2025

PhD Program

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INTRODUCTION

The activities developed by the AIR Centre need the best available science. This is the only way to strengthen the community, make available qualified information to people and to the economic sector, and promote in any place of the Atlantic the same level of knowledge that already exists for the most advanced countries. To cope with this collective need, we must be able to benefit from all resources available at the AIR Centre network, but also to cooperate with the most advanced research groups that deal with the ocean, space and climate challenges, in a time when environmental and energy transitions add to the existing challenges to ensure the well-being of our communities.

Consider the different programs of the AIR Centre:

Ocean Policy and Stakeholders Engagement ask for new insights to develop science-based marine policy concepts and new methodologies to address key challenges in ocean governance, institutional cooperation, and citizen engagement.

Biodiversity and Blue Economy ask for new tools to monitor marine ecosystems and to ensure a better integration between the use of marine resources and the preservation of the ocean environment, based on solid biological research and new biotechnological approaches.

Space Systems and Applications need to better relate the Earth Observation (EO) observables to the ecological and biogeochemical processes that take place in the ocean.

Data Science, Cloud Infrastructure and Development need to expand the use of AI tools to describe internal ocean processes and their effects on the biosphere and infrastructure. Also, there is a need to progress in the development of Internet of Things (IoT) low-cost approaches, as a tool to increase the monitoring capacity of the community.

Ocean and Coastal Modelling are now a very dynamic area, building up the first pieces of what will be the digital twins able to represent the physical, chemical or biological processes, improve forecast skills, and better serve people and the economy.

Blue One Health need to cope with the relationship between the ocean and the health system that has evolved in the last decade.

The PhD programs that were funded by the Portuguese Foundation for Science and Technology are an important tool to progress in all these areas. In this document you can find a description of the topics that are handled by several Atlantic research groups or universities, the steps already taken and the challenges ahead.

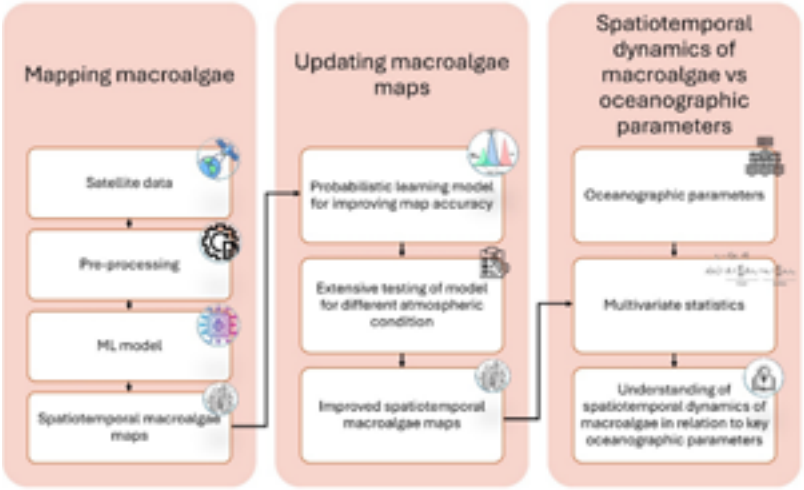
This new generation of Atlantic researchers is our best hope for the common future.

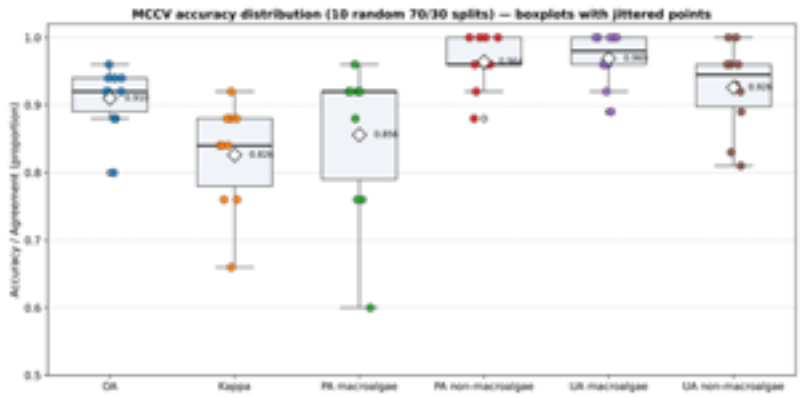
Ahmed Ali

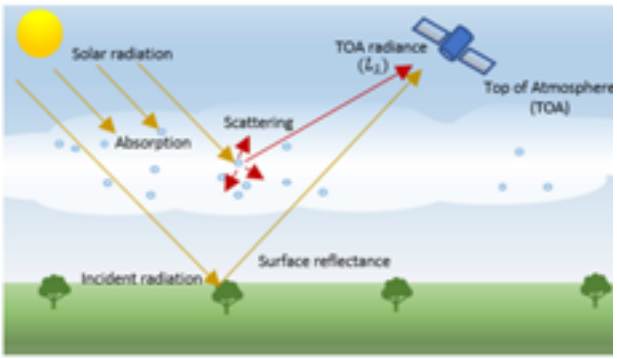
Machine learning approaches for the analysis of marine ecosystem indicators for present and future scenarios

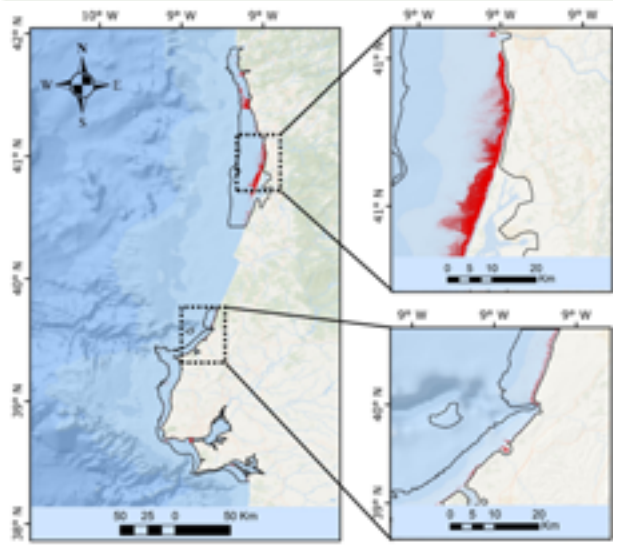
Abstract

Climate change is reshaping the distribution and abundance of marine species, including macroalgae, which are key to ecosystem structure and coastal resilience. This project aims to develop a robust framework for mapping and monitoring intertidal and subtidal macroalgae (up to 10 m depth) along the Portuguese coast using high-resolution satellite imagery such as Sentinel-2, Spot-7, and WorldView-2. Traditional *in situ* methods are costly and limited in spatial coverage, while optical satellite observations face challenges from cloud cover, shadows, and water turbidity. To address these limitations, this research integrates advanced image pre-processing, feature engineering, and machine-learning algorithms to improve classification accuracy and temporal consistency. The study also investigates the relationships between macroalgal distribution and key oceanographic parameters to enhance understanding of their spatiotemporal dynamics. The outcomes will support the continuous, large-scale monitoring of coastal ecosystems under changing climatic conditions.









Coastal macroalgae are vital indicators of marine ecosystem health and productivity, yet their monitoring at large scales remains technically challenging. This project leverages machine learning and satellite remote sensing to develop efficient, data-driven tools for identifying and tracking macroalgae under variable environmental conditions.
By processing large multi-source datasets, including optical reflectance, bathymetry, and oceanographic parameters, the research aims to enhance the precision and frequency of ecosystem assessments.

The methodology emphasizes automated classification, correction of atmospheric and water-column artifacts, and integration of temporal data for improved change detection. Ultimately, this work will contribute to sustainable marine resource management and support adaptive conservation strategies in response to climate-induced ecosystem shifts.

Acknowledgements

This PhD project is supervised by Isabel Sousa Pinto, from CIIMAR, University of Porto, César Capinha, from IGOT, University of Lisbon and Patrizio Mariani, from the Technical University of Denmark. Cooperation with IEAPM and University of Cadiz. The PhD project started in September 2024. FCT grant 2024.11175.PRT.

Alcindo Neckel

Conservation and restoration of natural systems, from the rainforest to the ocean

Abstract

The plan of this PhD project is based on the analysis of the ecosystems services associated to the integral system, from the tropical forest and high mountains to the infralittoral zone, including the lowland areas usually dedicated to intensive culture or urbanization, and the coastal areas including reef zones. The research will explore the patterns of connectivity and the critical components that define the functioning of these diverse ecosystems. Building on this understanding, the project will develop proposals aimed at preserving and restoring key ecological elements, with particular emphasis on strategies that enhance the resilience of coral reefs and other coastal systems under threat. The project will include case studies that apply these remediation strategies in real-world contexts, accompanied by systematic monitoring to assess the ecological outcomes of their implementation.

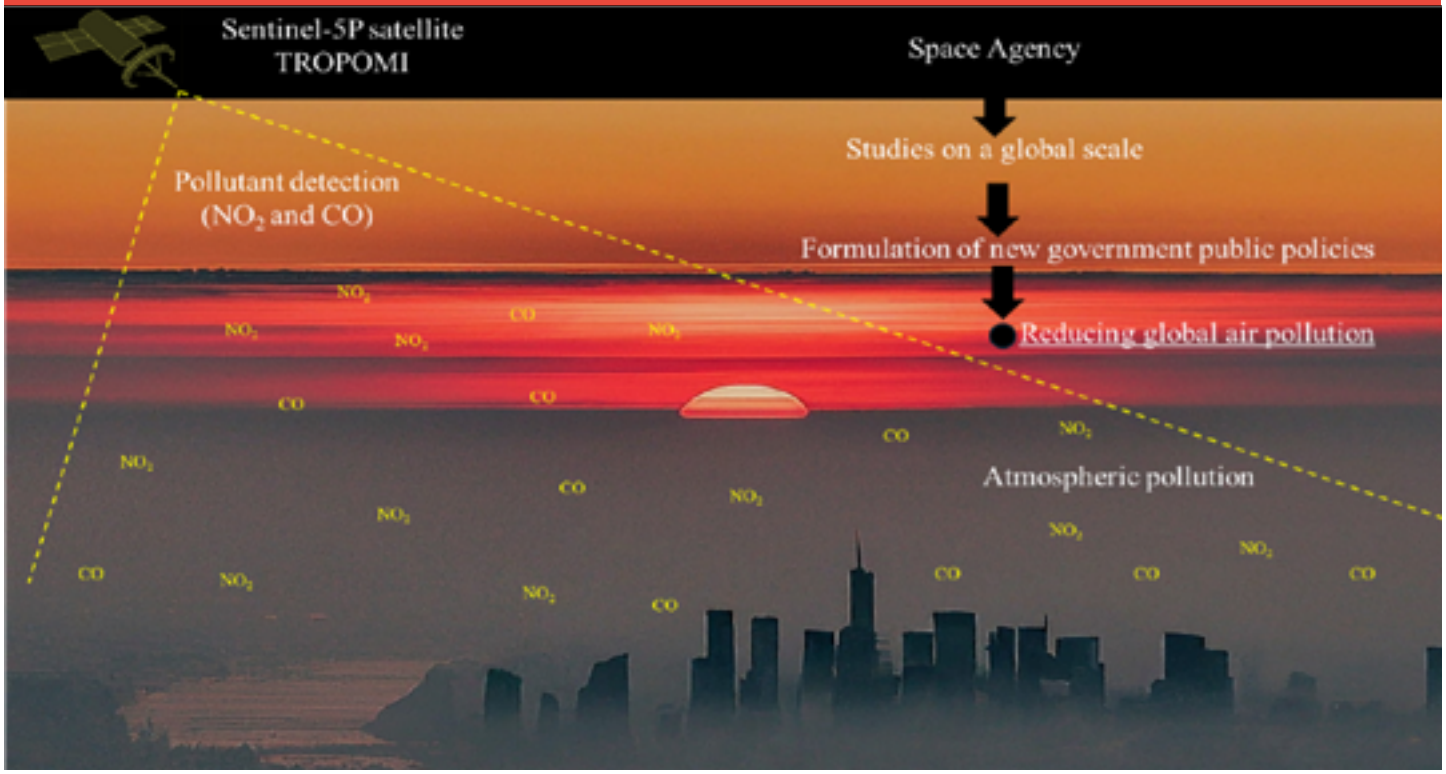


Figure 1 - Global-scale geospatial detection dynamics.

The current pressure on the planet's greatest biosphere reserves is endangering their health. On one hand, these represent important biodiversity reserves and guarantee the continuity and preservation of species, contributing very significantly to climate and atmospheric equilibrium and guaranteeing the so-called ecosystem services. On the other hand, these are increasingly threatened by the need to exploit the soil, extract raw materials and advance in urbanization, or by the densification of the coasts such as the one caused by port or extractive activities. In this context, it becomes increasingly relevant to identify, characterize and quantify ecosystem services and the impact they have on all aspects of livelihood and human well-being. Marine and coastal systems are especially relevant and present patterns of close connectivity establishing a continuum between the tropical forest, rivers, lakes and lagoons, estuaries and coastal zones, and the infralittoral zone.

Figure 1 demonstrates the role of the Sentinel-5P satellite (TROPOMI sensor) in the remote detection of atmospheric pollutants, with emphasis on nitrogen dioxide (NO_2) and carbon monoxide (CO) distributed in the urban atmosphere. The data obtained on a global scale by space agencies support wide-ranging environmental studies, enabling the assessment of atmospheric pollution.

This scientific information supports the formulation of new government public policies, with the ultimate goal of reducing air pollution on a global scale.

Acknowledgements

This PhD project is supervised by Eduardo Pereira, from the University of Minho. The PhD project started in June 2023. FCT grant PRT/BD/154704/2023.

Anton Tolstonogov

Adaptive marine environment inspection and mapping using networked surface and underwater robots

Abstract

The key topic of this PhD project is developing decentralized algorithms for localization and motion planning. In practice, underwater and surface vehicles often operate at distances where sustained high-bandwidth communication links are infeasible due to physical limitations, such as those imposed by acoustic modems, multipath effects, and energy constraints. Therefore, a centralized approach may be impractical or impossible in many operational scenarios because it requires the continuous transmission of raw measurements to a single processing unit. Decentralized solutions, where each vehicle processes locally available data and exchanges only essential information with its neighbours, offer significant advantages in robustness, scalability, and operational autonomy. This project deals with two interconnected research questions: 1) the decentralized localization issue is addressed by developing algorithms that allow each tracker to update and improve its estimate of the target states (position, velocity, possibly motion patterns) based on only the partial and locally available time-difference of arrival (TDoA) measurements and, 2) the optimal trajectory planning problem in a cooperative and decentralized setting. By integrating these two components the project seeks to enable an autonomous marine robotic swarm to perform sustained and efficient tracking of multiple underwater targets. The proposed methods are intended to be functional in actual ocean environments where communications are intermittent, target numbers are dynamic, and observation opportunities are extremely limited in space and time. This would significantly enhance marine life monitoring missions and defense scenario exercises, providing more comprehensive data on which to base ecological studies and informed conservation and management decisions.

There is considerable interest in the development of tools and methodologies for ocean exploration, with a particular emphasis on the pressing and challenging issue of monitoring marine life and studying how the concentration and movement patterns of certain species relate to the state of the environment (e.g., temperature, salinity, pH, and type and concentration of nutrients). This activity is of paramount importance to translate marine animal tracking data into conservation policy and management. However, achieving this objective is fraught with challenges, primarily due to the vastness of the ocean and the limited operational time and robustness afforded using single marine robots.

Current trends are driving the development of multiple collaborative marine vehicles. These vehicles can determine, based on real--time data gathered during observation and monitoring missions, the most effective course of action to take. This approach aims to circumvent the need for exhaustive surveys and/or blind sampling of the environment, thereby optimizing the allocation of resources and ensuring the most efficient use of time. Furthermore, cooperative systems are required to collectively localize and pursue multiple underwater species simultaneously. This can be achieved using acoustic tags on targets and receivers placed on-board autonomous surface vehicles (ASVs) or even underwater robots (AUVs or gliders). While these capabilities are highly relevant for marine animal monitoring, these cooperative tracking and localization methodologies also hold strong potential for a variety of other critical ocean-related missions. These include providing navigational assistance to autonomous or remotely operated vehicles engaged in seabed mapping, surveying and mapping marine habitats on the sea floor, and supporting adaptive ocean sampling tasks.

The specific nature of this type of tracking problem poses challenges not commonly found in other areas of marine robotics. Underwater acoustic tags must be small and consume very little power. Consequently, most tags are simple emitters, making it virtually impossible to compute their position using acoustic receivers through range-based trilateration techniques. This creates an imperative for alternative methodologies that employ TDoA strategies utilizing multiple receivers on a single or networked vehicle operating in cooperation. The adoption of such strategies, however, raises a further challenge: how to plan the motion of the trackers so that their manoeuvres generate a sufficiently rich set of information to enable accurate target localization from TDoA-based measurements.

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Armin Halicki

Coordinated autonomous ocean and air vehicles

Abstract

This PhD project focuses on bridging the semantic gap between high-level scientific goals and the low-level execution of multi-vehicle oceanographic surveys. The approach involves the development of a requirement specification frame and a hierarchical control architecture that translate scientific objectives into executable robotic plans. The aim is to enable coordinated surveys in which fleets of autonomous underwater, surface, and aerial vehicles can together to achieve synoptic, persistent, and high-resolution observations of the ocean. Execution is evaluated by the data: a survey is only successful if the observations satisfy the scientific requirements. This PhD project aims to deliver three outcomes: 1) a specification framework that captures resolution, synoptic window, coverage, target feature, and intended strategy, and that reports feasibility and compliance, so unmet requirements are flagged early, 2) a hierarchical control architecture that keeps goals traceable to vehicle actions and supports replanning when scientific requirements are at risk, not only when low-level faults occur. This ensures resources are directed where most needed and reduces the burden of manual plan design, and; 3) demonstrations in simulation and field trials, including heterogeneous fleets, that show requirement-first planning meets scientific requirements more effectively than traditional methods. Together these contribute toward science-aware ocean autonomy that expands the range and quality of oceanographic data obtainable with available resources.

The motivation for coordinated autonomous ocean and air vehicles control comes from the growing demand for observations that resolve fine-scale variability while capturing the rapid dynamics of ocean features within their broader context. Surveys must achieve sufficient spatial and temporal resolution to resolve ocean features as they evolve, and they must be carried out with enough synopticity to obtain a snapshot of the environment before ocean dynamics change it. Ship-based surveys have supported marine research for decades, but they are costly, manpower-intensive, and constrained by sequential sampling, which makes synoptic coverage difficult. Satellites now provide valuable surface data, but they cannot replace *in situ* sampling needed for subsurface processes and for validation of remote-sensing measurements. Autonomous systems offer persistence, cost-effectiveness, and distributed coverage. The central challenge lies not only in their deployment and operation but ensuring that autonomy produces scientifically reliable data. Vehicles must coordinate under communication limits, adapt to changing conditions, and translate high-level scientific requirements into executable actions.

We formalize survey requirements and embed them within a hierarchical control architecture. At the mission level, we capture scientific intent in terms of spatial and temporal resolution and the synoptic window needed. At the team level, the requirements are translated into survey frames, transect layouts, and task allocations with strategies chosen according to the feature under study. At the vehicle level, we build on the *Laboratório de Sistemas e Tecnologia Subaquática* (LSTS) toolchain while extending it with specification-driven planning and monitoring components. This keeps goals traceable down to execution and allows adaptation to currents, delays, or platform constraints. The approach is not tied to a single toolchain; layered control is standard in robotics, which makes the framework transferable.

