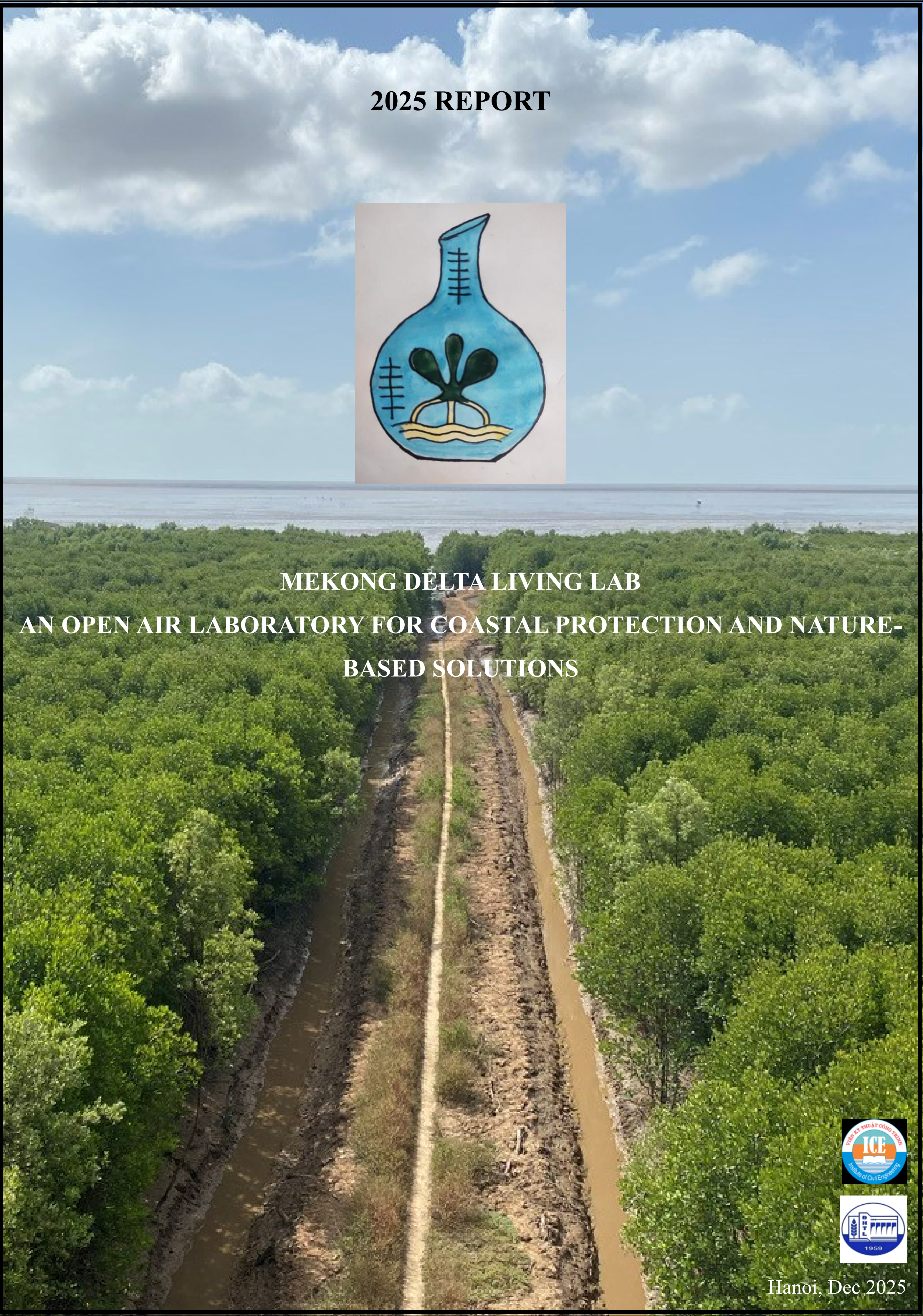

2025 REPORT

MEKONG DELTA LIVING LAB

AN OPEN AIR LABORATORY FOR COASTAL PROTECTION AND NATURE-BASED SOLUTIONS

Hanoi, Dec 2025

The Mangrove Living Lab team

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1 Introduction

1.1 Project description and activities

The Living Lab project is going on in its second year of its process. In 2025, a number of activities has been performed to assist what has been left out in the first year (Mission Report Sep 2024).

The fieldworks aim to achieve a view of engineering aspects on a location that has barely been impacted by artificial coastal measures, such as a permeable breakwater (the hollow piles – rocks), except for earthen sea dikes. The team has looked at hydraulics and mangrove aspects in this fieldwork campaign, including wave-flow and mangrove characteristics. The difference and improvement compared to the 2024 campaigns are that the first offshore-wave measurement had been deployed. Even though the results met the team's expectations, many challenges arose due to the real "laboratory conditions".

Table 1.1. Recall of measurements conducted since 2024 till now

No.	Location	Time	Measured elements							
			Water levels	Waves	Flow	SSC	Bed Sed	Weather	Sanility	Bathymetry
1	Phu Long, Cat Hai, Hai Phong	Mar/24	x	x	x	x	-	x	-	-
2	Hoa Binh Wind farm, Bac Lieu	Apr/24	x	x	-	x	-	-	-	-
3	Nha Mat, Bac Lieu	Aug/24	x	x	-	x	-	x	x	-
4	Phu Long, Cat Hai, Hai Phong	Sept/24	x	-	x	x	-	x	-	x
5	Hoa Binh Wind farm, Bac Lieu	Dec/24	x	x	-	x	x	x	x	x
6	Ham Luong, Ben Tre	Mar/25	x	x	x	x	-	-	-	-
7	Kim Son, Ninh Binh	Apr/25	x	x	x	x	-	-	-	x
8	Vinh Chau, Soc Trang	Jun/25	x	x	x	x	x	-	-	X
Bed Sed: Bed sediment collection										

1.2 Fieldwork description

The first two campaigns were conducted in March and June 2025 at Ham Luong, Ben Tre[*] (Ham Luong river estuary) and Vinh Chau, Soc Trang[*], respectively.

- Time and measurement duration

+ Ham Luong, Ben Tre: 25 March to 3 April, 2025; Measurement duration: 7 days

+ Vinh Chau, Soc Trang: 10 June to 21 June, 2025; Measurement duration: 7 days

- Location:

Ham Luong, Ben Tre: 9°56'59.60"N, 106°37'21.80"E.

Vinh Chau , Soc Trang: 9°17'36.41"N, 105°58'33.36"E.

Figures 1-1 and 1-2 are the maps of two provinces (after merging) where the measurement campaign occurred.

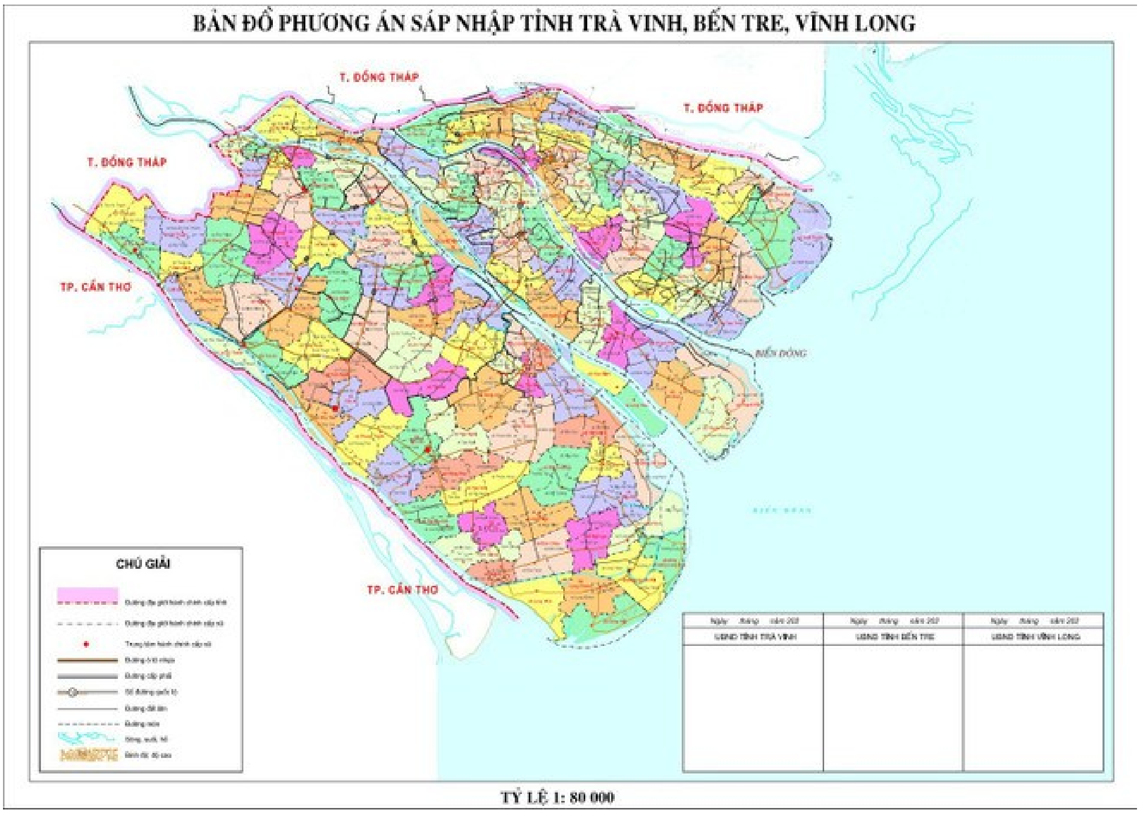


Figure 1-1. Map of new Vinh Long including Ben Tre province (Trung tâm Thông tin công tác tuyên giáo, 2025).

[*] Ben Tre and Soc Trang are belong to (new) Vinh Long and (new) Can Tho, respectively, after 1st July, 2025

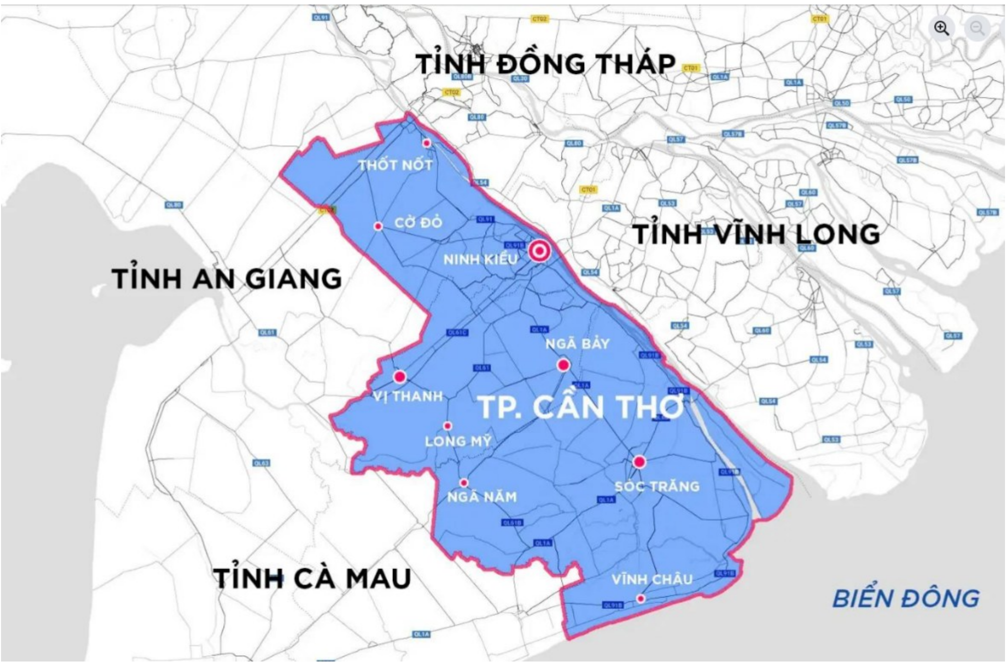


Figure 1-2. Map of new Can Tho city. Measurement locations are located in the south, named Vinh Chau (Governmental sources).

1.3 Equipment

The list of equipment is listed below:

Table 1.2. List of active equipment for the projects

No.	Name	Description	Quantity
1	OBS-Wave buoy400	Real-time full wave and sea surface temperature. Observational Buoy	01
2	Level Gauge	Real-time water level measurements using a highly accurate radar sensor.	01
3	Pressure-based Wave Gauge	Pressure sensor wired to power and telemetry module. Measure non-directional wave spectrum and bulk wave parameter.	02
4	Weather station	Comprehensive weather data comprising wind speed and direction, air temperature and pressure, solar radiation, rainfall, relative humidity, and lightning.	01
5	Rain gauge	Real-time gauge with 0.2 mm resolution.	01
6	CT Station (Water physical parameter)	All-in-one conductivity, temperature and salinity measurements.	01
7	Time-lapse camera	Real-time image capture.	01

The equipment is developed by the Obscape company, Delft University of Technology. Measured data will be streamed to the Obscape servers with a high-speed internet connection installed inside the device. Every station is equipped with solar power cells that can recharge in the sunlight. As a result, the installed devices can measure for up to a year without changing batteries.

(a) Wave buoy: OBS-Buoy 400

(b) Weather station

(c) Time-lapse camera

(d) Pressure-based wave gauge

(e) Level gauge Radar

Figure 1-3. Obscape devices.

Other than those devices, additional options for measuring water levels, water depth, waves and flows can be list in the table below.

Table 1.3. List of equipment deployed in all measurement campaigns

No.	Name	Origin	Quantity	Team	Measured elements							
					Water levels	Waves	Flow	SSC	Bed Sd	Weather	Sanility	Bathymetry
1	Radar water level	Obscape	1	ICE	X	-	-	-	-	-	-	-
2	Divers	Vanesen	4	ICE(2), ICOE(2)	X	-	-	-	-	-	-	-
3	Wave buoy	Obscape	2	ICE	-	X	-	-	-	-	-	-
6	Pressure-based WG	Obscape	4	ICE(2), ICOE(2)	X	X	-	-	-	-	-	-
7	AEM213	Japan	1	ICE	-	-	X	-	-	-	-	-
8	RTK	-	1	ICE	-	-	-	-	-	-	-	X
9	Low Range	-	1	ICE	-	-	-	-	-	-	-	X

No.	Name	Origin	Quantity	Team	Measured elements							
					Water levels	Waves	Flow	SSC	Bed Sd	Weather	Sanility	Bathymetry
10	Weather station	Obscape	1	ICE	-	-	-	-	-	x	-	-
11	CT Station	Obscape	1	ICE	-	-	-	-	-	-	x	-

Water levels and water depth

Level gauges use the method below, where d is the distance between the sensor and the water surface.

$$z_{water} = z_{housing} - d$$

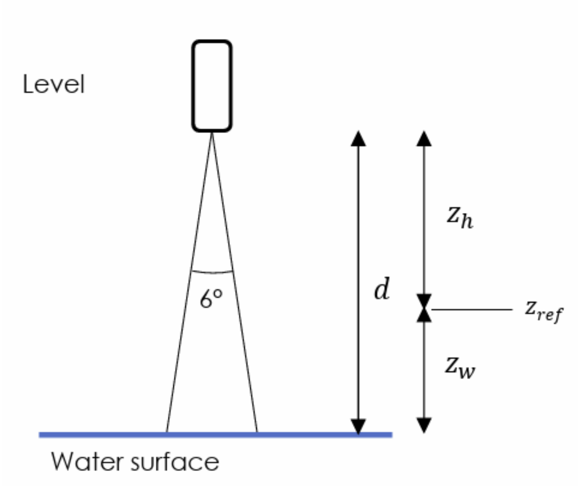


Figure 1-4. Level gauge radar principle.

Wave and flow

OBS-Buoy 400 can be installed at an offshore location so data can be obtained for model validation and calibration. Wave buoy uses 8 Lithium D-cells (3000mAh, 3.7 V), resulting in data recording up to 10-12 months. Data specifications are presented in Table 1-4.

Table 1.4. Wave buoy characteristics

No.	Data specifications	Note
1	Wave spectrum	Fully directional, including height and period, using the Maximum Entropy Method
2	Bulk wave parameters and SST	SST, H(m0, max), T(peak, m01, 02, 10, max), Dir(peak, mean)
3	Sample frequency	6.25 Hz
4	Filtered frequency range	0.05 – 1.00 Hz (~20 – 1 sec)
5	Bust duration	30 minutes for each recorded data
6	Storage	Data portal, External storage
7	Communication modes	GSM (4G)

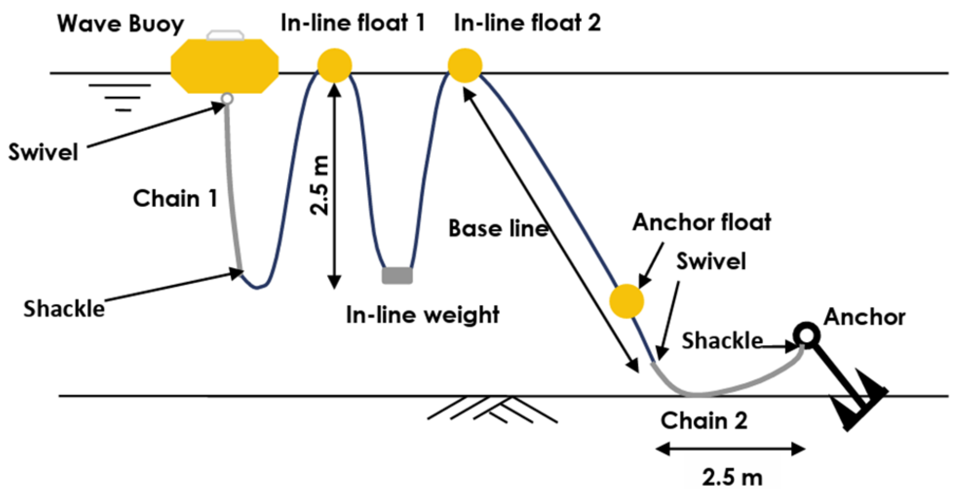


Figure 1-5. Measurement scheme of Wave buoy.

