The development of floating devices to absorb oil spills at sea.

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Abstract

This research began with a study of water quality data at Mod Tanoi Beach, Kantang District, Trang Province, from 2017 to the present. The study found that the average water temperature has increased, pH levels have decreased, dissolved oxygen (DO) levels have declined, while salinity levels have remained constant. These changes may be due to the discharge of untreated household wastewater into the water source by local residents, as well as a high volume of marine transportation in the area.The research team conducted field studies on water quality at two locations: the Mod Tanoi Beach community and the area behind Mod Tanoi Beach, Kantang District, Trang Province. Water quality parameters collected included temperature, pH, DO, and salinity. The results indicated that water quality in the community area was below standard, with a significant presence of oil slicks in the water.To address this issue, researchers designed and developed a floating oil-absorbing device to remove oil spills. The float structure is made of rust-resistant coated steel, measuring 1.3 meters in width, 1.5 meters in length, and 0.93 meters in height. The oil absorption tank is a box made from HDPE, equipped with an external oil slick sensor beneath the box. Inside the box, there are additional sensors for detecting oil slicks, measuring pH levels, and monitoring temperature. The device operates using solar panel energy.Testing results showed that the absorption efficiency of the filter ranged between 10.92 to 12.05 times its weight. Water quality tests of the treated water from the device revealed that the temperature ranged between 28.9 – 29.3°C, pH levels between 7.0 – 7.4, DO levels between 4.7 – 5.1 mg/L, and salinity between 31 – 33 ppt. These values fall within the standard limits for safe discharge into the sea.In conclusion, the floating oil-absorbing device effectively absorbs oil spills and can be used to help reduce marine oil pollution. Additionally, the device utilizes natural materials for oil absorption.

Keywords: Floating oil-absorbing device; Marine oil spill; Chrysopogon zizanioides; Water quality

Introduction

A field study was conducted in the front beach area (near the community) and the back beach area in Kantang District, Trang Province. The results showed that oil slicks were present in the front beach area due to transportation, maritime activities, and oil spills at sea. When these floating oil slicks react with oxygen, they reduce the dissolved oxygen levels in the water, blocking the photosynthesis of phytoplankton, algae, and aquatic plants. This alters the decomposition process of bacteria in the water, negatively impacting marine life in the area, such as fish, benthic organisms, corals, and water birds. Furthermore, it leads to the accumulation of toxic substances in the food chain, affecting organisms from primary producers to the final consumer—humans.

There are several existing methods for removing oil slicks, but they often come with environmental drawbacks. For example, chemical dispersants break down oil slicks into smaller particles that sink to the ocean floor, causing long-term ecological damage. The burning of oil is a fast method but leads to air pollution. The use of booms and skimmers is popular but may be limited by equipment constraints and the potential for oil leakage. A highly promising approach is the use of natural materials for oil absorption, as they effectively absorb oil, degrade naturally, and do not introduce toxic chemicals into the environment.

Chrysopogon zizanioides (Vetiver grass) has physical characteristics suitable for oil absorption. Its tiny hairs create spaces that trap oil while repelling water. The lightweight nature of the flowers enhances their ability to remain on the water's surface and efficiently absorb different types of oil pollutants. Moreover, vetiver grass is considered an unwanted weed by farmers due to its invasive nature and economic damage to crops.

Based on these findings, the research team proposed the development of a floating oil-absorbing device incorporating vetiver grass. The device consists of a rust-resistant coated steel frame measuring 1.3 meters in width, 1.5 meters in length, and 0.9 meters in height, with plastic floats attached to the lower frame. The oil-absorbing tank, made of HDPE plastic, measures 37.5 cm in width, 52 cm in length, and 38.5 cm in height. The tank is equipped with an oil slick detection sensor beneath it, while the interior contains a filter bag filled with vetiver grass, a high-pressure pump to create a vortex, an oil detection sensor, a pH sensor, and a temperature sensor.

The floating oil-absorbing device activates when the sensor detects an oil slick. The first pump draws in water with oil contamination until it reaches 20 liters, at which point a float switch stops its operation. The second high-pressure pump then creates a vortex flow to allow the filter to absorb oil for five minutes. If no oil is detected in the tank and the pH and temperature remain within standard ranges, a solenoid valve releases the treated water back into the sea. The device is powered by solar panels attached to the float.

Once the prototype is built, it will be tested in seawater to evaluate its efficiency. Water quality will be measured before and after passing through the device, and the results will be used to improve and refine the design. The research team hopes that this floating device will effectively absorb oil spills in the ocean and help reduce environmental pollution.

Research questions

1) How does the water quality in the Ban Mod Tanoi community area compare to that in the back beach area of Ban Mod Tanoi, Kantang District, Trang Province?

2) Can the floating oil-absorbing device effectively absorb oil spills in the sea? If so, how?

3) How does the water quality differ before and after passing through the floating oil-absorbing device?

Research hypotheses

1) The water quality in the Ban Mod Tanoi community area and the back beach area of Ban Mod Tanoi, Kantang District, Trang Province, is different.

