Study of Microplastic Contamination in Soil, Seawater, Seagrass, and Carbon Sequestration in Soil and Seagrass at Pak Khlong Beach and Mod Tanoi Beach, Trang Province

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Abstract

This research examined microplastics in soil, water, and seagrass, focusing on their quantity, size, shape, and color in the above-ground and below-ground parts of seagrass, alongside carbon sequestration. Conducted at Pak Khlong and Mod Tanoi Beaches, the study found two seagrass species at Pak Khlong Beach (*Thalassia hemprichii* and *Cymodocea serrulata*) and one at Mod Tanoi Beach (*Thalassia hemprichii*). Results revealed that the above-ground part of Thalassia hemprichii at Mod Tanoi Beach contained the highest amount of microplastics, primarily long black particles from fishing-related waste. Soil had the highest microplastic concentration, followed by seagrass and water. The study also showed that the below-ground part of seagrass sequestered more carbon than the above-ground part, with Pak Khlong Beach exhibiting higher carbon sequestration and fewer microplastics than Mod Tanoi Beach, likely due to Mod Tanoi's higher population density.

Keywords: Seagrass, Microplastics, Carbon Sequestration Capacity

Introduction

Over the past thirty years, seagrass has been steadily declining. Since 1930, seagrass has been degraded worldwide. Recent surveys estimate that up to 7% of seagrass is being lost each year – the equivalent of a football field every 30 minutes. Seagrass meadows are crucial for carbon sequestration and marine biodiversity, providing food for species like dugongs and sea turtles. A 2023 survey by the Department of Marine and Coastal Resources found seagrasses in Trang province to be in fair to moderate condition, with species such as Zostera, Thalassia, and Syringodium. However, microplastic accumulation in water and sediment poses a threat to seagrasses. Microplastics are non-biodegradable, absorb pollutants, and may harm the food chain. Seagrasses stabilize soil and store carbon, making them more efficient than forests in carbon sequestration, helping mitigate global warming.

Given the decline in seagrass abundance in Trang, this research aims to compare microplastic levels and carbon storage at Pak Khlong Beach (a restricted area) and Mod Tanoi Beach (a community area with fishing). The study will explore the relationship between microplastic concentration and carbon sequestration to inform conservation efforts and raise awareness of plastic pollution in coastal areas.

Research Question:

1. Are there differences in microplastics in the soil and water at Pak Khlong Beach and Mod Tanoi Beach?

2. Are there differences in the quantity, size, shape, and color of microplastics in the above-ground and below-ground parts of the same and different species of seagrass?

3. Are there differences in the quantity, size, shape, and color of microplastics in the above-ground and below-ground parts of the same species of seagrass at Pak Khlong Beach and Mod Tanoi Beach?

4. Do the above-ground and below-ground parts of seagrass have different carbon sequestration capacities?

5. Do seagrasses at Pak Khlong Beach and Mod Tanoi Beach have different carbon sequestration capacities?

Objectives:

1. To study the amount of microplastics in different soil and water.

2. To study the amount of microplastics, size, shape and color of seagrass above the ground and the underground part.

3. To compare the amount of microplastics, size, shape and color of seagrass the above-ground part and the underground part are different.

4. To study the amount of carbon storage of seagrass above the ground and underground.

5. To compare the carbon capture capacity of the same type of seagrass, different species and different areas.

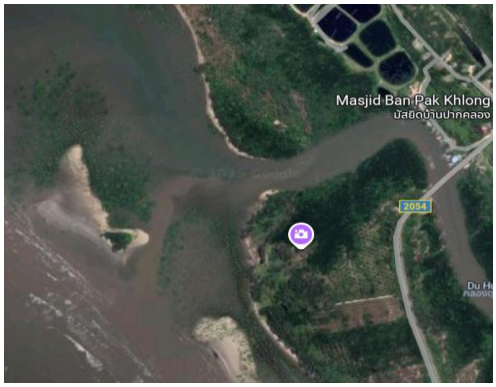
Materials

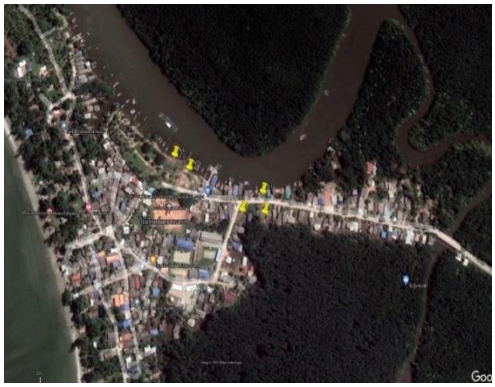
1. 50x50 cm Population Counting Frame
2. Aluminum Foil
3. Planting Spoon
4. 300 Micrometer Filter Cloth
5. Plastic Bags
6. 20 Micrometer Filter Cloth
7. Mesh Screens (5 mm and 1 mm)
8. Gloves
9. 1000 ml and 500 ml Beakers
10. Vacuum Pump

