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Abdulla Alson Athif - Improving nearshore wave predictions by incorporating spatially variable Friction

Abdulla Alson Athif*[1,2], Jeff E. Hansen [1,3,5], Paul Branson[2] , Ryan J. Lowe [1,3,4,5], Ron Hoeke[2]

[1]School of Earth Sciences, The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia
[2]Commonwealth Scientific and Industrial Research Organization (CSIRO), Oceans and Atmosphere, Aspendale, Australia
[3]Marine Energy Research Australia, 55 Proudlove Parade, Albany, Western Australia 6330, Australia
[4]Oceans Graduate School, The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia
[5]Oceans Institute, The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia
*Corresponding author: alson.athif@research.uwa.edu.au

Keywords: *Wave Modelling, Remote Sensing, SWAN, Rocky Reef*

Rocky reefs are commonly found along temperate coasts around the world. In combination with the spatial variability of rocky reefs, the uneven distribution of flora and fauna that colonize these areas leads to a range of different roughness in temperate reef systems. The hydrodynamic impact of such benthic ecosystems has been mainly studied through idealised representations of aquatic canopies in laboratory and field-based studies. However, the ability to predict how small-scale hydrodynamic interactions with individual roughness features translate over these larger ecosystem scales remains limited. Therefore, conventional wave modelling approaches rely on tuning a spatially uniform bottom friction parameter. Such approaches, however, fail to address importance of spatial heterogeneity on the accuracy of wave forecasts. This study uses an optical remote sensing framework to identify benthic zones and calibrate the bottom friction and vegetation parameters in the spectral wave models. Two methods were developed and compared to constant bottom friction 1) Friction factor that varies spatially based on spectral reflectance 2) Friction where bulk vegetation properties are varied based on spectral reflectance and friction for sandy substrate is varied based on the bathymetric roughness. The methodology has been applied for a year of wave observations at Dawesville, Australia. Our findings suggest that incorporating the spatial variability increases the skill of the model. The difference in model skill was higher for lower spatial resolutions of the wave model. These findings have direct implications for coastal management, wave energy and marine port operations seeking to increase the predictive capability of the hydrodynamics of regions with
aquatic ecosystems.

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Alfredo Jaramillo – Comparison of Beach Profile Methods According to Technical, Operational and Economic Criteria

Juan Guillermo Torres[1], Alfredo Jaramillo-Velez [1,2] *, Camilo Botero [3]

[1]GISMAC - Universidad de Antioquia, Turbo, Colombia
[2]JCDR - Massey University, Wellington, New Zealand
[3]Coastal Systems Research Group, Santa Marta, Colombia
*Corresponding alfredo.jaramillovelez.1@uni.massey.ac.nz

Keywords: *Beach profiles, Low-Cost Methods, Multicriteria comparison*

Beach profiles are useful tools to show the spatio-temporal coastal surface variability. Knowing the applicability of the different methods available for beach profile measurement is relevant both at scientific and management levels. This research carried out the comparative analysis of fifteen methods for measuring beach profiles, based on three criteria: technical, operational, and economic. The field comparison was carried out on two beaches with different characteristics and oceanographic conditions (dissipative and reflective) in the Gulf of Urabá (Colombia). The methods were classified as manual and technological, according to their nature and complexity. The total station method was used as the reference to perform the statistical analysis with the other methods since it is considered the most accurate in the scientific literature. The hierarchical analytical process technique was used to compare the fifteen methods. Initially, it was found that manual methods dominate over technological ones. The Puleo method obtained the best values in the three evaluation criteria, and the Echosounder method was the lowest. Regarding the economic factors, the manual methods continued to present a marked difference over the technological ones, with the Emery method being the most economical among all. These results reject the postulate that there is not enough data on beach profiles due to a lack of budget, since it is shown that with equipment of just a few dozen dollars, sufficiently reliable and relevant results for coastal management can be generated.

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Alysha Johnson - The Coastal Geomorphology of Norfolk Island

Alysha Johnson[1] *, Elizabeth Johnstone[2], Mark Dickson[3], Agathe Hussherr[4], Rafael C. Carvalho [1,5], Colin Woodroffe[1]

[1]University of Wollongong, Wollongong, Australia
[2]Precision Hydrographic Services, Australia
[3]University of Auckland, Auckland, New Zealand
[4]Ocean Infinity, Australia
[5]Monash University, Melbourne, Australia
*Corresponding author: amj959@uowmail.edu.au

Keywords: *Rocky Coast, Erosion, Boulder Beaches, Cliffs, Oceanic Volcano*

A geomorphic description of the Norfolk Island coastline and submarine morphology has been completed using various field, geospatial and bathymetric methods. UAV photogrammetry, high-resolution LIDAR, shallow marine LADS, rock resistance testing, and field observations have been used to compile a geomorphic map of the coastline, which is predominantly rocky, made up of cliffs interspersed with boulder beaches, shore platforms, sea caves, offshore stacks and arches. Pockets of the coastline are sandy with carbonate beaches produced by biogenic production in the south and northwest. Lithological and structural differences around the Norfolk Island coast can be attributed to variations in morphology and erosion. For example, the prominence of columnar basalt in the north of the Island is closely tied with the formation of offshore stacks (up to 48 m tall) and extensive boulder beaches at cliff bases (Figure 1). This contrasts with the Island's south, where calcareous sandy beaches have formed adjacent to the Island's coral reef. The rocky coast geomorphology of Norfolk Island, as well as the mass wasting deposits and erosional scarps, indicate the efficacy of erosion processes on oceanic volcano landscape evolution and capture a volcanic island in the gradual process of truncation. In this case, it attains evidence of erosion and truncation on Norfolk Island.

Figure 1: Columnar basalt offshore stack in front of columnar basalt and tuff cliffs and boulder beach. Photo: Cadd (2021).

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Aminath-Inan Abdul Muhsin - Using remotely sensed imagery for estimating biomass in an Irish salt marsh

Aminath-Inan Abdul Muhsin[1]*, Iris Moeller[1]
[1]Trinity College Dublin, University of Dublin, Dublin, Ireland
*Corresponding author: abdulmua@tcd.ie, moelleri@tcd.ie

Keywords: *Blue Carbon, Remote sensing, Multispectral satellite imagery, UAV Imagery, Vegetation Indices*

Blue carbon zones have substantial potential for carbon uptake and long-term storage. An estimated 9.2 megatons of carbon is stored in Irish salt marsh and seagrass habitats covering 162km2 (Cott et al., 2021). Above-ground biomass (AGB) is a key input parameter for forecast models that predict the sea level rise response of carbon content in coastal marshes (Swanson et al., 2013, cited in Guo et al., 2017). Considering the challenges and risks of field surveying, Remote sensing is essential for monitoring coastal ecosystems (Yeo et al., 2020). This research focused on comparing the accuracy of using low and medium-resolution multispectral imagery (Sentinel-2 and PlanetScope) and high-resolution Unmanned Aerial Vehicle Red-Blue-Green (UAV RGB) imagery to estimate the AGB in a lower salt marsh zone of an Atlantic salt meadow habitat, where grassy species were dominant. AGB was measured in field samples obtained from 1m2 quadrats. The precise coordinates were imported to ArcGIS Pro to generate vegetation index (VI) values. The statistical relationship between field measurements and VI values was analysed using linear models and exponential models. The results supported the superiority of UAV-RGB sensors compared to low and mediumresolution multispectral satellite sensors (Sentinel-2 and PlanetScope-derived). However, contrary to existing research, the UAV-RGB VIs showed a significant negative relationship with field measurements. The exponential decay models outperformed their linear models in significance with Excess Green Index being the best VI proxy for estimating AGB in this study. In conclusion, the heterogeneous nature and fine-scaled variations in salt marsh habitats necessitated high spatial resolution imagery to estimate the small-scale variations accurately and precisely. By establishing a better understanding of the temporal RGB profile for dominant species in the habitat and their biomass-reflectance relationship and blue carbon habitats can be effectively monitored, contributing to their conservation and management.

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Ana Paula da Silva - The Eco-Morphodynamics of the Great Barrier Reef: Past, Present and Future

Ana Paula da Silva[1]*, Thomas E. Fellowes[1], Lachlan Perris[1], Kate Whitton[1], Maria Byrne[2], Tristan Salles[1], Laura Cagigal[3], Fernando Mendez[3], Giovanni Coco[4], Ana Vila-Concejo[1]

[1]Geocoastal Research Group, School of Geosciences, The University of Sydney, NSW, Australia
[2]School of Life and Environmental Sciences, The University of Sydney, NSW, Australia
[3]Geomatics and Ocean Engineering Group. Departamento de Ciencias y Técnicas del Agua y del Medio Ambiente. Universidad de Cantabria, Santander, Spain
[4]School of Environment, University of Auckland, Auckland, New Zealand
*Corresponding ana.dasilva@sydney.edu.au

Keywords: Coral Reefs, Eco-Morphodynamics, Coastal Protection, Tropical Storms, Climate Change

The Great Barrier Reef (GBR) is facing drastic changes to its coral cover and biodiversity. Consequently, the ecosystem services provided by the GRB (e.g., coastal protection) is also changing because of the impacts of anthropogenic climate change. Increased thermal stress has led to more frequent and widespread bleaching events in the GBR. Ocean acidification is lowering reef's ability to produce carbonate, in particular on the inshore reefs. The compound effect of these and many other stressors are decreasing reef resilience and leading to the collapse of reef structures, which compromises the reef's ability for coastal protection by wave dissipation. Hence, there is an urgent need for a comprehensive assessment of past, present and future reef ecosystem services, including coastal protection, as they directly impact many coastal cities and low-lying islands worldwide. Here we aim to develop a fine-grid numerical framework to quantify the eco-morphodynamics transformations over the GBR, accounting for biotic and abiotic feedbacks, and to provide predictions of the future geomorphic state of the reefs under the IPCC scenarios to the year 2100. The first stage of this research builds on compiling literature and the last 40-years of open-access ocean and climate data to estimate the current state of the GBR, and to determine which stressors have a significant impact. In addition, a multi-scale wave and surge emulator for present climate – hindcast period - and for CMIP6 climate change projections is being developed to assess the changes in hydrodynamic stressors over the reef and the resulting impact on GBR islands and coastline. This research will then develop a classification algorithm that delivers predictions on the ability of different areas of the GBR in providing coastal protection from now until 2100. The knowledge on the eco-morphodynamic evolution developed by this research will be a ground-breaking outcome for the future management of the GBR.

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Arnold van Rooijen - Observations and modelling of wave runup reduction by salt marsh vegetation

Arnold van Rooijen[1]*, Ryan Lowe[2], Marco Ghisalberti[2]
[1]University of Western Australia, Perth, Australia
*Corresponding author: Arnold.vanRooijen@uwa.edu.au
Keywords: *coastal flooding, nature-based coastal protection, wave attenuation*

While the attenuation of waves by vegetation has been extensively studied, research on the reduction of wave runup and its components, such as wave setup, sea-swell swash, and infragravity wave swash, is scarce. In this talk I will present results from a combined laboratory and numerical investigation into the potential of emergent vegetation canopies (such as those formed by salt marsh vegetation) to reduce wave runup and its components on coastlines. The experimental results obtained in a large wave flume show a strong dependence of wave runup on the Iribarren number, while increasing the density of the vegetation canopy significantly reduced the wave runup and its components. A phase-resolving, non-hydrostatic wave model was validated using the observations and subsequently used to study wave runup reduction for a wide range of wave conditions, beach slopes and canopy densities. The effectiveness of the vegetation canopy in reducing wave runup height and its components (setup, sea-swell-band swash and infragravity-band swash) was found to be strongly dependent on the Keulegan-Carpenter number. Lastly, a simple formulation was derived that allows for runup prediction based on the offshore wave conditions and canopy density. Overall, this study provides important new insights in how emergent vegetation canopies such as those formed by salt marsh vegetation reduce wave runup and therefore play an important role in reducing coastal hazards.

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Ashvittha Santhaseelan - The Role of Clear and Effective Communication Tools in Climate Adaptation Decision-Making

Ashvittha Santhaseelan[1]*, Sian John[2], Rebecca Kruse[3]

[1]Royal HaskoningDHV, Sydney, Australia
[2]Royal HaskoningDHV, Auckland, New Zealand
[3]Auckland Council, Auckland, New Zealand
*Corresponding author: ashvittha.santhaseelan@rhdhv.com

Keywords: Climate adaptation planning, Interactive communication tools

Early engagement of the community using effective communication techniques make it possible to encourage diverse perspectives and active participation. Communication tools that are interactive and easy-to-interpret provide helpful context, increasing the likelihood of successful implementation of climate adaptation initiatives.

Auckland Council is developing a 100-year adaptive management approach in response to water-related climate change impacts. As part of the project, Royal HaskoningDHV (RHDHV) developed a package of information, tools, and methodologies to depict and assess adaptation relating to Too Much Water (TMW) events to support community engagement. The package provides guidance on adopting to TMW events and making decisions on adaptation options. A key output from which was an interactive iReport that provides webpage links, photographs, maps, schematics, and downloadable reports for in-depth information access. RHDHV conducted a thorough literature review, collaborated with international experts, and considered Mātauranga Māori (Māori knowledge and perspectives) in delivering this package.

The iReport tool can be further enhanced with features such as an interactive map viewer and community survey capabilities, promoting engagement and informed decision-making. It can also be updated with new information, ensuring ongoing relevance.

RHDHV similarly produced an iReport for community engagement for the Thames Coromandel Shoreline Management Pathways project. This project was fundamentally community lead and embodied the significance of effective communication tools and different approaches. Local communities and hapū were involved via a co-governance structure and coastal panels representing different parts of the district. This approach ensured that different opinions and values were considered in the decision-making process.

Through regular communication via the Thames-Coromandel District Council website, newsletters, fact sheets, surveys, and presentations, detailed information on community understanding of coastal hazards and consequences was collected. As a result, the values and risk appetites of locals were incorporated into the development of 138 coastal adaptation pathways tailored to each specific community.

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Athavan Rasenthiram - Exploration of Risk Assessment for the Ebro Delta of Spain

Athavan Rasenthiram[1] *
[1]Norwegian University of Science and Technology, Norway
*Corresponding author: rathavan@1995@outlook.com

Keywords: *Ebro delta, Risk, Sea level Rise, Flood, Hazard*

The Ebro Delta is a good example of how vulnerable coastal regions are to sea level rise since upstream dams significantly reduce the potential for deltaic sediment accretion by retaining a considerable amount of material. Thereby putting the priceless ecosystem at risk. It is therefore no gainsaying that the impact of climate change and sea level rise cannot be overemphasised when evaluating risk for a coastal system like the Ebro Delta since it raises the potential for harm. Thus, it is important to put this into consideration when assessing risk for the Ebro Delta. The analysis relied solely on the provided data, which may not capture a comprehensive historical record. Incorporating additional years of sea level and wave data would have enhanced the accuracy of the assessment. Additionally, the wave data utilised originated from a buoy located southeast of the study area, potentially under representing wave conditions during east and northeast storms. Using a fixed slope for the three beaches leads to nonrealistic representations of the run up and swash zone values. Moreover, assuming independence between sea level elevation and wave events may introduce uncertainties in the risk evaluation. Lastly, while the risk values were calculated based on a combination of events with a 50-year return period, further analysis exploring different return periods would provide a more comprehensive understanding of the risk dynamics. This risk assessment conducted for the northern hemi delta of the Ebro Delta, in Catalonia, examined various scenarios and horizons of mean sea level rise and incorporated extreme sea level elevations and run-up events to evaluate a potential retreat and assess the risk. The assessment focused on factors such as beach width, exposure, and vulnerability, utilizing information from Llibre Verd, CIRC (2010).

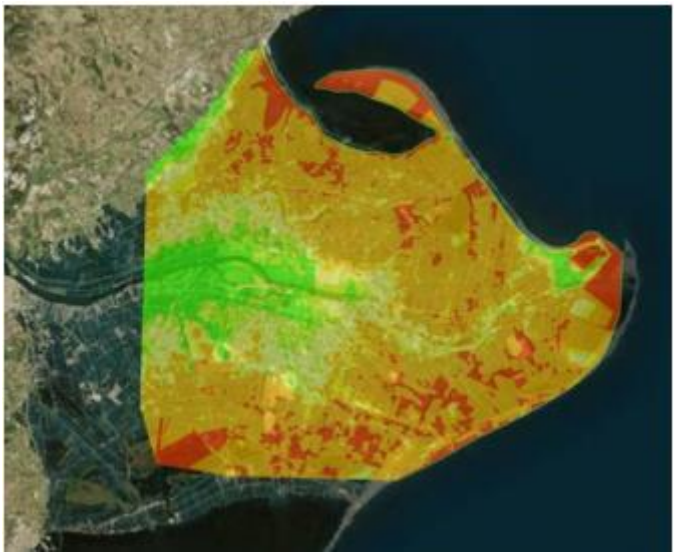

Figure 1: RCP 8.5/non-stationary Ebro Delta northern hemi delta floodplain map. 2030 horizon (red), 2100 horizon(orange), areas higher than 1.5m(green).