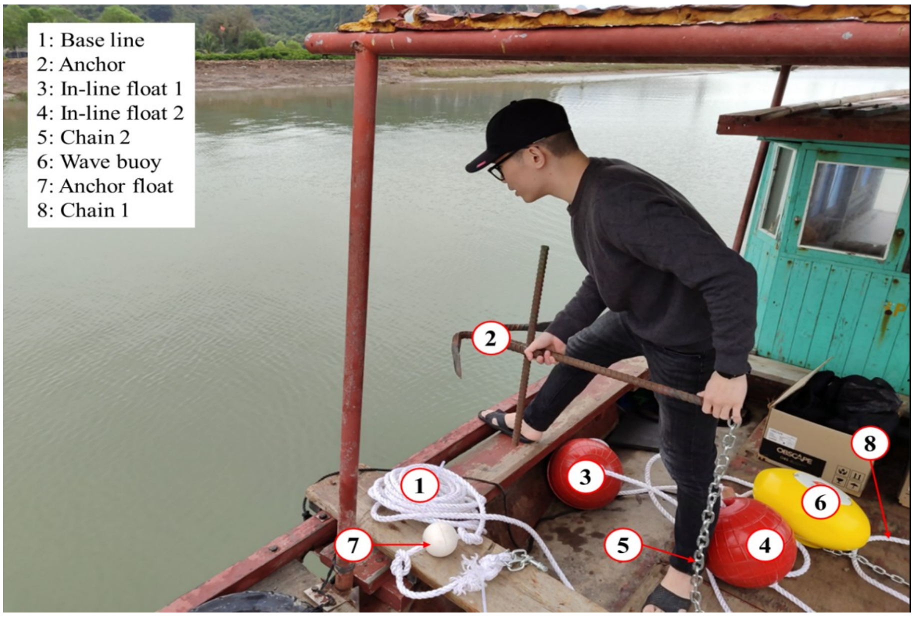


Figure 1-6. Wave buoy installation processes.

Figure 1-7. The wave buoy system has been installed. Two red balls on the left side are the in-line floating connected with easy-spot objects (flags and lights). The yellow spot on the right is the wave buoy. This system can work up to 12 months under normal conditions.

In the field, the wave buoy is vulnerable under strong wave conditions, so it should be observed and have daily checks during the measurement campaign. The team checks the buoy every 03 hours. The ideal time should be 7, 10, 13, 16, 19, and 21 hours, including several aspects, such as the general information, abnormal functions, data streaming portal, and device location. Figure 7 below shows the daily measurement and telemetry cycle.

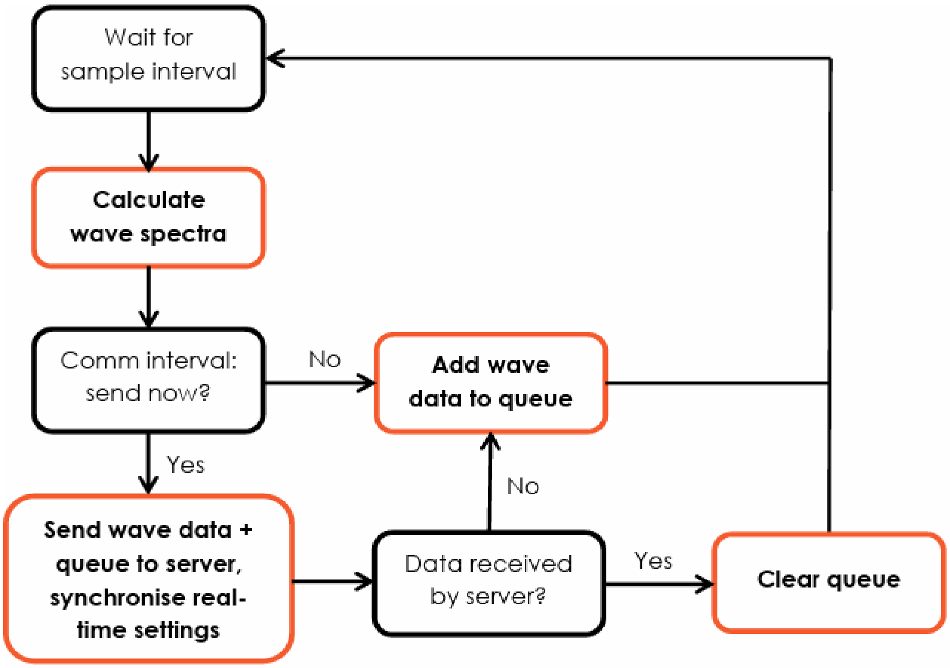


Figure 1-8. Measurement and telemetry cycle during the campaign.

Flow measurement

Flow measurements were conducted continuously throughout the survey period, with data collected at various layers. The number and location of measurement layers depend on the local depth (H) of the measurement site.

Flow measurement settings: readings were taken every 30 minutes. Each time, 10 values per flow parameter (velocity and flow direction at different layers) were recorded. Measurements were performed continuously over 7 days and nights.

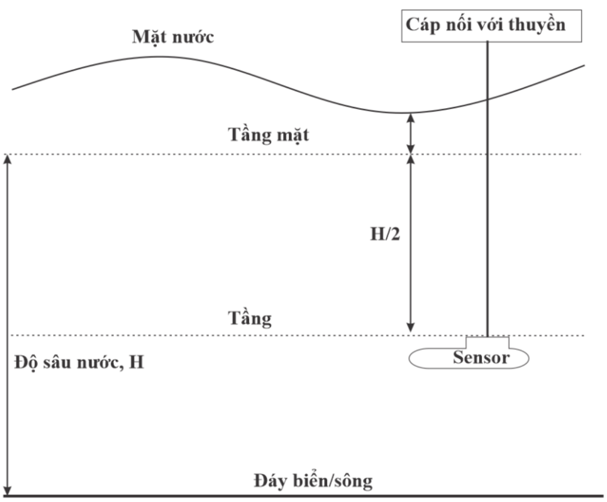


Figure 1-9: Layout diagram for flow velocity measurement at the flow measurement station

Sedimentation

Data will be collected from both mobile stations (extracting from the equipment) and manual. Within the field campaigns, the team collects sedimentation following the method.

Sedimentation data is collected at a frequency of 3 times per day at the current/flow or wave stations. Collecting toolkits include a 40-60cm diameter tube (See Figure 4) being collected at different depths by ropes. An ideal volume for each collecting time is designed by the supporters with metadata written, e.g., location, date and time.

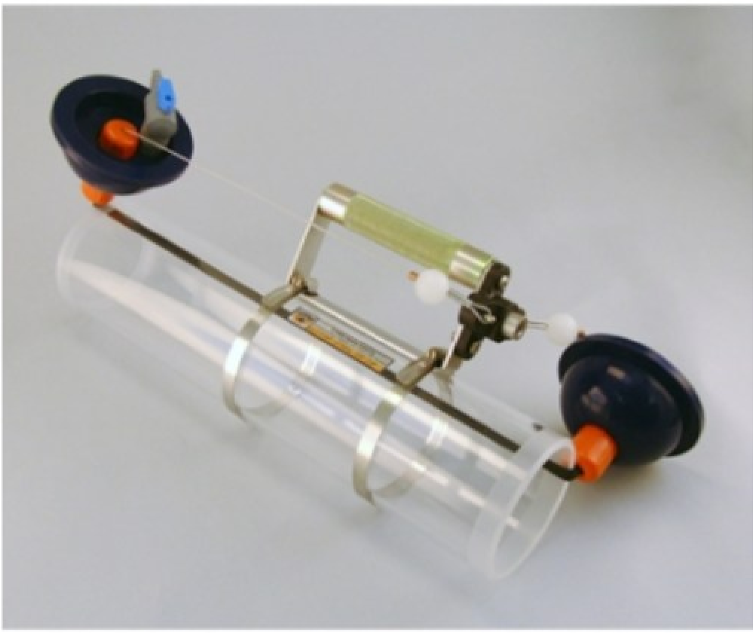


Figure 1-10. Sedimentation/Water quality collection toolkit

Every sample should be maintained in good condition before being brought to the laboratory for further analysis. Figure 5 presents the processes for sedimentation analyses.

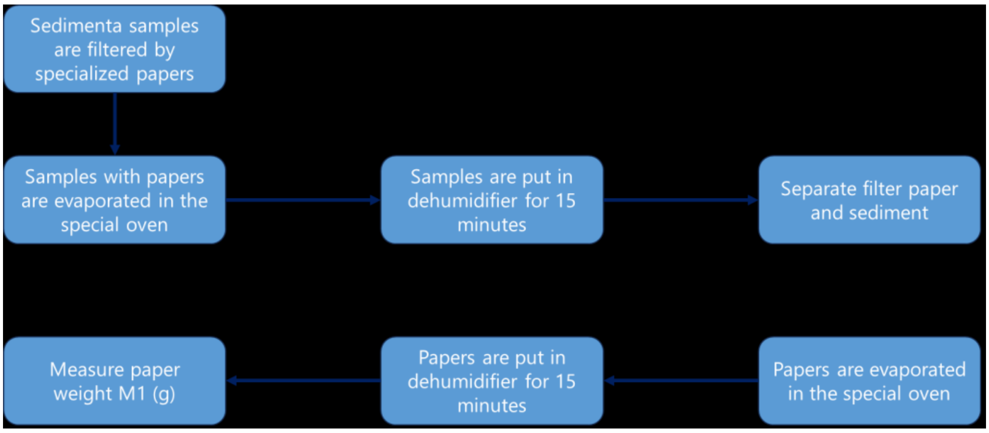


Figure 1-11. Analyzed processes for sedimentation

The sedimentation samples, including the filtered papers, are then brought to measure the secondary weights. The final result will be written in the field notes.

1.4 Participants and Partners

A list of partners and participants joining both campaigns is described below:

Table 1.5: Partners

No.	Institution	Person in charge
1	Institute of Civil Engineering Thuyloi University	Assoc. Dr Le Hai Trung
2	Hanoi University of Natural Resources and Environment	Dr Dao Hoang Tung
3	Faculty of Water Resource Engineering College of Engineering Can Tho University	Dr Dinh Van Duy
4	Institute of Coastal and Engineering	Dr Phan Manh Hung

Table 1.6: Participants

No.	Name	Institution	Position
1	Đào Hoàng Tùng	HUNRE-ICE	Head of Technician team, Project members
2	Đỗ Tuấn Anh	HUNRE-ICE	Technician
3	Mai Duy Khánh	TLU-ICE	Technician
4	Trần Thị Lợi	TLU-ICE	Technician, Mangrove expert
5	Lã Phú Hiến	TLU-ICE	Technician
6	Phan Mạnh Hùng	ICOE	Head of ICOE team, Project members
7	Lê Nhật Minh	ICOE	Technician
8	Lê Hữu Nghĩa	ICOE	Technician
9	Đinh Nhật Duy	Can Tho Uni.	Head of CTU team
10	Lê Hải Trung	TLU-ICE	Project coordinates
11	Trương Hồng Sơn	TLU	Project members
12	Phan Khánh Linh	TLU	Project members

2 Ham Luong estuary - Ben Tre, the 1 st campaign of 2025

2.1 Campaign description

The fieldwork in Ham Luong, Ben Tre†, occurs from 25 March to 3 April, 2025, which cooperates with a research project funded by the Viet Nam government (Dr Truong Hong Son is the manager of another research project at TLU, funded by MoST). This campaign is one of the first in 2025 and partly links to the activities in the second package of the project.

Ham Luong River is a branch of the Mekong River in the Mekong Delta region, belonging to (old) Ben Tre province. This location contains interesting aspects in mangroves and flow due to the rich of nutrients and sediments from upstream flow. This study area is also highlights as the flow dominant for mangrove coasts, which is fit with the project activity aims.

2.2 Measurement settings

Measurement stations are chosen as shown in Figure 2.1, the team decides to have 01 offshore station for wave measurement and 01 nearshore station for wave, flow and suspended sediment concentration.

Figure 2-1. Measurement stations in Ham Luong.

Figures 2.2 and 2.3 illustrate the offshore and nearshore stations, respectively. The offshore waves are recorded by a wave buoy, while the nearshore station includes water depth, flows and collecting sediment samples.

† Ben Tre is part of Vinh Long Province after 1st July, 2025

Figure 2-2. Wave buoy deployment in the field.

Figure 2-3. Wave gauge and Divers deployment. The diver in the left panel measured the water depth/level at the seaward location while the one in the right panel did the same job at the mangrove edge.

Table 2.1. List of devices and their locations

No.	Device's name	Purposes	Lat/Lon	Note
1	WB2026	Offshore wave	9°57'26.40"N, 106°38'58.40"E	Full 07 days
2	Logger Divers Y6818	Water depth	9°56'59.60"N, 106°37'21.80"E	Full 07 days
3	Pressure-based Wave gauge PTM6005	Wave	9°56'59.60"N, 106°37'21.80"E	Full 07 days
4	AEM213	Flow	9°56'59.60"N, 106°37'21.80"E	Full 07 days
5	SSC	Sediment samples	9°56'59.60"N, 106°37'21.80"E	Full 07 days

Measurement period: 25 March to 3 April, 2025; total 7 days

2.3 Data presentation

Water level

Water level can be converted from water depth that has already been collected by Divers. Figure 2.4 shows the water depth at two nearshore locations (see Figure 2.3).

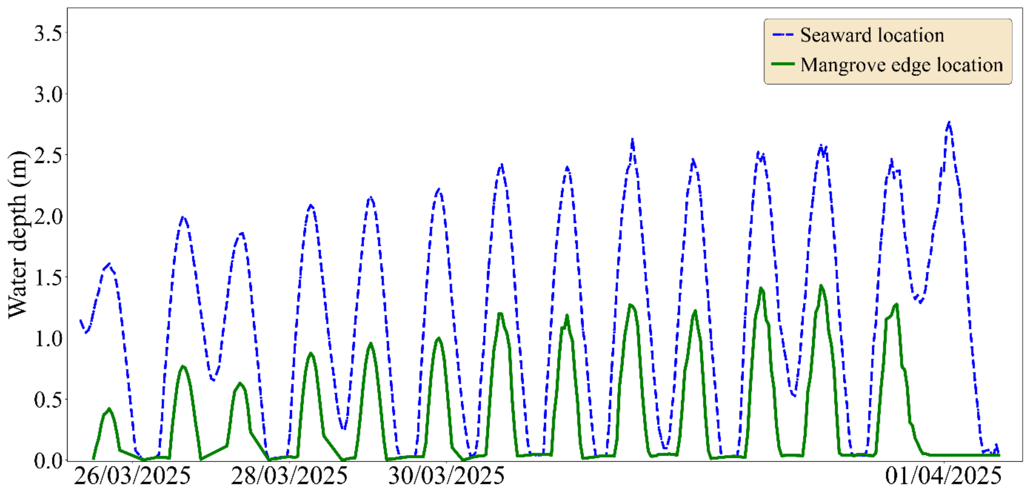


Figure 2-4. Water depth at two locations.

Wave

Wave characteristics are recorded and plotted from 2 stations, offshore (Wave buoy, Figure 2.2) and nearshore (Wave gauge, Figure 2.3). Data plots include significant wave heights, peak wave periods and wave direction (wave rose).

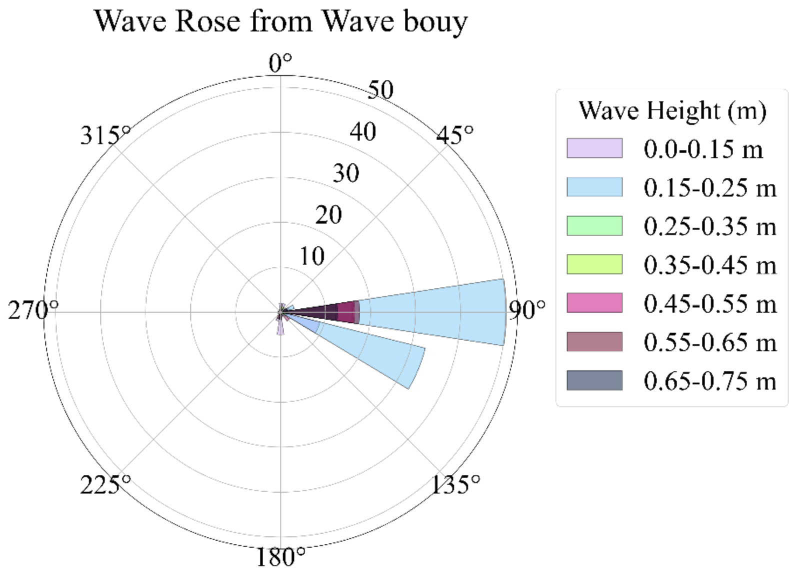


Figure 2-5. Wave rose for wave height at the offshore station recorded by the Wave buoy.

In Figure 2.5, wave directions are mostly from the East as the data recorded are still getting effective in the winter monsoon.

