



GLOBE VSS 2026

Research Proposal: Assessing Urban Mangrove Health in Cartagena Through Biomonitoring

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Abstract

Mangrove ecosystems play an important role in coastal protection, biodiversity, and water quality. In urban coastal areas such as Cartagena, Colombia, these ecosystems are affected by pollution, land-use changes, and other human activities, which makes monitoring their condition especially important.

This research proposal is guided by the following questions: What indicators of mangrove health can be identified through biomonitoring using GLOBE protocols, bird counts, and basic microbiological analysis? and How does water quality vary among different urban mangrove sites in Cartagena under different levels of urban pressure?

The objective of this study is to assess the health of urban mangrove ecosystems in Cartagena using bioindicators. The project combines field-based scientific research with citizen science and active learning approaches involving high school and university students. Data will be collected using standardized GLOBE Biosphere and Hydrosphere protocols, complemented by bird counts as biodiversity indicators and basic microbiological water analyses. Student-collected data will be compared with existing GLOBE datasets and satellite imagery.

As this is a research proposal, we expect that mangrove sites exposed to higher urban pressure will show lower water quality, reduced biodiversity, and changes in biological indicators compared to less impacted sites. These differences are expected to reflect variations in overall ecosystem health.

This study aims to show that biomonitoring and citizen science are effective tools for evaluating urban mangrove ecosystems and for strengthening environmental awareness among students. Future research could include longer monitoring periods and additional study sites to support conservation actions and urban coastal management.

Keywords: mangrove health, biomonitoring, urban ecosystems, water quality, citizen science

Research Questions

Main Research Question and Hypothesis

Research Question

What indicators of mangrove health can be identified through biomonitoring using GLOBE protocols, bird counts, and microbiological analysis?

Hypothesis

We hypothesize that mangrove health can be assessed using a combination of GLOBE biomonitoring protocols, bird abundance and diversity, and basic microbiological water analysis. Healthier mangrove ecosystems are expected to show higher biodiversity, better water quality parameters, and more balanced microbial communities.

Secondary Research Questions and Hypotheses

Research Question 1

How does water quality vary across different urban mangrove ecosystems in Cartagena?

Hypothesis

We expect water quality parameters to vary among urban mangrove sites. Ecosystems located closer to intense urban activity are likely to show lower water quality values compared to less disturbed sites.

Research Question 2

How do urban pressures influence mangrove ecosystem conditions in the selected study sites?

Hypothesis

Mangrove ecosystems exposed to higher levels of urban pressure, such as pollution and land-use change, are expected to show reduced ecosystem quality and changes in biological indicators compared to sites with lower urban impact.

Research Question 3

What is the current health status of urban mangrove ecosystems in Cartagena based on biological and environmental indicators?

Hypothesis

We expect the health status of urban mangrove ecosystems in Cartagena to vary among sites, ranging from moderate to degraded conditions, as indicated by differences in biodiversity, water quality, and biomonitoring results.

Research Question 4

How do bioindicators reflect the impact of urban pressures on mangrove ecosystems?

Hypothesis

Bioindicators, such as bird species diversity and microbial presence, are expected to reflect the intensity of urban pressure, with lower biodiversity and changes in microbial communities in more impacted mangrove sites.

Research Question 5

How can citizen science and active learning methodologies support environmental monitoring of mangroves?

Hypothesis

We hypothesize that citizen science and active learning approaches can improve data collection processes and increase environmental awareness, supporting long-term monitoring of urban mangrove ecosystems.

Study Site



Photo: Google Earth, 2026

This study will be conducted in Cartagena de Indias, Bolívar, Colombia, a coastal city located on the Caribbean Sea. The research focuses on four urban mangrove ecosystems that are strongly influenced by human activities and urban development:

- Ciénaga de las Quintas
- Caño de Bazurto
- Laguna San Lázaro
- Chambacú

These sites are part of a coastal urban landscape where mangrove ecosystems coexist with roads, neighborhoods, markets, and other urban infrastructure. As a result, they are exposed to different levels of pollution, land-use change, and water circulation alteration.

The approximate geographic location of the study area is 10.3932° N, 75.4832° W. The region has a tropical climate, characterized by high temperatures, high humidity, and two rainfall seasons (Apr-Jul, Ago-Nov), which influences water quality and biological activity in mangrove ecosystems.

To support the analysis of these study sites, satellite imagery, maps, and land cover observations will be used alongside field data. This combination helps provide a broader understanding of the environmental context and allows comparisons among sites with different degrees of urban pressure.

Data Collection Plan

In this study, we will use GLOBE Biosphere protocols to monitor biological and ecosystem indicators, and GLOBE Hydrosphere protocols to assess water quality in urban mangrove ecosystems. Data collection will include bird counts as biodiversity indicators and basic microbiological water analyses to evaluate environmental conditions.