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Audilia Sanjaya - Lake Cathie-Innes Estuary: Integrated Catchment and Coastal Modelling for an ICOLL

Audilia Sanjaya[1]*, Luke Kidd[1], Hoan Nguyen[1]
[1]Royal HaskoningDHV, Newcastle, Australia
*Corresponding author: audi.sanjaya@rhdhv.com

Keywords: *ICOLL, numerical model, integrated catchment-coastal*

Lake Cathie-Innes Estuary is an intermittently closed and open lake and lagoon (ICOLL) located near Port Macquarie, NSW. The ICOLL's connection to the sea is dynamically shaped by complex interactions between freshwater inflow, coastal geomorphology, tidal action and waves. Recent droughts (2018-2019) resulted in the exposure of acid sulfate soils (ASS) causing acid leaching and mass iron-floc events. Royal HaskoningDHV were appointed by the local council to develop an integrated catchment and coastal hydrodynamic and water quality model to enable the assessment of potential scenarios for future management of the estuary. This presentation will describe work undertaken to develop the integrated hydrodynamic model which includes: (1) eWater Source catchment model to estimate rainfall-runoff volume from the local catchment, (2) MIKE-21 to simulate tidal and flooding hydrodynamics, (3) MIKE- SW to provide nearshore wave conditions, (4) MIKE-ST to simulate erosion, transport and deposition of sand during an entrance breakout event. The models were calibrated and validated to field measurements of water levels, currents and tidal discharge collected between April and June 2022. Results demonstrate that the flow model can represent important coastal, estuarine and fluvial processes during open (tide- dominated) and closed (rainfall-dominated) entrance conditions.

The models provide a solid foundation for future assessment of management options related to dredging, changes to hydraulic structures, mechanically-induced entrance breakout, hydraulic disconnection of Lake Innes from Cathie Creek, gradual lake drawdown during drought conditions, flooding resulting from coastal inundation (sea-level rise or storm surge conditions), and flooding resulting from rainfall events. These models also provide the framework for the upcoming development of a water quality model (MIKE-ECOLAB) to understand management implications on estuarine water quality. The project will provide valuable science and predictive tools to improve baseline process understanding and to inform optioneering and selection of management actions for the Lake Cathie-Innes estuary.

Figure 1: Lake Cathie-Innes estuary during an iron floc event.

Ben Hague - Australian coastal flooding trends, forcing factors and future projections

Ben Hague[1]*
[1]Bureau of Meteorology, Melbourne, Australia
*Corresponding author: ben.hague@bom.gov.au

Keywords: *coastal flooding, sea-level rise, astronomical tides, tide gauges*

Coastal flooding occurs when water levels are sufficiently high to impact coastal environments and infrastructure. Hence, data on water levels and impacts are required to identify and quantify coastal flood hazards. By combining new methodologies for defining impact-based coastal flood thresholds (Hague et al. 2019) and a high-quality tide gauge dataset (Hague et al. 2021), we present the results of the first national assessment of coastal flood hazards due to recent historical sea-level rise (Hague et al. 2022). The frequency of impactful coastal flooding has increased at many major Australian cities including Sydney, Melbourne, Brisbane, Adelaide, and Perth (Figure 1). We find that this increase is not because storm surges are getting larger or more frequent, but because high tides are reaching higher levels due to increased mean sea level. This demonstrates that a major shift in the processes that lead to coastal flooding is underway, because of global mean sea level rise. This shift will continue with future sea-level rise and highlights the emerging threat of chronic flooding. New perspectives on extreme sea levels are required that focus on both changes in heights and frequencies of present-day coastal extremes. We will discuss research being conducted and planned by the Bureau of Meteorology as part of the Australian Climate Service to help coastal communities make decisions to limit the impacts of coastal flood hazards now and in the future.

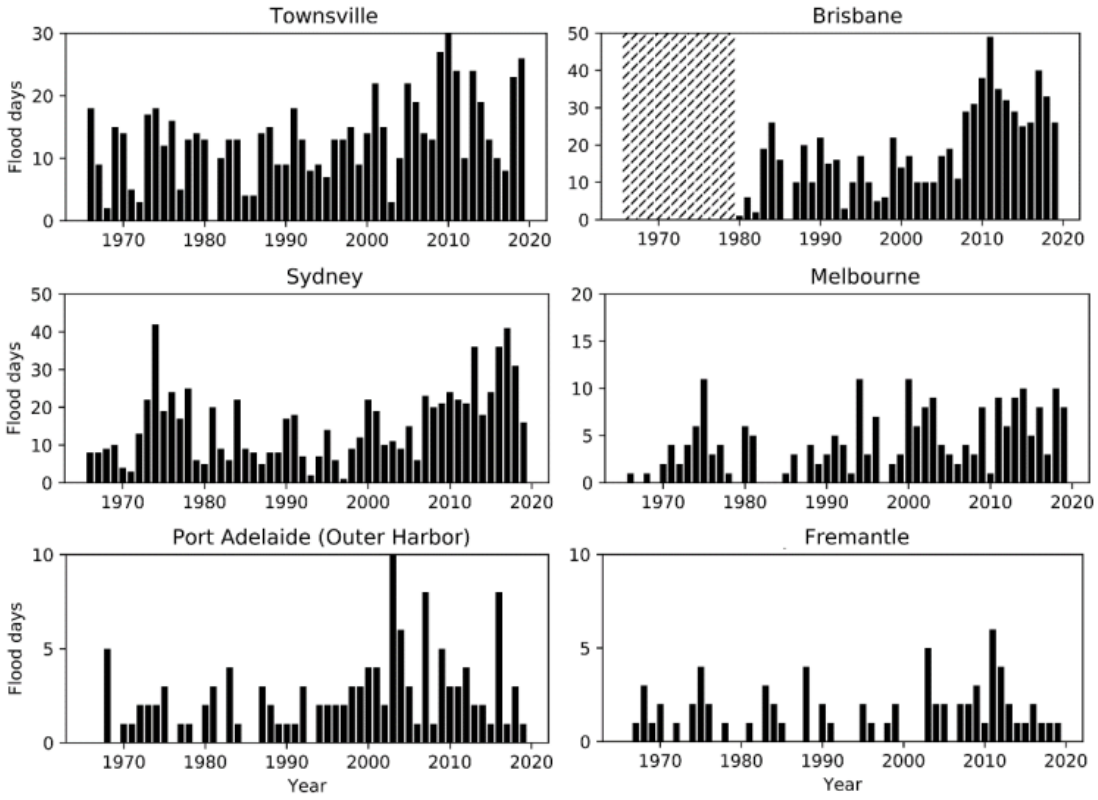

Figure 1. Observed flood days at six Australian coastal cities. Modified after Hague et al. (2022)

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Benjamin Perry - What can we learn from one-line shoreline models? Two case studies applying ShorelineS

Benjamin Perry [1,4]*, Bas Huisman[2], Dano Roelvink[3], Eddie Beetham[4], Jak McCarroll[5], Patrick Hesp[1], Graziela Miot da Silva[1]

[1]Flinders University, Adelaide, Australia;
[2]Deltares, Delft, Netherlands;
[3] IHE Delft, Delft, Netherlands;
[3]IHE Delft, Delft, Netherlands;
[4]Tonkin + Taylor, Auckland, New Zealand;
[5]Department of Energy, Environment and Climate Action, Victoria, Australia
*Corresponding author: ben.perry@flinders.edu.au

Keywords: *Shoreline, modelling, management*

Shoreline retreat can significantly impact coastal communities. Active coastal management is therefore often needed to mitigate threats to coastal infrastructure and buildings. One-line shoreline models have been used in an array of engineering applications to help with this decision making, largely to predict shoreline behaviour following the introduction of a structure or nourishment at a seasonal to multi-year timescale. This talk will provide an overview of some lessons learnt from applying the recently developed one-line model 'ShorelineS' by Roelvink et al. (2020) to two Australian case studies. The first case study is the application to Adelaide's Managed Beaches, where the model has been used to hindcast a 32-year period and assess the efficacy of the managed strategies including hard structures and beach nourishment used on this stretch of coastline. The second case study is an application at Sandringham Beach in Victoria where strong seasonal behaviour of beach rotation and long-term change is represented along a complex coastline within Port Phillip Bay.

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Billy Howitt - Living with coastal hazards now and into the future – six First Nations communities

Billy Howitt[1]*, Adam Brook[1], Marika Seden[1], Pamela Wong[1]
[1]Alluvium, Brisbane, Australia
*Corresponding author: billy.howitt@alluivum.com.au

Keywords: *First Nations, coastal management, climate change, coastal hazards*

Coastal hazards, including storm tide inundation and tidal inundation due to Sea Level Rise (SLR), have and will continue to impact coastal communities. Research highlights that climate change-related natural disasters will disproportionately affect the world's poorest countries and citizens (Hallegatte, 2016). Far North Queensland is expected to experience many climate change-related changes, including but not limited to higher temperatures, hotter and more frequent hot days, rising sea levels and more frequent sea-level extremes (DES, 2019). Some of the most vulnerable Australians at risk from current and future coastal hazards are our Indigenous Aboriginal and Torres Strait Islander peoples. Many of these First Nations peoples live in remote coastal communities, including in Far North Queensland. The first funding round of the QCoast2100 Program supported Queensland coastal councils to develop Coastal Hazard Adaptation Strategies (CHAS) that enabled the implementation of adaptation actions in their shires. The second funding round was intended to support councils serving First Nations communities that did not participate in the first round, to better understand the scope of coastal hazards and impacts on their communities by identifying potential risks to cultural, economic, and environmental assets along the coast. In 2022, six First Nations communities were visited, including Doomadgee, Lockhart River (Figure 1), Mornington Island, Kowanyama, Wujal Wujal and Palm Island. A variety of stakeholders was canvassed, including the shire council, community leaders, artists, women's groups, land and sea managers, business and landowner interests and other residents. Identifying critical cultural and community values potentially impacted by coastal hazards was the primary objective of in-community engagement. A great diversity of tangible and intangible cultural values was evidenced, all integral to more faithfully appreciating the risks associated with coastal hazards for these unique locations and communities.

Figure 1. On Country engagement with Mayor Wayne Butcher of Lockhart River Aboriginal Shire Council

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Braiya White - The Shoalhaven Foreshore Education Project: promoting best-practice dune management by foreshore residents

Braiya White[1]*, Neil Dufty[2], Chris Beadle[2], Cherie Parmenter[3], Nigel Smith[1], Michael Roberts[1]
[1]Shoalhaven City Council, Australia
[2] Water Technology Pty Ltd, Parramatta, NSW
[3] NSW Department of Planning and Environment
*Corresponding braiya.white@shoalhaven.nsw.gov.au

Keywords: *engagement, education, vegetation, collaboration, management*

Global research has found that environmental education provides a catalyst for genuine collaborative efforts between different organisations and local communities. Environmental adult education strategies can empower community members to critically evaluate environmental issues, which can result in a commitment to enhancing environmental outcomes. The Shoalhaven LGA has 165 kilometres of coastline, one of the largest coastal extents in NSW. Residents in foreshore areas regularly interact with the beach landscape, including dunes and estuary environments. In many cases, these interactions are in concert with good coastal management and include active volunteer groups e.g. Dunecare. However, there are other behaviours and actions that degrade these environmentally sensitive areas. These include constructing informal beach access tracks, cutting down or removing dune vegetation to improve visual amenity, weed incursions from garden escapes and predation on locally endemic wildlife by free-ranging companion animals.

Acknowledging the importance of engaging with local communities to promote positive and collaborative coastal management, the Shoalhaven Coastal Zone Management Plan 2018 set out actions to engage with foreshore residents on the value of dune ecosystems. From this, Shoalhaven City Council obtained funding from the NSW Government to engage Water Technology Pty Ltd to assist in developing, implementing and evaluating the Foreshore Education Project.

The project involved an interactive and experiential workshop format and the development of eleven educational factsheets. The workshops were targeted to residents from three high-risk beaches in the LGA where there is a high incidence of informal access tracks, dune vegetation vandalism and property ownership on the coastal margin. The workshops were received with varying degrees of success. This paper will discuss key lessons learnt when delivering education programs to foreshore residents. It will highlight challenges in promoting best practice coastal management where there are strong private interests and opinions, in order to achieve balanced outcomes.

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Brooke Conroy - Blue carbon contributes to climate mitigation and vertical adjustments of coasts to sea-level rise

Brooke Conroy[1], Jeffery Kelleway[1] , Sabika Maizma[2] , Gabriele Motta[2] , David Child[2] , Kerrylee Rogers[1]
[1]University of Wollongong, Wollongong, NSW
[2]Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Heights, NSW
*Corresponding author: bc715@uowmail.edu.au

Keywords: *organic matter additions, carbon sequestration, coastal wetlands*

Sea-level rise (SLR) influences organic matter and carbon sequestration in blue carbon ecosystems. Research is needed to understand coastal wetland below-ground dynamics (e.g., organic matter production/preservation, sedimentation, vertical accretion) which are important for maintaining their relative position within a tidal frame that is being modified by SLR. This study aims to (1) measure short-term additions of root mass and volume to coastal wetland substrates in southeastern Australia, and (2) quantify long-term sedimentation rates from organic and carbonate sediments in northern Australian mangrove settings. Field data analyses from Towra Point, Sydney; Westernport Bay, Victoria; and Low Isles, Great Barrier Reef, Queensland, reveal spatial variability in root productivity and organic matter accumulation across different tidal positions, vegetation communities (mangroves, saltmarsh, supratidal forests) and environmental settings. Generally, all sites indicate greater aboveground biomass (i.e., woody biomass wetlands) is associated with greater rooting depths and additions of root mass and volume. Root production variability between sites and vegetation communities indicates carbon sequestration rates are influenced by latitude and morphodynamic setting. Lead-210 analyses of sediment cores confirmed sediment accumulation varies with substrate age and vegetation structure. For example, Low Isles old growth mangrove forest (established pre-1928) reached relatively stable sediment accumulation rates ranging between 0.11–0.17 g cm2 year-1 over the past ~60 years, whereas a younger forest (established pre-1945) exhibited variable sediment accumulation rates ranging between 0.10–0.20 g cm2 year-1 over a similar timescale. Hence, coastal wetland's capacity to maintain substrate elevations with SLR is largely dependent on sediment supply, tidal positioning, and vegetation age-structure. This study informs model parameterisation and calibration indicating the vertical and lateral response of coastal wetlands to SLR. These models will facilitate the projection of organic carbon addition to substrates adapting to SLR, and model outputs will provide the required confidence needed to commence blue carbon restoration projects.

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Charlotte Uphues - Storm response of beaches in complex coastal environments featuring reefs and headlands

Charlotte Uphues[1] *, Graziela Miot da Silva[1], Arnold van Rooijen[2], Patrick Hesp[1]
[1] BEADS Laboratory, Flinders University, Adelaide, Australia
[2] Oceans Graduate School, University of Western Australia, Perth, Australia
*Corresponding author: charlotte.uphues@flinders.edu.au

Keywords: *complex morphology, high-energy wave-dominated coastlines, cross-shore beach profiles, storm erosion*

Complex coastal and nearshore features (e.g., headlands, bays, reefs) are common along South Australia's limestone coast and are known to have considerable influence on coastal hydro- and sediment dynamics and morphological changes. However, due the fact that the vast majority of studies worldwide have focused on sandy shorelines without any of these features, the influence of complex morphology on short-term storm behaviour of sandy beaches is not fully understood. Having a comprehensive understanding of hydrodynamics and morphological behaviour on a coastal area is critical for developing coastal management strategies to diminish the impact of coastal hazards due to natural and/or anthropogenic activities. This study investigates the morphological response of beaches to varying storm conditions in the high-energy wave-dominated environment around the town of Robe, SA. Robe has a rocky reef-fringed coastline and is located around a headland. To monitor the morphological response of beaches to storms, multiple cross-shore beach profiles were surveyed before and after significant storm events at five different beaches, and beach erosion volumes and extent were computed. To relate the observed profile changes to the hydrodynamic forcing, wave height, wave direction, water levels, and currents were measured using offshore and inshore wave buoys, a tide gauge, and a current meter. The combined measurements indicate that - contrary to most previous studies where wave height was found the dominant parameter - here wave direction and mean water level played a crucial role in the impact on the shoreline. This is likely due to the complex local wave dynamics due to the presence of the headland. Further work includes using a validated process-based numerical model to study sediment transport pathways under storm conditions. The study's results will not only benefit the local community of Robe but have broader implications for managing complex coastlines featuring reefs and headlands.

Figure 1: Examples of storm beach erosion at various beaches in Robe, SA

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Claire Phillips - Mapping and investigating intertidal exposure on Australian coastlines using open-source satellite data

Claire Phillips[1], Robbi Bishop-Taylor[1], Steve Sagar[1], Vanessa Newey[1]
[1]Geoscience Australia, Canberra, Australia
*Corresponding author: claire.phillips@ga.gov.au

Keywords: Intertidal, Exposure, Mapping, Dataset, Habitat

Atmospheric exposure of intertidal flats from seawater has an important influence on the distribution of habitats and species that occupy intertidal environments. Digital Earth Australia (DEA) has produced a national dataset that models intertidal exposure as part of its new suite of intertidal mapping products.

Intertidal exposure is derived from elevations that are calculated within the parent DEA intertidal dataset suite and which are reprojected against global tidal modelling. The national dataset is generated as a percentage of time exposed for three-year epochs from 2016 onwards. Custom analyses enable the selection of tailored time periods and tidal stages. Such analyses can produce models that map daytime, nighttime or seasonal exposure, coupled with specific tidally defined ranges, such as high-tide, low-tide, neap and spring.