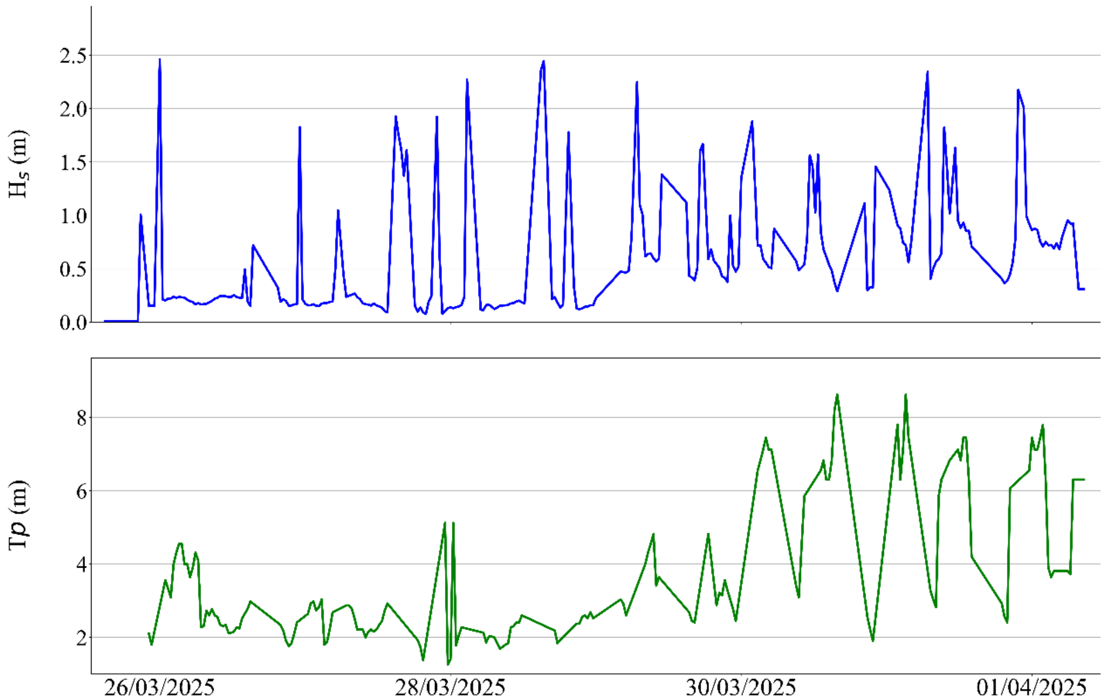


Figure 2-6. Significant wave height and peak wave period from the offshore station.

In Figure 2.6, maximum wave heights are quite high some of the time, but mostly averaging around 0.8 to 1.2 m. There are larger waves recorded from 31 March to 01 April due to the high wind event.

Flow

Flow velocities are plotted in Figure 2.7 with time. The average value is approximately 0.15 m/s and reaches a peak at high water level, at a maximum of 0.77 m/s.

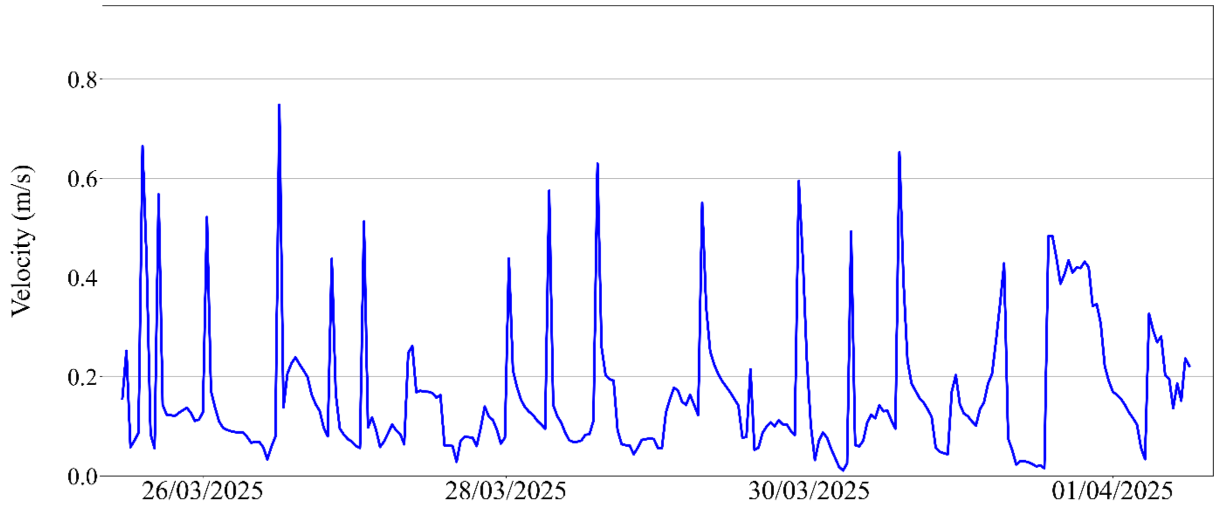


Figure 2-7. Flow velocity at the mangrove edge

Flow direction-value distributions show that the maximum value of velocity is about 0.15 m/s, and the majority follow the North-East direction.

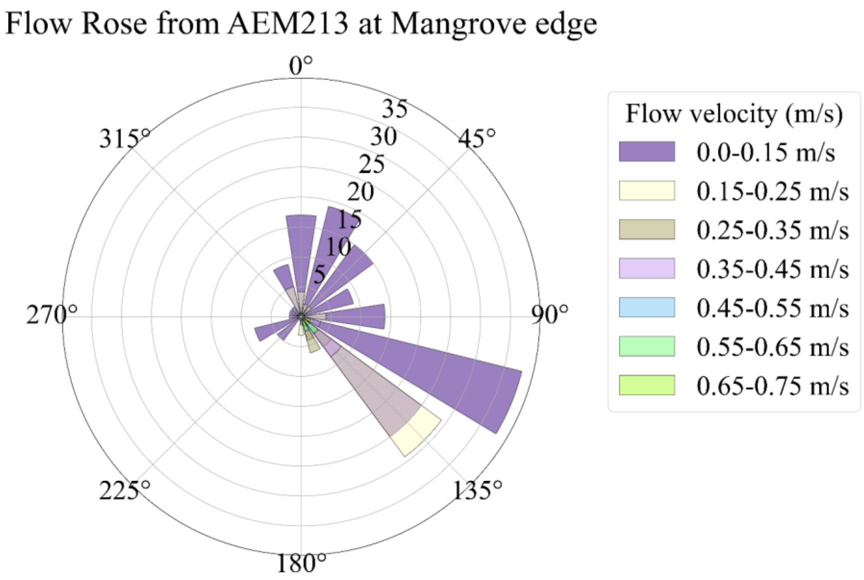


Figure 2-8. Velocity rose from flow data.

Suspended sediment concentration

Suspended sediment concentration is calculated from the weight of sediment in a 1.5-litre sample. The data changes over time and follows the water elevation during the day. The highest SSC shows at over 1.0 g/dm^3 at the deep water (1.4 m). On average, the mean SSC ranges at around 0.2 g/dm^3.

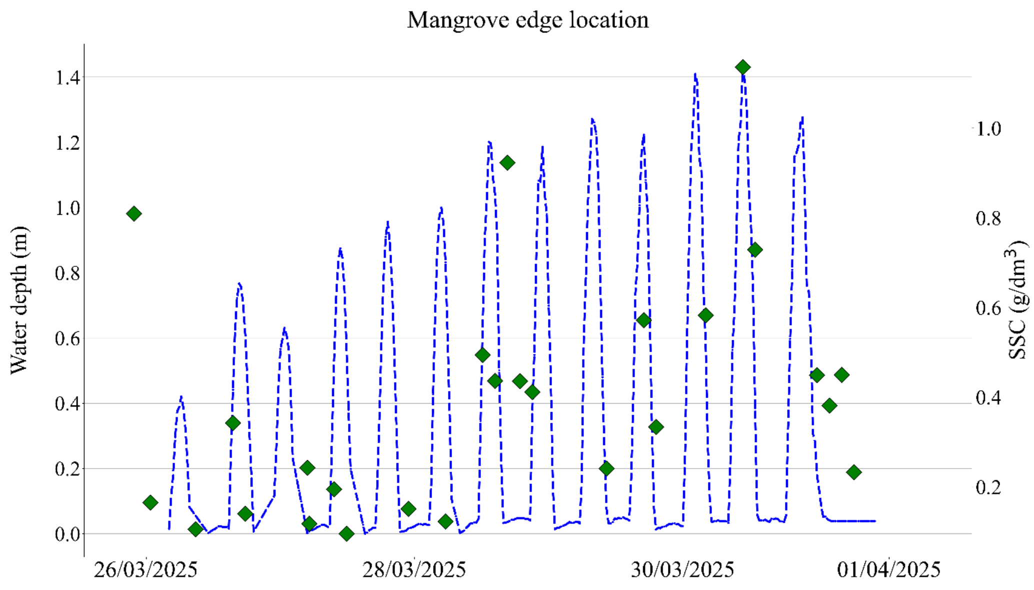


Figure 2-9. Suspended Sediment Concentration (SSC) at the mangrove edge.

3 Vinh Chau - Soc Trang, the 2nd measurement campaign of 2025

3.1 Campagin description

The Vinh Chau - Soc Trang fieldwork occured at the time the team found an interesting phenomenon happening along the Vinh Chau coast. There is also a necessity to start activities at the shore where mangroves are healthy and less susceptible to human intervention. More importantly, the Vinh Chau mangrove coast can be set as a laboratory where the team can fix the boundary for further measuring.

This measurement started on 10 June and ended on 21 June, including many activities, i.e., measuring offshore and nearshore waves, obtaining offshore flow, and collecting SSC and bed sediment samples. Bathymetry and mangrove surveys are also carried out.

3.2 Measurement settings

The team has decided to use devices/equipment that can measure nearshore and offshore measurements. Wave buoy (WB2006, Obscape) and Sentinel-V20 (Acoustic Doppler Current Profilers – ADCPs, US) were installed in an offshore location. The Logger TWR2050R-RBR for waves and Divers – Vanessen for water levels. The team also set up Radar Water Level (PTM6003) for water level at the Hoa Binh Wind farm. Other than those collection methods, technicians collected samples, including suspended sediment and bed sediment samples, manually. The list of devices is shown below.

Table 3.1. List of devices and stations

No.	Device's name	Purposes	Lat/Lon	Note
1	WB2026	Offshore wave	9°15'35.80"N, 105°57'23.90"E	Full 07 days
2	Sentinel-V20	Offshore wave & flows	9°15'35.80"N, 105°57'23.90"E	Full 07 days
3	Logger TWR2050R-RBR	Nearshore wave	9°17'21.99"N, 105°58'27.19"E	Full 07 days
4	Logger Divers Y6818	Water depth	9°17'21.99"N, 105°58'27.19"E	Full 07 days
5	PTM6003	Water level	9°9'23.85"N, 105°42'29.58"E	As long as possible

Figure 3-1. Locations of stations. The left figure includes the nearshore and offshore wave-flow stations (WB and Flow). The right figure consists of a nearshore wave station (WG01), Suspended Sediment Concentration (SSC01 and SSC02), Bed Sedimentation (BSd-011 to BSd-033), Standard Mangrove Measured Size (OTC-01 to OTC03) and Cross-shore profiles (yellow lines). Vinh Chau Fishery Port is located in the north, where the team works with partners.

Here are photos from the fieldwork for device installation:

Figure 3-2. Wave buoy (left) and Sentinel-V20-ADCP (right panel)

Figure 3-3. AEM213 installation

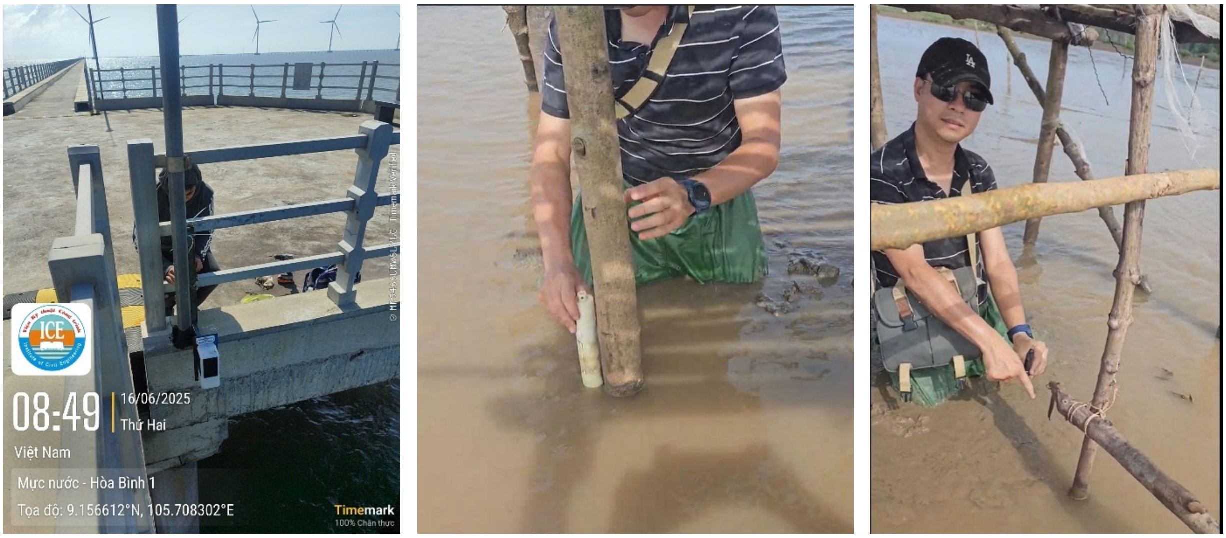


Figure 3-4. Radar water level PTM6003 (left), Logger RBR (middle) and Divers (right)

Nevertheless, suspended and bed sediment samples are collected in a traditional way at chosen locations based on the actual situations. In Figure 3.5, suspended sediment samples are collected at two locations, near the shore and offshore. Samples are kept in a plastic bottle (01 Litre) and filtered with special papers, date and time are carefully recorded for later analyzing. Bed sediment samples are collected manually at chosen locations along the chosen cross-shore profile (Figure 3.1). The figures below present actual activities in the field.

Figure 3-5. Suspended Sediment samples are collected and kept in a plastic bottle at the offshore station.

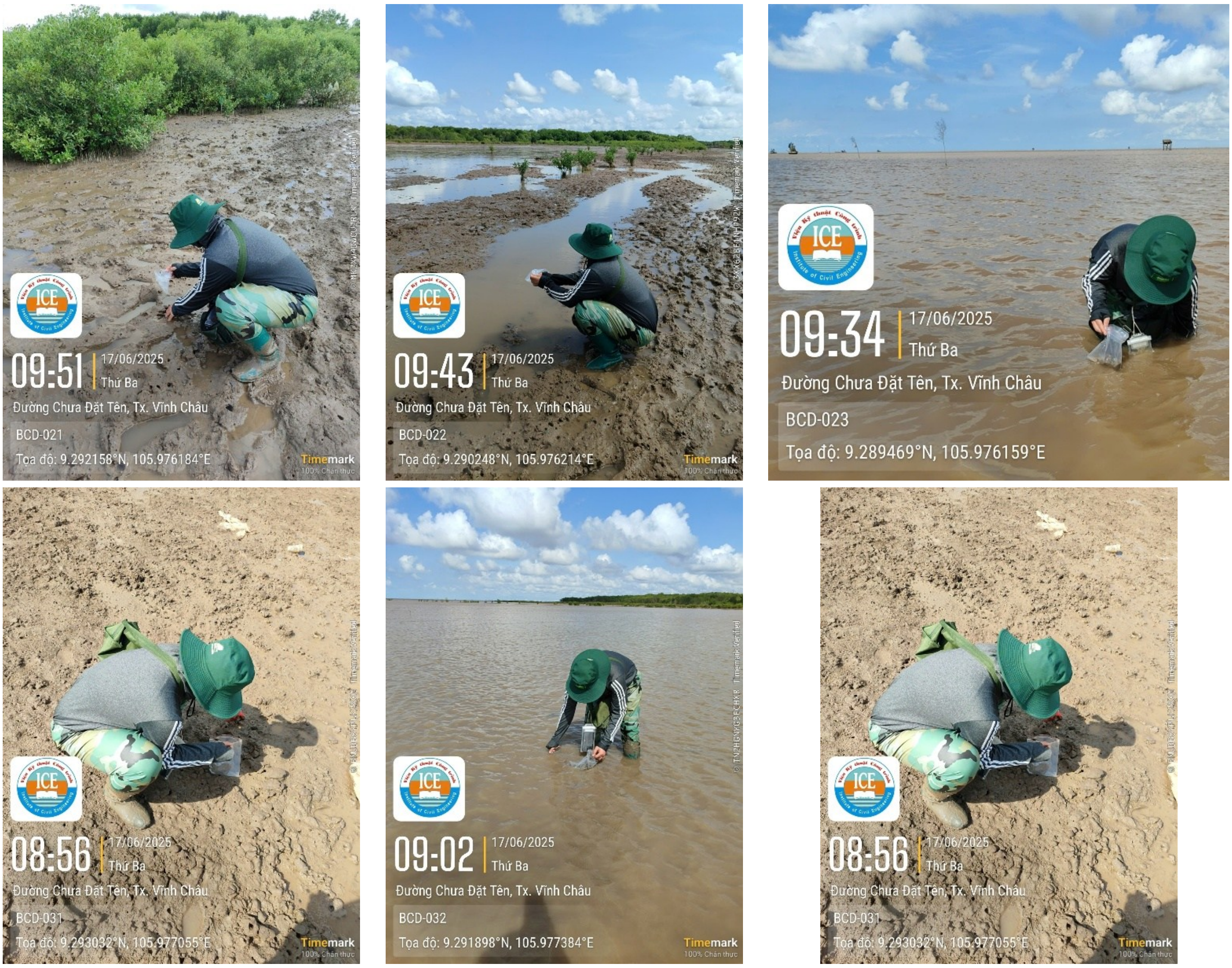


Figure 3-6. Collecting bed sediment samples

3.3 Data presentation

Water level and depth

Water level and water depth are collected at offshore and nearshore stations. As seen in Figures 3.7 and 3.8, water elevations follow the movement of tidal motions. At the nearshore location, water depth reaches 1.0 m as the deepest value, while water depth at the offshore station averages around 3.0 m.

