is achieved.

We need robust, reviewed and agreed upon methods for valuing marine habitats and ecosystems, and, in turn, methods for assessing the quantum of loss and the size of offsetting/compensation packages required to achieve no net loss or net gain. These could, for example, build on the EIANZ guidelines and the biodiversity compensation models variously applied to projects around the country. To be fit for purpose and more widely used and accepted, however, they will require review and co-development across agencies and sectors to ensure rigour, uptake and consistent application.

Summary

Key points to note from this work are:

- Most efforts to address residual adverse effects in the marine environment will result in compensation rather than offsetting.
- The standard for compensation in the marine environment should consequently be high and focus on high-quality environmental compensation outcomes.
- Offsetting and compensation packages should be designed in consultation with local communities, mana whenua and technical experts, be strategic, and indicate a high likelihood of success.
- Where information is limited, compensation might include funding relevant marine research, but this should not be more than 20% of the total package.
- Offsetting and compensation efforts must include robust monitoring and clear measures of success.
- An adaptive management approach should be adopted and a 'backup plan' in place if monitoring metrics are not achieved within specified timeframes.
- Monitoring and results of offsetting and compensation efforts should be widely reported to ensure that practioners can share in and improve outcomes for marine species, habitats, and ecosystems.

Key next steps to advance this work and address gaps include:

- Seek urgent peer review and expansion of the EIANZ guidelines to include valuing marine habitats.
- Consider more targeted methods for calculating the metrics and quantum of loss from coastal development and the subsequent quantum of offsetting or compensation required to address lost biodiversity, ecosystem services and function.

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C-SIG Species Keys – Coastal Taxonomic Resource Tool

Sadie Mills, Principal Technician - Marine Biology, NIWA

A new web-based taxonomic resource tool has been developed to support nationally consistent identification of soft sediment estuarine and coastal benthic macroinvertebrates across Aotearoa. A collection of six keys, images and identification resources are now available via the Regional Council Coastal Special Interest Group (C-SIG) Species Keys - Coastal Taxonomic Resource Tool at https://specieskey.atlasmd.com

Monitoring of intertidal and shallow subtidal soft sediment coastal habitats such as estuaries is a key regional council activity, and commonplace as part of resource consent assessments and State of Environment monitoring.

The macroinvertebrates living in and on these habitats are significant contributors to coastal biodiversity and underpin ecological functioning. Their presence and abundance are used as indicators of ecosystem health and a suite of macroinvertebrate population and community metrics are used to assess the state of soft sediment habitats, monitor for changes over time, inform decision makers and determine management responses.

The importance of providing correct and consistent identification of the macroinvertebrates occurring in these habitats nationwide is critical to determining overall ecosystem health.

What's in the tool?

The six keys currently available in the tool assist with the identification of over 200 species in the groups:

- Amphipoda – 40 species
- Cumacea – 3 species, 8 families
- Isopoda – 24 species
- Decapoda (crabs and shrimp) – 8 species
- Annelida – 84 species, 20 families/subfamilies
- Mollusca – 74 species.

Information sheets are provided for each species with taxonomic and ecological

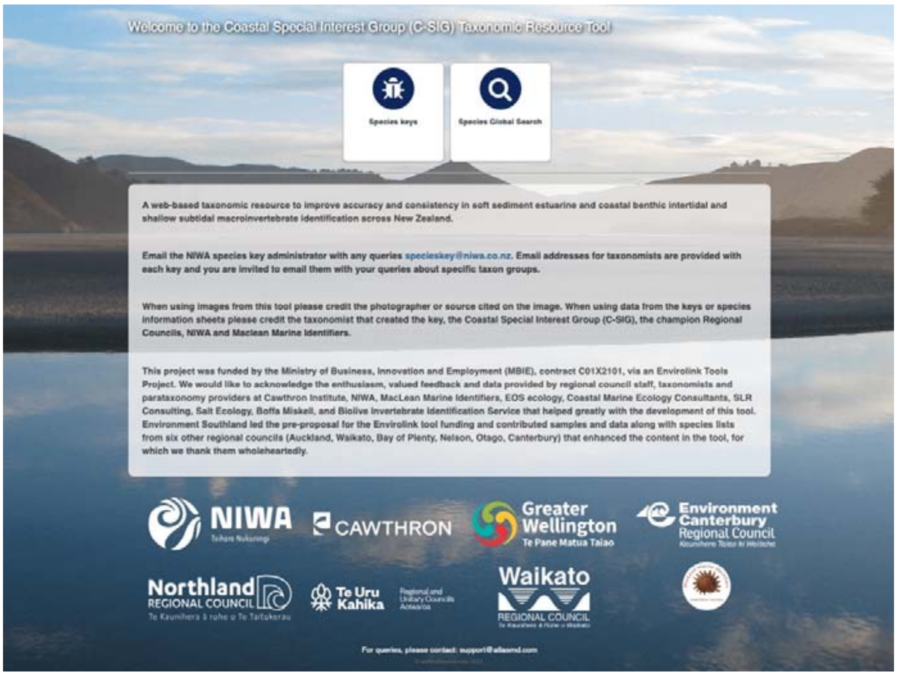

Figure 1: Screenshot of the public user welcome page for the CSIF Species key tool at https://specieskey.atlasmd.com (Credit: C-SIG Species Key tool).

information and these will be updated over time as more information becomes available.

