Coastal Connectivity (CC PRTP)

Ollscoil Teicneolaíochta an Atlantaigh

Atlantic Technological University

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TU RISE is co-financed by the Government of Ireland and the European Union through the ERDF Southern, Eastern & Midland Regional Programme 2021- 27 and the Northern & Western Regional Programme 2021-27

Rialtas na hÉireann Government of Ireland

Arna chomhchistiú ag an Aontas Eorpach Co-funded by the European Union

Tionól Réigiúnach Tuaiscirt & Iarthair Northern & Western Regional Assembly

Tionól Réigiúnach an Deiscirt Southern Regional Assembly

HEA AN tÚDARÁS um ARD-OIDEACHAS HIGHER EDUCATION AUTHORITY

Coastal Connectivity (CC PRTP)

The Postgraduate Research Training Programme (PRTP) in Coastal Connectivity offers 12 PhD research scholarships to commence in 2024. Each project will include an enterprise placement of minimum 12 weeks duration. Project awards will include:

- **A student stipend (usually tax-exempt) valued at €22,000 per annum**
- **Annual waivers of postgraduate tuition fee**
- **Extensive research training programme**
- **Support for travel, consumables and dissemination expenses**

The goal of the coastal connectivity PRTP is to collaborate with coastal enterprises to improve their competitiveness while concentrating on the social and economic requirements of the area. By bringing cutting-edge experts (high-tech scientists and engineers, innovative modelers, creative artists, and environmental researchers) together with regional enterprises to strengthen research, technology development and innovation, the collaboration will work to develop long-term solutions for the environmental, social, and economic problems they encounter while accelerating the transition to a low-carbon economy.

The projects within this PRTP align with the overarching smart specialisation marine and blue economy, examining issues such as the sustainable management of marine resources, impacts and prevention of pollution, ecosystem health and coastal dynamics. Our industrial project partners span the North/Western Region and represent a diverse range of industries including advanced manufacturing, environmental services and management and analytical sciences. All sectors which are instrumental in the economic growth of our region.

Supported by our bespoke professional and personal development program, a Coastal Connectivity graduate will possess advanced research expertise in complementary areas relating to coastal management. They will have a high level of proficiency in addressing complex interdependent problems and extensive experience in integrating their research into real world applications.

Postgraduate Research Training Programme

Year 1:

Community Building and Induction

Year 2:

Annual Conference

Year 3:

Knowledge Transfer Events

Annual Conference

Year 4:

Advanced Academic Development

Annual Conference

Indicative Training programme and subject to change

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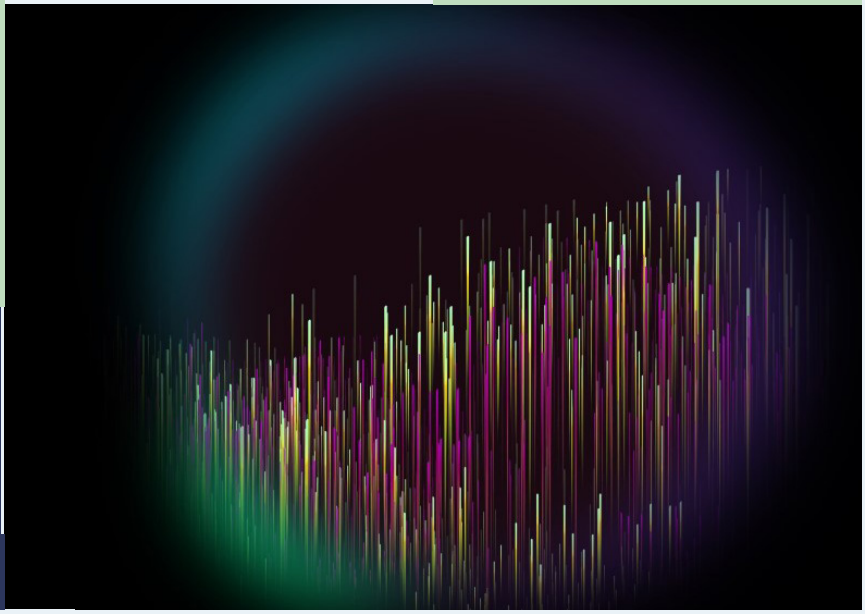

The integration of Earth Observation, Citizen Science, Low-Cost Sensing Technologies and machine learning for Real-Time Coastal Dynamic Monitoring

This groundbreaking PhD research project focuses on advancing real-time coastal monitoring through the integration of Earth Observation, citizen science, low-cost sensing technologies, and machine learning. By synergising satellite observations and on-site low-cost sensors, the study aims to capture dynamic coastal changes in unprecedented detail for unmonitored coastal lines. Citizen science initiatives will actively involve communities, fostering a participatory role in data collection. The collected data will then undergo sophisticated analysis using state-of-the-art machine learning algorithms. This integrated approach not only ensures a comprehensive understanding of coastal dynamics but also empowers local communities to contribute actively to coastal management strategies. The project will present an innovative combination of technologies and community engagement, which will provide a new approach in coastal monitoring, where real-time data and collaborative efforts lead to informed decision-making in the face of environmental variability.

