2025 Half-year Report

ICOE

MEKONG DELTA LIVING LAB

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

At a Glance

Earlier works	Achievements	Ahead activities

Introduction

The Mekong Delta Living Lab project has reached its halfway point in its three-year timeline. In the first half of 2025, several documentation trips to local areas within the project's scope were conducted, as well as collaboration on measurements with project's member teams in Soc Trang province. Besides that, the ICOE carried out several studies on the correlation between infrastructure and coastline changes, and the impact of rising water levels on subsidence.

Upcoming tasks will include field measurements, analysis and evaluation of collected data, and planning for the selection of suitable locations for the living lab. Additionally, there will be activities to welcome delegations of professors and students from the Netherlands for exchange and training cooperation.

Field survey & Data Collection

Figure 1. Meeting with the local authorities

In the beginning of 2025, ICOE conducted several fieldtrips for surveying in Soc Trang, Bac Lieu provinces to collect updated information on the current mangrove situation in localities.

Throughout the trip, we met and worked with local authorities and residents to understand their perspectives and vision for the Living Lab project.

We also consulted them on possible locations for deploying and building this laboratory.

Figure 2. Discussing mangrove forests with local people

Figure 3. Survey the recently reforested mangrove areas

Through discussions with local authorities and residents, we gathered information about areas experiencing severe erosion, such as a section of the coastal area of Lai Hoa (Vinh Chau, Soc Trang);

Areas where breakwaters have been constructed and mangrove forests are showing signs of recovery, such as another part of the coastal area of Lai Hoa (Vinh Chau, Soc Trang); areas where breakwaters have recently been built and mangrove forests have just been replanted

Figure 4. Survey the planted mangrove areas showing signs of healthy growth

Figure 5. Survey planted mangrove area without intervention

Areas where no breakwaters have been constructed, but mangrove forests are still being replanted and showing signs of recovery.

Areas where breakwaters have been constructed but mangrove planting efforts were unsuccessful, such as in the Nha Mat area of Bac Lieu.

Figure 6. Survey area with intervention but unsuccessful in planting mangrove

Fieldtrip measurement

From June 11 - June 19, 2025, Thuyloi University and ICOE team operate measurements in Soc Trang province. The measured factors included water levels, waves, sediments, and mangrove biomass.

Figure 7. All stations on the Vinh Chau and Soc Trang coast

The activities included deploying and transporting the **wave buoy** for nearshore wave measurements, installing **wave gauges** to measure waves and water levels in mangrove areas, and collecting suspended sediment samples at estuary and canal mouths.