2) The floating oil-absorbing device that was developed can absorb oil spills in the sea.

3) The water quality before and after passing through the floating oil-absorbing device is different.

Materials

1) Desho glass Flower
2) 3 Relay Modules
3) HDPE Plastic Box
4) 1 Panel of Breadboard
5) 60 W 18 V Solar Panel
6) Arduino Nano V 3.0 Board (1 unit)
7) 12 V Water Pump
8) 1/2 Inch Solenoid Valve
9) 12 V 8 Ah Dry Battery
10) 12 V Float Switch for Pump
11) DC Submersible Pump DCP-002
12) Oil Sensor
13) Two 17.5*120 cm Floating Buoys
14) Temperature Sensor
15) Solar-Powered Battery Charging Controller
16) pH Sensor
17) Arduino Nano V 3.0 Board (1 unit)
18) pH meter
19) Thermometer
20) DO meter
21) Salinity Refractometer

Methods

1) Study sites

The researchers conducted field studies at two locations: the Mod Tanoi Beach Community, located at latitude 7.3067648°N and longitude 99.4171529°E, and the area behind Mod Tanoi Beach, located at latitude 7.609159°N and longitude 99.27742°E, in Koh Libong Subdistrict, Kantang District, Trang Province, as shown in Figure 1.

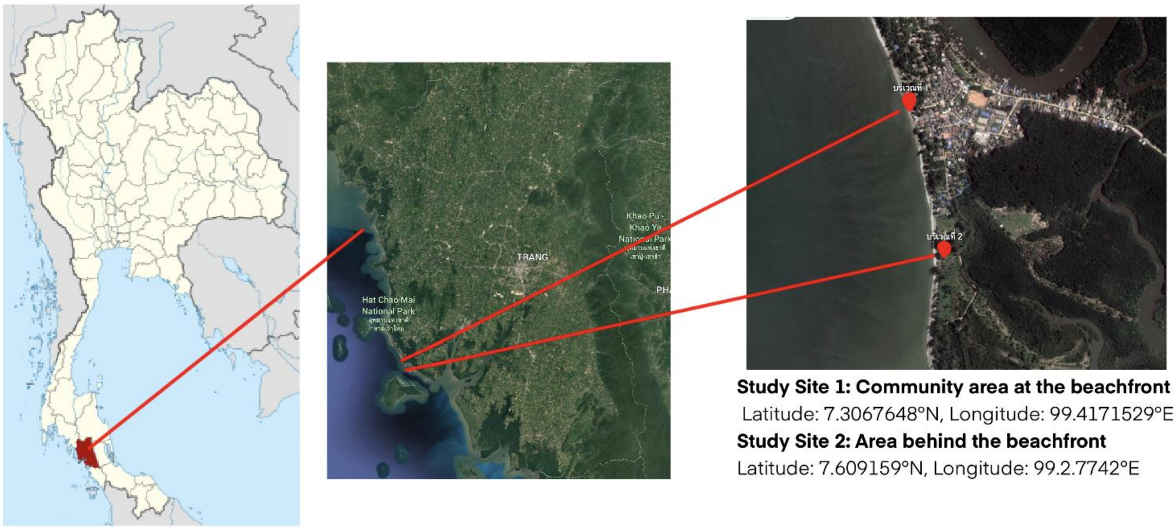

Figure 1 shows the study locations at Mod Tanoi Beach, Kantang District, Trang Province.

2.2) Water Quality Data Collection

The research team conducted water quality measurements according to the GLOBE methodology by measuring temperature, pH, DO (dissolved oxygen), and salinity at two study locations as follows:

1.2.1 A thermometer was immersed in the water to a depth of approximately 10 cm for 3-5 minutes. The temperature was then read at eye level and recorded. The measurement was repeated 3 times.

1.2.2 A pH meter was immersed in the water, ensuring the pH bulb was submerged. The pH reading was recorded and repeated 3 times.

1.2.3 A DO meter was immersed in the water, and the DO reading was recorded. The measurement was repeated 3 times.

1.2.4 Salinity: 2-3 drops of water were placed on a Salinity Refractometer, and the salinity reading was recorded. The measurement was repeated 3 times.

1.2.5 The temperature, pH, DO, and salinity readings were entered into the GLOBE Data Entry system.

2.3) Design and Creation of the Floating Oil-Absorbing Device

Based on the findings of crude oil contamination in the water around the Mod Tanoi Beach community area in Kantang District, Trang Province, the research team decided to design a floating oil-absorbing device. The team created an initial design and consulted experts from Rajamangala University of Technology Srivijaya, Trang, to refine the design. After incorporating suggestions, the final design was created, and the floating oil-absorbing device was built.

2.4) Testing the Performance of the Floating Oil-Absorbing Device

2.4.1 The oil absorption capacity was calculated using the formula:

$$\text{Oil absorption capacity} = \frac{(Weight\ of\ Filter\ after\ Filtering - Weight\ of\ Filter\ before\ Filtering)}{Weight\ of\ Filter\ before\ Filtering}$$

2.4.2 Water Quality After Filtering: Temperature, pH, DO, and salinity were measured after the water passed through the device.