Methods

1) Study sites

This study was conducted at two locations: Pak Khlong, Bo Hin Subdistrict, Sikao District, Trang (Latitude: 7.5922°, Longitude: 99.2895°), and Mod Tanoi Beach, Ko Libong Subdistrict, Kantang District, Trang (Latitude: 7.3076°, Longitude: 99.4221°), as shown in Figure 1.





Pak Khlong beach

Mod Tanoi beach

Figure 1 : Shows the study sites

2) Data collection

2.1) Soil Quality Data Collection

1. Soil samples (600g) are collected from five random locations (5 cm depth).
2. Analyzed for pH, nitrogen, phosphorus, potassium, organic matter, and moisture.

2.2) Water Quality Data Collection

1. Water samples from three points are tested for pH, dissolved oxygen, and salinity.
2. Additional samples are collected for microplastic analysis.

2.3) Microplastic Study in Soil

1. Soil is sieved, dried, and weighed.
2. WPO digestion and filtration are done.
3. Microplastics are observed under a microscope.

2.4) Microplastic Study in Water

1. Water samples are collected with a manta net and filtered.
2. WPO digestion and filtration are done.
3. Microplastics are observed after drying.

2.5) Microplastic Study in Water

1. 30 seagrass samples are collected.
2. Seagrass is cut, rinsed, and digested for microplastic extraction.
3. Microplastics are filtered and observed.

2.6) Seagrass Morphology Preparation

1. Seagrass is stained and observed under a microscope.

2.7) Data Analysis

1. Mean and standard deviation are calculated.
2. Water quality is compared using a t-test.
3. Microplastics are analyzed using Two-way ANOVA.

2.8) Carbon Sequestration Calculation

1. Seagrass is collected, dried, and weighed.
2. Carbon content is calculated based on organic carbon percentage.

Results

Chapter 1: Microplastic Study Results

1.1 Water Quality Study

The study found similar pH and salinity levels at Pak Khlong and Mod Tanoi Beaches, but the dissolved oxygen (DO) was higher at Pak Khlong, as shown in Figures 2, 3, and 4.

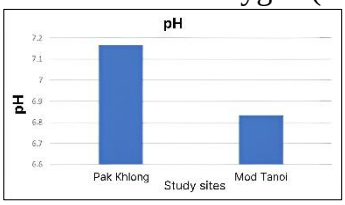


Figure 2 : The chart show pH

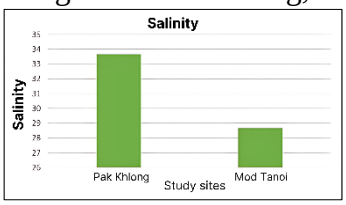


Figure 3 : The chart show salinity

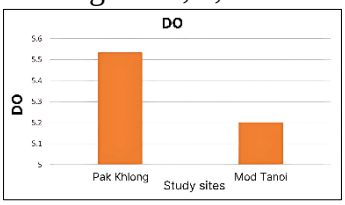


Figure 4 : The chart show DO

1.2 Microplastic Study in Water

The microplastic study found no significant difference in levels between Pak Khlong and Mod Tanoi Beaches. The highest concentration was at Mod Tanoi Beach, as shown in Table 1.

Study sites	Microplastic Quantity per 300 mL of Water (Pieces)		
	1mm-300µm	300-20 µm	Total
Pak Khlong	2 ± 0	2.667 ± 0.577	4.667 ± 0.577
Mod Tanoi	3.333 ± 0.577	3.333 ± 0.577	6.667 ± 0.577

Table 1: Microplastic Quantity per 30 mL of Water (Pieces) in Two Study Areas, $p > 0.05$

1.2.1 Study of Microplastic Shape and Color in Water

The study found two microplastic shapes in both areas: fibers, which were more abundant than fragments, and black microplastics, the most common color in both areas, as shown in Figures 5 and 6.

