

2025 Year-end Report



MEKONG DELTA LIVING LAB

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

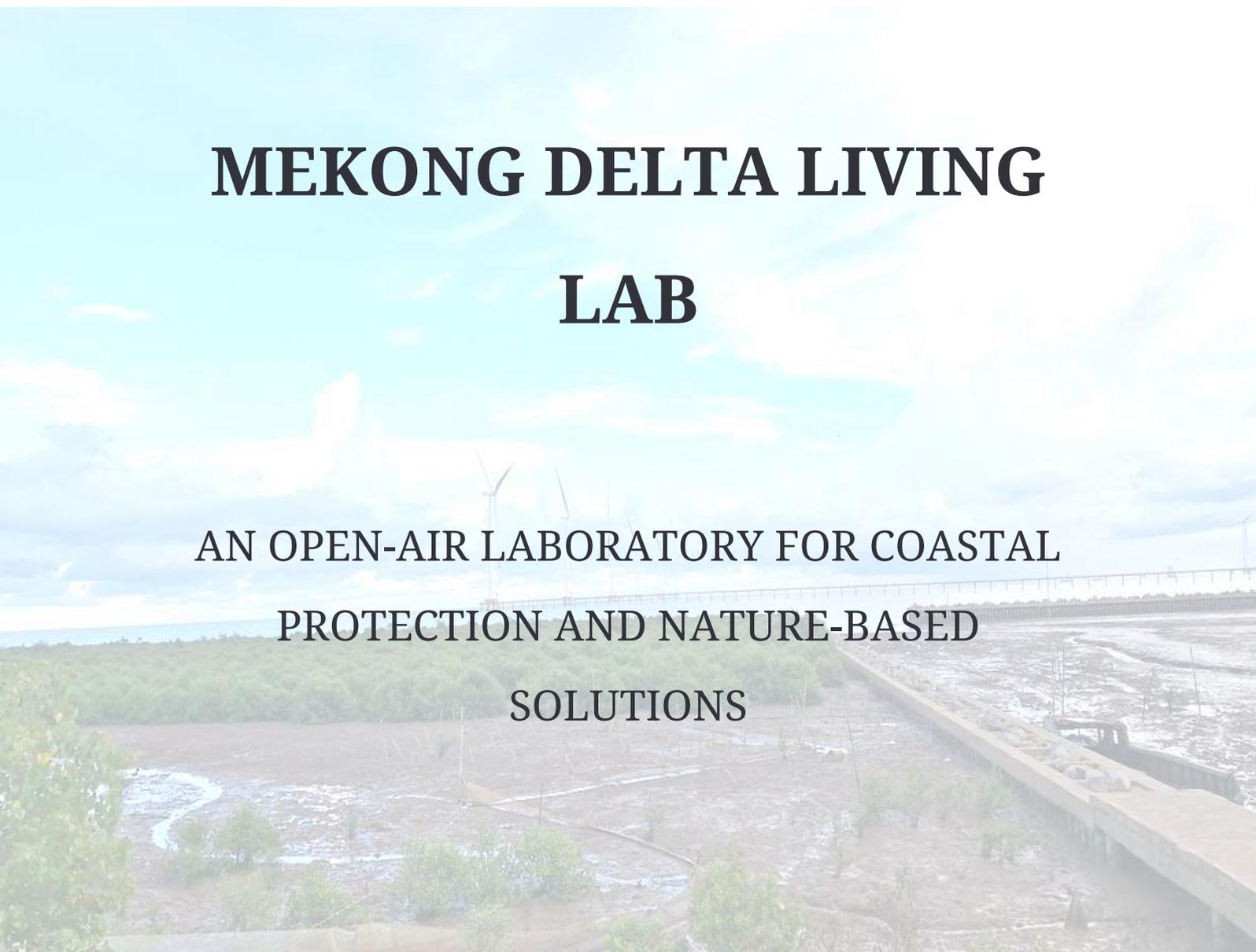


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Introduction



The Mekong Delta Living Lab project has entered the second year of its three-year timeline, having implemented significant work and achieved notable results. In 2025, the ICOE team, in collaboration with Thuy Loi University, conducted multiple field trips to Can Tho, Soc Trang, and Bac Lieu to assess mangrove forest status and carry out measurement activities. In parallel, ICOE staff provided supervision and support to master's students from TU Delft and the MDP program conducting thesis research in the Delta and at the ICOE office.

Project dissemination efforts included a presentation at the VietWater Conference and a poster presentation at the Conference on Marine Science and Sustainable Development in November 2025. On the technical front, the team installed suspended sediment measurement equipment at the Dai Ngai hydrological station. Work is also ongoing to update the Living Lab website, develop the project's database software, and establish a computational hydrodynamic model for the study area. Upcoming tasks focus on field data analysis, site selection for the Living Lab, and preparing to welcome academic delegations from the Netherlands for exchange and training.

Major Activities



During the early months of 2025, field surveys were conducted in the Mekong Delta provinces to assess the status of mangrove forests, alongside the implementation of measurement activities in Can Tho.



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.



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 1. Measurement in Vinh Chau

July - August

In early July 2025, Ms. Floor Machielse, a graduate student from the Faculty of Civil Engineering at TU Delft, joined the Institute to conduct her Master's thesis research under the supervision of Dr. Hung and ICOE staff.

Furthermore, the Institute of Coastal and Offshore Engineering (ICOE) had the honor of welcoming Professor

Baar—two leading experts in coastal engineering and water resources—to discuss future research directions and conduct field surveys in the coastal provinces of the Mekong Delta. During this period, ICOE also received a range of advanced monitoring and surveying equipment (for water levels, waves, currents, and sediment transport) sponsored by the Netherlands to support the project's research activities.

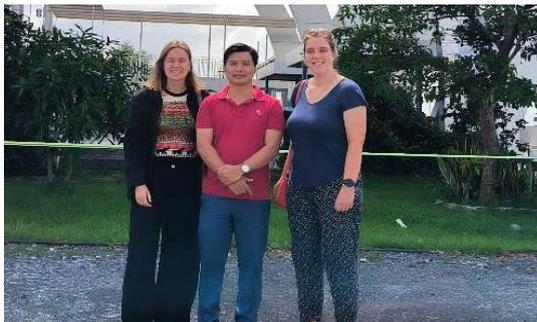


Figure 2. Supporting students in completing their thesis.

September

In continuation of the support and training cooperation for the MDP student delegations in 2025, ICOE was pleased to welcome graduate students from TU Delft in September to collaborate on the Living Lab project.

This year's MDP delegation comprised students from the faculties of Civil Engineering, Industrial Design and Technology, and Policy and Management.

These efforts culminated in the preliminary completion of the project website, which can be accessed at:

<https://www.livinglabmekongdelta.com/>

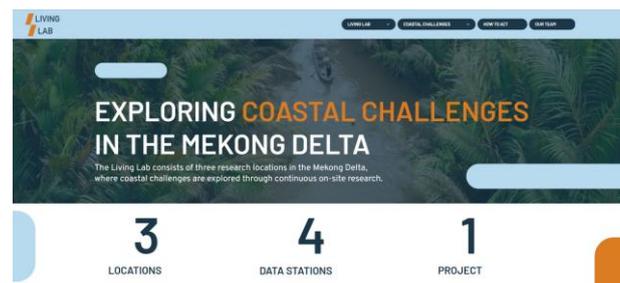
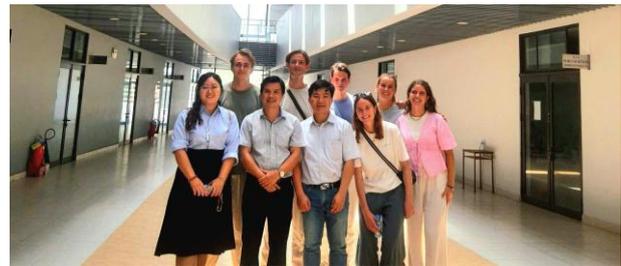


Figure 3. Activities with MDP

During the creation process, they combined their specific areas of expertise to develop a complete and comprehensible platform. The Civil Engineering students oversaw the contents displayed on the platform, The policy students decided how this content was effectively translated and the design students developed the final platform.

In addition to their office-based

to Can Tho and Ca Mau provinces.

The team met and worked with experts at Can Tho University (Dr. Vo Quoc Thanh) and conducted interviews with local residents regarding the status and factors affecting mangrove restoration.

The MDP student delegation and ICOE experts deployed

research and technical assignments, the students joined ICOE on field expeditions

sediment monitoring equipment at the Dai Ngai hydrological station.



Figure 4. Fieldtrip in Mekong River Delta

October

In October, we had the opportunity to meet with the Embassy of the Kingdom of the Netherlands in Vietnam and present the Living Lab project at the VietWater conference.

During the conference, representatives from the Netherlands Embassy, the ICOE team, and MDP students presented recent research findings as well as future project plans.



Figure 5. VietWater Conference

Subsequently, the delegation from the Netherlands Embassy conducted field visits to the installation sites of wave and water-level monitoring equipment in Hoa Binh and Vinh Chau

—the primary study areas of the Mekong Living Lab project. On-site, experts presented the current status of mangrove forests in key project locations and discussed upcoming research directions.



Figure 6. Delegations at site

November

ICOE presented a report on the Living Lab project for the short course organized by Kasetsart University, Thailand, during the first week of November.

Short Course on Nature-Based Solutions for Disaster Risk Reduction in Southeast Asia
 Part I: Thailand Experience
 3-8 November 2025 | Kasetsart University, Bangkok Thailand

DAY 1 & 2
 An overview of NbS and its underlying principles and classifications/Disaster Risk Reduction concept/ Ecology principles/NbS in landscape/Bio-slope stabilization/Coastal protection/Vetiver grass system hands-on practice

DAY 3
 NbS water treatment/ Sponge city/ Mangrove/ Visit to Benchakitti Forest Park

Speakers:
 Prof. Thom Bogaard, Delft University of Technology, the Netherlands
 NBS overview and Disaster Risk Reduction
 Dr Apintri Jotisankasa, Kasetsart University
 Course coordinator: Bio-slope stabilization, IoT slope monitoring, biochar, and case studies
 Dr Giulia Bossi
 Dr Gianluca Marcato
 Consiglio Nazionale delle Ricerche, Italy
 Developing climate-resilient and eco-sustainable railway earthwork (RESOLVE project)
 Dr Sani Limthongsakul, Kasetsart University
 NBS and landscape
 Dr Nisa Leksungnoen, Kasetsart University
 Ecology principles for NbS

Additional Speakers:
 Dr Sompratana Ritphring, Kasetsart University
 Coastal protection, NbS vs grey structure
 Dr Vittoria Capobianco, Norwegian Geotechnical Institute
 NBS for slope stabilization in Europe and within a Norwegian/Scandinavian context
 Kotchakorn Voraakthorn, Landprocess
 Porous City Network and NbS game
 Dr Surat Bualert, Kasetsart University
 NBS water treatment: A case study of Laem Phak Bia Royally Initiated Project
 Wang Dong, TURENSCAPE
 Sponge city concepts and applications in major cities
 Dr Manh Hung, Center for Marine and Coastal Resources Research
 Development of Mangrove in the Mekong Delta

Figure 7. Short course in Thailand

On 14/11, ICOE participated in the Scientific Conference on Marine Science and Sustainable Development at the University of Science (HCMUS), VNU-HCM.

At the conference, we presented a poster for the Mekong Living Lab project, showcasing the project's preliminary research findings.



Figure 8. Conference in HCMUS

December

In December, ICOE welcomed Ms. Kim Vo, a student from the Faculty of Industrial Design to conduct her graduation thesis research. Her study focuses on plastic waste collection and management.



Figure 9. ICOE with Kim Vo



Figure 10. ICOE with Master students from Copenhagen

Along with

ICOE hosted a group of graduate students from the University of Copenhagen for an academic exchange. The students visited to learn about the Living Lab project and discuss their Master's thesis research titled: 'Investigating Mangrove Forests in the Mekong Delta Using Remote Sensing Technology'.

ICOE supported the students in conducting fieldwork to collect mangrove forest data across the Mekong Delta provinces.

Fieldwork measurement

Deployment of Sedimentation Sensor

During the fieldwork in early October, we deployed a suspended sediment sensor at the Dai Ngai hydrological station in Soc Trang province. This installation aims to quantify the sediment flux from the Hau River to the downstream study areas of Nha Mat and Vinh Chau. The data has been continuously updated and monitored up to the present.



Figure 11. Deployment of Sedimentation Sensor

The sensor deployment location and the sediment measurement results at the Dai Ngai hydrological station are presented below.