Different features require different strategies, which we use to test the framework. Fronts are sampled by repeated perpendicular crossings, eddies by center-passing transects and radial sweeps, plumes by following concentration gradients. These strategies are treated as parameterizable templates. The specification includes the target feature and environmental variables, the intended strategy, the required spatial and temporal resolution, and the synoptic window. The architecture translates this into survey geometries and vehicle allocations, while supervisory components monitor whether requirements are being maintained as the environment evolves and survey continues.

We developed prototype modules that generate survey geometries with transects and vehicle assignments. They also evaluate whether resolution and synoptic windows are satisfied, issuing warnings when requirements are at risk. This enables replanning triggered by scientific criteria rather than only by technical failures. In multi-AUV simulations, the framework sustained boundary crossings within the synoptic window and reallocated vehicles when requirements would otherwise be violated. It can also signal when specifications are infeasible with the available resources, giving scientists the chance to adjust requirements instead of unknowingly collecting inadequate data. Unlike uniform grids, which distribute effort evenly and often impose unnecessary PhD projectload, the requirement-driven approach directs resources to informative regions, avoids redundant sampling, and reduces operator burden. This non-uniformity may resemble adaptive sampling, but it differs in being requirements-driven and verifiable: survey effort is allocated and checked against explicit scientific specifications, whereas adaptive methods typically react to sensor cues without guaranteeing compliance. Preliminary results indicate that requirement-first planning can keep execution aligned with scientific objectives while reducing PhD projectload for scientists and operators.

Acknowledgements

This PhD project is supervised by João Borges de Sousa and Renato Mendes from INEGI and University of Porto. The PhD project started in March 2023. FCT grant PRT/BD/154497/2021.

Arthur Fernando Veronez de Sousa

Multidisciplinary Assessment of Ecological and Human Dimensions in Atlantic Mangroves Sustainability

Abstract

The sustainability of Atlantic mangroves in Portuguese-speaking African countries (PALOP) is shaped by complex ecological and social dimensions. This study adopts a multidisciplinary perspective to integrate ecological, cultural, and material contributions of nature to human well-being. A comprehensive review of regional knowledge highlights uneven documentation of ecosystem services and reveals significant gaps in understanding key ecological processes. Field assessments of benthic communities and functional traits underscore spatial heterogeneity and the importance of diverse structural and functional roles in maintaining ecosystem integrity. Analyses of scientific effort reveal thematic fragmentation and a concentration on selected taxa, emphasizing the need for a broader research framework. By synthesizing ecological, social, and cultural dimensions, the study provides a foundation to identify research priorities and inform evidence-based conservation strategies that enhance both ecological resilience and the livelihoods of local communities. This integrative approach supports sustainable management of mangrove ecosystems by aligning environmental, cultural, and socio-economic considerations in policy and practice.

The core motivation for this research was to address the escalating threats to mangrove ecosystems in the Portuguese-speaking African Countries (PALOP) by establishing a comprehensive, integrated understanding of their function and socio-cultural value, which is currently fragmented and unevenly documented. The project conceptual foundation relies on the IPBES framework of Nature's Contributions to People (NCP), providing a structured, holistic approach that evaluates material, non-material, and regulating services. This lens was essential because conventional ecological assessments often inadequately account for the cultural values tied to traditional land use and community identity, which are integral to the socio-economic resilience of coastal communities in PALOP countries. The research advanced the state of the art at a regional scale through several key components:

Systematic Knowledge Diagnosis: The initial work involved a systematic review to synthesize the state of mangrove research across PALOP countries. This effort rigorously identified thematic and geographic gaps, revealing the complete absence of studies addressing key ecological functions, specifically NCP2, 5, 6. This diagnosis creates a crucial roadmap for future targeted research and resource allocation in highly vulnerable countries and mangroves ecosystem areas, where display the largest knowledge gaps.

Ecological Status and Bioindicator Development: Subsequent field investigation in Guinea--Bissau provided novel empirical data on benthic macroinvertebrate communities, organisms recognized for their pivotal roles in nutrient cycling, decomposition, and trophic support. By applying established bioindicator tools like AMBI and M-AMBI, the study characterized the ecological integrity of the mangroves. This effort established regional baselines necessary for long-term monitoring and provided essential taxonomic knowledge, exemplified by the documentation of the first occurrence of the polychaete *Namalycastis senegalensis* in Guinea-Bissau.

Functional Research Bias Analysis: The thesis further advanced regional understanding by performing a specialized functional analysis of invertebrate research, confirming that existing effort is overwhelmingly skewed toward Detritivores and Bioindicators. This analysis highlighted the severe underrepresentation of functional groups critical for ecosystem structure, such as Ecosystem Engineers and Prey Species, confirming a fragmented understanding of mangrove functioning that compromises the ability to design robust conservation and restoration strategies.

Historical Integrated Framework for Management: By integrating these ecological findings with socio-environmental perspectives, including the analysis of historical Portuguese sources, the dissertation furnishes a comprehensive, multi-dimensional framework that explicitly links ecological resilience with local livelihood and cultural needs. This research directly supports the development of adaptive conservation strategies and evidence-based policies tailored to the complex socio-ecological realities of West African mangroves.

Acknowledgements

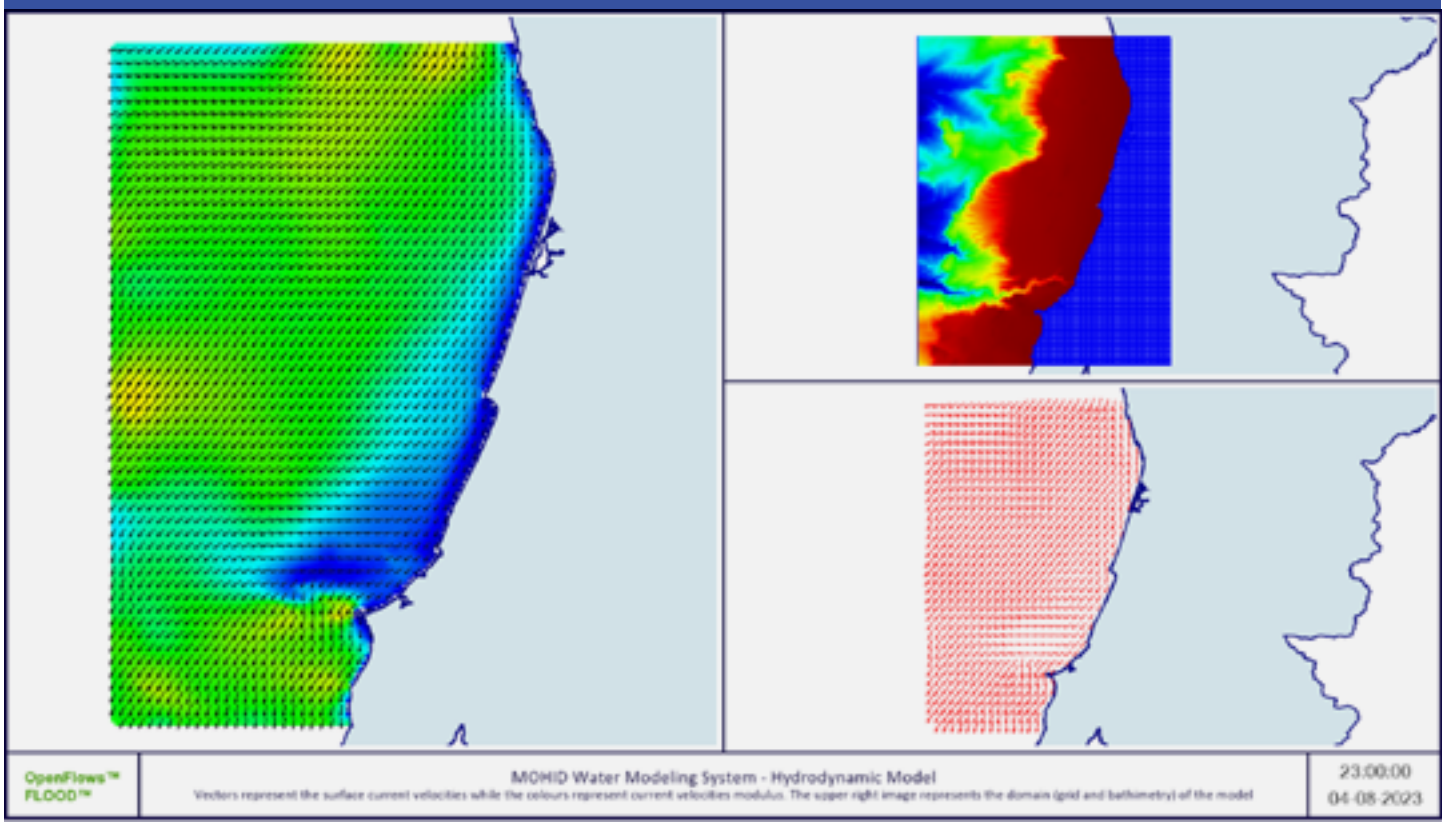
This PhD project is supervised by Helena Freitas, and António Gouveia, from the University of Coimbra. The PhD project started in February 2022. FCT grant PRT/BD/153040/2021.

Bárbara Viana da Silva

Near shore harmful algal blooms generation models

Abstract

The cause of Harmful Algal Blooms (HABs) is not yet fully understood. However, it is accepted that HABs are a consequence of unbalanced nutrients that favour the species that can live with fewer nutrients or even extract the missing nutrients from alternative sources (e.g., mixotrophy). Toxic algae species have those capacities, and the species that bloom in each condition depend on specific stressful conditions. With present knowledge, it is not yet possible to predict HABs deterministically, but one can seek a probability of occurrence based on stress conditions. The aims of this PhD project are to improve and validate a biogeochemical model for the Iberian Atlantic, able to identify nutrient stress conditions, and further collect remote sensing data for model validation. Finally, combining these two sources of information with *in situ* toxic algae data measured along the Portuguese coast (blooms and regular monitoring) and bibliographical data, will allow to create a HAB probability index.



HABs present a significant problem in coastal areas worldwide. In some regions, they occur due to increased nutrient loads from human activities, while in others, they are triggered by coastal hydrodynamics. The Eastern Boundary Upwelling Systems (EBUS) experience recurrent HABs events because of nutrient inputs from intermediate water masses that flow to the surface throughout the year. The Portuguese coast is part of an EBUS, and its coastal dynamics can promote the growth of diatoms or dinoflagellates (two groups that promote HABs). Those events depend on wind patterns and upwelling-relaxation-downwelling cycles. These algae groups are known for their succession in highly productive areas, alternating between growth and decline. Diatoms generally bloom during upwelling events when nutrient-rich waters reach the surface, while dinoflagellates flourish after nutrient depletion and a weakening of upwelling conditions. Besides monitoring data, biogeochemical and hydrodynamic models can aid in understanding and predicting toxic bloom events. These algae groups, after a bloom, can be concentrated by filter feeders used for human consumption (e.g., molluscs, clams, oysters), becoming a serious threat to public health and to the aquaculture industry. For their implications on human health, they are monitored regularly. Alerts are issued by public authorities whenever they are detected. The displacement of the bloom is often forecasted using particle-tracking models, giving some time to aquaculture producers to take mitigation actions (e.g., earlier cropping). Warnings based on the probability of the occurrence of a bloom would increase benefits for aquaculture but are still a challenge for the scientific community.

Models and remote sensing are the best tools to identify those conditions. The former provide information about nutrients in the water column, while the latter offer insights into properties related to primary production (e.g., surface temperature and chlorophyll) and are readily accessible.

The first year of PhD project was devoted to compiling historical data, reviewing the literature, and studying and understanding the MOHID model, which is the basic modelling tool to be used in this PhD project. During this year, data on toxic algal cell density and biotoxin concentration from IPMA monitoring programs were compiled, as well as satellite data on chlorophyll-a along the Portuguese coast. The hydrodynamic model implemented covers the entire Portuguese coastal zone, with a spatial step of 6 km; and a more refined hydrodynamic model (with a resolution of 1.3 km) is being implemented covering the area from Porto-Matosinhos to the Mafra region (Portugal).

Acknowledgements

This PhD project is supervised by Ramiro Neves and Lígia Pinto, from MARETEC, Instituto Superior Técnico, University of Lisbon and Sofia Saraiva, from SMHI Oceanographic Research Unit. The PhD project started in September 2024. FCT grant 2023.18551.PRT.

Cátia Alves

The genetic structure in populations of crustacean decapod crabs in oceanic islands: contrasting evolutionary and biogeographic patterns

Abstract

This PhD project aims to better understand the biogeographical and evolutionary patterns of marine invertebrates in the Azores (Portugal), using a population genetics and phylogeographic approach for three shallow-water crustacean decapod crab species, naturally occurring in the Northeast Atlantic Ocean. The results will valuably contribute to increase the current knowledge in the Azorean biodiversity and provide crucial information to address the effects of climate changes on islands.

Three shallow-water crustacean decapod crab species, naturally occur in the Northeast Atlantic Ocean: the warty crab *Eriphia verrucosa*, with a wide geographic distribution, stretching from the Mediterranean Sea (including the Black Sea) to the East Atlantic Ocean, from Brittany to Mauritania and the Azores, Madeira (Portugal) and Canary Islands (Spain); the marbled crab *Pachygrapsus marmoratus*, a species that occupies the intertidal levels of the rocky coasts of the Mediterranean Sea, and NE Atlantic Ocean, from Brittany to Morocco, including the Azores, Madeira and Canary Islands; and the red rock crab *Grapsus adscencionis*, a species associated to rocky shores.

This study aims to enlighten the diversity and population structure of these species and factors shaping it, to clarify their evolution in remote oceanic islands and to understand the possible role of seamounts, ocean-currents and periodic climatic changes in the long--distance dispersal/invasion process of the archipelago.

Acknowledgements

This PhD project is supervised by Sérgio Ávila, António Santos and Manuel Curto, from CIBIO-InBIO, University of Porto and the Institute for Integrative Nature Conservation Research of the University of Natural Resources and Life Sciences, INF-BÖKU, Vienna, respectively. The PhD project started in September 2021. FCT grant PRT/BD/151537/2021.

Claudia Sacchetti

Marine biogeography functional patterns and processes in Atlantic archipelagos

Abstract

This PhD project uses state-of-the-art geological knowledge on Atlantic archipelagos, coupled with biological and ecologica information of selected species of shallow-water marine molluscs. The results obtained will be relevant to promote the conservation and sustainability of species diversity and better inform and raise awareness among decision-makers, and local stakeholders.

Biogeography, Genomics, GIS and Numerical Ecology can contribute to develop the knowledge concerning marine biogeographic processes. These tools will be used in a case--study focused on Atlantic Archipelagos, particularly the Macaronesia Islands, to support the development of theoretical models of marine island biogeography and evolution, in the context of climate change that affects insular marine ecosystems.

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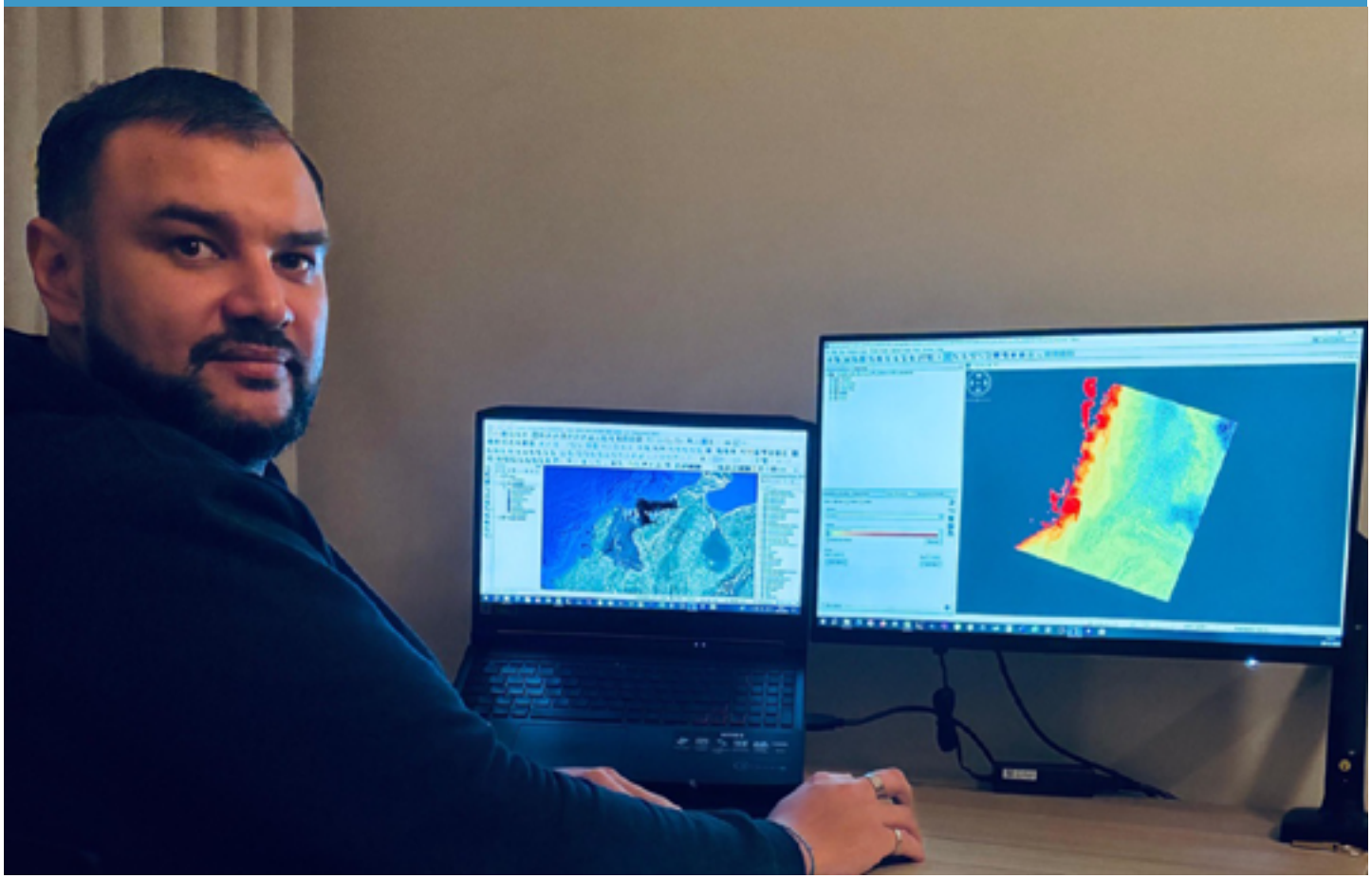
This PhD project is supervised by Sérgio Ávila, Rui Freitas and António Múrias dos Santos, from CIBIO-InBIO at the Azores, Atlantic Technical University at Cabo Verde and CIBIO, respectively. The work started in September 2021. FCT grant PRT/BD/152218/2021.

