Assessment of Blue Carbon Ecosystem (Seagrass) around the island of Mauritius

Component 2: Blue Carbon Storage Capacity in Seagrasses

Report

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1.0 Introduction

Seagrasses are flowering plants (angiosperms) that are adapted to live entirely submerged in the marine environment. There are about 60 species of seagrasses worldwide and 13 species are known to occur in the Western Indian Ocean (Gullstrom et al. 2002). They often grow forming extensive meadows which can be monospecific (single species) or multispecific where more than one species of seagrass can co-exist. They are situated in shallow areas of the lagoon up to 20 meters or deeper if environmental conditions permit photosynthesis. Seagrass beds play key ecological roles in marine and estuarine environment. They procure important ecological services such as maintaining the populations of commercially exploited fisheries by providing nursery and feeding grounds for juveniles to complete their life cycle or provide a safe haven from larger predators (Jackson et al. 2001). They also serve as a valuable direct food source to a myriad of organisms and support high biodiversity. They also act as stabilizing agents in coastal sedimentation and erosion processes and as a natural filter for pollutants and nutrients. Seagrass has strong linkages with coral reefs and mangroves forming one of the most productive coastal habitat. Seagrass can play a critical role in buffering the effects of ocean acidification on adjacent coral reefs (Anthony et al. 2011)

Seagrass ecosystems have been recently acknowledged for their blue carbon potential. Blue carbon, is a recent concept used to refer to organic carbon stored in coastal and marine ecosystems. Mangroves, salt marshes and seagrass beds possess enormous potential to capture, store and release carbon (The Nature Conservancy, 2018). These blue carbon ecosystems are considered important natural carbon sink sources. They absorb carbon dioxide from the atmosphere and the ocean for the process of photosynthesis, but not only, they can sequester and store carbon for a long time in the underlying sediments (McKenzie and Unsworth, 2009). Marine sediments are often anoxic and accumulate sediment vertically where organic carbon can be preserved over significantly long time scales (Kennedy et al. 2010). In a study by Kennedy et al. (2010), carbon burial by seagrass meadows has been estimated to be between 48 to 112 Tg yr- 1 making seagrass beds a hotspot for carbon sequestration.

Unfortunately, seagrass beds are globally being impacted by multiple anthropogenic stressors from coastal development, nutrient enrichment, sediment runoff, physical disturbance, commercial fishing practices, invasive species, diseases, aquaculture, algal blooms and global warming (Duarte, 2002; Short et al. 2014). The result of seagrass loss worldwide is leading to a loss of associated ecosystem services, which makes it a contributing factor to the degradation of the ocean's health (Waycott et al. 2009). Reported seagrass losses on a global scale, have led to increased awareness of the need for seagrass protection, monitoring, management, and rehabilitation or restoration.

Seagrass restoration refers to returning a seagrass bed to a pre-existing condition in terms of same species composition, distribution, abundance, and ecosystem function while seagrass rehabilitation implies returning seagrass beds to an area where seagrass previously existed but not necessarily with the same species composition, abundance or equivalent ecosystem function (Seddon, 2004). Escalating loss in seagrass beds reported worldwide and recognizing the importance of seagrass ecosystem in the coastal zone; scientists and resource managers are investigating ways to protect existing seagrass beds while restoring degraded ones. Restoration/rehabilitation of seagrass beds has been recognized as a means to accelerate the recovery of seagrass beds within reasonable timeframes in an area which has been widely studied (Wear, 2006). Greiner et al. (2013) also showed with evidence that seagrass habitat restoration enhances carbon sequestration in the coastal zone.

