Observing variations in growth of Mangroves at Roches Noires Lagoon

School name: Pamplemousses State Secondary School

Country: Mauritius island, Indian Ocean.

Educator: Mr. Avesh Rajiv Abeeluck

Student participants: Ruchika Soololl
Tanishka Khamun
Juggoo Manshika
Yukhta Woochit

Duration: 28/10/24 – 21/02/25

1 - Abstract

This study investigates one mangrove species in Roches Noires, Mauritius. The aim of the project is to collect data on mangrove growth using quadrat sampling and physical measurements of tree height and diameter, along with observations of their reproductive life cycle. Field visit was conducted around GPS points 20°06′ S and 57°43′ E, to find out density of mangroves for estimating, comparing and monitoring of expected growth. Mangroves, known to have unique viviparous method of reproduction, help them spread and establish themselves in areas where they can grow. We found that survival rates of seedlings depend mostly on tidal fluctuations among many other abiotic factors.

2 – Research Questions

1. Are Mangroves biotic or abiotic components of Roches Noires ecosystem?

2. Does a Mangrove tree grow taller on land than in water?

3. How does presence of Mangrove trees affect Wetlands of International importance in Mauritius?

4. To what extent has planting successfully enriched biodiversity of selected Lagoons?

5. What is the actual estimate of reproduction occurring naturally by seeds and their survival rates?

3 - Introduction with a review of recent literature.

Mangroves are vascular endemic plants of Mauritius. Due to massive deforestation, mangrove trees migrated during the last century from a terrestrial habitat to mostly wetlands. Only a few species, like Red mangrove and *Bruguiera gymnorrhiza*, have succeeded as mangroves in colonizing coastal areas. Where the land meets the sea, many species including shrimps, crabs, fishes and molluscs are now able to thrive without damage from waves and other water level fluctuations. It creates a unique environment filled with life of all kinds. Mangroves are also beneficial as they shelter thousands of species at all levels of its food web. Through special adaptations of roots, these plants can breathe under water and provide physical support. Mangroves have even adapted to brackish/saline water, fine grained alluvial soil and anoxic conditions among the harshest of conditions. Mangroves, that form the biotic components of Mauritian coastal lagoons separated by hundreds of metres or less, show all seven characteristics of life. For example, reproduction takes place by a process known as vivipary whereby young adults of Red mangrove (*Rhizophora mucronata*) grow while remaining attached to their parent plant. Some seedlings detach and fall as propagules from mangroves. The propagules float for a period of time before sinking to the bottom of the ocean and taking root in the mud. In Mauritius, 3 sites are declared as Wetlands of International Importance of Mauritius and one of them is the Rivulet Terre Rouge Estuary Bird Sanctuary. With a suitable growth, mangrove trees create a profession for local fishermen which contribute to economic level of Mauritius and they also provide for a source of protein in the diets of the local communities. They also play an important role in protecting shorelines by reducing wave energy and providing a buffer against storms, tsunamis or other natural marine disasters.

4 – Aims and objectives

This project aims to study how growth has taken place naturally over time in one coastal region known as Roches Noires.

The objectives are: collecting data through quadrat sampling and estimating temporal change.

- Number of plants in an area using a quadrat.
- Physical dimensions of trees using a measuring instrument.

Precautions to be taken include an adult supervision and avoiding dangerous water currents.