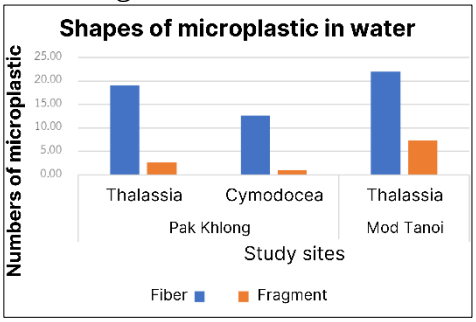


Figure 5 : Shows the shape of microplastics

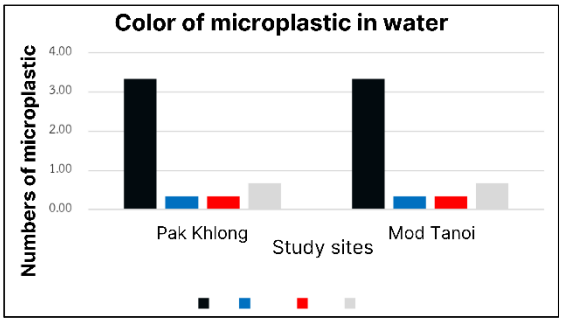


Figure 6 : Shows the color of microplastics

1.3 Microplastic Study in Seagrass

The study found a significant difference in microplastic levels between seagrass at Pak Khlong and Mod Tanoi Beaches. The highest concentration and largest microplastics were found in the above-ground seagrass at Mod Tanoi Beach, as shown in Table 2.

Study sites	Type of seagrass	Microplastic Quantity in 30 grams of Seagrass		
		1mm-300µm	300-20µm	Total
Pak Khlong	Above-ground Thalassia seagrass	11.333 ± 0.577	7.333 ± 0.577	18.667 ± 0.577
	Below-ground Thalassia seagrass	7.333 ± 0.577	5.333 ± 0.577	12.667 ± 0.577
	Above-ground Cymodocea seagrass	8 ± 1	5.333 ± 0.577	13.333 ± 1.528
	Below-ground Cymodocea seagrass	5.333 ± 0.577	3.667 ± 0.577	9 ± 1
Mod Tanoi	Above-ground Thalassia seagrass	12.333 ± 1.528	8 ± 1	20.333 ± 1.528
	Below-ground Thalassia seagrass	9.333 ± 0.577	6 ± 1	15.333 ± 1.155

Table 2: Microplastic Quantity in 30 Grams of Seagrass

1.3.1. Study of Microplastic Shape and Color in Seagrass

The study found two microplastic shapes (fibers and fragments) in both seagrass and manatee grass, with fibers more abundant. Black microplastics were the most common in both species, both above-ground and below-ground, as shown in Figures 7 and 8.

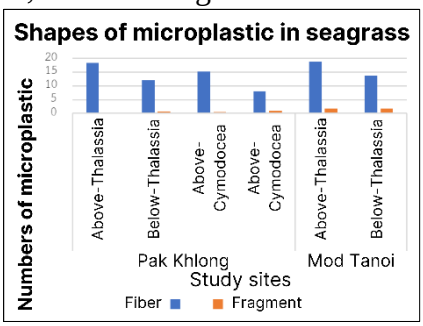


Figure 7 : Shows the shape of microplastics

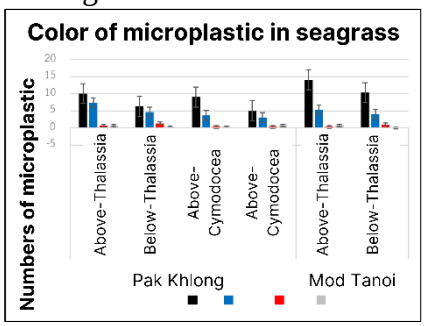


Figure 8 : Shows the color of microplastics

1.4 Microplastic Study in Soil

The study found significant differences in microplastic levels between the soils at Pak Khlong and Mod Tanoi Beaches. The highest concentration was in the seagrass soil at Mod Tanoi Beach, followed by Pak Khlong Beach's seagrass and manatee grass soils, as shown in Table 3.

