Young Coastal Scientists' and Engineers'

YCSEC 2025 PROGRAMME

3 – 4 April 2025
Dove Marine Lab

Newcastle University

Sponsors

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Contents

About

YCSEC

YCSEC is a conference for early career researchers and practitioners in the field of coastal sciences and engineering. It provides a welcoming and supportive environment for MRes, MSc, and PhD students, along with postdoctoral researchers, and recently qualified practitioners to present and discuss research, and to share good practice. It is a great opportunity to interact with a small community of researchers, allowing you to expand your knowledge and network.

The interdisciplinary audience and subject areas are designed to promote connections and integration between early career coastal scientists and engineers focusing on both the physical and biological processes within the coastal environment. In the past, this has included presentations on a diverse selection of topics, such as, but not limited to: marine renewables, coastal ecology, flooding and climate change, coastal erosion and morphological modelling, green engineering, and the effects of pollution.

Venue

The conference will be held at Newcastle University's Dove Marine Laboratory at Cullercoats. The Dove represents a history of over 110 years of marine science in the north east of England. The lab has always played an important part in teaching and research of marine sciences at Newcastle and many alumnus have fond memories of being at Cullercoats during their studies. Now part of Newcastle University's School of Natural and Environmental Sciences, parts of the Dove have been modernized for contemporary teaching but the historic character remains. Situated right on the beach at Cullercoats, it's the perfect place to host YCSEC!

Local organising committee

Sebastian Pitman   Heather Sugden   Chris Hackney   Jack Duffy

Steering committee

Jenny Brown	National Oceanography Centre
Chris Blenkinsopp	University of Bath
Daniel Conley	University of Plymouth
Nick Dodd	University of Nottingham
Suzanna Ilic	Lancaster University

Timetable

Thursday 3rd April

08:30–09:10	**Registration**		
09:10–09:15	**Welcome remarks**		
09:15–10:00	KL	**Oli Burns** Environment Agency	Keynote talk: Changing coasts: A perspective on the evolving future of coastal management
10:00–10:45	**Poster session with Coffee**		
10:45–11:00	CT	**Tom Hamilton** University of Plymouth	Spatial and Temporal Variations in Sediment Grain Size Distribution on a Composite Gravel Beach in Response to Extreme Hydrodynamic Forcing
11:00–11:15	CT	**Melanie Biausque** British Geological Survey	Studying the evolution of gravel systems in the UK: a Rapid Evidence Assessment (REA) for the UKGravelBarriers Project
11:15–11:30	CT	**Leo Pancrazzi** University College London	Large-scale morphometric analysis of gravel barrier systems around the UK using digital elevation data and aerial imagery
11:30–11:45	CT	**Naomi Lockwood** Mott MacDonald	Adapting Coastal Communities: Lessons from Storm Babet and the Berwickshire Coastal Change Adaptation Plan
11:45–12:00	CT	**Jingjing Yan** HR Wallingford	Satellite enhanced computational modelling of underwater noise and ecological impacts in coastal areas
12:00–12:15	CT	**Ewan T Richardson** Royal HaskoningDHV	Coastal Adaptation at Northey Island, Essex

12:15–13:15	**Lunch**		
13:15–13:30	CT	**Katie Lee** University of York	How did the Great Barrier Reef become so great? Modelling tidal dynamics of the last 9,000 years to understand how the Great Barrier Reef developed
13:30–13:45	CT	**Zehua Zhong** University of Southampton	Linking Large-Scale Climate Oscillations to Local Wave Climate and Storm Surge: Insights from a Weather Typing Approach
13:45–14:00	CT	**Matthew Appleton** University of Nottingham	Dynamic Equilibrium on Cliff and Shore Platform Systems
14:00–14:15	CT	**Ashley Holsclaw** University of Plymouth	Observations of Wave Setup on a Coral Atoll
14:15–14:30	CT	**Samuel Rose** University of Bath	Measurements of wave runup on an atoll island using LiDAR
14:30–14:45	CT	**Quan Nguyen** University of Nottingham	Numerical investigations of bottom boundary layer hydrodynamics under a dam-break-driven swash event on a mobile bed
14:45–15:00	CT	**Munawir Pratama** The University of Edinburgh	Ebb Tidal Jet at Montrose Bay: Insights from 2DH vs 3D Models and Validation with Satellite Imagery

15:00–15:45	**Poster session with Coffee**		
15:45–16:00	CT	**Jack Duffy** Newcastle University	Novel techniques for designing hydrodynamically scaled kelp mimics for use in laboratory wave attenuation experiments
16:00–16:15	CT	**Rebecca Lister** University of Plymouth	Kelping up with the satellites: Filling in the gaps of a study on ‘the short-wave attenuation by kelp forest canopy’ using Sentinel-2
16:15–16:30	CT	**Xinyi Zhang** University of Aberdeen	Wave attenuation by rigid suspended canopies
16:30–16:45	CT	**Sabana Parvin** London South Bank University	Modeling of Air Pressure Dynamics and Water Height Response in a Pneumatic Tsunami Generator
16:45–17:00	CT	**Jenny Cudmore** University of York	Trees vs Tsunamis: Mangrove Forests as a Defence against Tsunamis
17:00–17:15	CT	**Dominic Shaw** University of Bath	A risk based approach to Welsh tsunami vulnerability in the Severn Estuary, UK.
17:15–19:15	**BBQ Dinner and Social**		

Friday 4th April

08:30–09:15	**Coffee and Pastries**
09:15–09:30	**Conference Prize Presentation and Closing Remarks**
09:30–12:00	**Field Excursion to St Mary’s Lighthouse**

Keynote Speaker: Oli Burns

Talk Title: Changing coasts: A perspective on the evolving future of coastal management

Biography:

Oli Burns is a Principal Geomorphologist at the Environment Agency with 13 years' experience working on coastal management and conservation. Oli joined the EA in 2012 after graduating from the University of Portsmouth. His career at the Agency has seen him progress from area officer for East Anglia to become the organisation's national lead for coastal geomorphology. His work involves influencing national policy and strategy development, as well as providing technical support for colleagues working on the most complex casework. Oli is also a Chartered Geographer and Fellow of the Royal Geographical Society.

Book of Abstracts – Talks

Spatial and Temporal Variations in Sediment Grain Size Distribution on a Composite Gravel Beach in Response to Extreme Hydrodynamic Forcing

[1*]Hamilton, T., [2]Masselink, G., [2]Scott, T., [2]Conley, D., & [2]Poate, T.
[1]tom.hamilton@plymouth.ac.uk , University of Plymouth, United Kingdom
[2]University of Plymouth, United Kingdom

Gravel beach and barrier systems, including pure, mixed and composite types, are ubiquitous in mid- to high-latitude regions of the world, typically being found along paraglacial coasts and coastlines backed by mountain ranges. The coarse-grained, hydraulically rough, and permeable nature of gravel beaches makes them widely recognized as cost-effective and sustainable forms of natural coastal defense, protecting back barrier coastal zones from inundation and erosion. Research into the storm responses of mixed and composite type gravel beaches is lacking in current literature, primarily due to the logistical challenges associated with data collection. Consequently, little is known about how the relative proportions of sand and gravel modulate their morphodynamic responses and how these responses are distinguishable from the processes of sediment transport on single sediment-type beaches. Here, we address this gap in our understanding by capturing the spatial and temporal variations in grain size distribution on a composite sand and gravel beach in response to an extreme wave forcing event.

Data collection consisted of deploying a 2D LiDAR scanner, 2 video cameras, 5 pressure sensors (PTs), and 2 Acoustic Doppler Velocimeters (ADVs) to continuously monitor the beach evolution in response to extreme hydrodynamic forcing conditions. Regular topographic and sedimentological surveys were conducted every low tide with an RTK-GPS and DGS (digital grain size) camera along 5 cross-shore transects (Figure 1). Additionally, pre- and post-storm topographic surveys were conducted with a UAV to capture the overall 3D evolution of the beach.

Preliminary analysis of results indicates that the beach experienced significant morphological change in response to very large and long period waves. Flattening and widening of the beach slope occurred across the steep upper gravel section with a seaward migration of the break point interface between the upper beach and low-tide terrace. DGS results showed the gravel became more well sorted following the storm event, with a fining of gravel/cobble material from the beach crest to low-tide terrace interface.

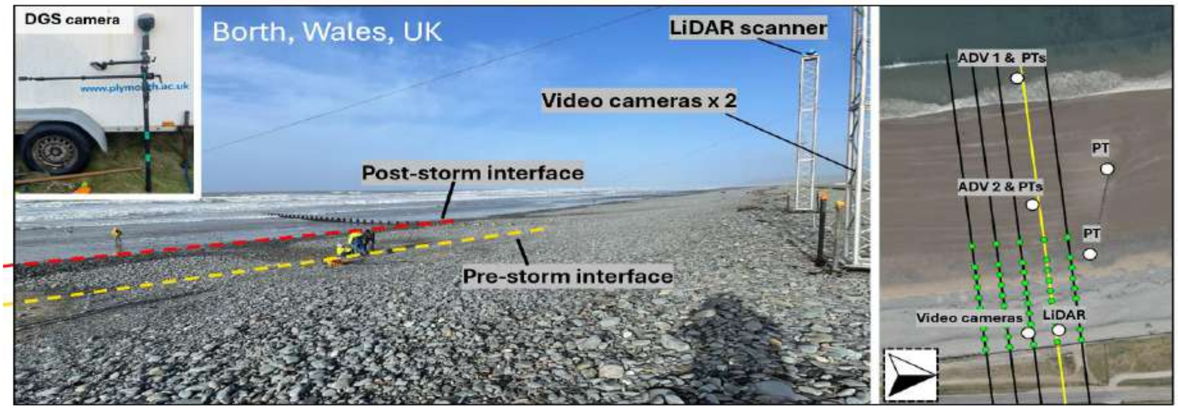

Figure 1: Diagram of storm response study site showing locations of the 5 cross-shore transects and the locations for different equipment deployments. Green points indicate DGS samples. Dashed yellow and red lines depict the seaward migration of the break point interface between upper gravel and lower sandy beach sections.