Figure 8. Fieldwork activities

The relationship analysis between shoreline changes and interventions

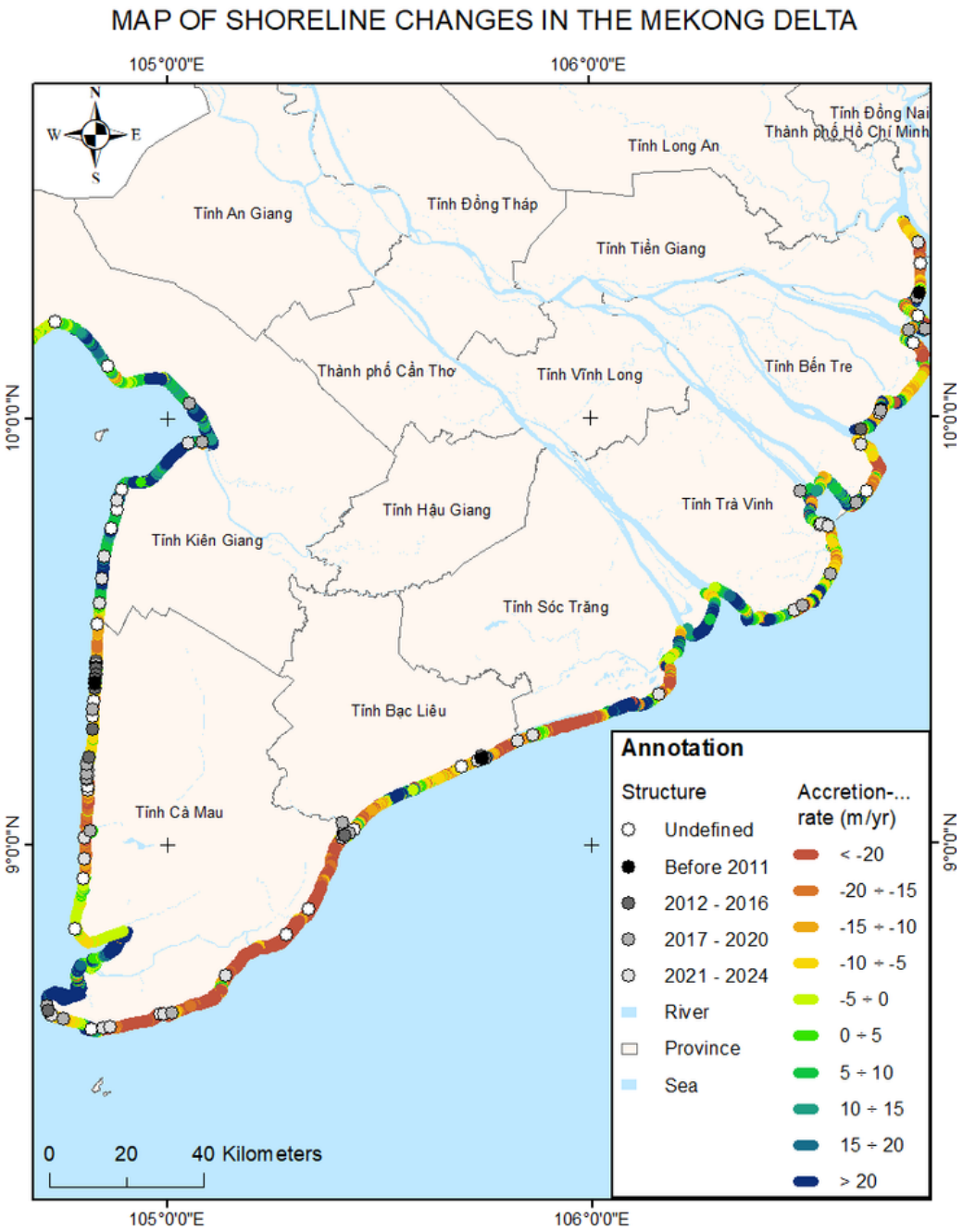


Figure 9. Map of shoreline changes in the MeKong Delta

Method

Based on Raster images and DSAS tools in GIS applications (ArcGIS, QGIS,...), we analyzed the accretion/sedimentation rate of coastal area in Mekong Delta.

Along with that, we identified and digitized most of the interventions implemented in recent years along the Mekong Delta coastal area using GIS, in order to assess their success or failure in land accretion and mangrove restoration