New users are invited to self-register for a public access account at the link provided. Regional council service providers can also register using the link provided and will be given access to additional tools upon verification.

Additional tools for verified regional council parataxonomy providers put providers in touch with taxonomic experts to have voucher specimens and images verified. Verified images submitted via the tool can then be used to enhance the information available in the tool for everyone in the community when updates are made.

Guidelines on the identification of macroinvertebrates are also available through the tool to help users to get themselves set up to provide regional council taxonomic services.

Collaboration and co-development

The C-SIG Species key tool was developed by NIWA in collaboration with Atlas Meanwhile Ltd. The population of the tool with taxonomic and ecological data, images, and maps, and building of the keys was funded from an MBIE funded Envirolink Tool

Figure 2: Macroinvertebrates collected from soft sediment habitats in Wellington Harbour during state of environment monitoring for Greater Wellington Regional Council (Photos: NIWA).

project. The project team developing the taxonomic keys included taxonomists from NIWA, Te Papa Tongarewa (National Museum of New Zealand), and parataxonomists and marine ecologists from NIWA and MacLean Marine Identifiers Ltd. Greater Wellington, Environment Canterbury, Waikato and Northland Regional Councils championed the tool, Environment Southland led the pre-proposal for the Envirolink tool funding and regional council staff, taxonomists and parataxonomy providers at Cawthron Institute, NIWA, MacLean Marine Identifiers, EOS ecology, Coastal Marine Ecology Consultants, SLR Consulting, Salt Ecology, Boffa Miskell, and Biolive Invertebrate Identification Service provided valued feedback and data during tool development. Ongoing support for the tool is currently funded by the Regional Sector Holdings (RSHL) fund, which all Regional Councils contribute to.

Future projects to provide new keys and increase the number of species in existing keys are essential to keeping this tool relevant and feedback from users can help provide direction on this.

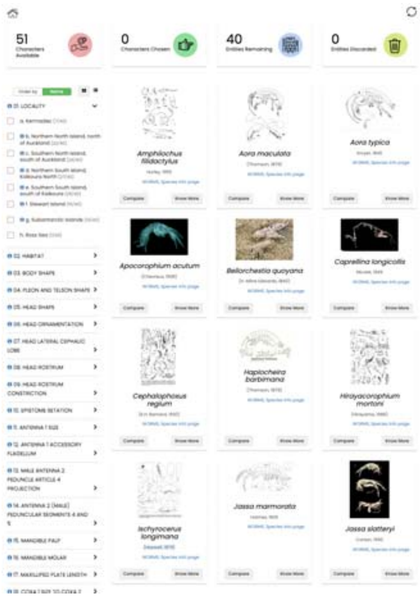

Figure 3: An Amphipod key in the tool, illustrating the characters on the left available to help narrow down selection of the species on the right (Credit: C-SIG Species Key tool).

Figure 4: A species information page available through the tool for polychaete species Terebellides narribri *(Credit: C-SIG Species Key tool).*

Please direct any enquiries you might have about the tool to specieskey@niwa.co.nz or check out the tool for yourself at https://specieskey.atlasmd.com

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High-resolution satellites provide a glimpse into the erosional impacts of Cyclone Gabrielle

Murray Ford, School of Environment, The University of Auckland

Cyclone Gabrielle caused massive impacts along a broad swathe of the country. Much has been said about the devastation caused by landslides and flooding across much of the North Island. Along with the high winds and record rainfall came massive swells, which contributed to coastal flooding and erosion along the east coast. Gabrielle arrived late in a La Niña summer that had already seen a handful of storms impact the east coast, with several reports of erosion from storms in January from Northland and Coromandel.

As part of the Resilience to Nature's Challenges (RNC) National Science Challenge, we've been mapping coastal change around the entire country. Typically, this has involved processing thousands of historic aerial photographs from Retrolens, along with the recent collections of orthophotos available on the LINZ data service. This record now tells the story of coastal change over the last 70-80 years for much of New Zealand. While instructive in terms of telling the multidecadal story of coastal change, we had no control over the sampling interval of this record. It's an opportunistic record that wasn't designed to elucidate event-driven coastal erosion.

Even before Gabrielle had reached New Zealand, we had given some thought to how we might expand our multidecadal RNC work to include event-driven change. Immediately following Gabrielle The School of Environment at the University of Auckland stumped up some funding to quickly get to work capturing satellite imagery of coastal areas. The plan was to see if we could rapidly map coastal change at selected locations, hoping to eventually find support to map all affected regions.

The availability of high-resolution satellite imagery, those images with a spatial resolution of less than 1 m, has significantly increased over the last few years. The increased availability of satellite imagery has changed the way in which we can monitor the coast in high resolution. There are two ways in which we accessed high-resolution imagery following the storm. First, following disasters, the operators of commercial earth observation satellites typically ramp up the collection of imagery covering impacted areas, allowing us to purchase 'archival imagery' from the various providers.