Studying the evolution of gravel systems in the UK: a Rapid Evidence Assessment (REA) for the UKGravelBarriers Project

[1]*Biausque, M., [2]Payo, A., [2]Tappin, D. & [2]Banks, V.
*lead presenter
[1]mbiau@bgs.ac.uk, BGS, Belfast, Northern-Ireland
[2] BGS, Keyworth, England

UKGravelBarriers is a NERC-funded project aiming to investigate the short-term (e.g., storm-scale) to long-term evolution of gravel systems in the UK (spanning the last 20,000 years to the horizon of 2150). Defined by a NERC highlight call, the spatial scope of this project targets gravel beach and barrier systems, including pure gravel, mixed sand and gravel (MSG), and composite beaches around England, Wales, Scotland, and Northern Ireland.

The project is structured around six research questions addressing various topics, such as the relationship between barriers and back-barrier ecosystems—including their protective role—the decadal to future morphological evolution of gravel systems in response to climate change, and the influence of internal composition, structure, and hydraulic conductivity on barrier behaviour.

To answer these questions and identify research gaps, a Rapid Evidence Assessment (REA) was conducted. Unlike traditional literature reviews, the REA follows a systematic process, defined by an agreed protocol, to review and analyse existing research, including grey literature. The purpose of this REA is to provide decision-makers with insights regarding the morphodynamics and future evolution of gravel systems using a structured approach, enabling stakeholders to make informed choices based on the best available evidence. The team, composed of researchers from multiple UK institutions, followed DEFRA guidance to produce this REA.

One of the first steps of the REA was to define key words for each research question using the PICO method. Preliminary results, however, show the high sensitivity of the process to the selection of key words, as they significantly influence the relevance of the evidence found. After careful screenings of the different pieces of evidence gathered, the results from the REA have, to date, helped clarify the classification of gravel systems in the UK based on the description of their dominant gravel fraction and identified research gaps that will be addressed throughout the UKGravelBarriers project.

Large-scale morphometric analysis of gravel barrier systems around the UK using digital elevation data and aerial imagery

[1]*Pancrazzi, L. & [1]Burningham, H.
*lead presenter
[1]l.pancrazzi@ucl.ac.uk, University College London, UK

The ability of coastal barriers to adapt to sea level changes and fulfil their protective role is closely tied to their geomorphological heritage that controls both accommodation space and sediment supply. Understanding the morphodynamics of specific coastal features over several decades or centuries requires, therefore, not only in-depth knowledge of the features themselves, but also of the surrounding environment. Systemic approaches are usually considered at a local scale and rarely applied beyond the immediate sedimentary cell. To enhance consistency and gain a more comprehensive understanding of coastal barrier contexts and controls across the broader range of geomorphic contexts, a new approach of analysing these coastal features is needed.

The UK has an abundance of gravel beach-barrier systems that can be found in several geomorphological contexts, and a highly developed coastal monitoring network that has been delivering measurements since the 1990s. Most of the coastline is covered by digital elevation models and aerial images that can be used to analyse the morphology and evolution of coastal environments. Although gravel beaches are all characterized by a predominance of coarse-grained particles (> 2 mm), they are often mixed with varying amounts of finer sand particles, resulting in different beach sub-categories (e.g. pure gravel, composite, mixed sand-and-gravel). In addition to sediment variability (which links to sediment availability and supply), gravel beaches, like their sandy counterparts, organise themselves into various barrier landforms, such as spits, barrier beaches or beach ridge plains. This diversity of gravel barrier morphosedimentary character is currently one of the major obstacles to the creation of modelling tools for predicting the evolution of this type of coastal features.

To illustrate the benefits of a large-scale geospatial approach, an inventory of more that 250 sites, gravelly shorelines have been identified around the UK and subdivided in accordance with the beach and barrier type. Here, we demonstrate a framework for systematic morphometric analysis of gravel beach-barrier systems at the national scale. Barrier metrics (e.g. width, height, volume), inland topography, nearshore bathymetry and habitat mapping are extracted at a system scale that is divided into multiple segments to facilitate categorisation. The results represent a step forward towards a typology classification of gravel barrier systems. They also allow to highlight the importance of the various data sets when considering this approach, as well as identifying important gaps in data availability.

Adapting Coastal Communities: Lessons from Storm Babet and the Berwickshire Coastal Change Adaptation Plan

[1]*Lockwood, N.B, [2] Morrison, D., [3]Hutchison, Z. & [3]Deakin, V.
*lead presenter
[1]naomi.lockwood@mottmac.com, Mott MacDonald Limited, UK
[2] Scottish Borders Council, UK
[3] Mott MacDonald Limited, UK

In October 2023, Storm Babet hit the east coast of Scotland, and much of the UK. Extreme rainfall sustained high winds and stormy seas which resulted in loss of life, major road closures and widespread damage to houses, infrastructure, and other key assets. Coastal communities like those found along the Berwickshire Coast can be disproportionately affected during a storm due to their remote location and vicinity to potential coastal hazards; becoming isolated and physically unable to reach key services in an emergency. Scottish Government published the Coastal Change Adaptation Plan (CCAP) guidance which aimed to encourage local authorities to work collaboratively towards adapting coastal communities to mitigate potential future climate change related disasters.

Scottish Borders Council employed Mott MacDonald Limite through Scottish Government funding to produce one of the first Stage 1 CCAP reports. This report sets strategic short and long-term policies for managing the risk to people and the developed, historic and natural environment through a Dynamic Adaptative Pathways approach. The series of ‘pathways’ link the short and long-term policies and contain individual action plans. An action plan, change in policy or reassessment of the overall plan, would be initiated by a “trigger” point. A trigger could be physical, inhibiting or enabling. The impact of coastal erosion and flooding on this recreational asset was assessed for the Stage 1 report using high-level data from Dynamic Coast (erosion and sea level rise) and Scottish Environment Protection Agency (SEPA) (flooding), as well as a shoreline change hazard assessment conducted as part of the wider project scope.

This baseline assessment concluded that Coldingham Bay Beach would not be at a significant risk of failure based on the data available. Despite this, Storm Babet decimated the sand dunes which provide some protection to beach huts within Coldingham Bay. An event like Storm Babet would be considered as a “physical” trigger point because it drastically changed the usability of, and safe access on to, the beach. Therefore, Storm Babet was included in the assessment of the short and long-term policies. The root cause of the Coldingham Bay Beach (and sand dune) collapse was not assessed as a part of this project. However, it is assumed that the high winds and easterly direction of the storm (which coincided to directly face the beach) exacerbated the erosion.

Although the coastal flooding and erosion from Storm Babet was significant, it was largely constrained to this area of the Coastal Management Unit. The area surrounding Coldingham Beach is largely unpopulated and undeveloped. However, Public consultation showed that Coldingham Beach was very important to local residents. As such, the short-term policy needed to allow for maintenance, at least in the short-term. Therefore, the short-term policy was set as No Active Intervention (NAI) – Local Activity Only with the intention of potentially transitioning to a long-term policy of NAI – Cease to Maintain. The final plan will need to balance the communal desire to retain the beach against the technical feasibility. Collaboration with the community will be vital in understanding how to decouple a potential for “behavioural lock-in” from an increasingly unsustainable management policy.

Satellite enhanced computational modelling of underwater noise and ecological impacts in coastal areas

[1]*Yan, J. & [2]Benson, T.D.G.
*lead presenter
[1]j.yan@hrwallingford.com, HR Wallingford, Wallingford OX10 8BA, UK
[2] HR Wallingford, UK

Underwater sound modelling has become an essential approach for understanding and mitigating noise pollution from human activities in the marine environment such as shipping, construction, dredging and mining. It is now an important aspect of Environmental Impact Assessments (EIAs), yet the lack of comprehensive baseline noise data significantly limits our ability to assess and understand the impacts of marine activities and proposed new developments on the underwater soundscape.

Much of the long-term background (ambient) noise generated in the marine environment is generated by vessel activity in combination with natural sounds generated by weather (rain, wind and waves). We propose a novel computational model to incorporate Automated Information System (AIS) vessel data and weather data from the ERA5 global reanalysis dataset to provide accurate spatial predictions of the ambient noise sound spectrum. AIS data itself does not provide direct information on vessel noise emissions, posing challenges for accurate noise characterisation. To create a robust model for predicting underwater ambient sound maps for vessels in ports and harbours, a comprehensive evaluation of existing vessel noise source level spectrum models was first conducted, encompassing statistical approaches, and empirical models dependent of vessel characteristics (e.g. length, speed, type) and operational conditions. Notably, these source level models often yield different predictions for the same scenario, highlighting the need for a unified framework for underwater noise predictions.

Due to its extensive field validation, the JOMOPANS-ECHO model was chosen as most suitable for modelling the sound source levels for moving vessels, which are dominated by propellor noise. A limitation of this model is that it does not account for engine noise. Hence, on its own, it is not suited to creating noise maps in coastal areas (particularly harbours) where many boats are moored or manoeuvring slowly. To overcome this limitation, we incorporated a second noise source model to account for the machinery noise, based on engine characteristics (e.g. engine mass and number). However, depending on the types of the AIS data available, and because of data gaps being present, these parameters are not always available. To fill these data gaps, an existing regression relationship was used to derive the most common engine characteristics using the available vessel length, speed and type information, allowing the model to be adapted to various types of AIS data. Using Falmouth Harbour (UK) as a test case, the modelled vessel source level spectra were then combined with local bathymetry data and fed into an underwater sound propagation calculation using an acoustic flux formula to generate maps of average vessel noise.

The present study proposes a robust computational underwater noise model, aiming to provide reliable and quantitative prediction for anthropogenic underwater noise, to better support environmental impact assessments for both coastal areas and the open ocean. Further studies will build on the present work by incorporating more complex sound propagation methods to provide more accurate sound level predictions in shallow water environments. Additional regression analysis is also planned, which will improve the model parameter estimation and applicability of the model to the various types of AIS data.

Coastal Adaptation at Northey Island, Essex

[1]Richardson, E.T.
[1]ewan.richardson@rhdhv.com
[1]Royal HaskoningDHV, Newcastle-Upon-Tyne, United Kingdom

Coastal adaptation at Northey Island has strengthened and enhanced saltmarsh habitat in the Blackwater Estuary for the next 100 years.

