

Mekong Delta Living Lab

An open air laboratory for coastal protection and nature-based solutions



October 2023





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The background features a solid blue area at the bottom, which transitions into a green area at the top. The transition is a diagonal line that slopes downwards from left to right. The green area is divided into two horizontal bands: a lighter, lime-green band at the very top and a darker, olive-green band below it.

01

Project

Introduction



Introducing the project

Background

The Mekong Delta in Vietnam is facing a dire threat of near-complete submersion by the end of the century unless urgent actions are taken throughout the river basin. Without intervention, this delta, home to nearly 20 million people, could see up to 90% of its land underwater, with profound local and global consequences. Land subsidence, accelerated by human activities like excessive groundwater extraction and aggravated by sea level rise, is causing the delta to sink below sea level. To address this crisis, it is essential to implement measures that harness natural processes to protect against devastating and recurrent flooding. Collaboration from national governments, international organizations, the private sector, and civil society is crucial.

The submersion of the Mekong Delta is threatening the vulnerable communities, particularly those situated near the six estuarine river mouths. Historically, these coastal and estuarine mangrove habitats have served as natural shields, dissipating wave energy and capturing sediment. They have been

indispensable in safeguarding the provinces' inhabitants. Furthermore, these mangrove ecosystems have nurtured rich ecological diversity and supported lucrative tourist and fishery industries. However, the ongoing degradation of Mekong coastal habitats raises significant concerns regarding their continued ability to provide these vital services in the future. Urgent action is needed to preserve these critical ecosystems for future generations.

Mangrove restoration and planting is a complex undertaking that requires political, social, economic and biophysical enabling conditions. Therefore, the implementation of these types of nature-based solutions should be conducted on the basis of local knowledge and expertise and involve participatory decision-making and long-term monitoring and data collection. A long-term physical living lab in the Mekong Delta will be able to validate these conditions and strengthen this with actual data and evidence-based understanding.

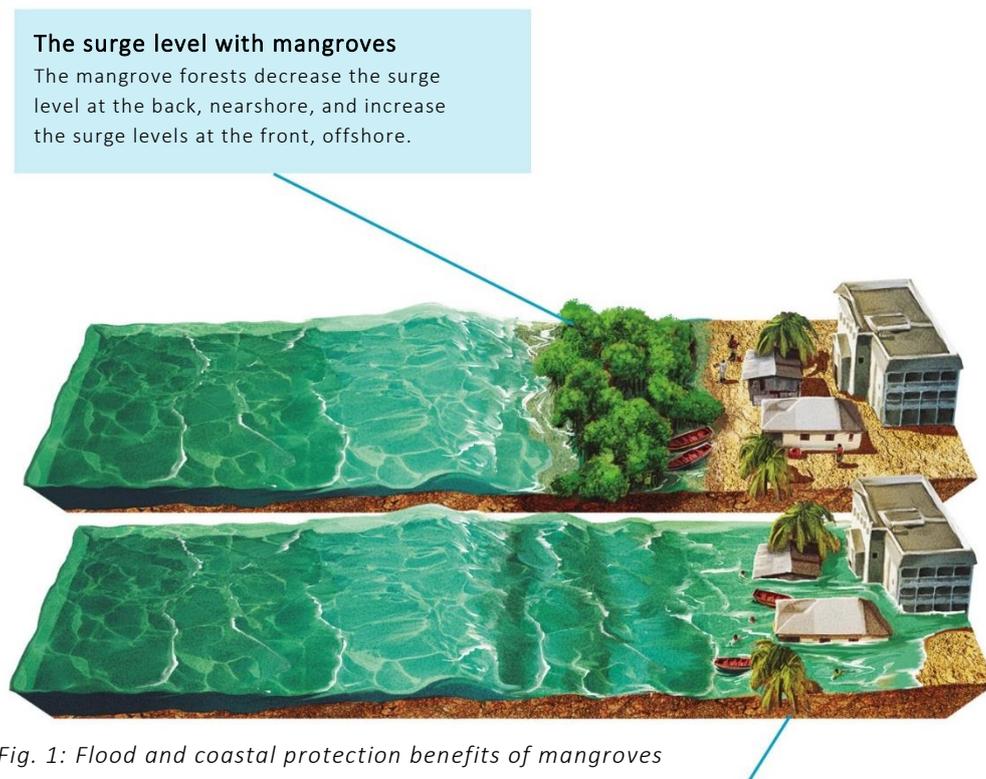


Fig. 1: Flood and coastal protection benefits of mangroves

The rationale behind a living lab

What is a living lab?

We define a living lab as a physical space in which to study and solve complex (bio-)physical and societal challenges by bringing together various stakeholders for collaboration and collective ideation and learning.

Living labs serve as a crucial link between knowledge developers and innovation users, facilitating the development of research projects, pilot initiatives, and field experiments. This dynamic involvement in practical projects helps raise awareness of innovative practices. As a result, universities become more integrated with society and have greater influence when providing advice to various partners.

At TU Delft, living labs like The Green Village and Flood Proof Holland play pivotal roles in accelerating innovation and building support for climate-adaptive solutions. These living labs offer real-time experimentation and validation of innovations through monitoring, making it easier for public entities to adopt new solutions.

In contrast, traditional Vietnamese responses often lean towards hard engineering solutions and permanent structures, influenced by a

historical tradition rooted in river and estuarine training structures. This approach is exemplified by the widespread use of sea dikes, which have been an official strategy in many coastal regions for years. Unfortunately, these sea dikes often lead to coastal and estuarine constriction, adversely affecting precious mangrove forests. Currently, a lot of mangrove understanding is produced in hydraulic laboratories on laboratory scales. The physical complexity of mangrove systems is difficult to mimic in the laboratory, let alone the socio-cultural and socio-economic aspects. Therefore, we propose to create a permanent living lab in the Mekong Delta that will be centered around **2 main pillars**:

1. Gaining better insight and knowledge through conducting of in-field measurement campaigns, long-term monitoring and a wide variety of research experiments;
2. Demonstrating and showcasing various lessons learned and potential (nature-based) solutions for coastal management in Vietnam

Next to this permanent field lab, we will also invest in a set of mobile monitoring equipment to conduct short-term measurement campaigns in various places in the Mekong Delta. Setting up such a living lab requires a substantial amount of time and resources. This initiative represents the first phase of the living lab setup.

“*Living labs are a new way of developing and applying knowledge. Living labs involve all the different parties required for identifying solutions to social issues. It is not just about technical progress, but also about social innovation. We often see multiple problems come together, and living labs are a particularly suitable tool for addressing these types of complex problems*”

Jasper Deuten, Coordinator Rathenau Institute

Our team of experts

At Thuy Loi University (TLU) and the various research institutes in Vietnam, there are a dozen of young researchers who have obtained their PhD at TU Delft in the field of coastal protection and nature-based solutions, specifically mangrove related research in the Mekong Delta. They are eager to apply their knowledge and skills for better mangrove and coastal projects in Vietnam. As two renowned universities in the field of coastal management and long-term partners (TLU and TU Delft) and together with the research institutes in the North and South of Vietnam, we developed together the idea of a mangrove living lab in the Mekong Delta. We see a clear need for a field site where long-term monitoring and research can be done and potential solutions can be monitored, improved and demonstrated to a variety of stakeholders (e.g. national, provincial and district government, media, artists, donors, communities, students, researchers etc.). This permanent field site will be strengthened and complemented by a variety of short-term measurement campaigns in the form of a mobile lab.