We also 'tasked' a couple of providers to ensure imagery of a few locations was captured soon after the storm. Tasking comes with considerable risk as the pricing structure is dictated by how high up the tasking queue you're willing to pay and how much cloud you're prepared to accept. An image can be nearly entirely cloud-free, except for a niggly cloud sitting right over the beach you're studying, leaving us paying for an image of little use to us. Conversely, archival imagery provided us the chance to inspect images before ordering, with the downside of the availability of imagery entirely out of our hands. The mix of tasked and archival satellite imagery, along with some aerial photo surveys, has provided us with a post-storm view of the entire coast from North Cape to Cape Kidnappers. In some places, this imagery was captured as soon as two days after the storm passed. For most of the area we have cloud-free imagery within a few weeks post-Gabrielle.

We've also accessed imagery from as soon before the storm as possible. In some places, this imagery was captured only days before Gabrielle. Within weeks of the storm we'd published some pre- and post-storm coastlines on https://data.coastalchange.nz. A few months later, we got funding from MBIE-led Extreme Weather Science response to expand our analysis, with much of the post-storm shoreline now mapped.

Early results indicate that several beaches, particularly those in Northland and the Coromandel, experienced ~10 m of horizontal beach retreat as the storm surge and swell cut into the dunes. The full, regional-scale story of the impacts of Gabrielle will be evident in the coming months as we wrap up the analysis. We also hope to stretch our funding to provide an additional picture of the coast from the summer of 2023/24 to assess whether erosion is continuing.

A few valuable lessons have emerged from our work mapping coastal change using commercial satellite imagery. First, there are multiple providers, so it's best to maximize your opportunities for timely and cloud-free imagery by working with as many providers as possible. For the most part, much of the imagery is sold through web portals, with nothing more than a credit card needed. Each provider has quirks around ordering and licensing, so it's best to work through these before events unfold. Second, tasking

Matarangi, post-storm, with the pre-storm line in red (Image copyright Airbus 2023).

is risky; the rules often mean you are paying for large amounts of imagery you'll never use if you're only interested in the coast. However, based on needs and budget, tasking is a viable option to explore. Finally, high-resolution satellite imagery is not the single solution for coastal monitoring. However, when used alongside field surveys, ground-based accounts of erosion and analysis from moderate resolution (10-30 m) free imagery, it can help accurately quantify the impacts across regional scales.

A special issue of Coastal News was published in July 2023 documenting the impacts of Cyclone Gabrielle around Aotearoa. The lead article by Ben Noll and Connon Andrews discussed the intensity of Gabrielle in the context of other significant storms that have affected our country in the past, and looked at the role that our changing climate might have on the frequency and severity of storms that will occur in the future. Also included in this issue was an expanded regional news section covering the cyclone's impacts in Northland, Auckland, Waikato, Bay of Plenty and Hawke's Bay. If you missed this special issue, it can be downloaded from: https://www.coastalsociety.org.nz/assets/Uploads/files/CN-81-2023-7.pdf

Canterbury wave monitoring network

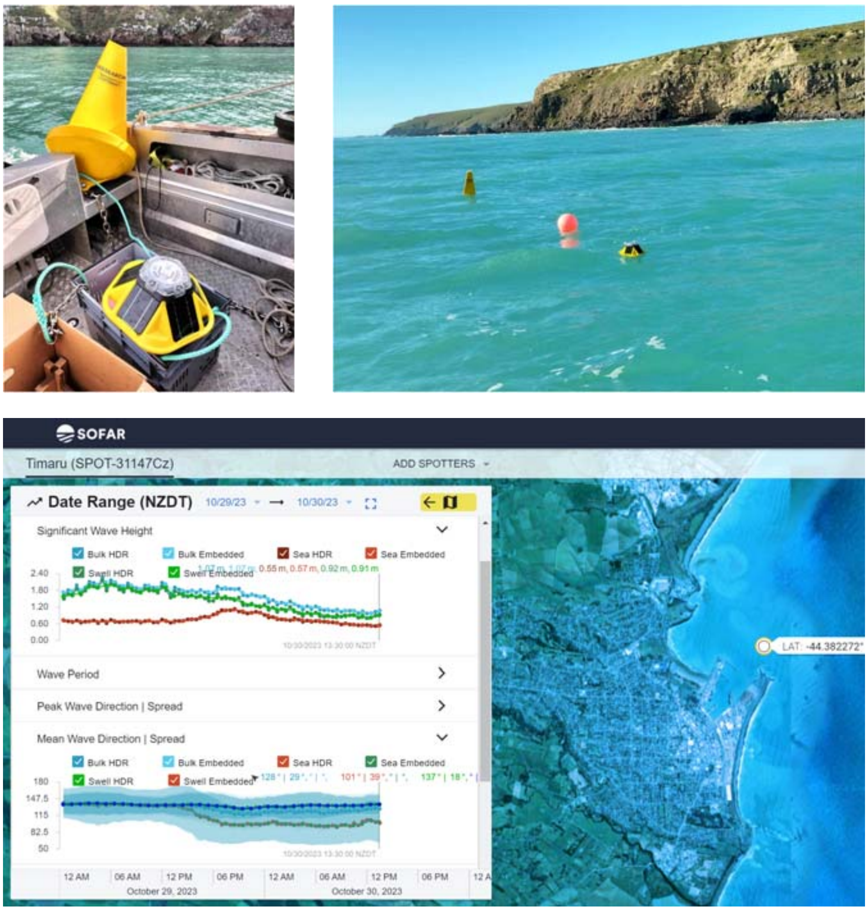
Sarah McSweeney, University of Canterbury

The University of Canterbury and Environment Canterbury are creating the first ocean wave monitoring network for Canterbury. We aim to provide free, open access data for all, which is displayed in near real time online. The goal is to have a good spatial distribution of wave monitoring around the Canterbury coast that will build towards a long-term dataset of wave and synoptic processes.