Northey Island is a nature reserve owned and managed by The National Trust in the Blackwater Estuary, Essex. The island is designated as a nationally and internationally important place for nature conservation and has been at the forefront of coastal adaptation for over 30 years. The island is surrounded by saltmarsh, which is recognised as a 'Priority Habitat' under the UK Biodiversity Action Plan. Saltmarsh habitat delivers vital ecosystems services, including carbon sequestration, natural flood management and resource provision for fish and wildlife. At around 90ha (222 acres), the island forms the largest single block of saltmarsh in the Blackwater Estuary. Without management, almost all saltmarsh at Northey would be lost over the next 100 years.

To mitigate against the impacts of climate change, rising sea levels, and failing defences The National Trust have implemented a Coastal Adaptation Strategy. Building upon managed realignment undertaken in 1991, the Strategy has seen a number of significant civil engineering projects undertaken since 2017. These include beneficial use of dredged sediment, managed realignment through breaching historic embankments, construction of new flood embankments, creation of freshwater and brackish ponds, drainage improvement works, undergrounding of overhead electricity cables and various access and landscaping works.

Between 2021 and 2023 the managed realignment of a coastal flood embankment of some 600m length, resulted in over 4ha of suitable saltmarsh habitat being created. This included a rare 'transitional zone,' in the south east of the island, which means that by the year 2100 rising sea levels will have doubled the area of suitable habitat created in this location. By realigning the coastal flood embankment, the effects of coastal squeeze have been mitigated.

The design of the managed realignment considered the topographic features of the island along with environmental sensitivities including presence of badger setts and a water vole colony. These environmental factors lead to extensive changes the layout of the managed realignment scheme, including the construction of closing banks and freshwater ponds, into which a colony of 13 water voles was successfully translocated.

The construction of the works required careful programming and planning. Royal HaskoningDHV who undertook the design, consenting, project management and site supervision of the scheme, assisted both The National Trust and the Principal Contractor in delivering the construction works safely and in accordance with the Specification. The works were designed such that all embankment fill materials were liberated from excavations and breaching activities elsewhere on the island, resulting in no material import or export.

The project demonstrates practical and sustainable adaption to climate change and rising sea levels. Post construction monitoring of the island indicates that colonisation by pioneer saltmarsh species has begun rapidly. Furthermore, undergrounding of overhead cables has increased bird counts, with record numbers observed since construction was completed.

How did the Great Barrier Reef become so great? Modelling tidal dynamics of the last 9,000 years to understand how the Great Barrier Reef developed

Katie Lee*[1], Jon Pitchford[2], Jody Webster[3] and Jon Hill[1]
[1.] kl909@york.ac.uk Department of Geography and Environment, University of York, UK
[2.] Departments of Biology and Mathematics, University of York, UK
[3.] School of Geosciences, University of Sydney, Australia
*lead presenter

We can learn about the future of the Great Barrier Reef (GBR) by using the past. Tidal models of the last 9,000 years up to the present day have been built to simulate how 45 metres of rising sea level from the Last Glacial Maximum have affected coral larvae transportation and coral growth, allowing us to watch the GBR develop virtually. Pairing these tidal models with Lagrangian particle tracking software has shown there is a key relationship between the strength of tides and how individual reefs of the GBR are connected. This relationship developed around 8,000 years ago, coinciding with the modern GBR initiation, and may disappear in the future with rising sea levels. Modelling the initiation of the modern GBR will give us a better understanding of the influence of sea level on tidal dynamics, allowing us to better predict what will happen to GBR connectivity in the future. Understanding ecological effects of this physical change will be paramount to future conservation efforts. From these coral transportation models, resulting connectivity matrices of larval exchange illustrate changes in coral population throughout time in connection to available networks. Modelling past tidal behaviour and larval transport can provide insights into how the GBR grew from a handful of small reefs to the largest coral reef on the planet, which in turn will help inform expectations on future connectivity.

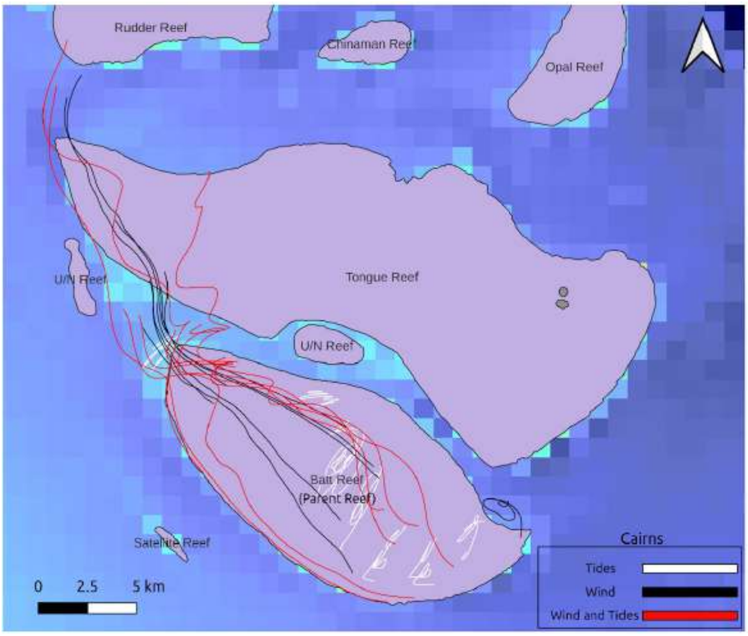

Fig. 1. Map of example trajectories of particles in three models in the Cairns area, displaying the difference physical forces have on coral larvae transportation. Models are: tidal forcing only, wind forcing only and tides & wind combined.

Understanding the impact of large-scale climate oscillation patterns on local wave and storm surge conditions using weather types

[1]*Zehua Zhong, [1]Hachem Kassem, [1]Ivan D. Haigh, [2]Dafni E. Sifnioti & [3]Ye Liu
*lead presenter
[1] Zehua.Zhong@soton.ac.uk, School of Ocean and Earth Science, University of Southampton, UK
[2] EDF Research & Development UK Centre, UK
[3] HR Wallingford, UK

The temporal and spatial variations of nearshore hydrodynamics are crucial for understanding shoreline evolution and the potential of coastal hazards. Local waves and sea levels not only respond to daily weather conditions but are also modulated by larger-scale climate oscillation patterns. Despite the explicit mechanisms remaining unclear, numerous works have demonstrated the linkages of these interannual climate variabilities with local wave climates and sea levels in many regions. Most past research has relied on correlation and other statistical analyses to identify the dominant climate patterns, investigate the spatial variations, and quantify their impacts on mean and extreme sea states. In this research we explore the possibility of relating climate oscillation patterns with local wave climates and storm surge conditions through weather types, an approach not commonly used in previous studies. Weather types are a set of quasi-stationary and recurrent synoptic circulation patterns able to characterise the climate variability over a region. The analysis is conducted at Hartlepool UK, where we have developed 36 weather types to assess the exposure to coastal hazards for a local nuclear power station.

First, we examined six climate indices and found that the North Atlantic Oscillation (NAO) and the Scandinavian pattern (SCAND) have significant correlations with local wave and storm surge variables. Second, we associated each weather type with the positive or negative phases of these two patterns based on its occurrence probability. Each weather type is also associated with unique distributions of wave and storm surge variables, which allows us to compare the wave and storm surge characteristics under different climate patterns. For weather types associated with NAO- or SCAND+, the storm surge distributions generally exhibit a narrow and tall peak with a mean roughly at 0 m, whereas most distributions associated with NAO+ or SCAND- have a wider but lower peak and a positive mean. The differences in the relative locations and shapes of storm surge distributions can be related to the two major drivers of storm surge: atmospheric pressure and wind stress. We found the means and standard deviations of surge distributions are very well correlated with the inverse barometer effect (Pearson's coefficient ρ=0.80) and the squared wind speed (ρ=0.92). This indicates that local storm surge responds to variations in the air pressure and wind speed, which are then modulated by the phases and intensity of NAO and SCAND. Distinct features are also found for distributions of wave variables. The peak wave period tends to have a bimodal distribution with two peaks at roughly 5 and 10 s during NAO+ or SCAND- and an unimodal distribution with the majority falling in between 5-10 s during NAO- or SCAND+. This is likely attributable to the different behaviours of wind waves and swell waves. We also find different patterns in the directional distributions of the two wave components. Our research demonstrates the potential of weather types as a powerful tool for understanding the impact of climate oscillation patterns on local sea states. Although the findings are specific to Hartlepool, they are potentially applicable to the nearby regions with similar coastal settings and atmospheric forcings, particularly along the UK's east coast.

Dynamic Equilibrium on Cliff and Shore Platform Systems

[1,2*]Appleton, M., [1]Briganti, R., [1]Dodd, N. & [2]Payo, A.
*lead presenter
[1]matthew.appleton1@nottingham.ac.uk, University of Nottingham, United Kingdom
[2] British Geological Survey, United Kingdom

Cliffed coasts are characterised by a cliff formed of rock or consolidated sediment and a shore platform extending seawards from the base of the cliff, possibly overlain by a beach. Erosion of these coasts can have significant impacts on these environments. Models exploring long-term evolution of coastal systems are important tools for local stakeholders planning for an uncertain future.

In many coastal systems forced by a stationary climate, it is often thought that an equilibrium state is approached over time. Equilibrium is often used to justify the use of simplifying assumptions of coastal models, since near-equilibrium systems are well-approximated by their equilibrium state. This is of particular interest since climate change is likely to affect wave climates, pushing coastal systems away from an equilibrium they may have settled to. For cliffed coasts, approach towards a “dynamic equilibrium” is thought to occur, where the time-averaged shore-platform morphology is approximately constant, even as the cliff recedes.

Numerical models have been proposed to describe how waves propagate over and erode consolidated material. However, the potential of these models in the approach of a shore platform to some equilibrium shape has not been fully explored. The fundamental behaviour of the model’s governing equations are not well known. We couple the governing equations of a simple time and phase-averaged hydrodynamic model with a 2D representation of a shore platform. We force the shore platform with a stationary wave climate and fixed still water level, and allow its morphology to evolve over time. As the platform erodes, its shape changes, changing the distribution of erosion, allowing a feedback loop that may lead to equilibrium approach. This coupling is expressed as a system of partial differential equations. Unlike previous studies attempting to model these systems, we take a more analytical approach, directly studying the long-term behaviours of the governing equations.

We prove that erosion by our hydrodynamic model does not lead to an equilibrium platform morphology. Instead, the submerged shore platform is predicted to become steeper indefinitely.