Study sites	Seagrass	>5mm	5mm-1mm	1mm-300µm	300-20µm	Total
Pak Khlong	Thalassia Seagrass	2.67 ± 0.57	4.33 ± 0.57	6.33 ± 0.57	8.33 ± 0.57	21.67 ± 1.52
	Cymodocea Seagrass	1.67 ± 0.57	2.33 ± 0.57	4.33 ± 0.57	5 ± 1	13.33 ± 0.57
Mod Tanoi	Thalassia Seagrass	3.33 ± 0.57	5.67 ± 0.57	9 ± 1	11.33 ± 0.57	29.33 ± 2.08

Table 3: Show the Quantity of Microplastics in Soil

1.4.1. Study of the Shape and Color of Microplastics in Soil

The study of the shape and color of microplastics in soil found two shapes in both areas: fibers and fragments. Fibers were found to be more abundant than fragments in both areas, as shown in Figure 9. Regarding the color of the microplastics, black microplastics were found to be the most common in both areas, as shown in Figure 10.

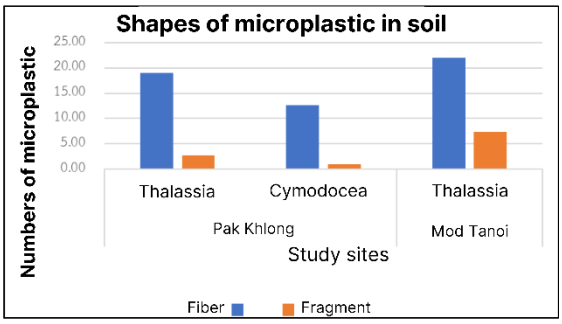


Figure 9 : Shows the shape of microplastics

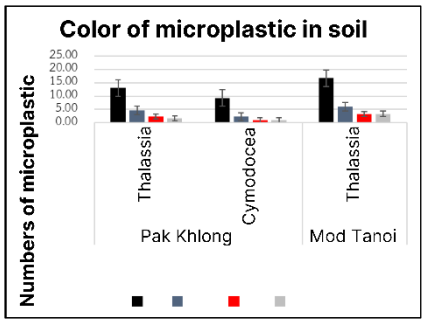


Figure 10 : Shows the color of microplastics

1.5 Study of Seagrass Morphology

Figure 11 : Thalassia leaf

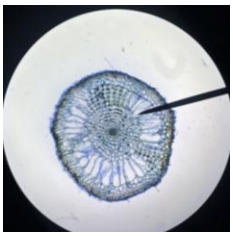


Figure 12 : Thalassia root

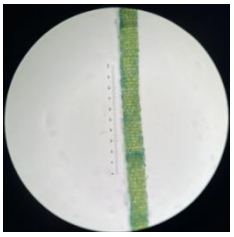


Figure 13 : Cymodocea leaf

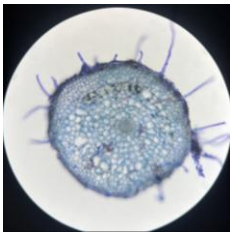


Figure 14 : Cymodocea root

Chapter 2: Carbon Sequestration Study

2.1 Study of Soil Nutrients and Carbon Sequestration in Seagrass Areas

The study found significant differences in soil nutrients and carbon sequestration between seagrass areas at Pak Khlong and Mod Tanoi Beaches. The soil in the Cymodocea grass area had high phosphorus and potassium levels, while both beaches had high potassium levels. Cymodocea grass at Pak Khlong Beach stored the most carbon, followed by seagrass at

Pak Khlong, with the least carbon sequestration at Mod Tanoi Beach, as shown in Tables 4 and 5.

Study sites	Seagrass	N	P	K
Pak Khlong	Thalassia	Trace	High	Medium
	Cymodocea	Low	High	High
Mod Tanoi	Thalassia	Low	Low	High

Table 4: Nutrient Levels in Soil of the Two Study Areas

Study sites	Seagrass	Dry weight		%OC	Sample site	Sample	Carbon (MGC/ha)		
		Above	Below				Above	Below	Total
Pak Khlong	Thalassia	9.5	3.34	0.82	Pak Khlong	Thalassia	0.06	0.09	0.15
	Cymodocea	7.12	24.06	0.3		Cymodocea	0.13	0.41	0.54
Mod Tanoi	Thalassia	1.2	1.22	0.11	Mod Tanoi	Thalassia	0.01	0.04	0.05

Table 5: Carbon Sequestration in Seagrass

Chapter 3: Study of the Relationship Between Carbon Sequestration and Microplastic Levels

3.1 Study of the Relationship Between Carbon Sequestration and Microplastic Levels in Seagrass and Soil

The relationship between carbon sequestration and microplastic levels in seagrass and soil shows an inverse correlation. Higher microplastic levels in seagrass and soil result in lower carbon sequestration. For example, the above-ground seagrass at Mod Tanoi Beach had the highest microplastic levels but the lowest carbon sequestration, as shown in Tables 6 and 7.