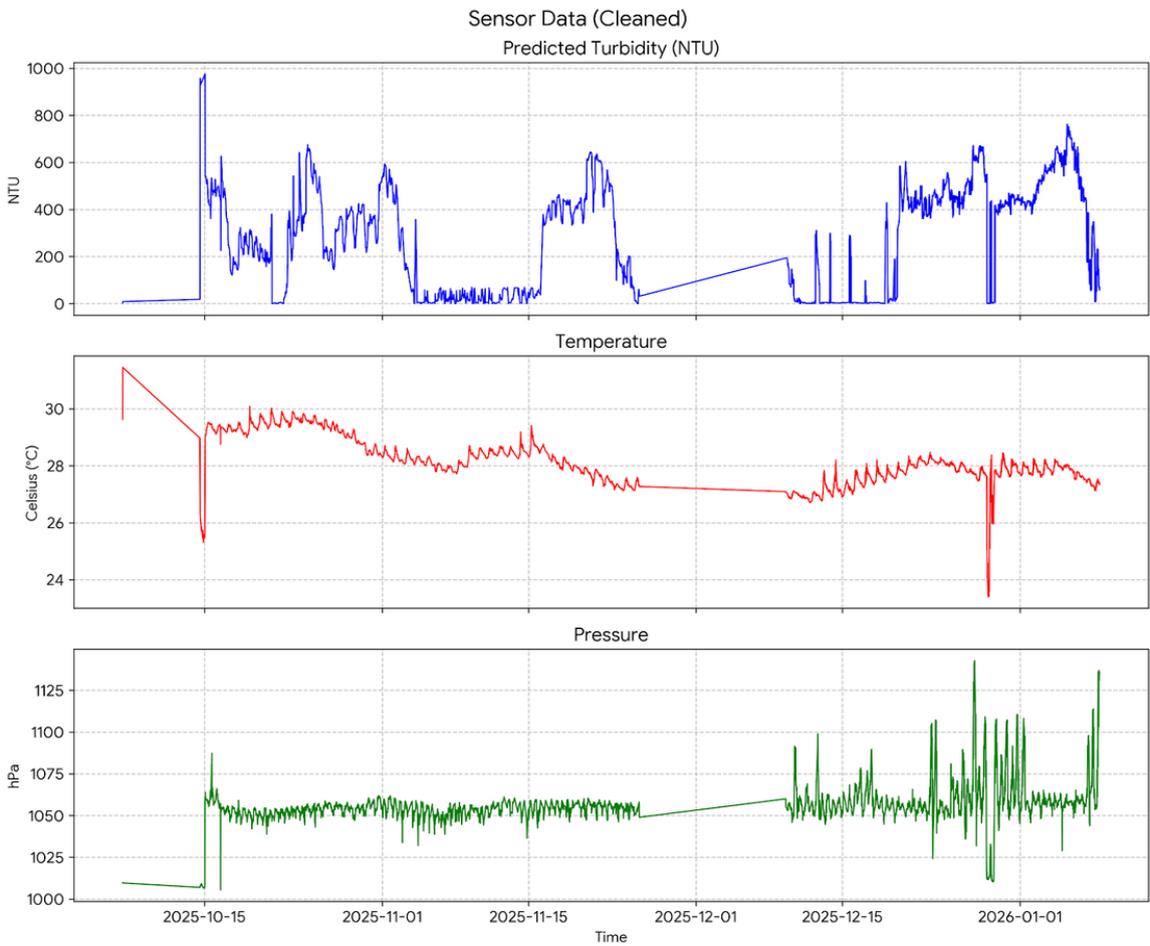
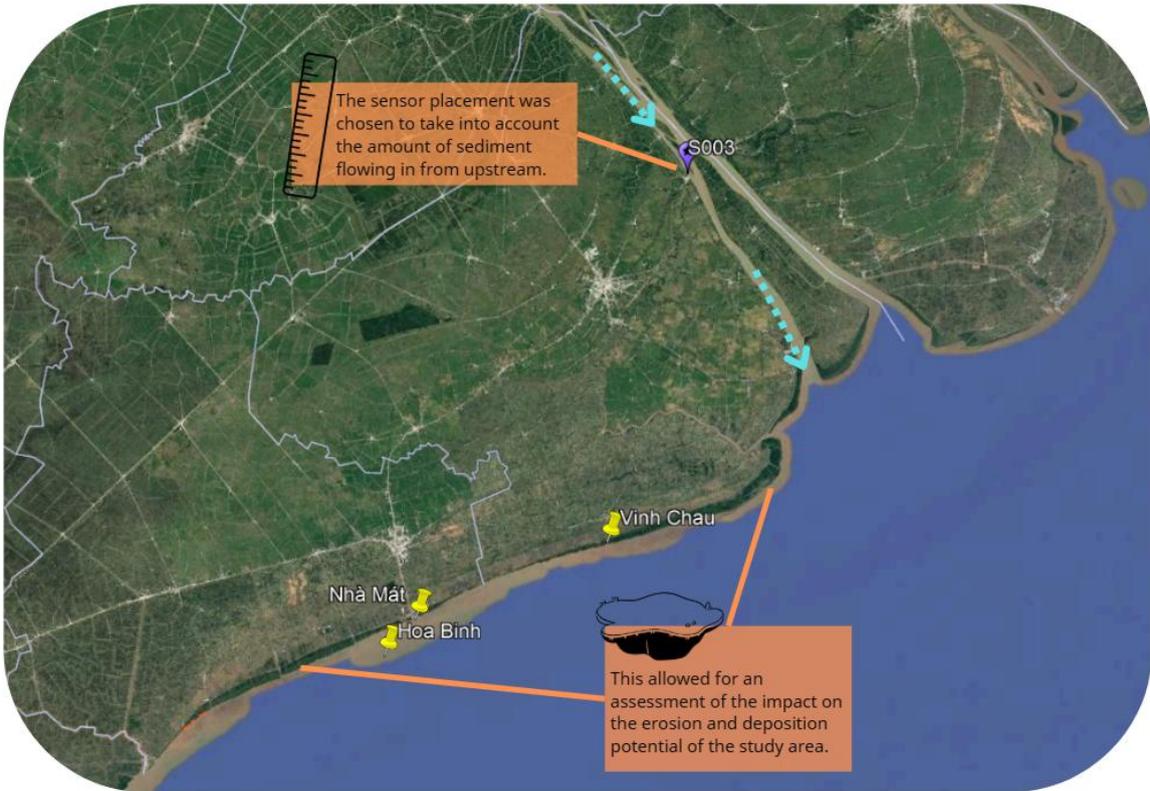


Figure 12. Initial result from Riverkin Sediment Sensor

Ongoing Works

Digital Living Lab

Building upon the achievements of the MDP student delegation, we are continuously updating and expanding the Digital Living Lab platform. This online portal serves as a strategic bridge between scientific research and practical application, translating complex research findings into accessible insights and actionable data for policymakers in the Mekong Delta.

The project successfully designed the Digital Living Lab (DLL) as an effective communication tool. It translates complex hydrodynamic and morphological data into visual, understandable insights for policymakers, who often lack deep technical expertise.

Organizing information through "Site-specific storylines" proved to be a logical and effective method. This structure connects:

- Current State: Erosion or accretion trends.
- Drivers: Natural and anthropogenic causes.
- Interventions: Engineering or nature-based solutions.

The integration of interactive maps (specifically satellite data tracking mangrove coverage from 1988–2025) allows users to visualize long-term trends that traditional paper reports cannot convey. This directly supports evidence-based decision-making.

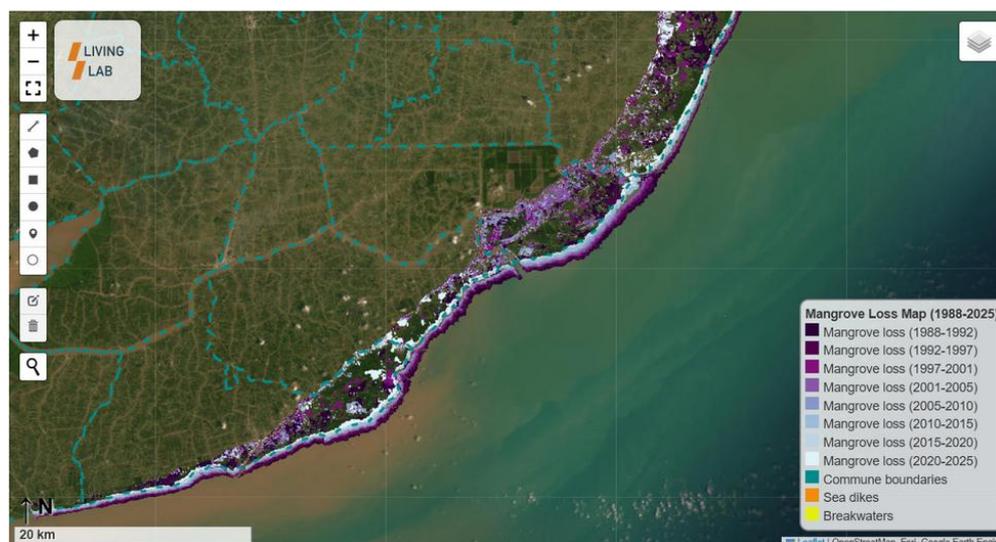


Figure 13. Mangrove Loss Map (1988-2025)

The report emphasizes that the DLL is not a static product but a "living" platform. The team developed a comprehensive Manual (covering Technical, Design, and Content aspects) to ensure that future students and researchers can independently update data, maintain the website, and expand the project's scope.

Coastal management in the Mekong Delta is both a social and technical challenge. Decisions on which interventions are implemented depend on multiple stakeholders, their values, and the institutions in which they operate. To design a Digital Living Lab that supports evidence-based decision-making, it is essential to understand these dynamics

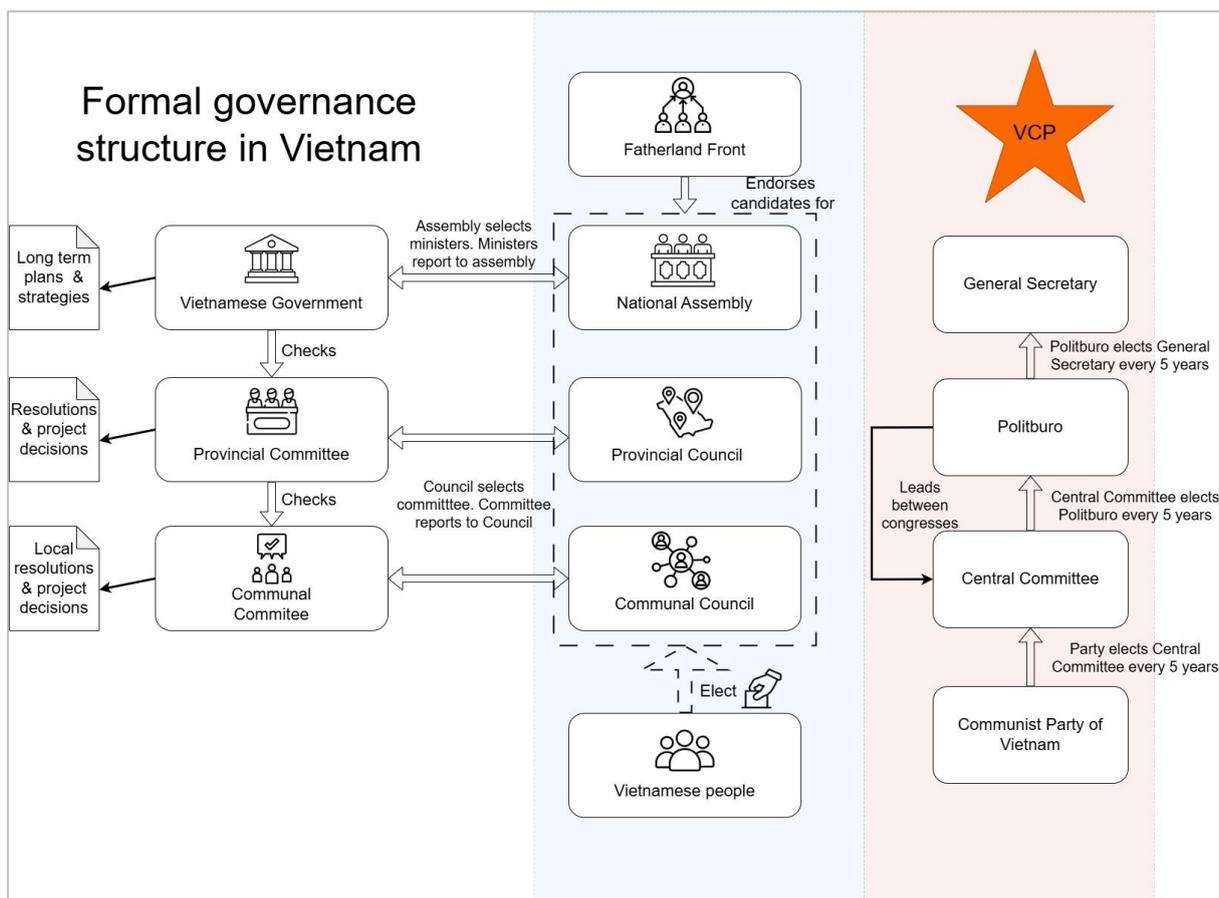


Figure 14. The formal governance structure in Vietnam

Table 1. Decision-makers and appraisers in the Vietnamese investment process

Project Category	Pre-Feasibility Study or Investment Intentions Report	Feasibility Study
Nationally Important Projects	A: State Appraisal Council D: National Assembly	A: State Appraisal Council D: Prime Minister
Category A	A: Inter-ministerial Council or Appraisal Leading Agency D: Prime Minister	A: Technical Line Ministries D: Proposing LM/Provinces
Category B	A: Proposing LM/Provinces D: Proposing LM/Provinces	A: Technical LM/Provinces D: Proposing LM/Provinces
Category C	A: Proposing LM/Provinces D: Proposing LM/Provinces	A: Technical LM/Provinces D: Proposing LM/Provinces

Notes: A = Appraiser; D = Decision-maker; LM = Line Ministry.