Intertidal exposure modelling can be applied to support studies of migratory species pathways, such as seabirds, dugong and turtles by improving the mapping and reporting metrics of available occupation and foraging space in Australian coastal environments. It also supports mapping of Australian coastal ecosystems, aiding in the classification of intertidal seagrass habitats.

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Colby Lawton - Developing a strategic partnership approach to Marine Spatial Planning in Victoria

Colby Lawton[1]*
[1]Alluvium Consulting, Sydney, Australia
*Corresponding author: Colby.lawton@alluvium.com.au

Keywords: Marine Spatial Planning, policy, strategy, management, legislation

This project undertook a review of legal, governance and funding mechanisms that may support or enable a Marine Spatial Planning (MSP) process in Victoria, an analysis of case studies that demonstrate best practice approaches and synthesis of data to further advance implementation of an initial MSP process. The findings of this study offer crucial insights into the effective implementation of MSP and emphasise the importance of a partnership governance model, a long-term, iterative and strategic approach and the need to define and provide appropriate tools to MSP planning groups (Zuercher et al., 2022).

A partnership governance model is the optimal structure to enable funding and provide legitimacy to MSP. This inclusive approach empowers self-determination for First Nations groups and stakeholders. The outcomes of the MSP process must align with the objectives of relevant sectors, stakeholders and rightsholders to be successful. Participation in MSP processes can be encouraged through the prospect of building capacity to advance sectoral objectives, strengthening protections for relevant values and providing clarity and/or reducing the regulatory burden on stakeholders.

A strategic approach is enabled through a long-term, iterative MSP implementation process. Integrating MSP into relevant parallel processes and utilising/emulating existing enabling mechanisms can facilitate the development of innovative funding structures and win-win solutions for partners and relevant stakeholders.

Equipping MSP planning groups with the right tools is vital for achieving the best outcomes. These tools often require a spatial component, such as spatial overlays, to facilitate effective analysis and decision-making. Additionally, they should be supported by relevant regulatory processes and backed by regulatory authorities to ensure their credibility and acceptance.

This research underscores the importance of adopting a partnership governance model equipped with the appropriate tools to facilitate a strategic approach to implementing MSP over the long term. These conclusions can contribute to the development of effective MSP frameworks.

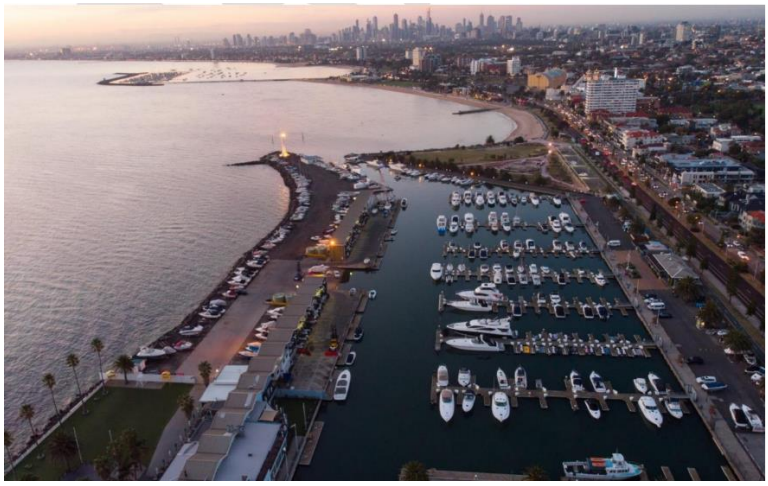

Figure 1: Picture with mixed uses of the marine space

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Courtney Smith - Offshore Wave Climate of the Great Barrer Reef

Courtney Smith[1]*, Ana Vila-Conjeco[1] , Tristan Salles[1]
[1]School of Geosciences, Geocoastal Research Group and Marine Studies Institute, The University of Sydney, Camperdown, Australia
*Corresponding CourtneySmith3223@gmail.com

Keywords: *Wave climate · Altimeter · Great Barrier Reef · Remote sensing · Tropical cyclones*

The Great Barrier Reef (GBR) is the largest coral reef system on earth, with ecological and scientific importance for the world and economic and iconic value for Australia. However, the characterisation of its offshore wave climate remains challenging because of its remoteness and large dimensions. We present a detailed analysis of the offshore wave climate of the GBR, unveiling the details of both modal conditions and extreme events. We used a calibrated satellite radar altimeter dataset (spanning from 1985 to 2018) to quantify wave climate, assess the influence of climate drivers, and analyse the wave conditions generated by tropical cyclones at three main regions of the GBR (northern, central, and southern). Our results indicate average significant wave heights of 1.6 m, 1.5 m, and 1.7 m for the northern, central, and southern GBR, respectively. The modal wave climate exhibits substantial seasonality, particularly in the northern region with dry season wave heights up to twofold larger than during wet season. The northern and central wave climates show decreasing wave height and wave energy trends over the last 33 years, whilst the southern region remains stable. Consistent with prior studies, we found that the wave climate in the southern region is modulated by the El Niño-Southern Oscillation and the Southern Annular Mode, with influence additionally extending to the central region. Analysis of the extreme waves generated by tropical cyclones revealed they generate large, long period waves, frequently above 7 m, resulting in wave power up to 32-fold higher than median conditions.

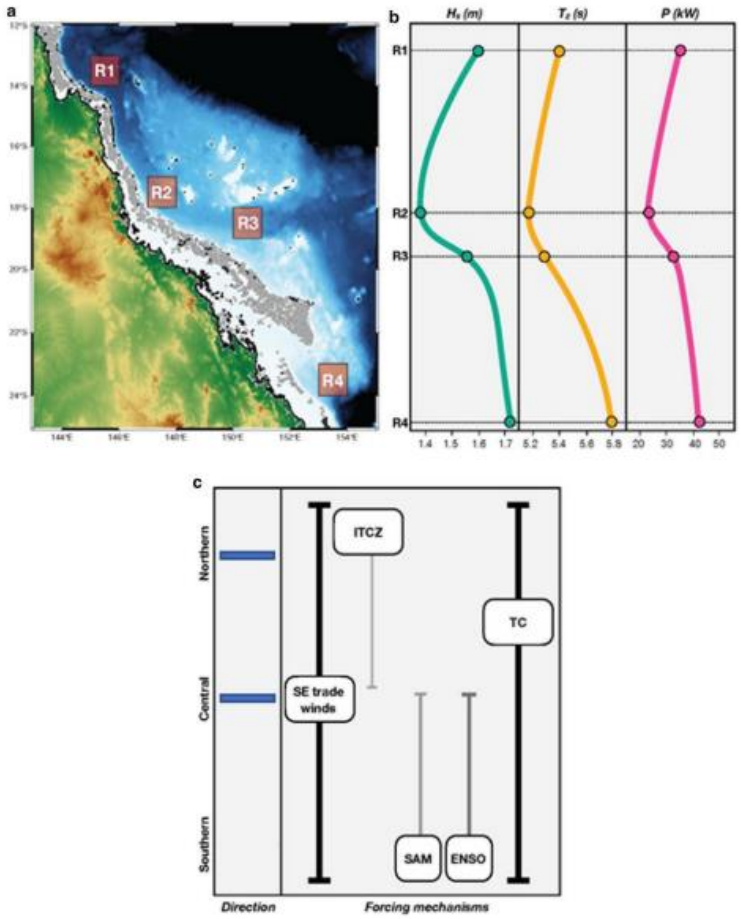

Figure 1: Wave climate variations along a latitudinal gradient in the Coral Sea, depicting changes between the three wave climate regions. a. Queensland coastline with regions 1–4. b. Changes in mean significant wave height (Hs), wave period (Tz) and wave power (P), respectively, as latitude increases, where dots indicate study sites. c. Direction of decadal trends of Hs and Tz, indicating a negative trend for the northern and central regions, and no trend for the southern region, and their corresponding forcing mechanisms. The extent of the line indicates the area of influence, and thickness indicates relative importance to overall wave climate.

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Dana Lanceman - Assessing spatio-temporal evolution of ecosystem services and values in restoring coastal ecosystems

Dana Lanceman[1,2]*, Mariana Mayer-Pinto[1], William Glamore[2,3]
[1] Centre for Marine Science, University of New South Wales, Sydney, Australia
[2] Water Research Laboratory, University of New South Wales, Sydney, Australia
[3] Restore Blue, Sydney, Australia
*Corresponding author: d.lanceman@unsw.edu.au

Keywords*: restoration, saltmarsh, mangroves, ecosystem services, connectivity*

In the 21st century, we are increasingly turning to coastal ecosystem restoration and nature-based solutions to help combat issues of climate change, biodiversity loss and coastal protection. This involves rehabilitation of diverse coastal habitats including mangroves, saltmarsh, mudflats, seagrass, kelp forests and oyster reefs. Advancements like the Australian Government's 2022 blue carbon credit scheme are allowing such projects to become more economically viable and widespread. However, there are still numerous knowledge gaps associated with restoring coastal ecosystems. While we have substantial understanding of the ecosystem services and habitat values of natural coastal ecosystems, the temporal and spatial evolution of these values, and trade-offs and synergies between values, in restoring sites is less clear. In addition, most studies focus on site-based restoration outcomes, and the role of connectivity between habitat patches and types in shaping restoration success and broader estuary health is less clear. To help fill these gaps, we explored trajectories of ecosystem service and habitat value development using a space-for-time substitution in two estuaries in eastern Australia – the Hunter estuary in Newcastle, NSW and the Maroochy estuary in the Sunshine Coast, QLD. We measured mangrove and saltmarsh functional traits as proxies for ecosystem functions and services at natural reference sites and 5 and 35 year old restoration sites to help us understand how ecosystem services such as flow attenuation and carbon sequestration evolve over time since tidal restoration. We investigated theoretically how physical, hydrological and genetic connections within and between habitat types in an estuary could influence restoration outcomes, and potential trade-offs between ecosystem services. Our next steps include quantitatively testing relationships between habitat functional traits and ecosystem services, and quantitatively assessing the role of hydrological and genetic connectivity in shaping estuarine dynamics and restoration outcomes. Our work will have far-reaching consequences for coastal ecosystem management, restoration and policy.

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Daniel M. Gilbert - The use of 2D, 3D and quasi-3D modelling for coastal applications

Daniel M. Gilbert*, Ian Coghlan
Water Research Laboratory, University of New South Wales 110 King Street, Manly Vale NSW 2093
E-mail: D.Gilbert@wrl.unsw.edu.au

Keywords: *Physical modelling, coastal structures*

Physical hydraulic modelling is an invaluable tool for understanding complex coastal processes and has informed engineers, managers and decision makers for over a century. A physical model is a scaled representation of a system so "major dominant forces acting on the system are represented in the model in correct proportion to the actual physical system" – Hughes (1993). Coastal models are typically scaled so the ratio of inertial and gravity forces is equivalent in the model and real world, however friction forces and surface tension are not scaled correctly, especially at smaller scales. Selection of scale must balance accuracy, available laboratory space and budget. For the most complex coastal processes and largest coastal structures, 3D modelling in a basin can be used, although these models generally have smaller scales (typically 1:40-1:100) and higher costs. Where incident wave fronts are parallel to a coastal structure with simple geometries, such as a representative length of rock revetment, testing one or more 2D sections in a flume can enable effective modelling at larger scales (typically 1:5-1:40) with comparatively lower costs. Finally, another option which combines the benefits of both 2D and 3D modelling is quasi-3D modelling (Q3D), where a 3D structure is constructed in a flume and is subject to uniform wave action across the width of the flume. Q3D modelling is typically conducted at scales similar to 2D modelling with smaller footprints than 3D modelling. Costs for Q3D modelling are moderate and it is a particularly useful tool for testing breakwater roundheads. This paper discusses the role of physical modelling as a tool for simulating complex conditions within the coastal environment, ultimately informing management of our coasts. The benefits and limitations of 2D, 3D and Q3D models are also discussed, presenting the recommended application of these design tools for coastal engineering challenges.

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Diana Vargas Ortega - Analysis of different formulations for drag coefficients associated with mangroves

Diana Vargas Ortega[1]*, Marco Ghisalberti[1], Arnold van Rooijen[1], Ryan Lowe[1]

[1]Oceans Graduate School, The University of Western Australia, Crawley, WA, 6009, Australia
*Corresponding author: diana.vargasortega@research.uwa.edu.au

Keywords*: mangrove's roots, nature-based solutions, wave attenuation, drag coefficient*

Mangrove forests are recognised as nature-based solutions due to their effectiveness in flow and wave attenuation, Maza (2019), as well as their provision of a wide range of valuable ecosystem services. Assessment of the capacity of flow and wave attenuation is needed for habitat restoration and conservation. One of the key mechanisms by which mangroves attenuate waves is frictional drag. Their roots and branches act as a barrier that slows down the movement of water and reduces the force of the waves. However, the understanding of mangrove-wave hydrodynamics remains limited, particularly the physical processes that govern the wave attenuation in the mangrove's root system, and by consequence, this frictional drag has not been properly quantified or modelled. Experimental studies have been carried out to quantify and predict this wave attenuation through the estimation of the drag coefficient of the mangrove forest, Kelty (2022). This has led to several empirical formulas for estimating the Cd being established as functions of Reynolds number or Keulegan-Carpenter number. This quantification of Cd is not easy in the complex mangrove's root systems because the frontal area (A) and the velocity of reference (U_{ref}) vary horizontally and vertically in these systems, which makes the choice of one velocity and area difficult. This lack of agreement in A and U_{ref} attempts to investigate the effect of the mangrove's root systems on wave attenuation to diminish the degree of uncertainty in the estimation of Cd. This work aims to understand the differences between empirical formulas for drag coefficients through different definitions of A and U_{ref}.

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Duphrin Joseph - Improving surface wave predictions using data assimilation

Duphrin Joseph[1*], Marzieh H. Derkani[1], Jeff Hansen[1]

[1]The University of Western Australia, Perth, Australia
*Corresponding author: duphrin.joseph@research.uwa.edu.au

Keywords*: data assimilation, numerical modelling, ocean waves*

Wave models have seen significant developments in the last four decades driven by advancements in both understanding of wave dynamics and computing capabilities. Nevertheless, existing wave models are impaired by errors associated with limitations in observational data, inaccuracies in initial and boundary conditions, and uncertainties in model parameterisations. Data assimilation has been proven to be highly effective in improving modelling capabilities. Through assimilation, observational data are combined with numerical models to reach the best estimate of the sea state. While a variety of assimilation methods are available, only a few of them have been previously utilised to enhance wave prediction capabilities (see, for example, Smit et al., 2021, Houghton et al., 2022 and Houghton et al., 2023). This study aims to explore the effectiveness of existing data assimilation methods and apply new assimilation methods to improve the accuracy and reliability of wave predictions.

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Dylan McLaughlin - Monitoring Coastal Changes: Which Data Suits Best?

Dylan McLaughlin[1]*, Tom Doyle[2], Emma Asbridge[1], Kerrylee Rogers[1]
[1] University of Wollongong, Wollongong, Australia
[2] NSW Department of Planning and Environment, Lidcombe, Australia
*Corresponding author: dm068@uowmail.edu.au

Keywords*: coastal data, climate change, management*

Coastal processes influence coastline morphology over a range of spatial and temporal scales. Determining the response and interaction of coastal processes to potential impacts from climate change, including modified wave climate, sediment budgets and transport, coastal inundation, and sea-level rise, is critical for managing and mitigating coastal hazards and risks. Accurately monitoring coastline morphology and assessing change requires appropriate data and analysis techniques; access to this data can limit accuracy and precision when reporting trends. In this study, the temporal and spatial suitability of datasets and technologies for monitoring coastal change was assessed. Illawarra beaches from three sediment compartments were selected based on the availability of suitable data for undertaking geospatial analyses, including aerial and terrestrial LiDAR data, photogrammetry, maps of morphodynamics, and beach profiles. Study sites included Woonona Beach in the Illawarra Coast (north) compartment, Warilla Beach in the Illawarra Coast (south) compartment and Minnamurra Beach in the Kiama Coastal compartment. Both Woonona and Warilla feature considerable anthropogenic modification, which was primarily in response to erosion or beach safety issues and Minnamurra features comparatively low disturbance. By comparing and validating the outputs from existing and emerging coastal datasets with in-situ captured data the effectiveness of coastal monitoring methods and technologies in assessing shoreline changes was quantified. This study demonstrates that limitations of current datasets could be minimised by supplementing existing records with high spatial resolution data to monitor changes at the compartment scale. A baseline strategy was developed that will improve the application of data for coastal monitoring. Recommendations from this project support coastal management in NSW and will improve decision making that enhances the resilience of coastlines to anticipated climate change impacts.