Cleiton Korcelski

Contaminants in suspended sediments and hazardous elements in the Sierra Nevada watershed

Abstract

This PhD project aims to analyse the adsorption of potential contaminants, suspended sediments, and hazardous elements in the Sierra Nevada de Santa Marta and La Guajira watersheds (Colombia) through the analysis of spectral bands obtained from the ESA Sentinel mission. To do so, we will determine coloured dissolved organic matter, total suspended matter and chlorophyll-a concentrations in suspended sediments (SSs) in water bodies, monthly, correlating with the distribution of rainfall from 2022 to 2025. The detection of hazardous elements and nanoparticles in water bodies uses Sentinel-3 OLCI, correlating with rainfall distribution. Mining sites, urban centres, land use and population concentrations will be assessed resorting to Sentinel-2 data. Air quality and concentration of trace gases, such as nitrogen dioxide (NO_2) and carbon monoxide (CO) will be made with the aid of the Sentinel-5P TROPOMI satellite. Concentrations of Fe-NPs + HEs in water bodies will be correlated with rainfall distribution. This project will propose possible future solutions and recommendations for public policies for the conservation and understanding of the potential resources of the Sierra Nevada de Santa Marta and La Guajira.



The Sierra Nevada de Santa Marta Park covers a total area of approximately 17.000 km² and is located across the departments of Magdalena, La Guajira, and Cesar in Colombia. The specific need for this project is to understand the actual contamination of the waters in the Sierra Nevada de Santa Marta and La Guajira watersheds. Despite other studies have addressed specific traces of contamination in nearby watersheds, these are insufficient due to the large territorial scale and variations in the flow velocity of these waters. Unlike previous analyses, the results obtained from satellite imagery can provide a more comprehensive analysis of the entire watershed. This project is of great importance for the development of new public policies aiming at conserving the Sierra Nevada de Santa Marta and La Guajira watersheds.

It is important to note the constant presence of gold and coal mining, agricultural activities, and cities along this watershed, which accumulate waste and metallic components in the riverbeds that supply drinking water to the population. Likewise, the viability and relevance of this proposal for the territory must be considered in the short, medium, and long term to build future nature conservation actions.

As it is a new evaluation technique using novel imagery from the ESA Sentinel mission, this PhD project will provide public managers and other researchers with a more modern analytical approach on a global scale, enabling the formulation of public policy recommendations aimed at the preservation of the Sierra Nevada de Santa Marta and La Guajira watersheds, especially in the Sierra Nevada Natural Park area, a site of enormous biodiversity.

Images captured by the satellites on the 15th day of January, March, June, and September will be selected from 2021 to 2025, comprising 20 assessments of the target area. With this data, it will be possible to determine the concentration of ADG_443_NN, TSM_NN, and CHL_NN.

For atmospheric contamination, resorting to Sentinel-5P TROPOMI satellite, regional images of NO_2 (nitrogen dioxide) and CO (carbon monoxide) will be collected 1) December to February, and 2) June to August, covering two seasons and four different years of evaluation.

Alongside the expeditions mentioned earlier, mining sites, urban centers, and population concentrations within the predetermined study area will be identified. The geographic coordinates will be plotted on maps and correlated with the optical images obtained from the Sentinel-3B OLCI satellite. To detect Fe-NPs + HEs and for biodiversity analysis, expeditions will be carried out in the study area, and water samples will be collected from relevant water bodies.

The expected results of this PhD project aim to build a theoretical framework and provide a scientific basis for geospatial surveys targeting the contamination of estuaries in the Colombian Caribbean and Tropical Andean region. Preliminary results highlight that high concentrations of terrestrial and atmospheric contaminants pose a risk to human health and affect the environmental quality of an area of global importance due to its rich biodiversity. Continuous monitoring of contaminants and the formulation of new public policies by government agencies are recommended to identify and mitigate sources of pollution in the region.

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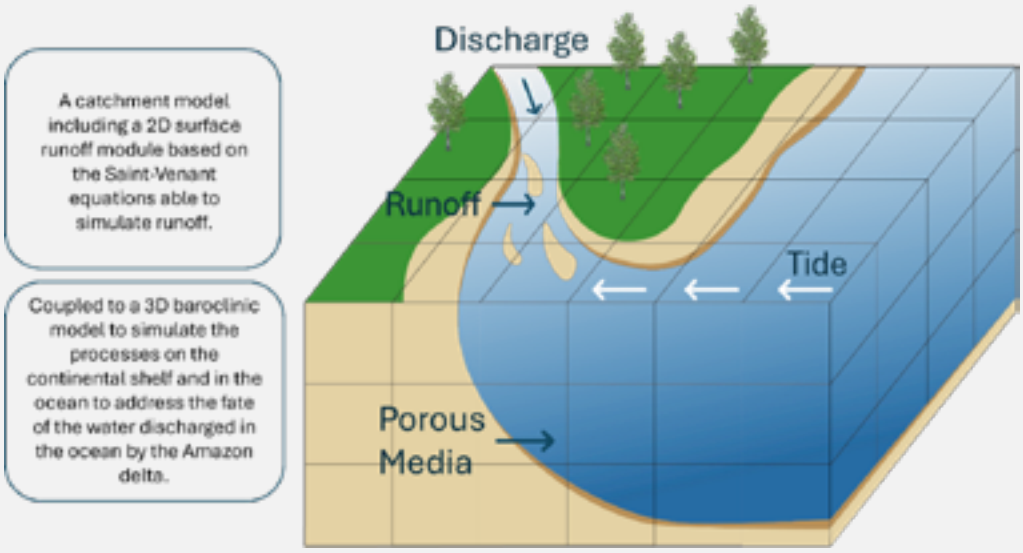
Débora Pereira

Healthy Atlantic basin

Abstract

The Amazonian Delta has been object of many research projects using *in situ* measurements, remote sensing and modelling, but an integrated view of the processes occurring in the Delta is still missing. What is the contribution of the Amazonas river water to the processes in the Pará Estuary? How does the exchange along the Breves Straights compares with the exchange through the mouth associated to the tidal flow? How does it compare with other rivers discharge and with the freshwater discharge generated inside the Delta and transported along the local small catchments? The difficulty to answer these questions is a consequence of the large size of the Delta and of the complexity of its morphology that turns *in situ* data into "small data" for this purpose. The answer to the above questions will contribute to compute budgets of suspended matter to the Pará estuary for which the Amazon water is a major source. The suspended matter plays a major role on the control of the planktonic primary production in the upper Pará Estuary, enhancing the importance of the mangrove areas, including in the Guajará Bay where the major urban area - Belém (Brazil) is located. This PhD project will focus on Healthy Atlantic Basin. Research will address marine and coastal ecosystem modelling in the Amazon Delta to support management practices and decision making. New knowledge and technologies will contribute to protect and restore exploited ecosystem services and to identify and sustainably explore new ecosystem services still strengthening resilience against climate change. The Amazonia Delta was chosen for its dimension, for the range of interdependent estuarine processes and for the impact of the freshwater plume in the Atlantic Ocean, that extends up to the Caribbean region.



The global picture of the Amazon Delta must be based on remote sensing and modelling, the only technologies able to address the Delta as a whole. Used together, these tools can give global and local solutions and can contribute to explain the processes controlling them. The new generation of Sentinel satellites produces high-resolution data sets covering very wide areas of the delta, that can be zoomed up to the local scale. Remote sensing needs to be complemented by modelling because it cannot address all important properties neither the processes responsible for the results. The combination of remote sensing and a system of nested models can link the whole estuary scale to the local scale, addressing processes and variables not measurable by remote sensing both in the water column and in the local catchments.

The combination of remote sensing, modelling and local *in situ* truth data will give the optimal solution to explain, quantify and protect local ecosystems in the delta. A former implementation of a set of models for the estuary and the assessment of Sentinel images for suspended matter put into evidence the role of the permanent flow along the Breves straights for the particulate matter budget of the Pará estuary and the importance of sporadic communication between the Amazon Estuary (southern channel and the Pará estuary mouth). The study also suggests that some local catchments (e.g., Guamá) also contribute with important suspended matter loads.

For all reasons pointed above it is suggested modelling to be carried in two steps. In the first step a catchment model including a 2D surface runoff module based on the Saint-Venant equations able to simulate the tide is proposed. This model will simulate the whole delta, including the catchment and will compute water and sediment budgets. Then this model will be coupled to a 3D baroclinic model to simulate the processes on the continental shelf and in the ocean to address the fate of the water discharged in the ocean by the Amazon delta.

The whole system will be forced by the CMEMS results in the ocean boundary, by ANA (The Brazilian Water Agency) in the river Boundaries (Amazon, Tocantins and Xingu) and by meteorological data provided by GFS (if CPTEC/INPE data is not available). The whole system will be validated using remote sensing data and *in situ* data.

The MOHID modelling system includes branches (Land and Water) that are the basic infrastructure to build the system of applications described above. MOHID also includes pre and post processing tools to couple the model to boundary sources and to carry validation.

Acknowledgements

This PhD project is supervised by Ramiro Neves, from MARETEC, Instituto Superior Técnico and Marcelo Rollnic from the Federal University of Pará. The PhD project started in February 2022. FCT grant PRT/BD/152578/2022.

Diogo Moreira

Coral reef modelling of a marine protected area near Cartagena (Colombia)

Abstract

The focus of this PhD project is on the coral ecosystems within the Marine Protected Area of Rosario and San Bernardo National Natural Parks (MPA-RSBNNP), located approximately 45 km off the coast of Cartagena (Colombia) and covering an area of about 1200 km². This region experiences three main seasons: a dry/windy season from January to April, marked by strong trade winds; a transitional season from May to August, characterized by a decrease in wind intensity and rising water temperatures; and a wet/rainy season, during which heavy rainfall and land runoff increase river discharge into a marine protected area. Considering these threats, this research aims to answer two fundamental questions concerning coral reef vulnerability within a marine protected area. First, it seeks to understand the factors that control the spatial and temporal variability of sediment plumes entering offshore waters from Barbacoas and Cartagena Bays. Second, it seeks to understand how seasonal variations in water quality parameters influence the likelihood of exceeding coral survival thresholds in the area. One of the project's key outcomes is an open-access data server, connected to a user-friendly web-based platform that enables near real-time visualization of oceanographic and environmental data in Cartagena Bay. The platform will support communities, researchers, and decision-makers in addressing coastal environmental challenges.

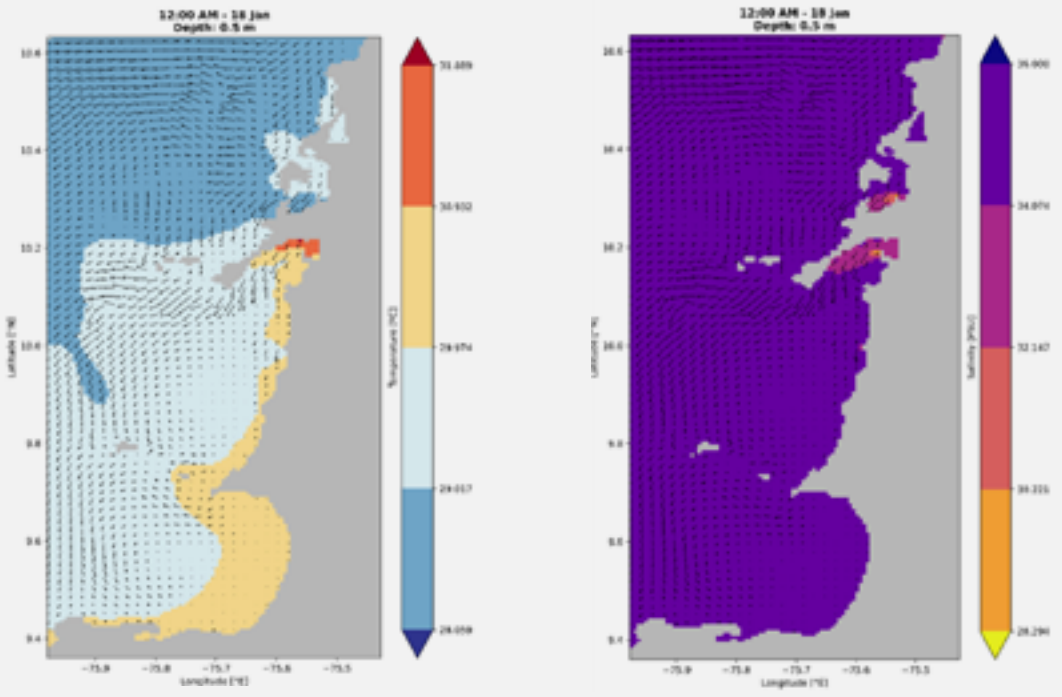


Figure 2 - GUARD-MPA outputs for Sea Surface Temperature (SST) (left) and Sea Surface Salinity (SSS) (right) with water velocity overlayed.

Seasonal changes influence the transport and deposition of sediments, particularly those carried by the Dique Canal, which discharges into the coastal waters through the Cartagena and Barbacoas Bay outlets. The resulting sediment plumes pose an ongoing threat to the coral communities in the region, by affecting the symbiotic algae in the corals and their immunity system. This research aims to understand the factors that control the spatial and temporal variability of sediment plumes entering offshore waters from Barbacoas and Cartagena Bay and to understand how seasonal variations in water quality parameters influence the likelihood of exceeding coral survival thresholds in the area. To address these questions, a new high-resolution three--dimensional hydrodynamic model, GUARD-MPA (Generating Understanding on Aquatic Resources in a MPA), is developed.

This regional model was built using the MOHID Water Modelling System (Figure 2). The regional model consists of two nested grid levels: Level 0, which provides 2D tidal boundary conditions, and Level 1, a 3D Eulerian hydrodynamic model that receives boundary inputs from the global CMEMS (Copernicus Marine Service) hydrodynamic model and the NAM (North American Mesoscale) atmospheric forecast system, as well as estimated riverine discharges from the Dique Canal.

The current phase of the research is dedicated to coupling and calibrating a Lagrangian particle module to simulate the behaviour and spatial extent of sediment plumes affecting coral reefs, with the primary objective of identifying areas at high risk of suspended sediment accumulation.

The model configuration incorporates both vertical deposition processes and the horizontal and vertical transport of deposited particles, with simulations performed for wet and dry seasons and sediment discharge scenarios tested at varying depths. Model outputs will be validated against satellite imagery to strengthen confidence in plume dispersion patterns and improve understanding of sediment-related threats within the MPA-RSBNNP. Building on this PhD project, the next phase will focus on providing answers to the second main question of the research, where it will generate risk maps based on sediment load variability to provide critical decision-support tools for reef management and conservation, while also develop early-warning indicators of coral health derived from model outputs. The final objective of the research is to deliver a fully configured model coupled with the BASIC model, running in operational mode, and integrated into both the TDS and a web-based interface for real-time visualization of the data, with the results of the risk maps and early warning indicators will also made available to visualize.

Acknowledgements

This PhD project is supervised by Flávio Martins, from CIMA, University of Algarve, and Marko Tosic, from UNESCO-IOCARIBE and the University at Medellin, Colombia. Collaboration with CoLab +Atlantic. The PhD project started in November 2023. FCT grant PRT/BD/154981/2023.

Eduardo Serrano

Sustainable ocean engineering and marine renewable energies based on ecosystem accounting and integral ecology

Abstract

This PhD project aims to be a novel contribution to the field of sustainable ocean engineering by integrating ecosystems accounting and integral ecology as key tools for assessing the ecological and socioeconomic impacts associated with the development of marine renewable energies (MRE). Rather than developing an entirely new framework, the research focuses on strengthening and complementing existing interdisciplinary methodologies by connecting Earth observation technologies, marine ecosystem services valuation, and marine spatial planning tools with the aim of improving ocean governance and decision-making. In the current context of energy transition, offshore technologies have become central elements in global strategies for climate change mitigation. However, their implementation raises environmental and social challenges, such as habitat alteration, species displacement, conflicts with fisheries, and pressures on ecosystem services. In response, this project adopts a holistic and integrative perspective that seeks to reconcile ecological sustainability with energy goals, also considering environmental justice and the inclusion of multiple stakeholders. The methodology is structured around four interconnected pillars: Ecosystems accounting following the UN SEEA–EA satellite remote sensing of essential ocean variables such as chlorophyll-a and sea surface temperature; spatiotemporal analysis of maritime traffic using Automatic Identification System (AIS) data; and valuation of ecosystem services in both biophysical and monetary terms. These components are articulated within a conceptual approach grounded in integral ecology, which enables a transversal and critical interpretation of the relationships between technology, society, and the environment

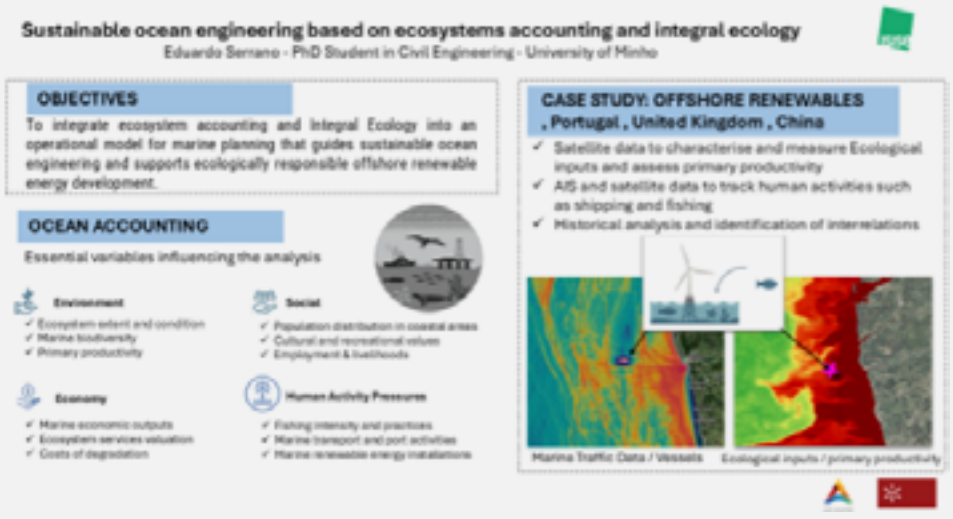


Figure 3 - Proposed research approach.

Currently, the analytical phase of the project is ongoing, focusing on the generation of multiannual time series of chlorophyll-a in three regions with active MRE development: the Atlantic coast of Portugal, the United Kingdom, and the coast of China. These areas (Figure 3) were selected for their ecological importance, diverse governance contexts, and availability of high-quality data. The satellite data has been processed using specialized software for this purpose, generating spatial trend maps of chlorophyll. Chlorophyll-a is used as a proxy indicator of primary productivity, offering an initial approximation of the state of phytoplankton, the base of the marine food web.

Areas have been identified where chlorophyll-a values show variations that may be associated with the presence of offshore wind infrastructure or oceanographic condition changes induced by maritime traffic. These results make it possible to begin characterizing the influence of MRE on the immediate ecological environment, although it is acknowledged that more variables and indicators must be incorporated for a comprehensive assessment.

In the upcoming stages, maritime traffic analysis will be integrated using AIS data and possibly satellite data. This will allow for the identification of navigation densities and spatio-temporal patterns around offshore installations, as well as possible overlaps with ecologically sensitive or high-value fishing areas. This information will contribute to assessing cumulative pressures and estimating the potential risks derived from intensive human activity in the marine environment. In addition, statistical relationships will be sought between traffic intensity and the variations in previously identified ecological indicators.

In addition to the impacts from MRE, the project considers other anthropogenic pressures. One complementary study will address marine litter in coastal areas, aiming to estimate the economic benefits of its reduction. Another study will focus on blue carbon ecosystems – such as mangroves, salt marshes, and seagrasses – analysing their role in carbon sequestration and valuing their ecosystem services using approaches such as replacement cost and existence value, within the frame of the PhD project of environmental accounting.