Table 2. Stakeholders, their values, and information needs relevant for the Digital Living Lab

Stakeholder	Values	Information needs
Ministry/Department of Agriculture & environment	Feasibility, compliance, Effective governance	Technical data, Legal Frameworks, Financial parameters, Environmental and land-use data, Expert advice, Risk assessments, Concise (pre-)feasibility reports
National assembly/People's councils	Representation, Compliance, Prosperity	Elaborate policy plans, Holistic system view, Weighted costs & benefits
Experts (Consultants)	Technical quality, Applicability, Efficiency	Broad and up-to-date data, Cross-sector input,

Benchmarks, Legal frameworks, Financial parameters, Broad stakeholder view

Researchers (Living Lab)	Truth, Transparency, Impact	System-wide datasets, Long-term monitoring
Locals	Safety, Livability	Practical outcomes, Effects on food yields, Floods

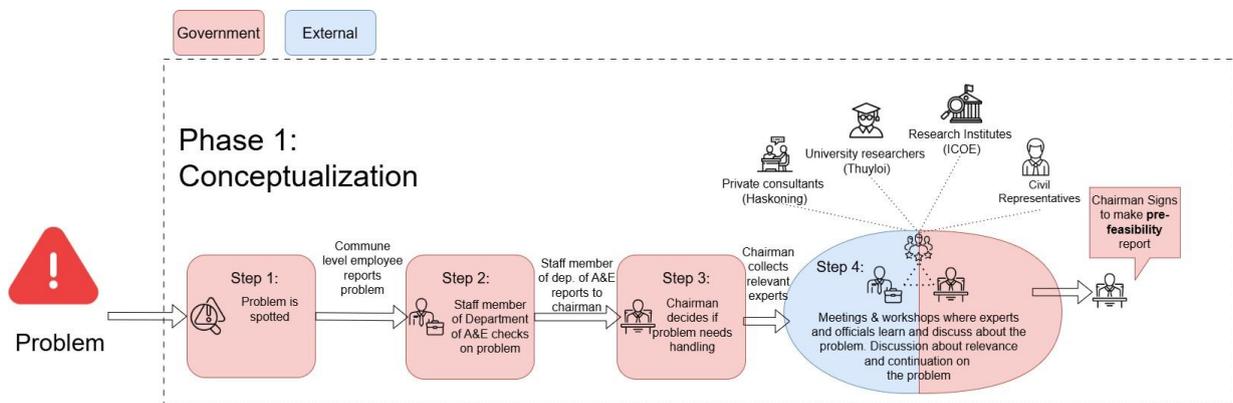


Figure 15. The general course of the conceptual phase in the Mekong Delta in detail.

To successfully impact policy, the Digital Living Lab (DLL) must be designed to accommodate the 2025 government reforms, such as the merging of departments into the Ministry of Agriculture and Environment (MAE). Furthermore, the platform must be visual, concise, and mobile-friendly—specifically optimized for communication channels like Zalo or LinkedIn. By grounding technical data in economic benefits and livelihood security, the DLL can provide the credibility and practical weight necessary to persuade high-level decision-makers.

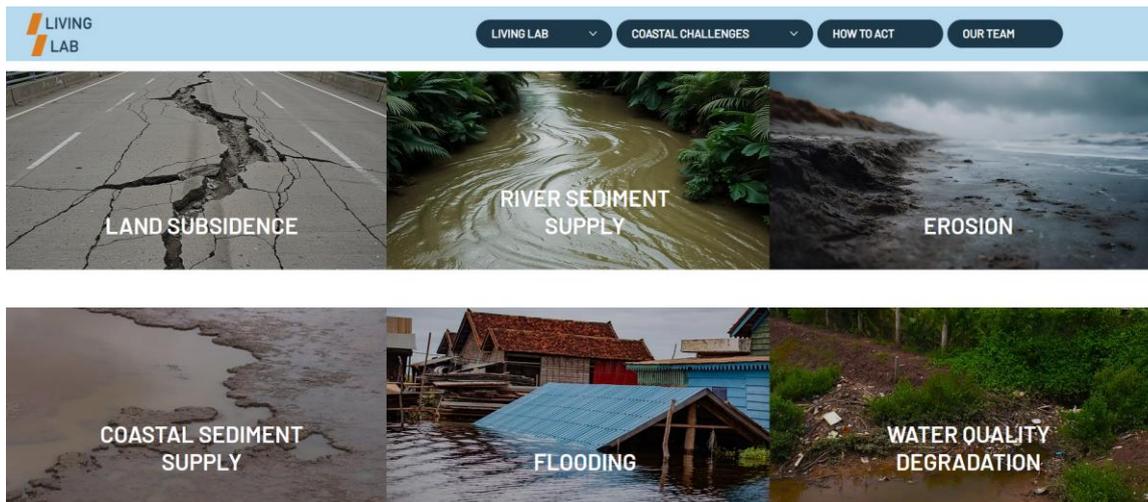


Figure 16. DLL Mission: A visual and accessible platform.

While the platform functions well conceptually and visually, it requires continuous maintenance from stakeholders (universities, research institutes) to avoid becoming obsolete. The choice of a web builder (Wix) facilitates easy editing but has certain customization limits compared to custom coding. Future work should focus on validating the platform with decision-makers and translating the content into Vietnamese.

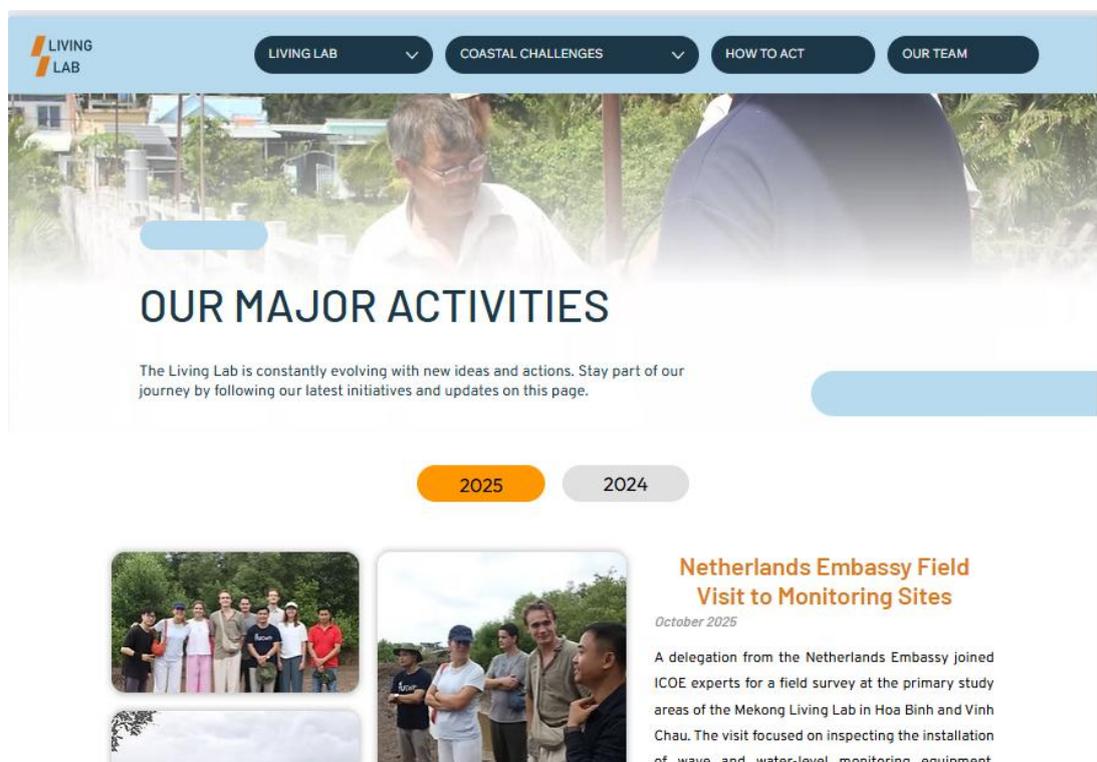


Figure 17. Updating on DDL

While the platform functions well conceptually and visually, it requires continuous maintenance from stakeholders (universities, research institutes) to avoid becoming obsolete. The choice of a web builder (Wix) facilitates easy editing but has certain customization limits compared to custom coding. Future work should focus on validating the platform with decision-makers and translating the content into Vietnamese.

Establishment and development of a computational hydrodynamic model for the Living Lab study area

During 2025, we developed and set up a hydrodynamic–hydrographic modeling system for the coastal waters of the Mekong Delta using the Delft3D modeling suite, incorporating key processes such as tides, currents, and waves. The model was established to comprehensively simulate the hydrodynamic characteristics of the river–estuary–coastal system, serving as a basis for analyses of hydrodynamic interactions and transport processes within the study area.

The hydrodynamic calculations were performed using the Flow Flexible Mesh (FM) model based on an unstructured mesh composed of polygonal cells, allowing flexible representation of the complex geometry of river channels, estuaries, and nearshore areas. The mesh resolution was refined in regions with strong hydrodynamic variability, such as rivers, estuaries, and coastal zones, while coarser resolution was applied offshore to ensure computational efficiency without compromising simulation accuracy.



Figure 18. Computational domain

The computational domain extends from upstream boundary sections at Can Tho and My Thuan along the Tien and Hau River systems, passing through seven main estuaries, including Cua Tieu, Cua Dai, Ham Luong, Co Chien, Cung Hau, Dinh An, and Tran De (the Ba Lai estuary was excluded due to blockage by the Ba Lai sluice). Offshore, the domain covers the entire coastal sea area within approximately 100 km from the shoreline, with the coastline stretching from Vung Tau City around Ca Mau Cape, ensuring adequate representation of tidal forcing from the East Sea and offshore hydrodynamic processes affecting the study area.

Hydrodynamic mesh parameters:

- Number of elements: 52,004 elements
- Number of nodes: 48,736 nodes

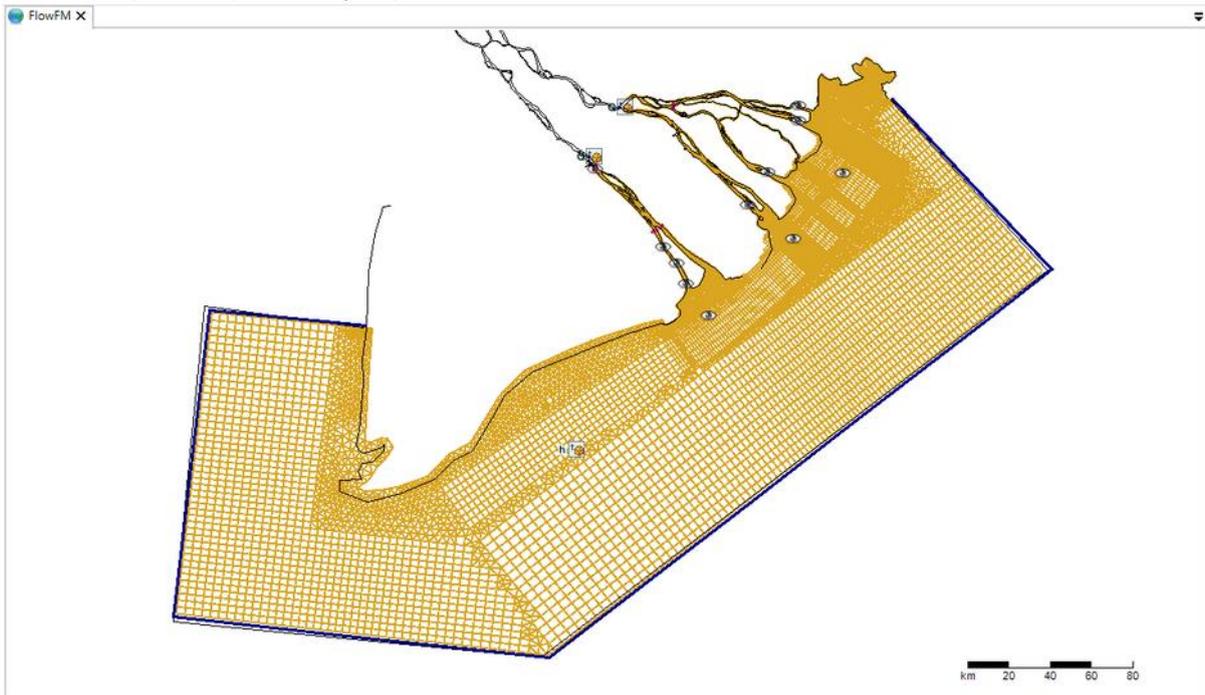


Figure 19. Unstructured computational mesh for hydrodynamic modeling of the study area

