Environmental and Human Impacts on the Mangrove-Dune Systems of the Rio Preguiças Estuary, Brazil

Newcastle University

The Jeremy Willson Charitable Trust

Introduction

Mangrove forests are vital for mitigating climate change, stabilising coastlines, and supporting biodiversity. They sequester carbon through photosynthesis and store it long-term in biomass and waterlogged soils, where it can persist for centuries (Nyanga, 2020). Mangroves lower atmospheric CO_2, provide critical habitats (Spaulding et al., 2010) and protect coastlines from erosion (De Silva & Amarasingh, 2023). However, climate change, rising salinity, altered rainfall, storms, and human pollution threaten their health (Biswas & Biswas, 2023). Our study area near Atins and Barreirinhas, Maranhão, Brazil—home to 26,000 km^2 of mangroves—offers a key opportunity to examine how tropical coastal ecosystems respond to environmental pressures on all scales.

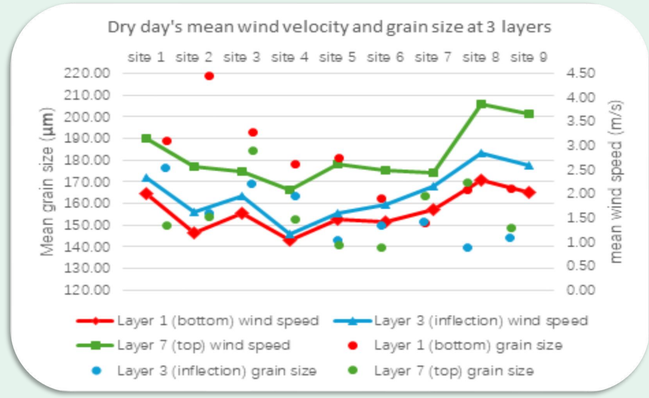


Figure caption: Figure 1 shows the total nine sites of mean wind velocity and grain size collected on dry days.

Aims and hypotheses

Carmen examined **mangrove carbon storage and saltwater intrusion**, quantifying belowground carbon stocks and modelling the potential impacts of sea-level rise. It was hypothesised that under a worst-case sea level rise scenario, saltwater intrusion would be extreme enough to significantly reduce mangrove health and therefore carbon storage capacity.

Max investigated **sediment grain size dynamics** across dune systems, exploring how wind velocity, surface moisture, and vegetation influence sediment sorting. Stronger winds were expected to produce coarser grains, while wetter surfaces would yield finer sediments.

Rowan analysed **diatom community structures** to identify environmental drivers of microalgal distribution, hypothesising that salinity gradients determine species composition, with clear shifts between seaward and inland zones.

Lydia studied **microplastic pollution** in mangrove soils along an urban–rural gradient, predicting higher concentrations in finer, low-energy sediments near urban areas.