As a team, the Vietnamese colleagues who obtained their PhD at TU Delft, with financial support of both the Vietnamese Ministry of Education and the NUFFIC, will play a leading

role in the development and daily operations of the living lab. Since the living lab will be in the Mekong Delta, an important implementing role will be played by the Institute of Coastal and Offshore Engineering (ICOE) in the South and the Institute of Civil Engineering (ICE) under Thuyloi University (where also some of the TU Delft alumni are currently working). The Vietnamese team will be supported by a renowned team from the TU Delft, existing of coastal experts, water management and monitoring experts and technology policy and management experts whom all bring in extensive experience in Vietnam. Throughout the project we also foresee to involve a lot of TU Delft and other students (e.g. WUR, HBO etc.) that can team up with Vietnamese students and staff. In the past years, this student exchange has proven to be a very effective way of conducting research together and gaining better insight into the challenges in Vietnam. In the annex of this document we have included an overview of all involved staff members, including their expertise and role in the project. It is noted that the collaboration that **has developed over the last 20 years** between the Thuy Loi University (MARD founded) and Hanoi University of Natural Resources and the Environment (MONRE founded) can be developed further in this project. The collaboration between the two ministries is of high strategic importance.

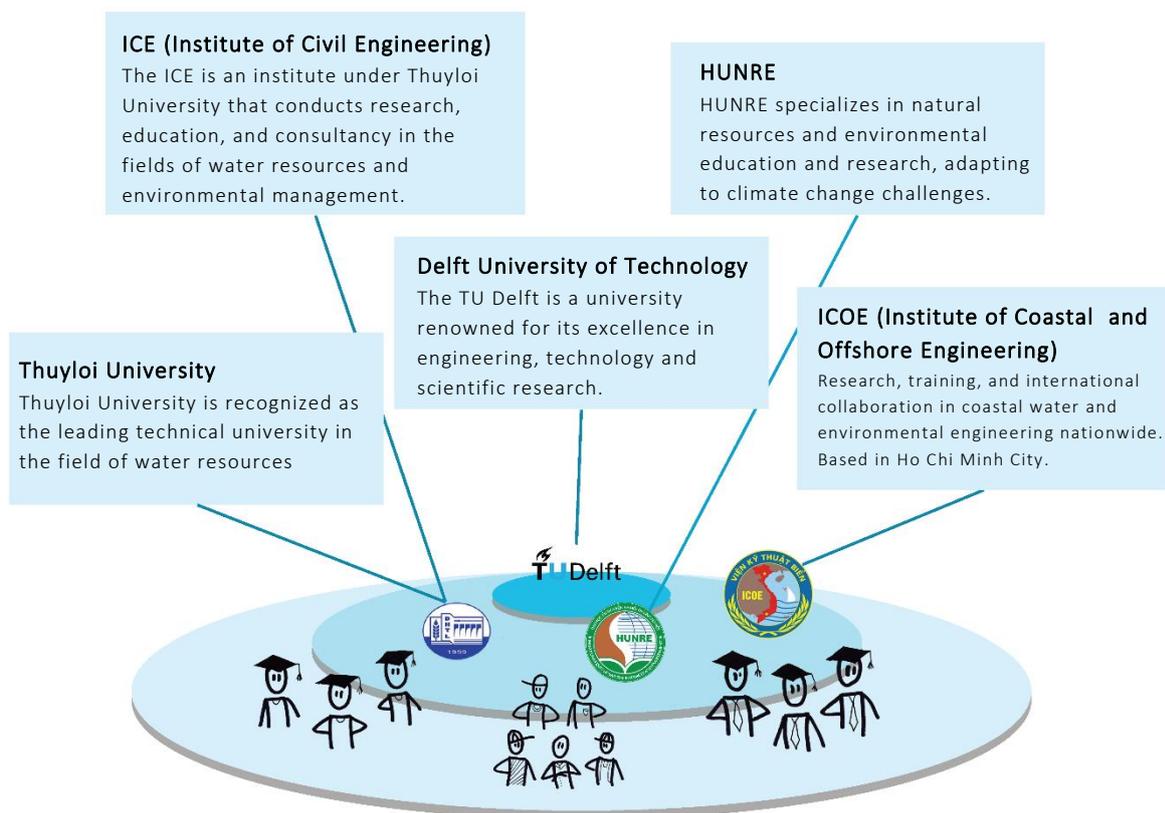
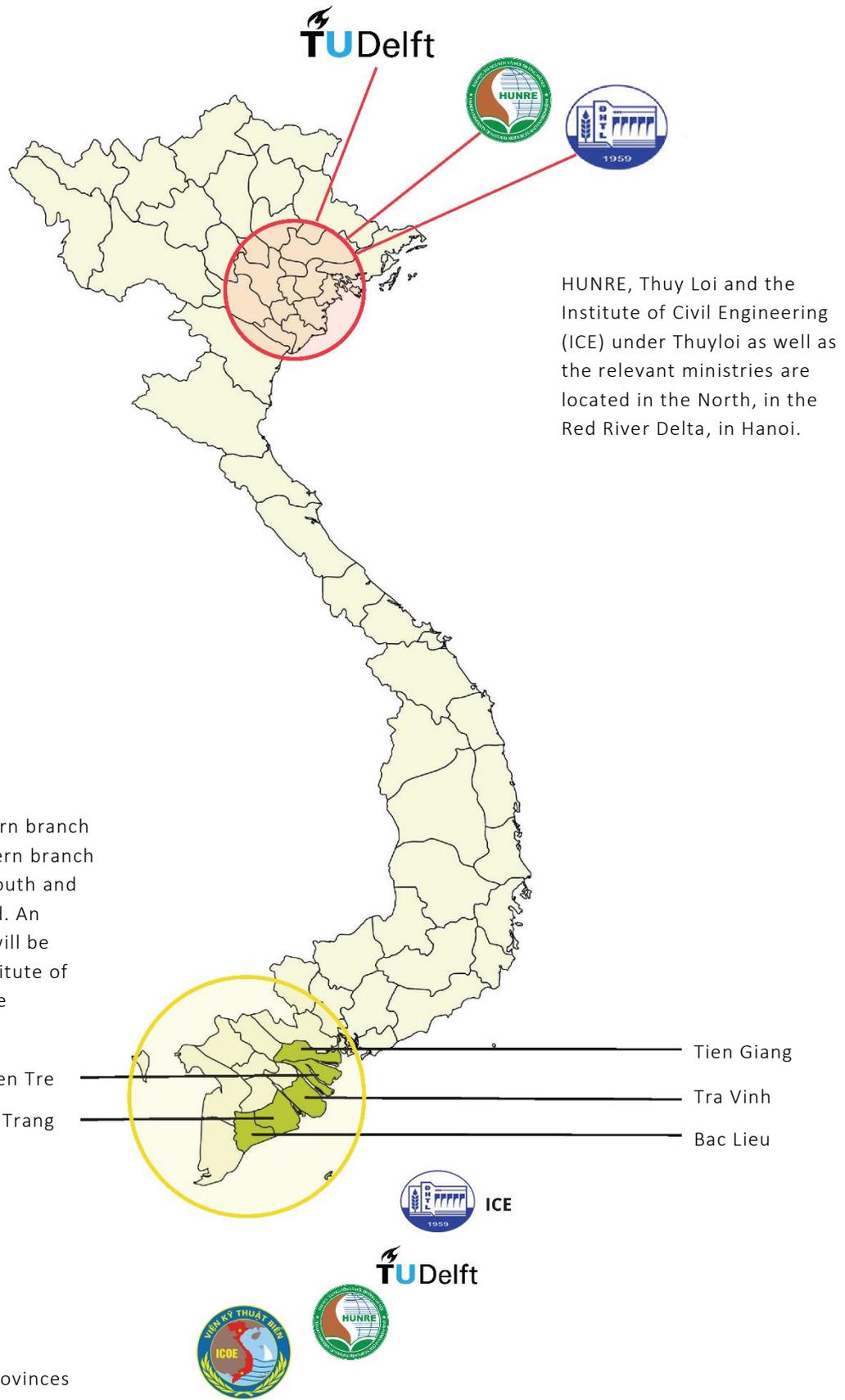