Study sites	Seagrass	Carbon Sequestration (MGC/ha)	Numbers of microplastic
Pak Khlong	Above-Thalassia	0.06	18.667 ± 0.577
	Below-Thalassia	0.09	12.667 ± 0.577
	Above-Cymodocea	0.13	13.333 ± 1.528
	Below-Cymodocea	0.41	9 ± 1
Mod Tanoi	Above-Thalassia	0.01	20.333 ± 1.528
	Below-Thalassia	0.04	15.333 ± 1.155

Table 6: Relationship Between Carbon Sequestration and Microplastic Levels in Seagrass

Study sites	Soil in seagrass areas	N	P	K	Carbon Sequestration (MGC/ha)	Numbers of microplastic
Pak Khlong	Thalassia	Trace	High	Medium	0.15	21.67 ± 1.52
	Cymodocea	Low	High	High	0.54	13.33 ± 0.57
Mod Tanoi	Thalassia	Low	Low	High	0.05	29.33 ± 2.08

Table 7: Relationship Between Carbon Sequestration and Microplastic Levels in Soil

Discussion and Conclusions

Microplastic levels in water at Pak Khlong and Mod Tanoi Beaches were similar due to their shared geographical features. However, soil microplastic concentrations differed significantly, with Mod Tanoi Beach showing the highest levels, particularly around Thalassia seagrass. This is due to Thalassia's longer leaves and filaments that trap more microplastics. Microplastic levels were higher in the above-ground parts of seagrasses than in the underground parts, with Thalassia having higher concentrations than Cymodocea. Most microplastics were filamentous and black, likely from fishing nets.

Regarding carbon sequestration, seagrasses stored more carbon in their below-ground parts due to higher organic matter content. Higher microplastic levels in the soil were linked to lower carbon sequestration. Thalassia at Mod Tanoi Beach, with the highest microplastic concentration, had the lowest carbon storage, while Cymodocea at Pak Khlong Beach, with lower microplastic levels, had the highest carbon storage. This reflects Mod Tanoi's community and fishing activities versus Pak Khlong's enclosed, low-waste environment.

Acknowledgements

We would like to express our gratitude to Bor Hin Farmstay, the Pak Khlong Community Enterprise, and the Mod Tanoi Community Enterprise for their kind support in providing both the location and facilities for sample collection and data gathering related to this research. We would also like to thank the administration and teachers of Princess Chulabhorn Science High School Trang, especially Mrs. Pacharee Chaipetch, our project advisor, as well as the parents who supported this research project.