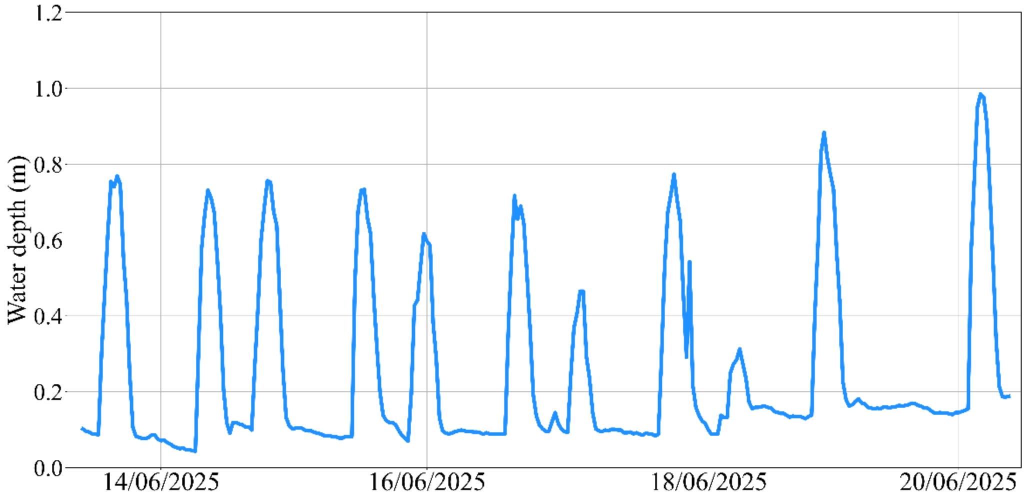


Figure 3-7. Water depth from Divers at nearshore location (See Table 3.1 and Figure 3.1)

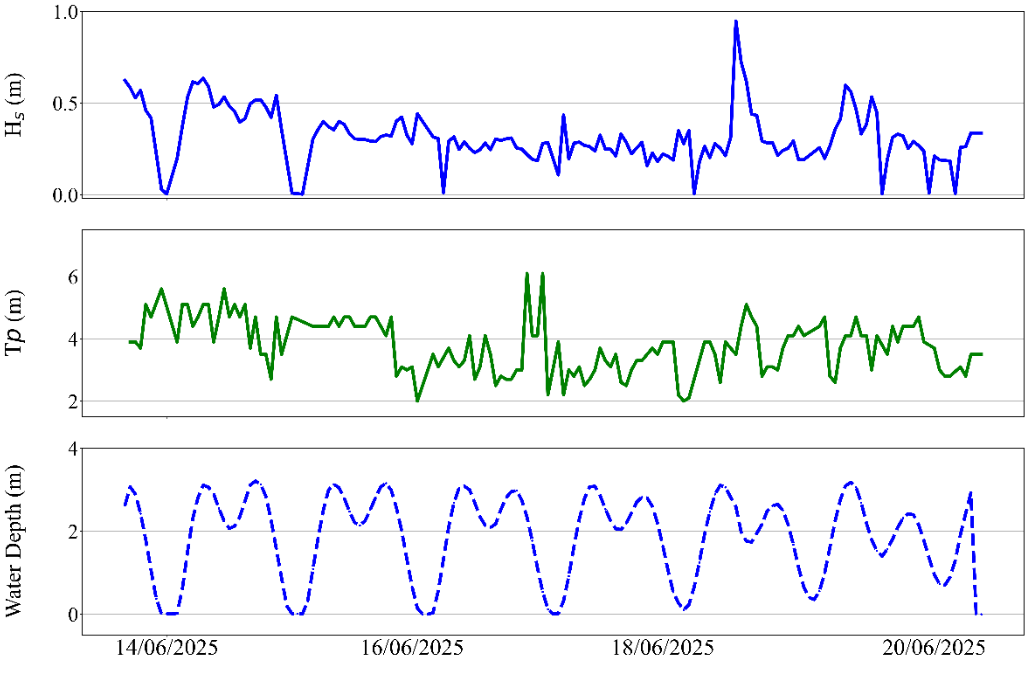


Figure 3-8. Wave data records from Sentivel-V20 at the offshore location, including water depth (bottom panel).

Water level station

Water level station was set up in July 2025 and consistantly sent good and long dataset as shown in Figure 3-9.

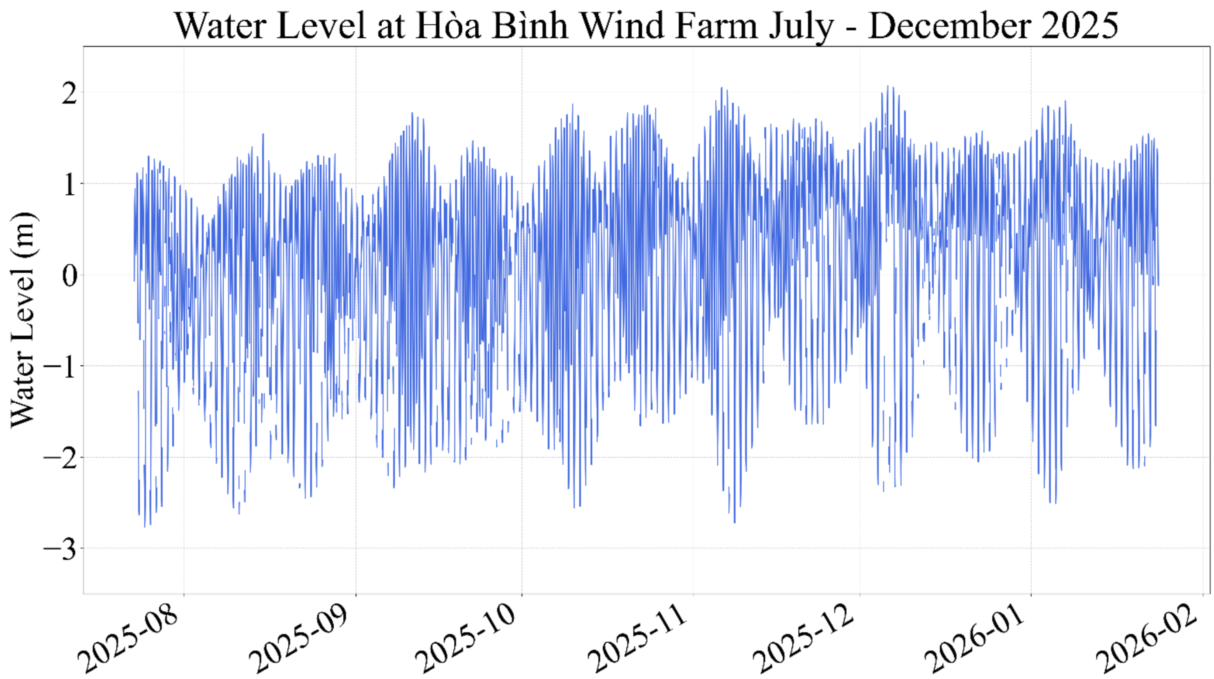


Figure 3-9. Water level at Hoa Binh Wind farm from July to December 2025.

Waves

Figure 3.9 presents the wave heights, wave periods and water depth at the nearshore station. As seen in it, wave heights are quite small and dependent on water elevation. The largest wave has over 0.4 m of height, and the mean height is around 0.1 m. Due to the gentle forshore, waves are relatively small, with wave periods are only around 1.6 seconds.

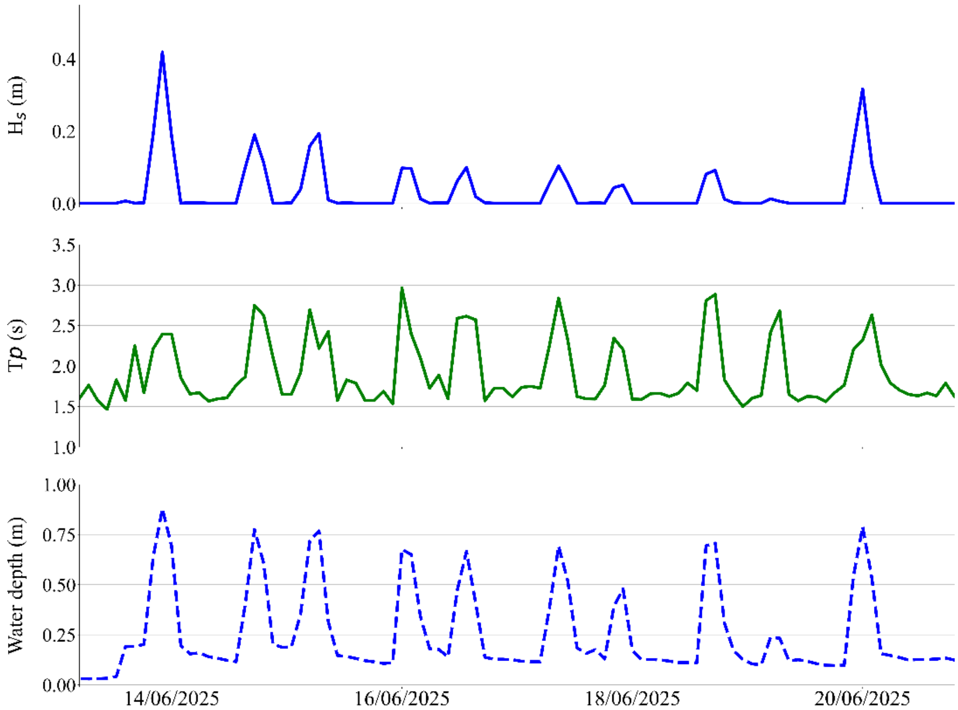


Figure 3-10. Wave characteristics at nearshore location, including significant wave height (Hs), peak wave period (Tp) and water depth.

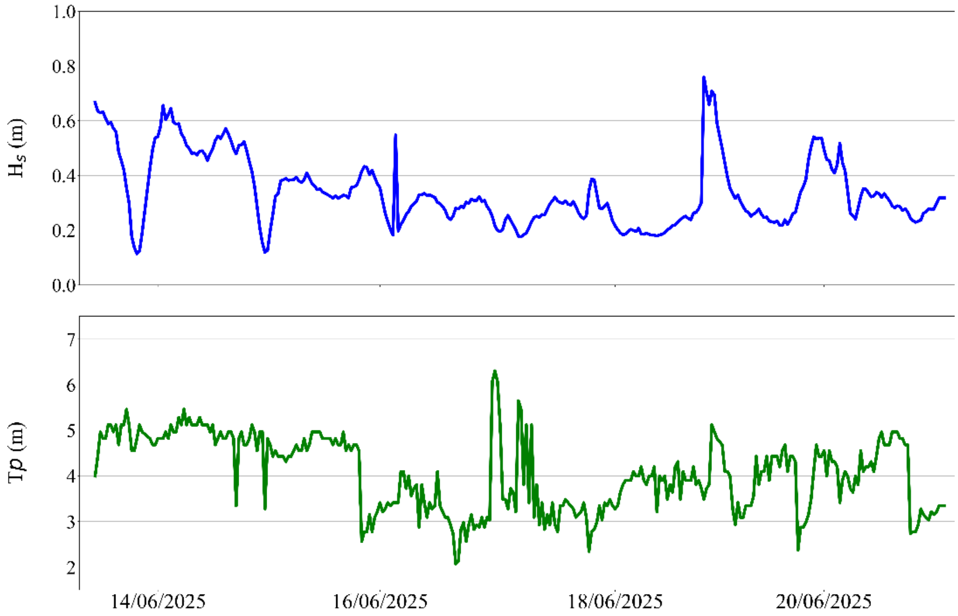


Figure 3-11. Wave characteristics at the offshore station.

The time of this fieldwork is during the summer monsoon; therefore, waves are relatively small even at the offshore station. The largest wave is recorded as 0.8 m on 19 June, but the period is relatively small at 5 seconds.

Wave directions in the summer monsoon are mainly SE, and the data show relatively close to the theory. Figure 3.11 shows the main direction is SE and secondly E, with the wave heights ranging from 0.25 to 0.35 m.

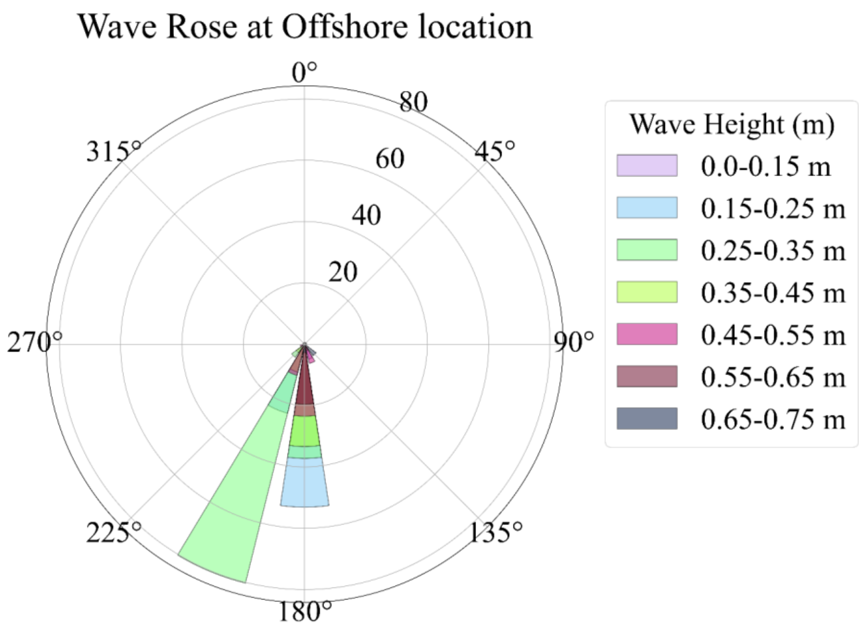


Figure 3-12. Wave direction contribution analyzed from the Wave buoy at the offshore location.

Flow

The support of colleagues from Can Tho University brings out the Sentinel-V20, which allows the team can record flow at different depths. In Figure 3.12, flow velocity at the vertical axis (from the top of the sensor, see Figure 3.2) is shown, which indicates to tell the flow velocity follows the tidal motions.

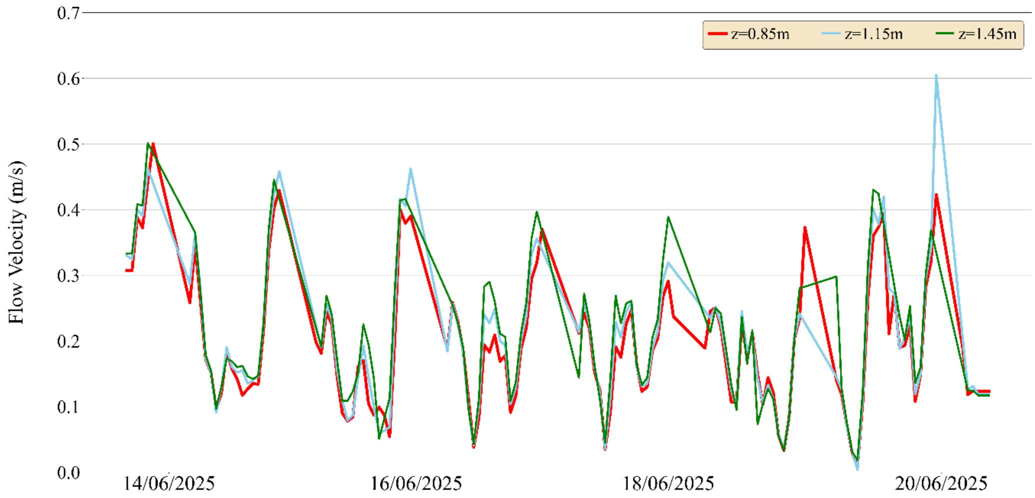


Figure 3-13. Flow velocity at offshore stations. Data is recorded at three vertical axes that are calculated from the device sensor.

Figure 3.13 presents flow velocity contribution with directions at the offshore station. The graph shows the SE flow with velocity of 0.15-0.20 m/s are the majority while lower velocities from S and SEE directions are ranging from 0.10-0.15 m/s. Higher velocities are only shown less than 10% of recorded data.

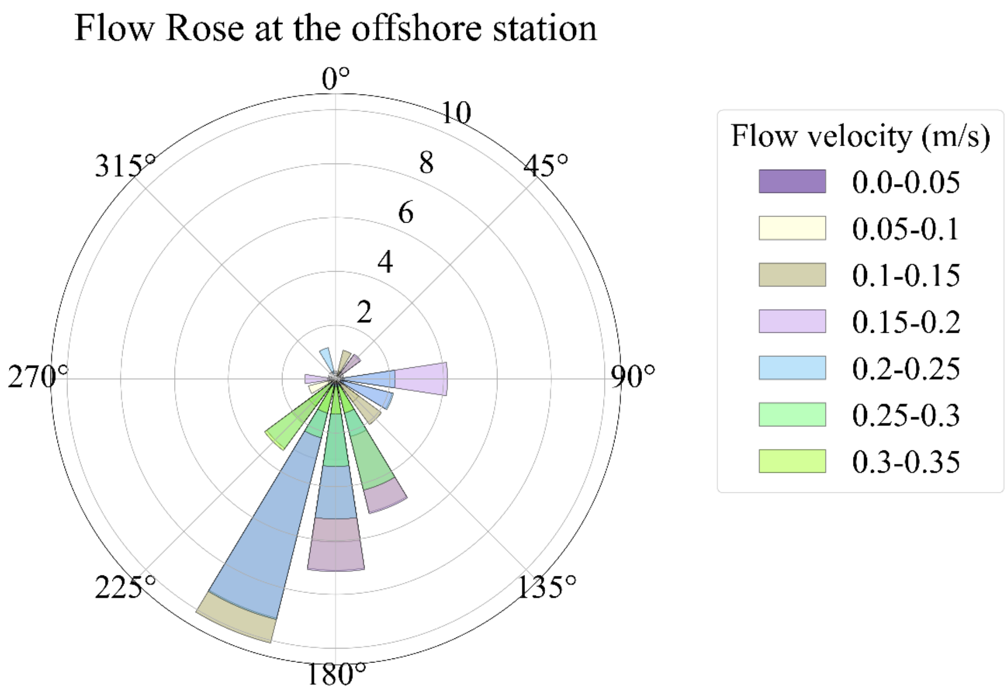


Figure 3-14. Flow velocity distribution at z = 0.85 m (close to sensor of Sentinel-V20)

The average flow velocity is around 0.2 m/s and reaches 0.4 to 0.5 m/s in some cases. In Figure 3.14, flows over depth are illustrated, giving an idea of wave structures.