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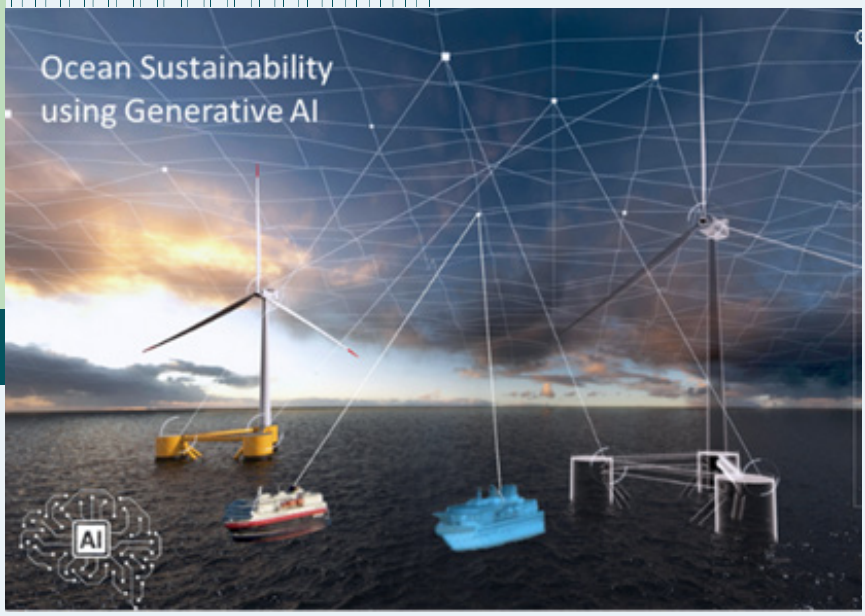

Generative Learning-Enabled Digital Twins and Predictive Modelling for Ocean Sustainability

Marine environments face pollution from waste, chemicals, oil spills, invasive organisms, and other elements. Additionally, the destruction of marine habitats, such as coral reefs and mangroves, poses threats to marine species. Overfishing contributes negatively to ocean acidification, and circulation pattern anomalies, and adversely impacts global seafood production and climate change. Recently, the UN declared a state of oceanic emergency, emphasizing the need to scale up ocean actions through innovative solutions.

Recent efforts aim to improve ocean sustainability by leveraging wireless sensor networks and Artificial Intelligence (AI). In this context, Digital Twins hold the potential to revolutionize ocean sustainability. However, several barriers impede the implementation of Digital Twins and predictive modeling for advancing ocean sustainability. A primary obstacle is the unavailability of quality data, attributed mainly to the challenges in deploying a large-scale sensing, communication, and computational environment, especially for hundreds of large marine ecosystems.

To overcome these challenges, this project aims to design and develop Deep Generative AI Approaches for generating or augmenting data related to fundamental oceanic processes/ phenomena. These approaches will be integrated into Digital Twins and other Deep Learning models to support various applications, including reducing overfishing, predicting marine pollution, adapting to climate change, and facilitating marine spatial planning.

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03

Anthropogenic Activities and Their Impact on the Functional Role of Saltmarshes

Saltmarshes are sumps for anthropogenic pollutants that lie at the interface between land and sea. They are important habitats particularly for overwintering birds and specialised salt-tolerant plants. While listed under the Habitats Directive, as habitats whose conservation requires SAC designation, the potential for anthropogenic alteration of the marshes will always exist. The inherent resilience to stressors and their capacity to absorb anthropogenic impacts have been strained and will now be further challenged with climate change and expected sea level rise. While the capacity for saltmarshes to adapt to sea level rise will largely be dependent on the possibility for this habitat to extend further into the terrestrial ecosystem saltmarshes must first survive the increasing and cumulative onslaught of contaminants and nutrients entering the systems.

Exploring the negative anthropogenic activities acting on saltmarsh habitats this project with the aid of mobile platforms will assess and monitor the community to see how they are impacting the health of saltmarshes. Evaluating the cumulative anthropogenic impacts will increase the understanding of how anthropogenic activities are interfering with the natural processes of the marsh and allow for the exploration for mitigation and/or restoration of saltmarshes to inform policy makers and the EU Water Framework Directive.