5 – Method of collecting data and carrying out an investigation

1. Data collection

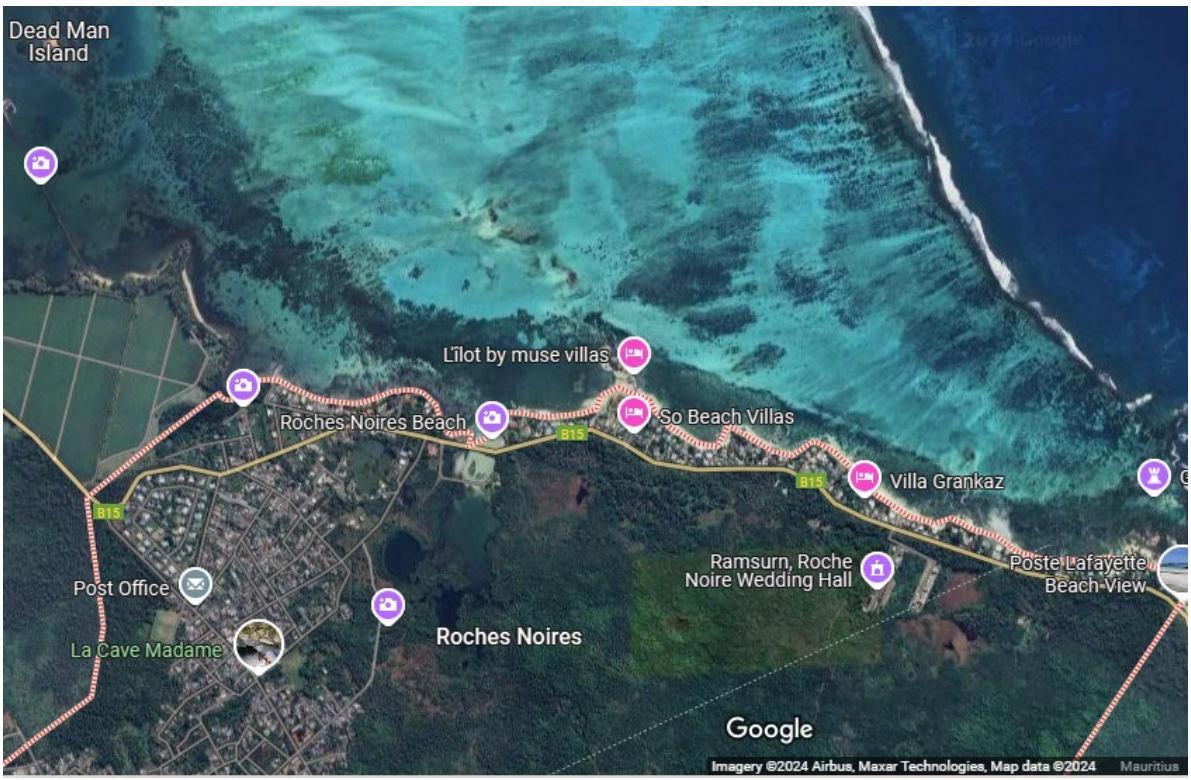


Fig. 1. Aerial view of Roches Noires Beach

Field visit was conducted in Mauritius, a hectometre around the east-north-east centred around GPS points 20°06′ S and 57°43′ E, to acquire number of mangroves for estimating, comparing and monitoring of expected growth. The site selected was Roches Noires, a relatively new area which has not yet been planted and located on the east coast of Mauritius. The site visit was conducted on the 6th of December 2024 and since the mangroves are not so dense and easy to penetrate, quadrat sampling was conducted on the landward side of the beach (refer to Fig. 1). To determine which locations were the most suitable, we walked along the path (refer to Fig. 2) and we identified rectangular plots for counting. Numbers of trees were collected using a generic mobile phone GPS with an accuracy of 5 m. Both sides were examined: eastwards of mangrove forest or seaward side and westwards of mangrove forest or landward side. Tidal level was low that day and inner mangroves could be penetrated. Between Roches Noires Beach and Roches

Noires Ganga Mandir, old mangroves grow along the shoreline of an estuary where underground water resurfaces slowly. The trees were thought to be densely interconnected and the rocky and deep-water areas made the trees difficult to access, especially along the beach not far from the public boat landing area. To monitor spatial change, square quadrats were placed randomly around mangrove trees and plants counted. To monitor growth of young adults, an approach of measuring both the height of mangrove trees using a customized rod-like metre rule and the diameter using a flexible tape was accepted to estimate their age relative to one another. More precisely, the height is defined as a measurement taken as vertically as possible along a straight line between ground level and highest leaf branching from the main stem. To monitor temporal change, however, historical data on mangrove trees was not available for this site but another site could be retrieved from GLOBE database. It is thus suggested that further data collection should be considered to include topography, density of forest, impact on coral reefs, etc. for more accurate and reliable results.

Fig. 2. Selected areas 1 to 5 spanning about 100m

2. Mangrove forest investigation.

Photographs taken by second participant during data collection in year 2024 illustrate and compare growth.