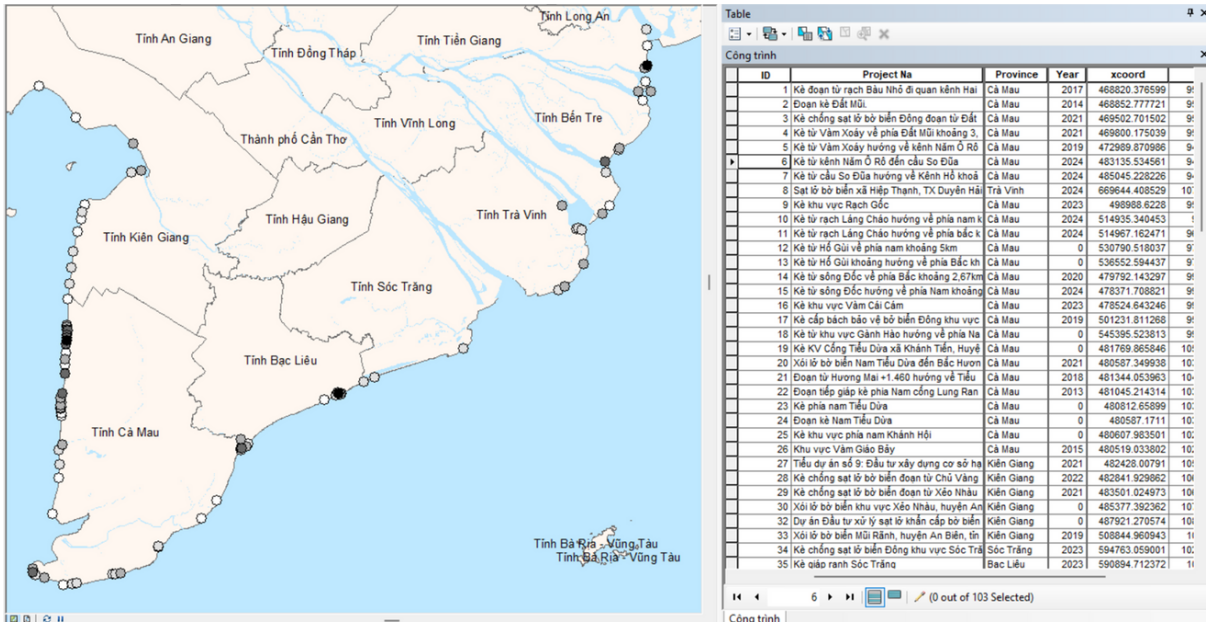


Figure 10. Digitization of constructions in the Mekong delta

We've cataloged over 100 structures (such as dikes and embankments) along the coastline of the Mekong Delta provinces. These structures have a lifespan ranging from 1 to 15 years, with the majority being under 5 years old.

Research results

From the analysis results, it can be observed that the south-eastern coastal sections experience strong erosion. The chart below illustrates the rate of accretion and erosion of the project sections, it can be observed that the areas with structures built earlier (during

the 2010–2015 period) exhibit more stable geomorphological conditions and a higher likelihood of accretion compared to structures constructed between 2015 and 2023. Hence, through initial study, it can be seen that it takes a sufficient period of time, at least 8-10 years, for the site to stabilize. More locations will continue to be collected to update and add more to increase the reliability of this study.

