Identificação Da Proposta

Título do projeto: Microplásticos no litoral do Paraná

Prazo de execução: 60 meses

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SUMÁRIO

Abstract

A 'clean ocean' is one of the societal outcomes expected for the UN Decade of Ocean Science for Sustainable Development (2021-2030). To achieve this, we need to be able to understand and map land and sea-based sources of pollutants. In the past decades, commercial plastic production has significantly increased and microplastics, small plastic particles within the 1 µm to 5 mm size fraction, have become a major environmental health concern. Even tough, most plastics are initially used and discarded on land, most of the plastic waste ends up in the ocean. These particles enter the marine environment through a variety of routes and interact with other chemical pollutants posing an additional threat to an already stressed environment. A significant part of these particles is retained near the coast. In these land-ocean connecting environments, microplastic pollution is particularly problematic, as they are essential habitats for several species' development. Our poor understanding regarding the sources, pathways and sinks of these particles in coastal and oceanic environments hampers our capacity to assess and manage microplastic pollution impacts. In this context, we aim to evaluate this pollutant presence and distribution in space and time at the Paraná coast, seeking to improve microplastic pollution understanding and impact management.

Key-words: pollution, coastal area, beach, South Brazil

Introduction and background

A 'clean ocean' is one of the societal outcomes expected for the UN Decade of Ocean Science for Sustainable Development (2021-2030). To achieve this, we need to be able to understand and map land and sea-based sources of pollutants. In the past decades, commercial plastic production has significantly increased and microplastics, small plastic particles within the 1 to 5,000 µm size fraction (Frias and Nash, 2019), have become a major environmental health concern. Hence, microplastics have captured widespread attention as a major global environmental issue. These particles may be grouped considering their origin as primary (intentionally manufactured within these sizes) or secondary (formed by fragmentation of larger plastics) and shapes (e.g., fibers and fragments) (GESAMP, 2015). Even tough, most plastics are initially used and discarded on land, most of the plastic waste ends up in the ocean.

In the marine environments these particles are ubiquitous, persistent and have negative impacts on the environment and biota (Andrady, 2017; Anbumani and Kakkar, 2018; Botterell et al., 2019), representing an additional stressor for marine environments. They enter the marine environment through a variety of routes, including atmospheric fallout, stormwater, and treated and untreated sewage discharges (SAPEA, 2019). Although, deep-sea sediments and marine organisms are recognized as the carriers and final destinations of microplastic, their journey often being on land. Hence, a significant part of the microplastics supplied to the marine environment is retained near the coast on beaches, wetlands, and estuaries (Zhang, 2017).

Coastal areas connect the land and ocean, naturally controlling the transfer of particles and dissolved substances between continental and marine systems. Moreover, due to their nature and strategic position between terrestrial and marine environments, these areas have been a center of attention for a variety of human activities including urban, industrial, and port developments. In these land-ocean connecting environments, microplastic pollution is particularly problematic, as they are essential habitats for several species' development. Microplastic accumulation in coastal environments, such as estuaries, is particularly problematic, once these environments are essential habitats for species development in all trophic levels (Gray et al., 2018). Given their ecologic and economic importance coastal zones have been a target of recent microplastic research (e.g., Alves and Figueiredo, 2019; Baptista Neto et al., 2019; Forero-López et al., 2021; Gray et al., 2018; Hitchcock and Mitrovic, 2019; Sruthy and Ramasamy, 2017; Zheng et al., 2019; Zuo et al., 2020). A major challenge for assessing, preventing, and mitigating microplastic pollution impacts relies on our poor knowledge regarding its presence in coastal and oceanic environments and knowledge of the long-term processes involved in the spatial and temporal distribution.