This work is important for long-term modelling of coastal evolution, since it demonstrate that, according to the governing equations, equilibrium platform shapes on eroding coasts cannot be maintained by the modelled wave action alone. Modelling of additional feedback mechanisms and comparison with long term observations are necessary. Deposition of sediment onto the platform could protect the platform from wave impacts, or increase abrasion. Some avalanching mechanism on the shore-platform would limit the platform steepness. This affects simplifying assumptions made by many coastal models, since hydrodynamic processes often assumed to control near-equilibrium dynamics may not be dominant.

Observations of Wave Setup on a Coral Atoll

[1]*Holsclaw, A., [1]Lindhart, M., [1]Masselink, G. & [1]Davidson, M.
*lead presenter
[1]ashley.holsclaw@plymouth.ac.uk, Coastal Processes Research, University of Plymouth, U.K.

Atoll island nations (such as the Maldives, Marshall Islands, and Tuvalu) are amongst the most critically vulnerable to climate change due to rising sea levels and subsequent flooding and overwash events. To investigate the wave and water level dynamics on a coral atoll, a six-month dataset consisting of three pressure gauges was collected at three distinct sites on the island of Dhigulaabadhoo in the Republic of the Maldives along with a tide gauge located in a nearby harbor. The observed setup varied across the sites and was found to correlate with the offshore significant wave height and period, as well as tidal water level. The sites with wider reef platforms and steeper forereef slopes were observed to have higher wave setup at the shore and a slightly stronger linear correlation between setup and offshore conditions. Furthermore, the results indicate the potential influence of incident wave direction on alongshore setup gradients. The aim of this work is to evaluate the controls and variability of wave setup on a coral atoll.

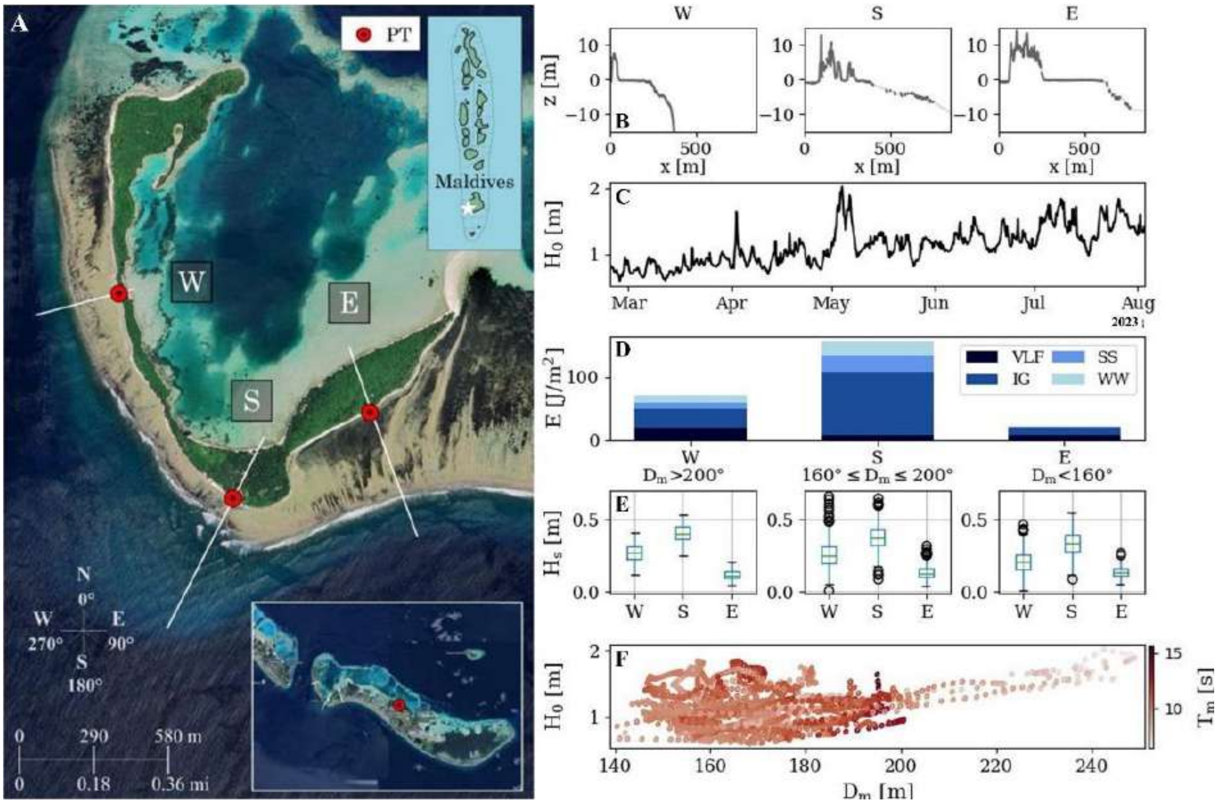

Figure 1. (A) Map of the site, (B) Topographic profiles of each transect, (C) offshore significant wave height, H_0, (D) distribution of mean frequency contributions to local wave energy, E, (E) local significant wave height, H_S, at each site partitioned by three equal ranges of mean offshore wave directions representing SW ($D_M > 200°$), S ($160° \leq D_M \leq 200°$) and SE ($D_M < 160°$), and (F) H_0 as a function of D_M with symbol color scaled by offshore wave period, T_M. Base maps from Google Satellite and OpenStreetMap.

Measurements of wave runup on an atoll island using LiDAR

Samuel T. Rose[1]*, Chris E. Blenkinsopp[1], Gerd Masselink[2], Ian L. Turner[3], Curt D. Storlazzi[4]

[1] University of Bath, Bath, UK. str24@bath.ac.uk
[2] University of Plymouth, Plymouth, UK.
[3] University of New South Wales, Sydney, AU,
[4] United States Geological Survey, Santa Cruz, USA

Introduction

Coral atoll islands are wave-formed accumulations of carbonate sediment on top of a reef platform that are low lying, often less than 2 m above mean sea level at their highest point. Consequently, they are extremely susceptible to flooding and island overwash. (Storlazzi, 2015). Climate change will exacerbate this problem, with predicted sea-level rise, coupled with the potential for an increase in the frequency and/or magnitude of storm wave events. Atoll islands are considered one of the most vulnerable environments to climate change.

Methodology

This study presents a 6-week continuous runup dataset, collected using a shore-mounted LiDAR scanner sampling at 10 Hz on a coral atoll island. These data were obtained as part of a 6-month deployment on Faresmaathodaa, Maldives, alongside 25 other oceanographic instruments that were deployed to fully explore the complex hydrodynamic processes on reef platforms. The cross-shore transect explored in this paper included an array of 6 pressure transducers and a velocimeter located on the fore reef and reef flat (Figure 1).

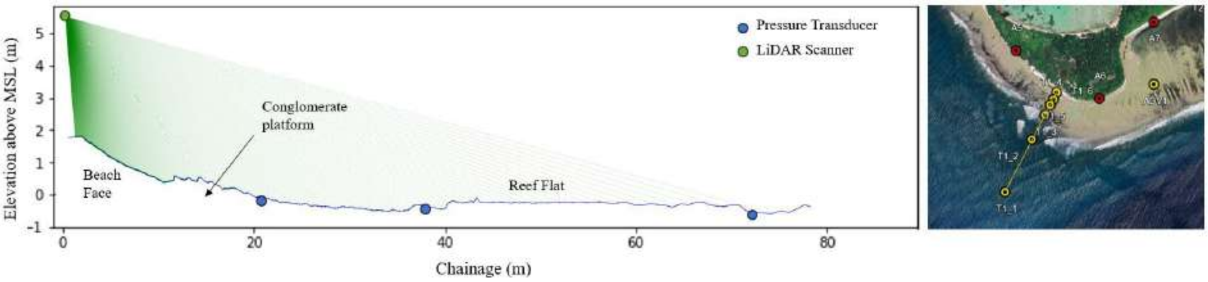

Figure 1. (Left) Cross shore LiDAR transect showing the three most shoreward pressure transducers and Livox Avia lidar scanning a 70.4° swath continuously at 10 Hz. (Right) Map of oceanographic instruments with yellow and red denoting location of pressure transducer arrays.

Preliminary Results

Initial analysis indicates that the total swash signal is dominated by the sea-swell (wave period, T<25 s) band, which is thought to be heavily influenced by undular bore decomposition over the reef flat. In contrast, when only the extreme swash occurrences that lead to the highest magnitude of runup are analysed, the lower frequency bands become more significant, with the infragravity (25 s<T<250 s) and very-low frequency (>250 s) contributing more than the sea-swell band. This supports the idea that lower frequencies play a significant factor in extreme runup, flooding, and island overwash (Cheriton et al, 2016). Water depth on the reef flat is demonstrated to be the dominant factor affecting runup, with wave generated setup significantly contributing to water depth on smaller tides due to increased gradients in radiation stress. The highest water depths on the reef platform (h_r) resulted in the largest values of the top 2% runup, $R_{2\%}$. It was found that the relationship was highly linear ($R_{2\%} = 2.91h_r - 0.93$) and strongly correlated (r = 0.89).