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Elisabeth Boles - Measuring coastal carbon and oxygen fluxes in coral reef environments with complex topography and waves

Elisabeth Boles[1]*, Alexy Khrizman[1], Dave Mucciarone[1], Rob Dunbar[1], Stephen Monismith[1]

[1]Stanford University, Stanford, USA
*Corresponding author: eboles@stanford.edu

Keywords*: ecosystem metabolism, eddy covariance, carbon cycling*

Coral reefs around the world are at risk due to compounding global and local stressors such as overfishing, pollution, thermal bleaching and ocean acidification (Kleypas & Yates, 2009; Anthony, 2016). It is imperative that we improve our understanding of what drives their resilience or collapse, and that we build capacity to monitor changes in reef health over time. Integrated ecosystem metrics such as Net Community Production (NCP) and Calcification (NCC) can provide valuable insights (Albright et al., 2015; Cyronak et al., 2018; Falter et al., 2012; Takeshita et al., 2016). We explore three in-situ, non-invasive measurements techniques for estimating NCP and NCC (control volume, eddy covariance and gradient flux methods) and discuss challenges and provide recommendations for deployments in complex coastal environments with waves and heterogenous benthic communities. Results will be shared from experiments performed on Lizard Island, Australia and Tabkukau Reef, Palau.

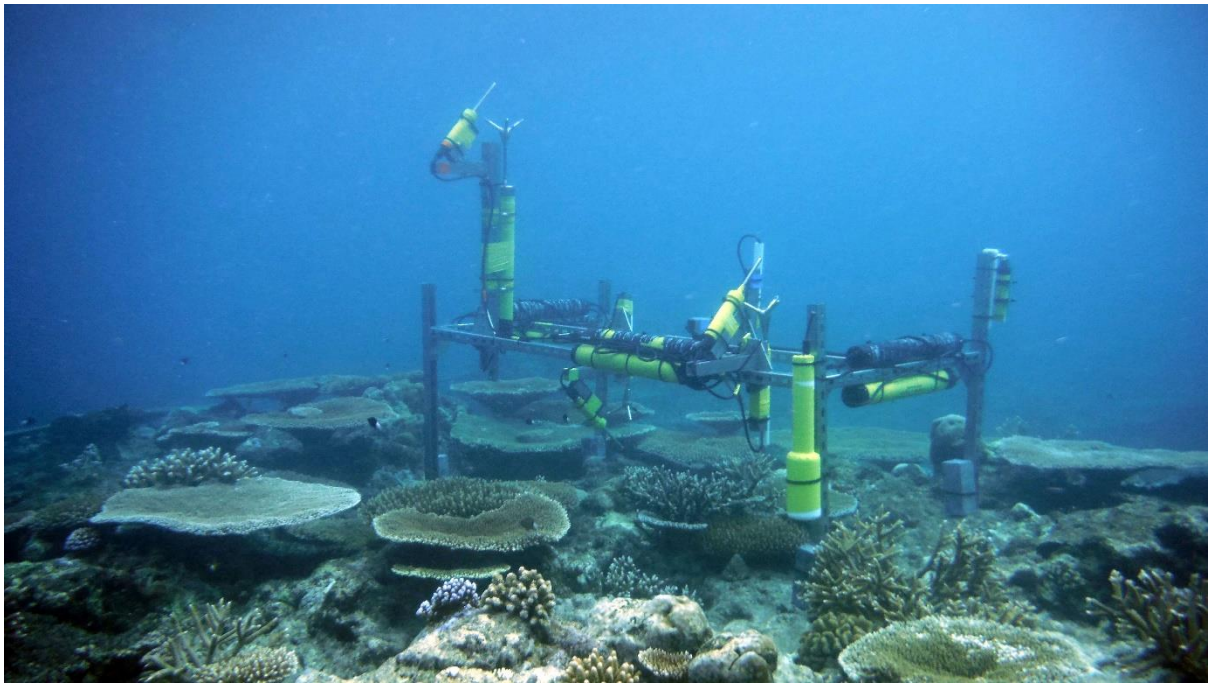

Figure 1: The eddy covariance flux frame deployment on Tabkukau Reef, Palau. Oxygen flux measurements were taken at four different heights ranging from 0.3 – 1.8 m above the coral canopy.

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Emily Lazarus - Resolving the spatiotemporal scale of cay morphodynamics on the Great Barrier Reef

Emily Lazarus* [1, 2] , A/Prof Scott Smithers[1] , Dr Stephanie Duce[1] , Dr Stephen Lewis[2]
[1]School of Earth and Environmental Sciences, James Cook University, Townsville, Australia
[2]TropWater, James Cook University, Townsville, Australia
*Corresponding author: emily.lazarus@my.jcu.edu.au

Keywords: *coral cays, morphodynamics, shoreline change*

Cays are low-lying reef islands which are formed through the complex interaction of reef hydrodynamics and carbonate sediment availability. They are high-value landforms within the Great Barrier Reef (GBR), providing habitat for nesting marine turtles and seabirds, and endemic plant species. However, cay morphodynamics over high spatiotemporal scales within the GBR are poorly understood despite their ecological significance. The Digital Shoreline Analysis System (DSAS) was used to determine cay shoreline change from monthly shorelines digitised using satellite imagery for 16 cays over a range of environmental settings within the GBR between 2015-2023. The study found that sand cays (n=11) exhibited the greatest range of overall net shoreline movement from -12.55 m (eroding) to 13.12 m (accreting) while shingle dominated cays (n=5) exhibited the least mobility from -4.43 m to 5.24 m and were predominantly eroding. Furthermore, there was little difference in the range of net shoreline movement between unvegetated and vegetated cays, suggesting that vegetation does not necessarily play a role in limiting the magnitude of cay morphodynamics. Regionally, cays within the Far North (n=2) and Mackay/Capricorn (n=10) management regions were determined to be undergoing either zero net shoreline change or accreting. In contrast, cays within the Cairns/Cooktown (n=4) region were found to be eroding, with the exception of Taylor Cay which was accreting. Vos et al. (2023) indicated that patterns of shoreline erosion and accretion along sandy beaches have been linked to variations in the Southern Oscillation Index (SOI). However, no clear relationship was evident between cay shoreline perimeter and SOI for the cays analysed in this study. Therefore, there are likely to be additional factors controlling the temporal scale of cay shoreline change. Overall, this study has contributed to an understanding of patterns of cay morphodynamics within the GBR which will better inform management to preserve ecosystem services.

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Fred Chaaya - CoastSnap: community-powered coastal monitoring using smartphones

Fred Chaaya[1]*, Mitchell Harley[1], Chris Drummond[2]

[1]UNSW Water Research Laboratory, Sydney, Australia
[2]NSW Department of Planning, Industry and Environment, Gosford, Australia
*Corresponding author: f.chaaya@wrl.unsw.edu.au

Keywords*: CoastSnap, citizen science, coastal monitoring, image analysis*

CoastSnap is a low-cost community beach monitoring program that provides a platform for local communities to collect and contribute measurements of coastline changes using their smartphones. By involving the community in the data collection process, CoastSnap provides a unique opportunity to both educate and collect high-quality coastal monitoring information. At the heart of every CoastSnap station is a stainless steel smartphone cradle, positioned to overlook the beach of interest from an easily accessible location. An accompanying sign promotes passers-by to take a photo using their smartphone and provides a QR code to allow them to upload it directly to a publically accesible centralised database. The use of a fixed cradle ensures reliable and comparable data across multiple sites and facilitates long-term monitoring efforts.

Coastsnap has been successful in amassing a substantial number of photographs from its dedicated volunteers. Since it's inception, over 17,000 images have been uploaded at over 100 official CoastSnap stations in Australia alone. Additionally, CoastSnap has achieved a global presence, with over 350 sites established in 25 countries. This international presence has resulted in a remarkable collection of over 60,000 images contributed by more than 5,000 unique users.

The images captured through CoastSnap serve a dual purpose, enabling both qualitative and quantitative analysis of coastal changes. Stabilized images are utilized to create timelapse videos, offering a visual narrative of beach dynamics for educational purposes and qualitative assessments. These videos engage the public and raise awareness about coastal processes. Additionally, advanced image processing algorithms can be used to quantitatively assess shoreline position and changes over time. This provides data-driven insights into erosion rates, accretion patterns, and the effectiveness of coastal management strategies. By combining qualitative and quantitative approaches, CoastSnap images offer a comprehensive understanding of coastal dynamics, supporting scientific research and informing evidence-based decision-making in coastal management.

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Grace Isdale - Restoring Essential Fish Habitat in the Saltmarshes of Pitt Water-Orielton Lagoon

Grace Isdale[1]*
[1]NRM South, Hobart, Australia
*Corresponding author: gisdale@nrmsouth.org.au

Keywords: Nature-based solutions, wetland restoration, fish habitat

The degradation of a substantial saltmarsh, located adjacent to the Pitt Water-Orielton Lagoon Ramsar site, has resulted in significant consequences for the crucial fish nursery habitat. One of NRM South's two Fisheries Habitat Restoration projects aims to restore 65 hectares of saltmarsh at Richmond Park Estate, a farm adjacent to the lagoon, by addressing key threats such as stock trampling, vegetation loss, and weeds.

Project activities include:

1. To mitigate livestock trampling, browsing, and nutrient inputs, we have installed 2.1 kilometers of new fences to safeguard the saltmarsh.

2. Targeted weed control has been implemented across the 65-hectare site, and 5.9 hectares of the site revegetated with native species. This approach will aid in suppressing weeds and will provide a supportive buffering microclimate, facilitating saltmarsh recovery.

3. To assess the impact of future hydrological restoration on fish communities, fish surveys were conducted during the winters of 2022 and 2023. Vegetation surveys were also carried out in 2022 and 2023 to monitor changes in vegetation cover, composition, and height.

4. Data collection efforts were undertaken to understand water level fluctuations, providing crucial baseline information for future hydrological restoration initiatives.

5. The local recreational fishing community were engaged in on-ground works, monitoring activities, and information events.

This project serves as a successful case study for the restoration of essential fish habitat in saltmarsh ecosystems. The findings and experiences gained from this project will contribute to the broader understanding of saltmarsh restoration.

The project, funded by the Australian Government's Department of Agriculture, Fisheries and Forestry, is a collaborative effort between NRM South, OzFish Unlimited, and the University of Tasmania.

NRM South has secured funding from the Australian Government's Blue Carbon Ecosystem Restoration Grant to continue and expand the restoration efforts until March 2025, including hydrological restoration through the removal of a bund.

Figure 1: Aerial view of Richmond Park Estate showing a bund that blocks natural hydrology from the Coal River, on the right, to the degraded saltmarsh on the left *(Image credit: Mark Bachmann, Nature Glenelg Trust)*

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Hannah McKnight - How community values are driving coastal management within the Greater Sydney Basin.

McKnight, Hannah[1]*, Peters, Connor[1]

[1] Sydney Water, Sydney, Australia
*Corresponding author: hannah.mcknight@sydneywater.com.au

Keywords*: Waterways, Sydney Water, community values, collaboration, partnerships*

Estuaries play a key role in the liveability of Greater Sydney. Like our beaches, they provide important habitats for the species that call them home and local recreation opportunities for the surrounding communities.

Traditional coastal management focuses on the physical processes that occur at the interface of land and sea. However, delivering tangible outcomes to the health and well-being of our urban coastal areas is most effectively driven by the perspectives and intentions of the local human population.

The NSW Government sets water quality and river flow objectives for all waterways in NSW, based on the community's values and uses for our rivers, creeks, estuaries and lakes.

But this is just the beginning of the journey. In practice, driving change to protect and improve waterways requires a clearly articulated vision, the ongoing commitment and collaboration of many partners, continuing stakeholder engagement and effective governance, supported by great science.

Sydney Water has been working with the Parramatta River Catchment Group (PRCG) for many years. The PRCG released their Masterplan for the Parramatta River in 2018, with a mission to make the river swimmable by 2025. This mission became a reality in 2022, with the City of Canada Bay opening the first new swim site at Bayview Park. This exemplar of partnership working, has set a new benchmark for how waterways are managed in Greater Sydney.

Although much earlier in its journey, the Cooks River currently has an enormous groundswell of community and government support on which to build a future masterplan, with Sydney Water playing a key role in planning and delivery, working closely with other catchment partners.

While they differ in terms of scale and the unique challenges they face, these two rivers represent important case studies in harnessing community values to drive effective coastal management.

Figure 1: Bayview Park on the Parramatta River

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Hayden Golding - Digging Deeper into Severe Storm Recovery in SE Australia

Hayden J Golding[1]*, Kerrylee Rogers[1], Amy J Dougherty[1,2]

[1]University of Wollongong, Wollongong, Australia
[2]University of New South Wales, Sydney, Australia
*Corresponding author: hjg871@uowmail.edu.au

Keywords*: Remote-sensing, GIS, GPR, beaches, storms*

As anthropogenic climate change continues to accelerate rising sea levels, long-term coastal recession will become primarily driven by storm erosion. The most significant storm erosion recorded from New South Wales (NSW) accompanied a series of severe east coast low pressure systems (ECLs)in the mid-late 1970s. The occurrence of large (up to 15 m), high-energy waves coupled with unusually high tides permanently changed the characteristics of many beaches along the coast. The significant impact of these events led to the inception of NSW's definitive-design storm event, with an average storm-bite volume of 200m3/m. Whilst significant focus has been given to the direct impacts of this event, less is known about how individual beaches have recovered in the decades since. This study aims to evaluate severe storm recovery at eight beaches along the NSW coast, including four of the original sites used in developing the NSW definitive design storm. Ground-penetrating radar (GPR) was used to identify the most prominent storm-eroded beach profile preserved within the stratigraphy of each beach. Recovery volumes were obtained by calculating the volume between these eroded profiles, and the most accreted modern beach profiles obtained from LiDAR. Results vary widely, with some sites having recovered, and some demonstrating continued retreat such that any previously preserved storm profile has been eroded. The results further indicate that differences in recovery volumes and therefore beach behaviour (eroding, stable, prograding) do not directly correlate with geologic trends indicated by the associated barrier type (receding, stationary, or prograding). This research has implications for determining future storm-bite and cut back lines for individual beaches, as using presumed sediment budgets based on shoreline behaviour over millennia can be misleading. The methodology presented can be widely applied to many beaches that do not have existing records of a recent large storm event or long-term recovery. This serves an important purpose, as future research into beach recovery is important, as it directly influences the resilience of the coastline to subsequent erosion.

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Jack Harkness - Coastal Protection at South Mollymook Beach: Past, Present and Future

Jack Harkness[1], Ben Morgan[2], Nigel Smith[3]
[1]Advisian, Newcastle, Australia
[2]Advisian, Sydney, Australia
[3]Shoalhaven City Council, Nowra, Australia
email: jack.harkness@advisian.com

Keywords: *Coastal protection structures*

Mollymook Beach, one of the gems of the Shoalhaven, is located on NSW South Coast and is a popular beach for locals, surfers, and tourists alike. The southern end of the beach is backed by seawalls and experiences beach level and width fluctuations, wave impacts, and overtopping of the seawall. The coastline of the beach suburb has been built-up over more recent decades with housing, roads, surf club, holiday apartments, foreshore parkland and a golf club. Four contiguous coastal protection structures have been built during this time at South Mollymook, however, there is limited knowledge of three of these and the longest structure, a gabion revetment, has been identified as inadequate for a 50-year design, RHDHV (2016). Shoalhaven City Council with funding support from the NSW Department of Planning and Environment have engaged Advisian to provide an upgraded coastal protection design to replace the existing structures. The primary objective of the improvements is to ensure costeffective, long-term coastal protection to mitigate current and projected coastal hazards risking impacts on public and private assets at South Mollymook. Where feasible, the recreational amenity of the area is to be enhanced by increasing beach access and improving accessibility. Advisian has produced a concept design of the coastal protection works in the form of a rock revetment transitioning into a reinforced concrete wall. This was aided by geotechnical investigations, coastal assessment, environmental assessment, community consultation and architectural input. The project is now moving into detailed design to eventually be called for tender and construction. This paper provides an insight into the planning and design of the future improvements as well as the history of coastal protection structures at South Mollymook Beach.

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Jin Liu - A high-resolution wave power assessment of south-east Australia

Jin Liu[1,2],* , Alberto Meucci[1], Qingxiang Liu[3,1], Alexander V. Babanin[1], Daniel Ierodiaconou[4], Xingkun Xu[1], Ian R. Young[1]
[1]University of Melbourne, Melbourne, Victoria, Australia
[2]Department of Energy, Environment and Climate Action, Melbourne, Victoria, Australia
[3]Ocean University of China, Qingdao, Shandong, China
[4]Deakin University, Warrnambool, Victoria, Australia
*Corresponding author: jin.liu.prc@gmail.com

Keywords: *wave power, south-east Australia, WAVEWATCH III, satellite altimeter, wave*

In this study, a third-generation ocean wave model (Liu et al., 2022) implemented on a highresolution unstructured grid was developed to investigate wave power in the south-east of Australia over the 40-year period from 1981 to 2020 (Liu et al., 2023). The simulated wave power shows good agreement with values estimated from multiplatform satellite data. Thus, the modelled data were used to study statistics (mean conditions, seasonality, extremes, and long-term trends) of wave power in the domain, which show impacts of Southern Ocean swell and protection provided by the land mass of Tasmania. The results indicate increasing wave power trends, with the largest values in the southeastern part of the domain over the 40-year period. These positive trends are mainly a result of an increase in significant wave height rather than peak wave period. By utilizing the simulated wave properties, we estimated regional annual electric power at 14 coastal locations using 9 typical wave energy converters (WECs). To do so, we conducted a comprehensive analysis (seasonal variations, wave power roses, probability distributions, and bivariate probability distributions) at these locations. The results demonstrate that the western and southwestern coasts of the domain are promising generation sites but with large seasonal variability. The central and eastern coasts are protected by Tasmania and exhibit more stable conditions but are far less energetic for electricity production. This study has critical implications for the region, which provides a benchmark for coastal WEC deployment.