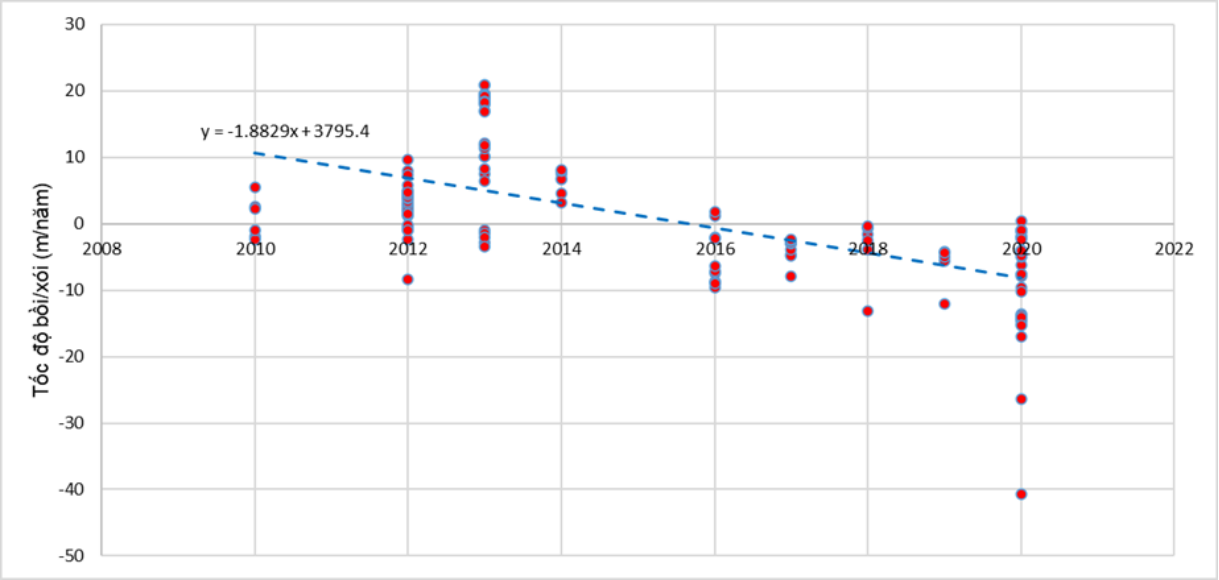


Figure 11. Erosion/Accretion rate of construction routes

The Change of Water Levels

Method

Figure 12. Permanent water level stations

We collected data from 9 coastal permanent water level stations from Vung Tau to Xeo Ro (Kien Giang) and then analyzed sea level rise and subsidence rate along coastal Mekong Delta within recent 17-25 years.

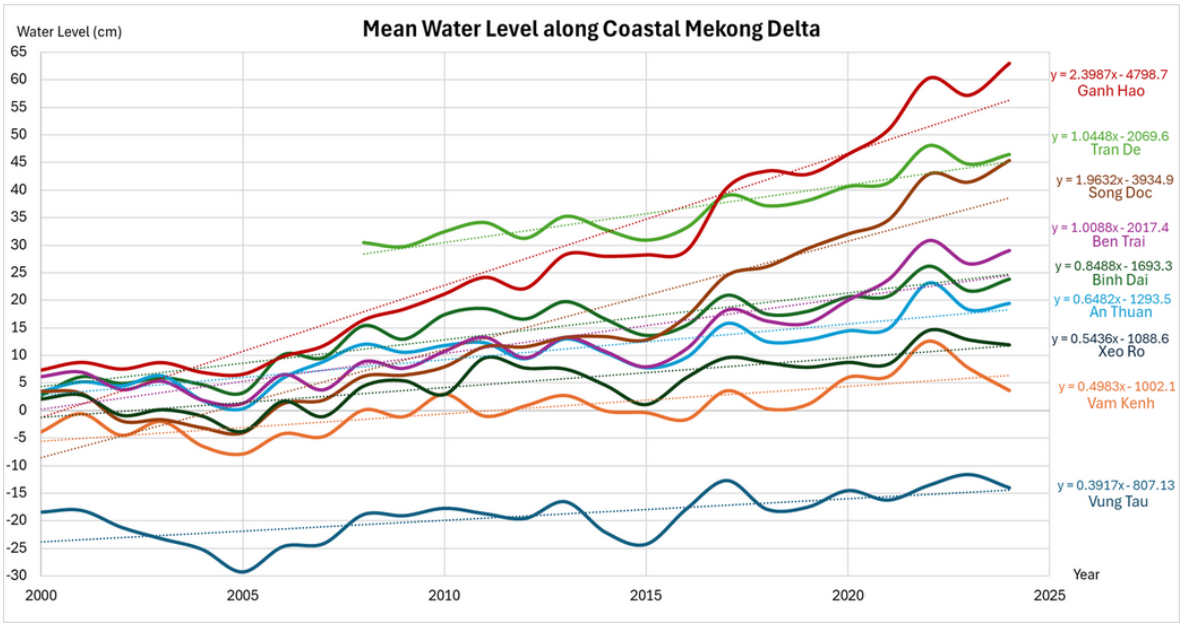


Figure 13. Mean water level along coastal MeKong Delta

In summary, coastal water levels in southern Vietnam have exhibited an increasing trend over the past 20 years. The Vung Tau station, located on stable bedrock and minimally affected by land subsidence, records water levels primarily influenced by tides and sea level rise. Therefore, this station was selected as the basis for analyzing sea level rise trends along the southern coast of Vietnam.

In addition to these two factors, water levels at coastal areas of the Mekong Delta are also significantly affected by delta subsidence.