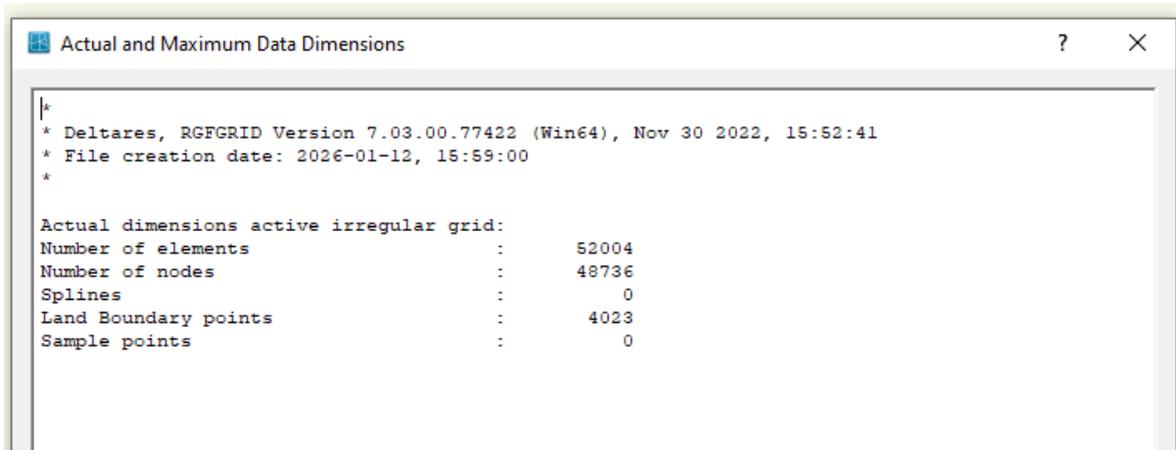


Figure 20. Hydrodynamic mesh parameters

The bathymetry of the study area exhibits significant spatial variability, gradually decreasing from approximately 42 m in the offshore deep-water zone toward the nearshore area. This depth distribution reflects the characteristic shallow continental shelf of the Mekong Delta region and plays an important role in controlling hydrodynamic processes, including current circulation and wave propagation.

Within the river system, water depths vary considerably, ranging from only a few meters in shallow reaches and depositional areas to more than 20 m in major river channels and estuarine sections, where the combined effects of river discharge and tidal forcing are strongest. This pronounced contrast in depth between riverine and marine environments provides an essential basis for designing an appropriate computational mesh resolution to accurately simulate hydrodynamic processes across the entire domain.

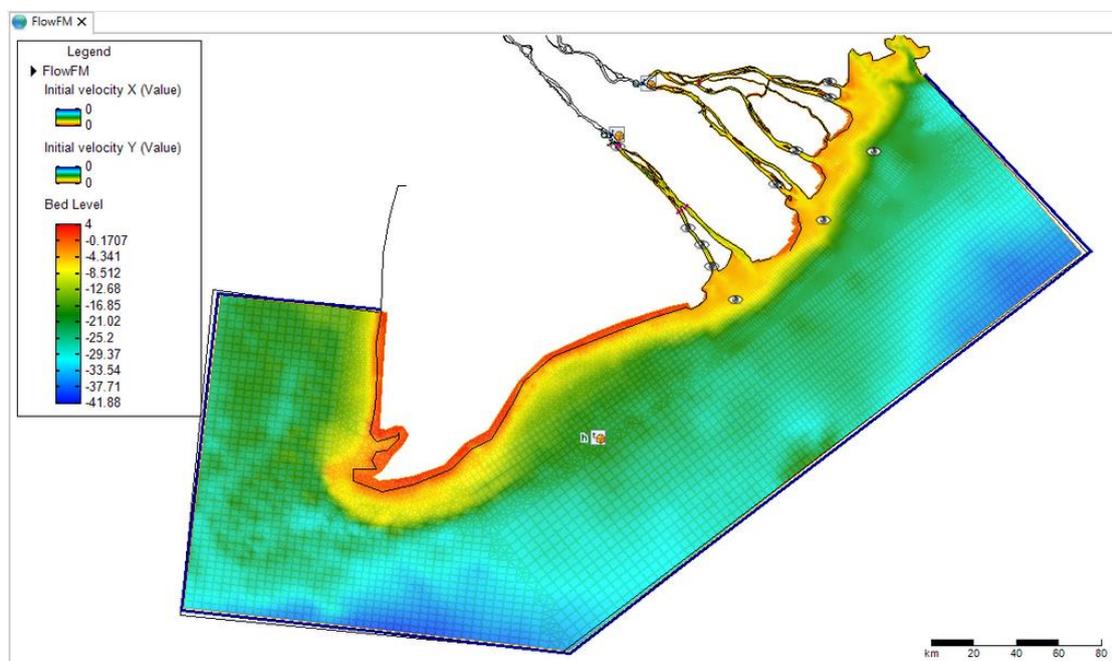


Figure 21. Bathymetry of the study area

The hydraulic boundaries of the model are defined by discharge boundaries at the main river branches and water level boundaries at the open sea. Specifically, upstream river discharges are taken from observations at the Can Tho and My Thuan stations, representing the hydrological conditions of the Tien and Hau Rivers, in order to accurately reflect the inflow from upstream into the model domain.

The open-sea boundary uses water level values extracted from the global tidal model developed by the Danish Hydraulic Institute (DHI), based on a global tidal parameter dataset with a spatial resolution of $0.25^\circ \times 0.25^\circ$, equivalent to approximately 27.5×27.5 km.

The combination of river discharge boundaries from inland hydrological stations and open-sea water level boundaries enables the model to realistically represent the interaction between river flow and tidal forcing, thereby improving the reliability of the hydrodynamic simulation results for the study area.

At the initial stage, the model has been set up and preliminary trial simulations have been carried out to reproduce the hydrodynamic regime in the study area. Some preliminary results are presented in the figures below, including water level fluctuations and flow fields, in order to illustrate the temporal and spatial patterns of hydrodynamic variations in the region.

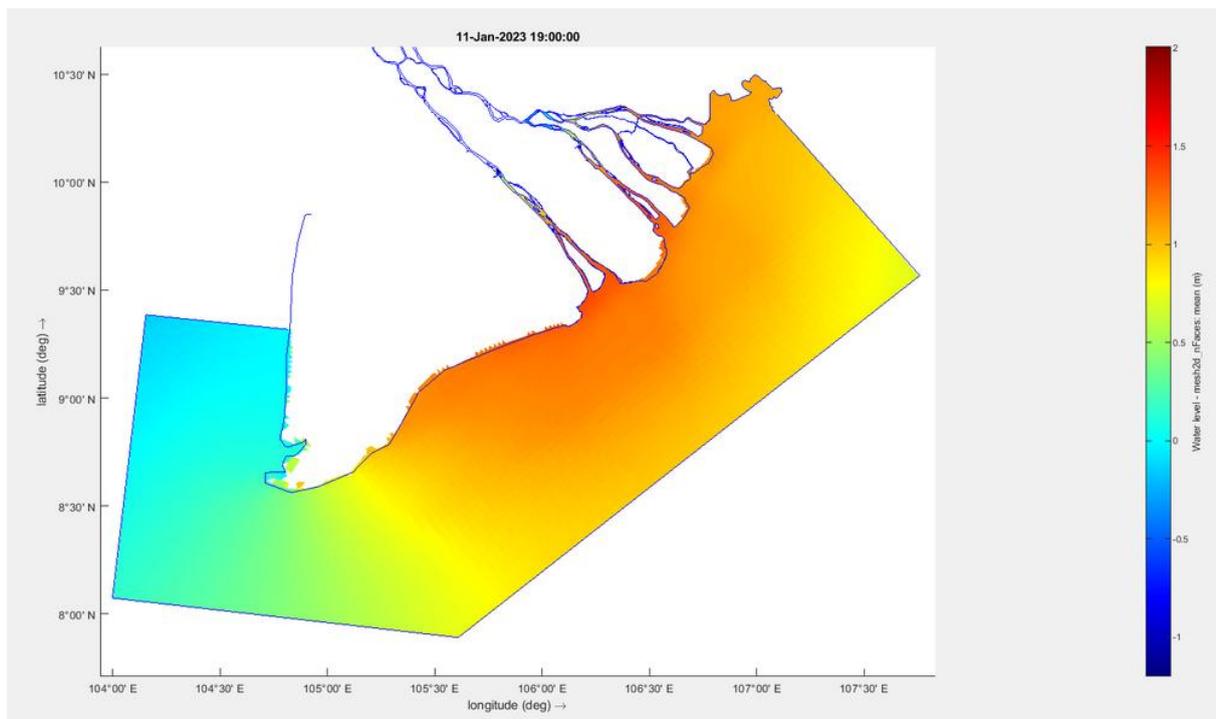


Figure 22. Results of Water Level Calculations in the Study Area

These results are mainly used for an initial assessment of the model's performance, serving as a basis for subsequent calibration, validation, and further model refinement in the following research steps.

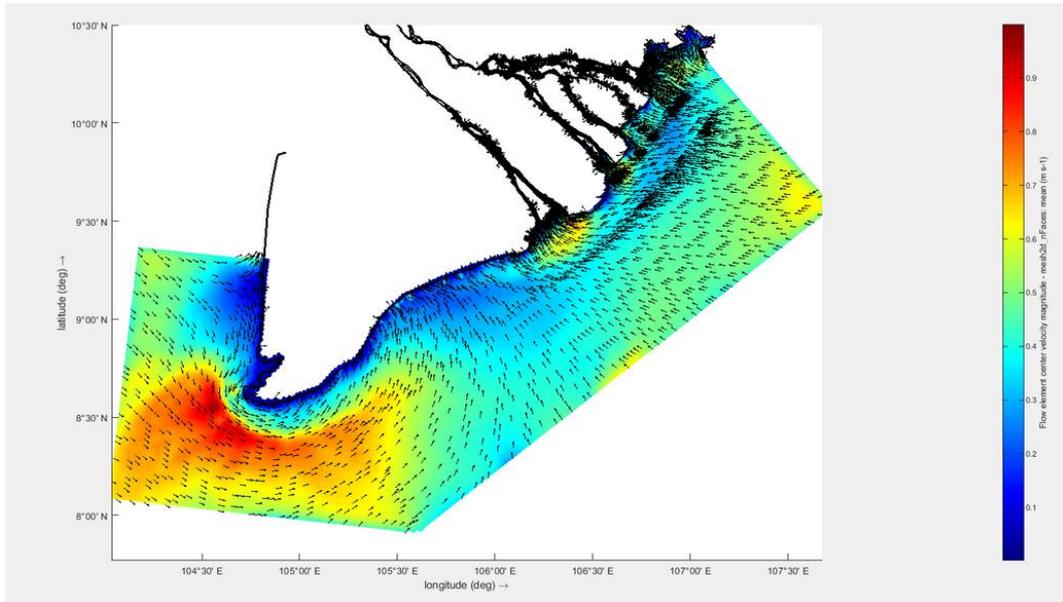


Figure 23. Results of Flow Field Calculations in the Study Area

In addition to the FlowFM hydrodynamic model, the research team developed and set up a wave model (Wave Model) to simulate in detail the characteristics of the wave field in the study area. The wave model employs a structured grid with quadrilateral cells, which is established consistently with the FlowFM hydrodynamic model, ensuring compatibility and consistency in the exchange and coupling of hydrodynamic and wave parameters in subsequent coupled model simulations.

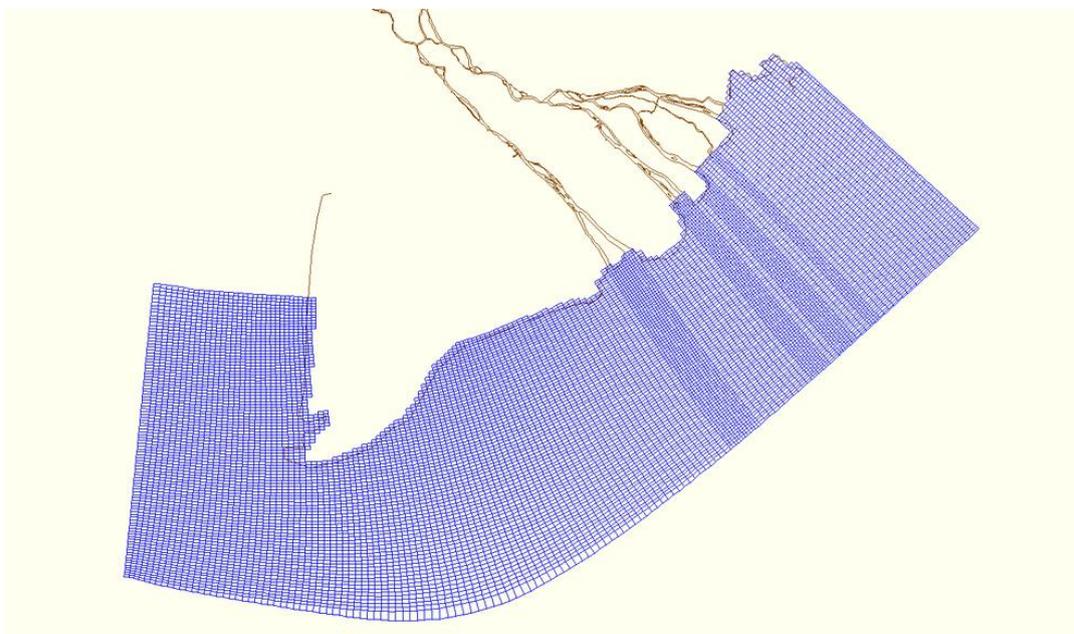


Figure 24. Structured grid for wave modeling in the study area

The computational domain of the wave model covers the entire marine area of the study region, extending from the river mouths and coastal zone to the offshore boundary approximately 100 km from the coast, corresponding to the extent of the FlowFM hydrodynamic grid. This approach enables the model to fully represent the generation, propagation, and transformation of waves from offshore into nearshore and estuarine waters, while ensuring the reliability and robustness of model results during subsequent calibration and validation processes.

