GLOBE VSS Research Proposal Template

Project Title:
Environmental monitoring of the Pericumã River using the GLOBE hydrosphere protocol.

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Research Question(s) and Hypothesis

Research Questions

1. How do the physicochemical parameters (pH, dissolved oxygen, nitrate, salinity, electrical conductivity) of tidal water in mangrove areas of Turiaçu/MA vary between sites with high, medium, and low levels of disordered urban occupation?
2. To what extent does the seasonal variation (rainy vs. dry periods) influence these water quality parameters in the context of anthropogenic pressure from irregular settlements?
3. What is the perceived relationship between the observed water quality and the health risks for the local population, which depends on this ecosystem for food (fishing, shellfish gathering) and livelihood?

Hypotheses

1. **H1:** Sampling points located in areas of high urban occupation (e.g., Bairro Rabelão) will show significantly more altered physicochemical parameters (e.g., lower dissolved oxygen, higher nitrate levels, altered pH) compared to points in areas of medium or low occupation, indicating a direct impact from the lack of basic sanitation.
2. **H2:** Water quality will show greater degradation (e.g., higher concentration of pollutants) during the dry season, when reduced water volume and flow lead to less dilution of domestic waste discharged directly into the mangrove.
3. **H3:** The data collected will corroborate community reports on environmental degradation and health issues, establishing a clear link between poor water quality, the contamination of collected species, and the prevalence of related diseases among residents.

Description of Study Site

1. Geographic and Administrative Context:

The study will be conducted in the municipality of **Turiaçu**, located in the western coastal region of the state of Maranhão, northeastern Brazil. According to the Brazilian Institute of Geography and Statistics (IBGE, 2023), Turiaçu has a territorial area of 2,622.281 km² and a population density of 14.30 inhabitants/km². The municipality is characterized by a significant expanse of coastal ecosystems, with a strong socioeconomic dependence on artisanal fishing and the extraction of mangrove resources.

2. Specific Location within the Mangrove Ecosystem:

The research will focus on mangrove areas subjected to disordered urban occupation within the municipality. A primary area of interest is the district of Rabelão, one of the oldest and most populous neighborhoods established within the mangrove zone.

This neighborhood, like others in similar situations (e.g., Santa Terezinha district), originated from informal settlements that expanded towards the mangrove, primarily consisting of stilt houses (*palafitas*).

3. Environmental and Social Characteristics:

- **Ecosystem:** The site consists of a typical mangrove ecosystem of the Maranhão coast, influenced by tidal dynamics (tidal flats), with soil composed of fine, waterlogged sediments rich in organic matter.
- **Urbanization Pattern:** The occupation is characterized as **disordered and irregular**. The area lacks essential urban infrastructure: there is **no basic sanitation system** (sewage collection or treatment), and domestic waste is discharged directly into the tidal channels. Many residences are stilt houses built over the mangrove soil.
- **Socioeconomic Activity:** The local population depends directly on the mangrove for subsistence and income, mainly through artisanal fishing, crabbing, and shellfish gathering (*sururu*, oysters).
- **Climate:** The region has a tropical equatorial climate with two well-defined seasons: a rainy season (approximately January to June) and a dry season (July to December). This seasonality is a crucial factor that will be considered in the sampling design, as it directly influences hydrology and pollutant dilution.

4. Justification for Site Selection and Sampling Points: Three sampling points will be strategically selected along a gradient of human impact within the mangrove area:

- **Point 1 (High Occupation):** Located within or immediately adjacent to areas of dense irregular settlement, such as the Bairro Rabelão, where the direct discharge of sewage and solid waste is most evident.
- **Point 2 (Medium Occupation):** Located in a transition zone, with some housing presence but lower density, allowing for the assessment of a moderate level of impact.

- **Point 3 (Low Occupation):** Located in a more preserved area of the mangrove, farther from major settlements, to serve as a **reference point** for comparing natural background conditions against anthropogenically altered ones.

This configuration will allow for a spatial analysis of how the intensity of disordered urban occupation correlates with alterations in the physicochemical quality of tidal water, providing concrete evidence of the local environmental impact and its implications for ecosystem health and public health.