2.5) Data Analysis

2.5.1 Analysis of temperature, pH, DO, and salinity using averages and standard deviations.

2.5.2 Comparison of water quality (temperature, pH, DO, and salinity) at the two study sites using a t-test at a significance level of 0.05.

Research Results

Part 1: Study of Water Quality at the Mod Tanoi Community Beach Area and the Back Beach Area of Mod Tanoi, Kantang District, Trang Province.

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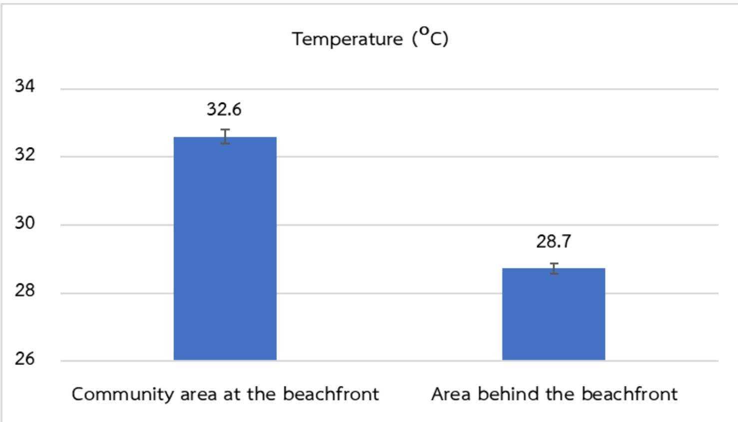


Figure 2 shows the water temperature at the study locations

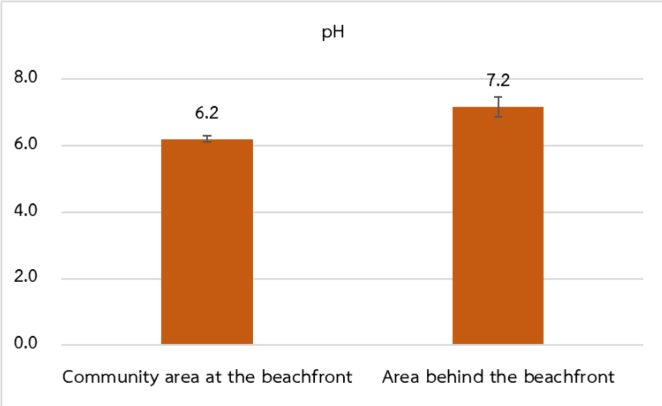


Figure 3 shows the pH of the water at the study locations.

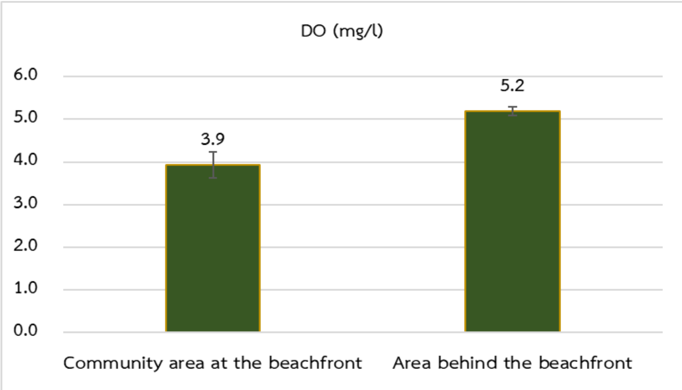


Figure 4 shows the DO of the water at the study locations.

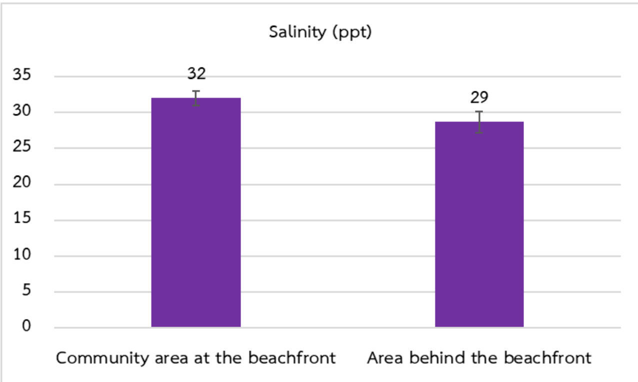


Figure 5 shows the Salinity of the water at the study locations.

The study of water quality at the Mod Tanoi Beach community area and the back beach area of Mod Tanoi, Kantang District, Trang Province, which included measurements of temperature, pH, DO, and salinity, revealed that the water temperature in the community area (front beach) was higher than in the back beach area. The community area had a lower pH value, which was acidic, compared to the back beach area. The DO value in the community area was lower than in the back beach area, and it was below the standard threshold of 5 mg/L. Additionally, the salinity in the community area was higher than in the back beach area.

Furthermore, the researchers discovered oil slicks in the community area due to marine transportation activities.