Research results

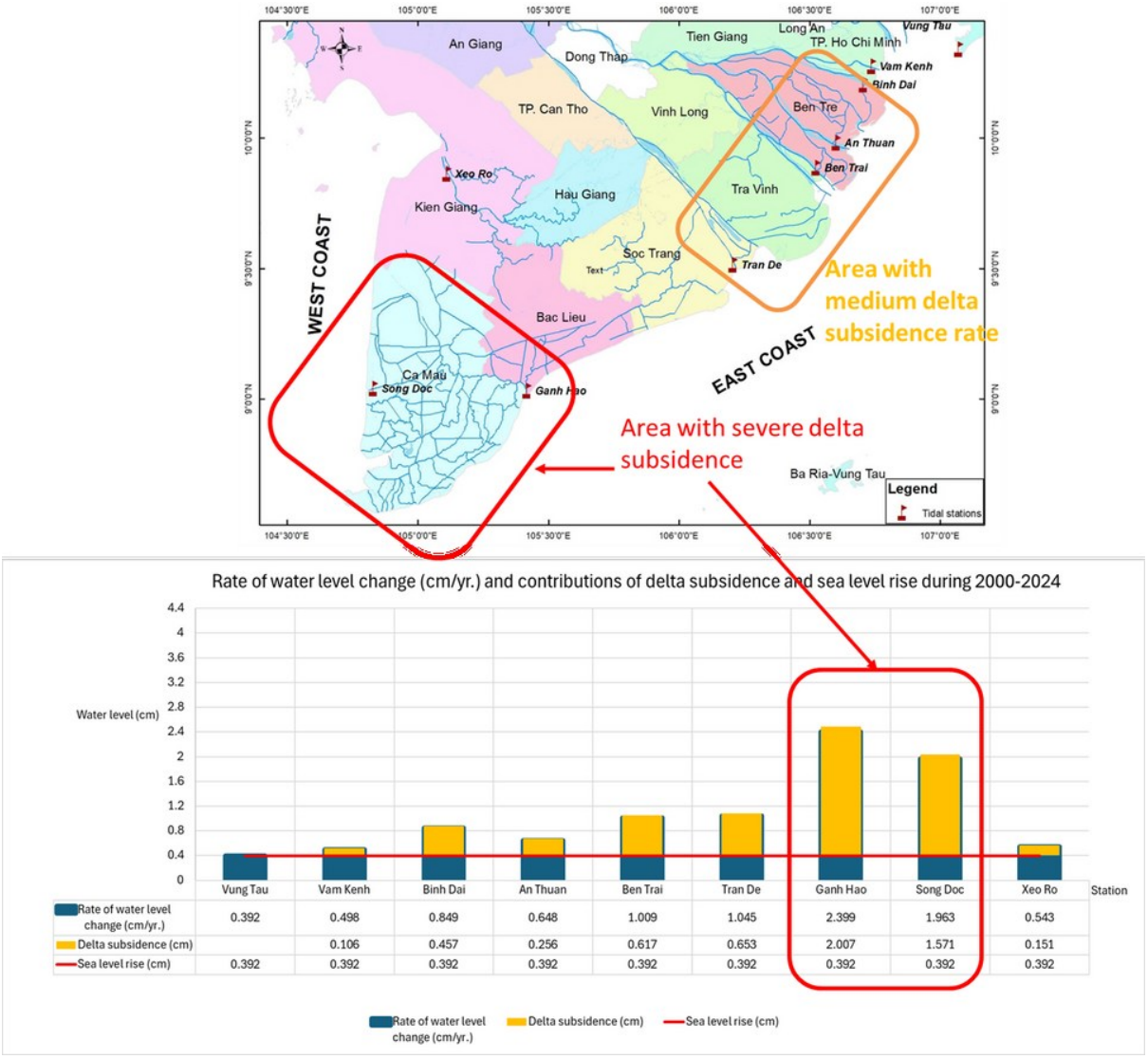
Table 1. Rate of water level change (cm/yr.)

Rate of water level change (cm/yr.)				
Stations	Trend 2000 to 2007	Trend 2008 to 2014	Trend 2015 to 2024	Trend 2000 to 2024
Vung Tau	-1.18	-0.24	0.842	0.392

Vam Kenh	-0.46	0.176	1.021	0.498
Binh Dai	0.732	0.582	1.056	0.849
An Thuan	0.294	-0.08	1.278	0.648
Ben Trai	-0.36	0.55	2.345	1.009
Tran De		0.602	1.706	1.045
Ganh Hao	0.374	1.976	3.847	2.399
Song Doc	-0.34	1.394	3.539	1.963
Xeo Ro	-0.45	0.335	1.033	0.543

Our analysis illustrate that the sea level rise is roughly 4 mm/yr. The rate of water level rise from 2015 to the present is greater compared to the earlier period.