Four Sofar Spotter^{TM} directional wave buoys are being deployed offshore of Kaikoura, the Waimakariri river mouth, the Rangitata river mouth, and Timaru. In conjunction with existing buoys offshore of Banks Peninsula (Environment Canterbury) and within Timaru Port (PrimePort Timaru), our network aims to provides good coverage of wave conditions across the whole open Canterbury coastline.

Using this data, we will be able to better understand spatial variability in wave conditions, validate modelling, improve estimations of nearshore sediment transport, and directly link shoreline change to wave processes. Environment Canterbury will also find the network useful for near-real time monitoring of coastal storm events and coastal inundation warnings.

Wave data is stored on a website 'Canterbury Waves' (https://can.9o.au/) with bulk parameter data being freely available and the site is open access. As we build a record of historic data, this will be fundamental in benchmarking future changes in wave climate. Our website also displays live wave, weather, and sea surface temperature data so anyone can look up these conditions in near real time.



Photos from test deployment at Banks Peninsula (top); and data from the Timaru buoy (bottom).

In October, our first buoy was deployed offshore of Timaru Port in collaboration with PrimePort Timaru. The Port will use the data to improve understandings of long-period waves and other hydrodynamic processes. Next up is either our Waimakariri or Kaikoura deployment. Thanks to the Canterbury University technical staff for your support. This is a collaborative project and we thank the support from other regional partners and contributors for helping in deploying and promoting the network.

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University news

Mitigating wave overtopping hazards with saltmarsh grass

Joshua Bagg, PhD Candidate, University of Auckland

Extreme weather events and sea level rise are increasing the frequency and intensity of coastal hazards (Paulik et al., 2020), such as wave overtopping. This can lead to pedestrian safety risks, scour, infrastructure damage and coastal flooding (EurOtop, 2018). Hybrid solutions, which combine an engineered structure with a nature-based solution, offer the potential to manage risk and achieve greater socioeconomic and environmental benefits (Blakely et al., 2023; IPCC, 2022). However, implementation is hampered by a lack of robust and definitive design guidance (Burmeister and Pomeroy, 2021).

Blakely et al. (2023) identified that saltmarsh grass, oioi (*Apodasmia similis*), placed on the crest of coastal protection structures, may be a feasible hybrid solution to mitigate overtopping hazards. Given the difficulty to accurately represent vegetation at scale, Blakely et al. (2023) concluded that future physical model tests using live vegetation under wave overtopping conditions are fundamental for understanding the true interaction between vegetation behaviour and overtopping flow.

For this research, experiments were conducted with real, field scale oioi placed in the dam break flume located in the Fluid Mechanics Laboratory at the University of Auckland. The dam break flume has been shown to replicate field scale green-water overtopping bore flow. Oioi effectively mitigated overtopping hazards by reflecting incident volumes and reducing the maximum downstream flow depths and velocities.

When the vegetation deflected until it became submerged and streamlined in the flow (initial rows at t = 2.0 s in Figure 1), the ability to mitigate hazards was reduced. However, this deflection response prevents stem breakage, allowing the oioi to rise and face subsequent overtopping events (t = 8.0 s, Figure 1). The second research phase is to validate numerical modelling methodologies, enabling assessment of oioi across the broad parameter space of hybrid protection scenarios. The results can be used to develop preliminary design guidance.

Figure 1: Five rows of oioi deflect in response to bore flow representative of wave overtopping. In the frame at t = 0.0 s, the arrow indicates the incident flow direction, and the dimension shows the array length. For this flow condition, the first few rows deflect until submerged, while the downstream rows remain emergent. The oioi then returns to approximately its original position.

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Indirect infrastructure impacts reveal higher risk from coastal hazards

Logan Brunner, PhD Candidate, University of Canterbury

Our increasingly interdependent infrastructure systems mean that hazards could result in cascading failures, significantly increasing the impacts and their spatial distribution. Considering direct risks alone, coastal hazards in Ōtautahi Christchurch threaten as many as 3,600 homes with inundation. However, there are an additional 7,800 homes at risk from losing one or more utilities from just the 1-in-10-year event.

These numbers are more severe when considering sea-level rise and the occurrence of more extreme inundation, such as the 1-in-100-year and 1-in-1000-year events, which we are expected to see more of[1]. For example, with just 30 cm of sea-level rise (which can be expected as soon as 2050[2]), the previously mentioned numbers of directly and indirectly impacted households increase by 50%, affecting about 13% of Christchurch from this same 1-in-10-year event. While most risk assessments focus on impacts to infrastructure (and typically to a single infrastructure type), our recently published study[3] shows the broader, often underestimated indirect impacts to both residents and interdependent infrastructure.

As our network of infrastructure gets more complex due to the connected nature of our utilities, we see a higher proportion of indirect impacts following a natural hazard event. Indirect impacts are the loss of utilities or loss of access, which isn't always fully understood or quantified in risk assessments. For example, while we have previously known how many electrical substations have lost power due to an inundation event, we typically haven't quantified the number of water pumps that have lost service due to the substation outage or how many residents have lost water due to the pump outage. This shows how failures 'cascade' through the various infrastructure, affecting our communities.