Part 2: Design and Construction of the Floating Oil-Absorbing Device

The designed floating oil-absorbing device has a structure made of rust-resistant steel to enhance its strength. It has dimensions of 1.5 meters in width, 1.3 meters in length, and 0.9 meters in height, providing sufficient space to accommodate the entire system and ensuring it remains stable while floating. The systems are contained within a box-shaped body made of High-Density Polyethylene (HDPE), which is resistant to the corrosion of seawater and lightweight.The device is equipped with an oil spill detection sensor under the box, and a 12V water pump is attached to the side of the box. Inside the box, there is a pressure pump, float switch, oil spill sensor, temperature sensor, and pH sensor. Additionally, a solar panel is installed on top of the float to provide energy for the device. The design layout of the floating oil-absorbing device is as shown in Figures 6-8.

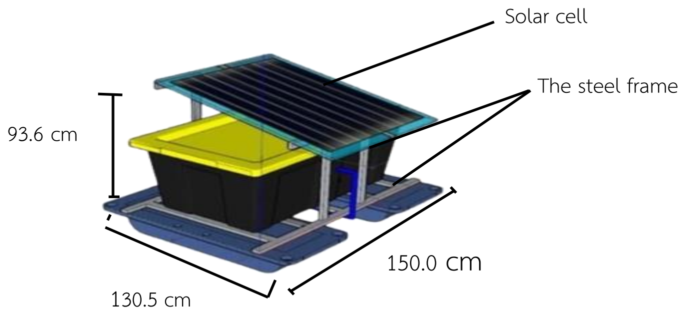


Figure 6: The design sketch of the floating oil-absorbing device created using SketchUp software.

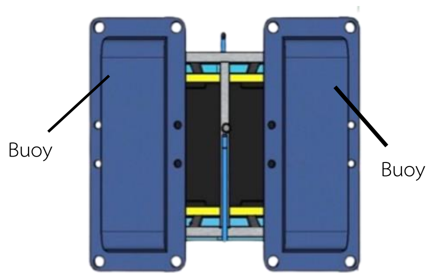


Figure 7: The design sketch of the underside device.

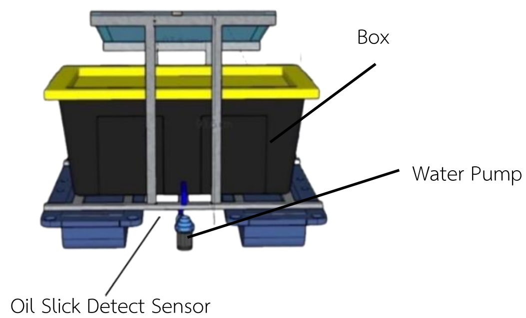


Figure 8: The design sketch of the side view of device.

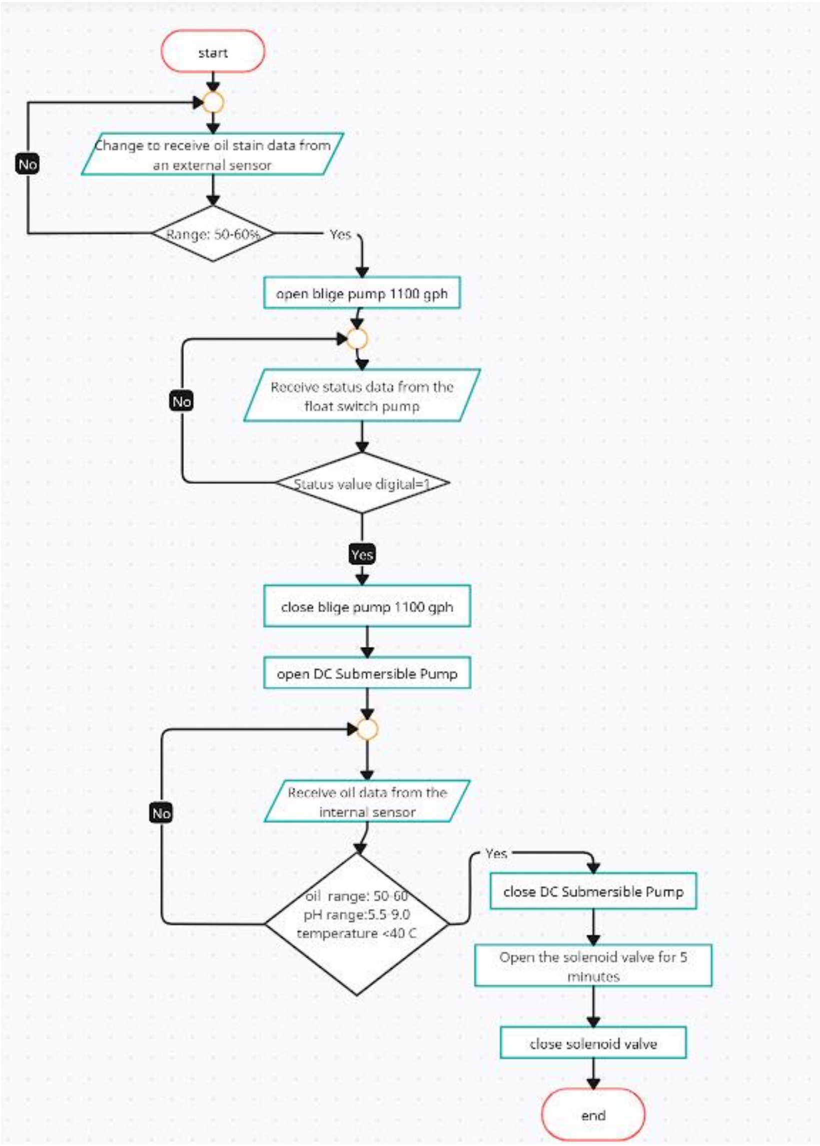
The floating oil-absorbing device that has been created is shown in Figures 9-11.