Fig. 2: The involved partners and stakeholders within this project

The location of our research and experiments

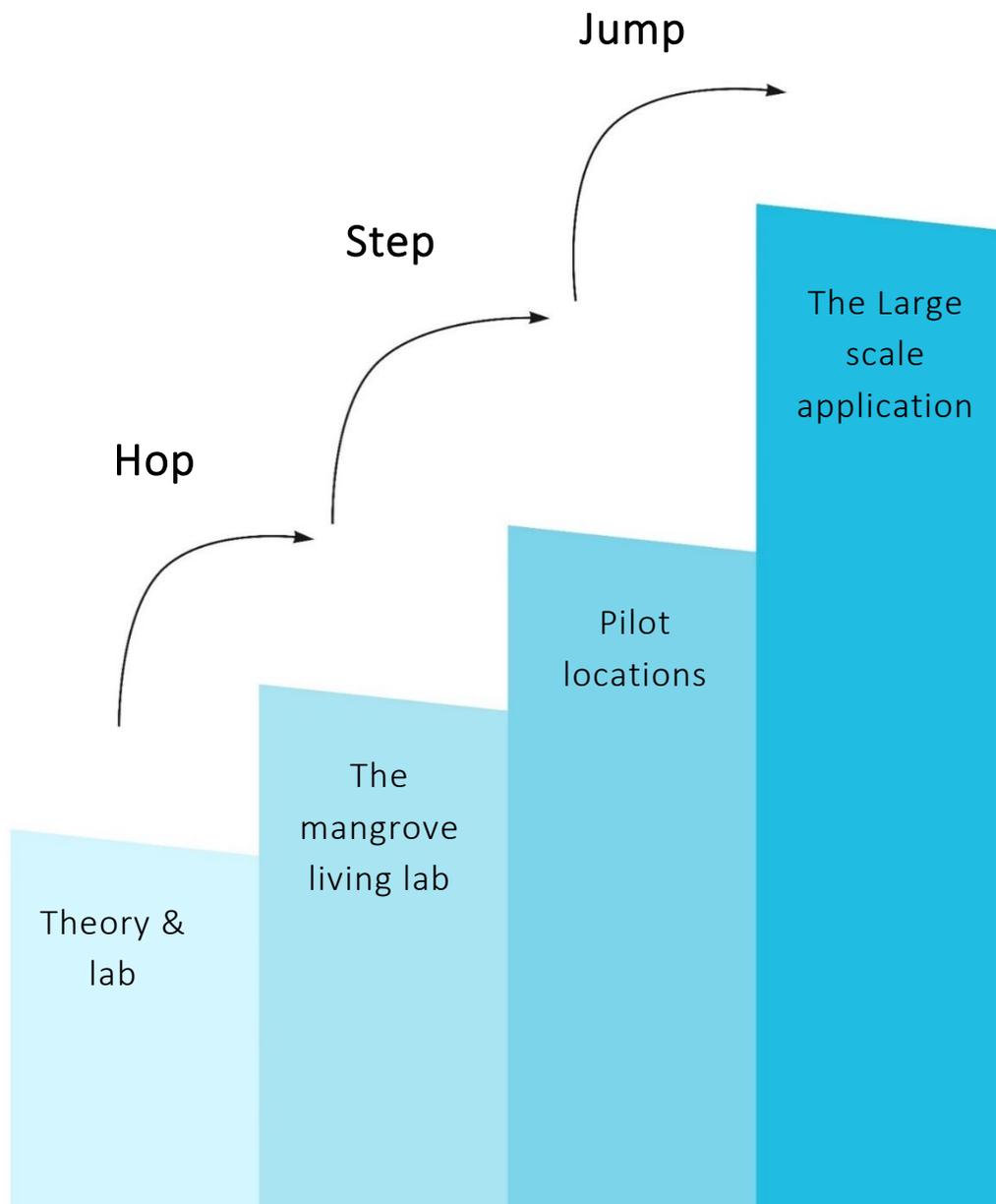


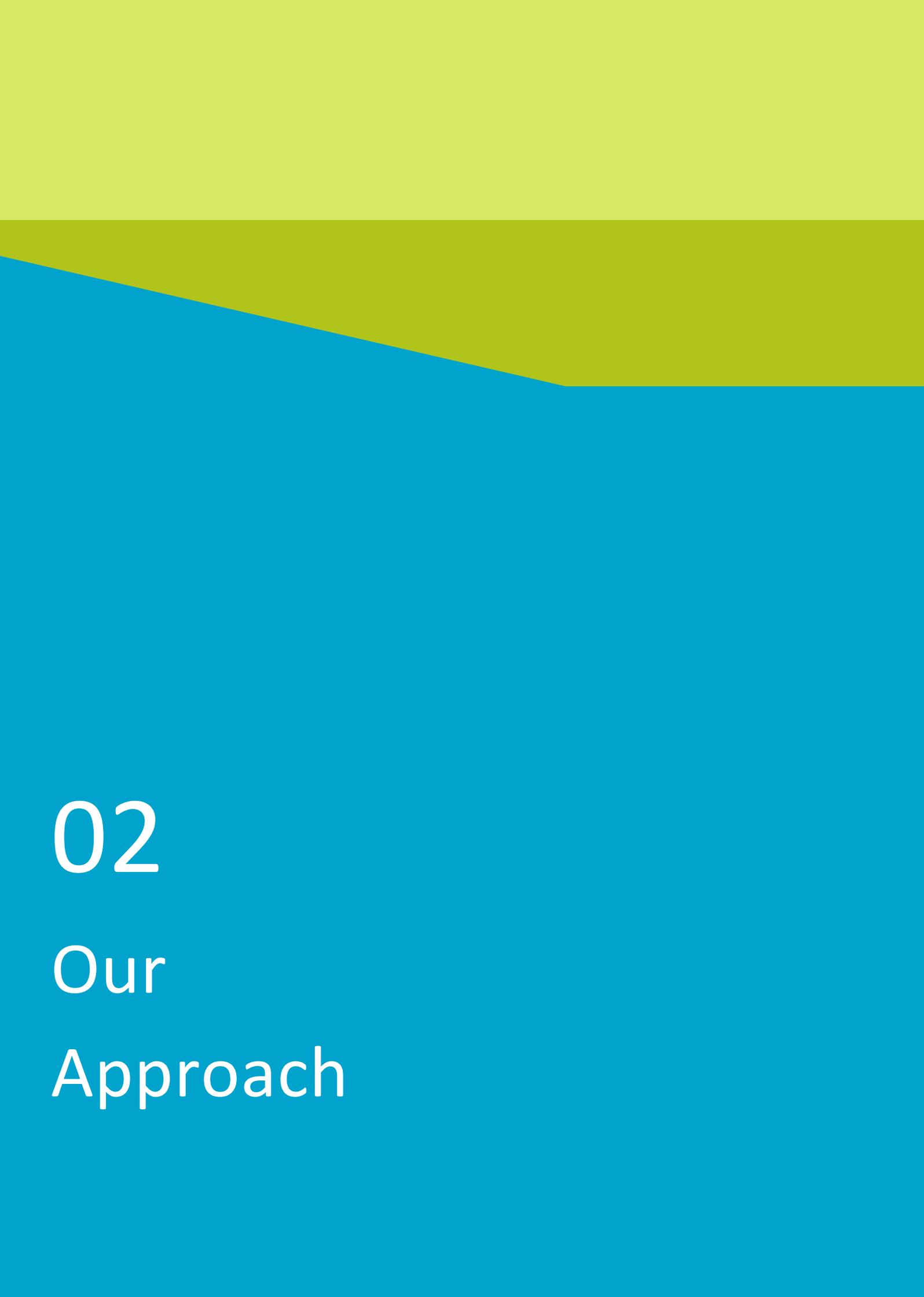
- Our 5 targeted provinces
- The Mekong Delta
- The Red River Delta