The Paraná coastal zone presents a contrast between urbanized and non-urbanized areas. Tourism activities are less intense it's in the northern portion (the Ilha do Superagui and Ilha do Mel), and more urbanized beaches further south (i.e., Matinhos and Praia de Leste). Additionally, the Paranaguá Estuarine Complex, at the central portion of the Paraná coastline, is a subtropical estuary with vast mangrove forest belts surrounded by an Atlantic Forest Reserve (Natural World Heritage Site – UNESCO, 1999). It comprises two environmental protection areas: the Guaraqueçaba Environmental Protection Area (RAMSAR site) and the Superagui National Park. However, the estuary also harbors the second largest grain port in Brazil, and the most populated city at the Paraná state coast, at Paranaguá. Recent studies reported the presence of microplastics on the Paranaguá Estuarine Complex sandy beaches (Mengatto and Nagai, submitted) and oysters hepatopancreas Vieira et al. (2021), with plastic pellets also reported at beaches located adjacent to the estuary mouth (Gorman et al., 2019; Moreira et al., 2016). Additionally, macroplastics (>2.5 cm) have also been studied at the PEC water column (Possatto et al., 2015), beaches (Krelling et al., 2017), and sea turtles Nunes et al. (2021). Yet, little is known about the presence and distribution of these particles' spatial and temporal distribution at the Paraná coastal zone. In this context, this project aims to unravel spatial and temporal distribution of these particles. By acquiring microplastic data at different beaches and at different time periods we will be able to identify potential sources of microplastics.

Objectives

This project aims to unravel spatial and temporal distribution of microplastic particles in the Paraná coastal zone. To achieve this the following goals are proposed:

i. Identify and determine the spatial distribution of microplastics in distinct beaches of the Paraná coastal zone;

ii. Identify and determine temporal changes in the distribution of microplastics in distinct beaches of the Paraná coastal zone;

iii. Identify potential sources of microplastics to the study area;

Study area

The Paraná coast has 98 km of sandy beaches interrupted by the Paranaguá Estuarine Complex and Guaratuba Bay mouths (Angulo, 1992; Lana et al., 2001) (Figure 1). The region's climate can be classified as humid temperate pluvial (Cfa), with precipitation of around 2000 mm, and averages above 22 °C (Lana et al., 2001). The tide is graduated as a semidiurnal micro-tide, with amplitudes of about 1.5 m (Marone and Jamiyanaa, 1997).

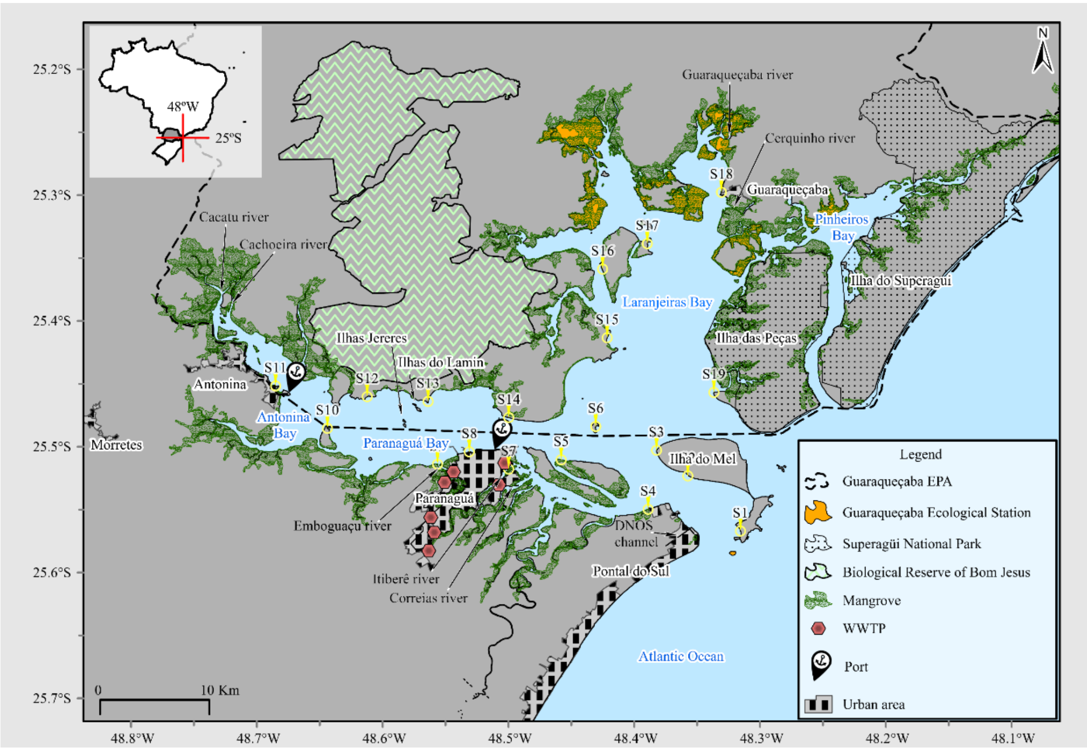


Figure 1 – Paraná coastal zone location map.