References

Storlazzi, C., Elias, E., & Berkowitz, P. 2015. Many atolls may be uninhabitable within decades due to climate change. Sci Rep, 5, 14546

Cheriton, O. M., C. D. Storlazzi, and K. J. Rosenberger (2016), Observations of wave transformation over a fringing coral reef and the importance of low-frequency waves, J. Geophys. Res. Oceans, 121, 3121–3140

Numerical investigations of bottom boundary layer hydrodynamics under a dam-break-driven swash event on a mobile bed

[1]*Quan T. Nguyen, [2]Joost W.M. Kranenborg, [1]Nicholas Dodd, [1]Riccardo Briganti, [2,3]Jebbe J. van der Werf, [3]Pieter C. Roos, [4]Fangfang Zhu

*lead presenter

[1]quan.nguyen@nottingham.ac.uk, University of Nottingham, UK

[2]Deltares, Delft, The Netherlands

[3]University of Twente, Enschede, The Netherlands

[4]University of Nottingham Ningbo, China

The swash zone is characterized by its dynamic nature and is the beach region quasi-periodically covered and uncovered by water in the uprush and backwash. Bed shear stress is an important hydrodynamic parameter that determines the mobilization and entrainment of sediment particles in the flow. In this study, a state-of-the-art bottom boundary (BBL) sub-model is investigated to simulate the hydrodynamics at the bottom boundary layer in the swash zone, with focus on the bed shear stress and the distribution of horizontal and vertical velocity within this region. The BBL sub-model was initially developed by Briganti et al. (2011). It is implemented in a 1D Nonlinear Shallow Water Equation (NSWE) model, so as to better represent bed friction than the usual Chezy-type relation. In this study, which has already been compared with the experimental data of a dam-break generated swash event on fixed, impermeable beds that were reported by Kikkert et al. (2012), is also compared against corresponding simulation data for the same event, generated from a 2DV RANS (VOF) equation solver (Kranenborg et al., 2022). We reproduce depth, depth-averaged velocity, horizontal and vertical velocity depth profiles, and other parameters, and compare against--where it exists--experimental data, and against the NSWE model incorporating the BBL sub-model. We anticipate that the comparison will allow us to improve the BBL sub-model, by revealing near-bed deficiencies in modelling of the bed shear stress, as well as the degree to which hydrostatic pressures pertain throughout the swash event. Ultimately, we anticipate an improvement in the BBL for a mobile bed too. The initial comparison between two models regarding the simulation of water depth, depth-averaged velocity, and vertical profile of horizontal velocity is presented, respectively, in Figure 1.

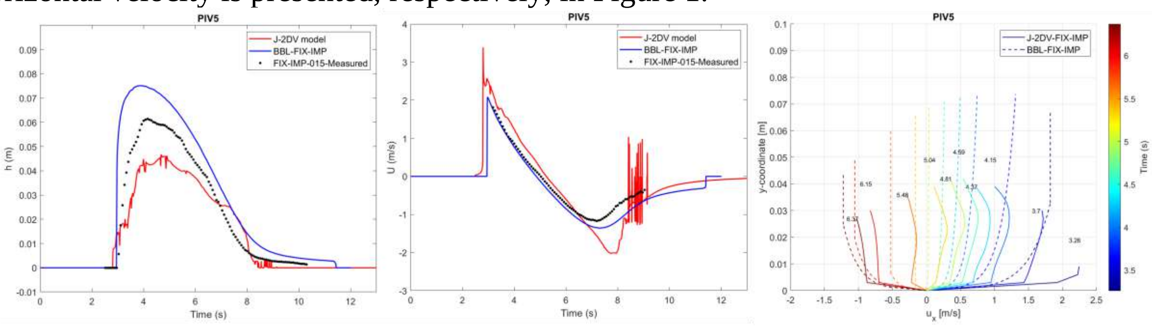

Figure 1. Comparison between BBL sub-model and 2DV RANS model regarding (left) water depth, (center) depth-averaged velocity, and (right) vertical profile of horizontal velocity.

References

J.W.M. Kranenborg, G.H.P. Campmans, N.G. Jacobsen, J.J. van der Werf, A.J.H.M. Reniers, S.J.M.H Hulscher. Depth-resolved modelling of intra-swash morphodynamics induced by solitary Waves. J. Mar. Sci. Eng., 10, 1175, 2022.

G. Kikkert, T. O'Donoghue, D. Pokrajac, and N. Dodd. Experimental study of bore-driven swash hydrodynamics on impermeable rough slopes. Coastal Engineering, 60:149–166, 2012.

R. Briganti, N. Dodd, D. Pokrajac, and T. O'Donoghue. Non linear shallow water modelling of bore-driven swash: Description of the bottom boundary layer. Coastal Engineering, 58(6):463–477, 2011.

Ebb Tidal Jet at Montrose Bay: Insights from 2DH vs 3D Models and Validation with Satellite Imagery

[1]*Pratama, Munawir & [1]Venugopal, Vengatesan
[1] munawir.pratama@ed.ac.uk, The University of Edinburgh, Scotland, UK
[2] The University of Edinburgh, Scotland, UK

Prior studies have revealed the existence of an asymmetrical ebb tidal jet at the southern end of Montrose Bay, which is anticipated to play an important role in transporting sediments from the beach face and the eroded dunes. This study employed numerical models to investigate the two- (2DH) and three-dimensional (3D) characteristics of this ebb tidal jet. The numerical models were constructed using Delft3D FM, supported with validation against an ADCP measurement. Further, several Sentinel-2 images were found showing discernible ebb tidal jet features, which were then used to calibrate and validate the modelled surface plume, resulting in a good agreement, as shown in Figure 1.

The model output was then used to demonstrate the ebb tidal jet characteristics, and the salinity and density dynamics in horizontal and vertical planes. Results showed that under typical daily discharge conditions, a 2DH model can reasonably represent the 3D flow field, except within the surface layers. The findings also supported the well-mixed assumption often employed in similar coastal systems, although minor stratification could form at the bay side during slack-to-flood transitions. However, in scenarios run with storm freshwater discharge, the inclusion of salinity differences and three-dimensionality in the model became necessary. As in the 2DH model, the movement of the surface plume was strongly restricted near the coastline. Overall, this study offers insights into useful techniques in constructing models at sites with ebb tidal jets, and demonstrates the use of satellite imagery for model validation.

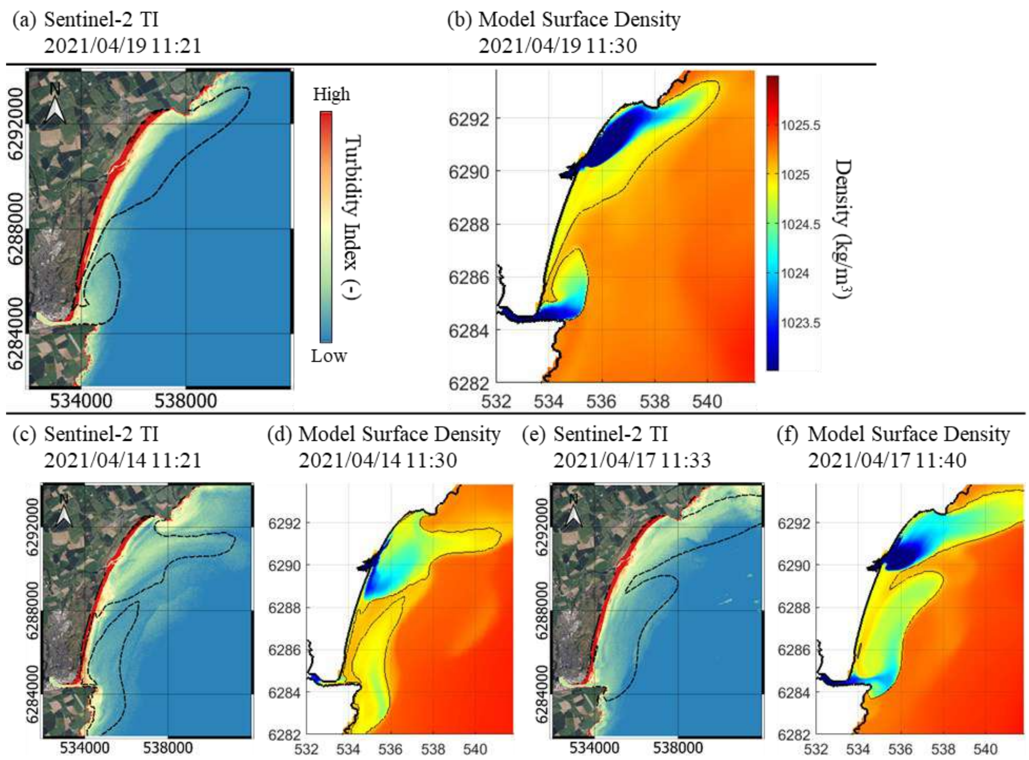

Figure 1. Comparison between model surface density against Sentinel-2 Turbidity Index (TI). Black splines are the modelled surface density plume drawn at 1025 kg/m^3.

Novel techniques for designing hydrodynamically scaled kelp mimics for use in laboratory wave attenuation experiments

[1*]Duffy, J.P., [2]Houseago, R.C., [3]Moore, P.J., [4]Sugden, H.

[1]j.duffy4@newcastle.ac.uk, Newcastle University, UK

[2]Newcastle University, UK

[3]Loughborough University, UK

[4]Newcastle University, UK

The use of natural habitats for coastal protection, so called nature-based solutions (NBS), is increasing in prevalence globally. Kelp forests, and the complex three-dimensional habitats they form, are promising candidates for NBS. Forests of *Laminaria hyperborea*, through their large biomass and surface area, are believed to generate considerable drag on waves propagating over them, potentially resulting in a significant reduction in wave energy reaching kelp dominated shorelines, leading to reduced coastal erosion. However, evidence supporting this ecosystem service is limited and further research is required to justify the use of kelp forests as an NBS for coastal protection. Hydrodynamically-scaled artificial kelp mimics in laboratory wave tanks can provide unique insights into the role of kelp forests in attenuating wave energy. The degree of environmental control and experimental replication that wave tanks and mimics provide is not possible with field studies. There are though distinctive challenges to such work, most notably ensuring the behaviour of the mimics under wave conditions is consistent with nature. To provide meaningful instruction on kelp forest wave attenuation requires careful choice of material properties and design to ensure geometric, kinematic and dynamic similarity with their natural counterparts. We outline how these conditions can be achieved through precise matching of dimensionless parameters governing kelp hydrodynamics between mimics and nature, and the use of novel construction techniques. Hydrodynamically important kelp biomaterial and morphological characteristics were identified, measured for collected kelp samples and used to inform kelp mimic design. Silicone moulds were made from 3D printed kelp, fabricated to exact measurements determined by the matching of the dimensionless parameters governing kelp wave behaviour. Kelp mimics were cast from these moulds using a liquid polyurethane rubber, selected to ensure the correct rigidity and density of the mimics. The polyurethane kelp mimics produced possessed the requisite material and geometric properties to hydrodynamically mimic a kelp forest in a laboratory wave tank.