Figure 9: The front view of the device.

Figure 10: The rear view of the device.

Figure 11: The side view of the device.

The workflow diagram of the ICT system of the floating oil-absorbing device.



Principle of Operation of the Floating Oil-Absorbing Device

The operation of the floating oil-absorbing device begins when the sensor detects an oil slick on the water's surface. The sensor sends a signal to the Arduino Nano V3.0 board, which commands the external pump to activate. This pump draws the contaminated water through a PVC pipe into the filter tank. When the volume of contaminated water inside the tank reaches 20 liters, the float system triggers a signal to stop the pump's operation.At this point, the internal pressure pump starts, creating a swirling motion that forces the contaminated water through a filter containing "grass flower" (a local plant) packed in a mesh bag. After 5 minutes of operation, and if the sensor does not detect any more oil slicks in the tank, and the pH and temperature sensors read values within the standard range, the pressure pump will stop. The solenoid valve will then release the filtered water back into the water source.

Part 3: Performance Testing of the Floating Oil-Absorbing Device

3.1 Study on the Oil Absorption Capacity of the Filter

From the study on the oil absorption capacity of the filter in the floating oil-absorbing device, it was found that the filter, made from *grass flower*, absorbed oil contaminating the water at a concentration of 10% v/v. The experimental results are shown in Table 1.

Table 1: Oil Absorption Capacity of the Filter

Before Absorption Filter Weight (grams)	After Absorption Filter Weight (grams)	Absorption Capacity (times)
5.00±0.01	65.25±3.90	12.05
10.00±0.01	119.69±1.10	10.97
15.00±0.01	178.75±1.18	10.92

From the experiment, it was found that the filter made from *Zygochloa sp.* flowers has an absorption capacity ranging from 10.92 to 12.05 times its weight. This result will be used to calculate the required amount of *Zygochloa sp.* flowers for the filter of the oil-absorbing buoy, based on the level of severe oil contamination in the sea water (1% oil). (Source: Marine and Coastal Resources Knowledge Base, April 19, 2023).

3.2 Study on Water Quality After Passing Through the Device

The study measured water temperature, pH, DO (Dissolved Oxygen), and salinity, as shown in Table 2

Table 2: Water Quality After Passing Through the Floating Oil Absorption Device

Water Quality Parameter	Value After Treatment
Temperature (°C)	29.1±0.2
pH	7.2±0.2
DO (mg/l)	4.9±0.2
Salinity (ppt)	32±1

The study found that the oil-contaminated water treated by the device had a temperature between 28.9 – 29.3°C, which is within the acceptable standard (not exceeding 35°C). The pH ranged from 7.0 – 7.4, which falls within the standard range of 5.5 – 9.0. The DO level was between 4.7 – 5.1 mg/L, close to the minimum standard of 5 mg/L. The salinity ranged from 31 – 33 ppt, which is within the standard range of 30 – 35 ppt
(Reference: Ministry of Science, Technology, and Environment Notification No. 3 (1996) regarding effluent discharge standards for industrial factories and industrial estates).

Conclusion and Discussion

The research on the development of a floating oil absorption device for marine oil spills began with a study of historical water quality data at Hat Mod Tanoi, Kantang District, Trang Province, from 2017 to the present. The findings revealed that the average water temperature had increased, pH levels had decreased, dissolved oxygen (DO) levels had declined, while salinity levels remained unchanged. These changes were likely due to the discharge of untreated household wastewater into water sources by local residents and the high volume of maritime transportation in the area. To further investigate, the research team conducted on-site water quality assessments at two locations: the Hat Mod Tanoi community area and the area behind Hat Mod Tanoi Beach, focusing on key water quality parameters such as temperature, pH, DO, and salinity. The results indicated that the water quality in the community area was below standard environmental criteria (as per the Ministry of Science, Technology, and Environment Notification No. 3 (1996)), with a temperature of 32.6°C, a pH of

6.3, a DO level of 3.9 mg/L, and a salinity of 32 ppt. Additionally, a significant amount of oil residue was observed floating on the water surface, confirming the severity of oil contamination in the area.