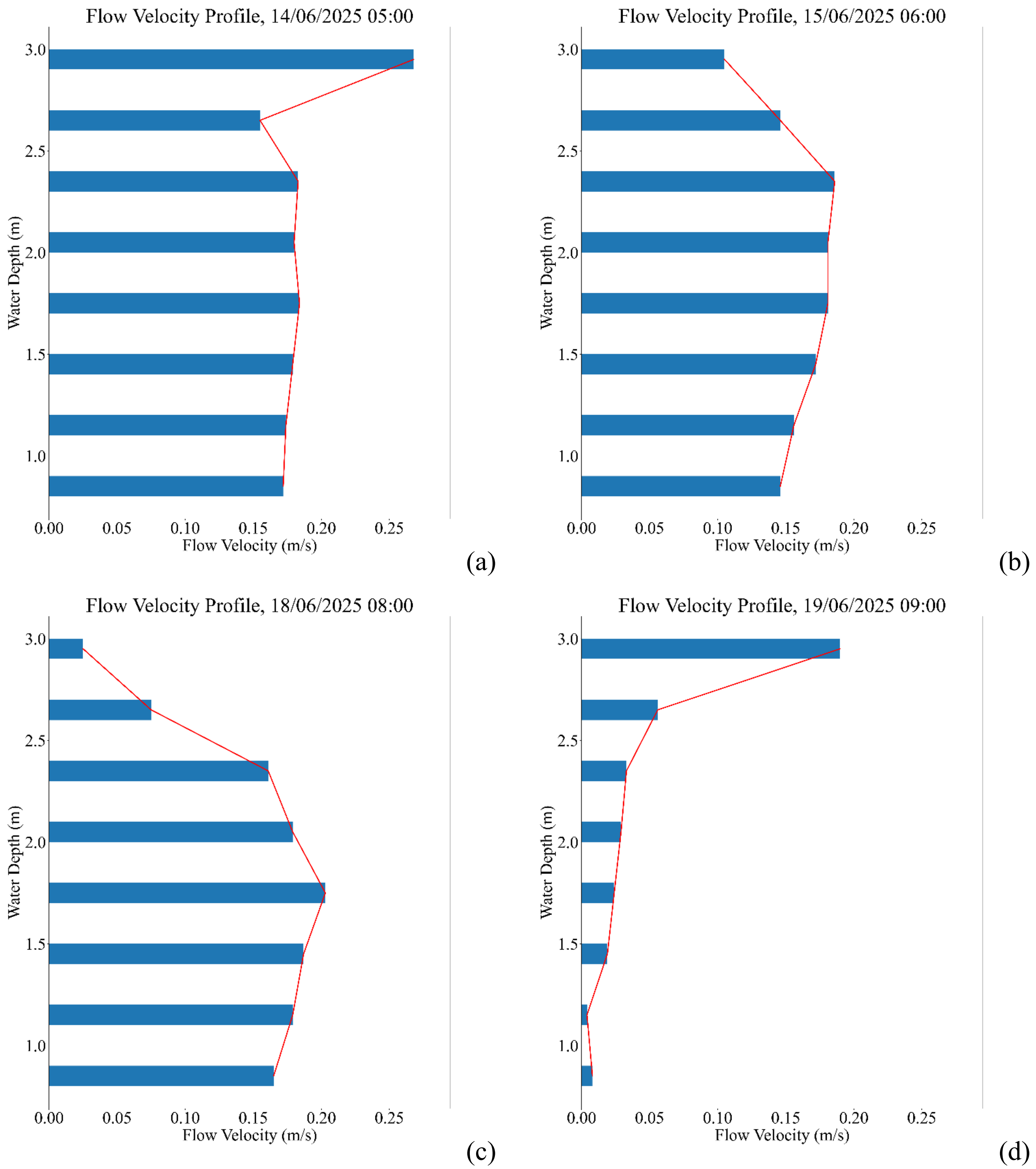


Figure 3-15. Flow velocity profile recorded from ADCP at offshore stations.

Suspended sediment concentration

Figures 3.14 and 3.15 present the SSC with water depth at two stations, near and offshore. In general, SSC on the shore are much larger and more dense than in the seaward location. The average of SSC in the offshore station is around 0.2 $g/dm^{3,}$ but this number in the shore is nearly triple.

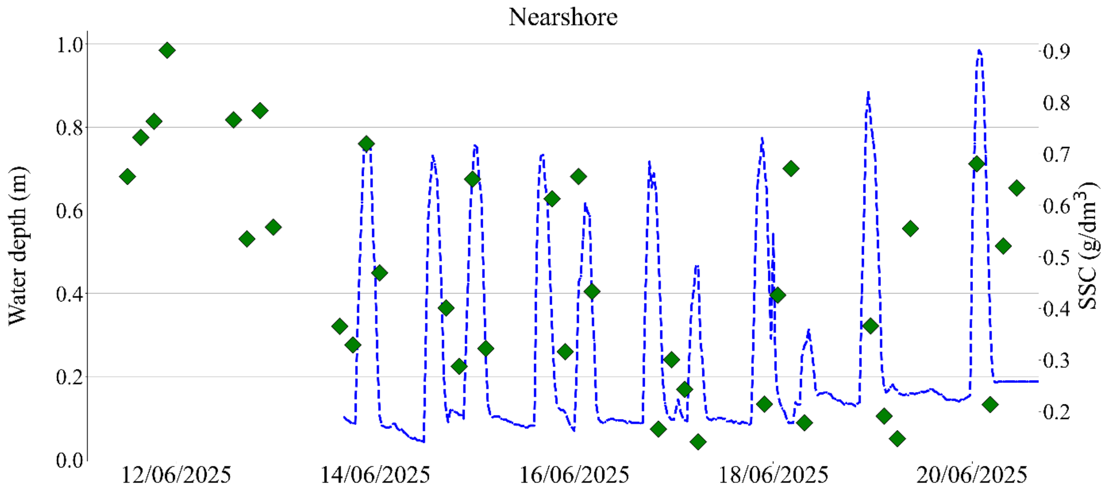


Figure 3-16. SSC at nearshore location

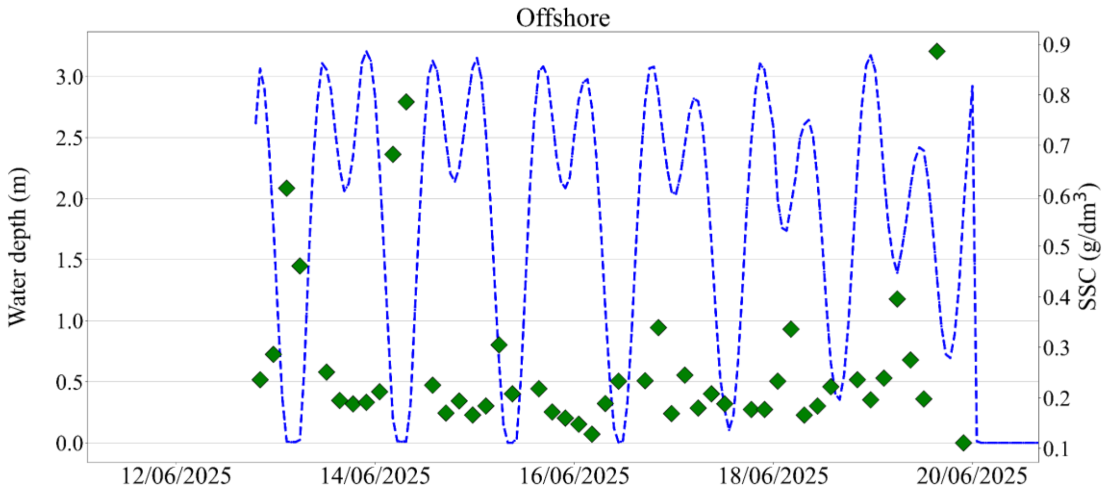
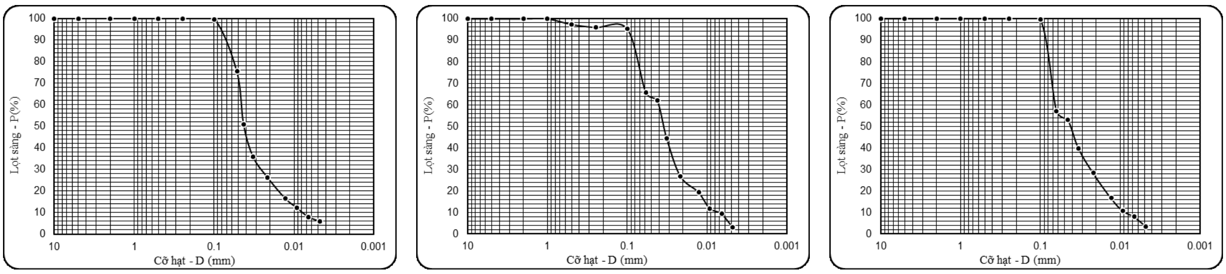


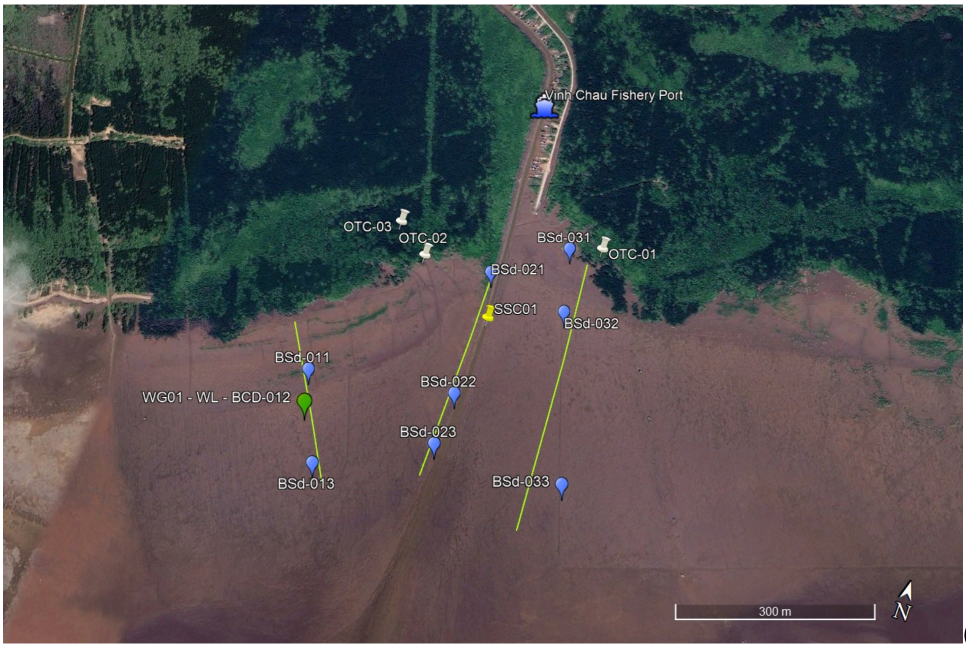
Figure 3-17. SSC at the Offshore station.

Bed sediments

Bed sediments are analyzed to have grain sizes as D50 and D90. In general, the grain size increases with the distance seaward. In Figure 3.16d, there are a total 09 bed sediment samples representing three standard sediments of the coast. Sand will be distributed more at the location further offshore, then finer sediments are at closer mangroves.



(a) (b) (c)



(d)

Figure 3-18. Bed sediment diameter contribution (a, b, and c in the left panel) and sample locations (d). Note that BSd is Bed Sediments

3.4 Bathymetry measurement

Settings

Bathymetry measurements are set to cover an area with a 4km in length and 700m in width as shown in Figure 1(left). Devices used for this task including the RTK and Fish-radar LowRange (See Figure 3.17).

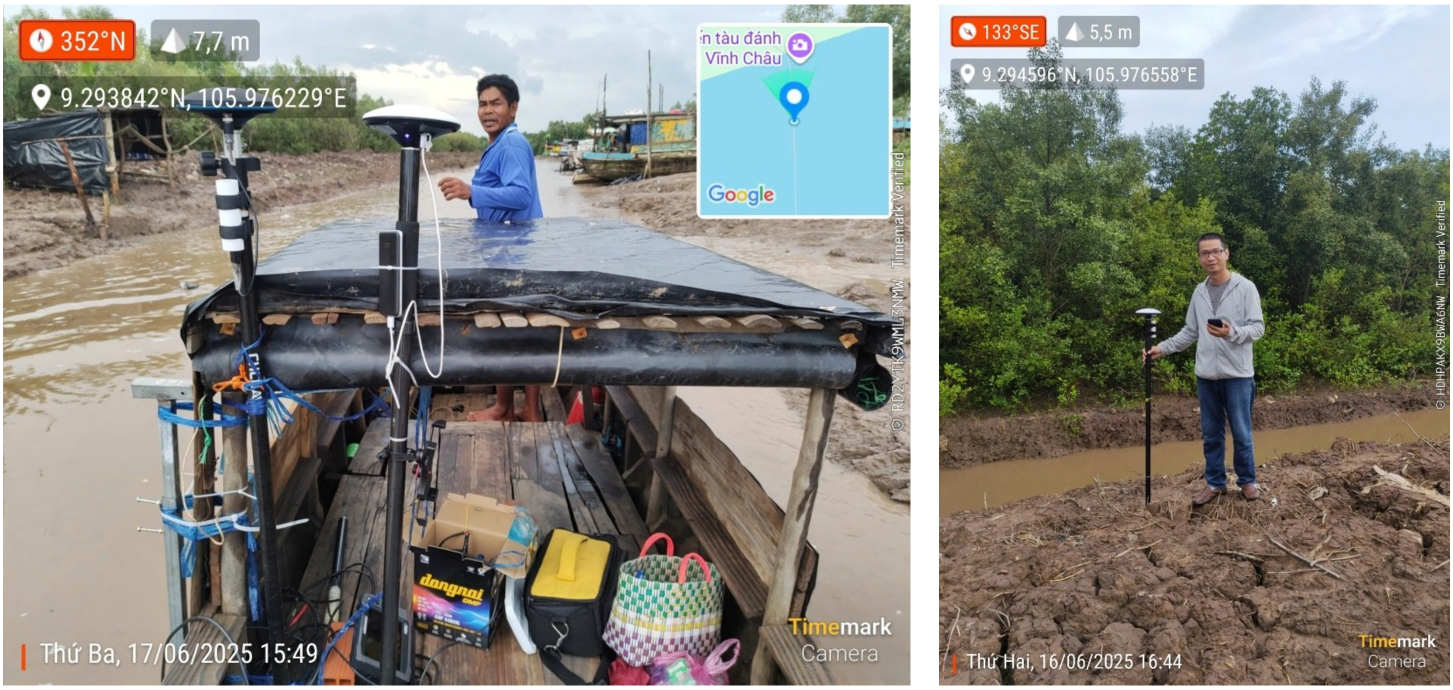


Figure 3-19. Equipment settings for bathymetry measurement

Data available

The data received after the fieldwork are presented in Figure 3.18.

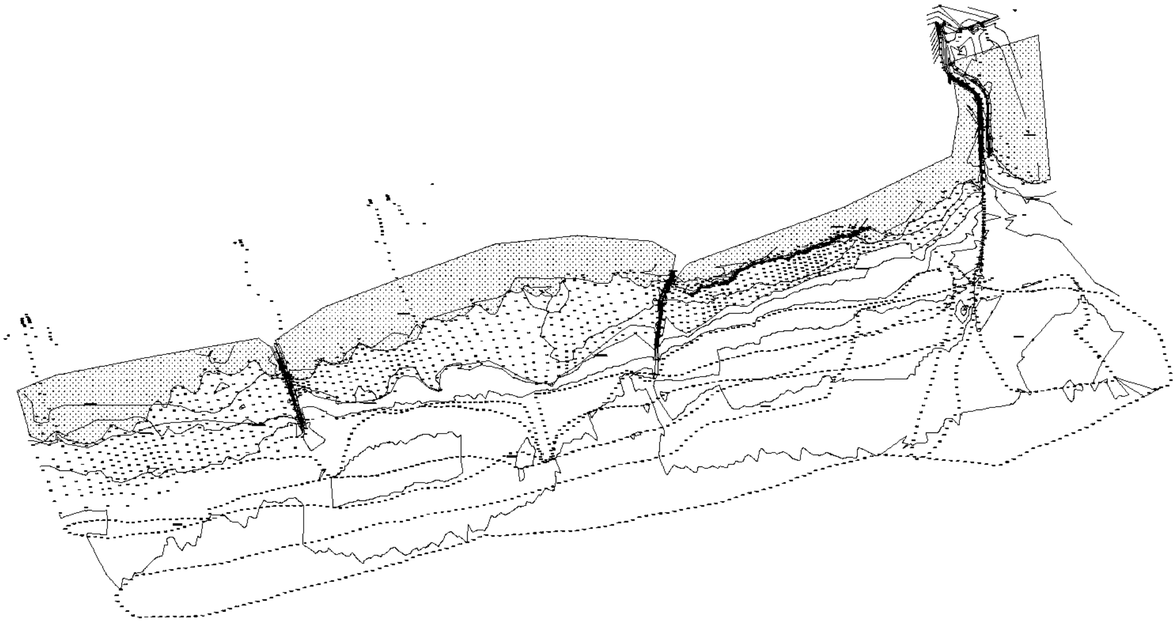


Figure 3-20. Bathymetry maps (raw) collection in Vĩnh Châu – Sóc Trăng area.