Expected outcomes of the project include: a replicable methodology to integrate ecosystem accounting into the assessment of marine energy projects; ecosystem service accounts expressed in physical and economic dimensions; and policy recommendations and planning tools. The research emphasizes the use of open-source tools and data (e.g., SNAP, QGIS, and free-access satellite databases), promoting transparency, reproducibility, and the scalability of its results to other geographic and technical contexts.

Acknowledgements

This PhD project is supervised by Eduardo Nuno Borges Pereira, and it is integrated into the PhD in Civil Engineering from the University of Minho. The PhD project started in October 2023. FCT grant PRT/BD/154932/2023.

Emanuelle Goellner

Environmental innovation and endogenous resources for the mitigation of illegal gold mining impacts in the Amazon River, Brazil

Abstract

This PhD project is based on the importance of studying the sediments transported by the Amazon River across vast seasonal regions. To do so, the PhD project plan analyses the levels of suspended pollution potential, chlorophyll-a, and water turbidity through geospatial analysis, based on Sentinel-3B OLCI satellite images, using the most advanced remote sensing techniques currently available, which provide adequate support for the execution of this research. This PhD project aims to understand the state of the art and the presence of hazardous chemical elements in aquatic sediments detected by satellite, to obtain comprehensive analyses of the study region and anticipate unnatural endogenous solutions in the Amazon River, in the cities of Manaus and Belém, which constitute the estuarine region of the Atlantic Ocean in northern Brazil.

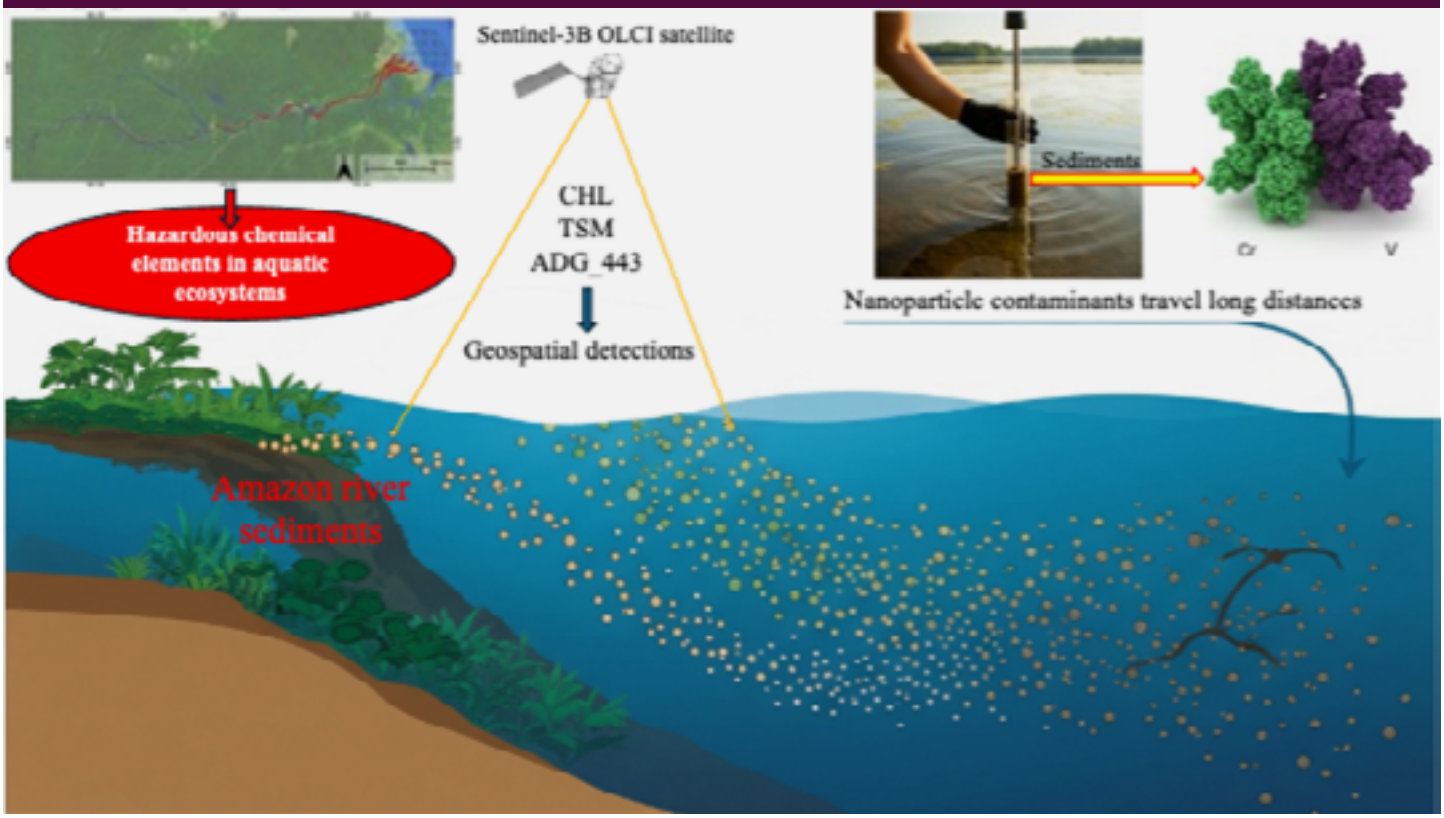


Figure 4 - Graphical schematic of field sampling and use of Sentinel-3B OLCI data.

Despite being considered essential for driving socioeconomic development at various territorial levels and enabling the production of consumer goods and services, mining activities on a global scale cause significant negative environmental impact, including soil and water pollution as well as a loss of biodiversity in both fauna and flora. This pollution of natural ecosystems, when related to gold mining activities, generates high negative environmental impacts on the waters of the Brazilian Amazon, with the accumulation of hazardous chemical elements in the form of nanoparticles (NPs) and ultrafine particles (UFPs) trapped in sediments at the bottom of water resources, affecting the survival of indigenous peoples in the Amazon region of Brazil, who depend on local natural resources for their survival, including numerous species of fauna and flora. Mining activities, considering the use of mercury and the presence of various hazardous elements in minerals associated with gold mining, resulting in high levels of environmental contamination in aquatic environments located in rural and urban areas, are capable of negatively compromising the biodiversity of fauna and flora, in addition to generating harmful risks to human health due to the high mercury load concentrated on the water surface and stored in sediments along rivers.

Nanoparticles can be easily transported by rivers, increasing the loads of dissolved material and suspended solids in their sediments. In this regard, the Amazonian rivers stand out among the five rivers in the world that contribute most to the transport of sedimentary material to the ocean. As a result, the Amazon River has a major impact on the budget of elements and isotopes directed to the Atlantic Ocean.

This PhD project highlights the relevance of the Sentinel-3A/B satellites, operated by the European Space Agency (ESA) dedicated to environmental monitoring, whose methodology will be consolidated with systematic updates, using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol (Figure 4). Twenty-six relevant studies have already been identified within the state of the art. In addition, frequency data will be collected and analysed based on the Content Analysis Method (CAM) and MAXQDA software. The preliminary results obtained under this PhD project show, based on CAM, an average frequency of approximately 36.0%, with Sentinel-3A representing 35.3% and Sentinel-3B varying between 31.89% and 40.08%. Satellite images allowed the prior identification of chlorophyll-a (CHL), total suspended matter (TSM), and dissolved organic matter absorption at 443 nm (ADG_443) in the Solimões and Amazon rivers. Through continuous collection of aquatic sediments throughout this doctoral study, advanced techniques of focused ion beam scanning electron microscopy (FIB-SEM) and high-resolution transmission electron microscopy (HR-TEM) will be used, both coupled with energy dispersive X-ray spectroscopy (EDS), to obtain results with a high degree of sample reliability. We hope to identify the possible presence of toxic elements in the form of nanoparticles smaller than 15 nm, which could pose serious risks to human health and the quality of aquatic ecosystems. Future findings may reveal the levels of sediment contamination and the significant trophic potential of Amazonian rivers, highlighting the urgent need for specific environmental attention.

Acknowledgements

This PhD project is supervised by Eduardo Nuno Borges Pereira, from the University of Minho and Marcos L. S. Oliveira from FAPESC. The PhD is organized under the Doctoral Program in Sustainable Built Environment from the University of Minho. The PhD project started in June 2023. FCT grant PRT/BD/154706/2023.

Francisco António Santos-Mella

The impact of *Sargassum* pollution on the coast of the Dominican Republic using a downscaling ocean operational modelling approach

Abstract

Sargassum pollution affects coastal ecosystems and the tourism industry, underscoring the immediate necessity for a proper operational forecasting and response plan. To cover this significant gap, the main objective of this PhD project is to develop and implement an operational model to evaluate the impact of *Sargassum* arrivals on the coast of the Dominican Republic. This will be achieved through (a) the implementation of an operational hydrodynamic model for the Dominican Republic coast and the adjacent ocean region, using the MOHID modelling system, in a downscaling methodology forced by existing global ocean forecasting systems, (b) the calibration and validation of the system using existing observation data (*in situ*, remote sensing, and cross-model validation), (c) the implementation of a Lagrangian *Sargassum* model coupled to the hydrodynamic model, capable of simulating the most critical *Sargassum* processes and fate, and (d) sensibility studies using the modelling system to evaluate the hazard and the risk of *Sargassum* landings on the Dominican Republic coast, resulting in hazard and risk maps.

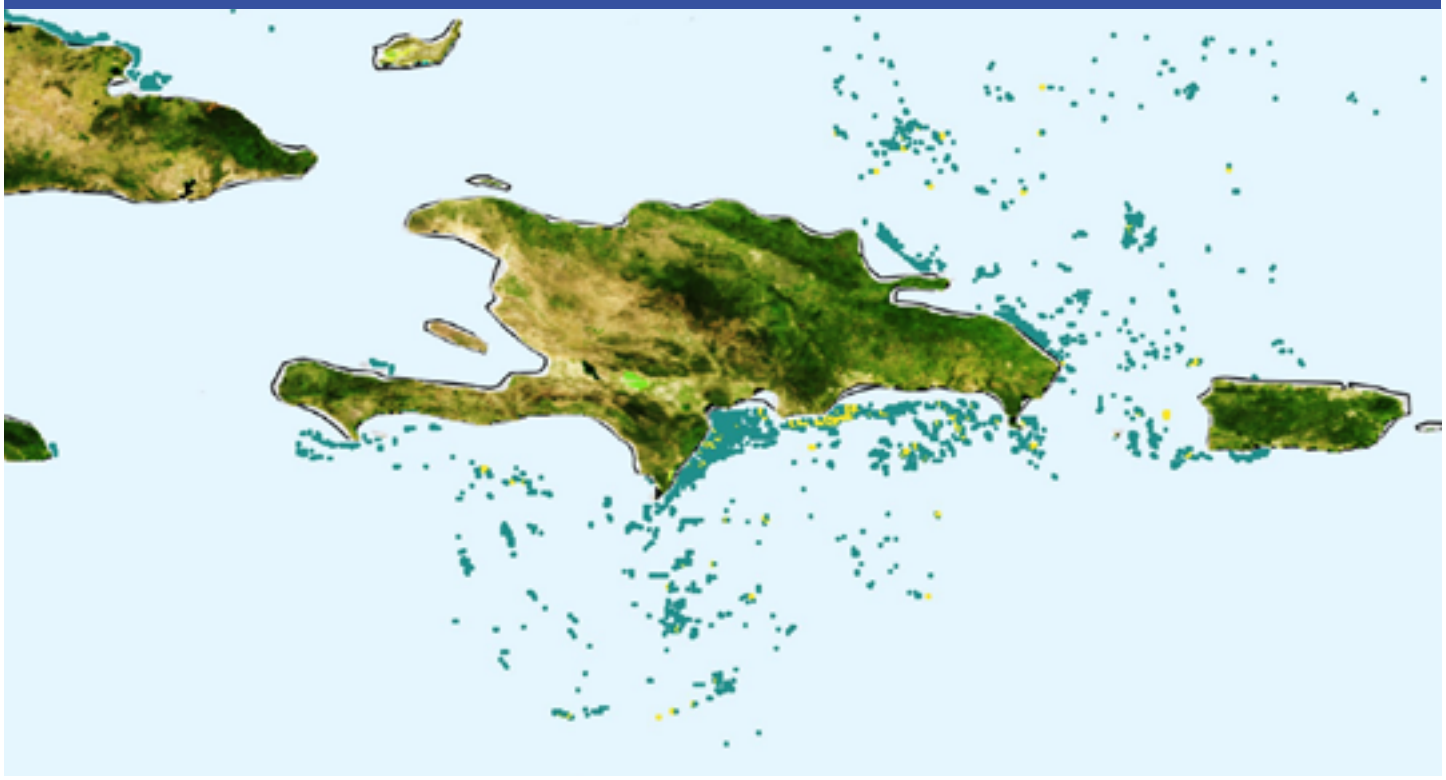


Figure 5 - Results from the Lagrangian model that simulates Sargassum.

Ocean modelling plays a crucial role in accurately forecasting ocean dynamics. The most common are the Eulerian and the Lagrangian models: while Eulerian models analyse advection and diffusion at specific locations, Lagrangian models track individual particles in a moving coordinate system, giving a detailed analysis of water properties and particle dispersion patterns. By integrating these two approaches, researchers can estimate ocean dynamic processes, particularly during events such as algal blooms, hydrocarbon spills, and the growing problem of *Sargassum* arrivals.

This issue hits close to home for the Dominican Republic, a Caribbean nation that depends heavily on its coast's assets. This country, located on the island of Hispaniola in the Caribbean region, boasting over 1,600 km of coastline, is famous for its marine ecosystems and luxury resorts. Tourism is a pillar of the national economy, contributing over 8,3% to GDP and providing employment to thousands of people. Therefore, the country's dependence on coastal resources makes it vulnerable to environmental disturbances.

Although the *Sargassum* arrival is a natural phenomenon, since 2011, there has been an unusual increase in this alga, resulting in economic losses for tourism dependent nations. Significant accumulations of *Sargassum* along beaches not only degrade the visual appeal of coastal areas but also negatively impact marine life, water quality, and the overall tourist experience.

In response to this, some countries apply advances in hydrodynamic modelling with the integration of satellite imagery to enhance the ability to forecast the *Sargassum* arrivals. Despite these scientific advancements, the Dominican Republic currently lacks a dedicated operational observing system to monitor and respond to these events along its coasts and surrounding areas and the ocean. This gap in observational ocean dynamics limits the ability to implement a rapid response strategy or a predictive tool capable of forecasting *Sargassum* landings.

Such a lack in observational ocean dynamics hinders the achievement of rapid response measures as well as forecast-based predictive tools for *Sargassum* landings (Figure 5).

Acknowledgements

This PhD project is supervised by Flávio Augusto Bastos da Cruz Martins, from Centro de Investigação Marinha e Ambiental, at the University of Algarve, and Brigitta I. van Tussenbroek from National Autonomous University of Mexico. The PhD project started in September 2023. FCT grant PRT/BD/154703/2023.

Frederik Feldmann

The genetic structure in populations of marine gastropods in oceanic islands: contrasting evolutionary and biogeographic patterns

Abstract

This PhD project proposes a population genetics and phylogeographic approach for three shallow-water gastropod species naturally occurring in the Northeast Atlantic Ocean, all with a planktotrophic mode of larval development. The results will valuably contribute to increase the current knowledge in the Azorean biodiversity and provide crucial information to address the effects of climatic changes in islands.

Three shallow-water gastropod species naturally occur in the Northeast Atlantic Ocean, all with a planktotrophic mode of larval development: *Bittium nanum*, an endemic species from the Azores (Portugal) with a putative European ancestral; *Tectarius striatus*, with a geographical distribution restricted to the Macaronesian archipelagos; and *Melarhaphe neritoides*, with a wide geographical distribution in the NE Atlantic.

This study aims to enlighten the diversity and population structure of these species, to clarify their evolution in remote oceanic islands and to understand the possible role of seamounts, ocean-currents and periodic climatic changes in the long-distance dispersal/invasion process of the archipelago.

Acknowledgements

This PhD project is supervised by Sérgio Ávila, António Múrias dos Santos and Manuel Curto from CIBIO-InBIO at the Azores, and Institute for Integrative Nature Conservation Research of the University of Natural Resources and Life Sciences, INF-BÖKU, Vienna, respectively. The PhD project started in September 2021. FCT grant PRT/BD/152217/2021.

Inês Pereira

Enhancing fisheries management through value chain analysis: The case study from the Azores, Portugal

Abstract

This research aims to enhance fisheries management in the Azores through a detailed value chain analysis of a selected fishery of socio-economic importance. The project's objectives are threefold: (1) to provide a comprehensive characterization of Azorean small-scale fisheries (SSF), (2) to generate a complete and actionable value chain map of a key fishery, and (3) to model and evaluate the potential outcomes of hypothetical management interventions. By combining empirical data collection with advanced modelling techniques, the research will identify leverage points where interventions could enhance sustainability, efficiency, and equity in the fisheries sector. Expected outcomes include detailed documentation of the socio-economic structure of Azorean fisheries, a fully mapped and analysed value chain for the case-study fishery, and simulation-based evidence on the potential impacts of various management measures. These outputs will inform both regional policy and broader discussions on sustainable SSF management, contributing to International Council for the Exploration of the Sea (ICES) Expert Groups and aligning with the Food and Agriculture Organization (FAO) guidelines for SSF.

SSF are of immense socio-economic and cultural significance worldwide, particularly for coastal and island communities. In the Azores, Portugal, SSF constitute approximately 90% of the regional fleet, supporting over 3,000 jobs and targeting a wide array of species including blackspot seabream *(Pagellus bogaraveo)*, blackbelly rosefish *(Helicolenus dactylopterus)*, veined squid *(Loligo forbesii)*, European conger *(Conger conger)*, alfonsinos *(Beryx spp.)*, blue jack mackerel *(Trachurus picturatus)*, and red porgy *(Pagrus pagrus)*. These fisheries are essential to local livelihoods but face growing challenges such as overfishing, habitat degradation, competition for resources, and market pressures. Addressing these issues requires a holistic understanding of the entire value chain – from capture to final consumption – and the socio-economic and governance structures that underpin it.

The project is structured in four main PhD project packages (WPs) spanning characterization, mapping, modelling, and dissemination. WP1 focuses on characterizing Azorean fisheries by combining literature review, stakeholder consultations, and socio-economic profiling to identify main fisheries, key species, fishing techniques, and sustainability challenges. WP2 will select a representative case-study fishery and map its value chain in detail, identifying all stages, stakeholders, processes, and information flows, and analysing governance structures. WP3 will integrate ecological, economic, and social data into a modelling frame using the Ecopath with Ecosim (EwE) software suite. This will allow simulation of different management and policy scenarios – such as quota adjustments, effort regulation, or spatial closures – to assess their ecological, economic, and social impacts. Finally, WP4 will compile the findings into a doctoral thesis and disseminate them through academic publications, conferences, and stakeholder-oriented materials.

Acknowledgements

This PhD project is supervised by Régis Santos, Mário Rui Pinho from the University of Azores and OKEANOS, and Ronaldo Angelini from Federal University of Rio Grande do Norte and the Department of Civil and Environmental and Engineering. The PhD project started in October 2024. FCT grant 2023.18553.PRT.