The 'hop' to large scale application

The primary goal of our living lab is the acceleration of sustainable innovation to scale up to large scale application. We form the 'hop', the first location for the researcher/entrepreneur to test their innovation in a real-life environment. Our living lab's primary goal is to demonstrate alternative coastal protection solutions in Vietnam and share knowledge, while the second objective is to conduct research and gather data. The

approach starts from lab and theory research and proceeds with real-life testing in the living lab (the 'hop') and share the data and information on a platform. We foresee that the the coastal protection innovation will expand to pilot location and become a part of existing programs and projects. Finally, the 'jump' phase involves implementing the innovative solution on a larger scale by the responsible stakeholders who have been convinced by the results in the living lab and pilot phase





02

Our

Approach



Proposed approach

Objective of the living lab

The envisaged living lab in the Mekong Delta will serve as a **1) platform and collection of relevant knowledge** and lessons learned based on a variety of in-field scientific measurement campaigns in the Mekong Delta, and **2) demonstrating a variety of solutions** to relevant stakeholders on a permanent physical site. Indoor flumes focus on scientific pursuits, whereas field measurement campaigns emphasize real-life solutions. Therefore, the aim of this living lab is: bridging the gap between theory and practice, from the indoor lab of Thuy Loi and the other institutes to the complex outdoor reality in the Mekong Delta. Especially since in the past years, many project efforts have been implemented to improve the coastal system, but had limited success. A living lab allows showcasing the various mangrove restoration methods and as such support improved and more evidence-based decision-making with a more long term commitment.

Many of these structural interventions suffer from a lack of understanding of the system and concerns about mangrove loss, coastal erosion and soil subsidence. Through the mangrove living lab, we aim to convey a crucial message that we need to understand the (bio-)physical system dynamics better, gather learnings, evaluate and minimize short-term interventions that could harm mangroves in the long term. Alongside, we will build a data platform where the data can be collected, summarized and shared throughout. This data platform serves the purpose of informing and supporting the decision-making process of ongoing and new projects. With the living lab we also address another crucial factor for learning, namely to showcase the learnings and results ‘in the wild’ and to connect with and make sure the communities are involved. This demonstration effect of the envisaged living lab will be instrumental in ensuring uptake of the gained insights and knowledge.



Showcasing different solutions and their effects through data collection and research

Visiting the field in March 2023 with our team of experts



On Flood Proof Holland, various parties investigate, test, and demonstrate temporary water barriers and other solutions for flooding. Flood Proof Holland has had an important role as a field lab and showcase for solutions to flood problems since 2013. Visitors from all over the world attend demonstrations in Delft. Flood Proof Holland stands as a beacon of innovation, seamlessly aligning with the envisioned Living Lab in Vietnam's Mekong Delta.



The benefits of a living lab

The benefits of the living lab can relate to the following three:

1. **Research**
2. **Showcasing**
3. **Education**

Below, a detailed list can be found.

Interdisciplinary collaboration

Understanding the challenge requires interdisciplinary collaboration, fostering active stakeholder participation through co-creation within the living lab framework. Our primary goal is to generate and share knowledge for continuous innovation. Involving key stakeholders - public entities, private organizations, end-users, and knowledge institutes - ensures ongoing decision-making influence throughout development.

Community engagement

Enhancing research relevance involves engaging the local community by providing them with essential local information, fostering a mutually beneficial knowledge exchange and creating an understanding.

Experiential learning

A living lab offers a unique opportunity for deep engagement with the challenges of coastal protection. It provides a tangible opportunity to acquire practical, real-world insights and expertise. Moreover, this immersive environment nurtures the cultivation of critical thinking skills for both staff, students and professionals in the field.

Knowledge transfer

Knowledge cultivated within the permanent and mobile living lab can be effectively distributed to educational institutions and students, enriching learning experiences within the Vietnamese communities. Furthermore, the living lab's versatile infrastructure provides an ideal venue for hosting various events, thereby contributing to sustainability efforts by addressing critical issues like climate change and resource management.

Innovation and prototyping

Given its role as a platform for experiential learning and fostering interdisciplinary collaboration, the living lab functions as a natural incubator for pioneering ideas. The solution development process within this framework follows an iterative approach, with the continuous collection of feedback a living lab enables refining and advancing the proposed solutions.

Data collection and analysis through research

A living lab serves as an environment for conducting in-depth studies and thorough analyses of the findings. This dynamic setting allows researchers to immerse themselves in real-world scenarios, gather data, and apply various methodologies to scrutinize and interpret results effectively. It offers a unique opportunity to bridge the gap between theory and practice.

Policy influence

Collaborating with the local government empowers us to shape policies and regulations, directly contributing to well-informed governance measures and fostering an environment conducive to sustainable initiatives and projects.

- Research related benefit
- Showcasing related benefit
- Education related benefit



Tours

Tours will be given to stakeholders and other external parties and community members to help create a deep understanding of the system and showcasing innovation



Experience center

A location where community members, governmental parties and stakeholders can be involved to share knowledge



Create awareness

The living lab is also used to create awareness among the Vietnamese government, the communities and stakeholders



Data collection and showcasing

Different solutions will be demonstrated, tested and validated while data is being collected.



The plan for developing this living lab

To develop this living lab, we foresee four main work packages, these are as follows.

1

Scoping & selection



Involved players

Team lead and team participants: TU Delft, Thuy Loi, the Institute of Coastal Engineering and the ICOE. External consultations: MARD, several provincial DARDs, HUNRE, SIWRP

Deliverables

Written documentation/feasibility study including photos of possible living lab locations using historical data and existing analyses based on physical criteria, but also based on practical, social and institutional criteria.

Duration: 6 months

Activities

- Conducting site investigations and analysis in the different provinces and understanding the differences between the provinces, their difficulties and their coastlines.

- Researching current solutions for coastal protection and developing an extensive database of findings regarding the different solutions that have already been tested.
- Organising meetings and workshops on the idea of a living lab with the responsible local authorities and communities to gather their input.
- Involving big donors like ADB and Worldbank by organising an event where we can present our first research.
- Based on the scoping of possible living lab locations in the Mekong Delta and the results of the stakeholder workshop, our team will make the selection of a suitable site in one of the provinces in the Mekong Delta.
- Permission needs to be granted for the chosen location of the living lab. The regulations need to be taken into account in order to start building the lab. Research has to be conducted into the local rules and regulations and the process of getting a permit.
- Involving the local communities with the search of a location for the living lab by organizing focus group sessions and creative sessions.
- Make a decision on the location of the living lab together with the Vietnamese colleagues.