3.5 Mangrove survey

Settings

Mangrove surveys can be done within a sampling plot shown in Figures 3.19 to 3.21 and located in Figure 3.16d. The composition of mangrove species in the sampling plots are identified. After choosing the plots, experts will count and measure all necessary mangrove aspects, including the diameter of bodies, trunks and roots. More importantly, experts and volunteers need to define mangrove species in order to draw conclusions about their relation to the hydrodynamics.

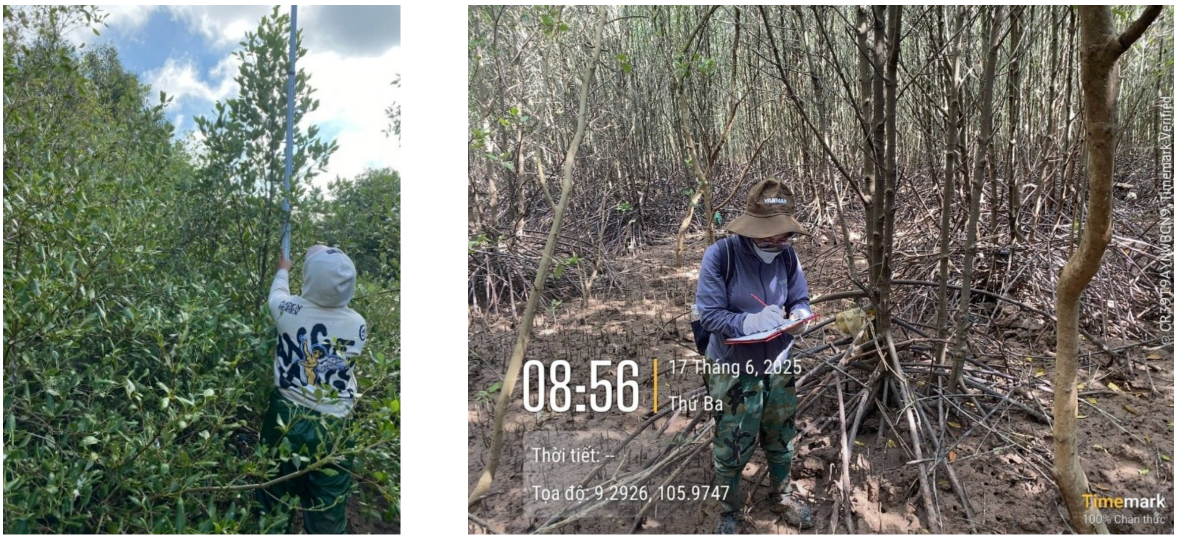


Figure 3-21. Avicennia marina in plot 1 (left panel), Rhizophora apiculata in plot 2 (right panel)

Figure 3-22. Avicennia marina in plot 3

Figure 3-23. Natural regeneration of mangroves on alluvial plain (left panel), Avicennia marina seedlings in plot 3 (right panel)

Data availability

Mangrove growth in sample plots is described below:

Table 3.2. Mangrove description in Vĩnh Châu – Sóc Trăng

Plot	Dominant species	Species	Hvn ±SD (m)	Do ± SD (cm)	D1.3 ± SD (cm)	Dt ± SD (m)
Plot 1	Mixed Avicennia marina + Rhizophora apiculata (Planted)	Am	3.03±0.96	4.0±1.8	2.2±1.5	1.54±0.56
		Ra	3.29±0.52	3.4±1.3	2.6±1.7	1.23±0.35
Plot 2	Mixed Rhizophora apiculata (Planted) + Avicennia marina (Natural)	Ra	7.11+1.27	6.1±1.7	5.3±1.5	2.34±0.75
		Am	6.23+1.83	8.4±4.7	6.4+3.6	1.87±1.20
Plot 3	Mixed Avicennia marina + Rhizophora apiculata (Natural)	Am	3.67±1.27	5.2±3.1	3.3±2.65	2.02±0.96
		Ra	5.25±1.77	9.9±1.5	5.7±0.8	3.50±0.56

Other than the data collected from the field, data from geographical images can also assist the project. Figure 3.22, mangrove distribution over the Vinh Chau coast can be shown in different colours. The majority of species are *Rhizophora apiculata*; however, nearly half of the area is still under discovering.

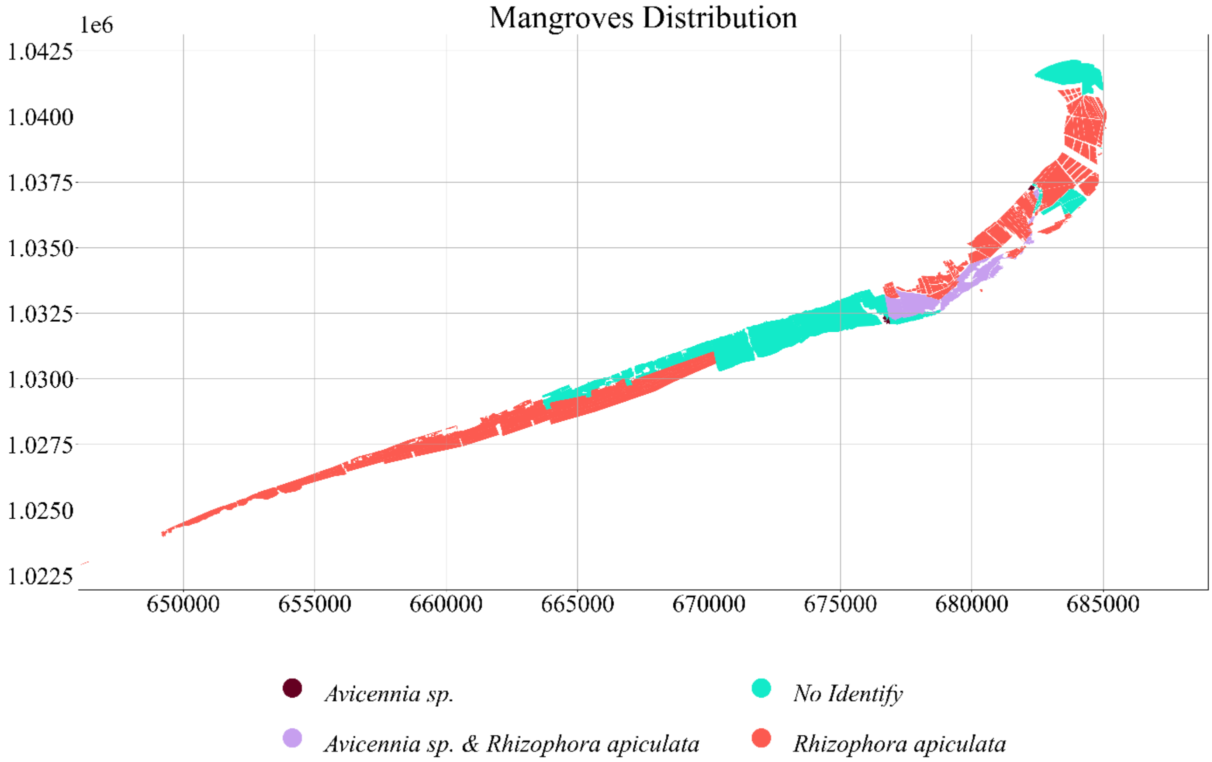


Figure 3-24. Mangrove distribution over Vinh Chau – Sóc Trăng.

3.6 Winter campain preparation

Our campaign finished and left many lessons for our next mission: "Complete a measurement year". The tasks for the winter measurement campaign were to repeat all stations installed in the summer campaign. This is because the water level will be much higher in winter, when most nearshore devices can capture signals. More importantly, the new setup will be deployed after discussion with experts.

July 2025, Bas Van Marren, senior specialist at Deltares and Associate Professor at Delft University, joined and supported the team in planning field campaigns and field activities. Within a week, the team focused on reviewing the summer measurement activities. Many pieces of feedback were received to improve the winter plan.

Figure 3-25. Meeting in July 2025 with Bas Van Marren for measurement plans.

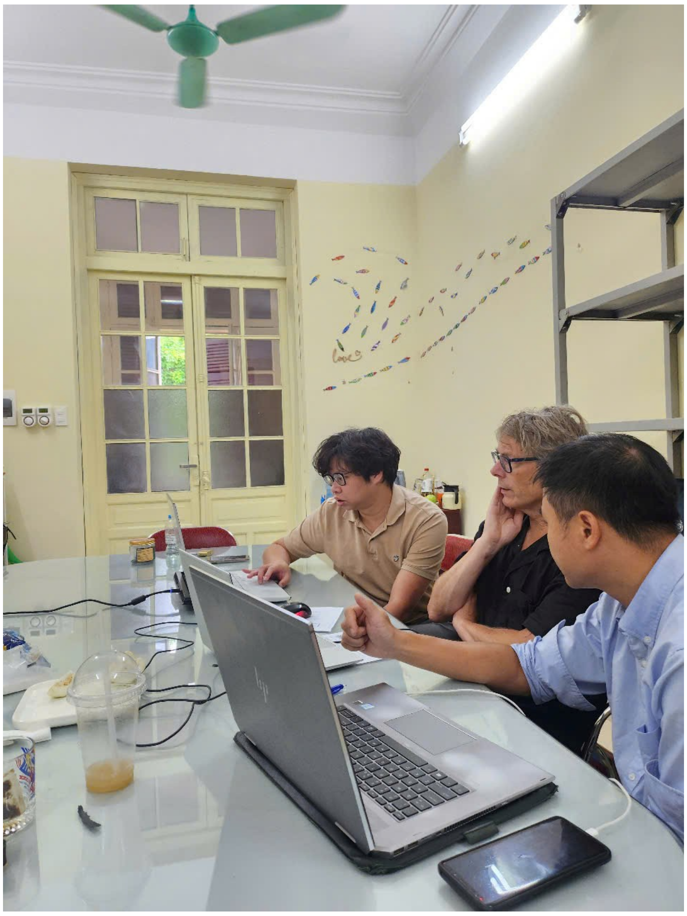


Figure 3-26. Disscussion on Mangroves Living Lab Website

The winter measurement plan was scheduled for the peak period, when the water level is highest. This plan was approved and agreed upon by the team to capture nearshore wave and water-level signals that had not been received in the summer.

Figure 3-27. The new set up for offshore wave stations. It is one more wave station which is set at water depth at 8 m (WB02). The previous station, WB01, is in the same location.

In addition, parallel stations were set up for an optional and interesting idea. This idea stems from the fact that mangrove reduction has been clearly documented over the years. The team also supported the simultaneous measurements to have a clear vision of hydrodynamic differences between healthy and "not" healthy mangroves.

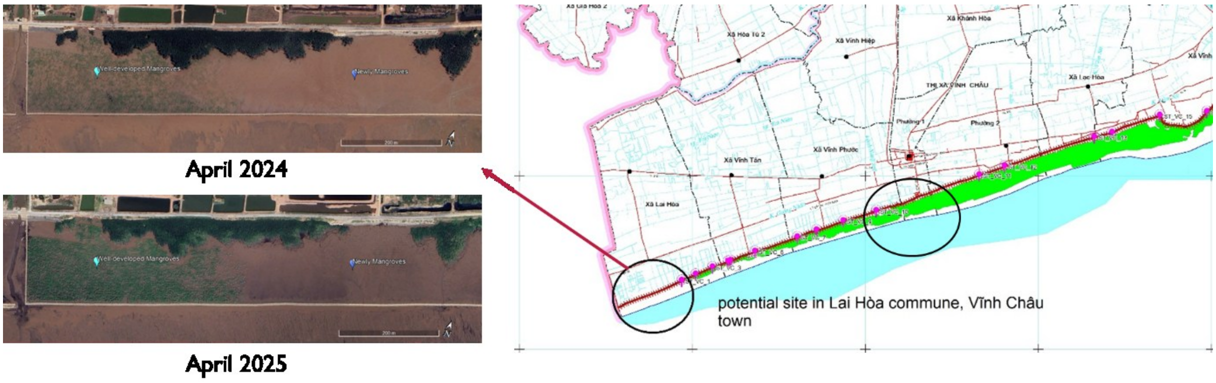


Figure 3-28. Ideas for simutinous stations.

The team had one more meeting in the first week of August, 2025. The Vietnamese team, once again, reviewed and reported to the Dutch side for the next field campaign. Also, the project goals were reviewed for the first time, as shown in Section 6.

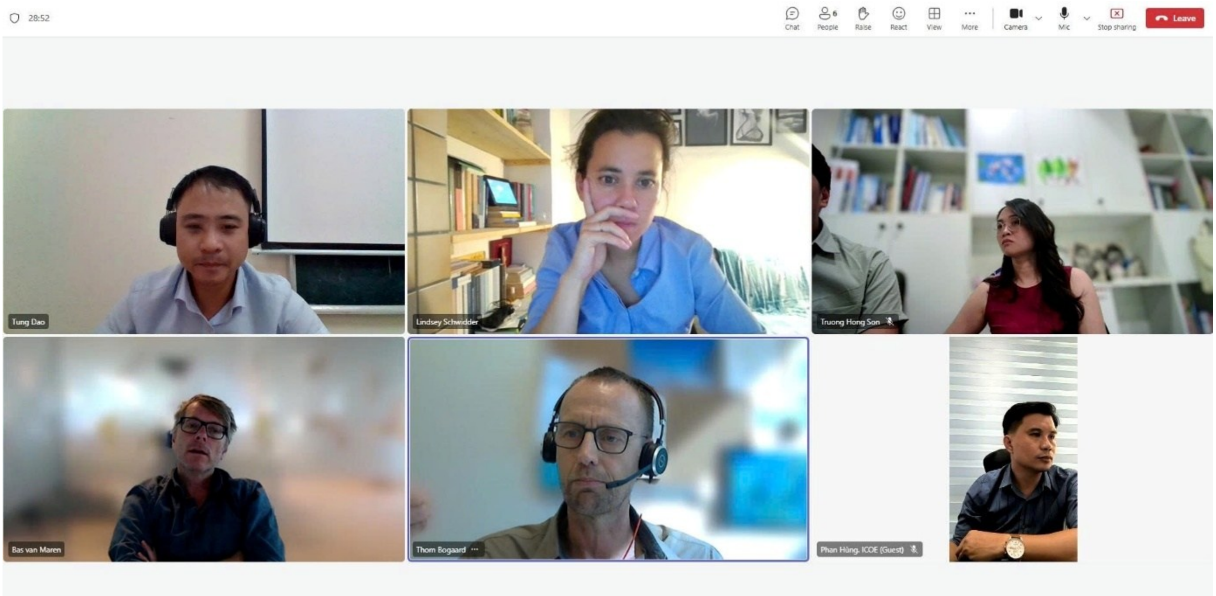


Figure 3-29. Meeting online for mid 2025 report.

4 Digital Living Lab Platform

4.1 Mangrove Living Lab's digital space

As part of the project, the team is developing a digital space, referred to as the Mangrove Living Lab's digital space. The primary purpose of this digital space is to support sharing and connection between the project and its stakeholders. This includes:

-/ Introducing the project's content, objectives, missions, approaches, expected outcomes, and collaboration opportunities to partners, stakeholders, donors, potential collaborators, interested individuals, and other research groups both domestically and internationally. (Living Lab Mission, Objectives, and Approach);

-/ Sharing project activities that have been implemented, are ongoing, or planned for the short, medium, and long term. (Living Lab Actions);

-/ Sharing knowledge, including concepts, terminologies, articles, publications, lessons learned, and experiences throughout project implementation, as well as the latest scientific hypotheses related to coastal mangrove restoration in the Mekong Delta and shoreline protection. (Living Lab Knowledge);

-/ Sharing datasets collected and measured by the project with relevant stakeholders, and seeking collaboration opportunities to expand or implement additional activities that require supplementary funding. (Living Lab Database).

Thus, the digital space serves as a primary connection point, acting as the central hub that links to the project's datasets and other relevant data repositories, facilitating the distribution and dissemination of project outputs.

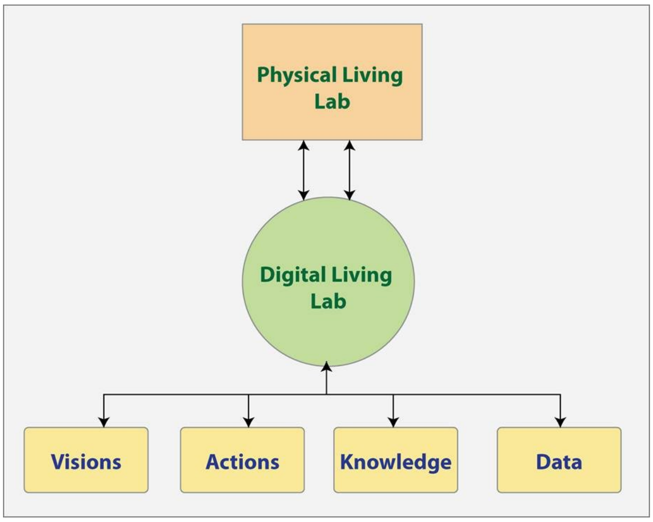


Figure 4-1. Conceptual idea of the Living Lab digital space

Initial Concept

Given that the Mangrove Living Lab project is highly scientific with in-depth technical terminology and content extending beyond knowledge sharing to include guidance, technical documentation, and datasets, the research team envisions the digital space as a wiki hub. This will act as a gateway to connect related digital components.