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04

Quantifying and Capitalising on Eco-Activism in Irish Water Sports for Planetary Health

Fáilte Ireland's research shows that overseas tourists who participated in outdoor activities in 2019 in Ireland spent €1.7 billion, with water sports such as surfing contributing significantly to local economies annually. However, with water quality declining and water pollution rising, these activities are under threat. Surfers are among the most vulnerable beach-going populations, given the length of time spent in the water and their presence in the sea outside of the regular bathing season, where pollution monitoring is limited. To tackle this issue, groups such as Surfers Against Sewage raise awareness of this problem with collaborative actions that significantly impact governmental policy and environmental improvements. This research aims to combine health and environmental issues using a planetary health approach to examine and determine the impact of pollution on the health and well-being of surfers in Ireland and their community's influence on improving water quality. In doing so, we will create collaborative platforms by which we can collect and monitor data and evaluate the impacts of various grassroots initiatives which will improve the health and well-being of our coastal communities.

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Extreme Weather Events and Plastic Pollution

Extreme weather events, such as storms and intensive prolonged rainfall periods are becoming more frequent due to intensive anthropogenic activities globally. Through investigating the impact of these extreme weather events on both spatial and temporal scales in marine coastal ecosystems this project will be able to assess both the fluctuating levels of marine plastic debris, including MPs, in the relevant environmental matrices immediately before and after such weather events. Previous research has highlighted that estuaries are hotspots for MPs within bays and that increased rainfall associated with both seasonal fluctuations in rainfall and storms are known to transport aquatic pollutants such as plastics and MPs to remote destinations.

Most studies on plastics and MPs focus on their abundance and distribution at a single timepoint, with few studies examining temporal fluctuations. Taking an ecosystem approach will establish a knowledge base on the extreme factors over time, contributing to increased MP loading in coastal habitats and help to inform cleanup efforts, particularly those targeting beaches. This increases the understanding of extreme events on the levels of pollution in coastal aquatic ecosystems which is crucial to implementing strategies such as, the Climate Action Plan 2023.

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Assessing the Flux of Buried Sedimentary Carbon to Marine Coastal Waters After Extreme Weather and Dredging

Humanity's physical disturbance of the coastal seafloor has expanded considerably in recent decades through dredging, bottom trawling and more frequent severe storms. The natural 'leak' in the carbon cycle from burial of vast quantities of carbon in sediments and the removal of harmful persistent organic pollutants from aquatic ecosystems are essential services provided by sediments. Largescale seafloor disturbance can potentially release previously buried carbon to water and the atmosphere and also expose humans and ecosystems to harmful pollutants. This issue has received little research attention and is a blind spot for planners and policymakers. In this project, we will use bays and estuaries in the west and northwest of Ireland as testbeds to characterize carbon at the molecular level, quantify carbon pools being released from disturbed and pristine sediments and assess whether more ancient carbon and previously buried persistent organic pollutants are being released from sediments. This project is critical and timely; if we reveal a major threat to our coastal carbon cycle and ecosystems, we will help with more effective planning of future human marine coastal activities and inform climate action plans to ensure we keep this carbon in the ground.

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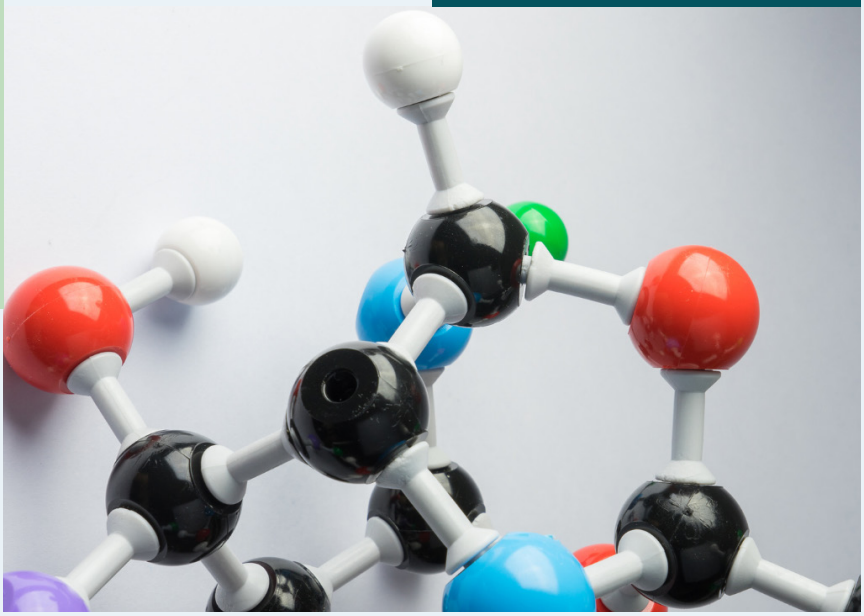