Fig. 3. Mangrove forest at Roches Noires

Fig. 4. Rooted propagule of *Rhizophora mucronata* metrics (approximately one year old)

Fig. 5. Growth of young adults

Fig. 6. Seedlings attached to parent

Fig. 7. Threaded quadrat dividing a rectangular measurable plot (Area = 1m x 1m)

6 - Data recorded in tables

Quadrat sampling

Location	Number of plants i.e. seedlings and adults			
	1st square	2nd square	3rd square	Average
Area 1 (land)	29	27	22	26.0
Area 2 (land)	42	37	34	37.7
Area 3 (land)	48	57	39	48.0
Area 4 (sea)	18	16	28	20.7
Area 5 (sea)	22	26	32	26.7

Alternative temporal monitoring

GPS coordinates of the areas 1, 2, 3, 4 and 5 / Degrees, Minutes, Seconds	Height of a tree selected at random / cm	Diameter of same selected tree / cm	Appearance of leaves (colour & relative size)
-20° 06' 17.2, 57° 43' 27.0	270	8.0	Yellowish Green 5.3cm x 2.8cm
-20° 06' 17.6, 57° 43' 27.1	110	4.5	Green 5.2cm x 2.3cm
-20° 06' 17.8, 57° 43' 27.1	90	3.7	Green 5.2cm x 2.1cm
-20° 06' 18.4, 57° 43' 27.6	460	17.0	Yellowish green 13.0cm x 6.8cm
-20° 06' 20.3, 57° 43' 27.2	495	17.0	Yellowish green 13.0cm x 7.5cm

GPS coordinates of the areas 1, 2, 3, 4 and 5 / Degrees, Minutes, Seconds	Height of a tree selected at random / cm	Diameter of same selected tree / cm	Appearance of leaves (colour & relative size)
-20° 06' 17.2, 57° 43' 27.0	150	3.0	Green 11.0cm x 2.4cm
-20° 06' 17.6, 57° 43' 27.1	240	9.5	Green 12.0cm x 6.0cm
-20° 06' 17.8, 57° 43' 27.1	280	8.0	Green 12.0cm x 6.0cm
-20° 06' 18.4, 57° 43' 27.6	310	15.2	Yellowish green 12.0cm x 5.9cm
-20° 06' 20.3, 57° 43' 27.2	375	14.8	Green 13.0cm x 6.8cm

7 – Results of experiment

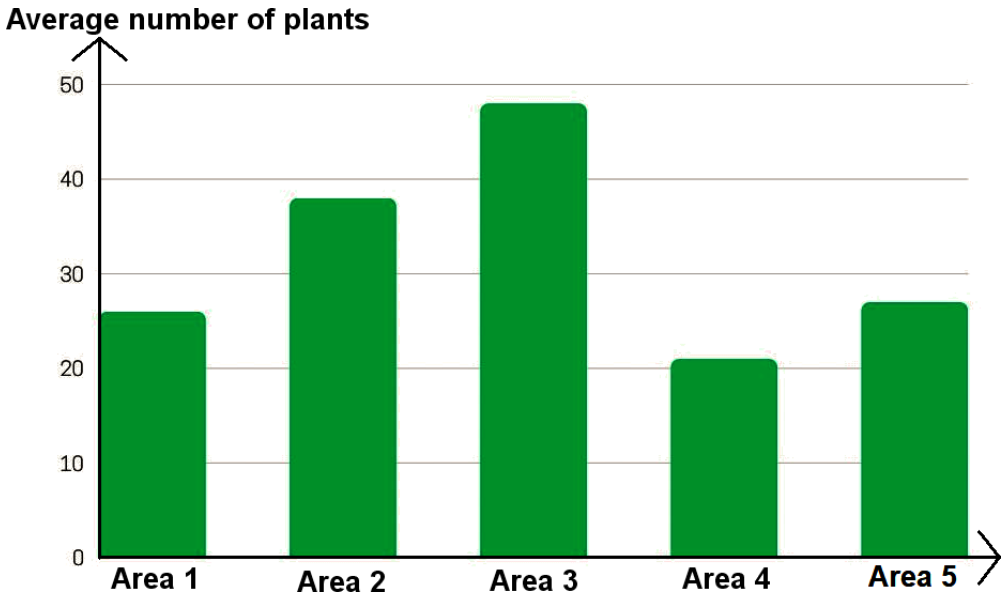


Fig. 8. Mangrove density nearly doubled moving from area 1 to area 3. Maximum of 48.0 plants/m² was found to be on the landward side while minimum of 20.7 plants/m² was found to be on the seaside. Areas 1 and 5 had almost similar density making the median density.