In Mauritius, the main pressure on seagrass emanates from tourism development in region where seagrass beds are cleared out for a more appealing lagoon to the tourists (ESA report, 2009; Daby, 2003). The seagrass meadows distribution has been receding since the advent of coastal development and intensification of the tourism industry in Mauritius. On the other hand, overfishing and anthropogenic activities also affect the seagrass beds via mechanical destruction and pollutant inputs. In 2000, the Albion Fisheries Research Centre conducted a study on seagrass distribution and species composition at two sites around Mauritius; Albion and Pointe aux Canonniers. The purpose of the survey was to have a preliminary understanding of the status of seagrass in Mauritius and to build up a baseline reference on the species distribution and composition for the establishment of a long term monitoring plan with the objective to improve the management of the coastal zone of Mauritius. The dominant species identified in Albion was *Halodule uninervis* followed by *Halophile stipulacea*, *Halophila ovalis*, and *Syringodium isoetifolium* while *Syringodium isoetifolium* was predominant at Pointe aux Canonniers followed by *Thalassodendron ciliatum*, *Halophila ovalis*, *Halodule uninervis*, and small patches of *Halophile stipulacea.* The total seagrass cover at Albion was 20,890 m^2 over a total surveyed area of 72,000 m^2 while at Pointe aux Canonniers, the total seagrass cover was 1,252 m^2 out of 2,500 m^2 surveyed, (Paupiah et al., 2000).

Despite the study survey conducted on seagrass, there is a current lack of knowledge on seagrass species composition, density distribution and a knowledge gap on the efficiency of seagrass beds to act a natural carbon sink in Mauritius. Monitoring seagrass beds represent a valuable tool to help and improve coastal management practices and allow to identify environmental problem before any further damage or loss, areas that require conservation measures, understand natural or man-made variations in seagrass resources, and develop benchmarks against which performance and effectiveness can be measured. The purpose of the project is to investigate the current status of seagrasses around the coast of Mauritius and to determine their carbon sink potential to further enabling the develop of management strategies, to formulate policies gearing towards conservation and rehabilitation of seagrass ecosystems in Mauritius and to generate blue carbon credit.

2.0 AIMS AND OBJECTIVES

2.1 Aim

To determine the carbon sink potential in seagrass meadows around Mauritius in a view to develop management strategies and policies gearing towards the conservation and rehabilitation of seagrass ecosystems in Mauritius through the generation of blue carbon credit

2.2 Objectives

a) Carry out sediment coring at five specific seagrass meadow sites around Mauritius for organic carbon content determination.

b) Pre-treatment of sediment cores for C_{org} and %C/ C, %N/ N isotopes

c) Treatment of sediment samples for C_{org} and %C/ C, %N/ N isotopes

d) Analysis of sediment samples for C_{org} and %C/ C, %N/ N isotopes

e) Determination of carbon sequestration in seagrass meadows

3.0 METHODOLOGY

<u>Mauritius</u>

3.1 Site Selection

The sites were selected based on previous mapping and ground truthing carried out in Component 1: "*Seagrass assessment around the Island*" and on their area of significance (location, area, species composition and activities disturbance). The five sites were as follows:

Table 1: Surveyed sites, % seagrass species composition and area coverage

Site	Seagrass Cover Area (Ha)	Species Composition	% Ratio (*Si:Hu*)	Location	Disturbance
Mont Choisy	~ 77	*Syringodium isoetifolium / Haludule uninervis*	95:5	North	Boat mooring, in front of hotel, touristic sea activities
Poste La Fayette	~ 45	*Syringodium isoetifolium / Halodule uninervis*	95:5	East	Kite surfing, public beach
Le Morne	~ 180	Syringodium *isoetifolium / Haludule uninervis*	95:5	South-West	Kite surfing, public beach
Albion	~ 18	*Syringodium isoetifolium / Haludule uninervis*	40:60	West	Fishing activities, boat mooring and public beach
Banc d'Olive **(Control)**	~ 165	*Syringodium isoetifolium / Haludule uninervis*	95:5	South	Remote, near reef, fishing activities

3.2 Sediment Coring

Triplicate sediment cores were collected using a 1 m PVC corer at the selected site. Compression calculated and the core removed and brought to the laboratory for processing. The work was carried out during low tide for ease of removal of the core afterwards. The coring process carried out are shown in the photos below.