Seasonal changes in wave and wind dynamics, such as higher intensity and frequency of the atmospheric frontal systems during winter, result in beaches with intermediate morphodynamic states and sediments dominated by fine and medium sands (Angulo et al., 2016). During autumn and winter, these systems passage influence coastal and sedimentary dynamics, resulting in erosion of the emerged portion of the beach (Angulo et al., 2016; Quadros et al., 2009). In these events, sea height can reach 0.8 m above astronomical tide (Marone and Camargo, 1994).

In terms of human occupation and activities, the beaches can be classified as: urban, with active tourist activity and recreational use, beaches located in Matinhos and Pontal do Paraná; and more preserved beaches, with reduced human activity, such as the Ilha do Superagui and Ilha do Mel, which have visiting limit. Additionally, the Paranaguá Estuarine Complex harbors an Atlantic Forest Reserve (Natural World Heritage Site – UNESCO, 1999) protected by Brazilian federal law through the Guaraqueçaba Environmental Protection Area (Guaraqueçaba EPA), Guaraqueçaba Ecological Station, Superagui National Park, and Biological Reserve of Bom Jesus. In the estuary, there is also the second-largest grain port in Brazil (Paranaguá Port), and the most populated city at the Paraná state coast, Paranaguá city. Even comprising wastewater treatment plants, high concentrations of sewage indicators (chemical markers and fecal indicator bacteria) are found around Paranaguá (Cabral et al., 2018; Martins et al., 2010), representing a potential MPs source (Cole et al., 2011). Near the Paranaguá Estuarine Complex mouth, Krelling and Turra (2019) reported higher concentration of macro-waste (> 25 mm) in comparison to the rest of the coastal beaches.

Material and methods

Our sampling strategy includes acquisition of sediment samples at five distinct beaches of the Paraná coastline and still to be defined beaches located at Paranaguá Estuarine Complex in different time periods. This sampling strategy will allow us to recognize the spatial distribution of microplastics in the Paraná coastal zone and infer about temporal differences in their distribution. The spatial distribution sampling campaign will be performed once; after spatial distribution data analysis, two or three sites will be selected for temporal distribution sampling campaigns.

For coastline sediment samples will be retrieved from three distinct zones (infralittoral, high tide line, and supralittoral). For this, a 100-meter rope, marked at every 10-meters, will be used extended parallel to the water line. A total of four sampling points will be randomly picked at each beach. At inner Paranaguá Estuarine Complex beaches, following Alvarez-Zeferino et al. (2020), samples will be taken along four the high tide line. At selected sampling sites 10-meter sections of beach define the sampling points, which were randomly picked for each beach. A 10-meter rope marked at every 1-meter will be extended parallel to the high tide line to avoid sampling bias. During fieldwork, samples will be retrieved with the aid of stainless-steel cylinders (20 cm diameter and 5 cm depth), yielding approximately 1,570 cm^3 and 3 Kg of dry sediments. Samples collected will be placed in aluminum trays until processing in the lab.