Jennifer Moreno-Benavides

Deciphering climate change impacts on the Arctic Ocean nitrogen microbiome

Abstract

This PhD project aims to investigate the effects of climate change on Arctic nitrogen-cycling microbial communities through spatial and temporal analysis, interactions, functional roles, and predictive modelling. Based on the hypothesis that climate change results in alterations to microbial communities and their functions, consequently affecting biogeochemical cycles in the Arctic Ocean, this PhD project has specific objectives that will be addressed sequentially: (1) Analyse the taxonomic, genetic composition, and spatial distribution of nitrogen-cycling microbial communities in sea ice and water column; this will allow us to identify key species that play a fundamental role in nitrogen cycling; (2) Evaluate the spatial and temporal variations of nitrogen-cycling microbial communities in the Arctic Marginal Ice Zone; by analysing the long-term spatial shifts in their distributions, this objective aims to understand the impact of climate change on the communities involved in nitrogen (N) transformations; (3) Design a model that integrates genomic, environmental, and microbial activity data to predict the impact of climate change on the nitrogen cycle. We will determine the relationship between omics data (taxonomic groups, functional gene abundance, and transcription) and the rates of related N functions (N-fixation, nitrification, and denitrification) in controlled experiments using Arctic Ocean samples.

Figure 6 - Ice core sample collection during the Arctic Ocean 2023 campaign.

Nitrogen is a vital element for life in the oceans. It plays a crucial role in maintaining the functioning of marine ecosystems and will be a critical component in how the ocean reacts to global environmental changes. However, there is currently limited knowledge about how the nitrogen microbiome and its associated ecosystem functions in the Arctic will respond to climate change. To address this gap, this project aims to explore the effects of climate change on microbial nitrogen-cycling communities and fixed nitrogen sources.

The study is based on the Arctic Ocean 2023 oceanographic campaign, which included both ice and water column stations (Figure 6). The annual monitoring program, initiated in 2015, covers 22 water column stations across the Arctic Marginal Ice Zone in the Svalbard region. In addition, a weekly monitoring program, launched in 2019 and conducted from May to September at a single fjord station in Kongsfjorden, Svalbard, included several fjord water column stations. Researchers from the Norwegian Polar Institute (NPI) and CIIMAR participated in the expedition and were responsible for sample collection. Water samples were collected at eight stations at a depth of 10 m in the Atlantic water bottom layer. For the annual and weekly monitoring programs, seawater samples were collected at 22 stations, covering depths ranging from 50 to 3,000 m. A rosette system equipped with multiple Niskin bottles was used for sampling, and water was filtered through Sterivex filters with a 0.22 ɥm pore size before being stored at −80 °C. A total of twelve ice core samples were collected using a Kovacs ice drill at four stations. At each ice station, three replicate cores were extracted and sectioned into three depth intervals: 0–5 cm, 5–10 cm, and 10–30 cm.

For each depth interval, sections from all three replicate cores were combined after melting to produce a single composite sample. This procedure ensured a representative ice sample for each station and depth layer, providing sufficient biological material and consistency across the dataset. Samples were immediately stored at −80 °C for subsequent analysis. Environmental data was also collected, including salinity, temperature, chlorophyll, fluorescence, photosynthetically active radiation, and concentrations of oxygen, ammonium, nitrate, nitrite, phosphate, silicic acid, total dissolved nitrogen, dissolved organic carbon, and dissolved organic nitrogen.

The analysis of nitrogen cycling genes revealed already distinct patterns of abundance across stations and depths. Genes involved in dissimilatory nitrate reduction (e.g., nirB, nirD, nrfC) exhibited the highest counts per million (CPM), at stations 9 ICE and 11 ICE. Assimilatory nitrate reduction genes (nasA, nasB, nirA, NR) were also abundant but varied more across stations, with elevated levels at stations 9 ICE and 11ICE. In contrast, denitrification genes were consistently present at moderate abundance across stations 3 ICE, 9 ICE AND 11 ICE reflecting a widespread but possibly less dominant role. Nitrification genes and nitrogen fixation genes showed low abundance overall, suggesting limited activity of this process. The anammox marker gene was nearly absent, indicating minimal contribution of this pathway to nitrogen turnover in these samples.

Acknowledgements

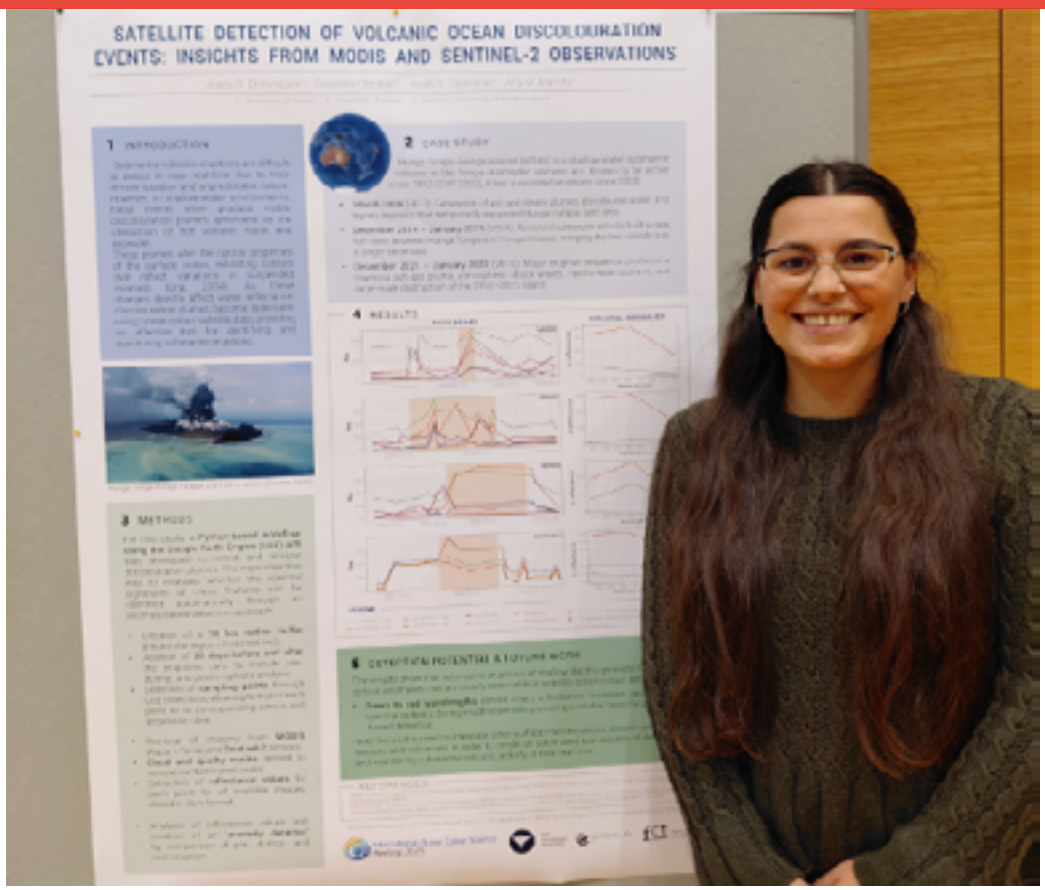
This PhD project is supervised by Catarina Magalhães from the University of Porto and CIIMAR, Julie LaRoche, from Dalhousie University in Canada and Miguel Semedo from CIIMAR. The PhD project started in March 2024. FCT grant PRT/BD/154995/2023.

Joana Domingues

Impacts of submarine volcano eruptions on the shallow ocean from satellite imagery and machine learning

Abstract

Satellite imagery has proven to be a valuable tool in volcano monitoring and assessing associated hazards. In the case of submarine eruptions, the interaction of hot volcanic fluids-rich in elements such as iron (Fe), aluminium (Al), and silica (Si) – and cold seawater triggers chemical reactions that generate distinct surface discolouration patterns in the surrounding ocean. The observed coloration depends on the relative concentration of these elements: higher Fe concentrations typically produce yellow to brown hues, whereas Al or Si dominated mixtures yield a white or greenish discolouration. However, identifying and classifying these expressions is not straightforward, as the colours depend not on absolute concentrations but on elemental ratios and the local mixing environment.
This PhD project has the objective of using various case studies of submarine eruption time series, to develop a tool that integrates satellite-derived oceanographic and meteorological data, enabling near-real-time (NRT) tracking of submarine volcanic events and their impacts. In addition to supporting risk mitigation efforts for maritime and coastal stakeholders, the project will also contribute to advancing scientific understanding of submarine volcanic processes and their oceanographic consequences.



Despite the prevalence of volcanic activity beneath the sea – estimated to account for ~75% of global volcanism – submarine eruptions remain significantly underreported, with fewer than 350 confirmed events documented in global databases over the past 10 000 years. In contrast, more than 10 000 subaerial eruptions have been documented during the same period, reflecting the significant disparity in observational coverage between land and seafloor environments.

As a result, the impacts of these events on the ocean are not well documented, despite being known to influence ocean geochemistry and providing important nutrients to marine ecosystems. In recent years, several notable eruptions of submarine volcanoes – such as 'Volcano F' (2019), Hunga Tonga-Hunga Ha'apai (2022), and Northern EPR at 9.8°N (2025) – have highlighted the need for improved detection and monitoring. Although the fundamental processes of submarine volcanic eruptions are broadly comparable to their subaerial counterparts, several key factors, including the effects of hydrostatic pressure on eruption dynamics, are insufficiently understood. Both types of eruptions can enhance nutrient concentrations in the surrounding waters, acting as natural fertilizer for phytoplankton and supporting rapid ecosystem recovery – particularly important in oligotrophic ocean regions.

Detection of submarine eruptions is a complex process due to their remote location and unpredictability. A prominent subset of submarine eruptions is characterized by surface expressions, typically associated with explosive activity and shallow vent depths. These types of eruptions can generate a variety of expressions at the ocean's surface, including discolouration plumes, ephemeral islands, pumice rafts, ash clouds, and even visible explosive activity. It is therefore essential not only to detect and monitor the eruptions themselves, but also to track their surface expressions over time. These phenomena can pose significant hazards for maritime navigation, air traffic, and coastal communities and infrastructure. Monitoring is therefore essential for hazard mitigation, particularly in relation to secondary effects such as tsunamis, as was the case of the January 2022 Hunga Tonga-Hunga Ha'apai eruption. Furthermore, assessing the impacts of explosive submarine eruptions on ocean chemistry and ecosystems is also critical for advancing our understanding of their role in oceanic environmental processes.

Model development will focus on distinguishing volcanic discolouration plumes – particularly those occurring near the eruption source – from other oceanic phenomena with similar optical characteristics, such as chlorophyll-a (*Chla*) blooms or sediment plumes. Evaluation metrics will assess the model's ability to extract information related to the timing of eruptions, their duration, and associated changes in surface and near-surface ocean properties, including biological responses such as phytoplankton dynamics.

Acknowledgements

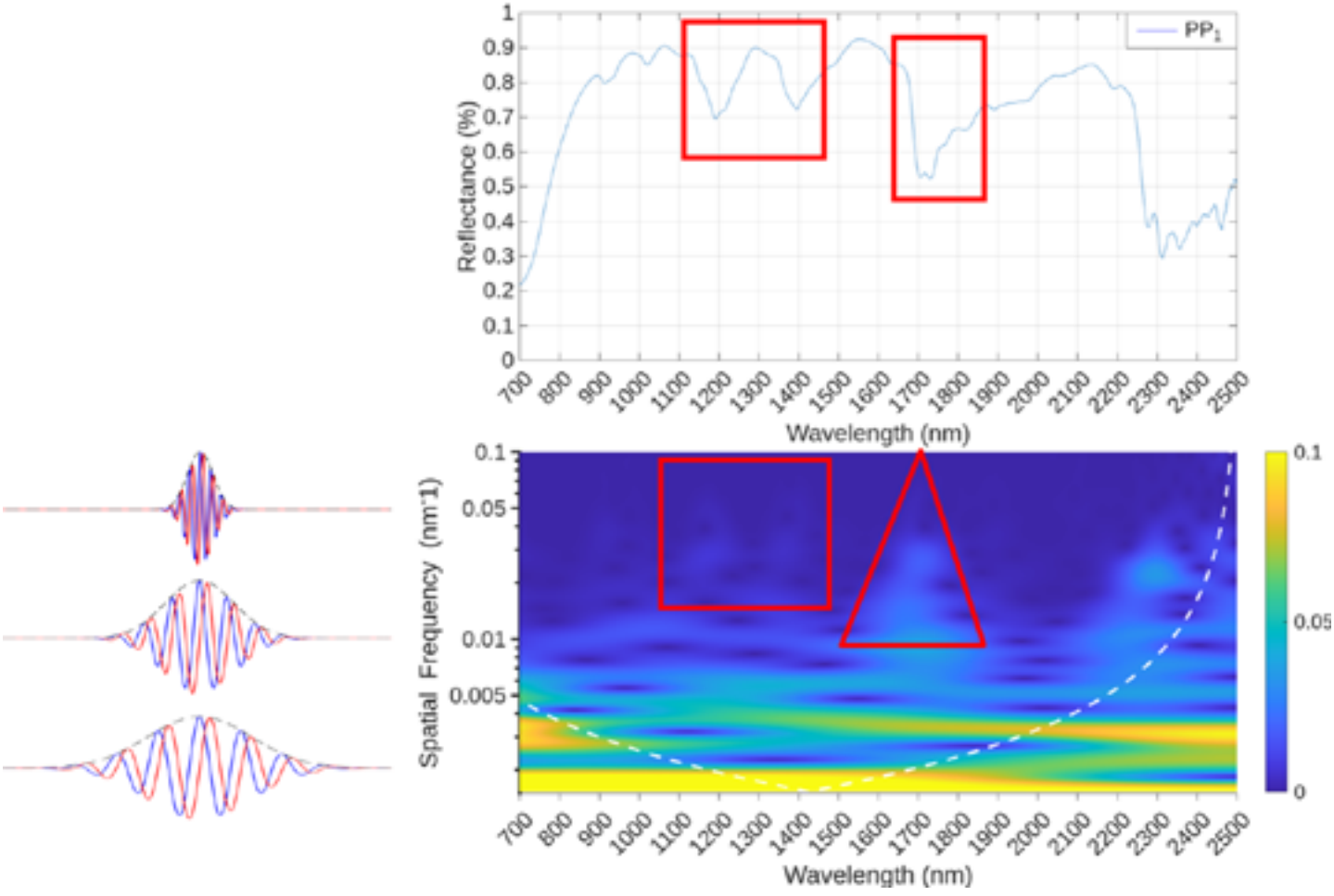
This PhD project is supervised by Ana Martins, from OKEANOS of the University of Azores, Susanna Ebmeier from the University of Leeds, and Issah Suleiman from the Memorial University of Newfoundland. The PhD project started in May 2024. FCT grant 2023.18552.PRT.

José Eduardo Silva

Aerial surveys of estuarine and beach plastic litter

Abstract

This PhD project aims at conducting research on the use small aircraft, drones, unmanned aerial vehicles (UAVs), balloons and other aerial technologies for detection, identification and monitoring of estuarine and beach plastic litter (SDG 14.1) and subsequent validation of results using satellite imagery and ground measurements such as visual inspection and citizen science. The main objective is to contribute to the hyperspectral image classification remote sensing topic, and its use on civilian applications through aerial robotic platforms applications. Particularly focusing in studying and developing novel methods that use hyperspectral imaging information to detect, classify and identify types of materials/marine litter in oceanic and coastal environments.



The research plan includes investigating novel optimization techniques, image processing and machine learning techniques, deep learning, as well as optical sensing information, to allow the exploration and development of different types of methods and approaches for extracting a variety of spectral, texture, and geometrical attributes of the images. It further aims to develop a digital hyperspectral imaging database using unmanned aerial vehicles, in different marine environment locations, and develop supervised and unsupervised methods to perform hyperspectral image classification of marine litter, and geo-reference with high precision the obtained data.

Acknowledgements

This thesis is supervised by Hugo Silva and Eduardo Silva, from INESC TEC. The PhD project started in September 2021. FCT grant SFRH/BD/151463/2021.

Juliano Marcelo Vilke

Comparative evolutionary ecotoxicological adaptations to anthropogenic disturbance in sea anemones from the Antarctica and the deep sea

Abstract

This PhD project investigates how sea anemones from Antarctica, deep sea and temperate shallow waters respond to metal contamination and ocean warming, two growing anthropogenic pressures affecting marine ecosystems. Antarctica and abyssal plains share cold, stable environmental conditions and limited baseline knowledge, making their fauna particularly vulnerable to multiple stressors such as manganese enrichment from local waste discharges, transported pollutants and prospective deep-sea mining activities.
Sea anemones are ecologically important bioindicators capable of bioaccumulating metals and exhibiting measurable physiological and molecular responses, offering a suitable model for comparative evolutionary ecotoxicology. By integrating metal accumulation analyses, biochemical biomarkers, transcriptomics and proteomics, this research aims to identify toxicity pathways, adaptation signatures and candidate biomarkers involved in metal metabolism, antioxidant defences, xenobiotic processing and oxidative damage.
Preliminary experiments on temperate shallow-water anemones exposed to manganese, deep-sea sediments and manganese-rich polymetallic nodule particles under current and warming conditions reveal dose- and time-dependent metal accumulation, stress in antioxidant and detoxification systems, altered ROS dynamics and evidence of oxidative damage. Upcoming experiments on Antarctic and deep-sea species will provide a broader comparative framework to test the hypothesis that these lineages share common evolutionary ecotoxicological adaptations and establish thresholds relevant for environmental management of deep-sea mining and Antarctic waste practices.

Antarctica and the deep-sea harbour unique, largely unexplored biota-adapted to cold and relatively stable environments, presenting intriguing parallels when considering vulnerability to anthropogenic disturbances. The evolutionary origins of Antarctic fauna and their affinities with deep-sea species remain unclear, with competing hypotheses suggesting either colonisation of deeper waters by shallow Antarctic taxa or expansion of deep-sea taxa onto the continental shelf. Cold-adapted organisms tend to exhibit slow metabolism, reduced growth rates and narrow thermal tolerances, which make them extremely susceptible to climate-driven changes. Combined with the logistical challenges of *in situ* deep-sea research and the risk of barotrauma during specimen recovery, these traits position Antarctic species as valuable proxies for deep-sea taxa in ecotoxicological assessments.

Antarctica is characterised by low internal pollutant emissions yet receives substantial external inputs transported from lower latitudes. Elevated concentrations of metals such as magnesium, iron, mercury and cadmium have been documented, although the balance between natural and anthropogenic sources remains uncertain. Local waste discharge near research stations further increases the availability of metals, including manganese, despite international obligations to minimise environmental impacts under the Antarctic Treaty.

Concurrently, the Antarctic Peninsula has warmed by approximately two degrees Celsius over the last half-century, reducing the thermal safety margins of stenothermal fauna and potentially altering metal bioavailability and toxicity. Under such multiple stressors, understanding how metal exposure interacts with warming is essential to determine organismal thresholds for toxicity and resilience.

In the deep sea, growing interest in mining polymetallic nodules stems from the rising global demand for metals essential to the energy transition. Manganese-rich nodules are widespread across abyssal plains such as the Clarion–Clipperton Zone. Mining activities may remove benthic habitats and generate sediment plumes capable of releasing complex mixtures of metals into the water column. Dewatering plumes from surface processing may inject particle-laden, warmer seawater back into deep environments, adding a thermal component to metal stress. Yet toxicological thresholds and ecosystem level impacts remain difficult to estimate due to limited baseline knowledge and the poorly constrained sensitivities of deep-sea fauna.