Wave mesh parameters: Grid comprising 13,271 elements

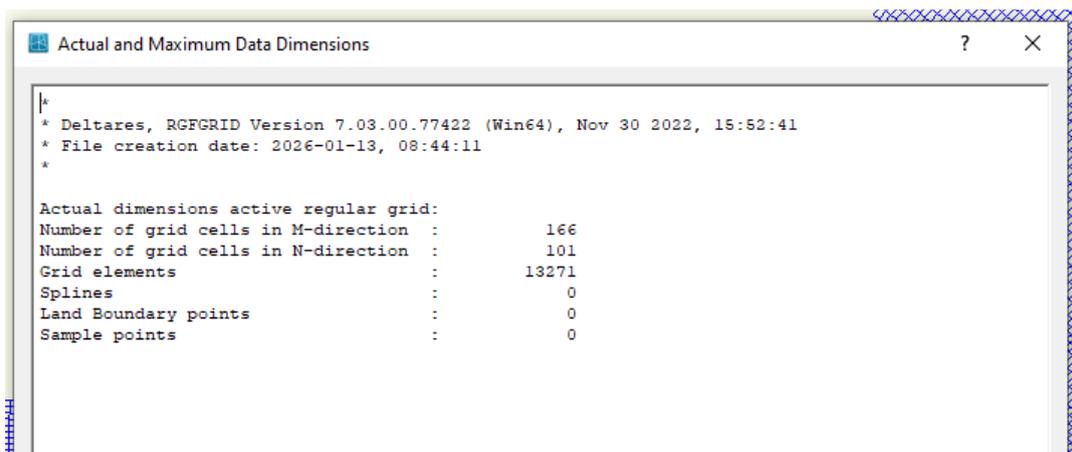


Figure 25. Wave mesh parameters

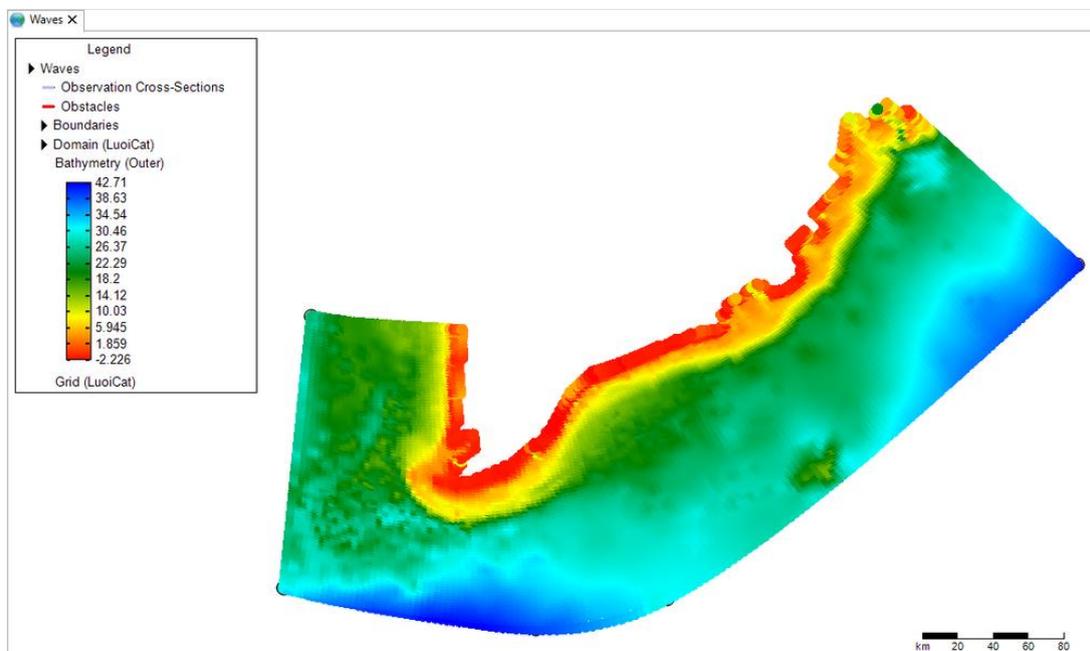


Figure 26. Bathymetry of the study area in the wave model

The wave and wind boundary conditions of the model are derived from the global wave model WaveWatch III (WW3) and the Global Forecast System (GFS) atmospheric model of NOAA/NCEP. Wave and wind fields from these models are used as input data for the regional wave model, in order to adequately represent offshore oceanographic and meteorological conditions affecting the study area.

The initial results of the wave model simulations are presented in terms of the significant wave height field, illustrating the spatial distribution of waves within the study area, as shown in the figure below. Based on these preliminary results, the wave model will be further calibrated and validated through comparison with observed wave and wind data in the study area, to assess model reliability and to finalize model parameters prior to their application in coupled hydrodynamic–wave simulations and subsequent analyses.

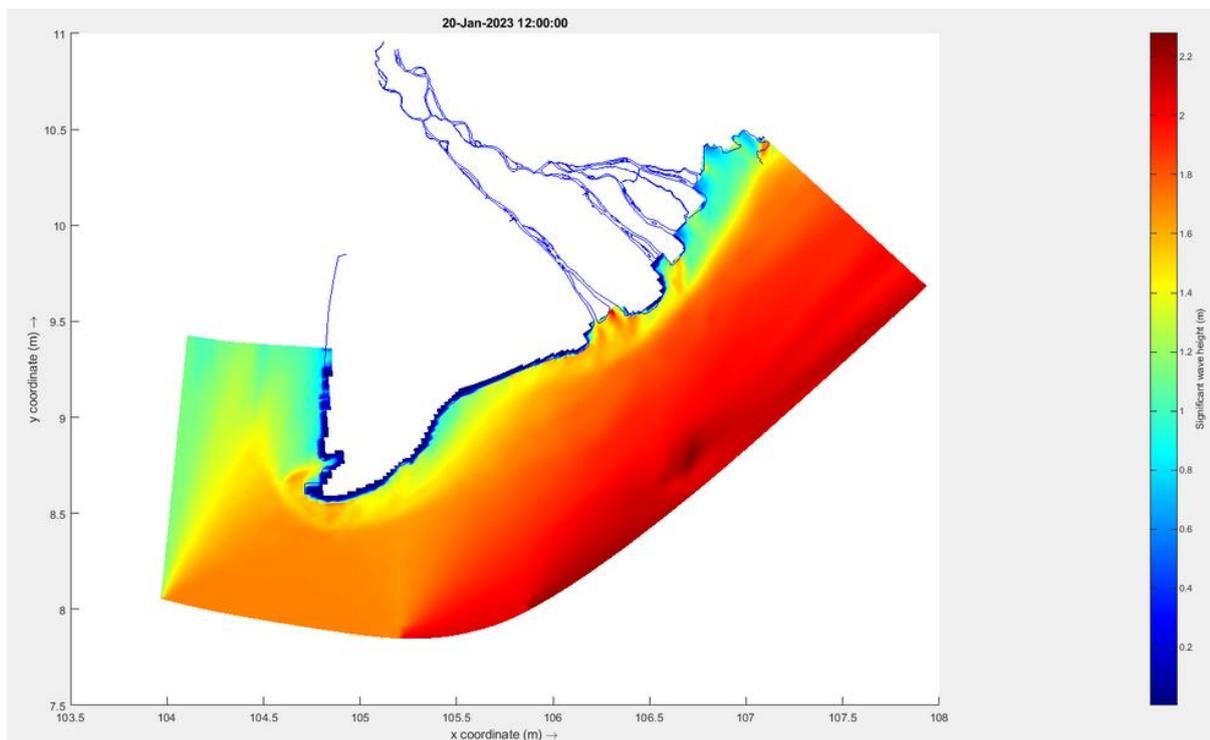


Figure 27. Results of significant wave height calculations in the study area

The Change of Water Levels

Method

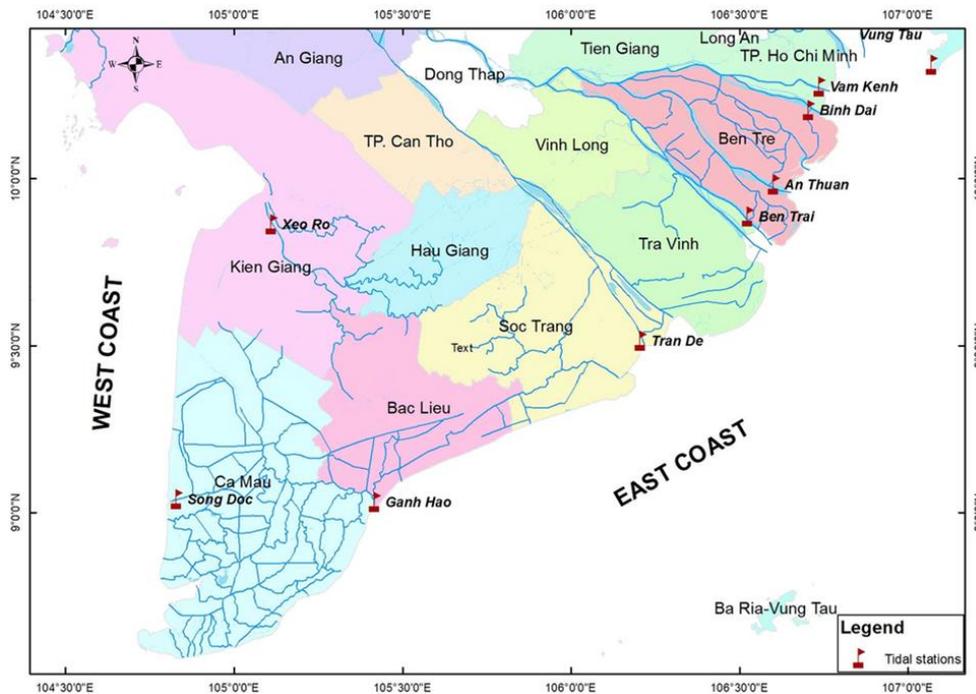


Figure 28. Permanent water level stations

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.

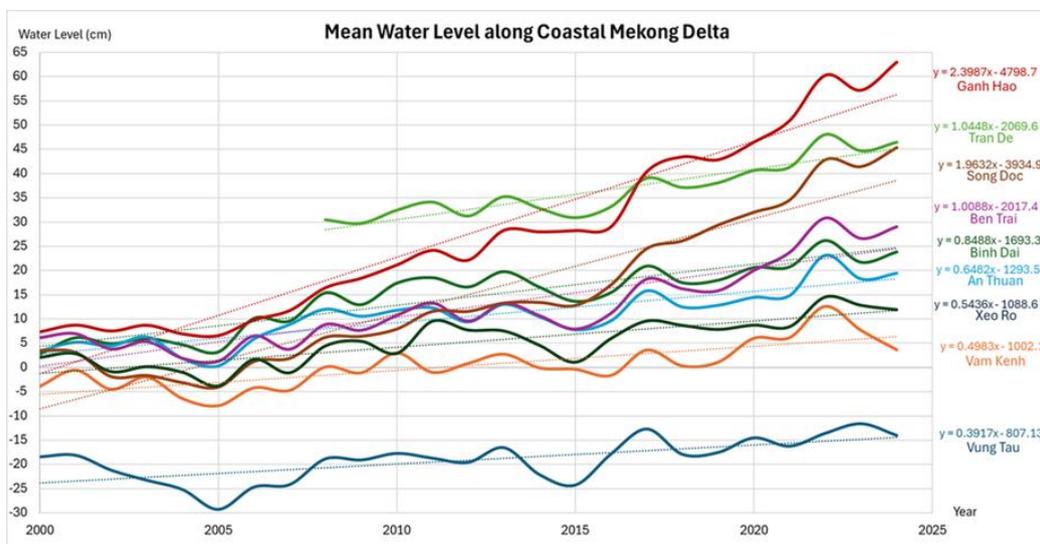


Figure 29. Mean water level along coastal Mekong Delta

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 3. 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.