To assess indirect impacts, we created a network model/digital twin of the interdependent infrastructure. By shocking the system with different hazard scenarios, we model the exposure and vulnerability of each asset based on their fragility. Any impact then cascades through the connected infrastructure, ultimately affecting downstream properties. To assess future impacts from climate change scenarios, the model has been designed with the ability to iterate through various hazard scenarios, such as coastal inundation Average Recurrence Interval (ARI) and increments of sea-level rise.

We have been able to apply this computational model to understand the potential impacts on Ōtautahi Christchurch from coastal inundation scenarios (funded by the Deep South Challenge[4]) on three utility networks: electricity, water, and wastewater. Ōtautahi is particularly susceptible to coastal inundation due to its low-lying areas and the presence of two rivers flowing to the ocean. Additionally, it is a large enough city to demonstrate the model's granularity, which can analyse household-level impacts.

After running the model, we get a clear understanding of the impacts on each infrastructure type, where they occur, and how they're distributed across the population. The 10-year ARI coastal inundation event with no sea-level rise is shown in Figure 1. The multiple colours shown in the figure indicate geographically specific vulnerabilities throughout the city; some residents lose just one utility (such as water, shown in light blue) and might be able to remain in their house following an event, while other residents lose all three utilities (shown in black) and might need to be housed elsewhere. These are in addition to the households directly inundated, which are shown in yellow. When we consider indirect risk, the total number of households affected is 216% higher than households subject to direct inundation.

This work demonstrates how we can assess direct exposure to infrastructure and residents and understand the indirect impacts from a natural hazard event. As noted, these indirect impacts can easily outweigh the direct impacts in terms of number of residents impacted and help to understand the heterogeneity of utilities available following a natural hazard event.

These results provide novel insights that can be used to inform emergency response and preparedness, adaptation planning, and building the resilience of our communities.

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2 https://www.nzherald.co.nz/nz/sea-levels-will-rise-30cm-around-nz-by-2050-new-report/VNRBO6MFWTJOD36QKSCRCP6N7A

3 Brunner et al. (2024). Understanding cascading risks through real-world interdependent urban infrastructure. *Reliability Engineering & System Safety*, 241. https://doi.org/10.1016/j.ress.2023.109653

4 https://deepsouthchallenge.co.nz/resource/extreme-coastal-flood-maps-for-aotearoa-new-zealand

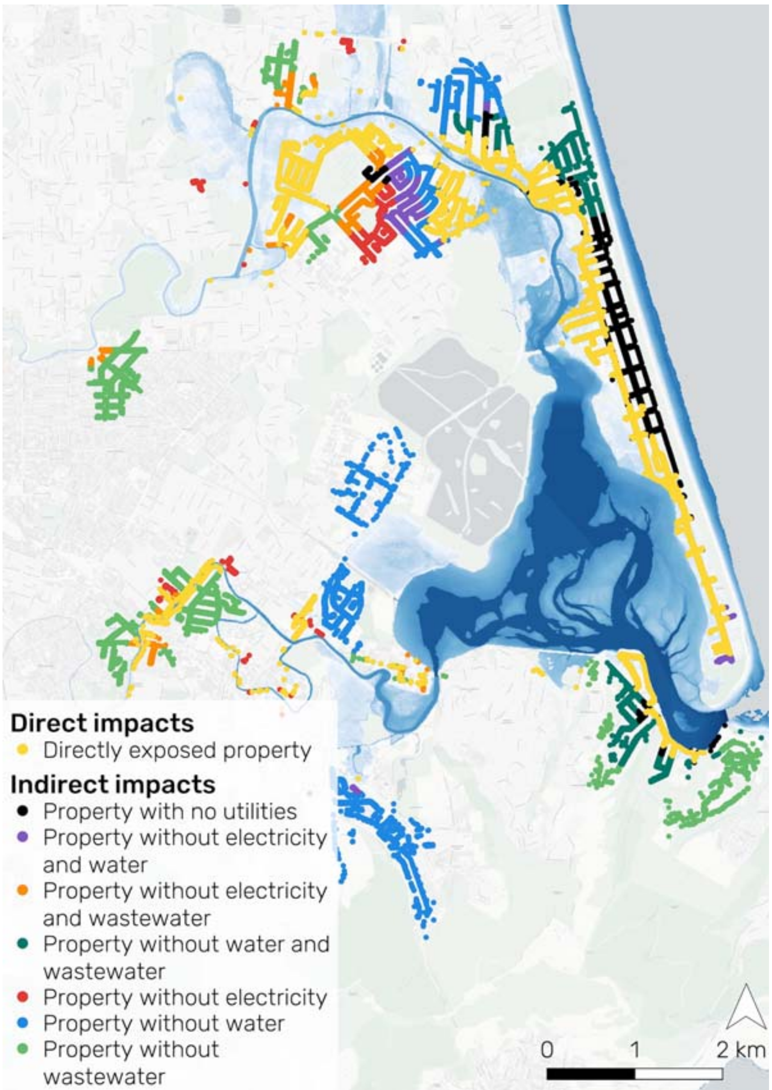

Figure 1: Exposure and indirect outages across Ōtautahi Christchurch due to a coastal inundation event with an ARI of 10 years and no sea-level rise (Brunner et al., 2024).