Sea anemones occur from tropical to polar regions and from shallow waters to abyssal depths, making them excellent bioindicator species. They are sensitive to numerous contaminants and capable of bioaccumulating metals in their tissues, producing measurable biological effects. Their ecological and physiological diversity provides an effective framework for comparative studies across Antarctic, deep-sea and temperate ecosystems.

Experimental designs can replicate Antarctic contamination scenarios, such as manganese enrichment near research stations, and DSM-like exposure conditions, such as sediment containing nodule particles, combined with warming experiments of four degrees Celsius to simulate both projected Antarctic temperature rise and deep-sea dewatering discharges. Comparisons with temperate shallow-water anemones allow the distinction between cold-adaptation signatures and generalised stress responses, while evaluating whether temperate species may serve as proxies for cold-adapted taxa.

Transcriptomic analyses of deep-sea vent anemones have revealed the presence of xenobiotic-processing enzymes indicative of chronic exposure to metal-rich fluids, while aluminium-rich exoskeletons in some amphipods point to metal-mediated structural strategies. Many Antarctic organisms exhibit attenuated or absent heat-shock responses, a well-known hallmark of stenothermy that limits their resilience under rapid warming. High--throughput omics, combined with physiological assays offer a comprehensive approach to mapping toxicity pathways, acclimation mechanisms and recovery processes, while identifying biomarker candidates for use in ecotoxicological risk evaluation.

Integrating metal chemistry, bioavailability and accumulation with biochemical and molecular endpoints is therefore essential to assess environmental hazards. Such an approach will contribute to defining thresholds for metal toxicity and temperature increase to support international regulations of deep-sea mining and Antarctic waste-management practices.

At a regional scale, insights from temperate ecosystems, such as studies in Ria Formosa lagoon (Portugal) anemones, can further assist in evaluating the combined risks of warming and metal contamination.

The main hypothesis is that sea anemones from Antarctica and the deep sea share common evolutionary ecotoxicological adaptations to anthropogenic disturbance. The overarching aim is to uncover evolutionary responses to the combined effects of metals, deep-sea sediments, polymetallic nodules and warming at the molecular level in sea anemones from Antarctic, deep-sea and temperate environments.

Acknowledgements

This PhD project is supervised by Nélia C. Mestre and Cármen S. V. Sousa from the Centre for Marine and Environmental Research – CIMA/ARNET, University of Algarve and by Deborah M. Power from the Centre of Marine Sciences - CCMAR, University of Algarve. The PhD project started in May 2024. FCT grant PRT/BD/154998/2023.

Laura Moreno Ferrer

Marine carbonate system in the Northwest Atlantic upwelling ecosystem

Abstract

The main aim of this PhD project is the study of the carbon cycle of the water column and the surface CO_2 exchanges, in the continental shelf of NW Iberia, by using observational systems locate at N of Portugal and S Galicia, in order to better understand the ocean atmosphere fluxes of CO_2 and the ocean acidification in the upwelling system of the Iberian Peninsula. The results obtained will be complemented with the analysis of numerical modelling outputs for the present, as well as for the future scenarios of the circulation and carbon cycle in the framework of the IPCC obtained with numerical model outputs. The strategy includes the implementation of a system for measuring carbon variables based on measurements taken on vessels for the regions of Aveiro and Galicia, evaluate the trends of *in situ* measurements incorporated in the ARIOS (Acidification in the Rías and Iberian Oceanic Shelf) expeditions database, assess the oceanographic conditions of the region of study that affects the carbon cycle, identification of the natural and anthropogenic drivers of the acidification rates along the coast of Galicia, and analysis of outputs from numerical models simulating the future behaviour of the marine carbon cycle along the coast of Galicia and northern Portugal, using scenarios and projections aligned with the latest IPCC reports.

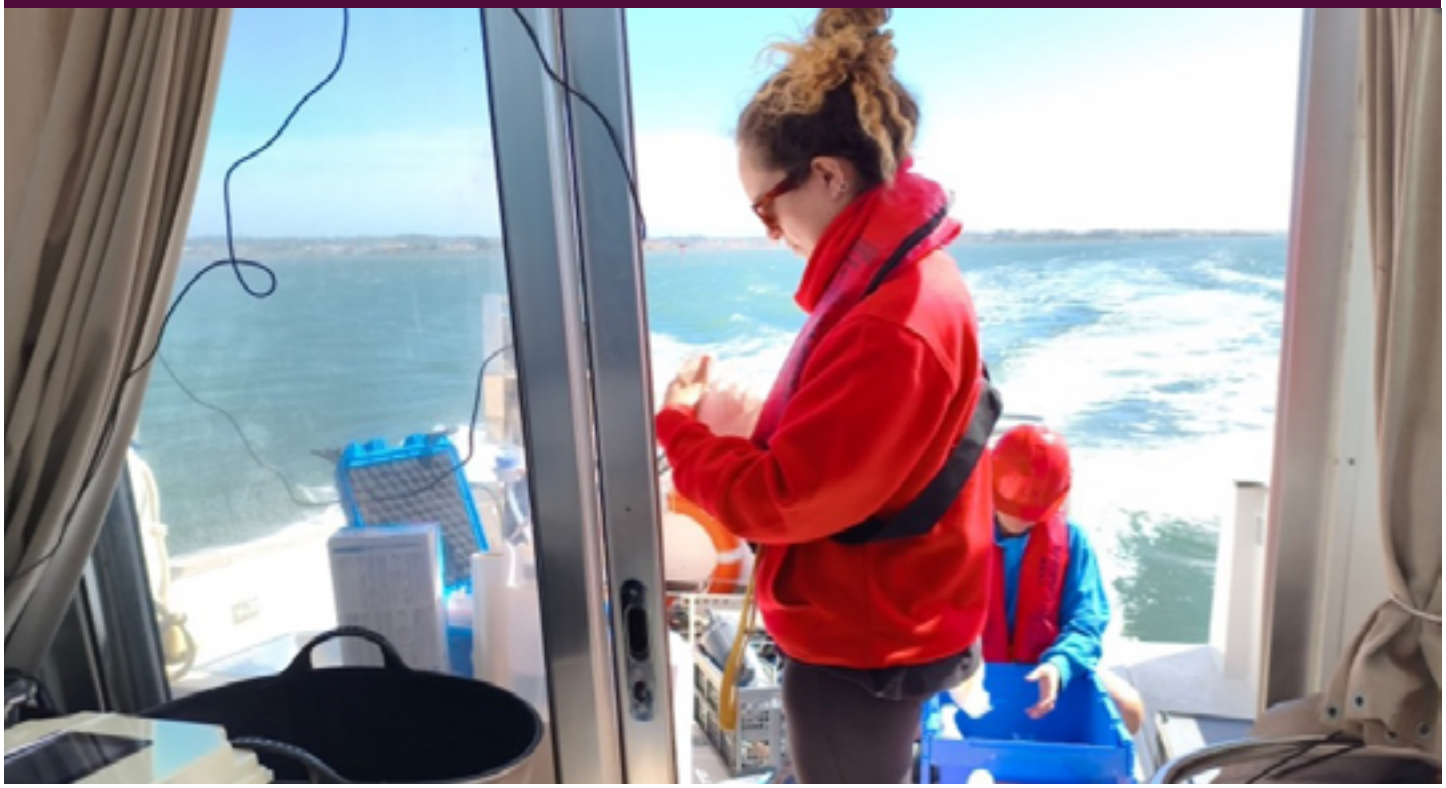


Figure 7 - Cruise in the Ria de Aveiro, September 2025.

The sustained ocean carbon sink uptakes ~37% of the fossil fuel CO_2 emissions, or ~25% of the combined fossil fuel burning and emissions due to land use changes between 1850 and 2019. This uptake of CO_2 is causing profound changes in seawater chemistry resulting from increased hydrogen ion concentration (decrease in pH), referred to as ocean acidification. Experimental and modelling studies provide compelling evidence that ocean acidification will put marine ecosystems at risk especially in coastal areas that provide marine resources and important ecosystem services to support human society.

Coastal environments play a crucial role in the global carbon cycle by acting as sinks for atmospheric CO_2. However, the underlying mechanisms that regulate carbon dioxide exchange, as well as the spatial and temporal variability of this process, remain insufficiently understood. The carbon flows in these waters can shift rapidly, making the estimate of the sea-air CO_2 flux subject to large uncertainties. Including the coastal ocean as a component of the global carbon cycle is critical for developing carbon and climate policies. And, among these coastal regions, the upwelling systems are especially important by accounting for ~20% of the global fish catch, in spite of constituting <1% of the world's oceans by area. Moreover, the responses of the upwelling systems to climate changes have a strong influence on their biogeochemistry and productivity, with serious socio-economic consequences. Despite the strong impulse to the ocean sciences in Portugal, almost no studies were published for observations of the biogeochemical cycles including carbon, and no information exist in the EEZ Portuguese waters, in the continental shelf region. It is important to understand the carbon cycle and the amount of carbon dioxide that sinks into the ocean (Figure 7), because the coastal transition zone is one complex region where opposite effects influence the cycle of source/sink of CO_2. This PhD project will also contribute to study the problems of trends of acidification in the oceanic EEZ of Portugal, crucial for living resources. Three-dimensional ocean numerical modelling and forecasting of ocean biogeochemistry are key issues in marine research and will gain importance in marine environmental management.

Acknowledgements

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Livia Sinigaglia

The genetic structure in populations of marine bivalves in oceanic islands: contrasting evolutionary and biogeographic patterns

Abstract

To better understand the biogeographical and evolutionary patterns of marine invertebrates in the Azores, we develop a population genetics and phylogeographic approach for three shallow-water bivalve species naturally occurring in the Northeast Atlantic Ocean. The results will valuably contribute to increase the current knowledge in the Azorean biodiversity and provide crucial information to address the effects of climatic changes in islands.

Three shallow-water bivalve species naturally occurring in the Northeast Atlantic Ocean: *Lasaea adansoni*, a brooding amphi-Atlantic species; and two species with a planktotrophic mode of larval development, *Ervilia castanea* and *Cardita calyculata*. *Lasaea adansoni* is very common in intertidal algal mats, *Ervilia castanea* is associated to sandy environments and *Cardita calyculata* to rocky shores.

This study aims to enlighten the diversity and population structure of these species and factors shaping it, to clarify their evolution in remote oceanic islands and to understand the possible role of seamounts, ocean-currents and periodic climatic changes in the long--distance dispersal/invasion process of the archipelago.

Acknowledgements

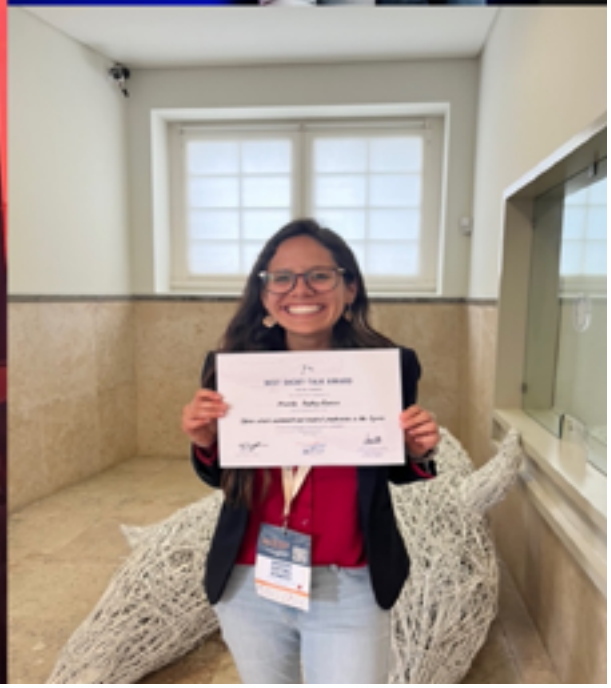
This PhD project is supervised by Sérgio Ávila, António Múrias dos Santos and Manuel Curto from CIBIO-InBIO at the Azores, and Institute for Integrative Nature Conservation Research of the University of Natural Resources and Life Sciences, INF-BÖKU, Vienna, respectively. The PhD project started in September 2021 and concluded on the 21st of July 2025. FCT grant PRT/BD/151539/2021.

Mareike D. Duffing Romero

Distribution modelling of oceanic megafauna towards dynamic ocean management

Abstract

The PhD project aims to develop and test a modelling framework to predict in near real time the distribution hotspots for key marine megafauna species and the risk from human activities in the Azores (Portugal). To do so, we will model species distribution and movements of key air-breathing megafauna (cetaceans and turtles) using near real-time environmental variables and assess their predictive performance, identify suitable habitats at various spatial and temporal scales and Identify risk areas from human activities (i.e., marine traffic) and determine how these risk change under different management scenarios.



Many marine megafauna (MM) species are experiencing significant declines due to anthropogenic activities (e.g., pollution, noise, entanglements, ship strikes). Place--based management is a common strategy for managing ocean activities and safeguarding vulnerable species and their habitats, which are generally implemented as a static approach. However, static conservation strategies cannot account for the dynamic nature of pelagic ecosystems in which marine megafauna reside, nor can they deal with the dynamism of human activities threatening megafauna taxa. An alternative to this approach is Dynamic Ocean Management, which uses near real-time data on the shifting physical, biological and ocean resource uses to rapidly update ocean zoning in space and time.

The strategy is to use satellite telemetry data of sperm whales, test alternative models (State Space Models, Hidden Markov Models, Non--parametric Bayesian Models) for data processing, discriminate different movement behaviours (e.g., transiting, socializing, foraging) through computation of movement metrics (i.e., speeds, displacements, move persistence). The characterization of the marine environment of the Azores includes static (depth, slope, seamount locations) and dynamic variables (temperature, salinity, currents, chlorophyll).

Pseudo-absence points are computed using correlated random works to represent potential absences of the animals' habitats. Species Distribution Models (SDMs) are developed by applying Generalized Additive Mixed Models (GAMMs) to their presence/absence data and various environmental variables. Preliminary results indicate that the interaction of temperature and salinity at surface, separate temperatures and salinities at mid and deep depths, sea surface height and distance to coast drive the distribution of sperm whales in the region.

Acknowledgements

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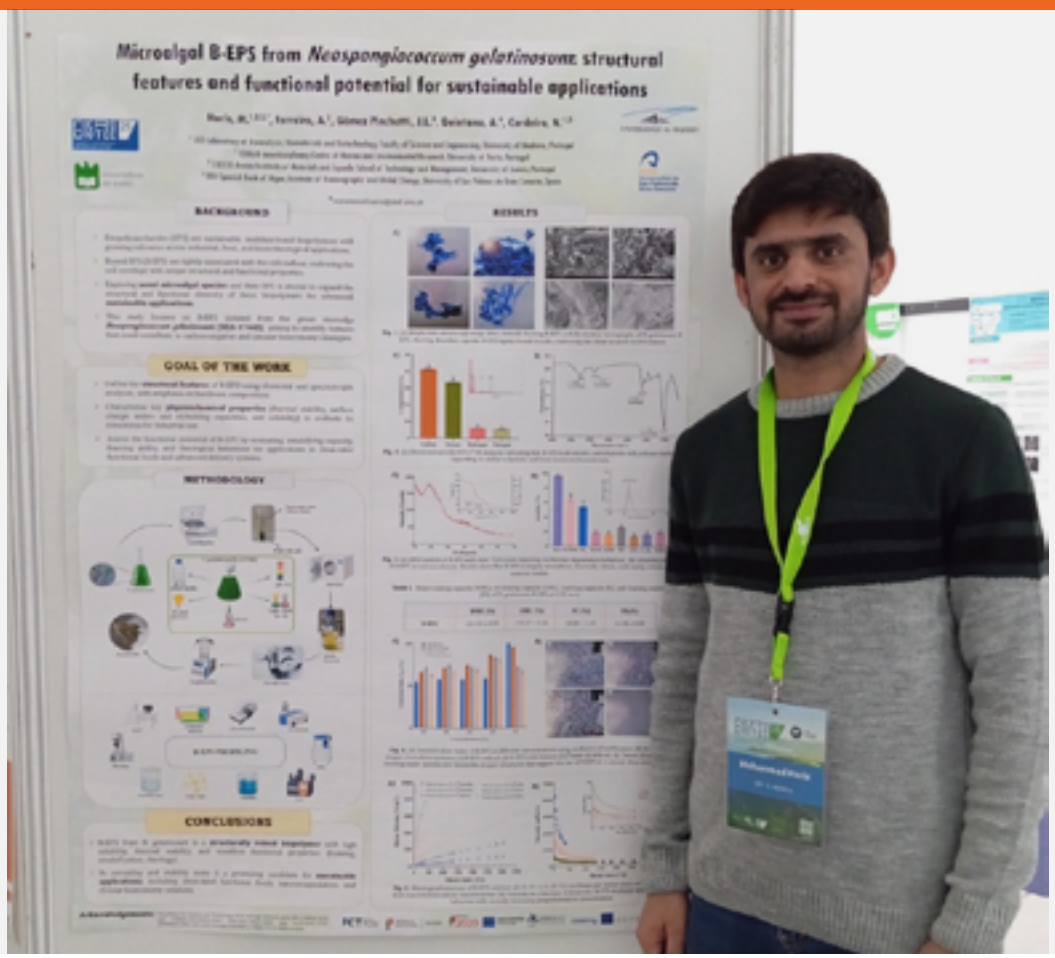
Muhammad Haris

Unlocking the potential of microalgae/ cyanobacteria: novel strategies for sustainable and intelligent biomaterials for food packaging

Abstract

Microalgae present a promising path toward achieving a carbon-negative bioeconomy and advancing sustainability in the food sector. Rich in proteins, lipids, carbohydrates, essential fatty acids, and vitamins, microalgae offer numerous health benefits and exhibit remarkable environmental adaptability, including CO_2 sequestration, growth on non-arable land, and cultivation in non-potable water. However, the direct commercialization of wet microalgae as food or as functional food additives remains limited due to key challenges, including poor sensory appeal, low bioavailability, and instability under processing conditions. This PhD research focuses on a novel approach: the use of microalgal exopolysaccharides (EPS) for nanoencapsulation, targeting two main goals: 1) improving the marketability of wet microalgae as a sustainable food source, and 2) enhancing their utility as bioactive functional additives in food products. Microalgal EPS are natural biopolymers recognized for their antioxidant properties, emulsifying capacity, and health benefits; however, their application in nanocapsules remains largely unexplored.



The research is divided into six main tasks: (1) Selection and Cultivation of EPS-producing Microalgae: EPS-rich strains will be selected from well-established microalgae banks (e.g., CIIMAR, BEA); cultivation parameters such as light, temperature, and nutrient composition will be optimized to maximize EPS production. (2) Extraction and Purification of EPS: EPS will be extracted using techniques like freeze-thaw cycles, agitation, and alcohol precipitation; the purified EPS will then be characterized in terms of molecular structure, sugar composition, rheological behaviour, and bioactivity. (3) Production of EPS-based Nanocapsules: various techniques (e.g., nanoprecipitation, ion gelation, emulsification) will be used to create nanocapsules; optimization will be conducted using statistical models to achieve ideal encapsulation conditions. (4) Characterization of EPS nanocapsules: Structural and functional properties of nanocapsules will be analyzed using techniques like SEM, TEM, DLS, FTIR, NMR, and MS. Stability, zeta potential, and encapsulation efficiency will also be evaluated under different environmental conditions. (5) Encapsulation and Controlled Release of Bioactive Microalgal Compounds: Selected compounds with nutritional or functional benefits will be encapsulated using EPS nanocapsules; their release behaviour will be studied using models like Higuchi or Korsmeyer-Peppas. *In-vitro* and *in-vivo* biocompatibility and safety assessments will be conducted, including cytotoxicity tests, hemocompatibility assays, and rodent model evaluations, and (6) Application in functional foods: EPS nanocapsules will be tested in food systems, and their effectiveness will be compared with conventional encapsulation systems like liposomes; sensory evaluations (colour, taste, aroma) will be conducted using colorimeters and sensory panels to assess consumer acceptability.