Field data collected by students will be complemented with existing data from the GLOBE database, as well as satellite imagery and other environmental datasets. Data will be collected during the academic research period through periodic monitoring sessions over several months.

To collect the data, we will use different tools and materials, including alkalinity, salinity, and dissolved oxygen test kits, thermometers, Secchi disks, and the GLOBE Observer app. Data collection will be carried out by student research teams, with teachers and mentors acting as facilitators and supervisors throughout the process.

Background and Supporting Information

Mangrove ecosystems are ecologically important because they provide key ecosystem services such as coastal protection, biodiversity conservation, and water quality regulation. According to Alongi (2008), mangrove forests play a crucial role in protecting coastlines and supporting diverse biological communities, especially in tropical and subtropical regions. For this reason, monitoring mangrove health is especially important in urban environments.

Urban mangrove ecosystems are increasingly affected by human activities such as pollution, land-use change, and habitat fragmentation. Several authors affirm that urbanization is one of the main drivers of mangrove degradation worldwide (Duke et al., 2007). These pressures can negatively affect water quality and biological communities, making biomonitoring a useful approach for understanding ecosystem conditions.

This research is part of a collaborative project developed with the Universidad Tecnológica de Bolívar (UTB), which focuses on the use of bioindicators and biomonitoring to assess mangrove ecosystem health. Recent investigations reveal that biological indicators and water quality parameters are effective tools for evaluating environmental impacts in aquatic ecosystems (Bonada et al., 2006). In this context, the UTB–Montessori project provides a scientific framework that supports the methodological approach of this study.

This study is highly relevant to the local community, as urban mangroves in Cartagena are directly affected by human activities. Through the GLOBE Biontessori program, the project promotes environmental awareness, citizen science, and active learning, encouraging students to engage with real environmental challenges affecting their city.

Expected Outcomes

Through this project, we hope to better understand the importance of mangrove ecosystems, birds, and microorganisms in our lives. By studying mangroves, we recognize them as key ecosystems that support biodiversity, help reduce the effects of climate change, and protect coastal areas.

This project also aims to help our community understand that urban mangrove ecosystems and their health are essential for many species and for human communities like ours. Many people are not aware of the role mangroves play in nature and in everyday life. Through environmental education and citizen science, this project encourages people to make more informed decisions to protect these ecosystems, which have often been ignored.

In addition, this study aims to contribute to environmental knowledge by supporting the monitoring of mangrove ecosystems and highlighting their importance for environmental health and human well-being. We also expect this project to encourage continued observation, conservation, and long-term monitoring efforts

Challenges and Considerations

One possible challenge in this project is maintaining consistent data collection over time due to weather conditions, access to mangrove sites, or scheduling limitations during the academic period. To address this, data collection will be planned in advance, and alternative sampling dates will be scheduled when needed.

Another challenge may be ensuring the accuracy and consistency of data collected by different student teams. This will be addressed through prior training on GLOBE protocols, the use of standardized data collection tools, and teacher and mentor supervision during field activities.

Limitations in equipment or resources may also affect data collection or microbiological analysis. To reduce these limitations, the project will rely on GLOBE-approved instruments, shared equipment, and complementary data from the GLOBE database and satellite imagery.

Globe Data Use Plan

Data collected during this project will be compared with information available in the GLOBE database, including data collected by previous Biontessori research teams between 2021 and 2025. This comparison will allow us to identify patterns and changes over time in urban mangrove ecosystems.

Additional data from the GLOBE database, such as precipitation records and satellite imagery, will be used to support data interpretation and strengthen the analysis of ecosystem conditions.

Badges

Our research group aims to obtain the following badges:

I Am an Earth System Scientist

This project studies the mangrove ecosystem by analyzing how different parts of the Earth system are connected. We combine data from the biosphere (birds and microorganisms), the hydrosphere (water quality), and land cover observations to understand mangrove ecosystem health. By using multiple GLOBE protocols and bioindicators, we explore how natural processes and human activities interact in urban coastal ecosystems.

I Work with Satellite Data

This project uses satellite imagery from the GLOBE database to support the analysis of urban mangrove ecosystems. Satellite data are used to observe land cover and environmental patterns and to compare them with field data collected by students. By combining satellite observations with ground-based measurements, we strengthen our understanding of mangrove ecosystem conditions.

I Am a Collaborator

This research project is based on collaboration between students, teachers, and external partners. High school students work alongside teachers and mentors, following GLOBE protocols. The project is developed in collaboration with the Universidad Tecnológica de Bolívar (UTB), which supports the scientific framework of the research. Teamwork and shared responsibilities make it possible to collect, analyze, and interpret environmental data.

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