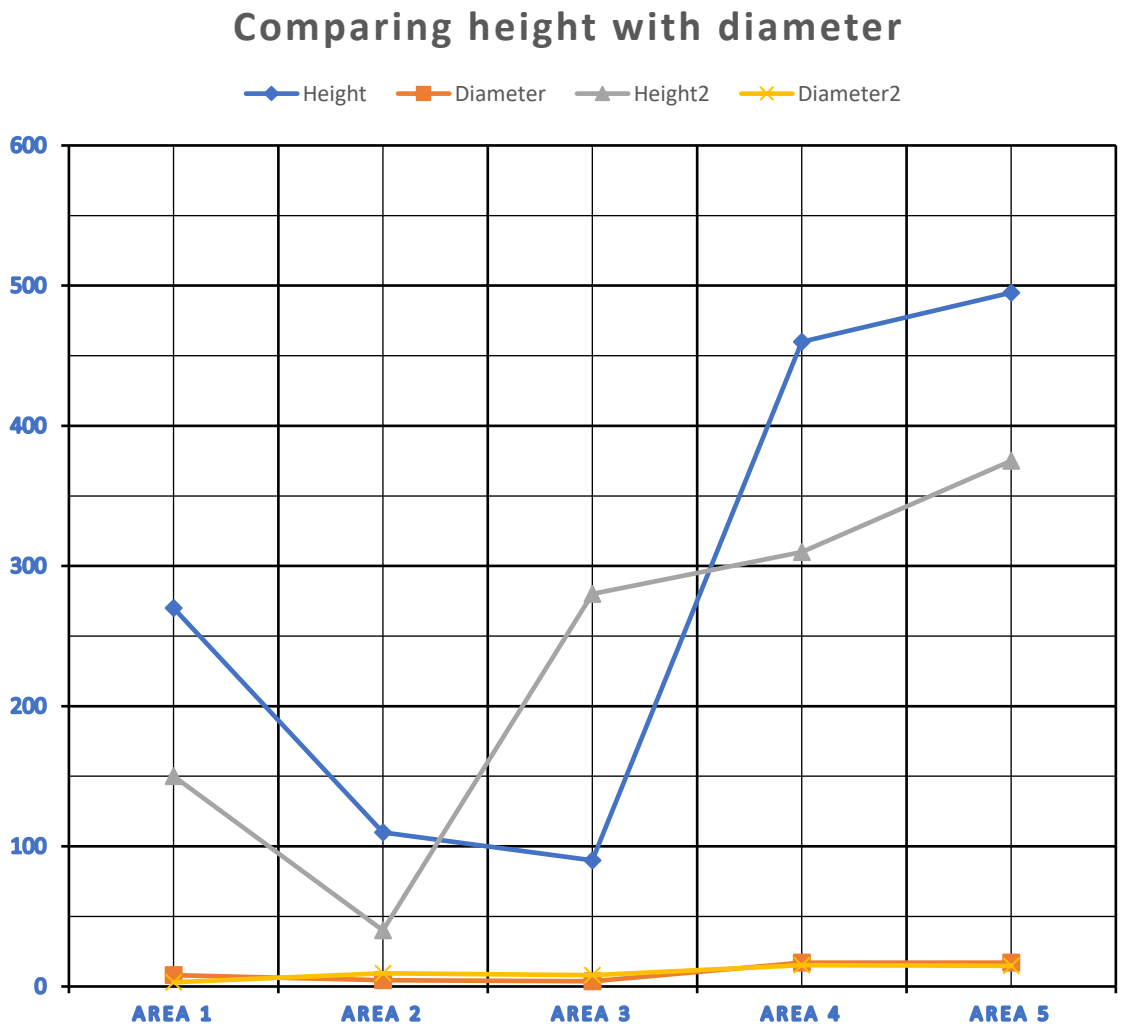


Fig. 9. Where *Rhizophora* rooted, its height increased proportionally with diameter with time.