Molecular Characterisation of Marine Plastic Leachates and Associated Environmental Impacts

Plastic production has risen exponentially since the 1950's when global production started, reaching a staggering figure of 390 million tonnes in 2021. Up to 10 million tonnes of plastics enter the marine environment annually with socio-economic and environmental implications that have captured global stakeholder attention. Under environmental conditions, plastics fragment into smaller pieces, potentially releasing additives to the surrounding environment. The aim of this project is to assess and characterize the molecules associated with chemical pollution from plastics and microplastics, resulting from weathering and degradation processes. Assessing these novel substances will allow for a better understanding of ecological risk of these compounds that are associated with chemical and biological pollution, along Ireland's coastline.

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08

Determining the Potential of Domestic Rainwater Harvesting to Decrease Pollution in Coastal Areas

Rainwater Harvesting (RWH) is not only a traditional drought mitigation method but is increasingly acknowledged as part of Sustainable Drainage Systems (SuDS), serving to reduce urban runoff frequency and volumes. RWH systems can prevent the conventional drainage network from becoming overwhelmed by storing runoff during storm events, reducing the risk of flooding and combined sewer overflows (CSOs), also known as stormwater overflows. In Ireland, sewer network modelling has estimated that cumulative annual spill volumes were in the order of 5–10% of the total annual combined flows and is particularly problematic in coastal areas where discharges enter the sea and interfere with local activities such as water sports, potentially causing not only damage to the ecosystem but also a health hazard.

A framework is needed that combines both aspects of individual system performance with the overall impact numerous systems can have on the catchment environment to quantify the feasibility of RWH systems and determine whether incentivisation is needed. This project aims to address this by quantifying and demonstrating the potential of domestic rainwater harvesting systems in coastal areas to act as an additional source of non-potable water and a surface water management tool individually and as part of a network.

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Enhancing Coastal Resilience: A Digital Twin Approach to Contrastive graph Generative Models for Coastal Protection

Earth's rising sea levels and the increased occurrence of severe storms, attributed to climate change caused by human activities, pose a significant threat to the sustainability of life. These changes have serious impacts on coastal regions, such as coastal erosion and flooding. Existing methods for coastal protection, including empirical models, simplify complex processes by learning parameterizations through data fitting. These models are widely employed in modelling dune erosion, demonstrating comparable performance to numerical methods with better computational efficiency.

However, these models are constrained to specific physical features, such as dunes/shorelines, thereby overlooking sediment dynamics, other contributors, and their interactions with coastal erosion.

To address the limitations associated with empirical models, this project proposes a modelling framework integrated with Digital Twins. Digital Twins aim to provide a virtual representation of the coastal environment, incorporating real-time/simulated data and dynamic factors. By embracing Digital Twins, the project seeks to enhance prediction accuracy and consider various elements influencing coastal erosion, extending beyond sediment dynamics. This understanding will be further leveraged to design graph generative models based on contrastively learned representations, which are expected to perform effectively in downstream tasks. Ultimately, this approach will facilitate the development of predictive mitigation strategies for effective coastal protection.

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Linking Oceanographical Connectivity Pathways and Environmental Pollution Pressures to the Genetic Structure of Planktonic Biota in Coastal Embayments

Various biological resources and ecosystem services are provided by coastal embayments. These have been impacted by growing human populations, overexploitation, habitat transformation and pollution associated with urban developments and agricultural practices. These pressures may be further exacerbated by climate change driven events. The monitoring of such pressures is enforced via several statutory instruments in the context of, for instance, water quality, waste discharge management or aquaculture practises. There is a multidimensional connectivity element to managing coastal environments, which needs to integrate the transport of water masses along the continental shelf (eg. coastal density driven jets, meteorological physical forcing) and a land-to-sea differential gradient of environmental pressures, including invasive species, harmful algal blooms, microbial and viral contamination in terms of biological risk, or fertilisers, pesticides, microplastics or pharmaceutical and personal care products in terms of chemical pollutants.

Sustainable management is key to safeguarding the exploitation of various marine biological resources and increasing the ecological status of the coastal environment. Delivering on this requires the conduct of diversity and stock assessments as well as the implementation of conservation measures or mitigation strategies.