Design and construction



Involved players

Team lead and team participants: TU Delft, Thuy Loi, the Institute of Coastal Engineering (ICOE) and the Institute of Civil Engineering (ICE)
 External stakeholders involved: MARD, DARD, MONRE, DONRE, Dutch Embassy Hanoi (but perhaps also other donors like the ADB, the World Bank and Invest international).

Deliverables

Written documentation on the consultations and discussions with relevant institutions and the resulting agreements/permission.

Duration: 6 months

Activities

- Make the design of the living lab. This entails the design of the experience center and the design of the showcase of the different solutions. The necessary research will be conducted in order to make the design feasible.
- Plan and design the interior layout of the lab, considering factors like equipment placement/storage, workstations, and safety measures to create a functional and efficient workspace.
- Partner up with a contractor who will be in charge of building/adopting the

living lab. Our Vietnamese colleagues will assist in finding a suitable local contractor and supervising the works.

- Building the living lab on the chosen location where the permission is granted.
- Conduct the first few experiments in the living lab together with students and staff of our partner universities/institutes.
- Organize a demonstration/opening event in the living lab for the Vietnamese government, the community members and other important stakeholders.
- Develop a (joint) research agenda to advance knowledge on nature-based solutions in the Mekong delta, together with other important stakeholders such as the ADB, WWF, Wetlands International, the Worldbank, Invest International and others that are working on the implementation of NBS in the Mekong Delta.
- Embedding the field lab in the various relevant institutions and programs through educational activities. Partner with universities, colleges, or schools to incorporate the field lab's activities into their curriculum. Besides the educational organizations, we will work closely with relevant government departments or agencies as well.
- Developing a digital platform in which we will share our research findings, provide input on policies, and support decision-making processes and ongoing projects.
- Engaging the local community by offering workshops, educational programs and public events.

Experimentation and research



Involved players

Team lead and team participants: TU Delft, Thuy Loi, ICOE, ICE and the TU Delft (also students). External consultations: MARD, DARD, MONRE, DONRE, Dutch Embassy Hanoi (but also other donors like the ADB, the World Bank and Invest International), and NGOs (Wetlands, WWF and Ecoshape)

Duration: 24 months, this includes experiments to validate the efficacy of the lab

Activities

- Identify and implement appropriate research methods and monitoring protocols required for the actual design and construction of the living lab.
- Evaluate the suitability of existing instrumentation and make informed decisions on acquiring new equipment if needed.
- Purchasing the necessary equipment and materials for monitoring and evaluation. This activity also involves setting up the measurement protocols and the platform in which we will collect the data gathered from the physical living lab and the short-term measurement campaigns.
- Carry out the experiments and the tests in the living lab. The experiments and the tests can be carried out with the relevant stakeholders and in collaboration with different students.
- Create and develop a specialized data platform for the physical permanent living lab location and the mobile measurement campaigns. These platforms are essential for efficiently collecting, storing, and analyzing the data generated by the experiments and measurements conducted in the living

labs. We will also ensure that we make the data accessible to researchers and stakeholders for research and decision-making purposes.

- Engaging with possible donor parties and large programs (such as the ADB mangrove project and Invest International) to ensure that our living lab can be incorporated in such a larger project to ensure the establishment of the living lab when the 3 year-period is finished.
- Forging partnerships with other relevant parties or companies active in the Mekong Delta and offer them access to the living lab but also involve them and gain access to their resources, expertise, and possible coastal solutions.
- Engaging the local community by offering workshops, educational programs, and public events.

Demonstration of the living lab



Involved players

Team lead and team participants: TU Delft, Thuy Loi, ICO and ICE, HUNRE and the TU Delft.

External consultations: MARD, HUNRE, Dutch Embassy Hanoi and other donors

Duration: The whole project duration (in total 36 months)

Activities

- Promotion material about the living lab, online as well as on site through visible sign posts and markings
- Documentation and communication material in which we share the various experiments and research set-ups in the living lab.
- Set-up demos for validation and testing purposes, organise tours/communication/YouTube/X, educational and artistic projects as well as events to share our findings and insights with the communities, government staff, donors, colleagues and other relevant stakeholders

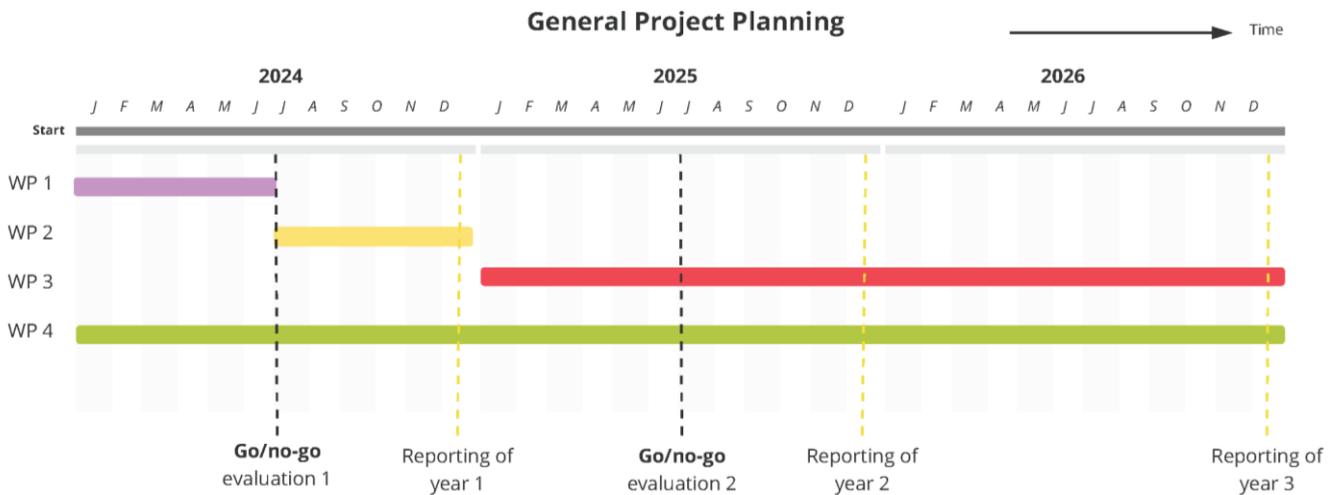
Foreseen planning of the project

The duration of the project is 3 years. We have already started the first work package by conducting some initial site investigations and having exploratory meetings with MARD and the various DARD offices in the provinces. Officially, the project will start on January 1, 2024. Our ambition is to select the field site within one month, so that we can start with the design of the living lab. This means that end of March, we aim to have already some monitoring installed and we can conduct the first experiments and have the official opening ceremony with VIPs.

Around the end of the first year, in December 2024 the report will be delivered concerning the first year activities. This report will entail a summary of the activities that have been implemented and the insights that have been gained over the first

year of experimenting, research and demonstration.

Already before the start of the project, initial discussions have taken place with important stakeholders such as the ADB and Invest International. This living lab will fulfill a crucial role in their larger plans for the Mekong Delta and the ambitions of the Vietnamese government. Therefore, throughout the entire project period we will ensure (through involvement and alignment with these important actors), that this living lab will be incorporated and embedded in these large and long-term initiatives. We are very positive about the prospects for the institutional embedding and sustainability of the living lab.