4th Australasian Young Coastal Scientists & Engineers Conference

Joshua Sargent (NZCS Waikato representative)

Hamilton isn't on the coast, but it's a hub for young coastal researchers! From the 6th to the 8th of September 2023, a dozen participants gathered to attend the 4th Australasian Young Coastal Scientists & Engineers Conference (AusYCSEC). Organised by the Australian Coastal Dynamics Research Network, AusYCSEC provides an opportunity for young researchers from interdisciplinary coastal fields to display their work, connect with other students, and learn from established professionals from academia, industry, and government.

For the past three years, the University of Waikato Hamilton campus has hosted the only NZ-based AusYCSEC local hub. This year's co-hosts Joshua Sargent and Emma Evenz made sure that participants felt welcome and were well fed. There were two express courses, lots of good networking, and local research collaboration possibilities were realised. In addition, three lightning talk presenters (Sanne, Alfredo, Joshua) virtually presented alongside students and early career researchers from across Australia and around the world (USA, Netherlands, Ireland, Colombia, Portugal and Norway).

More information about AusYCSEC is available on their website (https://www.ausycsec.com.au) and the full 2023 programme can be found at: https://www.ausycsec.com.au/wpcontent/uploads/2023/09/AusYCSEC23_Final_PROGRAM.pdf

Top left: Sanne Vaassen described the competition of mangroves and salt marshes in New Zealand (Photo: Joshua Sargent).

Top centre: Alfredo Jaramillo provided a brief comparison of beach profile methodologies (Photo: Joshua Sargent).

Top right: Joshua Sargent discussed a socio-hydrological model related to coastal flooding and agricultural land (Photo: Joshua Sargent).

Bottom: Group presentation (Photo: Joshua Sargent).

NZCS archive & downloads site

The NZCS website houses an extensive archive of the Society's publications from its inception, including:

- **back issues** of *Coastal News* (1996 to date) and 'hot topic' reprints of significant articles from previous issues;
- newsletter **author and article indexes** from issue 1 to date (updated yearly);
- an author's **guide to writing articles** for *Coastal News* and NZCS special publications; and
- copies of the five completed NZCS **Special publications** (published 2014-2022).

All these can be accessed at www.coastalsociety.org.nz under the 'Media>Publications' tab on the main menu.

News from the regions

Auckland

Lara Clarke, Matthew McNeil, Andrew Allison, and Eddie Beetham, Regional Representatives

Shoreline Adaptation Plans rolled out across the region

The development of Shoreline Adaptation Plans (SAPs) continues to be rolled out across the Auckland Region. The SAPs aim to plan for the future of council-owned land and assets across the Auckland Region's coastal areas in response to the impacts of coastal processes, climate change, erosion and flooding.

The Manukau South and Awhitu SAPs have been recently approved by the governing body, and the next three areas are 70% completed.

Storm response funding will enable an acceleration of the SAP programme over 2024.

Coastal monitoring

The Auckland Council is currently developing a significantly improved coastal monitoring programme. This includes the recent deployment of wave buoys off the open west coast and in the Hauraki Gulf, fixed beach monitoring cameras at Takapuna and Orewa, and a new tide gauge at Maraetai. Installation of further such monitoring instruments is planned.

The deployment of the wave buoys and further tide gauges will enable real time and hindcast wave and water level data, and an improved understanding of Auckland's wave climate.

The fixed beach monitoring cameras take images every 30 minutes, enabling improved monitoring of beach dynamics, and provide insights to support medium- and longer-term trend analysis.

Further, these instruments will assist in better understanding the magnitude, characteristics, and impacts of individual storm events. Improved local wave climate and extreme water level knowledge will also help inform future planning design criteria for coastal assets and shoreline response, as well as short-term operational management of beaches.

Figure 1: Wave buoys deployed off Bethells Beach (west coast), and in the Hauraki Gulf.

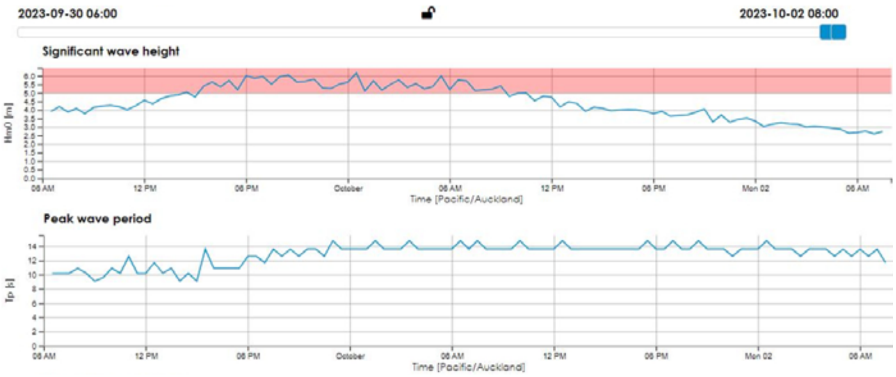

Figure 2: Wave data captured by the Te Henga wave buoy (positioned 2 km off Bethells Beach), during a very large long period swell event.