TOLSEN


3.3 Laboratory Processing

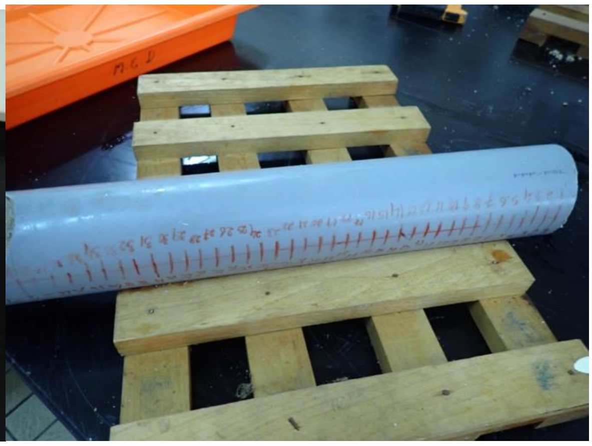
The cores obtained on field were measured and the length of sediment obtained from the 1 m corer for each site are given in Table 2 below:

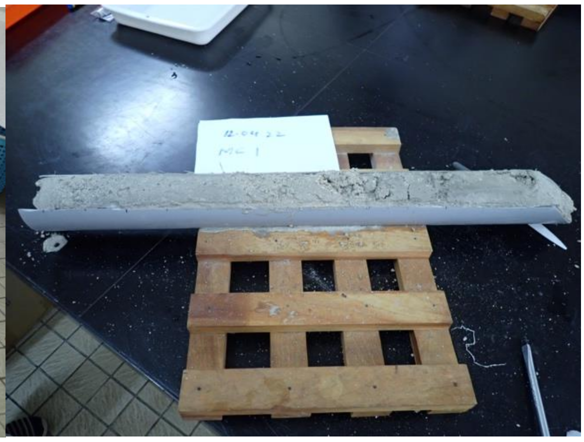
Table 2: Substrate core length and sediment type

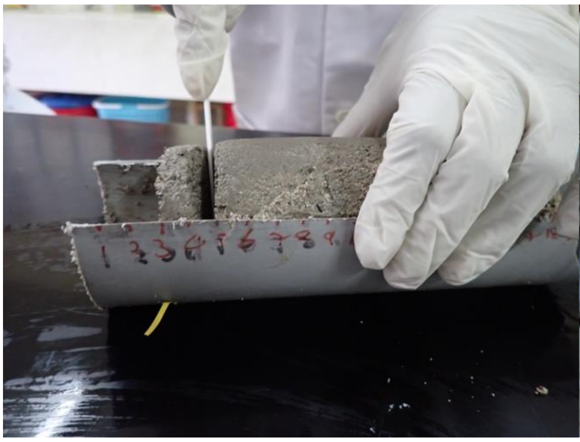
Site	**Core Code**	**Core length (cm)**	**No of 5 cm samples**	**Remarks**
Mont Choisy	MC 1	45	9	Fine sandy substrate
	MC 2	55	11	
	MC 3	60	12	
Poste La Fayette	PF 1	45	9	Coarse substrate with hard bottom after around 50 cm
	PF 2	45	9	
	PF 3	55	11	
Le Morne	LMM 1	30	6	Rubbles with hard plateau after around 30 cm
	LMM 2	25	5	
	LMM 3	40	8	
Albion	AL 1	55	11	Fine sandy substrate
	AL 2	52	10	
	AL 2	60	12	
Banc d'Olive	BO 1	50	10	Coarse substrate with hard rubbles after around 40 cm
	BO 2	45	9	
	BO 3	45	9	
Ferney	FBU 1	30	6	Muddy and fibrous with rocks
	FBU 2	70	14	
Le Morne	LM 1	45	9	Coarse substrate with hard rubbles
	LM 3	30	6	
Total number of Samples			**176**	

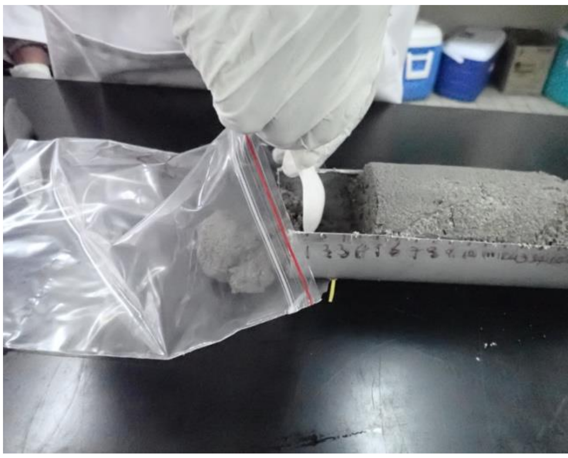
The sediment cores were measured, labelled and the PVC pipes were cut along the length and the core sliced using a ceramic knife at 5 cm after calculation of the compression factor. Each 5 cm carefully removed using a plastic spoon and placed in a labelled sampling bag as shown in the photos below.