The image effectively interconnects that the Mekong Delta is facing a significant challenge from land subsidence, particularly in its southern and southwestern regions, which is exacerbating the impacts of global sea level rise on water levels and increasing vulnerability.



	Vung Tau	Vam Kenh	Binh Dai	An Thuan	Ben Trai	Tran De	Ganh Hao	Song Doc	Xeo Ro
Rate of water level change (cm/yr.)	0.392	0.498	0.849	0.648	1.009	1.045	2.399	1.963	0.543
Delta subsidence (cm)		0.106	0.457	0.256	0.617	0.653	2.007	1.571	0.151
Sea level rise (cm)	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392

Figure 14. Rate of water level change and contributions of delta subsidence and sea level rise during 2000-2024

From the top map, subsidence rate in coastal area increase from Tien Giang to Ca Mau spit and then decrease to Kien Giang. The area with medium delta subsidence rate (Orange area) generally located in the central and eastern parts of the delta, encompasses provinces like Ben Tre, Tra Vinh, and parts of Vinh Long, Soc Trang, and Bac Lieu. This suggests that these regions are experiencing moderate sinking. Whereas the area with severe delta subsidence (Red area) is primarily concentrated in the southwestern part of the delta, specifically in Ca Mau province and potentially extending into parts of Kien Giang and Bac Lieu. The "Song Doc" and "Ganh Hao" stations

within this zone highlight specific localities experiencing significant sinking.

In addition, the bar chart and accompanying table present quantitative data on the rate of water level change and its contributions from Delta subsidence and Sea level rise during the time 2000-2024 for various locations across the Mekong delta.

Accordingly, the subsidence rates vary significantly across the stations. Meanwhile, the Delta subsidence varies significantly across the stations. In particular, the stations like Vung Tau (0.0 cm), Vam Kenh (0.106 cm), and An Thuan (0.392 cm) show relatively low or no recorded subsidence. While other Stations like Binh Dai (0.457 cm), Ben Trai (0.617 cm), and Tran De (0.653 cm) show a progressive increase in subsidence rates. Especially, at Ganh Hao (2.007 cm) and Song Doc (1.571 cm) stand out with exceptionally high subsidence rates. This directly correlates with the Area with severe delta subsidence identified on the map, particularly the Song Doc and Ganh Hao regions. Xeo Ro station (0.151 cm) shows a relatively low subsidence rate.

This indicates that delta subsidence is the dominant factor driving the observed water level changes in the Mekong Delta, far outweighing the contribution of sea level rise. For instance, at Ganh Hao, a 2.007 cm/yr subsidence combined with 0.392 cm/yr sea level rise results in a total water level change of 2.399 cm/yr.

In summary, the data strongly suggests that land subsidence is a much more significant and localized threat to the Mekong Delta than global sea level rise. This subsidence is likely driven by factors such as excessive groundwater extraction, sediment starvation (due to upstream dams), and natural compaction of soft deltaic sediments. The regions of Ca Mau, Song Doc, and Ganh Hao are

experiencing severe subsidence, making them highly vulnerable to increased flooding, saltwater intrusion, and land loss.

Delta subsidence and sea level rise have been identified as potential major drivers of mangrove forest degradation in the Mekong Delta, particularly in the Ca Mau Peninsula, due to their impact on forest inundation duration. In the next phase of this study, we will investigate how variations in inundation time affect the growth and regeneration of mangrove ecosystems.

Upcoming works

Based on research of sea water level, including sea water level rise and delta subsidence, evaluate inundation duration in mangrove areas and its impacts on mangrove survival. We plan to select locations for topographic surveys to explore the correlation between mangrove survival and coastal morphology and also conduct field measurements of waves, water levels, currents, sediment transport, seabed morphology, and mangrove biomass in areas where mangroves are either thriving or retreating, with and without the presence of wave-breaking structures.