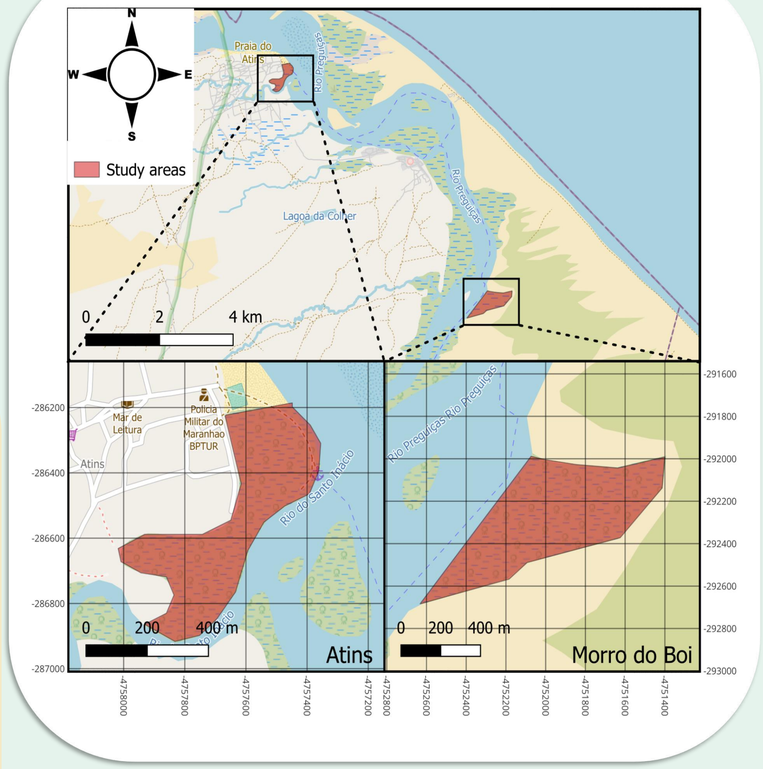
Methods

Carmen applied systematic random sampling to collect mangrove soil cores for loss-on-ignition analysis, quantifying soil carbon content. Tree height and diameter were measured to estimate above-ground biomass and below ground biomass, with both metrics combined to calculate total carbon storage. River water samples were also tested for salinity to establish a current salinity gradient across the study area.

Max investigated dune sediment transport by measuring mean wind velocity and deploying vertical sediment traps under both dry and wet surface conditions. A handheld GPS was used to record nine 100 m^2 quadrats, enabling precise spatial referencing and online mapping of sampling sites.

Rowan adopted a purposive, stratified sampling strategy to collect sediment samples across distinct microhabitats. These were analysed for environmental parameters such as salinity and pH and used to extract benthic diatoms for microhabitat community analysis.

Lydia investigated **microplastic pollution** in mangrove soils across urban and rural sites using a stratified sampling approach. Four transects were established at each site, with three surface soil samples (top 5 cm) collected along each. Samples were taken to the laboratory, where microplastics were counted, and measured under a microscope. Sediment grain size was also analysed to assess how soil texture influences microplastic accumulation.



Key Findings and Next steps

Carmen- mangrove carbon storage and saltwater intrusion

- Current findings show that soil carbon content ranges from 13–29%, with higher values observed in Morro de Boi compared to Vasouras, a forest further along the river. A clear salinity gradient has been established along the river, though it is less pronounced than initially expected, suggesting limited current saltwater intrusion.
- The next steps include refining the model and projecting future saltwater intrusion under NASA sea-level-rise scenarios.

Max – Sediment Grain Size Dynamics

- Wind velocity increased with height, though only site 7 showed a matching rise in grain size; most sites showed the opposite trend, with stronger winds producing finer sediments. An inflection occurred at ~6–11 cm above ground (layer 3), where grain size briefly decreased before increasing again, highlighting complex wind–sediment interactions.
- The next steps will be plotting GPS data on an aerial site map, creating quadrats and calculating vegetation density. Meanwhile, data errors encountered during sieving, should be discussed in the final report

Rowan – Diatom Community Structure

- Initial analysis revealed a high prevalence of *Navicula* and *Nitzschia* diatom genera, dominant in brackish and marine environments. Their abundance reflects broad salinity tolerance, consistent with the large salinity gradient observed across the study site.
- In the next steps, Benthic diatoms will be quantified and analysed against environmental variables to identify the most influential factors shaping their communities, providing a potential paleorecord for assessing future environmental change in the mangrove

Lydia- microplastic pollution

- In the next steps, GPS points will be mapped onto aerial imagery to quantify vegetation density. Diatom assemblages will be analysed in relation to key environmental factors. Microplastic counts and grain-size data will be used to examine variations across urban–rural sites and different energy environments.

Study Site

Our study sites consisted of two mangroves: The Morro do Boi (MdB) mangrove is located within the MdB community. It is roughly 37 ha in size (Presotto et al., 2020), and constitutes a brackish-estuarine environment, lying between Rio Preguiças and the Atlantic Ocean. The Atins mangrove lies 14km further down the river by the mouth, it is smaller and more marine, and borders the small Atins town to the north and west

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Acknowledgements

We gratefully acknowledge the support that made this expedition possible. Funding was provided by the Newcastle University Expedition Fund, Jeremy Wilson Trust, Harry Collinson Travel Scholarship Fund, Sonia Stonehouse Grant, and the Royal Geographical Society – Geographical Fieldwork Grants. We extend our sincere thanks to our supervisor Professor Rachel Carr for her guidance, and to Stu Hamilton, Andrea Presotto, and Ricardo Rodrigues dos Santos for their expertise and collaboration. Appreciation is also given to the Geography Department staff and technicians for their essential assistance.

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