Kelping up with the satellites: Filling in the gaps of a study on 'the short-wave attenuation by kelp forest canopy' using Sentinel-2

[1*]Lister, R.
*Lead presenter
[1]Rebecca.lister@students.plymouth.ac.uk, University of Plymouth, UK

Kelp are canopy forming macroalgae with global coverage, and the forest they form change in biomass seasonally, varying in surface appearance depending on tidal state. Kelp forests are key in ecosystems as they provide habitat, food and breeding grounds for many species in addition to providing many ecosystem services e.g., nutrient cycling, aquaculture and natural coastal defense. Global kelp abundance has seen a decline due to many anthropogenic threats e.g., global warming, keystone species eradication and over harvesting. Due to the remoteness of most forests only a few have been studied, e.g., Point Loma Kelp Forest in California, meaning there is not a complete understanding of the threats to kelp forest and their impacts.

Remote sensing is a valuable tool for studying kelp forests, as extensive datasets of past and present imagery are available with remoteness not having an impact on data availability. However, there is a need to improve remote sensing methods used to detect kelp canopy abundance as many of the datasets being used come from Landsat satellites which have a lower spatial and temporal resolution than Sentinel-2 satellites. The Landsat satellites also have electromagnetic bands which miss the edge of kelps reflectance signature which the Sentinel-2 satellites do not.

This study builds upon and addresses the remote sensing limitations of a recent study into '*Short wave attenuation by a kelp forest canopy'* by using an enhanced dataset. This dataset was made using Sentinal-2 data and a novel kelp identification index. The improved dataset, along with depth (tidal height) and wave attenuation data from the paper were used to show the kelp canopy area variability with the depth and its impact on short wave attenuation recorded. A time series of the kelp canopy area and sea surface temperature was also produced to determine the extent of annual change seen in the kelp forest in Point Loma, California.

The results show a negative linear trend between depth (tidal height) and kelp canopy area after accounting for seasonal declines. Additionally, there is a positive linear correlation between the kelp canopy area and wave attenuation recorded. From these correlations there is potential for models to be made by using tidal height to determine the level of wave attenuation by kelp forest canopy. Over the last 18 years, sea surface temperature in the area has significantly increased, while annual kelp canopy area over the past 7 years shows high variability. These variations detected can be correlated with physical factors, such as sea surface temperature and other environmental stressors, to better understand their impact on kelp abundance in a world constantly shifting due to climate change. Overall, by using improved remote sensing methods such as higher-resolution satellites and new kelp identification techniques, this study shows the potential for an improved and more detailed understanding of canopy forming kelp forests.

Wave attenuation by rigid suspended canopies

[1]*Zhang, X., [1]van der A, D.A. & [1]O'Donoghue, T.
*Lead presenter
[1]x.zhang9.23@abdn.ac.uk, School of Engineering, University of Aberdeen, UK

Many aquaculture farms, such as those cultivating seaweeds and mussels, form suspended canopies in coastal waters, which can act as nature-based coastal protection measures. Being suspended in the water column, these canopies may attenuate wave energy more effectively than benthic canopies like seagrass meadows (Zhu & Zou, 2017). While wave attenuation by benthic canopies has been extensively studied, research on suspended canopies remains limited (e.g., Zhu et al., 2021). This study aims to deepen the understanding of the wave attenuation potential of suspended canopies through detailed laboratory experiments.

Experiments were conducted in the Aberdeen University Random Wave Flume (AURWF), which is 20 m long, 0.45 m wide, and has a working depth of 0.7 m. The suspended canopy was modelled using arrays of PVC cylinders (0.3 m long, 1 cm diameter), positioned 0.2 m below the still water level and supported by individual frames. Four canopy configurations with varying line and lateral element spacing were tested under 17 regular wave conditions (H = 0.05 – 0.20 m, T = 1.0 – 1.8 s) and 10 random wave conditions (H_s = 0.065 – 0.13 m, T_p = 1.0 – 1.8 s). Water surface elevation was measured using nine twin-wire resistant type wave gauges, with a fine resolution (at least every 20 cm) along the canopy by repositioning gauges during repeat trials.

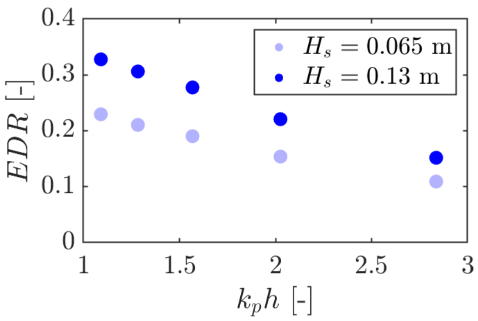

Fig. 1. Energy dissipation ratio (*EDR*) versus relative water depth $k_p h$ for various random wave conditions. The data correspond to a canopy comprised of 41 individual frames, each spaced 10 cm apart, with 20 cylinders per frame.

Preliminary results indicate that the energy dissipation ratio (*EDR*), defined as the ratio of dissipated wave energy to incident wave energy, rises with increasing incident wave height and decreasing relative water depth (see Fig. 1).

The presentation will provide a comprehensive analysis of wave attenuation by suspended canopies. The effects of canopy configurations and wave characteristics, including wave nonlinearity, spectral shape, and frequency-dependent dissipation, will be investigated. Additionally, the performance of existing wave attenuation models (e.g., Suzuki et al., 2012; Jacobsen et al., 2019) in predicting wave attenuation by suspended canopies will be evaluated.

Reference

Jacobsen, N. G., McFall, B. C., & van der A, D. A. (2019). A frequency distributed dissipation model for canopies. *Coastal Engineering, 150*, 135-146.

Suzuki, T., Zijlema, M., Burger, B., Meijer, M. C., & Narayan, S. (2012). Wave dissipation by vegetation with layer schematization in SWAN. *Coastal Engineering*, *59*(1), 64-71.

Zhu & Zou (2017). Three-layer analytical solution for wave attenuation by suspended and nonsuspended vegetation canopy. *Coastal Engineering Proceedings, 1*(35), waves. 27.

Zhu, L., Lei, J., Huguenard, K., & Fredriksson, D. W. (2021). Wave attenuation by suspended canopies with cultivated kelp (Saccharina latissima). *Coastal Engineering, 168*, 103947.

Modeling of Air Pressure Dynamics and Water Height Response in a Pneumatic Tsunami Generator

[1,2]*Sabana Parvin, [2]Ian Chandler, & [1]David McGovern
*lead presenter
Email*: sabana.parvin@lsbu.ac.uk
[1]School of the Built Environment and Architecture, London South Bank University, 103 Borough Road, London SE1 0AA, UK
[2] HR Wallingford, Howbery Park, OX10 8BA, UK

The pneumatic tsunami generator enables the generation of Froude scaled tsunami in laboratory flumes. The response of water height in a pneumatic tsunami generator is influenced by the air pressure within the tank, which in turn governs the wave formation in the connected flume. Understanding the interaction between air pressure and fluid dynamics is crucial in controlling the waveform produced, as pressure variations arise from changes in air density due to compressibility. This study aims to develop a comprehensive mathematical model of the air pressure at the top of the tsunami generator tank, incorporating both incompressible and compressible air behaviors. The model considers the fundamental physics of the tank, including the inflow and outflow of air, and the resulting effects on the water level inside the tank. The physical experimental data of a single tank generator are analyzed to derive the response of the water height and the corresponding wave dynamics in the flume. Simulations based on the derived mathematical air pressure boundary conditions are conducted and compared with the experimental data, providing valuable insights into the performance of the pneumatic tsunami generator and enhancing the understanding of air-fluid interactions within the system.

Keywords: Pneumatic tsunami generator, Air pressure dynamics, Mathematical modeling, Air-fluid interaction, Experimental validation.

Trees vs Tsunamis: Mangrove Forests as a Defence against Tsunamis

[1*]Cudmore, J., [2]Hill, J., [2]Touza-Montero, J., [3]Kesserwani, G. & [3]Bowman, E.
*lead presenter
[1] xkg506@york.ac.uk, University of York, United Kingdom
[2] University of York, United Kingdom
[3] University of Sheffield, United Kingdom

Tsunamis can cause large scale disasters, costing many lives and destroying property and livelihoods. The 2004 Indian Ocean Tsunami is an example of one of the most devastating natural disasters, responsible for the lives of over 225,000 people. This event highlighted the need for better preparation for extreme events. Moreover, rising sea levels mean we are likely to see increased risk from major tsunamis over the coming decades and beyond. Simulations examining the relationship between sea-level rise and tsunami impact find a doubling of inundation distance and a rapidly increasing risk to life. It is therefore critical and timely to devise suitable mitigation strategies, focusing on those that can track sea-level rise.

Mangroves have been used by coastal communities for protection against storms and flooding for decades. Flume and numerical experiments have also found them to act as an effective natural barrier against tsunamis, reducing the flow speed and inundation distance. Creating 3D numerical models of waves travelling through arrays of cylinders (mangroves), allows dissipation of tsunamis by mangroves to be ascertained in a quantitative way at flume scale (Fig 1.). The impact of a variety of factors such as wave height, tree height, and tree arrangement on wave inundation are determined and quantified. Future work will scale up these experiments to real-world scale and use more realistic representations of mangroves.