Our Vietnamese team members have had numerous knowledge sharing sessions and consultations already with the local governments and communities in the Mekong Delta.



Our impact strategy

Our foreseen impact will be centered around two main activities:

1. Performing experiments and research both in our own laboratory and at various locations within the Mekong Delta region: By collecting relevant information and data, we will develop a unique database of actual data and monitoring results. This database will be openly available and accessible and it will collect all relevant (research) experiments, publications, data and stories. It will be focused on the activities in the living lab, but also on the other ongoing experiments and research projects related to mangrove research in Vietnam.

2. Sharing knowledge and insights on the complex topic of mangrove restoration: By conducting field experiments, demonstrations and tours we will create a physical space and showcase for know-how related to mangrove ecosystems. This will be a truly unique space where theory and practice will meet and people can come together to learn and get inspired. This will accelerate the uptake of new knowledge and solutions and it will lead to more fact-based and practice-oriented understanding and decision-making. Simultaneously, this serves as a secure environment wherein innovations have the freedom to undergo iterative processes of failing and improving, fostering the development of enduring innovations with real-world applicability.

Involving local communities

Involving the local communities within the foreseen research has a lot of benefits. Local communities often have a deep understanding of the environment, culture, and specific issues that researchers may be studying. Incorporating this local knowledge can lead to more accurate and contextually relevant research outcomes. Furthermore, by involving local communities, researchers can address issues that are of direct concern to the community. This can lead to research that is more relevant and useful for both the community and the broader scientific community. Also, collaborative research with local communities can lead to more sustainable and long-lasting outcomes as mutual understanding is created. It can empower communities by building research capacity and facilitating community-based initiatives that

extend beyond the duration of the research project. Research findings that emerge from collaboration with local communities may have a stronger impact on policy and decision-making, as community members can advocate for change based on their own experiences and the research results. Establishing trust with local communities is crucial for the success of research projects, therefore our living lab will be situated in a province where we already have good local contacts and experience and a relationship we can build upon.

Local communities will be involved early on in the process, in a variety of ways during the project:

1. Introducing ourselves to the local community: Connect with the local members in an informal way, such as organizing drinks, a picnic or a tour to connect.
2. Involving community members within the search of a suitable location as well as with the design of the living lab.
3. Create awareness around the living lab and the research: This can be done by collaborating with local marketing agencies, presenting plans in community meetings, sending out flyers or promoting the lab on social media platforms that will reach local members.
4. Invite community members to collaborate on the realization of the lab: Having people voice their opinions and collaborate effectively can be done by organizing workshops, creative sessions or by inviting local advisory boards. In order to make the lab more visually appealing, collaborating with local artists or other members can even be considered.
5. Involve the members within the actual research: this can be established by creating focus groups and conducting surveys and interviews but also organising citizen science campaigns.
6. Collaborate with local players: Involve local marketing agencies, local building partners and other relevant players that are necessary to develop the living lab.

Other important ways to involve are described in the next section, to also minimise the potential risks.



Above is an example of Vietnamese street art that could potentially be incorporated on the living lab container. Below, the societal and public recognition is displayed for all the work the TU Delft has been doing together with MARD for the Mekong Delta.



Potential Risks

There are quite some risks related to the implementation and potential success of the project, these risks are as follows

1. Institutional support

It can be quite challenging to find a location along the coastline in Vietnam where we will be allowed to measure, monitor, conduct experiments and invite a wide range of stakeholders. This means that the site should not only be practical (easy to reach and safe), but also the local authorities and communities need to be willing to work together with us and grant us permission to use parts of the coastline as a living lab. To minimize this risk, we'll need a site that is not only practical in terms of accessibility and safety but also requires cooperation and permission from local authorities and communities.

Fortunately, we have an advantage in this regard as many of our Vietnamese colleagues possess extensive research experience and have established valuable contacts in various Mekong provinces. This pre-existing network and expertise will be instrumental during the scoping phase, enabling you to minimize most of the associated risks. By leveraging these relationships and working closely with our colleagues, we can increase the likelihood of finding a suitable location where we will be granted the necessary permits and can establish workable agreements with the relevant authorities. This collaborative approach enhances the project's chances of success by building vital local support and ensuring the project's alignment with community and regulatory interests.

2. Delays

Official rules are set in place that can cause the project to get delayed. This concerns filling out excessive or seemingly unnecessary paperwork, obtaining licenses and permits for the living lab location and the building of the lab. These regulations may slow down the project or hinder decision-making processes. In order to avoid any unnecessary delays, we need to make sure we

are well-educated regarding the rules and regulations. The critical steps in paperwork need to be identified and the importance of the steps need to be clarified. Building relationships with relevant authorities can help in expediting processes as well as establishing clear and streamlined communication channels where issues can be addressed promptly and miscommunication can be avoided. Unavoidable delays will be anticipated for regarding the project planning and timelines.

3. Social acceptance

The concept of a living lab and working together with various institutes and authorities is relatively new in the Vietnamese context. We know from experience that for a living lab to be successful, it is crucial that many different types of stakeholders are actively involved and can see the added value. In this context, communication should not solely target the scientific and political communities in Vietnam but also extend to economic and social actors who are relevant to the living lab. Achieving social acceptance necessitates presenting the living lab concept in a manner that resonates with and attracts a broad spectrum of stakeholders. The following steps can be taken to minimise the risks involved. First of all, we should draft a comprehensive communication plan that outlines how the living lab concept will be effectively communicated to different stakeholders. The plan should address the specific concerns and interests of each group. Secondly, we should team up with social scientists who can conduct research into the local social and cultural dynamics to gain insights into the best ways to engage with and gain acceptance from different community groups. Thirdly, designers can aid us in making the lab more visually appealing and relatable. Design can help making complex topics and ideas engaging, understandable and actionable, transcending language barriers. Ultimately, we should utilize the network of the Vietnamese team members to build trust and understanding with the local communities.

4. Safety risks

Since we will be monitoring and measuring out in the open there are security and safety risks involved. For example, flooding and storm damage to our experimental set-ups and equipment is a risk, but also theft and vandalism. These risks can be addressed in two ways. First of all, we need to explore whether some of the local communities and local DARD offices can play a role in maintaining the living lab. Collaborating with community members to establish a sense of ownership and responsibility for the lab's security and upkeep. Their presence can act as a deterrent to theft and vandalism. We can engage in community dialogues to address concerns and promote mutual understanding.

Furthermore, we should implement safety measures that include securing equipment. Install lockable containers to protect valuable tools and instruments, reducing the risk of theft and damage during extreme weather events. These containers should be designed to withstand adverse environmental conditions, such as storms and flooding.

5. Local disruption of environment

Local disruption of the environment refers to the potential negative impacts that our living lab might have on the immediate surroundings and ecosystem. This could include mangrove forests and the adjacent coastal environment. The construction and operation of the living lab may disrupt the natural habitats of local wildlife, including bird species, fish, and other flora and fauna that rely on mangroves. This disruption could lead to changes in species distribution, nesting patterns, and feeding habits. When conducting our research, we will carefully take into account the presence of local plant and animal species in the area. This consideration is essential to ensure that our activities do not pose risks to these organisms or their habitats. By being mindful of the flora and fauna, we aim to minimize any negative impacts and promote responsible and sustainable research practices that harmonize with the natural environment.