Poste la Fayette
11.04.2022
SG 4 = PF









3.4 Sediment Pre-Treatment

The 176 samples were wet weighted, and oven dried at 60°C for 3 to 5 days until constant dry weight was obtained. Each sample were then crushed using a mortar and pestle to obtain a fine and homogenous sediment. The samples were kept in well labeled sampling bags until transferred to centrifuge tubes for transportation to Australia for analysis. The process of pre-treatment is shown in the photos below.

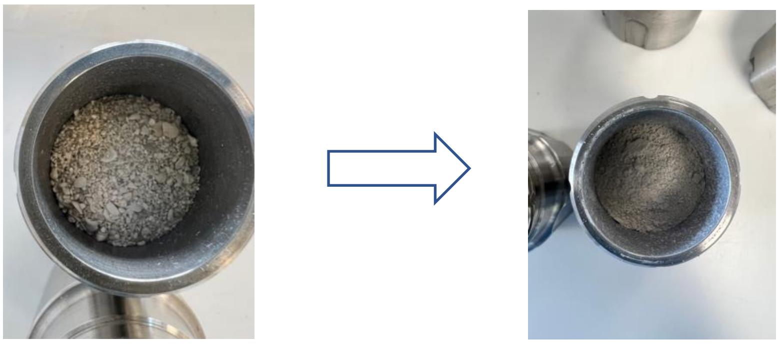
Australia

3.5 Samples Export

5 g of each 176 samples were securely placed in a 50 ml centrifuge tubes, packed and sent to Queensland through FEDEX to quarantine for gamma-irradiation. The samples were then posted back to CSIRO Lab for further processing and analysis.

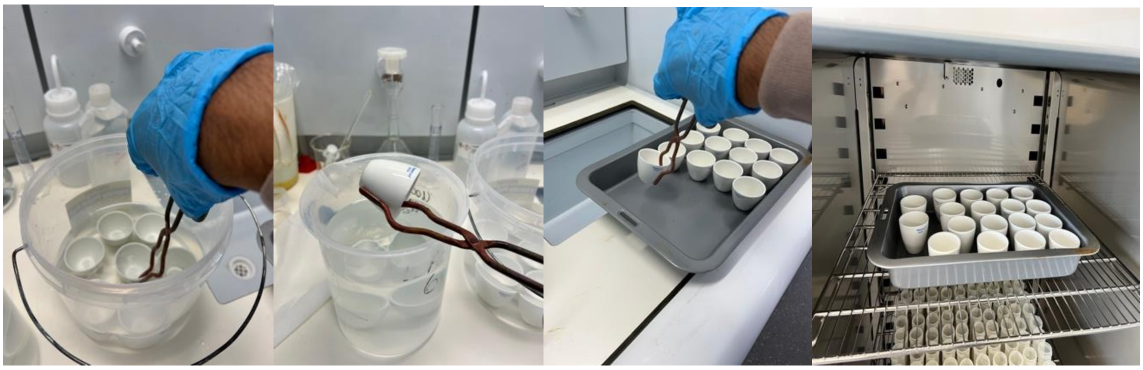
3.6 Sediment Grinding

The 176 sediments were oven dried at 60^{o}C for 24 hours and then grinded for 20 min to fine powder form using a Mixer Oscillating Mill MM 400.



3.6 Loss on Ignition (Total Organic Content)

4 g of each sediment samples were weighted and placed in a weighted marble crucible. The crucible with the samples were then weighted and placed for 4 hours in a Rapid Interval Furnace at 550°C. The crucibles with the samples, after cooling, were re-weighted and the loss in weight was recorded which represents the organic carbon present in the sediment. The experiment was repeated 10 times to complete the 176 samples after the crucibles were acid washed and allowed to dry in an oven at 60 °C overnight after each 18 samples were processed.