8 – Analysis and Evaluation

The number of plants in a square metre varied between 16 to 57. To understand distribution of adult mangroves, we looked at Fig. 8 and Fig. 9 for a finer analysis:

Area 4 and area 5, which can be classified as seaward side, contained much higher trees up to 4m 95cm and were less dense allowing more light propagation. There were environmental conditions there like dissolved oxygen in water with greater availability of water and nutrients for roots to uptake. Areas 1 to 3, on the landward side draining water from its sandy soil during low tide, had shorter trees or shrubs and were denser making a canopy for young adults (less woody).

Unique viviparous reproduction in area 3 were notably highest in anchoring spreading seedlings. In comparison, the other four areas visited were exposed to crashing waves or large animals. We thus found that survival rates of seedlings would depend mostly on tidal fluctuations, among many other abiotic factors. As per the International Union for Conservation of Nature Red List, all mangrove species examined categorized under "least concern." So, these young trees did not require immediate caring.

Based on photographs taken, preservation of mangrove trees against wood logging should and would have been successfully dealt through education. According to Triest et al. (2021), mangroves cover 137000 km^2 globally and face consequences of climate change namely rise in sea level. Together, we could study coastal geology to obtain coordinates to seed mangroves to lower climate change. Further investigation would allow us to find a nearby mangrove forest, measure distance of separation and plant mangrove seedlings in-between for observing subsequent forest regeneration process. Fortunately, nobody was injured by splinters, drowned in pools of seawater nor became lost in the forest.

The National Environment and Climate Change Fund (NECCF) planned Rs2 million per year for mangroves plantation and restoration under Rehabilitation, Protection and Management of Beaches, Lagoons and Coral Reefs Programme. Mangrove degradation in Mauritius (WIOSAP) requires urgent concrete action which will be more effective with on-the-ground data analysis. Murday (1990) wanted deflection booms to be placed seaward of mangrove habitats, hence protecting these areas from oil spills.

Considering that this site has not been planted yet, information was retrieved from GLOBE database on a known location as shown in Fig. 10. Planting of mangrove had been effective and was monitored by the school of Shree Swaminarayan Academy a few years back. The link for the website is as follows:

https://vis.globe.gov/GLOBE/?site_id=256452

Site Information

Site ID	256452
Name	Alishaan seaview - Mangrove planting activities
Latitude	-4.034915°
Longitude	39.672451°
Elevation	1.0m
Location Source	other

Greening Site

Comments	The trees planted are doing well
Activated At	2022-02-08 07:32:27.462429
Has Multiple Dominants	true

Carbon Cycle Site

Comments	
Activated At	2022-02-08 07:32:27.462661
Contains Trees greater than 15cm	true
Site Shape	standard
Total Area of Site (m/sqr)	1000.0

Fig. 10. Retrieval of data stored using GLOBE Visualization System

9 – Conclusion

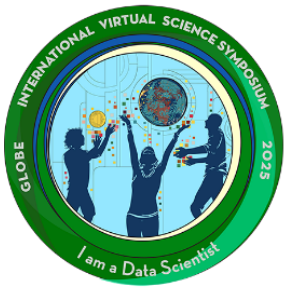
A range of 16 to 57 plants per square metre shows much variation in mangrove trees exists on the ground. Area 3 exhibited highest viviparous reproduction where seedlings grew most densely. We found, through comparison of areas, that survival rates of seedlings depend on tidal fluctuations. We also found that these young trees did not require immediate caring. It is thus suggested to:

- Collect further data.
- Promote preservation through sensitisation.
- Plan effectively future successful planting projects.