6. Infrastructure failure

This risk pertains to the potential issues regarding the physical structures and facilities within our living lab. Coastal areas are prone to natural disasters such as storms, hurricanes, and flooding, which can cause damage to infrastructure like boardwalks and observation platforms. Over time, infrastructure may experience wear and tear due to the heavy foot traffic of visitors, exposure to saltwater and coastal elements, and the impact of weather conditions. Insufficient maintenance or insufficient funds for repairs and upkeep can lead to infrastructure deterioration over time. To mitigate the risk of infrastructure damage from natural disasters, we should invest in resilient design and construction. We should ensure that structures are built to withstand coastal conditions and are resistant to storms, hurricanes, and flooding. We should use high-quality, durable materials that can withstand the corrosive effects of saltwater and strong winds. Next to using the correct materials, we should implement regular maintenance schedules to proactively address wear and tear. This includes routine inspections and maintenance activities to identify and address issues before they become significant problems. Regular upkeep can help extend the lifespan of our infrastructure and a portion of the project budget should be allocated for ongoing maintenance and repairs. This budget should be flexible and responsive to infrastructure needs, with the ability to address issues promptly.

03

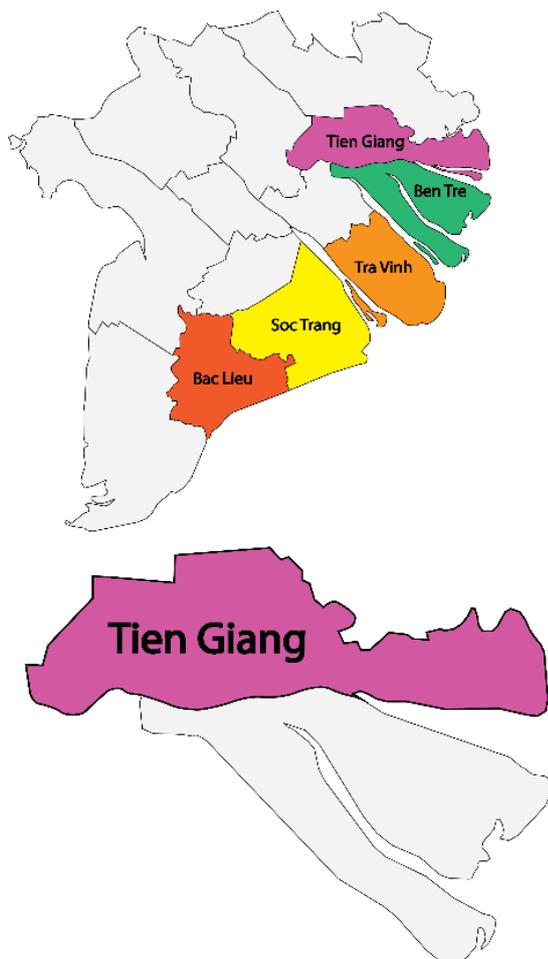
Current Status

Current status

A start with the project has already been made by visiting the 5 provinces in October 2023 and again in the first week of December of 2023. An important insight is that each province comes with its own challenges and opportunities regarding mangroves. Below, the activities are shortly presented per province. The final selection of the location of the demo living lab will be in one of these provinces. However, we will conduct short-term measurement campaigns in the other provinces as well, making use of our mobile lab facilities and equipment. So in the end, we will gain insights and monitor in the various provinces of the Mekong Delta

1. Tien Giang province

The mangrove degradation and coastal erosion are pictured below. In Tien Giang, we have conducted research with local farmers and officers. Below, the mangrove degradation is pictured as well as the coastal erosion that is seen in this province. Sedimentation is found behind the structures of Go Cong in Tien Giang. Behind the permeable dike, sedimentation and mangrove propagules is found.



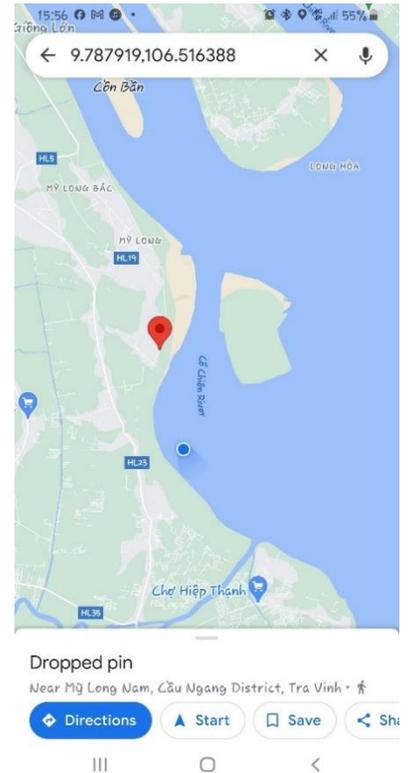
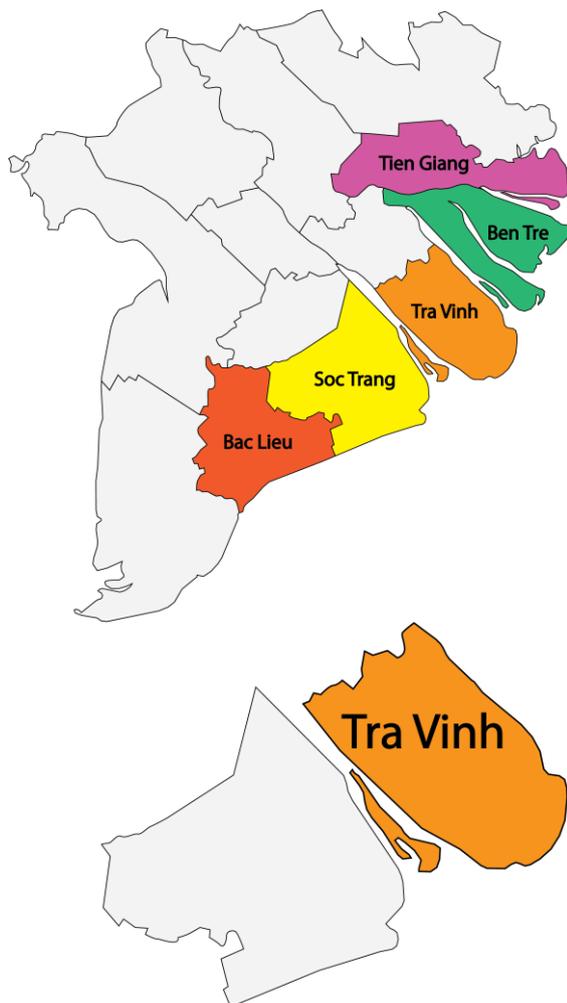
2. Ben Tre

In this province, we have collaborated with and exchanged information with local officials as well as residents. Data has been collected through a set of interviews and focus group sessions. During the field trip to this province, a sedimentation zone has been found in the Mudflats and pristine mangroves at Bai Lai, in the Ben Tre province. Below, these are pictured.