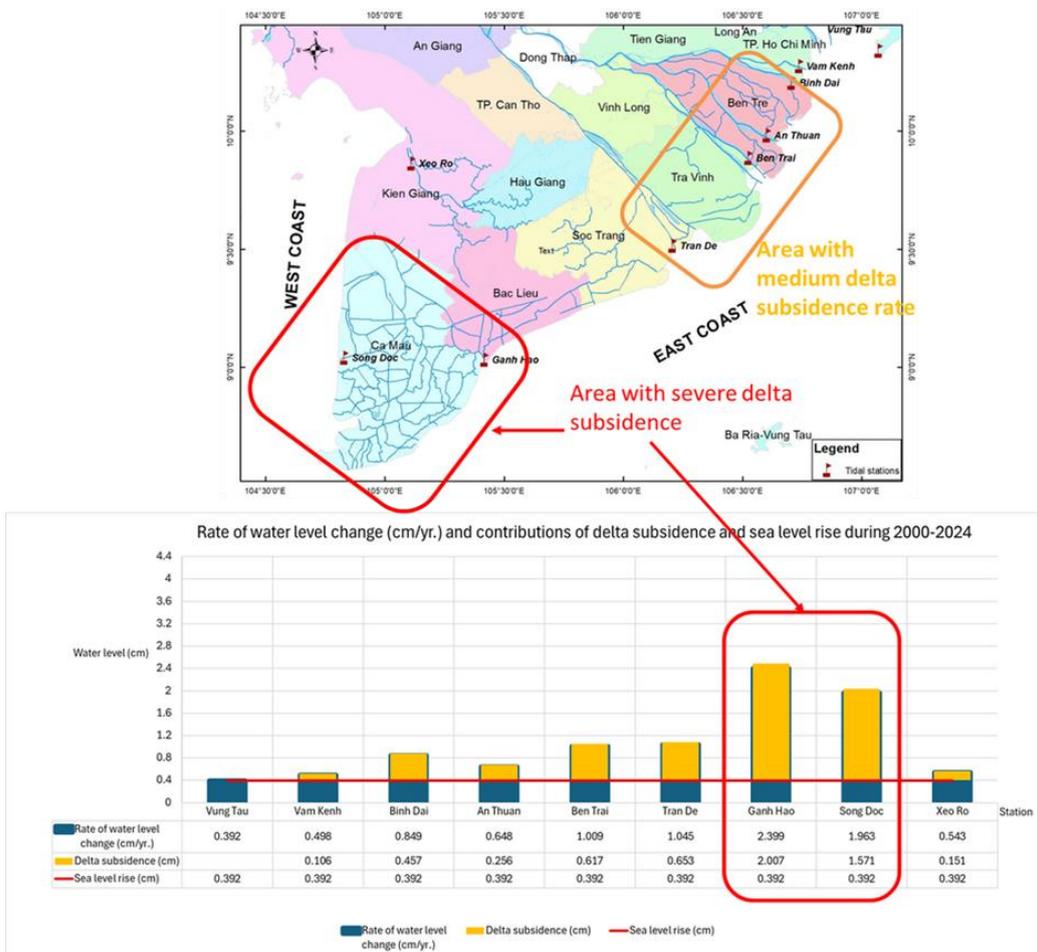


Figure 30. Rate of water level change and contributions of delta subsidence and sea level rise during 2000-2024

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.

Shoreline Changes Analysis

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

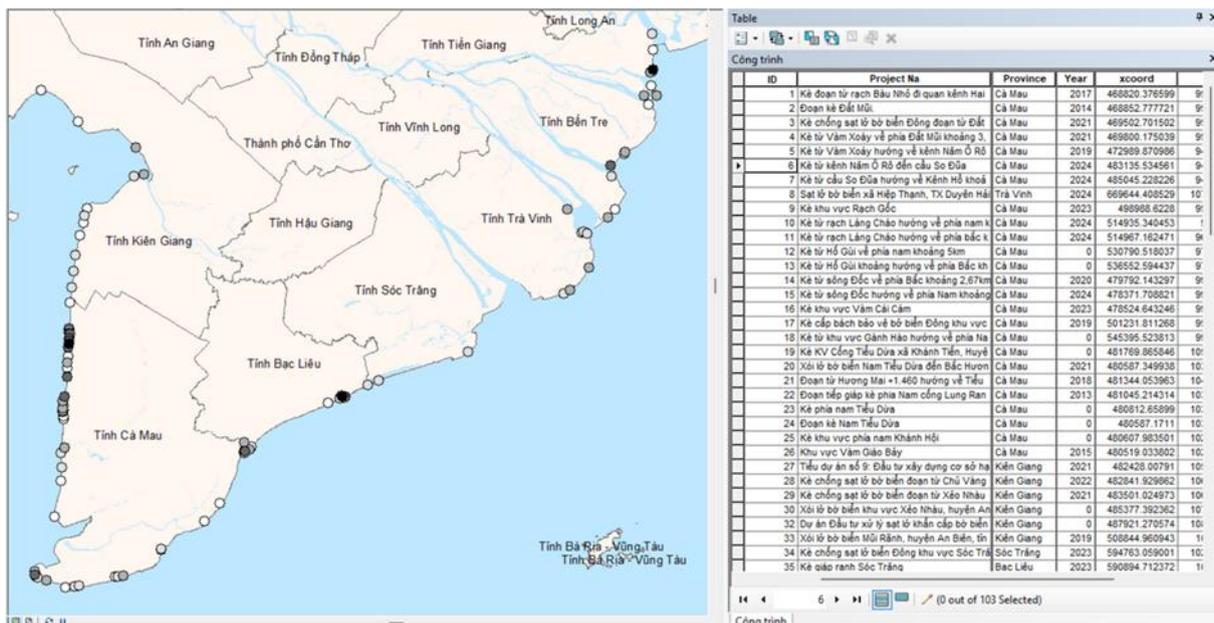


Figure 31. Digitization of constructions in the Mekong delta

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.

MAP OF SHORELINE CHANGES IN THE MEKONG DELTA

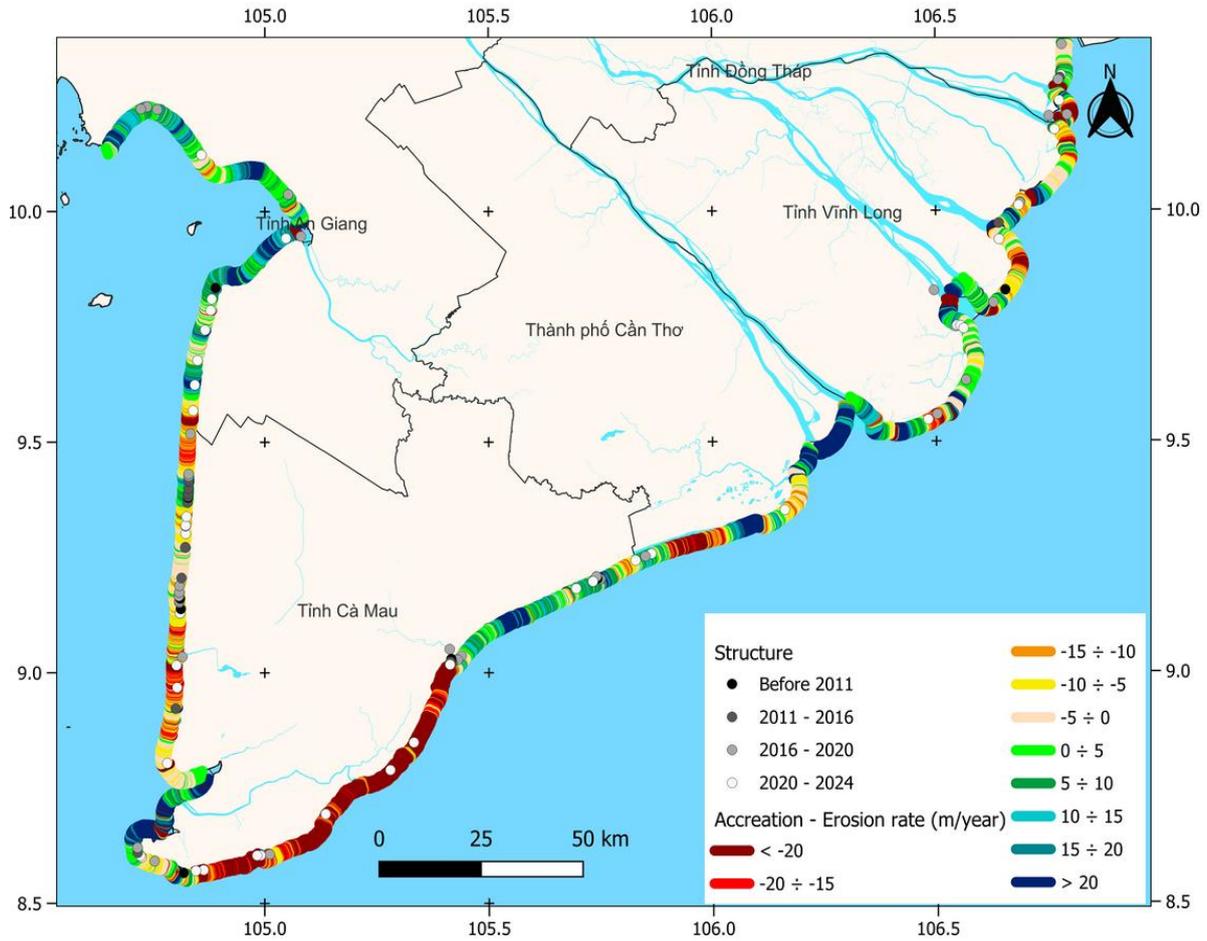


Figure 32. Map of shoreline change

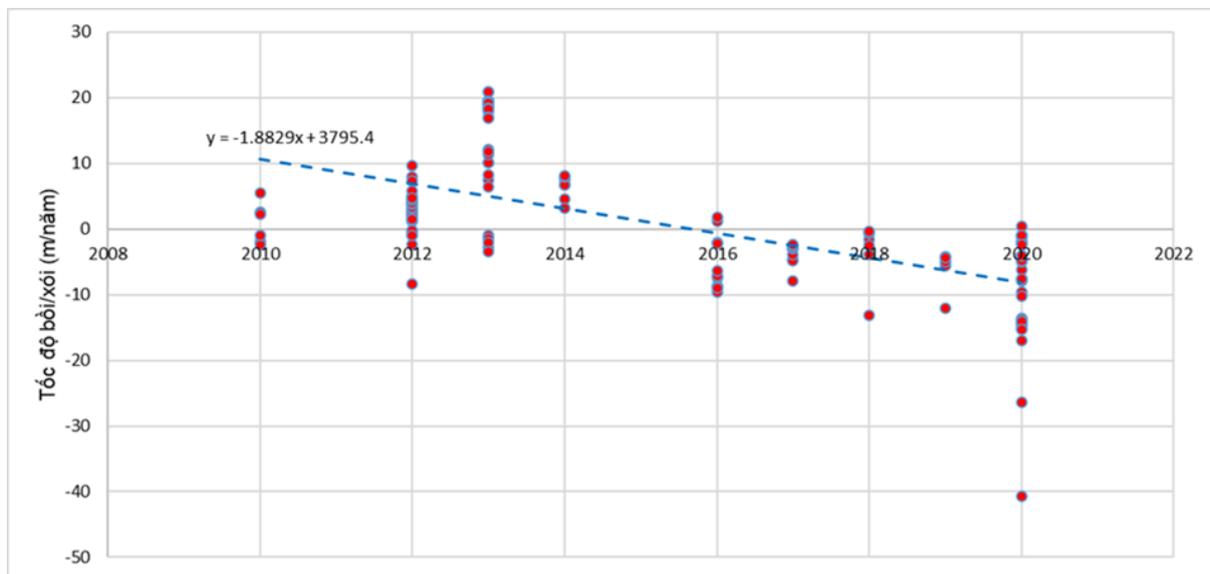


Figure 33. Erosion/Accretion rate of construction routes

Other Research

Database for Mekong Living Lab

In 2025, the research team initiated the development of the Database System for the Mekong Living Lab to support centralized, synchronized, and systematic data management and utilization. The system is designed to store, manage, and update monitoring datasets, research data, and information related to monitoring stations and measuring devices within the study area, as well as research result reports for different phases. At the same time, the system supports data retrieval and filtering by spatial location, time, and measured parameters. In addition, the system integrates related information such as contact details and links to relevant websites. This serves as an important initial platform, providing a foundation for data integration, analysis, visualization, and decision support in subsequent research and implementation phases of the Mekong Living Lab.