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Adapting the Biological Quality Elements (BQE) to Irish Benthic Coastal and Transitional Habitats

The EU Water Framework Directive (WFD) was adopted in October 2000 and is one of the most important pieces of legislation in relation to water quality in EU member states. The aim of the WFD is to protect and monitor all water bodies including surface waters (rivers, lakes, estuaries (transitional waters) and coastal waters) and groundwaters to achieve good water quality for these habitats. Water quality is monitored through the assessment of a variety of proxies or Quality Elements such as benthic invertebrates, phytoplankton, and water nutrient concentrations.

This research will investigate the relationship between benthic macroinvertebrates and (i) Ecological Status of waterbodies, (ii) other BQE's (Biological Quality Elements) with a particular focus on adapting the benthic BQEs to better reflect a wider range of habitats as currently they are restricted to fine sands and muds and/or the effect extreme events have on the water quality scores reported. In particular, the project will focus on the Infaunal Quality Index (IQI), a multimetric index, that expresses the ecological health of benthic macroinvertebrate (infauna) assemblages. Within the parameters of this metric the project will assess potential relationships between the benthic phytoplankton dormant stages present at time of sampling and the BQEs

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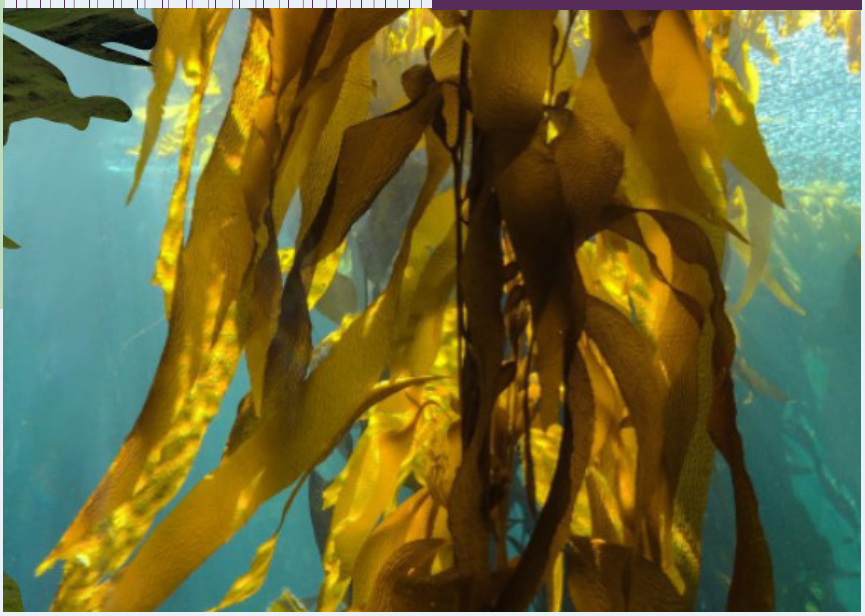

Seaweed Ecosystem Services: Evaluating the Role in Coastal Erosion Mitigation, Carbon Sequestration and Nutrient Re-Uptake From Anthropogenic Sources

This project aims to investigate seaweed's natural coastal protection potential, ability to capture carbon dioxide, water purification roles and its consequential benefits to soil health, aligning with the ERDF's focus on a smarter, more competitive, and greener Europe. Seaweed beds are not just underwater forests; they are nature's defense against ocean forces that cause coastal erosion. The North West's abundant seaweed also serves as a natural carbon sink, locking away carbon and mitigating the effects of global warming, contributing to ERDF's goal of a low-carbon, environmentally sustainable Europe. We are also examining how seaweed takes up excess nutrients from human activities, such as fertiliser runoff that eventually enters our seas, which can harm marine life. By studying these processes, we can better appreciate and utilise seaweed as a product and a critical environmental steward. Through collaboration with Donegal Seaweed, a leader in sustainable seaweed products, this project will offer insights into how we can protect our coastlines, clean our waters naturally, and protect our upland soils while promoting employment locally, aligning with regional sustainability and food security goals. This collaboration simultaneously enhances local professional services and industry capacity, fostering regional development in line with the ERDF metrics.

Lead Supervisor:
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Requirements/Qualifications

A minimum of 2.1 honours degree (Level 8) in a relevant discipline.

Project Duration:
48 months (PhD)

All projects will be available on a full-time study basis only.

Applications:
Application Form / Terms and Conditions can be obtained on the website: www.atu.ie/TU-Rise

The closing date for receipt of applications is 5pm, (GMT) Monday 29th April, 2024.

Only selected applicants will be called for an online interview (shortlisting may apply).

Funding Statement
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