Our measurements plan

In order to have an overview and fully evaluate the cases, we selected 4 feasible locations to conduct the measurement survey.

Table 2. Viable locations for conducting the measurement survey

TIME	LOCATION	FACTOR
August October December	Ward 2, Vinh Chau – Soc Trang (1) Lai Hoa, Vinh Chau – Soc Trang (2) Ganh Hao, Dong Hai – Bac Lieu (3) Vinh Hau A, Hoa Binh – Bac Lieu (4)	Coastal profile Wave Flow Water level Sedimentation Mangrove forest density

Table 3. Proposed locations for measurements

	Accretion	Erosion
Without interventions	 Ward 2, Vinh Chau – Soc Trang	 Lai Hoa, Vinh Chau – Soc Trang
With interventions	 Ganh Hao, Dong Hai – Bac Lieu	 Vinh Hau A, Hoa Binh – Bac Lieu

- Location 1: Ward 2, Vinh Chau, Soc Trang Province:
  - Observation Period: 2019 – 2024
  - Intervention Status: No intervention.
  - Findings: Mangrove ecosystems in this area exhibited robust development and expansion during the observation period.
- Location 2: Lai Hoa, Vinh Chau, Soc Trang Province:
  - Observation Period: 2020 – 2024
  - Intervention Status: No intervention.
  - Findings: This coastal segment experienced significant erosion, leading to a noticeable degradation of the mangrove cover.
- Location 3: Ganh Hao, Dong Hai, Bac Lieu Province:
  - Observation Period: 2019 – 2024

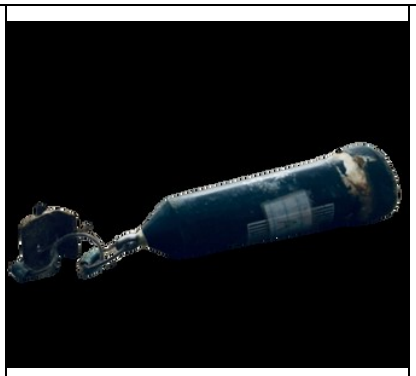
- Intervention Status: Presence of human intervention (e.g., restoration efforts, protective structures).
- Findings: The mangrove areas demonstrated substantial development, correlating with the implemented interventions.

- Location 4: Vinh Hau A, Hoa Binh, Bac Lieu Province:
  - Observation Period: 2020 – 2024
  - Intervention Status: Presence of human intervention.
  - Findings: Despite interventions, the mangrove ecosystems in this location showed signs of degradation.

Equipment to use

The Institute has received some survey and measurement equipment (waves, sedimentation) sponsored by the Netherlands to serve future research work.

- Hydraulic measurement

		
Wave Buoy	*Mini Buoy*	*Wave gauge*

- Coastal profile measurement

		
RTK Trimble	*Digital level*	*UAV Mavic 2 Enterprise Advanced*

- Sedimentation measurement

Figure 15. Riverkin sedimentation sensor

Table 4. Surveying equipment

No	Type	Purpose	Number of items
1	Wave Buoy	Real-time full wave	2
2	Mini Buoy	Measuring current	1
3	Pressure-based Wave Gauge	Measuring non-directional wave spectrum and bulk wave parameters. Measuring water level	2
4	Riverkin sedimentation sensor	Measuring suspended sedimentation	3
5	RTK Trimble	Measuring coastal profile	1

Other activities

In 2025, the ICOE continue to implement many cooperation and study activities with Delft University of Technology (TU Delft, Netherlands) within the framework of the international research project Mangrove Living Lab as well as support the training of postgraduate students.

Research collaboration within the framework of the Mangrove Living Lab project

Also, in July 2025, the Institute was honored to welcome Assoc. Prof. Bas Van Maren and Dr. Anne Baar - two leading experts in coastal engineering and water resources - to work and conduct field surveys in the coastal provinces of the Mekong Delta.

Figure 16. Discussion between experts from ICOE and TU Delft

The two sides discussed the implementation plan for the next phase of research projects in 2025. The working session opened up in-depth discussions on the current status, challenges and potential for restoring mangrove ecosystems.