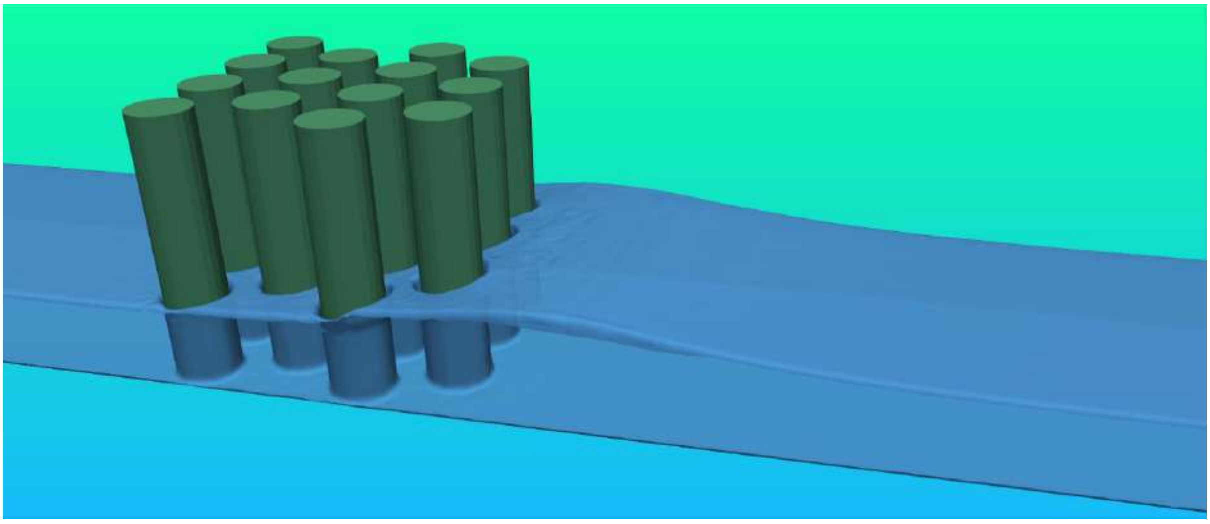

Fig. 1. 3D numerical model of a wave being attenuated by an array of cylinders (mangroves)

A RISK BASED APPROACH TO WELSH TSUNAMI VULNERABILITY IN THE SEVERN ESTUARY, UK

[1]*Shaw, D.J.
*lead presenter
[1]djs216@bath.ac.uk, University of Bath, UK

UK policy makers are transitioning towards a risk-based FCERM approach. The hyper-tidal Severn Estuary faces changing flood risk highly dependent on tidal cycle alignment. Although storm surge risk has been extensively studied, there is potential for a tsunami to hit during high tide which would cause catastrophic flooding. Welsh Government's commitments to sustainable placemaking in recent legislation (e.g Future Generations Act) require examination of such scenarios in a climate induced SLR context. This investigation explores how substantive tsunamigenic risk is to South Wales. A harmonic analysis successfully reconstructs astronomical constituents which define tidal height. Success is confirmed by comparing cleaned NNCRMP data and reconstructed heights in a K-S test, using Latin Hypercube Sampling. Using an adapted ASCE Level 1 methodology, outputs from two deterministic numerical model simulations are evaluated: loss if coastal defences hold (CDH); loss if coastal defences are breached (CDB). Probabilistic fragility curves are applied to median depth and momentum flux outputs, for 10m, 12m and 15m runup heights and outputs mapped. It is concluded, due to the infrequency of conditions when larger magnitude events are possible, DRR strategies should focus on tsunami risk with a runup of 10m or under. Discussion explores the implications of the models and the merits of mitigation strategies, including an EWS. Flood extent is shallow (<3km) potentially increasing viability of evacuation, however, unstructured dispersal of people could put more at risk than a shelter strategy. A 10m scenario is compared to other low-probability high-impact hazards using the National Risk Register. It is concluded without mitigation, deaths would be in excess of 10,000. Regardless of mitigation, 1000s of residential properties would be damaged and industrial infrastructure would be decimated costing (£) billions. Recommendations are suggested, including modelling evacuation of the coastal area and considering an EWS being linked to the UK emergency alerts system.

Foredune Notches – Constructed Morphology, Description and Emerging Evidence of Differing Morphological Evolution

Thomas Pagon[1]*, Thomas Smyth[2], Ryan Wilson[1], Bethany Fox[1]

*Thomas.pagon@hud.ac.uk

[1] University of Huddersfield, School of Applied Sciences – UK

[2] Liverpool Hope University, School of Computer Science and the Environment – UK

Due to the effects of climate change and changing land use, coastal sand dunes have experienced an increase in vegetation cover over at least the last century. This "dune greening" has led to geomorphic stabilisation and fixing of coastal sand dune systems, which often have negative effects on biodiversity and coastal resilience. Foredune notches are constructed interventions designed to mitigate the effects of this dune greening by acting as a conduit to increase the amount of wind-blown sand in the middle and back dune areas. Although some conservation organisations have promoted these interventions and site-specific studies exist, research on these artificial features remains limited. Consequently, the broader applicability of site-specific findings to other locations is unclear, as is the overall level of uptake of these interventions as a conservation and coastal resilience management strategy.

In this study, we have systematically identified and measured 133 foredune notches globally using aerial imagery to assess variations in constructed notch morphology and evolution. The results show significant variability in notch dimensions, with notches in France and New Zealand being notably smaller compared to those in the UK and the Netherlands, along with a wide variety of lengths and widths, which is especially notable in the Netherlands. This variation is not accounted for within the current literature. Building on this baseline dataset, we also evaluated the long-term impact of constructed morphology on notch evolution. Using ten years of remotely sensed data from selected sites across Europe and New Zealand, initial results indicate that differences in constructed morphology affect both the spatial expansion and contraction of these features and their persistence over time.

This diversity in constructed morphology and evolution underscores the need for a more nuanced and standardised method of description. We propose a new classification system, based on morphology and evolution, which provides a clearer and more consistent method of describing these features. By categorising these constructed features into a clear and transferable framework, we aim to facilitate comparisons between notches. It is hoped that this will be beneficial for site managers, enabling them to design notches with a better understanding of the likely morphological evolution of these features, thereby improving coastal management practices.

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Monitoring Morphological Variability of Gravel Barrier Typologies using 2D LiDAR

[1*]Jones, R.B., [1]Valiente, N.G., [2]Blenkinsopp, C. & [1]Davidson, M.
*lead presenter
[1]robert.b.jones@plymouth.ac.uk, University of Plymouth, United Kingdom
[2]University of Bath, United Kingdom

Gravel barriers are important landforms that provide numerous benefits, including protection against coastal erosion and flooding. Optimal coastal management requires a strong understanding of these environments. However, gravel beaches, especially those with both sand and gravel components, are relatively understudied. Furthermore, while high-energy swash and overwash events are the most likely to induce beachface change, there is a scarcity of intra-storm morphological measurements on gravel barriers. Thus, our understanding remains incomplete.

As part of the #gravelbeach project, this study investigates gravel barrier morphodynamics at three sites comprising three different typologies: Chesil Beach (pure gravel), Pevensey Beach (composite mixed) and Borth Sands (composite). LiDAR towers are used to capture 2D profiles with a cross-shore length of approximately 100m every low tide (see Figure 1). Over the winter of 2024/25, swash timeseries measurements are taken every high tide. This data is combined with hydrodynamic factors and other secondary data to enable analyses of the swash and overwash processes that occur during storms and the resultant consequences for beach morphology. Response to and recovery from storms in gravel barriers is examined, elucidating the differences between typologies. Preliminary analysis shows substantial differences between the sites. For example, of the two composite beaches, the winter swash was localized to the gravel component significantly more often at Pevensey than at Borth. Furthermore, Chesil showed the highest storm runup and clearest cross-shore sediment transport. These results suggest potential variation in the mechanisms by which different gravel barriers respond to storms.

This study will provide new insights into the intra-storm morphodynamics of different gravel barrier typologies, enhancing coastal knowledge and better informing coastal stakeholders.

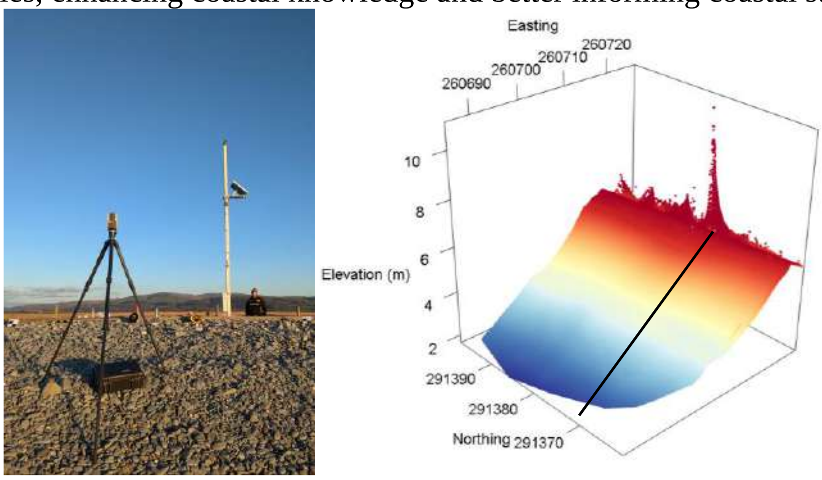

Figure 1: For the Borth site, the LiDAR installation (left) and a terrestrial laser scan taken 27/11/2024 interpolated onto a 10cm grid (right). The black line indicates the derived cross-shore profile.

Investigating the impacts of tidal energy extraction on species distribution in UK waters

[1*]Mackay, Z.L., [2]Stewart, B.D. & [3]Angeloudis, A., [1]Hill, J.,
*lead presenter
[1]zlm506@york.ac.yk, University of York, United Kingdom
[2] University of Plymouth, United Kingdom
[3] University of Edinburgh, United Kingdom

Climate change is considered one of the biggest threats to the global environment, economy, and people. To minimise this impact, the Paris Agreement challenges member countries to reduce emissions by 45% by 2030 and achieve net zero emissions by 2050 (UNFCC, 2015). Offshore wind energy is currently the primary source of renewable energy within the marine environment in the UK. To diversify energy production and meet net zero goals, tidal devices are currently being tested in UK waters, and interest in tidal energy is likely to increase.

The impacts of tidal energy development on the environment, from species to habitats to oceanographic systems, are still uncertain, and gaps remain in current research. Most studies to date have focused on impacts relating to collision, noise, displacement and localised hydrodynamic changes affecting sedimentation transport and benthic species composition. So far, there have been limited studies on the impacts of tidal energy upon habitats, species distributions (especially mobile, pelagic species), and the wider ecosystem. There has also been no consideration of cumulative environmental impacts of energy extraction at multiple sites and few studies have considered the comparative impacts of climate change.

Here, we simulate the tides on the UK continental shelf using the multi-scale unstructured mesh numerical model, Thetis. Spatially varying sea-level rise is applied to these models for the first time with data from the AR6 IPCC assessment to examine the impact of sea-level rise on tidal dynamics. Shared Socioeconomic Pathways (SSPs) 1.19 through to 5.85 at the 50% confidence interval for years 2050, 2100, and 2150 are used to predict sea-level rise under a range of scenarios. These numerical tidal models are then integrated into species distribution models for key benthic species, such as brown crab (*Cancer pagurus*), to determine the potential impact of tidal changes to those species. Finally, key proposed tidal stream energy schemes across the UK are incorporated into the tidal models, and the subsequent impact on the selected benthic species is predicted. We then compare the relative effect of tidal energy to sea-level rise in terms of tidally-induced impact on benthic species. Future work will include climate-induced change and pelagic species, as well as interactions between species such as trophic interactions and possible decoupling.