In response to these findings, the research team designed and developed a floating oil absorption device to remove oil contamination originating from household wastewater discharge and maritime transport activities. The device was equipped with an oil absorption filter made from Kachornchob grass, a natural and eco-friendly material known for its high oil absorption capacity. Additionally, the device featured an IoT-based control system, allowing for real-time monitoring of water quality parameters. The system was equipped with sensors to ensure that the treated water met environmental safety standards before being released back into the ocean. Throughout the development process, the research team collaborated with university experts to refine the design before finalizing and constructing the prototype.
The final version of the floating oil absorption device was designed with a rust-resistant steel frame, measuring 1.3 meters in width, 1.5 meters in length, and 0.93 meters in height. The oil absorption chamber was constructed using high-density polyethylene (HDPE) and integrated with external and internal oil detection sensors, a pH sensor, and a temperature sensor. The device was powered by solar energy, ensuring sustainable and autonomous operation in marine environments.

Testing results confirmed the high efficiency of the floating oil absorption device. The Kachornchob grass filter demonstrated an oil and water absorption capacity ranging from 10.92 to 12.05 times its own weight. Additionally, the water quality analysis after treatment showed that the device effectively restored water conditions to within acceptable environmental standards. The results were as follows: temperature between 28.9 – 29.3°C (standard: ≤35°C), pH levels between 7.0 – 7.4 (standard: 5.5 – 9.0), dissolved oxygen (DO) between 4.7 – 5.1 mg/L (standard: ≥5 mg/L), and salinity between 31 – 33 ppt (standard: 30 – 35 ppt). These results indicate that the device is capable of effectively removing oil contaminants while maintaining the necessary water quality standards required for safe discharge into the ocean (Reference: Ministry of Science, Technology, and Environment Notification No. 3 (1996)).

The floating oil absorption device developed in this research successfully demonstrated its ability to absorb oil spills, improve water quality, and reduce marine pollution. By integrating IoT technology, the device provided automated operation and real-time monitoring, ensuring that treated water met environmental standards before being released. Furthermore, the use of Kachornchob grass as a natural filter offered a sustainable and eco-friendly solution for oil spill management. Given its effectiveness, this device has the potential for deployment in coastal areas, harbors, and other marine environments affected by oil spills, offering a practical solution for environmental conservation and pollution control.

Acknowledgments

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GLOBE’s databases

Water data on GLOBE DATA ENTRY

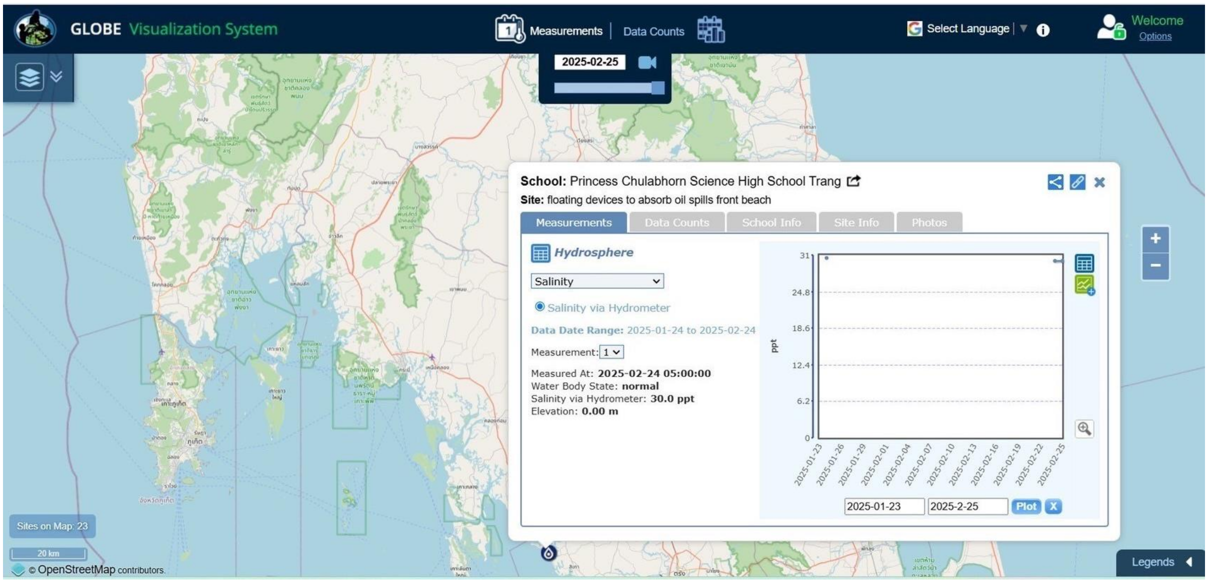

Figure 12 : Shows the water Salinity data at floating devices to absorb oil spills front beach on GLOBE DATA ENTRY