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Jokotola Omidiji - Pre- and post-uplift shore platform erosion in active regions: Implications for rock coast evolution

Jokotola Omidiji[1*], Wayne Stephenson[1], Mark Dickson [2] and Kevin Norton[3]

[1]School of Geography, University of Otago, Dunedin, New Zealand
[2]School of Environment, University of Auckland, New Zealand
[3]School of Geography, Environment and Earth Sciences, Victoria University of Wellington, New Zealand
*Corresponding author: jokotola.omidiji@gmail.com

Keywords*: tectonics, coastal erosion, shore platforms, Mahia Peninsula, Kaikōura Peninsula*

The morphology of rock coasts is difficult to attribute to a particular process because these coasts are shaped by a combination of factors including marine processes, weathering, and tectonics. Because changes to rock coasts are long-lasting to irreversible, there is a need to understand how gradual and high-magnitude events play a role in influencing the susceptibility of rocky coasts to erosion. In this paper, we report rates and patterns of erosion at two sites that provide unique opportunities to examine the developmental stages and erosional processes shaping inter-tidal shore platforms and marine terraces following coseismic uplift. Erosion measurements were carried out on shore platforms at Kaikōura and Kahutara Point Māhia Peninsula, on the east coast of the South and North Islands of New Zealand. At the Kahutara Point, a 3.1 m coseismic event around 100 to 300 years ago lifted a vast expanse of seafloor into the intertidal zone and created the anomalously wide inter-tidal shore platform. In comparison, at Kaikōura, the 2016 Kaikōura 7.8 Mw earthquake uplifted all platforms by ~1 m and extended the widths of a few platforms. Cross-scale erosion measurements collected over five years using the Micro-erosion meter (MEM), and repeat photographs subjected to Structure-from-Motion (SfM) photogrammetry showed that erosion rates were faster after the 2016 uplift of shore platforms at Kaikōura Peninsula. Platform erosion rates increased by 104%, from a pre-uplift rate of 1.100 mm/yr to a post-uplift rate of 2.247 mm/yr. Erosion rates measured from the inter-tidal mudstone shore platforms at the Kahutara Point, Māhia Peninsula, uplifted between 100 to 300 years ago, ranged from 0.069 to 5.820 mm/yr, with a mean annual erosion rate of 1.937 mm/yr. Results reveal a comparable pattern of erosion response at both sites following coseismic uplift and imply a centennial scale response time at Mahia that would have implications for erosion timescales at Kaikoura. Orthophotographs of the eroded rock surfaces support the combined role of marine processes (waves and tides), geology, subaerial weathering processes, salt weathering, and biological activity and tectonics in the erosion of the shore platforms. Results from this study demonstrate how tectonism can fundamentally alter the way geology, marine and weathering processes influence rock shore erosion rates.

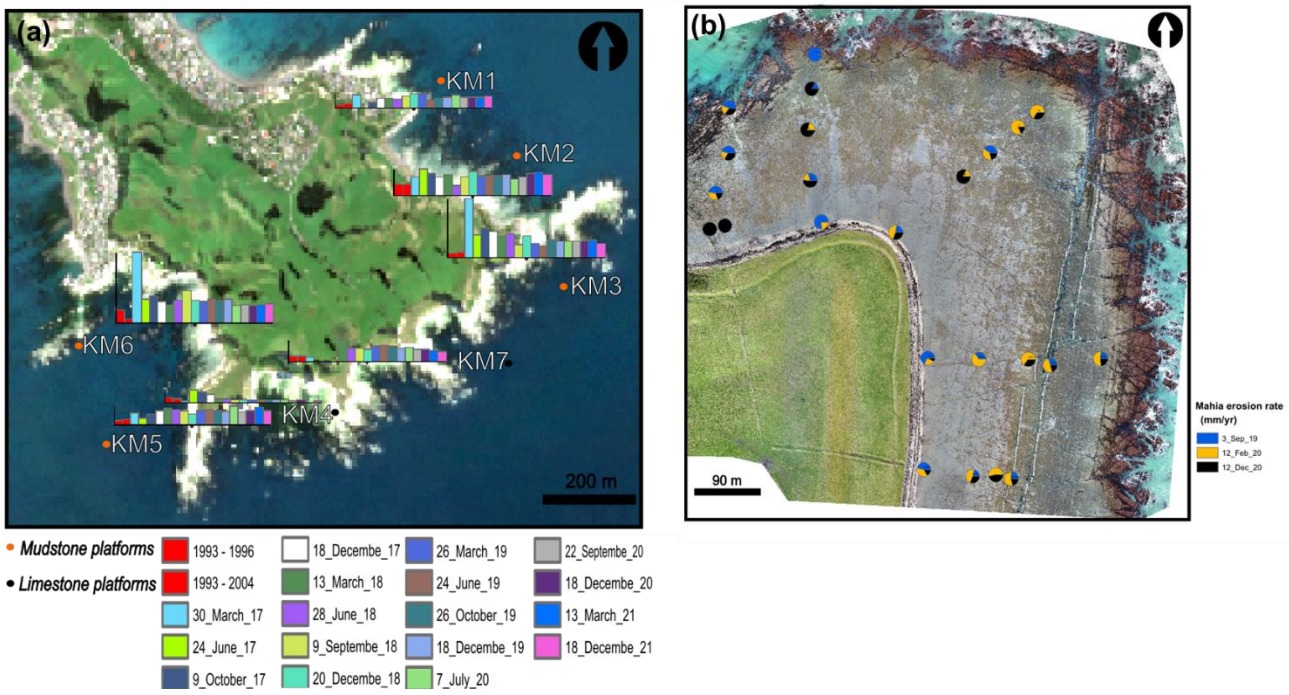

Figure 1: Erosion monitoring profiles installed on shore platforms at (a) Kaikōura Peninsula and (b) Kahutara Point Māhia Peninsula, on the east coast of the South and North Islands of New Zealand, respectively.

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Jonathan Chan - The Future of Coastal Management: Gold Coast's Cutting-edge Imaging Network

Jonathan Chan[1] *, Chris Drummond[2] , Matt Blacka[1] , Ian Turner[1]
[1] UNSW Water Research Laboratory, Sydney, Australia
[2] Department of Planning and Environment, Gosford, Australia
*j.chan@wrl.unsw.edu.au

Keywords: *Coastal imaging, shoreline mapping, people counting*

Figure 1: Rooftop mounted cameras providing panoramic of Rainbow Bay Beach

The Gold Coast of Australia, world-renowned for its iconic beaches and vibrant coastal environments, is perpetually evolving due to a blend of natural phenomena and human activities. For over two decades, the UNSW Water Research Laboratory has maintained a cutting-edge coastal imaging network across this coastline. Currently encompassing 44 rooftop-mounted cameras, the network meticulously captures approximately 32 kilometres of coastline, cementing its status as one of the largest networks of its kind globally. This abstract outlines the pivotal role of this expansive network in monitoring coastal dynamics and highlights the extensive analytical capabilities enabled by the captured images. Coastal imaging networks play a crucial role in monitoring and assessing the changes occurring along coastlines. The camera network provides real-time visual data, enabling researchers, coastal managers, and policymakers to gain valuable insights into coastal morphodynamics, including patterns of erosion in response to the fluctuating wave climate. By monitoring these changes, decision-makers can quantify the efficiency of coastal interventions and develop evidence-based strategies for coastal management and adaptation, ensuring the long-term sustainability of coastal communities and ecosystems. One of the key advantages of the coastal imaging network on the Gold Coast is its ability to capture a vast number of high-resolution images. These images are not only useful for visual documentation but also serve as valuable inputs for analytics. By utilizing advanced image processing techniques, such as computer vision algorithms, the captured images can be analysed to extract meaningful information. For instance, people counting algorithms can be applied to estimate visitor numbers and patterns along the coast. This information is vital for managing tourism, optimizing beach services, and ensuring visitor safety. Additionally, shoreline tracking algorithms can be utilized to assess the spatial and temporal changes in the coastline. Such analysis provides quantitative data on erosion or accretion rates, enabling better understanding of coastal dynamics and informing appropriate management strategies.

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Joshua Sargent - Simulating rural coastal flooding impacts: a socio-hydrological approach

Joshua Sargent[1]
* [1]University of Waikato, Hamilton, New Zealand
*Corresponding author: js535@students.waikato.ac.nz

Keywords: *coastal flooding, agriculture, socio-hydrology, system dynamics, synthetic storms*

Coastal flooding is the problematic result of a natural hazard occurring in proximity to where people would like to be. Globally, people are motivated to live and work along the coast for a multitude of reasons. In the case of the Hauraki Plains (New Zealand), land now used for agriculture was previously wetlands, which were drained over the course of the last century. Despite also preparing this area for people by building an extensive levee system, there still is a long history of flooding events. To explore the recent past (1990-present) relationships of anthropogenic and natural responses to flood hazards, the Di Baldassarre et al. (2013) socio-hydrological urbanriverine flooding model was modified and expanded to reflect rural-coastal conditions. This model was then applied to a series of synthetic storm scenarios to assess the further impacts of storm surge, storm delay, and storm clustering on flood impacts to agricultural systems. The results of this model aim to influence future coastal, rural resilience decision making and policy progress related to flooding events within the region.

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Julia Sa - Use of Spatial Analysis to Identify Triggers for the Opening of Intermittently Closed and Open Lakes and Lagoons (ICOLLs)

Julia Sa*, Laura Whitehouse[1] , Emma Maratea[1] , Tanja Mackenzie[1]
[1] Rhelm, Sydney, Australia
*Corresponding author:Julia.sa@rhelm.com.au

Keywords: *Entrance Management, ICOLLs, Intermittently Closed and Open Lakes and Lagoons*

NSW National Parks and Wildlife Service (NPWS) assumes responsibility for the management of the entrances of a number of estuaries throughout the Eurobodalla National Park that are subject to periods of closure to the ocean. These estuaries are referred to as intermittently closed and open lakes and lagoons (ICOLLs). Entrance management of ICOLLs essentially involves artificially removing or manipulating sand around the entrance (the 'berm'), to release built-up waters to the sea. This is done typically when water levels within estuaries exceed specific 'trigger' levels as a precursor to potential detrimental impacts on access, infrastructure or industry around the estuaries and their associated waterways. There are often demands for the ICOLLs to be opened artificially to overcome real or perceived problems. These typically involve flooding of private land or public amenities, ameliorating odour issues (that can be associated with estuarine muds), improving water quality and encouraging fish recruitment. However, artificial openings can result in impacts on estuarine ecology and other environmental values of the estuary. The analysis presented in this paper aimed to identity which ICOLLs within the Eurobodalla National Park required entrance opening policies and the triggers and procedures associated with these opening. The assessment comprised a total of 11 ICOLLs and it involved a detailed review of potential assets at risk of inundation, using spatial analysis tools and publicly available aerial imagery and digital terrain models (DEM). As an outcome of this assessment, formal entrance management plans for 5 out of the 11 analysed ICOLLs were prepared. Engagement with local residents and key stakeholders, along with an environmental assessment (in the form of a Review of Environmental Factors) were undertaken to inform the plans The plans will play an important role in mitigating inundation risks, whist protecting the local ecosystems.

Figure 1: Lake Mummuga entrance following manual opening (NPWS, July 2020)

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Kate Tunstill - Determining inundation regime of ICOLLs to understand conservation of *Litoria aurea*

Kate Tunstill[1]*, Hannah Power[1], Alex Callen[1], Matthew Hayward[1]
[1] Newcastle University, Newcastle, NSW, Australia
Corresponding author: kate.tunstill@uon.edu.au

Amphibians globally have undergone a severe decline caused by chytrid fungus, invasive species and the ongoing loss of habitat and pollution of vital ecosystems (Houlahan et al., 2000). Within Australia it is common to find frog species in coastal settings, with estuaries often containing slightly saline coastal lagoons. These mild levels of salt reduce the infection rate of chytrid fungus, making these locations a refuge for many individuals. Estuarine systems are considered the most valuable biome globally, but they are vulnerable to coastal development and are sensitive to climate change meaning they are often under threat. Within Australia, 184 estuaries occur along the New South Wales (NSW) coastline, with 60% classed as Intermittently Closed and Open Lakes and Lagoons (ICOLLs) (Roper et al., 2011). ICOLLs are classified as lakes and lagoons located near the ocean that are both permanently separated by a beach barrier or permanently open to the sea. These unique systems are important to consider in the context of hydrology in this study with many natural processes exist within these systems. This creates a highly fluctuating water environment, in which little is known about the effects on organisms that live within these systems. Of the 184 estuaries mentioned previously, 36% contain previous records of the green and golden bell frog (L. aurea). The bell frog has seen the disappearance of 90% of its historical range from NSW and Victoria, with this endangered species now only found in fragmentated populations along the coastline (Klop-Toker et al., 2021). Considering the abundance of frogs in these coastal setting and research suggesting that saline water can mitigate the spread of chytrid fungus it is therefore important to monitor water quality parameters in bell frog habitats. This project aims to understand how inundation regimes and tidal dynamics of ICOLLs in NSW affect the conservation of the endangered green and golden bell frog.

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Kate Whitton - Investigating the compound effects of coral reef stressors over the last 40 years in the Great Barrier Reef

Kate Whitton[1] *, Ana Vila-Concejo[1], Maria Byrne[1], Ana Da Silva[1], Tommy Fellowes[1]
[1]University of Sydney, Sydney, Australia
*Corresponding author: kate.whitton@sydney.edu.au

Keywords: *Climate change, Coral reefs, Eco-morphodynamics, GBR, Remote sensing*

Anthropogenic climate change is altering coral reef eco-morphodynamics leading to long-term impacts on reef ecosystems and the ecological services they provide (Perry et al., 2015). To quantify impacts on coral reef systems and their ability to provide coastal protection, a finescale analysis of reef stressors (e.g., sea-level rise, increased storminess) across multiple spatial and temporal scales is urgently required (De'Ath et al., 2012; Walsh et al., 2016). Here we synthesise 40 years of existing biogeochemistry, hydrodynamic, geological, and ecological data at 3 key locations spanning the North, Central and Southern Great Barrier Reef (GBR) (Figure 1): Lizard Island, Low Isle and One Tree Reef. By integrating a large set of variables, such as change in coral cover/composition, structural complexity, substrate, bathymetry, and biodiversity, the study allows for the mapping of intra- and inter-reef eco-morphodynamic variation via remote sensing techniques, plus a review of previous literature. Our research aims to identify the main environmental parameters that trigger long-term changes in coral reef ecomorphology, and the main factors associated with spatial variation. Through the parametrization of reef stressors, our findings will enable numerical modelling of future coral reef eco-morphological evolution, under IPCC projections, to inform policy and coastal management.

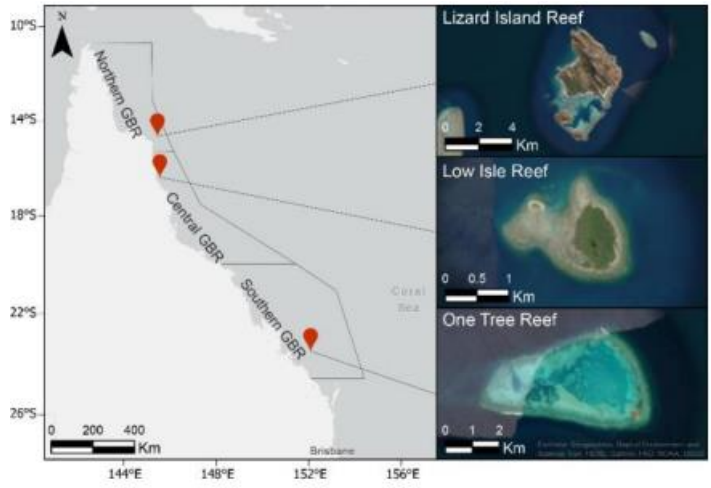

Figure 1: Map of study sites (red pins) including Lizard Island Reef in the Northern GBR, Low Isle Reef in the central GBR, and One Tree Reef in the Southern GBR. Aerial images demonstrate the diversity of size and geomorphology of the reefs.

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Katie Wilson - Seasonal variability and climate controls of shoreline position in Australia

Katie Wilson[1]*, Mitchell Harley[1], Kristen Splinter [1]
[1]Water Research Laboratory UNSW, Manly Vale, AUSTRALIA
*Corresponding author: katie.wilson@unsw.edu.au

Keywords*: coastal hazards, coastal erosion, ENSO, sandy beaches, wave-dominated*

Better understanding of coastal processes at the seasonal scale can enhance preparedness of coastal communities for coastal hazards such as erosion and coastal flooding. Early warning systems for coastal hazards have been recommended by the UN for disaster risk reduction, yet existing warning systems provide only a week's notice of extreme events. Further, modes of coastal erosion and flooding across sandy beaches in Australia are studied by considering the effects on individual beaches under a single storm event, or a design period of 10-100 years. As a result, the significance of oceanographic forcing drivers such as El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) are not considered at the continental scale, nor are seasonal patterns of coastal erosion and inundation well quantified.