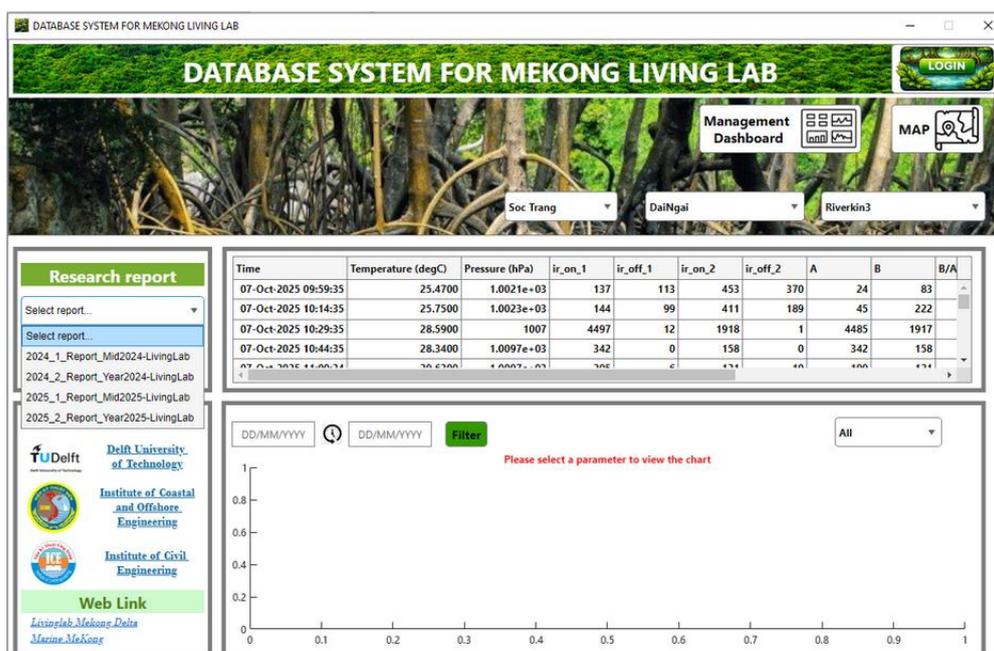


Figure 34. Demo Database System Software

On the Database System for the Mekong Living Lab, users can select provinces within the study area, including Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, etc. After selecting a province, the system allows users to choose the corresponding monitoring stations within the selected province and displays the list of measuring devices installed at each station. Based on the selected measuring device, users can then choose the appropriate monitoring parameters.

In addition, the system supports filtering data by the desired time period, enabling flexible data retrieval and analysis. The results are visualized in the form of charts, displayed according to the selected parameters and filtered time period, facilitating efficient monitoring, assessment, and utilization of observation data within the study area.

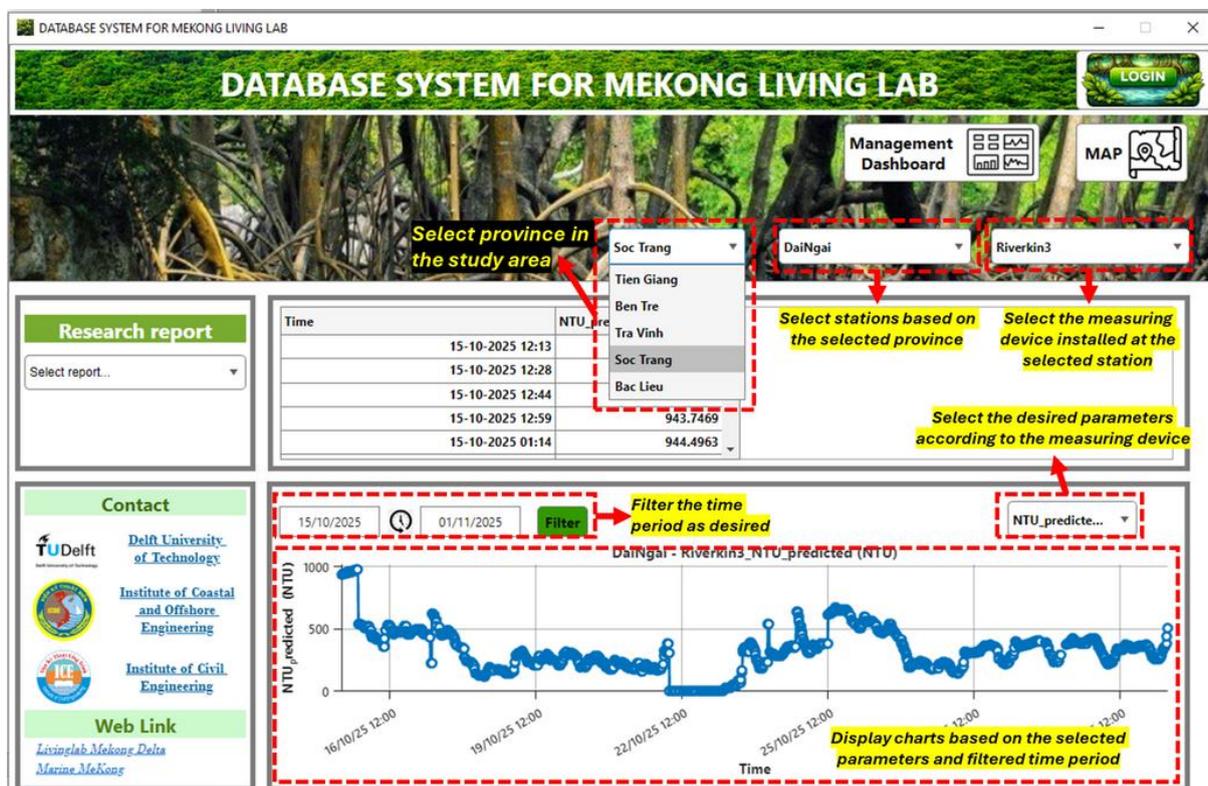


Figure 35. Demo User Interface

The Mekong Living Lab database system is developed with an intuitive interface that enables users to efficiently access and manage information. Through the mapping function, the system

supports the visualization and retrieval of the spatial distribution of monitoring stations within the study area. At the same time, the system allows users to select and access research reports by different implementation phases, supporting the compilation, monitoring, and evaluation of research outcomes.

In addition, the system integrates contact information of the organizations involved in the Living Lab project, thereby enhancing connectivity and coordination among stakeholders. The system also provides links to related websites, including information portals and project introduction pages, which helps expand information sharing, access, and utilization for research and management purposes.

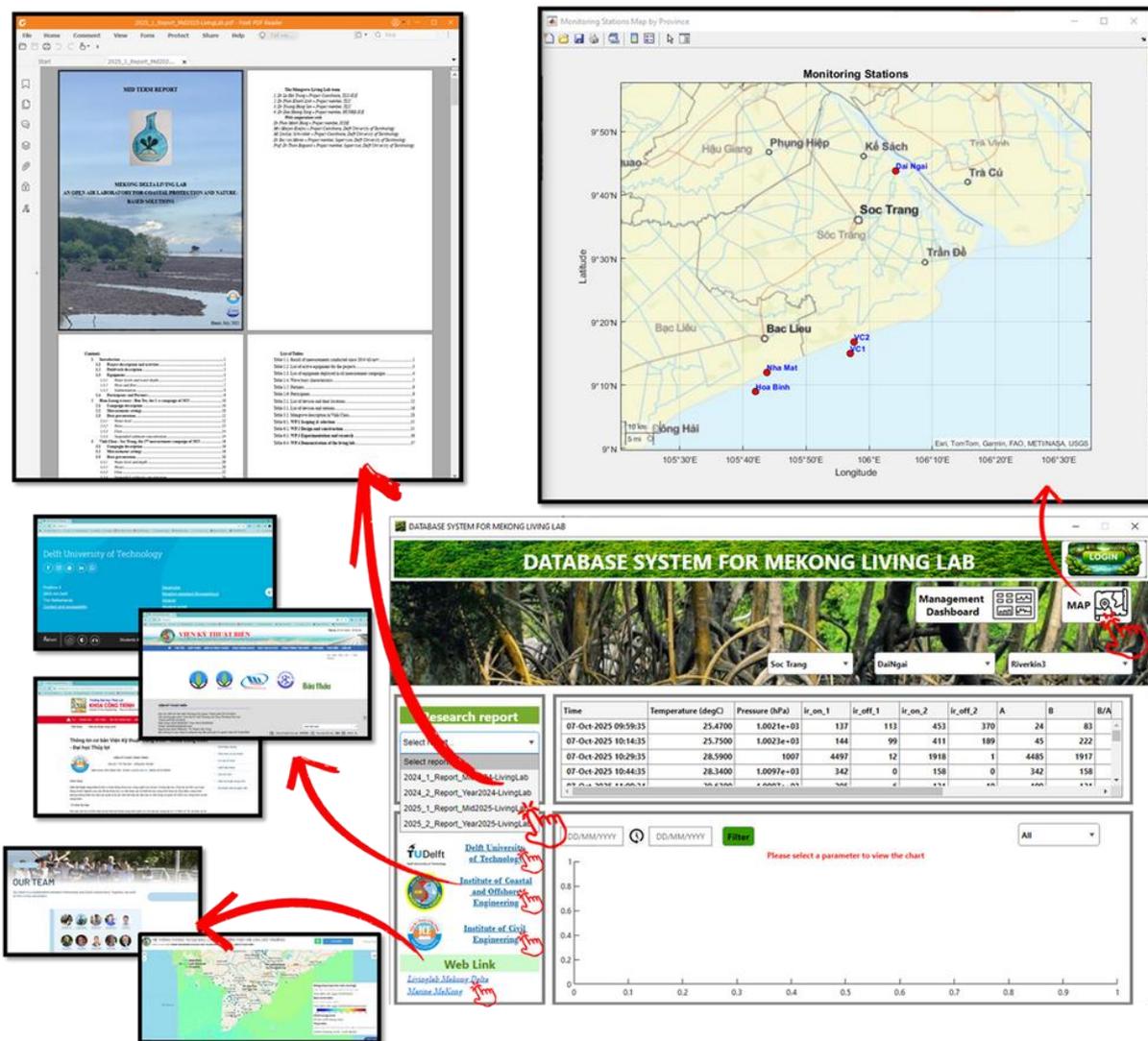


Figure 36. Demo functions and data

Assessing Future Sediment Dynamics under Climate and Anthropogenic Drivers

This research addresses a critical research gap: most previous studies focused on short-term changes, whereas this study utilizes a Delft3D 2D model to provide long-term (30-year) projections of sediment transport and bifurcation behavior. The main goal is to determine the relative impacts of these drivers on sand-dominated transport through the Dinh An and Tran De channels.

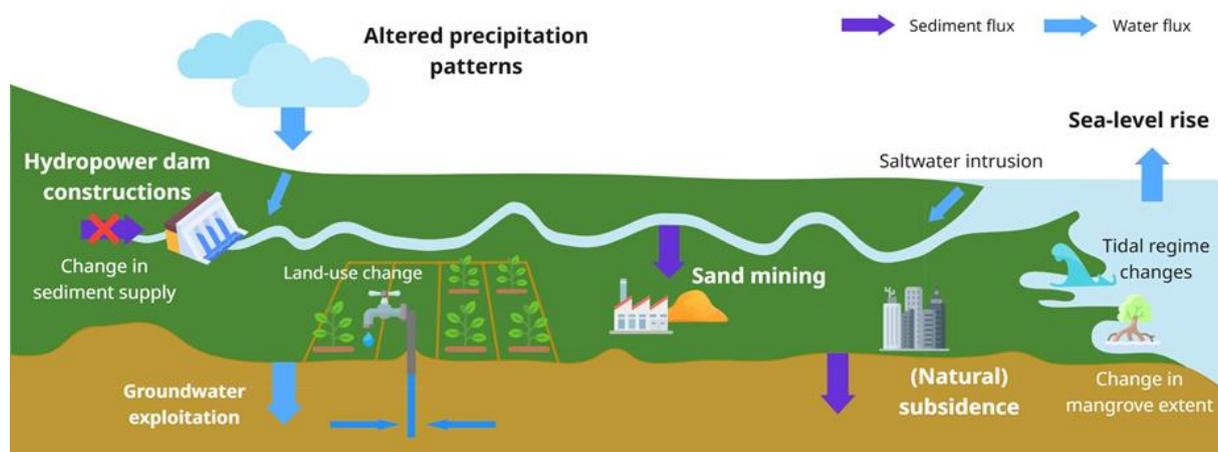


Figure 37. Schematisation of drivers influencing the Mekong Delta (modified from Minderhoud (2019))

The study's findings reveal a stark contrast between how climatic and anthropogenic factors influence the river system:

Impact of Climate Drivers

- Altered Precipitation (AP): Higher discharge generally increases the system's export capacity and reduces localized sedimentation, leading to a more balanced erosion-deposition pattern.
- Sea-Level Rise (SLR): Elevated water levels amplify backwater effects, slowing flow velocities. While this causes more sedimentation at river mouths, it reduces the inland spread of sediment compared to base conditions.

- Stabilization: Overall, climate-driven changes tend to stabilize the system, promoting a more symmetric distribution of flow and sediment between the two branches.

Impact of Anthropogenic Drivers

- Hydropower (HD): The flattening of the discharge hydrograph (lower peaks in the wet season) reduces the system's ability to export sediment during high-flow pulses, causing sediment accumulation in the Dinh An branch.
- Sand Mining (SM): Intensive extraction turns the Dinh An branch into a sediment sink, drawing material in from the sea and intensifying estuarine circulation. This results in Tran De becoming the primary sediment exporter to the ocean.
- Instability: Human interventions intensify asymmetries and push the system away from equilibrium.