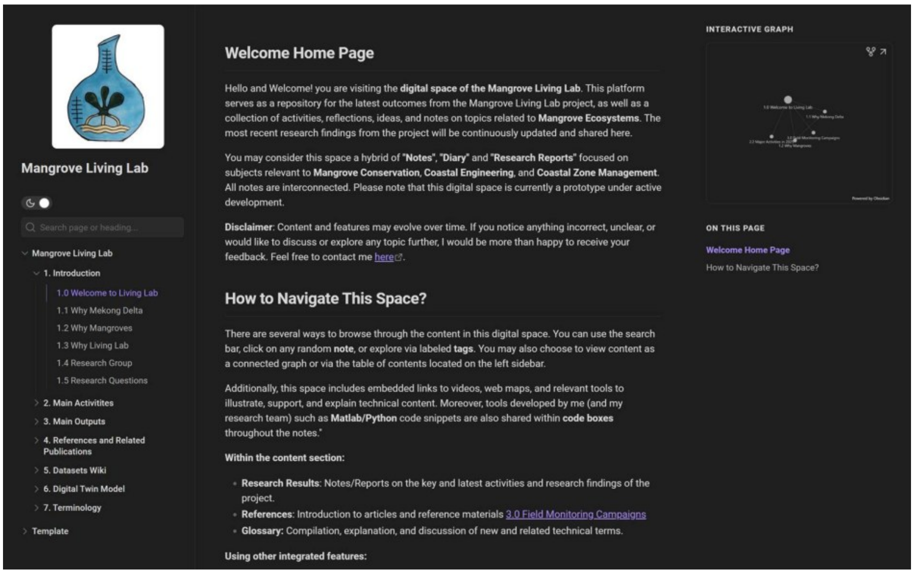


Figure 4-2. Welcome page of the Living Lab digital space

Technical Tools

The primary tool selected to establish the digital Living Lab space is Obsidian a note-taking application that allows users to publish content as a website. Its main advantages include simplicity, ease of use, updatability, and low cost. Moreover, Obsidian offers strong integration capabilities, allowing for the direct embedding of external websites, web applications, and web-GIS platforms, making the Living Lab digital space highly versatile and expandable. The digital space is currently under development. Its current version can be viewed at: https://publish.obsidian.md/livinglab/Mangrove+Living+Lab/7.+Terminology/Mangroves

In addition to Obsidian, other tools are being considered for web-GIS and web-app development, including ArcGIS, Python, and Streamlit, among others.

Examples of Integration

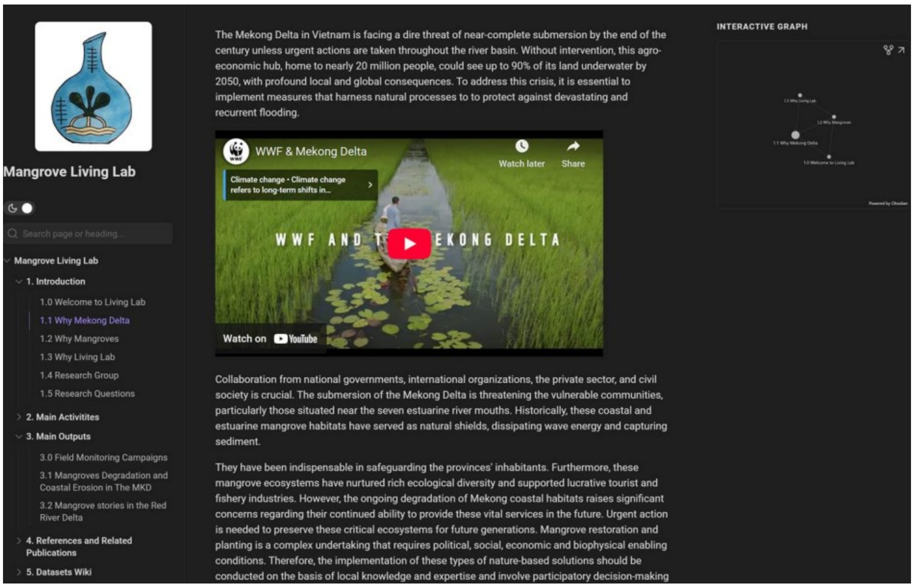


Figure 4-3. Direct integration with video platforms (e.g., YouTube), allowing users to watch promotional videos directly within the digital space.

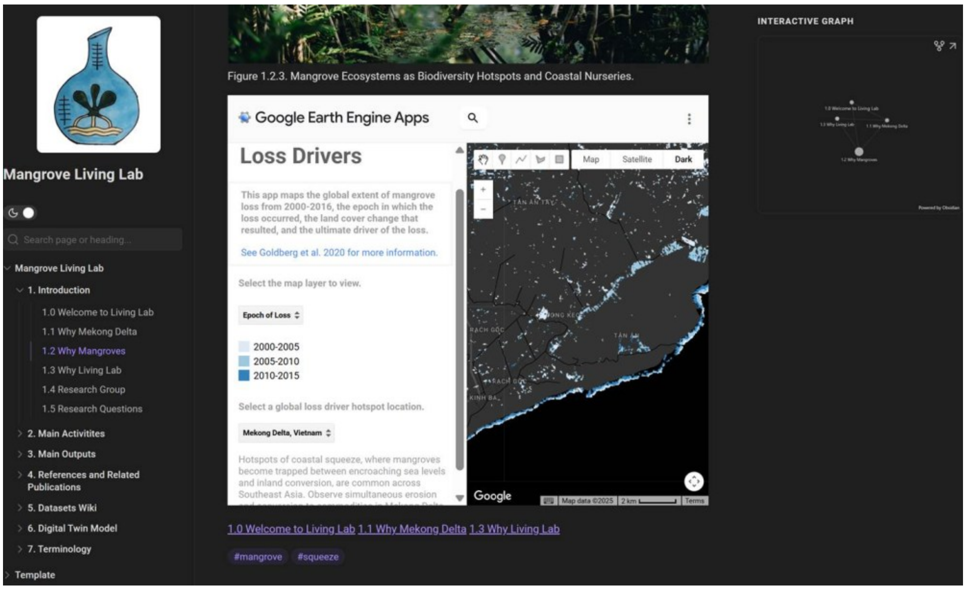


Figure 4-4. Direct integration with web-GIS platforms enables users to interact with integrated spatial datasets.

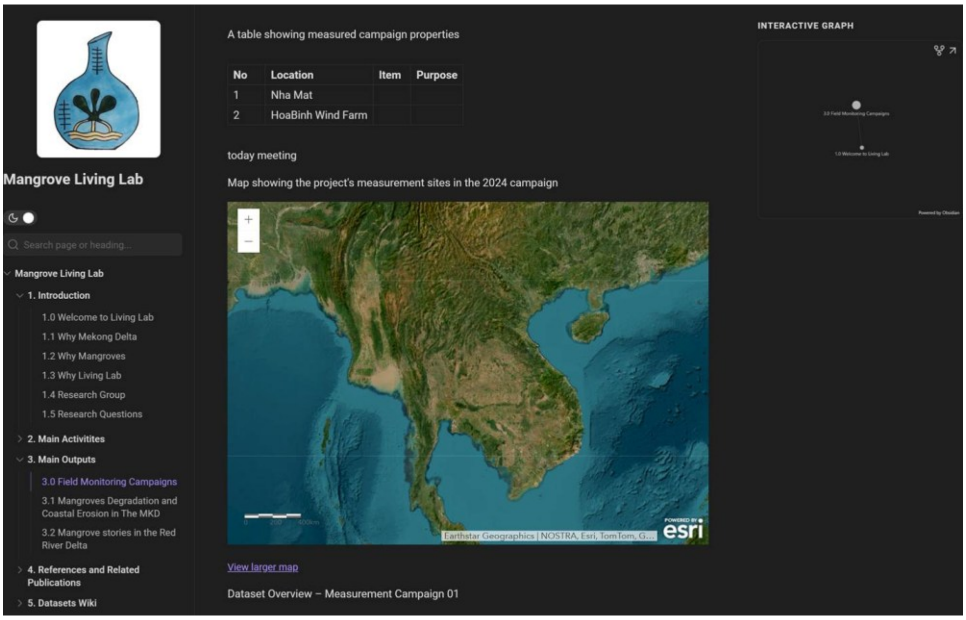


Figure 4-5. Mapping and measurement integration via web-GIS to display specific locations and recorded data.

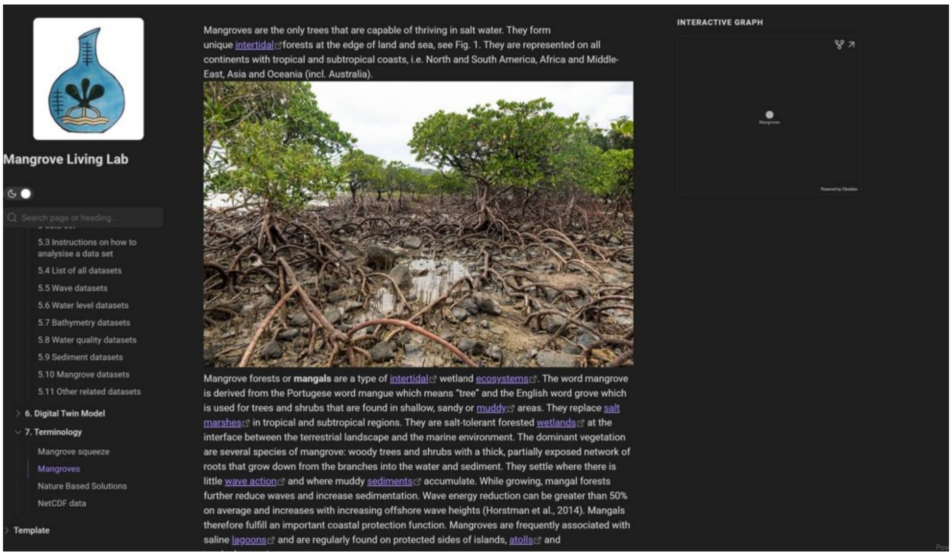


Figure 4-6. Interlinked scientific terms and concepts facilitate easier access and sharing of relevant scientific knowledge.

Implementation Plan

In addition to the core project members, the digital space will continue to be developed with support from members of the MDP student group from the Netherlands shortly.

4.2 DataWeb Platform

Data from previous fieldwork campaigns can be stored and presented via the WebGIS, which refers to the geographic information system. This allows the team and colleagues to access and download data. This WebGIS was developed in early 2024 by another team who strongly involved in collecting GIS data of mangroves and analyzing satellite images. This team also supports the data for Figure 3.23.

Figures 4.7 and 4.8 present the interface of the WebGIS of the project. Users can interact with a chosen station where data is available.

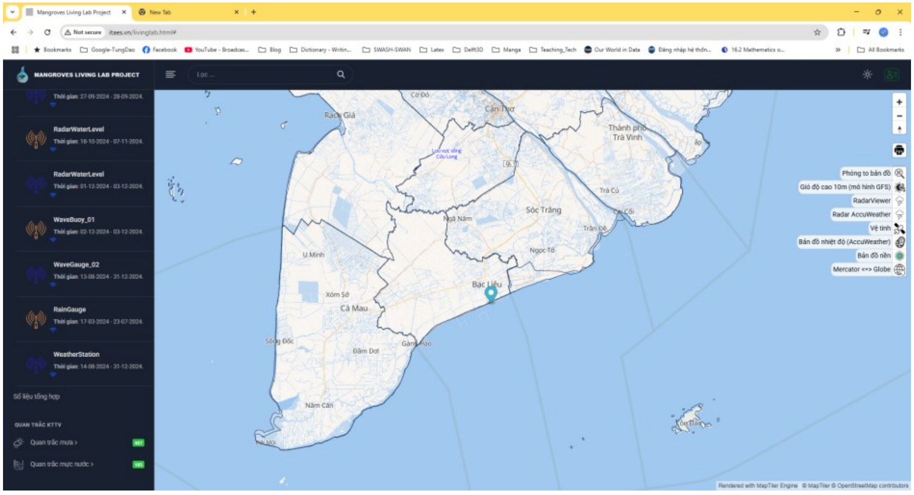


Figure 4-7. Data storage Website for the project. http://itaes.vn/livinglab.html

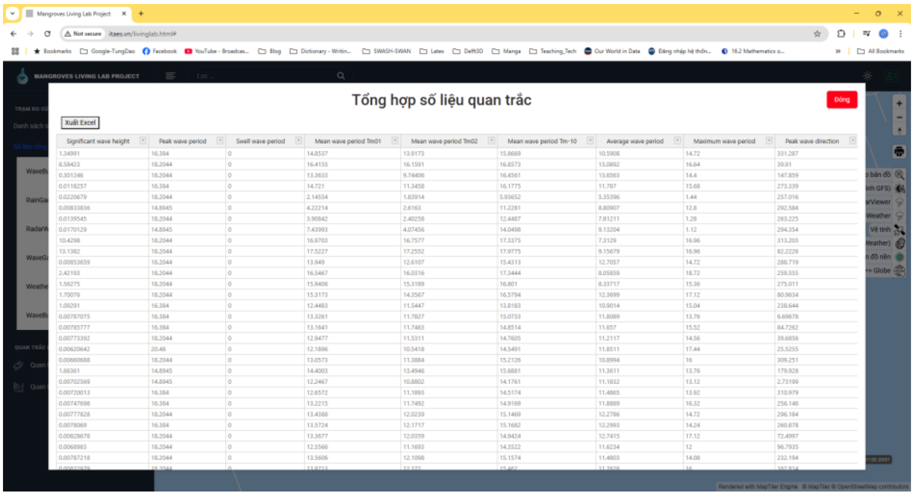


Figure 4-8. Data from one station can be extracted into Excel files and present again.

Even though this data web can be used for scientific and academic purposes, improvements for user updates should be added. The combination of Mangrove Living Lab's digital platform and DataWeb can be a good option.

5 Second term of 2025

The team will propose a list of activities for 2025 which is fit for the project goals. A number of activities can be listed below:

No.	Activity	Time	Equipment/Method	Note
1	Long-term monitoring of water levels at Hoa Binh Wind Farm	From July to October 2025	Radar Water Level Gauge	Equipment should be installed in July
2	Cross-shore profile monitoring test in Vinh Chau	July 2025	Bamboo/wooden poles	This is a test to see bathymetry changes.
3	Additional mangrove surveys in Vinh Chau	July 2025	Additional sampling plots	Additional parameters
4	Joint measurement campaign in Kim Son, Ninh Binh	October 2025	Wave buoy, Divers, Wave gauges, Flow and more	-
5	The second comprehensive measurement campaign at Vinh Chau in November (expected) during the spring tide period	November 2025	Repeat equipment and measurement set-up as in June 2025	Cooperative partners: ICE, ICOE, Cần Thơ Uni (postponed due to revision)

6 Conclusion

6.1 Remarks on Project Goals

The team has reviewed all working packages (WP) in the proposal and listed out below:

Table 6.1. WP 1 Scoping & selection

No.	Activities	Status	Plan
1.1	Site investigations	Plenty has been done	Continue in 2025, early 2026
1.2	Researching current solutions for coastal protection	Currently working	Continue in 2025, 2026
1.3	Organizing meetings and workshops on the idea of a living lab	Red River and Mekong Delta	Continue in 2025, 2026
1.4	Involving big donors like ADB and the World Bank	Currently working	Continue in 2026
1.5	Make the selection of a suitable site in one of the provinces in the Mekong Delta	2 Options: -/ Vĩnh Châu, Sóc Trăng -/ Hoa Binh Wind farm, Bac Lieu	Wait for the November 2025 field campaign for a decision.
1.6	Permission needs to be granted for the chosen location of the living lab	Currently working	September and October 2025 (ICOE)
1.7	Involving the local communities in the search for a location for the living lab	Currently working	Continue working (ICOE)
1.8	Make a decision on the location of the living lab	2 Options: -/ Vĩnh Châu, Sóc Trăng -/ Hoa Binh Wind farm, Bac Lieu	Wait for the November 2025 field campaign for a decision. First choice: Vĩnh Châu, Sóc Trăng

Table 6.2. WP 2 Design and construction

No.	Activities	Status	Plan
2.1	Make the design of the living lab	Currently working	Continue in 2025, 2026
2.2	Plan and design the interior layout of the lab	Currently working	Continue in 2025, 2026
2.2	Conduct the first few experiments in the living lab together with students and staff of our partner universities/institutes	Has done many MDP groups from TU Delft	Continue in 2025, 2026
2.3	Develop a (joint) research agenda to advance knowledge on nature-based solutions in the Mekong Delta	Has done in MKD, the Red River Delta (Kim Sơn, Ninh	Continue in 2025, 2026

No.	Activities	Status	Plan
		Bình)	
2.4	Embedding the field lab in the various relevant institutions and programs through educational activities	Has connected with: -/ Institue Technology of Bandun / IInstitut Teknologi Bandung, Indonesia in August 2024 -/ Kumamoto University, Japan in June 2025	Continue in 2025, 2026
2.5	Developing a digital platform in which we will share our research findings, provide input on policies, and support decision-making processes and ongoing projects	02 Platforms: -/ Mangrove Living Lab's digital space* -/ WebGIS Platform**	Continue working with contribution by Truong Hong Sơn, Phan Khanh Linh; and Nguyen Anh Hùng, Pham Quang Loi in 2025, 2026
2.6	Engaging the local community by offering workshops, educational programs and public events	One activity so far in Phù Long, Cát Hải, Hai Phong	Continue in 2025, 2026

**https://publish.obsidian.md/livinglab/Mangrove+Living+Lab/7.+Terminology/Mangroves*

***http://itaes.vn/livinglab.html*

Table 6.3. WP 3 Experimentation and research

No.	Activities	Status	Plan
3.1	Identify and implement appropriate research methods and monitoring protocols required for the actual design and construction of the living lab.	Discussion, inspiration by Prof Marcel Stive TU Delft Team visiting: -/ Bas & Thom visit September 2024 -/ Bas visit July 2025	Continue in 2025, 2026
3.2	Evaluate the suitability of existing instrumentation and make informed decisions on acquiring new equipment if needed.	Done	No further plan
3.3	Purchasing the necessary equipment and materials for monitoring and evaluation	Done	No further plan
3.4	Carry out the experiments and the tests in the living lab	07 campaigns in the Red River &	Continue in 2025, 2026

No.	Activities	Status	Plan
		Mekong Delta	
3.5	Create and develop a specialized data platform for the physical permanent living lab location and the mobile measurement campaigns	-/ Showcase in Hòa Bình wind farm, Bạc Liêu (new Cà Mau) -/ Measurement location in Vĩnh Châu, Sóc Trăng (new Cần Thơ)	No further plan

Table 6.4. ***WP 4 Demonstration of the living lab***

No.	Activities	Status	Plan
4.1	Promotion material about the living lab, online as well as on-site, through visible signposts and markings	Currently working	Hoa Binh wild farm: poster, brochures, after getting nice results
4.2	Documentation and communication material in which we share the various experiments and research set-ups in the living lab	Currently working	The report is under construction
4.3	Set-up demos for validation and testing purposes	Done in Vĩnh Chau campaign in June 2025	Continue in Vĩnh Chau campaign in November 2025

6.2 Lesson and learn

The project has done 05 measurement campaigns in its first year and 02 in the first 6 months of its second year in both the Red River and Mekong deltas. There are quite many activitives have done so far, including site investigations, organizing meetings and workshops on the idea of a living lab, conduct the first few experiments in the living lab together with students and staff of our partner universities/institutes, evaluate the suitability of existing instrumentation and make informed decisions on acquiring new equipment if needed, and reate and develop a specialized data platform for the physical permanent living lab location and the mobile measurement campaigns.