Data Collection Plan

A. Data Types and Sources

- **Primary Environmental Data:** Physicochemical parameters of tidal water: pH, Dissolved Oxygen (OD), Nitrate (NO^{3-}), Salinity, Electrical Conductivity.
- Source: *In-situ* collection at three predefined points in the Turiaçu mangrove, classified by urban occupation density (High, Medium, Low).
- **Contextual Data:** Georeferenced location of points, photographic records of the site and settlements, visual observation of sanitation conditions and waste disposal.
- **Secondary Data:** Previous socio-environmental studies on the region, municipal demographic data (IBGE), rainfall data for the region.

B. Data Collection Schedule

- **Planning & Preparation (Mar-Apr 2026):** Final literature review, definition and georeferencing of the three collection points, acquisition and calibration of equipment.
- **Field Campaigns (May-Jul 2026):** Execution of at least two sampling rounds at each point to account for seasonal variation (end of rainy season and beginning of dry season), following the protocols described.

- **Data Analysis & Writing (May-Dec 2026):** Laboratory analysis (if kits are used in the field), statistical analysis of data, correlation with occupation levels and seasonality, and writing of the thesis chapters.

C. Equipment and Tools

- Portable pH meter (pHmetro) and calibration buffer solutions.
- Commercial test kits for Dissolved Oxygen, Nitrate, and Salinity.
- Electrical Conductivity meter.
- Basic field material: Sterile sample bottles, distilled water, beakers, pipettes, towels, GPS, camera, standardized field data sheets.
- Data analysis software: Spreadsheets (Excel/Google Sheets) for initial organization and basic statistical software (e.g., Past, R) or tests for comparative analysis.

D. Who Will Collect the Data?

- **Primary Researcher:** The undergraduate student, Leticia Alves dos Santos, will be responsible for all stages: planning, field collection, analysis with the kits/meters, data recording, and initial processing.
- **Supervision:** The advisor, Prof. Dr. João Paulo Tenório da Silva Santos, will provide methodological guidance, assist in the interpretation of results, and review the process.
- **Potential Local Collaboration:** Although not explicitly stated, engagement with local community members for site access and contextual understanding is implied and would be crucial.

Background and Supporting Information

- **Why this topic?** This topic was chosen due to the clear and pressing environmental and social problem observed in Turiaçu: the disordered growth of urban settlements within mangrove areas, directly linked to the absence of basic

sanitation. This research aims to produce scientific evidence of the impact of this occupation on water quality, an ecosystem vital for local biodiversity and the economy (fishing), addressing a gap in localized studies.

- **Related Studies/Research: The project is grounded in:**
    1. **Local Socio-Environmental Studies:** Such as Ferreira (2016), who documented the disordered growth and its impacts in the "Bairro Rabelão".
    2. **Methodology:** It applies protocols adapted from the GLOBE Program extension project, ensuring scientific rigor in data collection.
    3. **Theoretical Framework:** It dialogues with literature on mangrove conservation, urban ecology (Coêlho, 2024), water quality (Parron et al., 2011), and public policies aligned with the Sustainable Development Goals (SDGs), specifically SDG 6 (Clean Water and Sanitation) and SDG 14 (Life Below Water).
- **Relevance to the Community and Region: This research is critically relevant because:**
    1. **Public Health:** It investigates a direct threat to the health of residents who are exposed to contaminated water and consume seafood from a potentially polluted ecosystem.
    2. **Environmental Awareness:** It seeks to transform collected data into accessible information for the community, raising awareness about the consequences of irregular waste disposal.
    3. **Foundation for Public Policies:** The results aim to serve as a technical-scientific substrate to advocate for effective public policies in basic sanitation, urban planning, and mangrove conservation in Turiaçu and similar municipalities.

Expected Outcomes or Goals

General Goal

To analyze the physical-chemical characteristics of water in urban areas within the mangrove swamp, as well as to compare the results of 3 different samplings, carried out at 3 sampling points: the first sampling in a highly occupied area, the second sampling in a medium-occupied area, and finally, the third sampling in a low-occupied area.

Specific Goals

1. To gather data on the physical and chemical quality of mangrove water in urban areas.
2. To highlight the environmental impacts caused by improper occupation in mangrove areas, raising public awareness about the proper disposal of waste, as well as the harmful effects of improper disposal, emphasizing the need for more effective public policies in this area.

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