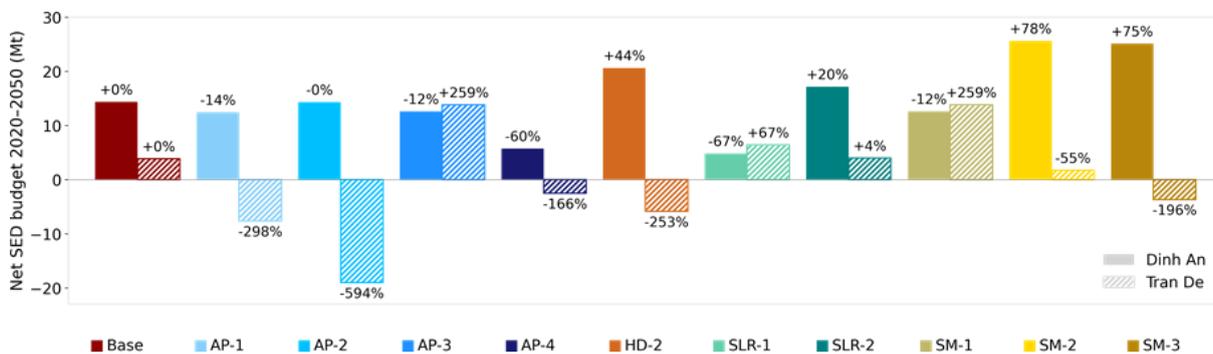


Figure 38. Overview of net change in Sediment Budget per scenario (2020-2050)

Bifurcation Dynamics: Symmetry and Stability

- Water Partitioning: The distribution of water between the two branches is relatively stable and insensitive to changes, with the asymmetry index (Ψ_Q) varying only slightly (-0.01 to 0.17).
- Sediment Partitioning: Conversely, sediment transport is highly sensitive to external forcing (Ψ_S ranging from -0.45 to 0.61). Small changes in human activity can lead to disproportionately large shifts in sediment storage and export.

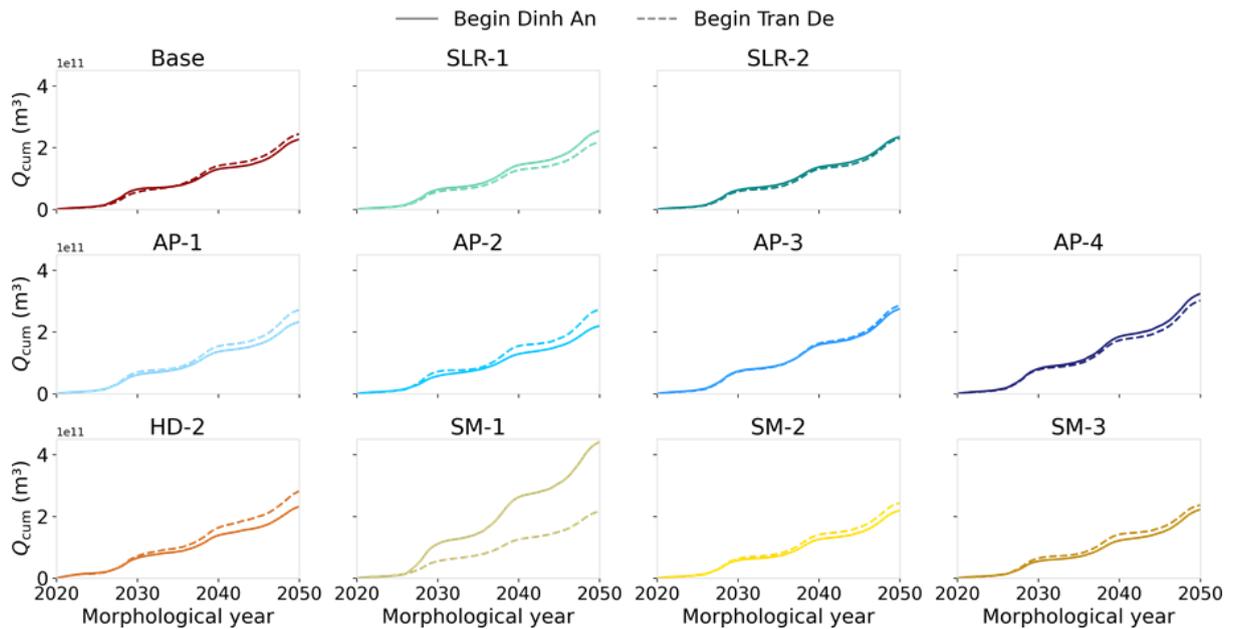


Figure 39. Cumulative Discharge for begin sections of the Dinh An and Tran De channels per scenario

Final Conclusion and Management Implications

The sources conclude that while climate change may move the system toward a more symmetric state, human-induced modifications are the primary drivers of instability. Under these interventions, the Tran De branch is likely to become dominant, leaving the Dinh An branch at risk of silting up. Strict regulation of sand mining and upstream discharge management is essential to maintain a stable sediment supply, which is vital for the resilience of the delta's coastal ecosystems, such as mangroves.

Analogy: You can think of the river bifurcation as a digital scale. Climate change acts like a software update that helps the scale find its balance more quickly. Human activities, however, are like someone physically pressing down on one side of the scale or removing the weights entirely; these actions create a "tilt" (asymmetry) that the system's natural mechanisms cannot easily correct.

Future 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 feasible locations to conduct the measurement survey.

	Accretion	Erosion
Without interventions	 <p>1 Dec-2019 Dec-2024 Ward 2, Vinh Chau – Soc Trang</p>	 <p>2 Nov-2020 Apr-2024 Lai Hoa, Vinh Chau – Soc Trang</p>



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

Equipment to use

Coastal profile measurement



RTK Trimble



Digital level



*UAV Mavic 2
Enterprise Advanced*

Hydraulic measurement



Wavebouy



Mini Buoy



Wave gauge

Sedimentation measurement



Figure 40. Riverkin sedimentation sensor

No	Type	Purpose	Number of items available
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

* Two OBS-Buoy400 devices **have been sent back** to the Netherlands for warranty **since January 2026**.

Basis for selecting the measurement period

To support the assessment and selection of appropriate periods for instrument installation, we conducted hourly water level simulations for the year 2026 at two representative stations, Ganh Hao and Tran De. The simulated results enable analysis of tidal fluctuations, water-level ranges, and tidal cycles in the study area, thereby providing a scientific basis for identifying favorable time windows that ensure technical safety and reliability of observational data during equipment installation and operation.

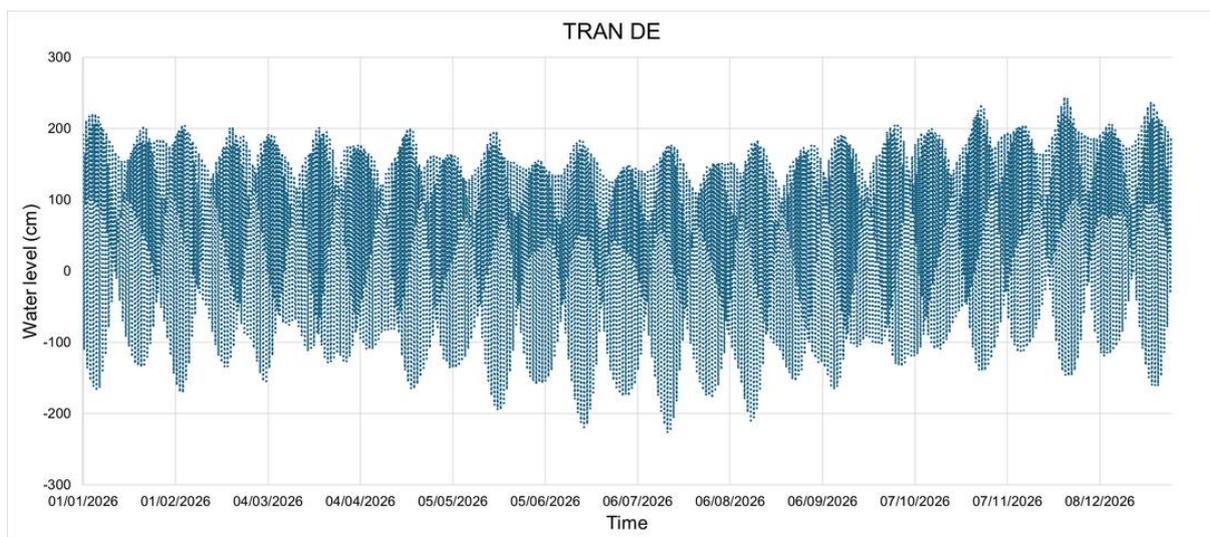


Figure 41. Forecasted Water Levels at Tran De Station in 2026

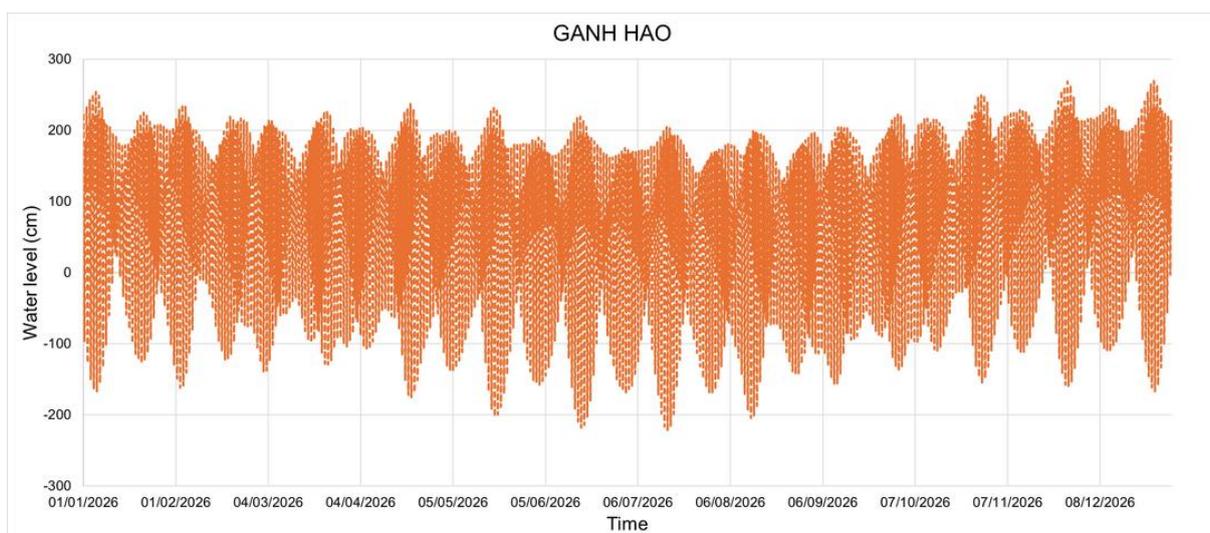


Figure 42. Forecasted Water Levels at Ganh Hao Station in 2026

Computation and assessment of the impacts of hydrodynamic and waves in the study area

Based on the established and simulated hydrodynamic and wave models, the research team will continue to implement a coupled hydrodynamic–wave (HD–Wave) model to simultaneously and comprehensively simulate the interactions among currents, water levels, and waves in the study area. The coupled model will be calibrated and validated through comparison with observational data, thereby ensuring the accuracy and reliability of the simulated results.

Using the calibrated and validated simulation results, the research team will then analyze the hydrodynamic and wave regimes in the study area, including current intensity, water level variability, and wave characteristics. Based on this analysis, the impacts and mechanisms of hydrodynamic and wave conditions on the development, stability, and recovery of mangrove ecosystems will be assessed, providing a scientific basis for management, conservation, and mangrove restoration strategies in the region.

Development and data updating for the Database System for the Mekong Living Lab

In the next phase, the research team will continue to update and supplement measurement datasets, monitoring data, and research reports into the **Database System for the Mekong Living Lab**, in order to ensure the completeness, continuity, and up-to-date nature of the system. At the same time, the system will be improved and its functionalities further expanded, including enhancing data analysis and visualization capabilities, as well as adding online access, thereby facilitating data access, sharing, and utilization by relevant stakeholders. These efforts will contribute to improving the overall

operational efficiency of the system and better supporting research activities, management, and decision-making within the framework of the Mekong Living Lab.

Reference

- [1] F.J.C Machielse. *Assessing Future Sediment Dynamics under Climate and Anthropogenic Drivers in the Song Hau Distributary, Mekong Delta*. TU Delft, 2025. URL: https://repository.tudelft.nl/file/File_45e60bdd-91be-4ea8-9b2a-c1b6d6556913?preview=1
- [2] Guusje Huijsmans, Mark Ketting, Maaïke Krap, Famke Michielsen, Sem Roozendaal, Menne van der Spek. *The Mekong Delta Digital Living Lab*. TU Delft, 2025.
- [3] Deltares. *D-Flow Flexible Mesh, User Manual*. 2025.
- [4] Deltares. *D-Waves, User Manual*. 2025.



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