In the coming months, many more activities will be done, and the team will always come up front and ready to learn from the mistakes. Several data lost due to the lack of experience and necessary acts after having a proper plan. Practice in the field needs special skills and in some cases, experts need to "taste" first before taking acts. In the second campaign of 2025 in Vinh Chau, the team will carefully plan and calculate every matter that can negatively impact the whole campaign.

7 Events and workshops

For a past 6 months of 2025, the team continuted to introduce and has already presented project's work to many potential partners. There are high school students that the team wants to focus on for future cooperation. In addition, there are potential partners who are already in partnership with TLU and ICE. Below messages are the evens, workshop and meetings the team join.

7.1 VinSTEM Fair

The VinSTEM Fair is the annual event that strongly encourages high school students in the VinSchool system to create their new researches. The team and TLU's students also attended on 11 January 2025 at VinSchool and introduced the Mangrove Living Lab. Additially, the team brought measurement equipment and answer many questions from high school students.

Figure 7-1. TLU's students and the team at VinSTEM Fair (https://vmat.vn/vi/tin-cong-ty/vmat-dong-hanh-cung-vinstem-fair-truyen-cam-hung-tu-khoa-hoc-den-xay-dung.html)

7.2 Delegation of CRISO, Chulalongkong University, Griffith University

On the morning of January 21, 2025, Thuyloi University held a meeting and worked with delegations from CSIRO, Griffith University (Australia), and Chulalongkorn University (Thailand). The meeting aimed to discuss research and training issues and seek cooperation opportunities in common research areas. The team also had a chance to introduce the Mangrove Living Lab at the workshop and received many well feedback for coming cooperation.

Figure 7-2. Dr Le Hai Trung at the workshop and introduce the Mangrove Living Lab (https://www.tlu.edu.vn/tin-tuc/truong-dai-hoc-thuy-loi-tiep-don-cac-27555)

7.3 Delegation of Langang Mekong Water Resources Cooperation Center

On March 19, 2025, Thuy Loi University had a working session and exchange with the delegation of Lancang-Mekong Water Resources Cooperation Center to discuss water resources management issues and seek future cooperation opportunities. The meeting was chaired by Vice President Nguyen Canh Thai, with the participation of leaders of units in the university and experts from Lancang-Mekong Center and Yangtze River Basin Research Institute.

In addition, Associate Professor Dr. Le Hai Trung also introduced the Living Lab project in the Mekong Delta: Initial monitoring of waves and mangroves, emphasizing the role of mangroves in mitigating the impacts of climate change and protecting the coastline. The project aims to build a monitoring system, collect real-world data to serve research and propose sustainable solutions.

Figure 7-3. Dr Le Hai Trung at the workshop (https://www.tlu.edu.vn/tin-tuc/truong-dai-hoc-thuy-loi-tiep-don-doan-28613)

7.4 US education partners and Thuy loi University

The purpose of this visit by the US education delegation to Vietnam is to learn about Vietnam's higher education system, seek opportunities for cooperation, and exchange training programs with Vietnamese universities, especially in fields such as artificial intelligence (AI), technology, science, and healthcare.

Currently, the United States is a destination for over one million international students, including more than 30,000 Vietnamese students, ranking fifth in terms of the number of international students in the US. Strengthening connections between leading universities in both countries will create a solid foundation for expanding learning, research, and teaching opportunities for students and faculty in both Vietnam and the United States.

During the meeting, representatives from US universities discussed the IAPP 2025 program, designed as a strategic bridge to strengthen connections between Vietnamese and US universities. Through this program, both sides will be supported in developing specific, practical cooperation plans aimed at long-term sustainable development. Representatives from the Water Resources University and members of the IAPP delegation discussed strategic cooperation directions for the future. Both sides agreed that educational and scientific research cooperation between leading US and Vietnamese institutions will contribute to promoting international integration and improving the quality of the global workforce.

Following the discussion, the delegation toured the laboratory facilities of the Water Resources University. The delegation visited the ACROSS Center of Excellence, the Chemical Engineering Department, the Biotechnology Laboratory, and the Hydraulic Synthesis Laboratory to exchange ideas with researchers on simulating and analyzing flow phenomena, serving research and design of hydraulic structures.

Figure 7-4. Dr Le Hai Trung on the mission to bring out Living Lab goals to the world. https://tlu.edu.vn/phai-doan-doi-tac-giao-duc-cac-dai-hoc-hoa-ky-toi-tham-va-lam-viec-voi-truong-dai-hoc-thuy-loi-35750/

7.5 Supervising the TU Delft MDP students under the MLL Project

Within the framework of the Mangroves Living Lab Project, supervising the annual MDP (the Netherlands) student team is a recurring activity that promotes academic exchange, strengthens international collaboration, and supports knowledge transfer for coastal management. This year's MDP group comprised students from the faculties of Civil Engineering, Industrial Design and Technology, and Policy and Management. The team's main objective this year was to develop a digital platform for the Living Lab, aiming to better structure project data, standardize information, and improve accessibility of scientific outputs for diverse user groups.

Over 10 weeks in Viet Nam, the team began in Ha Noi, where they met with supervisors and project members to clarify the Living Lab's objectives and target users. They also joined a field visit to the mangrove area in Ninh Binh, which helped them develop a clearer, experience-based understanding of mangrove ecosystems and related practical challenges.

Figure 7-5. Field trip to Kim Dong Mangrove Forest, Ninh Binh Province

After defining a more concrete direction, the team continued their work at ICOE and was guided on field visits to the Mekong Delta the project's primary focus area. On 23 October 2025, the Living Lab team member and the Dutch MDP students attended the Vietwater Conference in Ho Chi Minh City, where the project and interim student outputs were presented, with participation from representatives of the Embassy of the Netherlands in Viet Nam and RVO. The following day, a field visit to the Mekong Delta was conducted to showcase key Living Lab sites, including Nha Mat (wind farm) and Vinh Chau.

Figure 7-6. MDP Team Presentation at the Vietwater Conference and Group Photo with Representatives of the Embassy of the Netherlands in Viet Nam and RVO.

On 03/11, the team delivered a final presentation to a panel consisting of Dutch supervising professors and Vietnamese supervisors. The final presentation was also attended by a representative of the Embassy of the Netherlands in Viet Nam, highlighting the strong institutional support for the Mangroves Living Lab collaboration. A key output of the team was the "Mangrove Living Lab" website, which integrates information and tools for a wide range of users, including policy makers, researchers, lecturers, students, and local management agencies.

Figure 7-7. Final Presentation at Thuy Loi University with Vietnamese supervisors, online participation from TU Delft and ICOE, and a representative of the Embassy of the Netherlands in Viet Nam

The website provides an integrated overview of the Mekong Delta's coastal challenges and enables users to interactively explore and retrieve information on shoreline conditions, sea dike systems, wave-reducing/breakwater structures, mangrove restoration projects, as well as field measurement datasets generated by the Living Lab Project. Access is facilitated via an attached QR code, while data are updated daily and content continues to be expanded as the project progresses. Overall, the platform represents a practical and high-value product that enhances data sharing, supports evidence-based decision-making, and offers long-term benefits for Viet Nam's coastal research and management community.

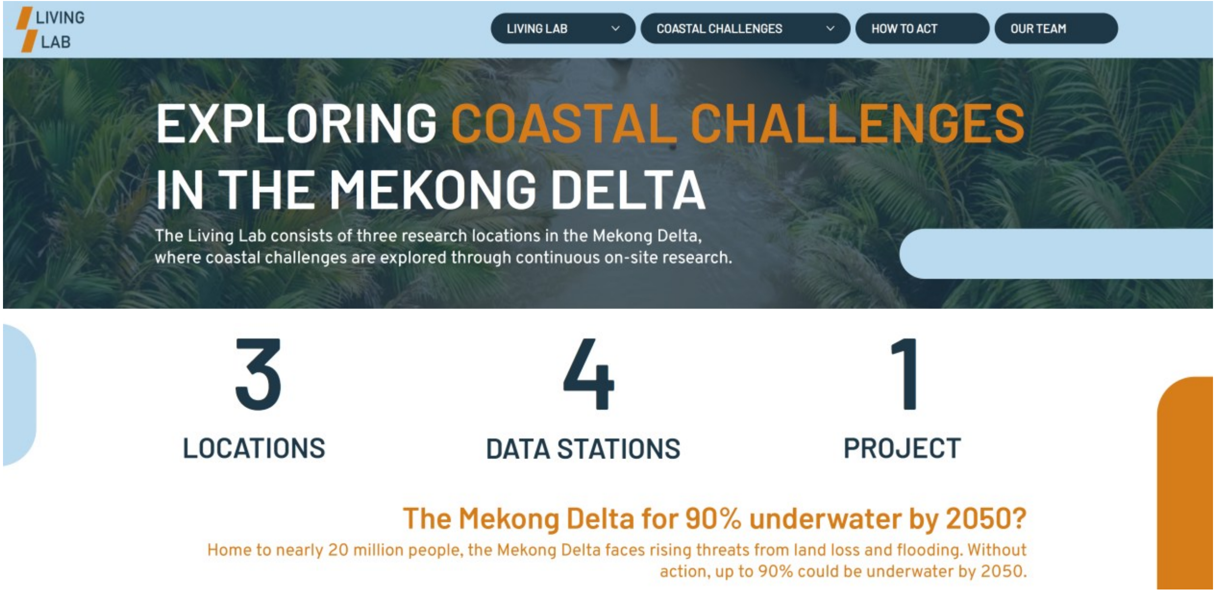


Figure 7-8. Mangroves Living Lab Digital Platform (Project Website), available at https://www.livinglabmekongdelta.com/

7.6 **A warm visit from RVO to measurement field**

In late October 2025, the team received an honour visit from RVO to the field at the long-term lab, the Hoa Binh Wind farm, Bac Lieu (now in Ca Mau after 1st July 2025) province, and the mobile lab, Vinh Chau Commune, Soc Trang (now in Can Tho after 1st July 2025). For this special event, Dr. Phan Manh Hung, Le Hai Trung, and Dao Hoang Tung presented a showcase of water-level, weather, and wave stations to guests and sought to identify erosion/mangrove reduction issues in the Bac Lieu coastal area.

Figure 7-9. Dr Phan Manh Hung disscus the mangrove issues in Hoa Binh Wind farm area

Figure 7-10. Dr Dao Hoang Tung disscussed and presented the measurement stations for research purposes.

On the same day, guests and the entire team travel to the mobile lab in Vinh Chau Commune, Can Tho, where the summer campaign took place. This location is presented as a healthy mangrove and receives good feedback from the guests.

Figure 7-11. Guests in the mobile lab, Vinh Chau Commune, Can Tho

Figure 7-12. Dr. Le Hai Trung and Guests in the mobile lab, Vinh Chau Commune, Can Tho.

7.7 Project team meeting in Hanoi

In late November 2025, the entire Living Lab team gathered at Thuy Loi University in Hanoi. In this meeting, the team discussed field activities from the outset, including reviewing all potential conflicts and solutions. Many strong arguments arose among team members due to a lack of proper communication before and after each field campaign.

Later that week, the team was honoured to meet the Rector of Thuy Loi University for a warm, welcoming discussion about the project's future. More importantly, the project and team were guaranteed to have full support from TLU.

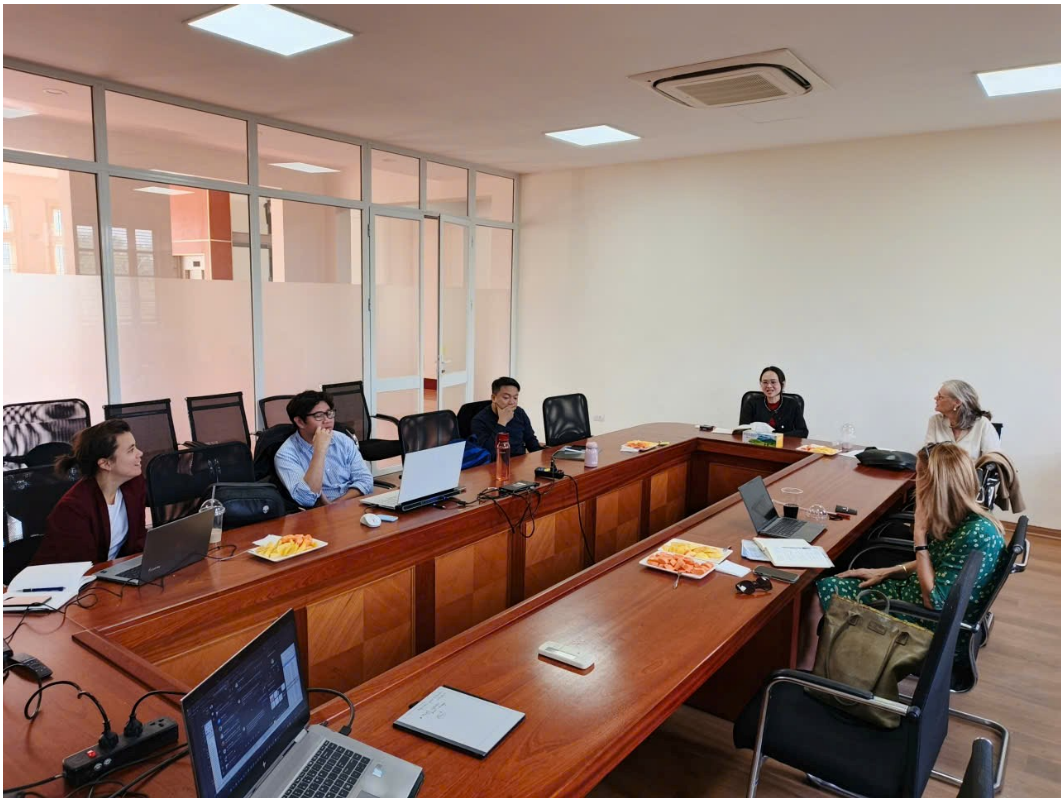


Figure 7-13. Solid discussion of the whole team

On November 24, 2025, the Water Resources University welcomed and held a working meeting with a delegation from Delft University of Technology (TU Delft, Netherlands) as part of activities to promote cooperation in training and research between the two universities. Professor Dr. Nguyen Trung Viet – Rector of the University – chaired the meeting, with the participation of leaders from the Department of Science and Technology & International Cooperation and the Faculty of Engineering.

The two sides exchanged information on the implementation of the Mekong Delta Living Lab Project, funded by the Dutch Ministry of Water Resources/Partners for Water Program. Ms. Marjan stated that the project is being actively implemented with close cooperation between research teams from both countries; in particular, Professor Marcel Stive and his team are completing the first scientific paper. Simultaneously, the initial results of the project will be presented at the VietWater Conference organized by the Dutch Embassy, with the participation of a delegation of TU Delft students.

The two sides focused on discussing trends in the internationalization of research activities, enhancing scientific publication capacity, and support programs such as scholarships and fellowships, especially in the field of interest such as semiconductors. From the Water Resources University, representatives from the Faculty of Engineering proposed continued cooperation in developing funding proposals for government-funded programs and international organizations, particularly for projects related to climate change and water resources.

Figure 7-14. The team meets the Rector of TLU, Professor Nguyen Trung Viet and staffs. https://tlu.edu.vn/52334-52334/

Figure 7-15. The team meets and discusses the project at the Embassy of the Netherlands