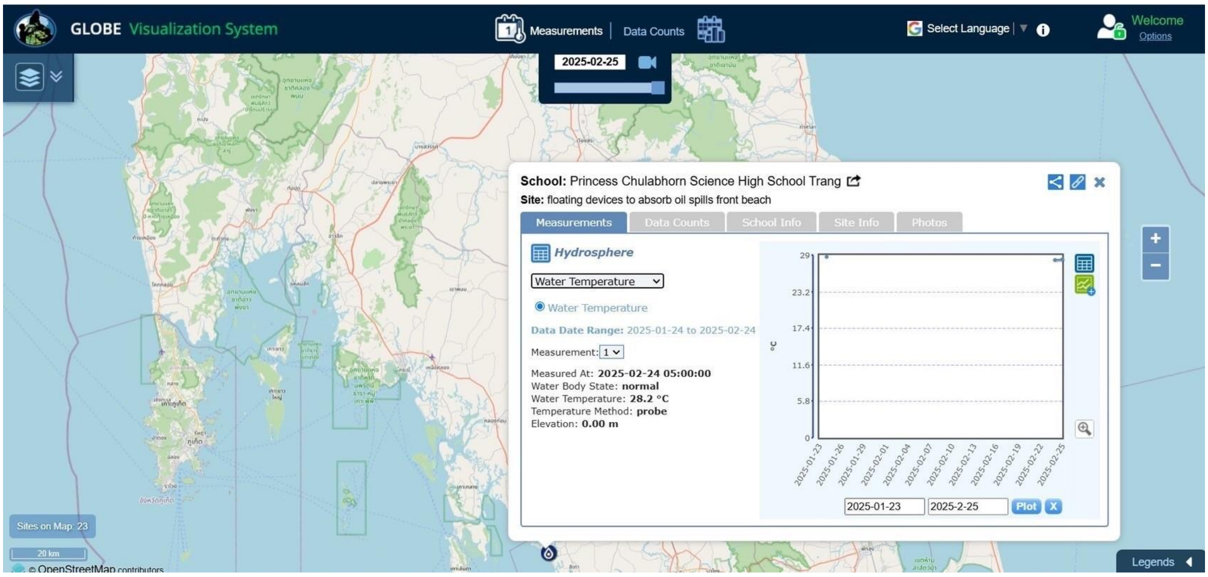

Figure 13 : Shows the water Temperature data at floating devices to absorb oil spills front beach on GLOBE DATA ENTRY

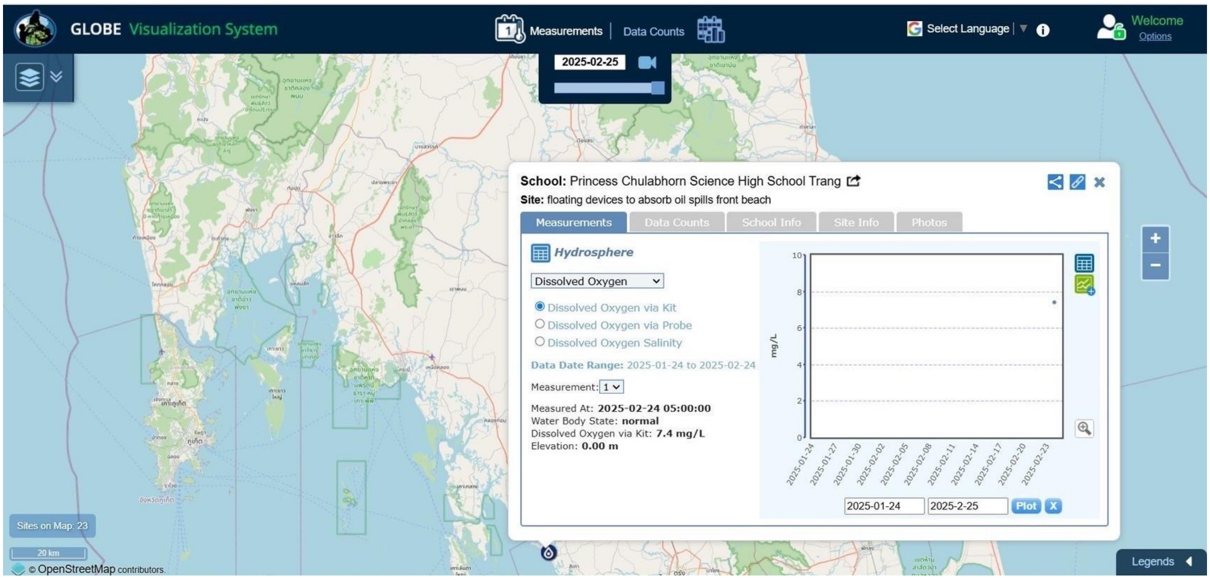

Figure 14 : Shows the water Dissolved Oxygen data at floating devices to absorb oil spills front beach on GLOBE DATA ENTRY