This study presents the first analysis of shoreline position and total water level (TWL) variability at the seasonal scale across Australia, utilising an unprecedented multi-decadal dataset of shoreline change (CoastSat) and TWL variability. Initial results indicate that at the seasonal scale, significant shoreline erosion and elevated total water levels occur more commonly during the Austral winter months and coincide with the La Niña phase of ENSO across Australia. La Niña was associated with 10-40m narrower beach widths than in El Niño or neutral states across Australia, although this was influenced at the beach scale by beach rotation. La Niña coincided with high water levels, especially across the Northern Territory and Western Australia. IOD was also associated with changes in shoreline position, with increased erosion generally found during the positive phase. These results show that insight on the effects of climate drivers on coastlines is integral to our understanding of long term coastal processes.

Results to be presented at AusYCSEC 2023 will show how these insights can be applied for seasonal forecasting applications across Australia.

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Lachlan Perris - Hydrodynamic observations of Cyclone Gabrielle at One Tree Island Reef, southern Great Barrier Reef

Lachlan Perris[1]*, Ana Vila-Concejo[1], Thomas Fellowes[1], Tristan Salles[1]
[1] University of Sydney, Sydney, Australia
*Corresponding Lachlan.perris@sydney.edu.au

Keywords: *Tropical cyclones, extreme waves, coral reefs, Great Barrier Reef*

Tropical cyclones generate extreme waves that can both damage coral reef frameworks (Done, 1992) and contribute formation of reef islands (Kench et al., 2022). Understanding wave transformation across the disparate morphological zones of a coral reef (i.e. – the fore reef slope) can provide insight into how these systems respond to such events. As coral islands are often remote, there is a lack of nearshore data on extreme wave events. Here, we present field data obtained from One Tree Reef (OTR) in the southern Great Barrier Reef during a period of extreme waves generated from Cyclone Gabrielle (February 2023) which tracked less than 270 nautical miles east of OTR (Bureau of Meteorology, 2023) (Figure 1 b). Nearshore wave characteristics on the exposed eastern fore reef of OTR (Figure 1 a) were measured with a pressure transducer (RBR Virtusoso3) recording continuously at 8 Hz on the upper fore reef of OTR (Figure 1) at a water depth of 4.2 m. Offshore wave measurements were recorded with a waverider buoy (Datawell directional waverider MkIII) on the outer forereef in an average water depth of ~16 m. Preliminary findings show a maximum zeromoment wave height (Hm0, max) of 11.6 m recorded on the buoy. A mean significant wave height (Hsig) of 2.1 m was recorded offshore and 1.34 m on the upper forereef for the 8 days of storm wave conditions. A mean wave height attenuation, $A_{\%}$, of 65% was recorded over a mean distance of 251 m for the duration of the storm event, demonstrating the considerable wave attenuation capacity of fore reefs in extreme wave events. Further analysis comparing wave parameters during this event with other cyclone-generated swells in the southern GBR is presented.

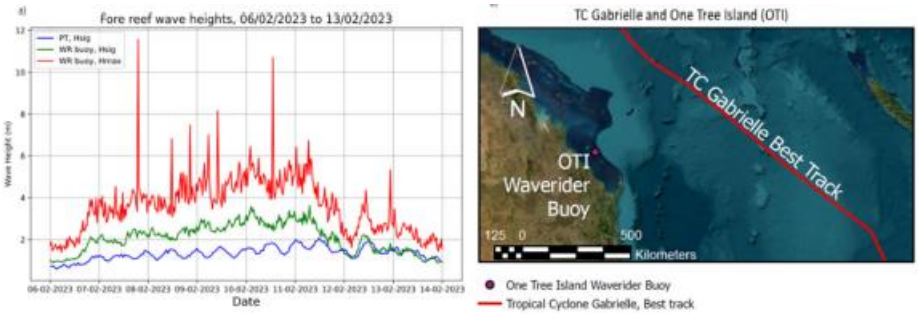

Figure 1: Wave measurements of Cyclone Gabrielle at One Tree Island. a) Significant wave heights (Hsig) at the pressure transducer on the reef edge (blue), wave rider buoy (green) and Hm0, max at the waverider buoy and b) best track for cyclone Gabrielle (Bureau of Meteorology, 2023).

Acknowledgements: This research is funded by the Australian Research Council (ARC) project DP220101125.

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Laura Montano - Entrance management impact on water quality and hydrology of Werri Lagoon

Montano Laura[1] *, Chaaya Fred[1], Tucker Toby[1], Osborne Max[2]
[1]UNSW Water Research Laboratory, Sydney, Australia
[2]NSW Department of Primary Industries| Fisheries, Kempsey, Australia
*Corresponding author: l.montano@wrl.unsw.edu.au

Keywords: *Werri Lagoon, lagoon entrance, ICOLL, water quality, hydrology*

Werri Lagoon is an ICOLL (Intermittently Closed and Open Lake or Lagoon) located in the NSW South Coast. The catchment area is considered small (less than 17 km2) and is characterised by steep topography with elevations ranging from sea level up to 500 m. These orographic conditions lead to fast flows which can flood the low-lying land surrounding Werri Lagoon. The catchment land use is considered highly disturbed with more than 80% of the land used for grazing, rural and urban development. Ongoing pressures from catchment land use contributes to high nutrient and sediment runoff deteriorating the water quality in Werri Lagoon. Werri Lagoon entrance opens and closes naturally depending on rainfall events, water levels in the lagoon and marine sediment accretion. Additionally, the entrance is artificially opened by Kiama Shire Council when the water level in the lagoon is above 1.65 m AHD to reduce flood impacts to infrastructure. Unauthorised entrance openings can also occur. The present project assessed the influence of the entrance conditions on the water levels and water quality in Werri Lagoon and identified the dominant processes influencing Werri Lagoon hydrology. For closed conditions, the water levels were mostly dominated by rainfall and evaporation processes leading to stagnant flows, decrease in dissolved oxygen levels and increase in nutrient concentrations with increasing duration of closure. When the entrance was open, the water levels in the Lagoon were influenced by the ocean tide resulting in higher dissolved oxygen levels. However, high nutrient concentrations were continuously observed for open entrance conditions. This analysis highlighted that management strategies in the catchment are required to reduce nutrient and sediment inflows into Werri Lagoon and improve its water quality.

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Margot Mason - Collecting and Incorporating Field Data in Estuarine Models

Margot Mason*[1], Alice Harrison[1], Yarran Doherty[1], Brett Miller[1]
[1]UNSW Water Research Laboratory, Manly Vale, NSW, Australia
*Corresponding m.mason@wrl.unsw.edu.au

Keywords: *Estuarine Modelling, Hydrodynamics, Fieldwork*

Sewage overflows occurring into estuaries in which oyster farming occurs often trigger temporary closures to oyster harvesting areas. To aid decision making about the need for closures after overflows, models of 11 NSW estuaries (covering 85% of the state's oyster production) have been created in the RMA modelling suite. RMA is a suite of finite element models including hydrodynamics and water quality models. Initial pilot models were calibrated on long term water level monitoring and historic tidal flow gauging where available. These models were then refined with targeted field data collection campaigns involving flow gauging, water level gauging, rhodamine tracer experiments, GPS drifter drogues and salinity measurements.

The field data was used to inform further model refinement to better simulate current conditions and understand model uncertainties. Uncertainties may be caused by changing conditions in the estuary, such as bathymetry, or simplifications made by the model in simulating the real world, especially in modelling dispersion. These uncertainties need to be understood to appropriately utilize model results. Furthermore, using a depth averaged hydrodynamic model has important implications on pollutant transport as it assumes transport time and concentration is consistent through the water column, which is rarely true in the real world. Understanding these nuances is vital to ensuring the models are fit for purpose and creating decision making frameworks which encapsulate relevant uncertainties. The project has been funded by the Australian and NSW government's Storm and Flood Industry Recovery Program and partner local Councils.

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Maria Kottermair - 3D Field Survey of Heron Island

Maria Kottermair[1] *
[1]University of Queensland, Brisbane, Australia
*Corresponding author: m.kottermair@uq.net.au

Keywords: *reef island, shoreline change, Heron Island, geomorphology, remote sensing*

Reef islands and coral cays like Heron Island on the Great Barrier Reef are highly dynamic and change in shoreline horizontal and vertical positions can occur rapidly over days or slowly over years to decades. Reef island environments are severely impacted by sea level change and human activities like dredging and shoreline hardening. These impacts are likely to be exacerbated in a future of higher sea levels and changing wave climates. Despite this there are very few studies that have examined shoreline and volumetric change of low-lying reef islands over time. Measuring the horizontal position and three-dimensional volume of low-lying reef islands at high spatial resolution (< 1 m) and precision over several seasons and years will provide a better understanding of the processes driving shoreline change and coastal erosion and accretion. In June 2023, we collected field data on Heron Island to characterise the intertidal zone and beach area using drones, laser scanners, and GNSS. The results from this study will help inform shoreline monitoring, management strategies and mitigation measures, facilitate greater accuracy in modelling future island states, and help ensure sustainability of the island. The overall aim is to protect the important ecosystem reef islands provide and to offer insights into tropical island change that will be relevant globally and throughout the entire Great Barrier Reef.

Figure 1: Aerial view of Heron Island.

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Md. Yousuf Gazi - Morphometric classification of cross-shore profiles in the beaches in estuaries and bays (BEBs)

Md. Yousuf Gazi[1,2]*, Ana Vila-Concejo[1], Thomas E. Fellowes[1], and Ana Paula da Silva[1]
[1]Geocoastal Research Group, Marine Studies Institute, School of Geosciences, University of Sydney, Australia
[2]Department of Geology, University of Dhaka, Dhaka, Bangladesh
*mdyousuf.gazi@sydney.edu.au

Keywords*: Morphometric Index, Beach profiles, BEBs, Beach morphodynamics*

Sandy beaches in estuaries and bays (BEBs) are common globally. BEBs differ from open coast beaches in terms of wave climates and shoreface morphology. Their morphological evolution is still unclear. This is due to the complex interactions of waves, sediments, climate change, and human interventions. Here, we propose a new methodology to develop a generalized morphometric index (ϒ) that mathematically classifies subaerial beach profiles into distinct morphotypes. For this study, three swash-aligned and one drift-aligned BEBs in Gamay Bay (NSW, Australia) were investigated. Each BEB has a unique position relative to the estuary entrance, fetch, and beach aspect. Beach profiles were measured regularly between 2016 and 2023 and we have identified some relevant factors and parameters for the morphotype classification, such as elevation, sign, and normalized factors. Results show that the beach profiles could be classified into 11 profile morphotypes: Concave, Mostly Concave, Concave-Convex, Linear concave, Linear, Mostly Linear, Linear convex, Convex-Concave, Combination, Mostly Convex, and Convex. We observed temporal variations in profile morphotype due to storm waves propagating into the estuary and sediment availability including those due to anthropogenic pressures (e.g., groynes). The generalized morphotypes index (ϒ) proposed here provides a novel way to classify BEB profiles and can be used to understand the morphodynamic process of BEBs.

Melanie James - A collaborative approach to identify and remediate sources of microbial contamination

M James[1]*, V McCann[1], C Williams[1], A Griffith[1], W Brown[1], J Nilson[1], A King[1], M Coote[1], D Lam[1], P Collins[1], C Hansell[1], H Pegg[1], M Ireland[1], N Galbraith[1], C Martlew[1], M Lee[1], C Bell[1], J Reid[1], M Brodbeck[1], M Lawless[1], R Brown-Mason[1], H Schwartz[1], J Loader[1], S Cox[1], N.L.R. Williams[2], N Siboni[2], S.L. McLellan[3], J Potts[4], P Scanes[4], C Johnson[4], J.R. Seymour[2] M Campey[4]

[1] Central Coast Council, Wyong, NSW
[2] Climate Change Cluster Faculty of Science, University of Technology Sydney, Sydney, NSW
[3] University of Wisconsin-Milwaukee, School of Freshwater Sciences, Milwaukee, WI, USA
[4] NSW Department of Primary Industries and Environment, Lidcombe, NSW
*Corresponding author: melanie.james@centralcoast.nsw.gov.au

Keywords*: collaboration, remediation, water quality, wastewater, swim safety*

Wastewater associated microbial contamination is a major emerging issue, impacting human and environmental health globally. Each year, there are more than 170 million cases of illness worldwide[1] and an estimated 180,000 illnesses in Sydney[2] due to poor water quality.

Recreational water quality monitoring through the NSW Governments State of the Beaches Report effectively identifies declining microbial water quality, however, the use of broad indicators cannot precisely identify the source or scale of poor water quality. To address ongoing poor water quality at Terrigal Beach, an audit was conceived as an innovative partnership between the community, Central Coast Council, the NSW Department of Planning and Environment and the University of Technology Sydney.

An environmental sampling program was implemented to define source and scale of pollution, producing hotspot maps to guide sewer and stormwater investigations. Engagement and collaboration programs were developed with local community groups to overview the communications, planning, research and decision-making process from start to end.

To date, more than 102 kms of sewer mains and 1036 private properties have been inspected. Repairs have been undertaken in 35.8 kilometres of sewer main as well as rectification of 23 illegal connections and a number of other private defects.

Since these remediation works, Terrigal Beach has received two “Good” ratings in the Beachwatch Program after a decade of “Poor” results, however, remediation and monitoring continue.

This project was a crucial step in protecting and improving coastal health for both recreational swim safety and ecosystem health on the Central Coast. This presentation covers the processes taken for the program, including community, university, and government collaboration - which has been fundamental to project development and delivery. This case study provides valuable direction and lessons learnt for other wastewater managers and agencies looking to develop frameworks for wastewater remediation and coastal management outcomes.

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Mia Gustavsson - Expanding beyond assets for understanding climate risk – a systems-thinking Approach

Mia Gustavsson[1] *, Ella Reeks[1], Kevin Hennessey[2]
[1] Alluvium Consulting, Brisbane, Australia
[2] Climate Comms, Melbourne, Australia
*Corresponding mia.gustavsson@alluvium.com.au

Keywords: *climate risk, exposure, vulnerability, systems-thinking, coastal hazards*

Assessing and managing risk from coastal hazards has been at the forefront of many initiatives across Australia (e.g. Queensland's QCoast2100 program). There are programs emerging which are exploring climate risk – including coastal hazard risks but also risks from fire, flooding, heatwaves, droughts and storms. This holistic, multi-hazard approach provides a means to capture risks from concurrent events, or events in close succession, which can reveal risks not seen by only considering one hazard at a time. We have piloted Phase 1 of the Queensland Climate Resilient Council's Climate Risk Management Framework (LGAQ, 2020) in a joint project between Noosa Council and Sunshine Coast Council, using a high-level systems-approach for identifying risks. Typically, risk is calculated as a combination of likelihood and consequence. We instead took a qualitative approach, presenting locally specific climate hazard scenarios to Council operational staff and asked them to identify impacts to their service delivery, and work backwards to identify their exposures and vulnerabilities (Figure 1). Coastal hazard risk assessment in Queensland is typically quantitative and has a strong emphasis on exposure and resulting risks to assets. Our approach allowed staff to consider the system as a whole, as service delivery involves people (staff and users) and activities (e.g. operational tasks such as maintenance, scheduling, etc.), as well as assets. This approach also highlighted cascading risks (e.g. impacts to critical infrastructure that flow on to Council), as well as how impacts to one service area may impact another. Perhaps most importantly, this project generated buy-in from service areas not typically involved in risk assessment (e.g. IT) as well as from executive-level staff by seeing their own staff identify the broad-reaching impacts of climate hazards in a locally-relevant context. This approach has generated some high-level risks that can be explored further through more detailed and quantitative assessments.

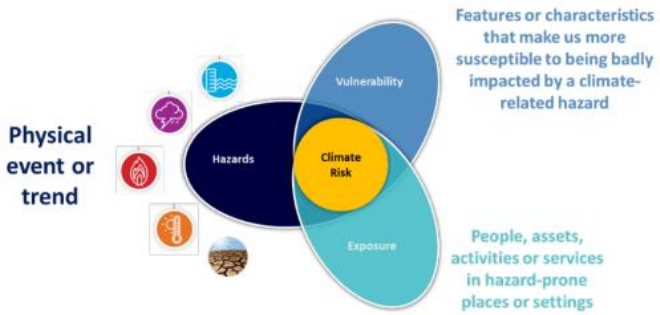

Figure 1: Climate Risk Framework

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Michael Thompson – Swash TV – in-water side view swash zone observations

Michael Thompson[1]*, Tom Baldock[1]
[1]The University of Queensland, Brisbane, Australia
*Corresponding author:michael.thompson2@uq.net.au

Keywords: *swash zone, video, swash dynamics, field data*

The dynamics of the swash zone are complex and not fully understood. To further the understanding of swash zone dynamics, different measurement techniques have been used in the field and in the laboratory, such as Lidar, ultrasonic sensors, shear plates, sand traps, stringlines, runup wires, pressure sensors, video timestacks, and flume sidewall video. A new 'Swash TV' apparatus (figure 1a) brings the benefits of wave flume sidewall video observations from the laboratory to the field. The Swash TV apparatus provides measurements of the water depth, beach slope and swash front motion, and allows visual qualitative observations of water flow and sediment transport. The Swash TV apparatus was placed in between swash events such that a swash event passes along the viewing panel while filmed. A machine learning based segmentation algorithm was developed to automatically extract the water surface of each filmed swash event (Figure 1c). From the rectified surface elevations, timestacks were produced including depth measurements (Figure 1b). The apparatus can aid in furthering the understanding of swash zone dynamics at the wave front.