Waikato

Jamie Boyle, William Dobbin and Joshua Sargent, Regional Representatives

Ex Tropical Storm Lola impacts

Yet another 2023 storm, however, the impacts from Ex Tropical Storm Lola were not as bad as they could have been. Whilst the Coromandel's east coast did suffer from both Cyclones Hale and Gabrielle, a quiet winter meant that the beaches recovered much better than the previous three winters. This enabled extra buffer (higher sand levels) to keep coastal erosion impacts low.

Having said that, the storm-tide reached 1.487 m MVD-53 (see the uncorrected and raw data from the gauge itself at https://waikatoregion.govt.nz/environment/envirohub/environmental-maps-and-data/station/44896/WL?dt=Level). This at the top end of all water levels since records began in 1999. The storm coincided with a spring tide, and while the wave heights weren't huge, the combined storm-tide was enough to flood locations like Tairua and Brophy's Beach (Whitianga). State Highway 25 at Brophy's Beach was closed over night due to wave overtopping and rainfall flooding

Tairua flooding (Photos: Thames-Coromandel District Council).

(including no capacity for gravity drainage during elevated water levels).

We had also recently completed over 700 m of dune restoration in southern Whangamatā. As the plants were juvenile and had not yet

Windblown sand at Whangamatā (Photo: Thames-Coromandel District Council).

grown big enough to trap sand, piles of windblown sand were evident in the adjacent private property boundaries. Not a significant impact, but enough to be a nuisance. These events do highlight the need to have a good coastal buffer to be able to effectively absorb coastal hazards and reduce the need to repair and maintain infrastructure and assets into the future.

Canterbury

Kate MacDonald and Tommaso Alestra, Regional Representatives

Coastal hazards adaptation planning programme underway

Like many councils around the motu, the Christchurch City Council is undertaking adaptation planning with communities to help prepare for rising seas. The Christchurch City Council's Coastal Hazards Adaptation Planning (CHAP) programme involves a co-creation approach with community and rūnanga representatives (a Coastal Panel), who are responsible for making adaptation recommendations to Council. Currently the CHAP programme is focused on Whakaraupō Lyttelton Harbour and Koukourarata Port Levy areas.

The Coastal Panel has identified six Priority Adaptation Locations (PALs) in Whakaraupō Lyttelton Harbour and Koukourarata Port Levy, where public assets are most vulnerable to coastal hazards. They have now drafted adaptation pathways for each PAL and will be seeking broader community input in an upcoming engagement phase from early October to early December. In addition to the pathways for each PAL, the Coastal Panel has also begun work on network-wide adaptation planning, which involves looking across the area and considering the wider risks and opportunities for long-term access around the harbour. This includes considering the role of 'access over water', as a way to support more sustainable long-term access to communities that might otherwise become isolated by rising seas.

The upcoming engagement phase will be a chance for the Coastal Panel to check in with the community and to share the work they have been doing on developing adaptation pathways. Community feedback will help the Coastal Panel to develop preferred pathways, which will be taken to Council for decision in mid/late 2024.

To find out more about this programme, see: https://ccc.govt.nz/environment/coast/adapting-to-coastal-hazards/our-coastal-hazards-adaptation-planning-programme

Christchurch coastal pathway completed

After years of planning and work, Christchurch's Coastal Pathway has now been completed and is fully open, with an official opening ceremony to be held on 30 November. The pathway is a 6.5 km shared-use path along the Estuary between the Ferrymead Bridge and Scarborough Beach, Sumner. While the concept of a coastal pathway has been talked about for 50 years, it was the 2010/2011 Canterbury earthquakes that finally provided the impetus to make it a reality.

In 2011, the Christchurch Coastal Pathway Group was formed, and in October 2012 the first draft designs were put forward. Work on the first section began in the same year. Following a $9.9 m funding contribution from the Christchurch City Council in 2013, work proceeded in earnest, with the first section completed in November 2013.

Further sections were progressively opened over the next few years, culminating in completion of the final section at Monck's Bay this year. This was the project's most complicated and costly section to construct since there was little land under the cliffs, which required the path to be cantilevered over the rocky shore – while penguins nested underneath.

The pathway is already a significant recreational resource for Christchurch, on track to become the second most visited attraction in the city after the Botanic Gardens.

For more, visit the Christchurch Coastal Pathway Group at https://www.ccp.org.nz or https://www.facebook.com/christchurch.coastalpathway.

For an early user's perspective, see the Press article at: https://www.thepress.co.nz/environment/350101536/coastal-pathway-fully-open-and-delightful

Christchurch coastal pathway route showing the construction stages. The final stage has now been completed and the pathway will officially open on November 30 (Graphic: Courtesy of the Christchurch Coastal Pathway Group, https://www.ccp.org.nz).

News you might have missed

With seemingly a plethora of storm-related coastal news to digest, it's easy to overlook some of the more unusual, entertaining and sometimes uplifting stories that pop up on the web. So here's this issue's collection of the weird and wonderful aquatic-related news that might have passed you by….