10 – Bibliography

- Murday, M. (1990). Oil Spill Contingency Plan for Mauritius, Page 89.
- True mangrove *Rhizophora mucronata* assessed in 2008 retrieved from: https://www.iucnredlist.org/species/178825/7618520
- Implementation of the Strategic Action Programme for the protection of the Western Indian Ocean (WIOSAP) published in 2021 retrieved from: https://mauritius.un.org/en/143489-implementation-strategic-action-programme-protection-western-indian-ocean-wiosap
- Triest, L. et al. (2021) Expansion of the mangrove species Rhizophora mucronata in the Western Indian Ocean launched contrasting genetic patterns. Sci Rep 11, 4987.
- Meeting the challenges to climate change adaptation: an NGO community-based successful projects in Mauritius by Anoradha Chacowry in GeoJournal (2023).
- Expert practical knowledge acquired in 2024 from Mr. Sooreadeo Khamun, Senior Technical Assistant, Marine Science department, University of Mauritius.
- Public Sector Investment Programme 2021/22 – 2025/26 retrieved from: https://www.mauritiusbudget.com/wp-content/uploads/2022/02/2021_22PSIP.pdf

Highlight Badge for 2025 IVSS Theme



I AM A DATA SCIENTIST
The report includes in-depth analysis of data downloaded from the GLOBE database as well as the students' own data sources, if new data was collected. Students discuss limitations of these data; make inferences about past, present or future events; or use data to answer questions or solve problems in the represented system.

Note: To be entered into the Earth Day stipend drawing the "I am a Data Scientist" badge must be met, in addition to at least one of the Optional Badges listed below.

Required Components

Data Table(s)

- Provide data tables that contain all data retrieved from the GLOBE database and any student collected data. Raw data (all data retrieved from the GLOBE database prior to any cleaning of the data) should be included as a separate page labeled "Appendix" for review.
- Data tables should be organized, be labeled with headings/titles/units, and clearly communicate the data collected as part of the project.

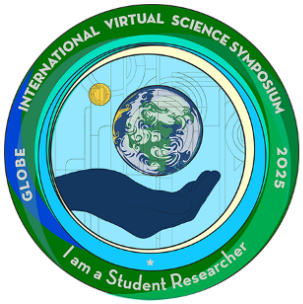
Analysis

- Graphs are present, correctly constructed, and appropriate to the type of data collected.
- Appropriate statistical/mathematical analysis is provided and carried out correctly.
- Results of statistical/mathematical analysis are clearly communicated. This can also be displayed in the form of a clearly labeled table.
- Where appropriate, qualitative data and observations are complete and thorough.

Discussion of Analysis and Conclusion

- A narrative describing the data and analysis should be included. All claims based on the data should be referenced to the data included in the project.
- Summarize trends observed in the data and discuss any statistical analysis and tests that were conducted.
- Compare your results with published and/or expected results.
- Discuss any problem areas of the data presented, and discuss how the issues surrounding the data could be addressed.
- Include proposals for future research.

Even with a large sample of data, our conclusion could be wrong. For another location or another point in time, be it past or future, the difference in number of plants between the two sides might be completely different.



I AM A STUDENT RESEARCHER

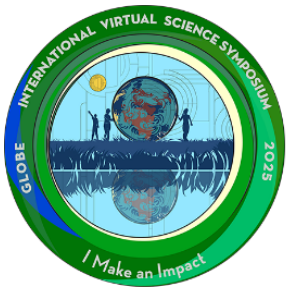
All students who submit a report to the IVSS receive an "I am a Student Researcher" badge. As such, students can earn up to four badges total.

For this project, we would like to point out that our research about variations in growth of Red Mangroves shows that there are more of those plants growing on landward side than growing on seaward side.

I AM A PROBLEM SOLVER

While working on environmental investigations, students may learn how they can be part of possible solutions to the problems they are investigating. This badge will be awarded to reports that demonstrate how GLOBE students are using Earth system science for a better world.

With the help of the GLOBE database, we have been able to collect data that we could not collect at Roches Noires.



I MAKE AN IMPACT

The report clearly describes how a local issue led to the research questions or makes connections between local and global impacts. The students need to clearly describe or show how the research contributed to a positive impact on their community through making recommendations or taking action based on findings.

It is recommended to encourage the public in protecting shorelines e.g. through sensitising people about the importance of mangrove ecosystem. We would be taking part in future investigations and planting projects.