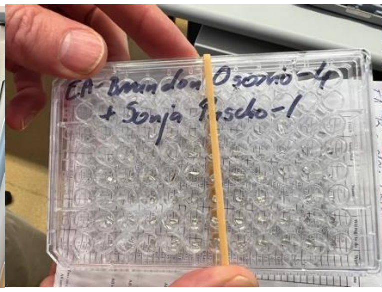
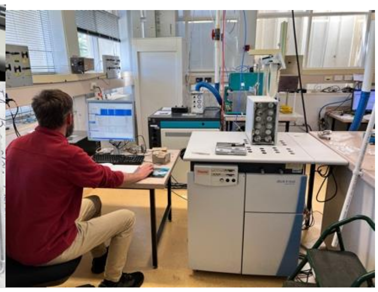
3.6 Elemental Analysis

3.6.1 Non-Acidified (Total Organic Carbon and Nitrogen) & Acidified (Total Inorganic Carbon)

2 g of the 176 powdered sediment were weighted and put into an Eppendorf for Total Organic Carbon and Nitrogen content analysis in an Elemental Analyzer. The samples were kept in the oven at 60^{o}C until sent to the Western Australia Biogeochemistry Centre for analysis. For the Inorganic Carbon content, 2 g of powered sediment was weighted from the stock sediments into a 50 ml centrifuge tube. 4% HCL was prepared and used to digest the organic content in the sediment overnight. Following the digestion process, the sample were centrifuged at 6000 rpm for 15 min to allow the non-digested sediment to settle at the bottom of the tube so to be able to discard the acid. The samples were washed with milli-Q water and centrifuged again. The process was repeated twice, and the water carefully discarded. The samples were then allowed to dry at 60^{o}C for two days before weighing to know the total weight of organic carbon digested from the sediment by the acid. The samples were then sent to the Western Australia Biogeochemistry Centre for analysis.



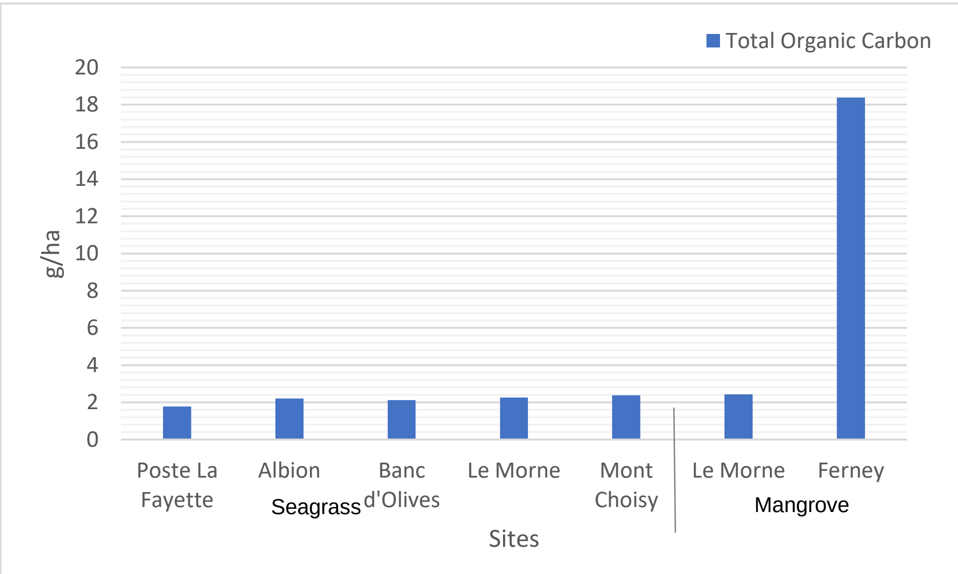


4.0 RESULTS

4.1 LOI - Total Organic Carbon

The highest Total Organic Carbon (TOC) was recorded in the seagrass meadow at Mont Choisy site with 2.37 g/Ha while for mangrove, (*B. gymnorhiza*), Ferney recorded the highest TOC with 18.37 g/Ha. The results from the Elemental Analysis are still being awaited from the Western Australia Biogeochemistry Centre.



5.0 CONCLUSION

This first study will help in determining the blue carbon capacity of the seagrass meadows in Mauritius and will also help in drafting policies and management strategies to protect and conserve these species in the future. Furthermore, this will be a first step towards the generating a blue carbon credit offset for Mauritius, hence generating money for Mauritius through its Blue Economy strategy.