Bubble curtains

Not one, but two recent stories look at the use of bubble curtains. The first is from Amsterdam, where plastic waste tossed in local canals is a major issue as it then enters the ocean. An experimental solution was to install a bubble curtain at the mouth of one canal, allowing an estimated 86% of the waste to be trapped and retrieved. For a video report on the project see: https://www.bbc.com/news/av/science-environment-66330010

Still in Europe, bubble curtains are now widely used to protect porpoises and other aquatic species from offshore wind farm construction noise. The curtains encircle the turbines as they are erected, lowering the noise to a level safe for nearby wildlife. The practice has become increasingly used as the number of offshore wind farms in Northern Europe soar. For a report on how it all works, see: https://www.bbc.com/future/article/20231106-the-big-bubble-curtains-protecting-porpoises-from-wind-farm-noise

Ocean news

Last year's Tonga volcano has obviously been widely reported on, but new research continues to provide new information. One such project features what the researchers described as an 'astonishing event', as they determined the eruption led to the fastest underwater flow ever recorded. For more, see: https://www.1news.co.nz/2023/09/08/tonga-eruption-caused-fastest-ever-underwater-flow-scientists.

Nearby, tiny Niue has unveiled a first-of-its-kind funding programme to ensure the long-term conservation of its territorial waters. The programme aims to generate funds by allowing individuals or companies to pay to protect 1 km^2 of ocean over a 20 year period. For more, see: https://www.stuff.co.nz/pou-tiaki/132986301/niue-targets-303m-to-fund-ocean-protection-plan.

The BBC recently published an in-depth article looking at the science and technology utilised by those who 'eavesdrop on the ocean'. It seems listening in to the ocean throws up more that just noise… (see https://www.bbc.com/future/article/20230815-how-undersea-sounds-help-us-understand-ocean-life).

Oceans and viruses might not strike an immediate connection, but a recent discovery 8,900 m down in the Pacific has yielded what is believed to be the deepest ever virus to be found – in this case, one with the somewhat snappy name of 'vB_HmeY_H4907'. Fortunately it seems it only infects, but doesn't kill (For more, see: https://www.indy100.com/science-tech/virus-discovered-mariana-trench-ocean).

And finally, a new theory has been proposed to explain the disappearance of the Vikings from Greenland in the mid-15th century, and the potential cause is surprisingly quite relevant to us today. To find out what it is, see: https://edition.cnn.com/2023/04/18/world/vikings-greenland-rising-sea-levels-scn/index.html.

Starfish, jellyfish and hammerheads

Those of you with young children or grandchildren might be all too familiar with SpongeBob SquarePants. If so, you might have wondered how Patrick (a starfish) has an obvious head, given that the real creature has five identical arms and no discernible head. Fortunately, new research sheds light on where exactly a starfish keeps its 'head' (see: https://edition.cnn.com/2023/11/02/world/starfish-head-body-plan-scn/index.html).

Moving to the Caribbean box jellyfish (this time minus a central brain), it seems these creatures have the surprising ability to both learn rapidly and retain new information. To find out how researchers came to this conclusion, see: https://edition.cnn.com/2023/09/22/world/jellyfish-brain-central-nervous-system-learning-scn/index.html.

Hammerhead sharks are so-named for an obvious reason, but quite how their hammers form has always been something of a mystery. However, a recent study on bonnethead sharks, the smallest hammerhead species, has yielded some clues. For more, and a link to the paper, see: https://www.indy100.com/science-tech/hammer-head-shark-embryo-study.

Regeneration

It's always good to hear positive news about ecosystems regenerating, whether planned or accidental, and three recent stories feature both kinds. Many people would not be familiar with Redonda, a small uninhabited island in the Caribbean. However, in only a few years, the island has been transformed from bare rock to a flourishing wildlife haven. The island has now been officially designated a protected area by the government of Antigua and Barbuda, with the reserve covering the island, the surrounding seagrass meadows, and coral reef. For more, see: https://www.bbc.com/news/world-latin-america-66922735.

A similar island recovery programme is nearer home, on Lady Elliot Island in Australia, this time spearheaded by one individual, rather than a government (https://www.bbc.com/travel/article/20230926-lady-elliot-island-a-paradise-island-where-you-make-a-pledge).

Turning to the accidental, the *Guardian* reports on the discovery of an explosion of marine life on abandoned oil rigs off the coast of California. However, as the rigs become redundant, there is a debate over whether they should be removed, with obvious consequences for their opportunistic residents (https://www.theguardian.com/environment/2023/oct/15/california-abandoned-offshore-oil-marine-life-fish-sanctuary).

On the lighter side

Bored Panda has helpfully collated 50 'frightening pictures' showing why we should stay well away from the ocean, though a few rivers and lakes also make the cut (https://www.boredpanda.com/deep-water-fear-thalassophobia). Meanwhile, *The Onion* reports on a 'bold new theory' about what is to be found in the world's unexplored oceans. Despite the source, the conclusions are hard to argue with... (see https://www.theonion.com/scientists-announce-that-unexplored-parts-of-ocean-prob-1850903644).

Accessing weblinks in the printed newsletter

Web links are an invaluable source of further information for readers, but in the printed version of *Coastal News* we can't include active links as we do in the pdf version.

We realise that manually copying long strings of seemingly random characters can be frustrating for readers, so for each issue we now produce a pdf file of live links – this can be found on the NZCS website at www.coastalsociety.org.nz/publications.

To make things even easier, you can access the pdf file by using the QR code to the right. The file contains every link published in each newsletter, organised by the pages where they appear, and all are active (clickable) links.

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The submission deadline for the next issue is 14 February 2024.

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.