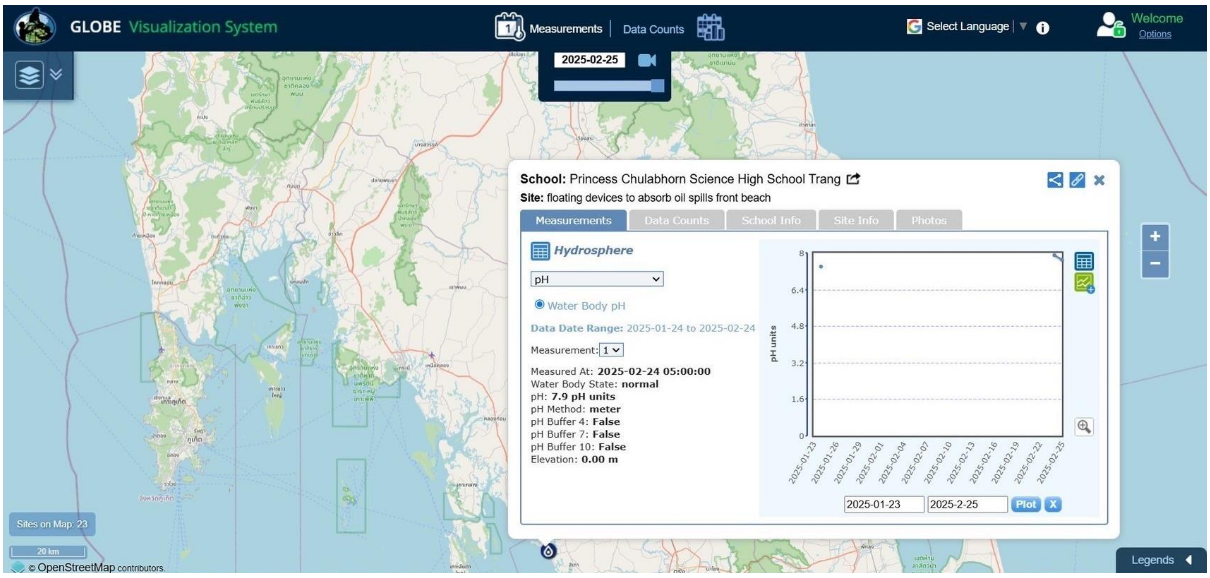

Figure 15 : Shows the water pH data at floating devices to absorb oil spills front beach on GLOBE DATA ENTRY

Badge descriptions

I AM AN ENGINEER

This research applies engineering principles to design and develop a floating oil-absorbing device. It began with an assessment of seawater quality in the Ban Mod Tanoy community and the area behind Mod Tanoy Beach. The findings revealed crude oil contamination from vessel spills in the community's waters, negatively impacting the local environment. To address this issue, the research team conducted an extensive literature review and consulted experts to create a device capable of absorbing oil spills. The team designed, developed, tested, and refined the device to ensure its practicality before deploying it in real-world conditions to mitigate the problem.

I MAKE AN IMPACT

This research aims to reduce the impact of oil spills in the Ban Mod Tanoy community, where marine pollution from transportation and logistics poses a serious threat to aquatic life, plankton, and coral reefs. Current oil spill response methods, such as burning and chemical dispersants, often cause additional environmental harm. As an alternative, the research team developed a floating oil-absorbing device using a filter made from *Chrysopogon zizanioides* (Vetiver grass), which effectively absorbs oil without introducing further pollution. This approach not only enhances oil spill remediation efforts but also repurposes an unwanted agricultural byproduct into a valuable environmental solution.

I AM A DATA SCIENCTIST

The research began with an analysis of historical water quality data from Ban Mod Tanoy, spanning from 2017 to the present. The collected data was statistically analyzed, including calculations of mean values and standard deviations. Key water quality parameters—temperature, pH, dissolved oxygen (DO), and salinity—were compared over time. The findings indicated an increase in seawater temperature, a decrease in pH and DO levels, while salinity remained constant. Additionally, oil contamination was detected in seawater due to maritime transportation and oil leaks from canal dredging activities.

Appendix with raw data

Water Quality Data from 2017 to 2025

Water Quality	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Temperature	26.9	27.0	27.1	27.3	27.6	27.9	28.1	28.5
pH	7.3	7.2	7.2	7.1	6.8	6.7	6.5	6.3
DO	5.4	5.3	5.0	4.8	4.9	4.7	4.6	4.4
Salinity	32	33	33	27	29	31	33	34

Water Quality Data of Ban Mod Tanoi Community, Kantang District, Trang Province

Water Quality	Measured values			
	1st time	2nd time	3rd time	average
Temperature	32.8	32.6	32.4	32.6±0.2
pH	6.2	6.3	6.1	6.2±0.1
DO	3.6	4.0	4.2	3.9±0.3
Salinity	32	31	33	32±1

Water Quality Data of the Area Behind Mod Tanoi Beach,Kantang District,Trang Province

Water Quality	Measured values			
	1st time	2nd time	3rd time	average
Temperature	28.6	28.7	28.9	28.7±0.2
pH	7.0	7.5	7.0	7.2±0.3
DO	5.2	5.3	5.1	5.2±0.1
Salinity	29	30	27	29±2

Water Quality Data of Mod Tanoi Community Area, Kantang District, Trang Province After Passing Through the Floating Oil Absorbent Device

Water Quality	Measured values			
	1st time	2nd time	3rd time	average
Temperature	29.1	29.3	29.0	29.1±0.2
pH	7.3	7.0	7.2	7.2±0.2
DO	4.8	4.9	5.1	4.9±0.2
Salinity	32	33	32	32±1