





### **REWRITE EU project**

PhD proposal (starting in 2025)

#### Title:

Biogeochemical dynamics in intertidal mudflats: high frequency measurements and carbon cycle upscaling

#### Keywords:

Carbon cycle Marine ecosystem modeling Field instrumentation

#### **Introduction:**

The dual crises of climate change and biodiversity loss represent two of the most significant challenges facing humanity in the 21st century. Intertidal sediment ecosystems, which span over 10,000 km<sup>2</sup> of Europe's tidal coastline, offer critical ecosystem services and benefits such as carbon sequestration, climate adaptation, and biodiversity support. However, these habitats face increasing threats from fragmentation, resource depletion, and rising sea levels. This PhD project, as part of the REWRITE (REWilding and Restoration of Intertidal Sediment Ecosystems for Carbon Sequestration, Climate Adaptation and Biodiversity Support) initiative, is precursor to innovative rewilding and restoration approaches to enhance the ecological and societal resilience of these vital ecosystems. Among these ecosystems, intertidal mudflats are characterized by a large gross primary production dominated by microphytobenthos. This specificity would allow remote sensing quantification of carbon stock and offer upscaling possibilities. These areas experience rapid physical, chemical, and biological changes driven by tidal cycles, weather patterns, and human activities. These processes may relocate and transform the carbon fixed by microphytobenthos. Thus, understanding the high-frequency dynamics of these interfaces is critical for predicting mudflat biogeochemical cycles evolution under climate change, and their capacity to sequester carbon.

#### **Overall research objectives:**

This PhD project aims to explore the high-frequency biogeochemical dynamics of intertidal mudflat interfaces and develop a robust model to predict the early diagenesis processes as well as provide boundary conditions to upscaling models. Specifically, the project will:

- 1. Measure high-frequency variations in the physicochemical properties of mudflat sediments (e.g., interfacial redox gradients, porewater composition and carbon fluxes, sediment topography).
- 2. Model the early diagenesis processes, focusing on organic matter degradation, nutrient cycling, and mineral transformations.
- 3. Participate to the development of an upscaling framework to translate station-scale findings to mudflat-wide assessments.







## Methodology:

- 1. Field Studies: Conduct high-resolution monitoring of intertidal mudflat sites, utilizing advanced sensor technology to capture variations in sediment properties, tidal flow, and environmental parameters with a time resolution in the range of 1mn to 1h. New automated benthic station will be operated first in mudflat of Loire estuary in France. The same equipment could be thereafter utilized in other European demonstrators, such as Ria de Aveiro, Portugal.
- 2. **Model Development**: Build a numerical model coupling high-frequency interface dynamics with diagenesis mechanisms specific to organic matter from different origins (autochthonous and allochthonous) (*i.e.*, contrasted reactivity). Incorporate multi-scale data to enable reliable extrapolation.
- 3. **Upscaling**: Use remote sensing, geostatistical and machine learning approaches to integrate local-scale processes across the spatial extent of the mudflat, ensuring applicability in ecological and management contexts.

# Expected outcomes:

- A comprehensive dataset characterizing the temporal variability of intertidal mudflat interfaces.
- A validated diagenesis model capable of simulating early diagenesis processes at high temporal resolution. Comparison between sites with different histories (recently or formerly restored/rewilded sites, abandoned sites, natural sites or heavily anthropized) will then be possible. These sites will be eventually chosen in consultation with REWRITE partners.
- An upscaling framework bridging fine-scale observations to regional ecosystem assessments.

## Significance:

This research will advance our understanding of intertidal mudflat dynamics, providing essential insights into their ecological functioning and resilience. The findings will inform conservation strategies, support carbon management efforts, and enhance predictive capabilities for coastal systems facing climate change. By integrating high-frequency dynamics, diagenesis modeling, and upscaling techniques, this PhD project will contribute to a deeper understanding of intertidal mudflat systems, bridging the gap between local processes and broader environmental management objectives.

## **Research skills needed**

We are seeking a PhD candidate with the following skills:

- Demonstrated experiences in the field of earth sciences: e.g., oceanography, aquatic systems, chemistry, physics
- Demonstrated experience with scientific computation
- Demonstrated ability to work independently and as part of a team
- Good written and oral communication skills in English.







#### **Contacts:**

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- Dr. A. Sousa (anaisousa@ua.pt)

## Application & starting date

Applicants should send to contact persons (see above) i) a curriculum vitae ii) a short statement of motivations and iii) name and email address of two references. PhD will start before the end of 2025.

### LSCE - Environmental Sciences and Climate Laboratory, France, (https://www.lsce.ipsl.fr)

Is a world-class research laboratory and a collaboration between CEA, CNRS and the University of Versailles Saint-Quentin -UVSQ. The main topics covered by the LSCE are climate and its impact on ecosystems and societies, carbon cycle including CO2 monitoring and forecast on land and ocean environments. The LSCE hosts approximately 300 researchers, engineers and administrative staff including many PhD and master's students. This project will provide the employee with the opportunity to work directly on advanced methods with researchers from the LSCE and other European institutions. Location: about 20 km from the heart of Paris, in the Orme des Merisiers green area.

#### LPG - Planetology and Geosciences Laboratory, France (https://lpg-umr6112.fr/en/)

Located on the campus of Nantes, Angers and Le Mans, the Planetology and Geosciences Laboratory (LPG) is a multi-site Joint Research Unit which currently depends on four supervisory authorities: the CNRS, Nantes University, Le Mans University and the University of Angers. Its activities are divided into three research themes: "Coastal and Marine Systems", "Earth", and "Planets and Moons". These activities are financed by international, national and regional research grant programs. They are based on various observation, analysis and experimentation platforms, at all scales, from space observations (remote sensing, magnetism) to geochemical analyses, to field observations (seismology, geology, offshore oceanic cruises), sample experiments (high pressure ice synthesis, thin section preparation, foraminiferal cultures, sedimentary core studies, soil remediation) and numerical modelling.

# <u>University of Aveiro, Portugal (https://www.ua.pt/en/), CESAM - Centre for Environmental</u> and Marine Studies (https://www.cesam-la.pt), Department of Biology (https://www.ua.pt/pt/dbio)

The University of Aveiro (Portugal) mission is to contribute to and develop graduate and postgraduate education and training, research and cooperation with society. UAveiro has over 17,000 students, 16 Academic Departments and 4 Polytechnic Schools, and fosters interdisciplinary collaboration, facilitating the exchange of knowledge between teaching and research. The Centre for Environmental and Marine Studies (CESAM) is one of the UAveiro Research Units (Associated Laboratory since 2005), whose mission is to promote transdisciplinary and transformative research and knowledge exchange to address societal needs, namely environmental and marine challenges, global change processes, and sustainable solutions for the management and conservation of natural resources, and the well-being of ecosystems and humanity. CESAM's multidisciplinary team gathers ca. 500 researchers, students and collaborators with knowledge spanning atmospheric and oceanic







process modelling, biodiversity and ecosystem structure, function and services, risk assessment, environmental management tools, policy, environmental economics and stakeholder engagement.

#### **References**

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#### Funding:

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Website: https://rewriteproject.eu/