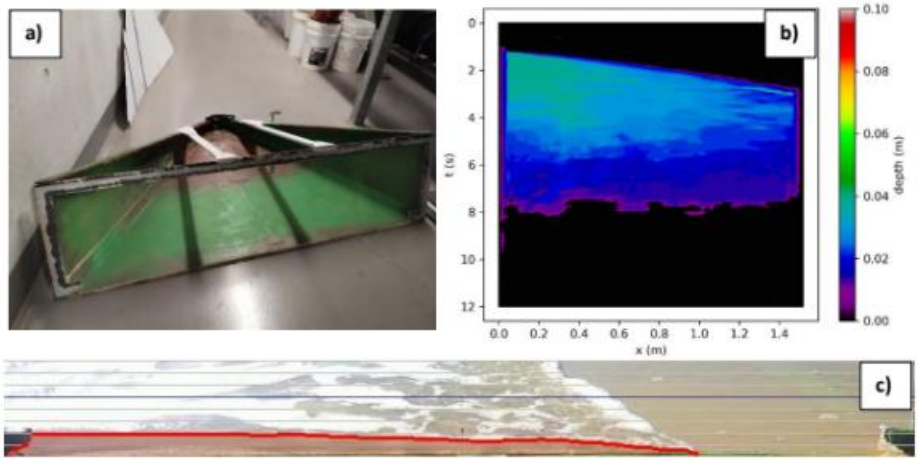

Figure 1: a) Swash TV device, b) Swash TV derived timestack, c) rectified Swash TV surface detection. For b) and c), $\tan(\beta) = 0°$.

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Miranda James - Observing Resilience of Clyde River Mangroves after the 2019-20 Bushfires

Miranda James[1] *, Jeffrey Kelleway[1], Colin Woodroffe[1], Shamaram Eichmann[2], Norman Lenehan[2]
[1]University of Wollongong, Wollongong, New South Wales, Australia.
[2]Batemans Marine Park, Department of Regional New South Wales, Australia.
*Corresponding author: mrj947@uowmail.edu.au

Keywords: *Mangroves, bushfire, estuary, climate change, disturbance*

The Black Saturday bushfires shifted the Australian public perspective on the impacts of climate change, and how Australian landscapes may be impacted by changing fire frequency. Some vegetation species are fire-prone and have developed mechanisms of recovery, however, the 2019-20 bushfires burnt ecosystems that do not appear to have such resilience. Coastal vegetation types were burnt across many parts of the southern New South Wales (NSW) coast, which was a rare occurrence according to literature. Among this fire-affected vegetation were mangroves and saltmarsh, with the mangrove species Avicennia marina and Aegiceras corniculatum experiencing a series of impacts.

This study builds on the early descriptive studies following the fires; quantifying the mechanisms, patterns, and processes of post-fire mangrove recovery for both species in the Clyde River estuary, Batemans Bay NSW. This study observed that mangroves which grew closer to terrestrial forests were more severely affected by the fires, and are recovering differently to those further away. NEARMAP imagery of the region exhibited evidence of scorched leaves on individual mangroves, which has been augmented by field surveys. A lack of regrowth was observed on forest-adjacent mangroves, however regrowth was evident throughout sites indicating that the degree of recovery is related to the distance from the terrestrial forest. The establishment of mangrove seedlings has also been assessed by field surveys. Observations suggest that the loss of productive, mature mangroves in particular areas may have resulted in a decrease in seedling supply.

Rehabilitation of post-fire mangroves may occur on longer time scales than typical of fireadapted species, however evidence has shown some capacity to recover from bushfire events. Ongoing monitoring studies may inform longer-term management of these blue carbon ecosystems, and offer insight into the adaptive capability of mangroves in recovering from fire disturbance.

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Oxana Repina - Calibrating shoreline change models with field measurements, satellite imagery, and photogrammetry

Oxana Repina[1] *, Rafael C Carvalho[1,2], Giovanni Coco[3], Colin D Woodroffe[1]
[1]University of Wollongong, Wollongong, Australia
[2]Monash University, Melbourne, Australia
[3]University of Auckland, Auckland, New Zealand
*Corresponding author: orepina@uow.edu.au

Keywords: *sandy beaches, decadal-scale modelling, validation, coastal monitoring*

Sandy beaches are dynamic environments where the position of the shoreline fluctuates over decadal scales in response to storm events, unbalanced sediment budgets and human impacts. Climate change over this century will add to this dynamic behaviour. Models can be used to forecast shoreline change, but to generate credible forecasts, they must first be calibrated and validated at the sites they are applied. This requires datasets of historical shoreline change, ideally spanning several decades to support decadal-scale forecasting. However, multi-decadal datasets of shoreline change gathered using traditional field survey methods are rare, both in Australia and worldwide.

Alternative datasets are available through remote sensing, two of which are considered here. With recent advances in sub-pixel shoreline extraction, satellite imagery can provide 35+ years of shoreline change data for beaches worldwide (e.g. CoastSat; Vos et al., 2019). However, the spatial accuracy of satellite-derived shorelines is lower than that of field surveys, limited by pixel size and errors associated with tides, wave set-up and swash. In NSW, an additional dataset of shoreline change has been made available through photogrammetric processing of historical aerial imagery (Harrison et al., 2017). While the spatial accuracy is comparable to traditional survey methods, the temporal sampling frequency is much lower, with gaps of years rather than weeks between observed shoreline positions.

Both CoastSat and NSW beach photogrammetry data have been rigorously compared against field measurements of shoreline change. However, little work has been done to evaluate the suitability of these datasets for calibrating shoreline change models, particularly over decadal scales. Here, a hybrid shoreline change model designed for multi-decadal simulations is separately calibrated with field measurements, satellite-derived shorelines, and beach photogrammetry data. A blind validation period is used to evaluate the degree to which the lower spatial or temporal resolution of the remotely-sensed datasets affects model performance.

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Pandian Soundara Pandian - The influence of vegetation flexibility and blade configuration on wave-induced drag forces

P. P. S. Pandian[1]*, Arnold Van Rooijen[1], Ryan Lowe[1], Marco Ghisalberti[1]

[1]University of Western Australia, Perth, 6009, Australia
Corresponding author: parameswara.soundarapandian@research.uwa.edu.au

Keywords*: coastal flooding, ecosystem-based coastal protection, seagrass, wave attenuation*

Submerged vegetation, such as seagrass, can provide several ecosystem services, including as a form of nature-based coastal protection system by dissipating incident wave energy. The effectiveness of dissipation increases with increasing drag force acting on the vegetation under waves. Flexible vegetation often bends under the wave-driven motion, which reduces both the seagrass frontal area and the fluid velocity relative to the blades that can reduce drag forces when averaged over a wave cycle. This study utilized a 54-m-long wave flume in the Coastal and Offshore Engineering Laboratory at the University of Western Australia to study drag forces on model of vegetation consisting of both (a) a rigid dowel (6.4 mm diameter, 300 mm height) and (b) flexible LDPE seagrass models (with 3 different blade configurations, 300mm height). The first flexible blade configuration consists of 6.4mm wide blade, which has the same frontal area of rigid dowel, while the second flexible blade configuration consists of 2 numbers of 10mm wide blades and the third flexible blade configuration contains 3 numbers of 10mm wide blades. Regular wave conditions with wave heights ranging from 2.5 to 15 cm and wave periods ranging from 1 to 3 seconds were generated in a water depth of 0.5 m. The forces acting on the vegetation models were measured using a Forsentek FNA-0.3 kg loadcell to study the influence of flexibility and blade configuration on the single plant drag force. The ratio of drag forces acting on the rigid vegetation to the flexible vegetation of same frontal area were found to be increasing with wave height, ranging between 2 and 5. These force measurements indicated that the influence of the flexibility is higher for long period waves. If the additional flexible blades are attached to the stem, the force per total frontal area was decreasing due to the shielding effects of adjacent blade. These results will be used to improve the wave energy dissipation models by refining the wave-driven drag force prediction models for flexible vegetation.

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Porni Mollick - Dynamic Mangrove Seaward Extent in Mary River, Northern Territory

Porni Mollick[1] *, Kerrylee Rogers[2] , Colin D. Woodroffe[2]
[1]University of Wollongong, Wollongong, Australia
[2]University of Wollongong, Wollongong, Australia
*Corresponding author: pm976@uowmail.edu.au

Keywords: *Mangrove, Coastline, Dynamic, Remote sensing, Change types*

Mangroves are dynamic along with the coastline. As the sea level rises, the susceptibility of mangrove extent is not entirely evident. This research aims to understand the dynamics of mangrove seaward fringe along the coastline adjacent to the Mary River, Northern Territory, for 35 years (1987 to 2022). It uses mangrove mapping undertaken by Geoscience Australia as part of Digital Earth Australia (DEA). These DEA Mangroves (Landsat) and DEA Coastlines datasets capture mangrove extent and coastline changes from 1987 (mangroves) and 1988 (coastline) onwards. This study also uses remote sensing approaches and the digital shoreline analysis system (DSAS), one of the ArcMap extensions, as the primary tool to determine mangrove seaward extent and coastline changes. For investigating the annual incremental changes and classifying the dynamic behaviours of mangrove seaward extent and coastline for 35 years through linear regression rate (LRR), one of the statistical methods from DSAS is evaluated. Moreover, DEA mangrove seaward extent is compared to high-resolution imagery where the DEA Mangroves dataset is suitable for evidently capturing mangrove seaward extent on a local scale. Based on the LRR values, the entire Mary River area's mangrove seaward extent is classified into four different change types, e.g., contraction, progradation, establishment and stable. This research also found dynamic behaviours of mangrove seaward extent, such as the highest amount of contraction recorded on the tidal creeks-dominated western coast of Mary River, where the coastline also contracted. Conversely, the highest progradation was recorded around large tidal creeks eastern coast of Mary River, where the coastline was also accreted. Overall, mangroves are dynamic, but with sea level rise, their behaviour in the future is less clear, so this study could be considered a valuable guideline for understanding behavioural change patterns of mangrove seaward fringe and would have a useful contribution to managing mangrove-dominated coastlines.

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Robbi Bishop-Taylor - Time and tide: A new pixel-based method for mapping dynamic intertidal Topography

Robbi Bishop-Taylor[1], Claire Phillips[1], Stephen Sagar[1], Vanessa Newey[1]
[1]Geoscience Australia, Canberra, ACT
*Corresponding author: Robbi.BishopTaylor@ga.gov.au

Keywords: *intertidal zone, remote sensing, coastal monitoring, bathymetry, elevation*

The intertidal zone represents a critical transition zone between land and sea. However, data on the physical extents and morphology of the intertidal zone is challenging and expensive to obtain at scale, often resulting in a "missing link" between terrestrial elevation and marine bathymetry data. Recently, freely available remote sensing data from earth observation satellites like Landsat have been combined with tide modelling to create the first threedimensional maps of Australia's intertidal zone (Bishop-Taylor et al. 2019). However, these datasets have been limited by their low spatial resolution and static characterisation of often highly dynamic and complex intertidal environments.

This talk will introduce a new method for mapping intertidal topography at unprecedented spatial and temporal resolution. Our approach combines analysis-ready Landsat and Sentinel-2 satellite imagery from Geoscience Australia's Digital Earth Australia program with state-of-the-art global tide modelling to analyse patterns of tidal inundation across Australia's entire intertidal zone. Our approach is applied at the pixel level, allowing us to extract finescale morphological details that could not be resolved by previous waterline-based intertidal mapping methods. This pixel-based method greatly decreases the volume of satellite imagery required to accurately model intertidal elevation, allowing us to produce multitemporal snapshots of the Australia's dynamic intertidal zone from 2016 to the present.

Our approach is based on open-source satellite data and code, making it suitable for analysing coastal zones globally. Our outputs will form part of the upgraded and freely available Digital Earth Australia Intertidal product suite, providing easy access to foundational intertidal elevation data for applications that require a detailed understanding of the changing topography of Australia's dynamics coastal environments.

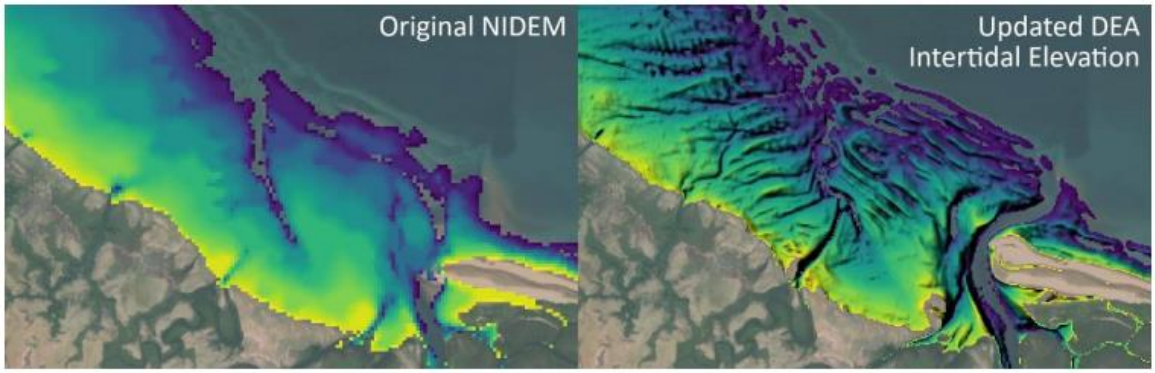

Figure 1: Comparison between the current National Intertidal Digital Elevation Model dataset and the updated DEA Intertidal Elevation dataset

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Ryan Cope - Blue Carbon Opportunities in the Lower Shoalhaven River

Ryan Cope[1,2]*

[1]University of Wollongong, Wollongong, Australia
[2]Shoalhaven City Council, Nowra, Australia
*Corresponding author:ryan.cope@shoalhaven.nsw.gov.au

Keywords*: Blue Carbon, Tidal Restoration, Wetlands*

Blue Carbon Ecosystems (BCE) play an important role as carbon reservoirs and have the potential to sequester more carbon than any other ecosystem. This has sparked interest in these ecosystems and their potential for use in climate mitigation strategies and carbon abatement. BCEs can be restored in areas which have been tidally modified through anthropogenic intervention. One location which has experienced tidal modification is the Lower Shoalhaven River, which has many floodgates separating associated tributaries from the tidal influences of the Shoalhaven River Estuary. Recent studies have investigated Blue Carbon potential at a national and state level, but there are limited studies at a regional scale. Using the Blue Carbon Accounting Model (BlueCAM) and the Forward Abatement Estimator (FAE) this study aimed to identify Blue Carbon abatement potential across the Lower Shoalhaven, investigate abatement upstream of a single floodgate as a case study, and identify impacts of tidal restoration. Abatement potential was determined using LiDAR in conjunction with land use mapping, to enable FAE and BlueCAM derived abatement values to be applied across the floodplain. This was done for 25- and 100-year permanence periods. This study found areas with low biomass were more suitable for Blue Carbon projects as these areas have lower ecosystem transition emissions. Lower elevations were less suitable for Blue Carbon projects as these areas go through multiple ecosystem transitions imposed by sea level rise. The Lower Shoalhaven was estimated to have high abatement potential. It was found that the FAE was better suited to determining future abatement potential when compared to BlueCAM, but the latter was more suited to reporting on ongoing Blue Carbon projects. Overall, this study recommends that Blue Carbon projects in the Lower Shoalhaven should target grazing areas and work alongside landholders to achieve economic, environmental, and social sustainability.

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Sanne Vaassen - Unravelling the Physical Controls on Shifts in the Mangrove-Marsh Ecotone

Sanne Vaassen*,[1]

[1]University of Waikato, Hamilton, New Zealand
*Corresponding author: sv184@students.waikato.ac.nz

Keywords*: saltmarsh, mangrove expansion, ecotone, vegetation dynamics, sea level rise*

Coastal wetlands are highly valuable ecosystems delivering ecosystem services varying from carbon sequestration to biodiversity and coastal protection. The northern, more temperate, regions of our globe are often dominated by saltmarsh species, whereas mangroves dominate in the tropics. Apart from a reduction in the overall area covered by coastal wetlands, climate change and an increase in human pressure have led to a shift in species composition. In temperate regions, the encroachment of mangrove species into salt marsh ecosystems has been observed (Swales (2021)). Recent studies have shed light on the complexity of physical forces driving these changes in the mangrove-marsh ecotone, which show large variability on both spatial and temporal scales (Rogers, 2019). To be able to manage our valuable coastlines sustainably, it is important to understand why coastal wetlands are changing and what that means for the ecosystem services they provide. This work aims to contribute to our still limited understanding of these ecotone shifts by carrying out remote sensing, modelling, and field studies in the context of Aotearoa New Zealand estuaries; an area where mangroves have expanded extensively over the last decades. The outcomes will provide valuable insights into saltmarsh- mangrove dynamics which can support long-term coastal management decisions.