A Review of the Digitisation of Historic Tide Records

*[1]Christian Kenwright, C.K., [2]Ivan D. Haigh, I.H., [3]Joanne Williams, J.W., [4]Robert Nicholls, R.N., [5]Steve McFarland, S.M., [6]Marc Becker, M.B.

*Lead presenter

ck1g20@soton.ac.uk, University of Southampton, United Kingdom

Affecting many regions globally on an annual basis, floods are regarded as the deadliest natural disaster. The World Resources Institute estimated 15 million people and $177 billion in urban property will be affected by coastal flooding annually by 2030. Coastal areas are particularly vulnerable due to rising sea levels, increased urban development, and the decline of natural habitats. Many coastal cities have long tide gauge records, these provide invaluable data for assessing past flood events, identifying long-term sea level trends, and investigating the anthropogenic impact on local environments. Such analysis aids in flood prediction and management. However, to analyse the data, it must be digitised first, a time consuming and expensive process. Due to the importance of historic data, the identification of tide records and evaluation of digitisation methods is paramount. This study examines previous digitisation efforts, highlighting the types of data recovered, the sources of these records, and the methods employed. It also compiles a list of historic records that, although recovered, remain undigitised, ensuring their preservation. Furthermore, using historic tide gauge data from the Clyde Estuary the study assesses digitisation software, evaluating the efficiency, cost, and usability of various programs for digitising historic tide charts. The Clyde Estuary is home to 12 tide gauge records, three of which date back to 1850. In future studies we aim to digitise the entire record at a high resolution, at least hourly, allowing for in depth analysis of past sea level trends and flooding events; aiding in future flood management strategies for settlements along the Clyde Estuary.

ForeCoast® Rail: Improving nearshore wave forecasts for Network Rail

[1*]Brazell, L. and [1]Luxford, F.
Lewis.Brazell@jbaconsulting.com.
JBA Consulting, UK

This poster will present recent wave modelling updates undertaken to improve ForeCoast® Rail: an advanced wave overtopping and scour risk forecasting system JBA Consulting runs for Network Rail.

ForeCoast® Rail forecasts sea level, nearshore wave conditions, scour and wave overtopping for 56 assets on the Network Rail Wales Route. The system sends out alerts or warnings if conditions exceed sea level or wave overtopping thresholds. Updates were made to improve the accuracy of nearshore wave and wave overtopping forecasts and make use of freely available offshore forecasts of winds and waves from MET Norway.

Example of coastal flood impacts

Nearshore wave forecasts were improved by replacing look-up tables with machine learning emulators. Creating the emulators involved the following steps:

1) Creating offshore event sets of possible storm conditions. Using a Heffernan and Tawn multivariate approach, three Monte Carlo event sets were simulated representing 10,000-years of storm conditions at the offshore boundary of three wave models (West Coast, South Coast and Severn Estuary).

2) Simulating nearshore wave conditions. A representative sample of storm conditions was chosen and run through SWAN 2D wave transformation models to calculate the corresponding nearshore conditions in front of Network Rail assets.

3) Machine learning was used to create a series of emulators at each of the Network Rail assets to establish a relationship between offshore wind, wave and sea level conditions and nearshore wave conditions. The SWAN 2D model results were used to train and then validate these emulators.

For all locations, the emulators were able to replicate the SWAN wave height within 10% or 0.25m and for waves with a wave height above 0.25m, wave period errors were less than 1s and wave direction errors less than 20º. Events with very small wave heights, wave direction and period were less well modelled however these small waves pose minimal risk to Network Rail assets. These machine learning emulators were then implemented directly in the Delft-FEWS forecasting system.

Exploring Green Nourishment: Can Seagrass Enhance Beach Nourishment?

*Forrester, James[1]. Leonardi, Nicoletta[2]. Cooper, James[3]. & Kumar, Pavitra[4].
sgjforre@liverpool.ac.uk
University of Liverpool, United Kingdom

Beaches are characterised as dynamic coastlines shaped by the continuous forces of wind, waves and tides. Forming a barrier between sea and land, they can act as a defence against flooding and erosion for coastal settlements. Beach nourishment has been employed as a management tool to maintain or alter the profile of erosive beaches. In doing so, a beach can continue to provide beneficial services such as coastal protection and amenity. Whilst beach nourishment has been widely accepted in a contemporary climate, projected increases in sea level and storm activity under a warming climate may change the effectiveness of beach nourishment as an intervention for coastal protection. Nature-based solutions have gained interest for their potential to provide effective coastal protection alongside additional ecosystem services such as habitat provision and carbon sequestration, whilst also having the potential to adapt to changes in climate. There is however limited guidance to support their implementation, providing incentive to test and quantify their performance in a range of coastal settings. Green nourishment is a novel concept that combines the stabilising and frictional properties of seagrass with beach nourishment to form a nature-based solution for coastal protection. In our study, we set out to further explore the effectiveness of green nourishment as a nature-based solution for coastal protection, by assessing the impact of adding seagrass to beach nourishment in an idealised model study. Using the Delft3D numerical model, we process 28 simulations combining a variety of nourishment dimensions and environmental conditions with and without seagrass, to compare and evaluate the efficiency of various scenarios, in terms of sediment volume loss from an area of interest. We found that for all scenarios of beach nourishment, seagrass improved the efficiency, however the amount is dependent on the dimensions of the beach nourishment. Seagrass continued to benefit the efficiency of a beach nourishment under an increasing boundary significant wave height, sea level and incident wave angle. Our results showed beach nourishments with a larger longshore length to be more efficient, with a less clear pattern for cross shore elevation and beach nourishment volume. Although we find seagrass to benefit the efficiency of beach nourishments under a variety of conditions, the magnitude of improvements is limited, with a maximum increase in efficiency of 3 %. While our study finds that seagrass does not substantially improve the efficiency of beach nourishment, we recommend that further research explore more specific and detailed green nourishment scenarios in order to develop a better understanding of its performance as a nature-based solution for coastal protection.

Holocene to Present Cliff Retreat Rates and Rock Coast Landform Evolution in the Pacific Northwest, USA

[1]*Wang, X., [1]Antwis, L., [2]Hurst, M.D., [3]McPhillips, D., [1]Piggott, M.D., [4]Rood, A.H., [5]Wilcken, K.M., & [1]Rood, D.H.
*lead presenter
[1]x.wang24@imperial.ac.uk, Department of Earth Science and Engineering, Imperial College London, London, United Kingdom
[2]School of Geographical and Earth Sciences, University of Glasgow, Glasgow, United Kingdom
[3]U.S. Geological Survey, Earthquake Science Center, Pasadena, California, U.S.A.
[4]Global Earthquake Model (GEM) Foundation, Pavia, Italy
[5]Centre for Accelerator Science, ANSTO, Lucas Heights, Australia

Earthquakes and coastal erosion are two of the most destructive natural hazards. The retreat of coastlines can significantly impact the regional to global community and environment, especially under future global warming and sea-level rise. Rocky coastlines are usually considered to be stable, yet recent studies show that these coasts can also be highly sensitive to sea-level rise. The overall aim of this study is to quantify rock coast cliff retreat rates for the past (Holocene to present) and future in the Pacific Northwest, USA, and identifying the main controlling factors, including tectonic and climate change influences.

This study uses a combination of geomorphology, remote sensing, cosmogenic radionuclide geochemistry, and numerical modelling methods. Cosmogenic beryllium-10 (^{10}Be) is measured in quartz from samples collected along transects on coastal rock platforms at Simpson Reef, Oregon, and Toleak Point, Washington. Historical coastlines and cliff retreat rates are mapped and calculated using the Digital Shoreline Analysis System (DSAS). The Holocene coastal retreat rates are modelled using a multi-objective optimisation model that couples the Rocky Profile Model (RPM) with a cosmogenic radionuclide production model.

The background-corrected ^{10}Be concentrations for samples collected at Simpson Reef range from ~2000 - 6200 atoms g^{-1} over a transect distance of ~290 m offshore. A shielded sample collected from a sea cave has a measured ^{10}Be concentration of ~2500 atoms g^{-1}, suggesting a significant inherited inventory present in the platform samples. Inheritance-corrected ^{10}Be concentrations range near ~0 - 3800 atoms g^{-1}, implying rapid and recent exposure of the platform by cliff retreat. Our first, preliminary results of the RPM model underpredicts the elevations of the observed topography and overpredicts the measured ^{10}Be concentrations, indicating that the true retreat rates may be faster than the initial best-fit model. These results also suggest that the mismatch between measured and modelled profiles may be due to insufficient exploration of model parameter bounds. Therefore, subsequent RPM model runs are being conducted with expanded parameter spaces for rock resistance and weathering rate to improve the modelled cliff retreat history results. The same methods will be applied to Toleak Point and other coastal sites throughout the Pacific Northwest, USA. The modelled retreat rate histories will be compared with relative sea-level changes to test the influence of sea-level rise on the acceleration of coastal erosion.

List of Participants

Appleton, Matthew	University of Nottingham
Biausque, Melanie	BGS
Brazell, Lewis	JBA Consulting
Cudmore, Jenny	University of York
Duffy, Jack	Newcastle University
Forrester, James	University of Liverpool
Hamilton, Tom	University of Plymouth
Hall, Benjamin	
Ho, Vincent	HR Wallingford
Holsclaw, Ashley	University of Plymouth
Jackson-Wojcik, Maddie	Royal HaskoningDHV
Jones, Robert	University of Plymouth
Kenwright, Christian	University of Southampton
Kent, Oliver	JBA Consulting
Lazenby, Joe	Mott MacDonald
Lee, Katie	University of York
Lister, Rebecca	University of Plymouth
Lockwood, Naomi	Mott MacDonald
Mackay, Zoe	University of York
Nguyen, Quan	University of Nottingham
Parvin, Sabana	London South Bank University
Pagon, Thomas	University of Huddersfield
Pancrazzi, Leo	UCL
Pratama, Munawir	The University of Edinburgh
Rose, Samuel	University of Bath
Shaw, Dominic	University of Bath
Siontorou, Anna	Mott MacDonald
Wang, Xinran	Imperial College London
Yan, Jingjing	HR Wallingford
Zhong, Zehua	University of Southampton
Zhang, Xinyi	University of Aberdeen

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