By addressing stability, solubility, sensory issues, and bioavailability, this research will pave the way for eco-friendly, health-enhancing, and consumer-friendly microalgae-based foods. The successful development and application of EPS nanocapsules will not only contribute to the circular economy but also position microalgae as a core solution in climate-resilient food innovation and functional nutrition.

Acknowledgements

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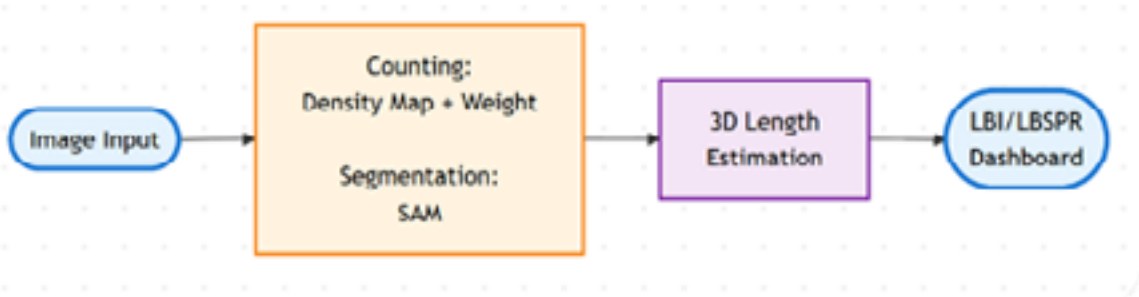
The PhD project started in January 2024. FCT grant PRT/BD/154904/2023.

Noor Ullah Khan

Vision and predictive analytics for monitoring sustainability of exploited fishing populations

Abstract

This PhD project aims to address the challenges posed by traditional methods for assessing fish stocks, by developing an innovative, non-invasive, and cost-effective system for monitoring exploited fishing populations. The core of this project is the application of advanced Computer Vision and Deep Learning techniques to automate the process of data collection and analysis directly from fishing operations. The primary objectives are to design, implement, and validate this data pipeline, ensuring its outputs are reliable and can be integrated into existing stock assessment models. The accuracy of the system will be rigorously validated against data from traditional survey methods.



Traditional methods for assessing fish stocks – such as research surveys and analysis of commercial landings – are often costly, labour--intensive, and subject to significant time lags. This data latency hinders the ability of policymakers and scientists to implement timely and effective measures for sustainable fisheries management, which is crucial for marine ecosystem health and food security.

The methodology involves processing video footage/images captured from cameras installed on commercial fishing vessels or at port facilities and fish markets. This data will be fed into an AI pipeline designed to perform several key tasks automatically. The first task includes fish detection and classification: the system will use deep neural network to detect individual fish in complex, unstructured scenes and classify them by species with a high degree of accuracy. The second task will estimate length and biomass by applying image segmentation and measurement algorithms, where the system will estimate the length of each detected fish; this data, aggregated across hauls, will be used to calculate size distributions and estimate total biomass. The third task will be real-time data generation; the ultimate goal is to process this information in near real-time, providing fisheries scientists and managers with up-to--date indices of abundance and population structure.

The successful implementation of this system will provide a transformative tool for fisheries science. By delivering high-frequency, high--quality data at a fraction of the cost of conventional methods, this project will enhance our ability to monitor exploited fish populations dynamically. It will directly support an Ecosystem Approach to Fisheries Management by providing the empirical data needed for more responsive and sustainable management strategies, ultimately contributing to the conservation of marine biodiversity and the resilience of our Ocean.

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This thesis is supervised by Gui M. Menezes, from the Institute of Marine Sciences – OKEANOS and the University of the Açores, Nuno Moniz from INESC TEC and the University of Porto and University of Notre Dame, and Rita P. Ribeiro from INESC TEC and the University of Porto. The PhD project started in October 2024. FCT grant 2023.18554.PRT.

Paloma Toscan

Remote sensing and AI for assessing and implementing urban nature-based solutions

Abstract

This PhD project seeks to address this gap by creating a replicable method capable of measuring Nature Based Solutions (NBS) impacts and recommending appropriate solutions for different urban contexts. The aim is to develop an innovative methodology that integrates remote sensing and artificial intelligence to assess and implement NBS in diverse urban contexts, with the goal of promoting the sustainable adaptation of urban spaces and mitigating global environmental impacts. The study has a global scope and focuses on multitemporal and multivariate analysis, integrating environmental, urban, and socioeconomic data to generate knowledge applicable to public policy and resilient urban planning. By combining multitemporal and multivariate analyses with advanced remote sensing and artificial intelligence techniques, this research aims not only to quantify the environmental impacts of NBS but also to provide technical support for resilient and adaptive urban planning decisions, thereby strengthening cities' capacity to respond to climate change and advancing efforts toward sustainable urban development.

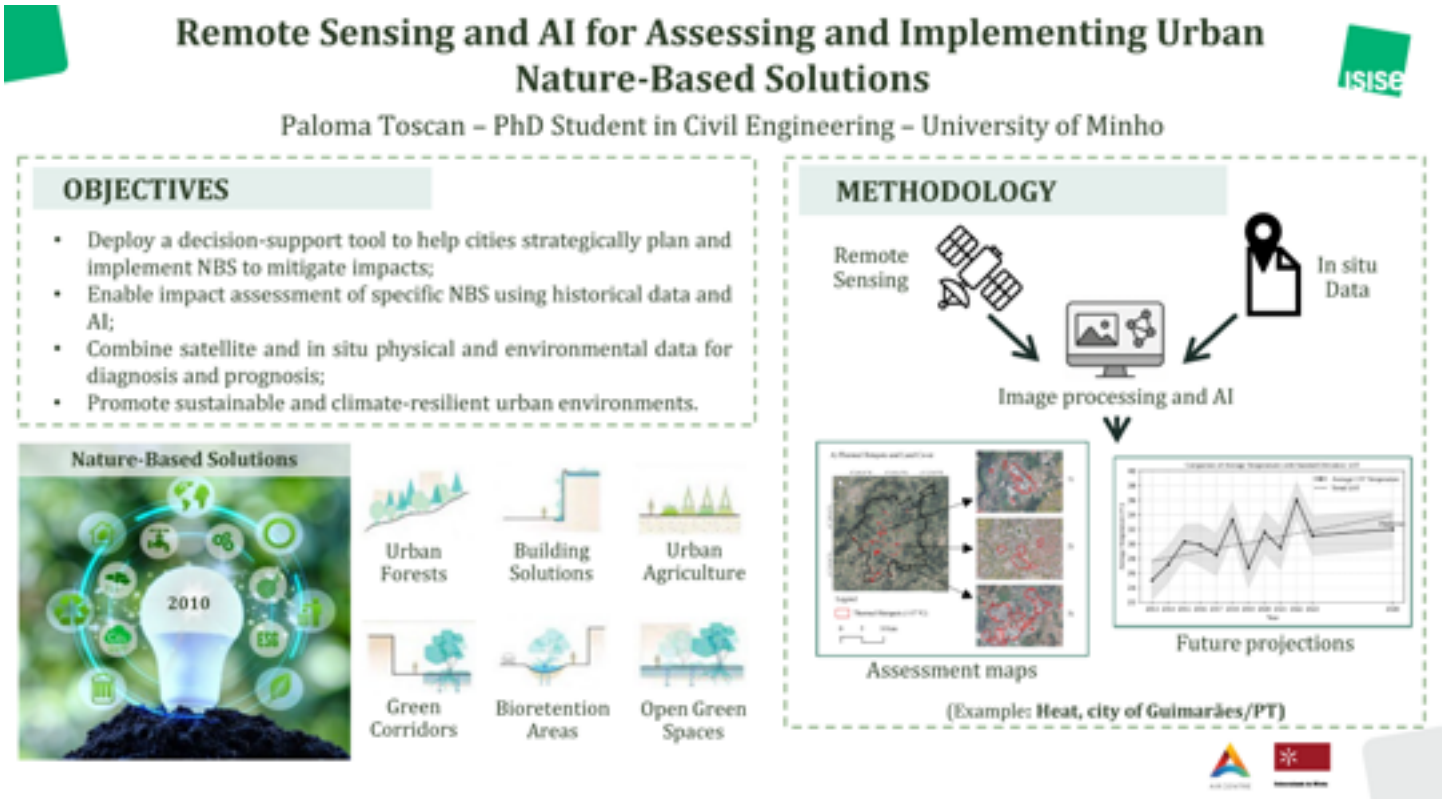

Figure 8 - Proposed research approach.

NBS are planned interventions that utilize natural processes and elements to address environmental, social, and economic challenges, such as mitigating urban heat islands, improving air quality, managing stormwater, and enhancing biodiversity. Although recognized by organizations such as the International Union for Conservation of Nature (IUCN) and the European Commission, their implementation and evaluation still lack standardized methodologies and more agile, user-friendly decision-support systems.

The PhD Project comprises six main stages: 1) a literature review, involving the collection and analysis of studies, tools, and methodologies used in the implementation and evaluation of NBS in urban areas, including their impacts on environmental variables measurable through remote sensing data, such as Land Surface Temperature (LST), the Normalized Difference Vegetation Index (NDVI), which provides insight into vegetation health, the Normalized Difference Built-up Index (NDBI), which assesses the presence and density of built-up areas, the Normalized Difference Water Index (NDWI), which indicates the presence and quantity of surface water, and air quality; 2) creating a global database of cities that have implemented NBS for at least ten years, using sources such as the Urban Nature Atlas, and compiling, for each city, information on the type of NBS, scale, objectives, urban context, and impact indicators; 3) remote sensing applications will be conducted, including the collection and processing of satellite imagery to analyse the temporal evolution of environmental indicators, assessing variations both within NBS areas and in their surroundings. Priority will be given to imagery with high spatial resolution (30 m) and long temporal coverage (at least ten years), obtained from sources such as Landsat and Sentinel, in addition to climate data. At this stage, tools such as QGIS, Google Earth Engine, and Python will be employed to extract metrics and integrate them with *in situ* data; 4) covers statistical and artificial intelligence analyses, including regression models, correlation analysis, clustering methods, and deep learning algorithms such as semantic segmentation and foundation models aimed at the automatic detection of NBS typologies in multispectral imagery. Causal relationships between variables will also be explored, and forecasts of future scenarios will be generated under different urban and climatic conditions; 5) focus on developing an NBS recommendation system that, based on metrics derived from remote sensing and artificial intelligence, suggests specific solutions for different urban challenges, considering previously analyzed environmental factors. This tool will seek practical applicability for urban planners and decision-makers, enabling comparisons across cities and estimates of the effectiveness of different NBS; and 6) writing the PhD dissertation and producing scientific outputs, including systematizing results and preparing publications to contribute to advance the knowledge in the field, while providing technical guidance for public policies and sustainable urban projects.

This PhD Project is expected to produce a standardized global database on NBS in urban areas, multitemporal and multivariate models for environmental impact analysis, algorithms capable of identifying NBS typologies in satellite imagery with high accuracy, and a practical NBS recommendation tool adaptable to different urban contexts, in addition to scientific publications and technical guides to support climate adaptation policies (Figure 8).

Preliminary results show that urban gardens had a substantial impact on reducing temperatures, with differences of up to 2.49 °C compared to surrounding areas. This study reinforces the potential of NBS to mitigate global environmental impacts – specifically, urban heat – and serves as a foundation for the enhancement and future application of artificial intelligence techniques for climate scenario forecasting.

Acknowledgements

This PhD project is supervised by Eduardo Pereira from the University of Minho and Marcos Oliveira from the University of La Costa. The PhD project started in June 2023. FCT grant PRT/BD/154707/2023.

Pedro Alves Guedes

Acoustic detection of submerged marine litter using multi-frequency echosounder water column data

Abstract

The main goal of the PhD project is to contribute to the underwater detection, classification and tracking of submerged marine debris by using robotic platforms. Marine litter is a growing threat to marine ecosystems and to global sustainability, it is estimated that 73 Mt of plastic will enter in the Ocean annually by 2030. In this context, the development of transparent, sensor-based monitoring systems becomes even more critical. Most detection methods focus on surface-level litter, relying on satellites, drones, and aircraft remote sensing. The usage of underwater cameras can capture detailed images of marine debris, suffering, however, from attenuation due to the underwater medium, which compromises the image field of view, range and quality. Acoustic waves, being mechanical waves, suffer from less attenuation and can spread over a wider range. By integrating acoustic and machine learning techniques, we can achieve a more complete and verifiable understanding of marine litter and allow the public to distinguish between genuine environmental progress and superficial marketing. Robotics can improve the detection of water pollution. The multibeam echosounder (MBES) acquires acoustic data, which can be expressed as water column data (WCD) in the form of acoustic images. Using learning--based approaches can be useful to discriminate different types of litter in the water column for future in-situ detection and collection with robotic platforms.

Figure 9 - Kongsberg's M3 HF MBES installed in the PORTUS Autonomous Surface Vehicle.

The PhD project focuses on studying and developing novel learning-based methods that use multi-frequency echosounder data to detect and classify different types of marine litter. The project proposes to: a) study state-of--the-art processing and learning-based approaches for multibeam echosounder (MBES) data that can be used for the detection and classification of marine litter; b) create a synthetic sonar imaging dataset by using and testing simulation environments; c) study how to store acoustic images by creating a water test tank dataset, validating how to store images based on different acoustic frequencies and how to extract images in different formats (polar, cartesian, and raw); d) validate whether different types of marine litter can be perceived with a MBES and characterise them based on the resulting acoustic images; e) apply computer vision methods to extract features from the collected images; f) apply classical machine learning approaches for marine litter classification; g) implement state-of-the-art detection algorithms through transfer learning; h) create, annotate, and validate a real-life scenario dataset through learning-based benchmarking approaches; i) implement tracking-based approaches to track marine litter in the new dataset.

The first set of objectives was completed by extracting the MBES data that were necessary due to the scarcity of sonar images for object detection and classification in the scientific community when compared to optical datasets. The acquired test tank dataset allowed for a qualitative characterisation and was augmented with synthetic data, including multiple targets in a single acoustic image for numerous detections. Afterwards, the test tank dataset was expanded with more variability, enabling the development, training, and testing of a multi-label SVM classifier and a shallow CNN multi-label classification model. Transfer learning was also applied to a Single Shot Detector (SSD) and to the You Only Look Once version 8 (YOLOv8) model to detect and label marine litter in the test tank data, validating the effectiveness of marine litter detection using MBES. Material-level differentiation was achieved using multiple acoustic frequencies. To increase variability and realism, and to contribute to the scientific community, a novel dataset was presented containing 8,156 acoustic images acquired at different acoustic frequencies using the Kongsberg M3 High-Frequency MBES, illustrated in the Figure 9. The dataset aims to foster the development of novel methods for detecting marine litter in the water column. It provides acoustic images for detecting and classifying 10 different types of marine litter. The data were collected in the manoeuvring basin of Leixões harbour.

The YOLOv8 detector was applied to provide metrics and validate the acquired data. Preliminary tracking results were presented at the OCEANS 2025 Brest conference using the DeepSORT tracking algorithm, based on the most recent dataset with acoustic video generation. Different types of data preprocessing were applied to the acoustic videos, providing insights for improved tracking performance. While the initial results were promising, the system faced common challenges such as occlusion and identity (ID) switching. At present, different tracking algorithms are being benchmarked and compared when applied to the underwater environment and its underlying constraints.

Acknowledgements

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Pedro Nascimento

Development of aquaculture technology for the Azorean limpet species: life cycle, culture systems and feeding

Abstract

This PhD project aims to advance the sustainable aquaculture of two ecologically and economically significant Azorean molluscs, *Patella* aspera and *P. gomesii*, by addressing critical knowledge gaps in their captive production. The research focuses on four interrelated key areas: (1) reproductive biology (spawning triggers, gamete viability, and larval development, to refine broodstock management); (2) aquaculture system optimization (substrate design and density-dependent growth dynamics, to enhance scalability); (3) nutritional requirements (biofilm and microalgal composition, to optimize growth); and, (4) conservation-driven production (assessing restocking efficacy). By systematically investigating these domains, the doctoral research is expected to generate actionable data to overcome existing bottlenecks in limpet aquaculture and provide a science-based framework for commercial-scale production and sustainable species management. Ultimately, this PhD project seeks to bridge fundamental marine biology with applied aquaculture, supporting the growing field of marine invertebrate cultivation while promoting ecological and economic sustainability.

Figure 10 – Induction tests for gamete release under simulated environmental conditions.

A primary challenge in limpet aquaculture is controlling reproduction. The life cycle comprises pelagic larval stages (trochophore → veliger → pediveliger) followed by benthic settlement and maturation. Systematic evaluation of extant literature revealed the main project-relevant constraints, including spawning limitations (unpredictable gamete release; current reliance on dissection for gamete collection), larval sensitivity (high mortality due to suboptimal environmental conditions and settlement cues) and genetic dependence (lack of domesticated stocks; reliance on wild broodstock). Current PhD research involves experimental spawning induction, artificial fertilization, and broodstock monitoring (Figure 10). The next objectives are to optimize spawning with hormonal inducers, refine larval rearing, and develop broodstock domestication protocols.

Unlike filter-feeding bivalves, limpets require hard substrates with biofilm coverage for grazing, necessitating alternative culture approaches including substrate-based systems (e.g., plastic or fiberglass plates; natural rock) deployed via cages, rafts or tanks. Major constraints include lack of data comparing system efficacy, standardized handling protocols, and optimized substrates. Current PhD work involves developing novel larval setups, evaluating growth on corrugated fiberglass with natural biofilms, and refining handling techniques. The next goals include testing alternative substrate materials, developing non-invasive handling methods, and performing a quantitative comparison of system types through growth and survival metrics.

Feeding strategies for limpets must account for ontogenetic shifts in nutritional requirements. Lecithotrophic larvae initially depend on yolk reserves before transitioning to biofilm and microalgal grazing post--settlement. Key challenges identified include the lack of standardized feeding protocols and optimized diets tailored to each life stage. Current PhD project focuses on evaluating growth performance using natural biofilms, while critical knowledge gaps remain in understanding feeding behaviour, gut content composition, and comparative efficacy of formulated versus natural diets.

Both limpet species face significant vulnerability due to three primary threats: overharvesting, coastal habitat degradation, and climate-driven ocean warming. These cumulative pressures have precipitated measurable population declines across Macaronesia (Azores, Madeira, Canary Islands), particularly where enforcement of harvesting regulations is inefficient. Current PhD conservation efforts focus on developing assisted reproduction techniques (spawning induction; larval rearing) to support future restocking programs. However, long term species recovery will require integrated strategies combining science-based breeding protocols, habitat restoration, strengthened fisheries management, and community engagement to reduce harvesting pressure.