Citations

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GLOBE's databases

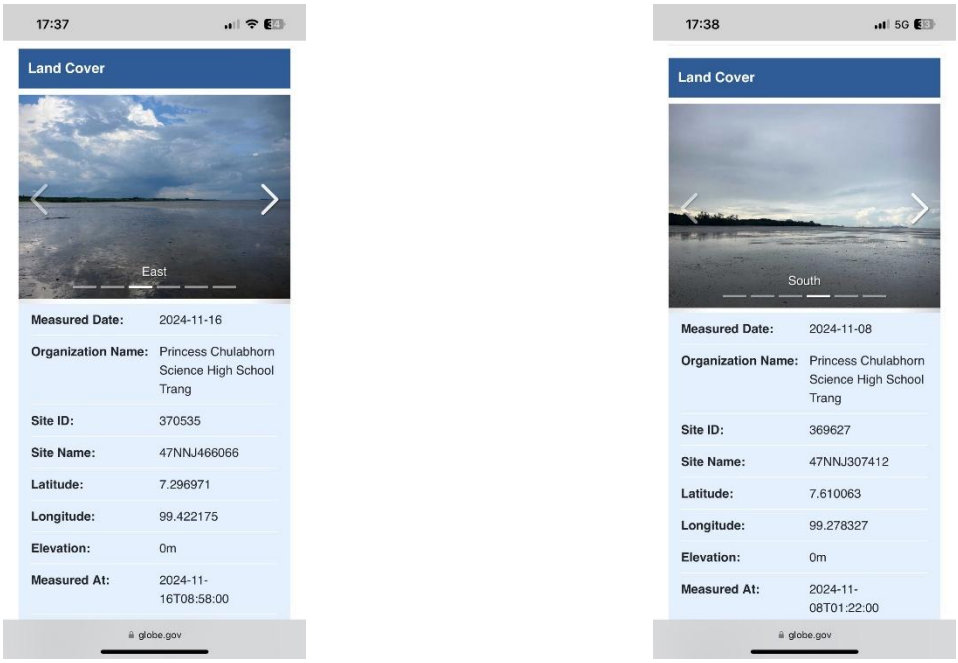

Figure 15 : Send Land Cover information

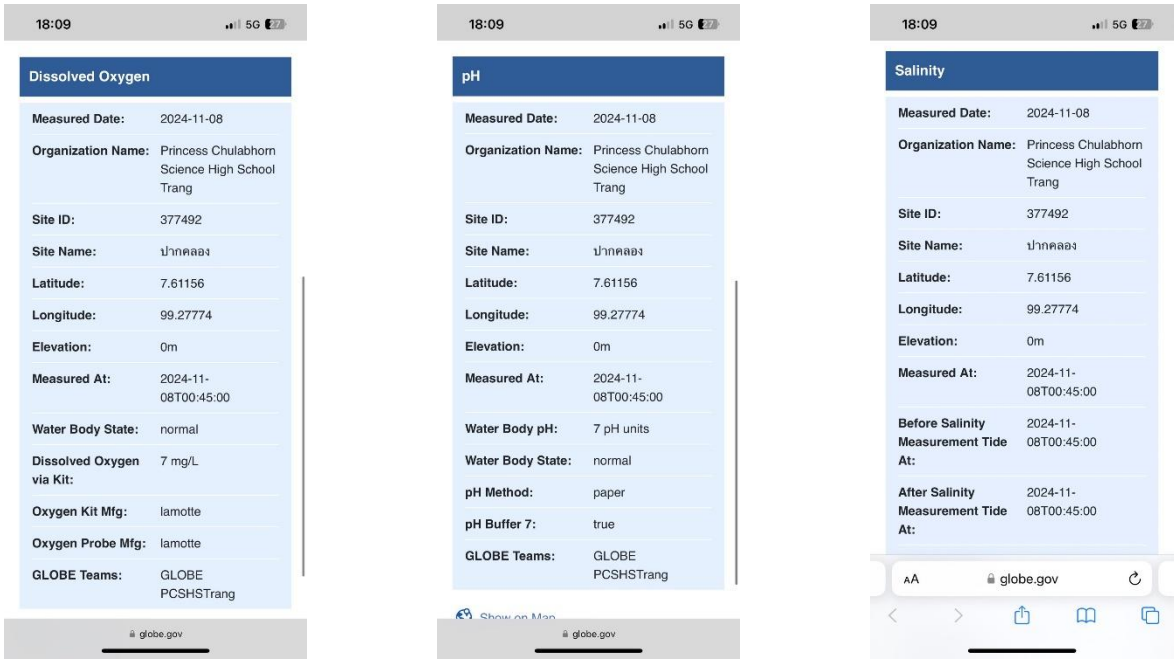

Figure 16 : Send Water Quality information into the data entry

Badges

I am a Problem solver: Our research into microplastics and carbon sequestration in seagrass helps address pressing issues like pollution and climate change. By linking scientific findings to practical solutions, we aim to raise awareness and guide conservation efforts. This sign will recognise the importance of using science to solve real-world problems and inspire more research to protect our environment.

I am a Data Scientist: Our research investigates the impact of microplastics on carbon sequestration in seagrass. By comparing sites with different human activities, such as Pak Khlong Beach and Mod Tanoi Beach, I analyze how microplastic concentration affects

seagrass health and carbon storage. The aim is to inform conservation efforts and raise awareness about plastic pollution's impact on coastal ecosystems.

I am a Collaborator: This research demonstrates the power of collaboration across schools and institutions, combining diverse expertise to address critical environmental issues. By analyzing the impact of microplastics on seagrass and carbon sequestration, our team has contributed valuable insights that can inform global conservation efforts. The teamwork and national collaboration have strengthened the research, making it more impactful and relevant to addressing global environmental challenges.