Figure 1: mangrove encroachment into saltmarsh vegetation in Whangateau harbour, Aotearoa New Zealand

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Stephanie Doumtsis - Building pathways for adaptation: Learnings from the Torres Strait Islands

Stephanie Doumtsis[1] *, Michael Rosenthal[1], Marika Seden[1]
[1] Alluvium Consulting, Melbourne, Australia *Stephanie Doumtsis:
stephanie.doumtsis@alluvium.com.au

Keywords: *Coastal hazards, engagement, adaptation, resilience, Torres Strait Islands*

With islands encircled by tropical seas, the Torres Strait is a distinctive Country, where the natural environment and traditional cultures intertwine and flourish together, creating an unparalleled connection to the land, sea and sky. For decades, the Torres Strait Island Regional Council's (TSIRC) 15 Island communities have been at forefront of climate change, and are susceptible to coastal hazards driven by tropical cyclones, storm events and annual trade or 'Kuki' winds. As the frequency and magnitude of coastal hazards across the region increases, further planning and funding is required to better prepare communities for the impacts of storm tide, coastal erosion and rising sea levels resulting from climate change.

In 2016, the Queensland Government, in partnership with the Local Government Association of Queensland (LGAQ), launched the QCoast2100 program, which has provided $13 million in funding to assist Queensland coastal Councils in developing Coastal Hazard Adaptation Strategies (CHAS's). With funding awarded to TSIRC, Alluvium have assisted TSIRC in developing the Zenadth Kes Coastal Hazard Adaptation Strategy (Zenadth Kes CHAS), a unique adaptation strategy and management tool for the Torres Strait Islands. The Zenadth Kes CHAS involves a holistic eight-phase process beginning with technical studies identifying coastal hazard extents and asset risk and vulnerability assessments, through to evaluations of adaptation options and finally, action implementation. The strategy aims to guide Council in developing a strategic medium- to long-term approach towards managing coastal hazards using the best available science and decision-making practices, to retain values and liveability across the 15 island communities.

This presentation aims to outline the leading practice technical approach towards building strategic adaptation pathways for coastal management, using the Torres Strait Islands as a case study example (Figure 1). It will also share project learnings on the importance of engagement in enabling communities to become champions in delivering coastal management actions, provide tips on how create simple and effective engagement maps, as well as highlight the opportunities and challenges faced when working across 15 geomorphologically unique Island communities.

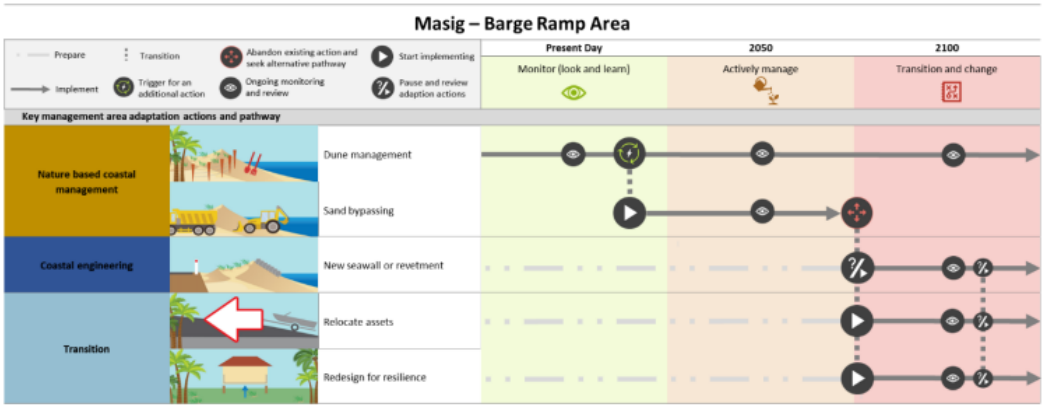

Figure 1: Adaptation pathway for the Masig community in the Torres Strait Islands.

Stephen Rigney - Flux and flow: inundation and salinity drive coastal wetland GHG emissions

Stephen Rigney[1] *, Jeffrey Kelleway[1] , Nicholas Deutscher[1] , Michael Hughes[2]
[1]University of Wollongong, Wollongong, Australia
[2]NSW Office of Environment & Heritage, Parramatta, Australia
*Corresponding author:sdr827@uow.edu.au

Keywords: *greenhouse, flux, wetland, inundation, salinity*

Coastal wetland ecosystems (blue carbon) are long-term carbon sinks capable of sequestering carbon for millennia. Consequently, their preservation and restoration are increasingly popular climate change mitigation solutions. However, for coastal wetlands to have a net cooling effect on the atmosphere, their carbon storage must exceed their emissions. Also, the conditions that facilitate carbon sequestration are favourable for the production of several potent greenhouse gases (GHGs), including methane (CH4) and nitrous oxide (N2O). These gases are modulated by two interconnected environmental conditions: inundation and salinity. While coastal wetland CO2 emissions are well understood globally, little research has been conducted on the drivers of CH4 and N2O, particularly within the Australian context. In summer 2022, soil-atmosphere fluxes were analysed via FTIR spectroscopy using 12 chambers installed over an elevation gradient spanning mangrove, lower saltmarsh, upper saltmarsh and swamp oak forest ecosystems. CH4 fluxes were higher in the two lower elevation communities (M= 21.6g m-2 s -1 , SD=30.8) than the two upper (M=1.11g m-2 s -1 , SD=2.57). In contrast, N2O showed the opposite pattern (lower M=-0.20g m2 s -1 , SD=5.8; upper M=19.2g m-2 s -1 , SD=11.3). A campaign will be conducted in winter 2023 for seasonal comparison. These findings provide insight into the effect of hydrology on coastal GHG emissions. With sea levels predicted to rise by 0.43-0.84m by 2100, it is critical that we understand how coastal GHG emissions will respond.

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Tomás León Cortés - Exploring hybrid modelling of the 1877, 2015 tsunamis in North-Central Chile

Tomás León Cortés[1]*, Annie Lau[1], Ananth Wuppukondur[2]
[1]School of Earth and Environmental Sciences, The University of Queensland, Brisbane, Australia
[2]School of Civil Engineering, The University of Queensland, Brisbane, Australia
*Corresponding t.leoncortes@uq.edu.au

Keywords: *Tsunami deposits, Sediment transport, TELEMAC, TSUFLIND*

The coastal areas of northern and central Chile experienced significant tsunamis in 2015, 1877, and 1868. This study focuses on the onshore characteristics of the 1868 and 1877 tsunamis in Arica and the 2015 tsunami in the Tongoy lowland. It compares inverse modelling using TSUFLIND, which estimates flow parameters based on deposit characteristics, with forward modelling using TELEMAC 2D and GAIA modules, which simulates tsunami hydrodynamics and sediment transport based on earthquake settings.

Meshes of different resolutions were created using onshore topography and offshore bathymetry, and tsunami sources were calibrated using field data. In Tongoy, the inverse modelling showed average onshore speeds of the 2015 tsunami ranging from 3.9 to 1.8 m/s and a flow wave height of 3.22 to 1.14 m at varying distances inland. The forward modelling indicated onshore velocities of around 3.12 m/s and sediment transport ranging from 0.02 to 0.3 m deposited inland. In Arica, both models exhibited velocities around 3.8 m/s and a wave height of 3.5 m at 400 m inland for the 1868 tsunami. For the 1877 tsunami, TELEMAC estimated velocities of 1.18 m/s and wave heights of 2.14 m, while TSUFLIND showed velocities of 3.3 m/s and wave heights of 2.86 m at 480 m inland. Deposits in Arica ranged from 0.05 to 0.1 m, with simulations revealing deposit thicknesses of 0.0017-0.08 m for the 1868 tsunami and 0.002-0.003 m for the 1877 tsunami.

The results from both the inverse and forward models showed agreement in simulating flow dynamics for the 2015 tsunami in Tongoy. In Arica, the models performed better for the 1868 tsunami. This study highlights the effectiveness of combining inverse and forward modelling approaches to estimate flow parameters and sediment transport, providing valuable insights into the onshore characteristics of tsunamis in Chile.

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Valeria Fanti - Assessing the impact of storms on barrier island systems using global models

Valeria Fanti[1]*, Carlos Loureiro[2,3], Óscar Ferreira[1]
[1]Centre for Marine and Environmental Research (CIMA/ARNET), Universidade do Algarve, Faro, 8005-139, Portugal
[2]Biological and Environmental Sciences, Faculty of Natural Sciences, University of Stirling, Stirling, FK9 4LA, Scotland, UK
[3]Geological Sciences, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Durban, 4001, South Africa
*Corresponding author: vfanti@ualg.pt

Keywords*: storm impact; barrier islands; global DEMs; wave reanalyses.*

The geomorphological impact of extreme coastal storms on barrier islands can be predicted with increasing accuracy due to the development of process-based models and the use of high-resolution in situ oceanographic and topo-bathymetric data. However, data availability is restricted in space and time, with large gaps preventing the assessment of storm-induced risks in many coastal areas of the world. The potential use of hydrodynamic forcing from global wave reanalyses and topo-bathymetric grids from global digital elevation models has yet to be comprehensively evaluated. This study used coarse-resolution boundary conditions and topo-bathymetric grids from openly available global datasets to model the impact of a 50-year return period synthetic storm on natural barrier islands using SWAN and XBeach. The synthetic storm was generated using ERA5 and WAVERYS wave reanalysis data, previously calibrated in Fanti (2023) to correct for the underestimation of wave heights and periods. The storm was then propagated over a synthetic barrier island profile derived from merging TanDEM-X and Copernicus GLO-30 global digital elevation models with ETOPO2022 global bathymetry. The global model runs were compared to a baseline run with high-resolution data. XBeach results showed an overall overestimation of the 2m shoreline retreat by all global model combinations (Figure 1). However, the erosional response to the synthetic storm was reproduced appropriately and erosion metrics were consistent with the baseline run. In particular, the higher-resolution global scenario with input data from TanDEM-X and WAVERYS achieved the best results, providing encouraging results for storm impact modelling with global datasets. Therefore, quantifying the uncertainties associated with using global datasets in morphodynamic modelling can increase the predictive accuracy and allow the definition of confidence levels for applying global models for storm impact assessment in barrier islands.

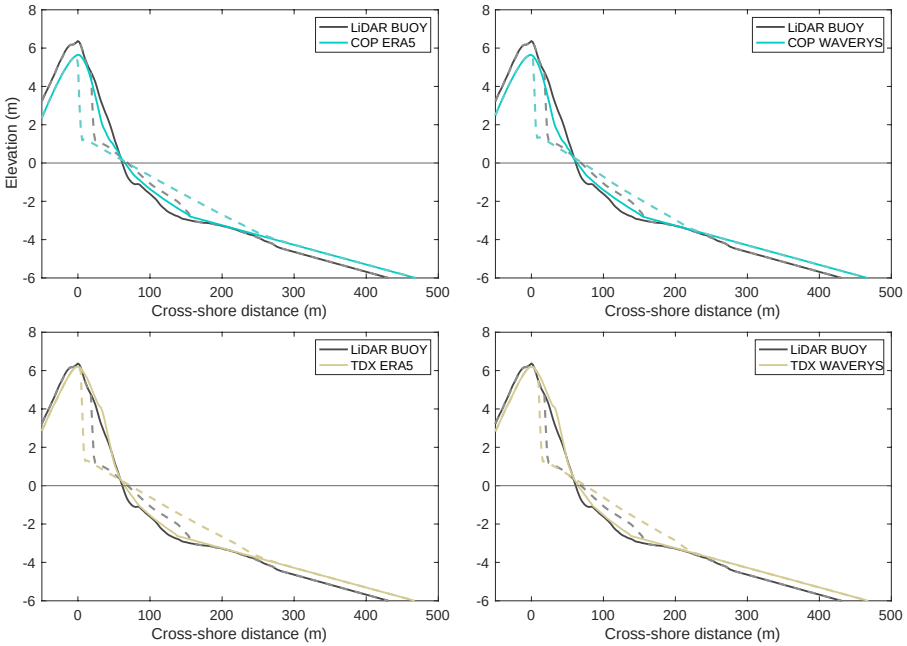

Figure 1: XBeach pre- (solid line) and post- (dashed line) storm profiles from Praia de Faro, Portugal. The baseline barrier profile (black) was extracted from Lidar data and compared with the profiles extracted from TanDEM-X (brown) and Copernicus GLO-30 DEM (turquoise). The storm was generated from Faro Costeira buoy data for the baseline run and WAVERYS and ERA5 for the global model runs.

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Yanyan Zhang - Enhancing Beach Accessibility: Overcoming Design Challenges for Beach Access in NSW

Yanyan Zhang[1] *, Nat Patterson[1], Gary Blumberg[1]
[1]Royal HaskoningDHV, Sydney, Australia
*Corresponding author: Yanyan.zhang@rhdhv.com

Keywords: *beach access, accessible beach*

Beaches are an iconic part of the Australian lifestyle. There has been a growing trend to provide equal access for individuals with less mobility, by constructing and upgrading beach access facilities in accordance with AS1428 Design for Access and Mobility. These improvements empower individuals with less mobility to access and enjoy their time at the beach.

However, designing these facilities presents several challenges. One of the primary constraints is the need for sufficient space to accommodate walkways, ramps, and landings that provide a continuous, wide, and accessible path of travel from amenities such as carparks, toilets, showers, change rooms, and kiosks, to the beach. The design must also take into account the irregular terrain of the beachscape and locations of local amenities. Another significant challenge is the loss of sand due to the dynamic coastal environment, including storm erosion, tidal conditions, and sediment transportation. If beach access facilities cannot provide consistent access to the beach after storms, they will pose a risk to users, particularly those with disabilities. As a result, scour and toe protection must be considered during the design process. Other challenges include service lifespan, cost, and ease of maintenance.

This paper will summarise and discuss Royal HaskoningDHV's past projects in designing beach access which provide ease of access for people with disabilities to go to the beach in NSW, including both permanent and temporary designs. It will demonstrate how these designs have successfully overcome the challenges to provide safe access to beaches and rock pools.

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Yarran Doherty - Merimbula Lake entrance bar: Insights from 35 years of satellite imagery

Yarran Doherty[1]*, Brett Miller[1], James Carley[1], Chris Drummond[1]
[1]UNSW Water Research Laboratory, Sydney, Australia
*Corresponding author: y.doherty@wrl.unsw.edu.au

Keywords: *remote-sensing, entrance bar, coastal monitoring, CoastSat*

Understanding the morphological evolution of coastal and estuarine systems is crucial for effective management and mitigation of associated hazards. This study presents a comprehensive analysis of the Merimbula Lake entrance bar, focusing on its temporal changes and the driving forces influencing its behaviour. Through the novel application of CoastSat, a satellite-based shoreline mapper (Vos, 2019), position of the entrance bar was extracted from publicly available imagery from 1987 to 2022. Enabling the creation of a longterm timeseries of entrance bar position, this data was supplemented with historical aerial imagery to understand the historic range of movement and long-term trends of key morphological features at the site. To develop a conceptual understanding of the broader sediment compartment, a data-driven evaluation of environmental forcing factors was undertaken by comparing channel alignment and entrance bar position against prevailing wave climate, water levels, catchment inflows, El Niño-Southern Oscillation (ENSO) and beach orientation index (BOI). The results of this study revealed that the Merimbula Lake entrance bar is largely contained within a consistent spatial boundary, maintaining a state of dynamic equilibrium at the complex interface between wave-driven sediment transport and estuarine tidal hydrodynamics. Periodic cycles of shoal blowout resulting in channel infilling and reduced channel navigability were observed primarily in response to discrete storm erosion events. These eroded states were observed to recover naturally over a six-month window as tidal forcing conditions returned deposited sediment back to the entrance bar. Highlighting the complex and site-specific variability of estuarine entrance bars, the results of this study further demonstrate the suitability of CoastSat as a tool for long-term entrance bar monitoring and management.

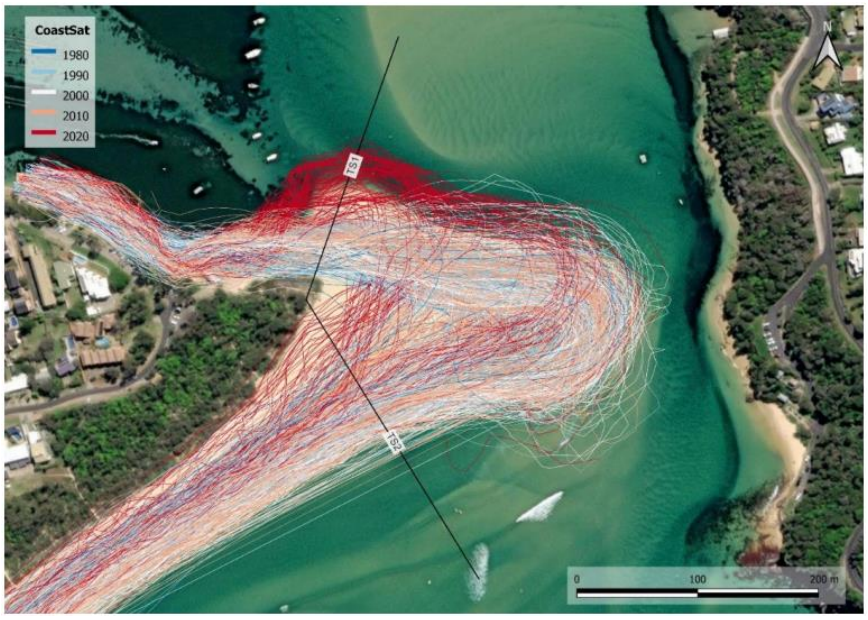

Figure 1: History of Merimbula Lake entrance bar position (1987-2022)

References:

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