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Pelayo Menéndez Álvarez

Assessing and forecasting trends in macroalgal beds distribution and productivity

Abstract

Adequate data and modelling to understand and predict marine biodiversity changes from local to global scales, are urgently needed to respond to the present world crises regarding biodiversity loss and forecast distribution changes. This is also the basis to assess the effects of management and plan adequately the measures to address this ecosystem crises. This PhD project aims to fill key gaps on the integration of observations collected with multiple techniques, analysis of the trends observed and predict future trends focusing on macroalgal beds, an Essential Ocean Variable in development. We will also address the implementation of best practices for formatting, archiving, curation, and sharing observations at both Portuguese and international scales. We aim at developing cost-efficient standardised methods of monitoring, using remote sensing and *in situ* observations, to allow testing hypotheses regarding trends in these ecosystems, as well as predict effects of measures for their recovery as Marine Protected Areas and ecosystem restoration. Novel data analyses will generate new insights into past and projected future trends in these very important ecosystems that may have a key role in carbon sequestration and will determine if increase in area, e.g. though cultivation, may be part of the solution for increasing carbon sequestration by marine ecosystems. This knowledge will be key for the conservation and restoration of marine macroalgal beds and its ecosystem services, including increase of carbon sequestration and mitigation of other effects of climate change in the coastal areas.

This PhD project will be done in the framework of the Group on Earth Observations Biodiversity Observation Network (GEO BON) specifically the Marine Biodiversity Observation Network (MBON) that is building a community of practice to increase and improve monitoring of marine biodiversity and the development of products that can be used by managers and policy makers from local to international levels.

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Rebecca Pabst

Analysing human-mediated changes in the global distribution of disease vector mosquitoes

Abstract

This PhD project addresses one of the defining aspects of the Anthropocene, the human-mediated introduction of species into new regions, focusing specifically on non-native mosquitoes that act as vectors of human disease. Main objectives are (i) to compile the first global database of first records of non-native mosquito species reported as human disease vectors, including data on origin and pathways; (ii) to identify spatiotemporal patterns and environmental, socio-economic, and biological drivers of introduction and establishment; (iii) to develop predictive models of mosquito invasion risk based on species traits and environmental suitability, and (iv) to support proactive surveillance and early-warning systems for emerging mosquito-borne diseases. This PhD project will contribute to enhancing health systems with proactive disease prevention strategies to support targeted vector control and preparedness for potential outbreaks.

Figure 11 - (Left) Field deployment of an adult mosquito trap during fieldwork in Brensbach, Germany. (Top row, middle) Presenting research at NOVA Health conference. (Top row, right) Microscopic identification of a blood-fed female mosquito. (Bottom row, middle) Data analysis. (Bottom row, right) Sampling of mosquito larval breeding sites in Sintra, Portugal

The introduction of non-native species of all taxa into new regions is a key element of the recent period of Earth's history, the Anthropocene, which is defined by human influence on ecosystems. Intercontinental introduction of species occurred with the beginning of shipping and was particularly driven by the development of transport

networks and the globalization of trade and labour markets since the beginning of the Industrial Revolution. Although attention and awareness towards this issue have increased, the accumulation of non-native species continues to grow worldwide. Apart from the threat to biodiversity posed by introduced species, the arrival of new disease vectors such as mosquitoes affects human health by altering the pattern and frequency of disease transmission. Throughout history, non-native vectors that invaded, settled and spread in new areas have caused epidemics of human diseases such as malaria, yellow fever (YF) and plague.

Arthropod-borne viruses (arboviruses) cause disease outbreaks mainly in tropical regions. The increase of disease in subtropical and temperate areas, alongside worsening outbreaks in tropical zones, results mainly from the expansion of key vector species: *Aedes aegypti* and *A. albopictus* into new regions. This expansion is linked to factors such as globalization, urbanization, human mobility, and climate change. The first comprehensive list of records of the introduction of insect vectors of human diseases into new regions was compiled in 2002. The continuation of this effort holds significant importance in monitoring the ongoing global expansion of disease vectors (Figure 11). However, the consistent implementation of active mosquito surveillance remains uneven across countries worldwide, and the ongoing monitoring and early identification of emerging spreading species rely on individual publications. The number of non-native arthropod species successfully colonizing Europe increased by almost twofold, rising from an average of 10.9 species annually between 1950 and 1974 to 19.6 species per year from 2000 to 2008, making an up-to-date database on the introduction of non-native mosquito species, their origin and transport routes more important than ever.

Great efforts have been made to develop suitability maps for the vectors of the diseases with the greatest disease burden (e.g., *Ae. aegypti, Ae. albopictus*). However, our understanding of how these vectors invade new regions remains incomplete. While the spatial and temporal spread of *Ae. albopictus* and *Ae. aegypti* is relatively well-documented, comprehensive documentation is lacking for other species. It is of utmost importance to observe whether there are species that are on the rise but not yet on the radar. Understanding the species that are undergoing expansion is crucial for implementing targeted trapping and control techniques aimed at vectors eradication before their establishment, as well as for preparing against potential disease outbreaks. Typically, local arbovirus outbreaks like chikungunya, dengue, YF and Zika have occurred within 5–15 years following the establishment of *Ae. aegypti* and *Ae. albopictus* populations, underscoring the central role of vector spread in disease transmission.

Studying the spatial and temporal patterns of species introduction also helps to identify the regional, intercontinental, and global spread of species, along the lines of studies carried out on other taxonomic groups such as ants, fungi and insects in general. Furthermore, it is still largely unexplored whether non-native species within the same taxonomic group show similar invasion dynamics, and which traits of these species lead to successful establishment, providing insight into why only a small proportion of the more than 3500 mosquito species succeed in invading new regions.

Acknowledgements

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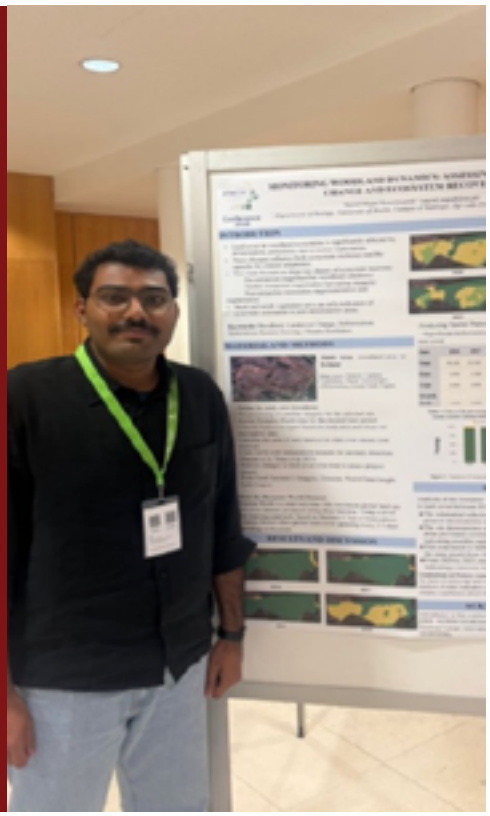
Sayed Majad

A serious game approach to a coastal community living lab

Abstract

How to contribute to better inform citizens the decision makers by mobilising local actors and coastal communities in active and passive marine ecosystem restoration and by co-creating socially and economically sustainable solutions? To address this question this PhD project will consider the 'Living Lab' concept that can enable transformative change advised by active and informed stakeholders and citizens; it implements fuzzy cognitive mapping to understand the relationship between anticipated social–ecological changes and differences in knowledge and perception; and builds on serious gaming approach, enabling stakeholders to participate at decision-making through their reasoning, viewpoints, arguments, and trade-offs. The main objective is to co-develop implementable social-ecological innovations for deliberative democracy process in the Portuguese coastal area, and to prepare a framework for up-scaling of the gamification approach beyond this region.



This PhD project will benefit from data and information that will be generated in close collaboration with on-going projects and involves: mapping of the main human driven and climate change related pressures, for identifying nature-based solutions for building climate resilience together with local authorities, business, and citizens, using a Living Lab approach; fuzzy cognitive modelling, to identify the key components of the coastal system and their inter-relationships; and developing the game that will build up on existing concepts like the Maptionnaire web-based application for accessing climate resilience (https://maptionnaire.com/). It will use real world GIS data (raster or vector) to create the "game world" and will have configurable in-game stakeholder groups.

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Sharath Chandra Thota

Atmospheric rivers role in extreme temperatures and precipitation and potential effect on microbial biodiversity on the Antarctic Peninsula

Abstract

This PhD project contributes to the understanding of how microbial life moves through the atmosphere, survives extreme environments, and interacts with global climate systems. FieldPhD project was conducted in January and February 2025, during a research campaign based at King Sejong Station (King George Island), where precipitation samples were collected during both atmospheric river (AR) and non-AR events. Preliminary findings offer a compelling example of how microbial ecology intersects with planetary science, highlighting the microbial fingerprint in atmospheric events and its potential feedback in a warming world.

This PhD Project is set in the rapidly warming Antarctic Peninsula (AP), a hotspot of climatic change marked by rising temperatures, ice melt, and shifting precipitation regimes. One of the key climate drivers in this region is the phenomenon of atmospheric rivers (ARs). ARs are narrow, transient bands of intense moisture transport from lower latitudes to Antarctica. These systems are capable of delivering not only heat and water vapour but also dust, bioaerosols which can also include microorganisms from distant regions.

The central goal of this PhD project is to explore how these AR events shape microbial biodiversity in Antarctic precipitation and what roles these microbes might play once they arrive to Antarctica.

Using a multidisciplinary approach, this research combines *in situ* precipitation sampling, microbial culturing, molecular identification through DNA sequencing, and whole-genome mining, precipitation chemistry, and stable isotope analysis. These techniques allow to characterize microbial community structure, determine the viability and metabolic potential of transported microbes, and trace their geographic origins through atmospheric back trajectory models.

A pivotal component of this research is the investigation of ice nucleation activity, a functional trait of some microorganisms that allows them to catalyze ice formation in clouds. These ice nucleating particles (INPs), which can be of biological origin, play critical roles in cloud microphysics and precipitation patterns. By identifying microbial INPs in Antarctic snowfall and rainfall, this study contributes to a growing field that connects microbiology with meteorology and climate science, offering insights into how airborne life might influence weather systems and feedback loops in polar regions.

Field PhD project took place during January and February 2025, in a research campaign based at King Sejong Station (King George Island), where precipitation samples were collected during both atmospheric river (AR) and non-AR events. These included: 1) Event 2 (AR event): sampled from 12 January 2025, 09:00 to 13 January, 11:00 (Figure 12). Characterized by intense snowfall, a short rainfall period, strong winds, and virga (a meteorological phenomenon where precipitation (rain, snow, or ice crystals) falls from a cloud but evaporates or sublimates before reaching the ground) at the beginning and end. Snow was collected during the steady precipitation phase; and 2) Event 24 + Event 26 (non-AR events): A combined event from 10 February 2025, 02:00 to 16 February, 00:03. Event 24 began with strong virga, followed by intense snowfall. Event 26 saw snowfall with vertical cloud extent decreasing from 4 km to <2 km.

The Venn diagram highlights the limited overlap in microbial genera among the events, with each event showing unique genera and only a few shared among them. This suggests distinct microbial seeding patterns potentially linked to differences in air mass origins, transport dynamics, and precipitation type.

Figure 12 - Sharath collecting of precipitation samples conducted during an Antarctic research campaign in February 2025.

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Teresa Ferreira

Megabenthos associated with cold-water coral reefs and mounds across the deep Atlantic Ocean

Abstract

Cold-water coral (CWC) reefs and mounds form complex deep-seafloor habitats that support rich megabenthic communities along Atlantic margins. Yet comprehensive comparisons remain limited. This project aims to characterize megabenthos associated with mounds and reefs using imagery and environmental data from Porcupine Seabight (NE Atlantic), Gulf of Mexico (NW Atlantic) and Angolan Margin (SE Atlantic) to assess distribution, composition and diversity of megabenthos, explore patterns in light of environmental settings, and build species distribution models.

Cold-water corals (CWCs) thrive on the deep seafloor below 200 m and play a key ecological role in benthic ecosystems. Reef-forming scleractinians, particularly *Desmophyllum pertusum* (formerly *Lophelia pertusa*) and *Madrepora oculata*, form complex three-dimensional frameworks along Atlantic continental margins. Present-day reefs are often associated with CWC mounds, where coral rubble and dead coral framework accumulated during recurring periods of reef formation under geological timescales. These habitats provide shelter, attachment surfaces, and enhanced food availability, supporting diverse megabenthic communities and complex ecological interactions essential to ecosystem functioning.

Despite their importance, comprehensive Atlantic-wide comparisons of CWC reefs and mounds are lacking, particularly regarding the distribution, composition, and diversity of associated megabenthos. Such knowledge is crucial to understand biodiversity patterns, identify environmental drivers, and inform conservation, especially as these habitats are recognized as Vulnerable Marine Ecosystems threatened by climate change and fishing.

Hence, the project aims to characterize the megabenthos associated with CWC mounds and reefs across the Atlantic by integrating seabed imagery and environmental data from Porcupine Seabight (NE Atlantic), the Gulf of Mexico (NW Atlantic), and the Angolan Margin (SE Atlantic).

ROV imagery collected between 250 and 850 m depth is used to identify and quantify megabenthos and reef-structuring species, classify substrates and detect anthropogenic disturbance, while high-resolution bathymetry and water mass data provide additional environmental context. As result, morphospecies are identified to the lowest possible taxonomic level and compiled into photographic faunal catalogues that incorporate morphological traits, functional classifications, links to external databases, and information on commercial relevance. Geographical differences are assessed using terrain variables derived from multibeam data together with water mass properties such as temperature, salinity and oxygen. The combined analysis of environmental and biological datasets will allow to explore relationships between environmental parameters and community structure and to develop species distribution models predicting megabenthos distributions.

Preliminary results show regional differences in morphospecies richness and composition across phyla, as well as area-specific habitat characteristics. Continued integration of environmental data and quantitative annotations will improve ecological interpretation. In the future, the project will deliver the first Atlantic-wide overview of the megabenthos associated with cold-water coral reefs and mounds. The results will enhance understanding of large-scale patterns, support the identification of priority areas for protection, and contribute to improved management of vulnerable deep-sea ecosystems.

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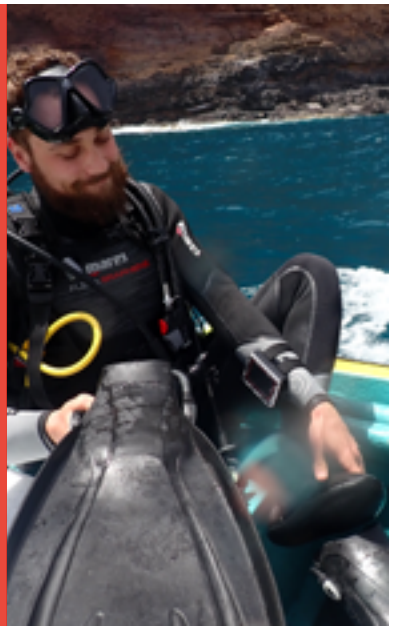
Tristan da Silva e Ornelas

Using biodiversity and function of coastal areas in Santo Antão island to set priorities in Marine conservation (Cabo Verde)

Abstract

This PhD project provides the first integrated baseline assessment of shallow water and mesophotic marine ecosystems around Santo Antão, Cabo Verde. The research focuses on biodiversity, ecosystem functioning, and conservation relevance across depth gradients, with emphasis on coastal fish communities, benthic assemblages, and mesophotic black coral forests. Fieldwork is conducted through SCUBA and rebreather diving, enabling systematic video transects, photo quadrats, and biological sampling for trophic analyses. Stable isotope and fatty acid analyses of fish and benthic organisms provide insights into trophic structure and support the reconstruction of local food webs. By generating highly valuable ecological data for an understudied region, this project contributes essential knowledge for evidence based conservation and sustainable marine management.



The Cabo Verde Archipelago represents a biogeographically unique ecosystem shaped by tropical conditions, oceanic isolation, and the influence of different water masses. Despite high levels of endemism and ecological importance, its marine ecosystems remain extremely understudied, particularly Santo Antão. This lack of baseline information constrains conservation planning, fisheries management, and the development of local monitoring capacity.

Shallow coastal habitats and mesophotic ecosystems, including black coral forests, are key components of Santo Antão's marine biodiversity, yet both remain poorly documented. These ecosystems support diverse fish and benthic communities, contribute to ecosystem functioning, and provide essential services to local communities. Understanding their structure, variability, and trophic dynamics is therefore critical for sustainable management.

This PhD project addresses these gaps by integrating taxonomic, functional, and trophic perspectives to characterize biodiversity patterns and ecosystem functioning across the entire coast of the island and different depths. The work directly supports the goals of the COAST Cabo Verde project by providing the scientific foundation needed to guide conservation strategies, strengthen local capacity, and inform long-term marine resource planning.

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Zahra Zarei

Bioactive and ecological coatings with microalgae and cyanobacteria for a sustainable future

Abstract

The advancement of biopolymers and biodegradable coatings presents a green alternative to the issue of plastic contamination. The industry's commitment to biodegradable materials with plastic coatings is visibly growing due to heightened investments in research and development. This PhD project aims to delve into and pioneer novel bio-coating techniques, setting the foundation for greener manufacturing processes and promoting a vision of enhanced sustainability for the future. The objectives of this project are (i) to efficiently identify, isolate, and cultivate high-yield EPS-producing microorganisms from microalgal and cyanobacterial sources, (ii) to design, optimize, and implement photoreactor setups that facilitate efficient in-line isolation and extraction of EPS from microalgal and cyanobacterial cultures, (iii) to develop EPS-based coatings suitable for disposable recyclable materials, and (iv) to develop innovative EPS-based coatings with bioactive and responsive features to enhance the utility and sustainability of disposable recyclable materials, thereby elevating their value and efficiency.

The natural environment is currently facing a serious threat because of plastic pollution. Plastic products, which are derived from fossil fuels, have provided immense convenience to our lives owing to their scalable manufacturing process, lightweight nature, robust mechanical properties, versatility, low cost, and corrosion resistance.

However, this has led to a global increase of twenty times in plastic consumption in the last fifty years. It has been reported that approximately 6,300 Mt of plastic waste were generated between 1950 and 2015, with an expectation of this number increasing to approximately 12,000 Mt by the year 2050. Unfortunately, only a minuscule fraction of the synthetic polymers produced are being recycled. In recent years, the growing concern for the environment has led to the search for more sustainable materials. The industry has been witnessing an increase in the creation of materials that are both recyclable and biodegradable.

However, the inclusion of plastic coatings in these materials raises important questions about their true sustainability.

Considering these problems, the need to explore alternative and more sustainable solutions is obvious. The search for innovative coating techniques, which can align the functionality of plastics with the sustainability of biodegradable materials, emerges as a promising area of research and development.

To enhance sustainability and reduce the environmental impact of these coatings, it is necessary to find a biodegradable coating produced with polymers derived from natural origins (biopolymer), to make the products 100% recyclable and biodegradable. Such resources encompass not only natural fibers, often derived from edible sources, but also a variety of microorganisms. Among microorganisms, cyanobacteria and microalgae exhibit potential as a viable source of biopolymers, in the form of polysaccharides, that are present either intracellularly (such as glycogen) or extracellularly, in the form of exopolysaccharides.

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