In the lab, samples will be processed following Enders et al. (2021) QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe) protocols. In the lab, each sample will be oven-dried at 60 ºC for 24 hours to obtain sample weight. Samples will be subjected to flotation for microplastic extraction. For this, a saturated sodium chloride solution NaCl (ρ=1,2 $g.cm^{-3}$) and NaI (ρ=1,6 $g.cm^{-3}$) will be used. The NaCl solution will be added to the sample in a beaker glass, in a ratio of four to one volume, respectively, stirred for 2 min with an overhead mechanical stirrer, and allowed to settle for 3 minutes. The supernatant will then be filtered through a 300 µm mesh sieve and vacuum filtered with a Whatman® GF/C ~1 µm (47 mm) filter. During MP extraction, air contamination will be monitored by exposing a Petri dish with a wet glass fiber filter during sample processing. All supernatant content will be placed on Petri dishes and visually inspected with a ZEISS SteREO Discovery V8 (80x) optical stereomicroscope, and microplastic particles will be separated.

Microplastics will be classified as hard plastic fragments, foam, film, line, pellet, and paint fragment, following the morphological descriptors of the Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean (GESAMP, 2019; Gaylarde et al., 2021). Particle colors will be visually determined, considering for the multicolored particles the dominant color. Additionally, chemical composition analysis of approximately 10% of microplastic particles will be performed via RAMAN spectroscopy at the Centro de Microscopia Eletrônica (CME/UFPR).

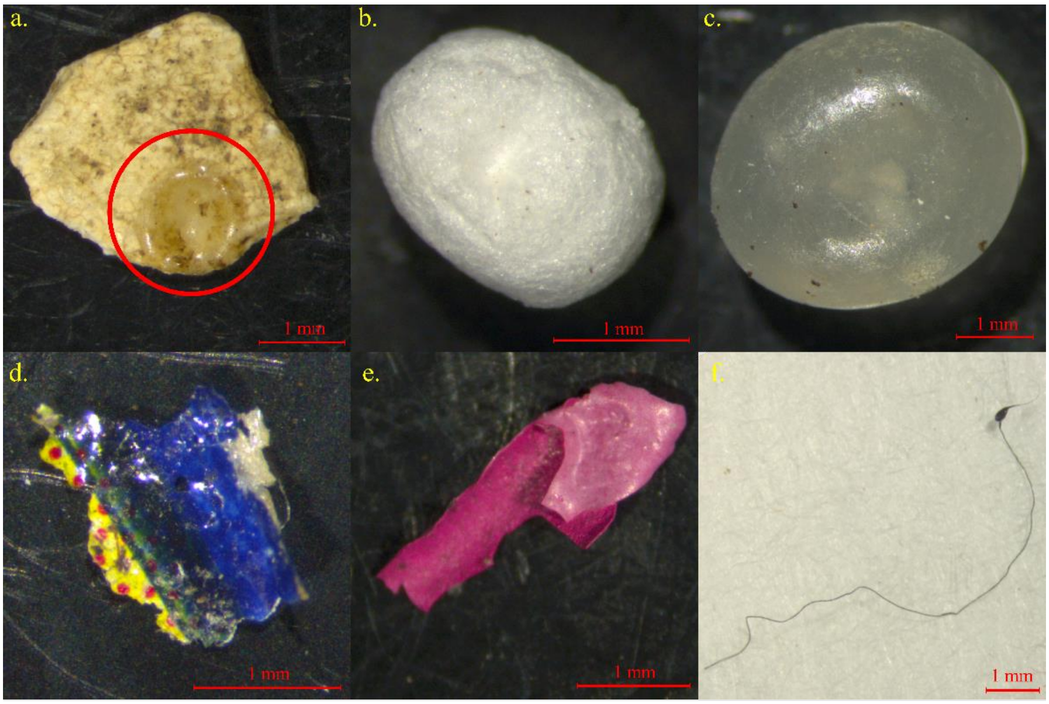


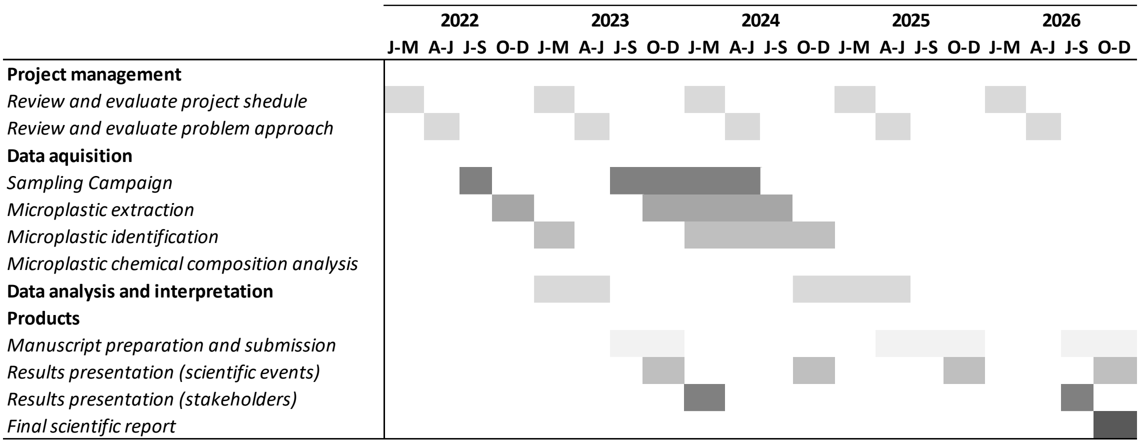
Figure 2 - Microplastic morphologies (a) “yellowing” hard plastic fragment, (b) white foam, (c) transparent pellet, (d) blue film, (e) pink paint fragment, and (f) black fiber identified at the sandy beaches within the Paranaguá Estuarine Complex. The red circle in panel (a) shows deformation from the hot needle test (source: Mengatto and Nagai, *submitted*).

Data analysis and interpretation involves producing charts and georeferenced maps, and statistical treatment of data with descriptive and multivariable statistics, which will aid the understanding of the spatial and temporal distribution of microplastics in the Paraná coastal zone. Our results will made available to specialized academic public (scientific publications and online databases) and other stakeholders (executive reports, news and media texts, infographic, workshops). The Paraná coastal zone is home to local fisherman communities, that depend directly on its natural resources for food security. Besides the community, public agents responsible for the RAMSAR site management (ICMBio agents) will also be directly impacted by our project results. Additionally, our results are also of interest of the Paraná State Government, Environmental Secretary.

Scientific party

The successful development of this project will be a result of a team group effort composed by: <u>Dr. Renata Hanae Nagai</u> (UFPR) – principal investigator; Dr. Cesar de Castro Martins (UFPR); Dr. Maikon Di Domenico (UFPR); Dr. Camila Domit (UFPR); Yan Weber Mesquita, Masters' student at Coastal and Marine Systems Graduate Program; Cecília Caroline Vieira Nunes Massignani (PIBIC/TCC - Undergraduate Course in Oceanography). Additionally, other to be defined students may be involved in this project: 03 graduate-level students (M/D – Coastal and Marine Systems Graduate Program); and 05 undergraduate level students (PIBIC/TCC – Undergraduate Course in Oceanography).

Project schedule



Available infrastructure

The project activities will be developed at the Laboratório de Paleoceanografia e Paleoclimatologia (LabPaleo^2) at the Center for Marine Studies/UFPR. Today, LabPaleo^2 has sampling and laboratory equipment and materials for the project execution. Sampling costs involve terrestrial and nautical transportation which are covered by the Center of Marine Studies/UFPR.

Results and impacts

This project results will be planned and prepared focusing on the specific stakeholders involved. As this is a research driven project, it is worth to note that this project results will be presented as academic papers and conference presentations. Our results will have the potential to improve our understanding of microplastic pollution in the Parana coastal zone. Aiming at public agents and policy makers, we will prepare an executive report with this research findings showing the baseline data of microplastic pollution and potential critical areas of microplastic accumulation areas, with recommendations for this pollutant prevention and monitoring. We hope that by raising awareness regarding this pollutant problem, public agents and state policy makers may improve these areas management. To reach local fisherman communities we plan on preparing simple and informative infographics, regarding its sources, sinks, and potential solutions to these problems. This material will also be adaptable to reach a broader community, as short media texts sent to local and regional media news. We hope that by improving local communities and the understanding of microplastic sources, risks and solutions these stakeholders will be inspired to change daily actions regarding litter disposal. Also, outreaching and communication our findings we hope to raise the general public awareness of microplastic pollution problem.

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