3. Tra Vinh

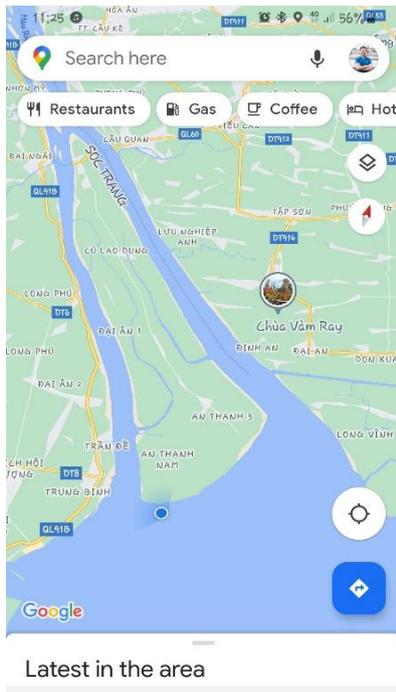
Field trip to Cau Ngan, My Long Nam (on map) where wooden fences (construct coconuts and bamboo branches) are partly destroyed. The mudflat elevation is increasing according to local officers. The small island (dune) has been developed since 1999. During our field visit to the Tra Vinh province, more data has been collected in information sharing sessions with officers as well as farmers.



4. Soc Trang

The field trip was taken to southeast Cu Lao Dung where mangroves are well developing. Along the coast from south to north, young mangroves are growing quite well. Local government wants to build wooden fences at the location where the photo was taken to

increase sediment acceleration and larger mudflat for mangroves. Again, during our field visit here, additional data has been collected through knowledge sharing sessions and focus groups with local officers as well as local farmers.



5. Bac Lieu

In the Bac Lieu province we have been interviewing several local farmers. They have told us about their difficulties they have experienced with farming under the forest canopy. Below, a livelihood model and mangrove-based aquaculture of farmers is located behind the dike. We have also visited a Wind farm at the north Bac Lieu, right at the boundary with Soc Trang province. The photos below show the erosion at closer locations.



Appendices

Appendix I: Selection of Vietnamese and Dutch experts involved

<i>name</i>	<i>Thieu Quang Tuan (Thieu, Q. T)</i>
<i>MSc education</i>	Thuy Loi University, Hanoi and IHE Unesco
<i>PhD education</i>	Delft University of Technology, Delft 2007
<i>Present position</i>	Professor of Coastal Engineering, Thuy Loi University
<i>Research expertise</i>	Wave overtopping (VN sea dikes)
<i>Publication #1</i>	Breaching vulnerability of coastal barriers under effects of tropical cyclones: A model study on the Hue lagoon – Vietnam; <i>Ocean Engineering</i> 258, 111846
<i>Publication #2</i>	Monsoon wave transmission at bamboo fences protecting mangroves in the lower mekong delta; <i>Applied Ocean Research</i> 101, 102259
<i>name</i>	<i>Tran Thanh Tung (Tran, T.T)</i>
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<i>PhD education</i>	Delft University of Technology, Delft 2012
<i>Present position</i>	Associate Professor of Coastal Engineering, Thuy Loi University, Vietnam
<i>Research expertise</i>	Hydrodynamic and Morphodynamic of coastal inlets (VN sea dikes)
<i>Publication #1</i>	Cross-sectional stability of tidal inlets: A comparison between numerical and empirical approaches, <i>Coastal Engineering</i> 60, 21-29.
<i>Publication #2</i>	Morphological modeling of tidal inlet migration and closure. <i>Journal of Coastal Research</i> , 1080-1084
<i>name</i>	<i>Nghiem Tien Lam (Nguyen, T.L)</i>
<i>MSc education</i>	Thuy Loi University, Hanoi and IHE Unesco
<i>PhD education</i>	Delft University of Technology, Delft 2009
<i>Present position</i>	Associate Professor Thuy Loi University
<i>Research expertise</i>	Estuarine dynamics, Numerical Modeling
<i>Publication #1</i>	Hydrodynamics and morphodynamics of a seasonally forced tidal inlet system
<i>Publication #2</i>	Morphodynamics of Hue tidal inlets, Vietnam
<i>name</i>	<i>Le Hai Trung (Le, H.T)</i>
<i>MSc education</i>	Delft University of Technology, Delft
<i>PhD education</i>	Delft University of Technology, Delft 2014
<i>Present position</i>	Associate Professor Thuy Loi University
<i>Research expertise</i>	Coastal Engineering; Sea Dikes
<i>Publication #1</i>	Quantification of changes in current intensities induced by wave overtopping around low-crested structures; <i>Coastal Engineering</i> , 55 (2), 113-124
<i>Publication #2</i>	Damage to grass dikes due to wave overtopping; <i>Natural hazards</i> 86, 849-875
<i>name</i>	<i>Mai Van Cong (Mai, V.C)</i>
<i>MSc education</i>	IHE, Delft
<i>PhD education</i>	Delft University of Technology, Delft 2010
<i>Present position</i>	Associate Professor Delft University of Technology and visiting professor Thuy Loi
<i>Research expertise</i>	Probabilistic design, Coastal Protection Strategies
<i>Publication #1</i>	Coastal protection strategies for the Red River Delta, <i>Journal of Coastal Research</i> , 25 (1), 105-116
<i>Publication #2</i>	Distribution functions of extreme sea waves and river discharges. <i>journal of Hydraulic Research</i> 46 (S2), 280-291
<i>name</i>	<i>Truong Hong Son (Truong, H.S)</i>
<i>MSc education</i>	Delft University of Technology (Erasmus Mundus EU program)
<i>PhD education</i>	Delft University of Technology, Delft 2018

<i>Present position</i>	Assistant Professor Thuy Loi University
<i>Research expertise</i>	Estuarine mangrove systems, Environment Fluid Mechanics, Nature-based solutions
<i>Publication #1</i>	Hydrodynamics of vegetated compound channels: Model representations of estuarine mangrove squeeze in the Mekong Delta

name Ms. Phan Khanh Linh (Phan, K.L)

<i>MSc education</i>	Delft University of Technology (Erasmus Mundus EU program)
<i>PhD education</i>	Delft University of Technology, Delft 2019
<i>Present position</i>	Assistant Professor Thuy Loi University
<i>Research expertise</i>	Mangroves, Waves, Nature-based solutions
<i>Publication #1</i>	The effect of wave non-linearity on wave attenuation by vegetation. <i>Coastal Engineering</i> , Volume 147, Pages 63-74
<i>Publication #2</i>	Coastal mangrove squeeze in the Mekong Delta, Vietnam., <i>Journal of Coastal Research</i> , 31(23), pp.243-253.

name Phan Manh Hung

<i>MSc education</i>	IHE Delft Institute for Water Education, The Netherlands, 2011
<i>PhD education</i>	Delft University of Technology, Delft 2020
<i>Present position</i>	Research specialist - Institute of Coastal and Offshore Engineering
<i>Research expertise</i>	Coastal Dynamics - Hydroinformatics - Remote Sensing and GIS in the Mekong Delta
<i>Publication #1</i>	Tidal wave propagation along The Mekong deltaic coast. <i>Estuarine, Coastal and Shelf Science</i> . 220, 73-98
<i>Publication #2</i>	Managing mangroves and coastal land cover in the Mekong Delta. <i>Ocean & Coastal Management</i> . 219, 106013

name Dao Hoang Tung (Dao, H. T)

<i>MSc education</i>	Thuy Loi University, Hanoi, 2014
<i>PhD education</i>	Delft University of Technology, Delft 2021
<i>Present position</i>	Assistant Professor HUNRE University
<i>Research expertise</i>	Coastal Engineering, Wave
<i>Publication #1</i>	Wave Damping due to Wooden Fences along Mangrove Coasts. <i>Journal of Coastal Research</i> , 34 (6), 1317-1327
<i>Publication #2</i>	Numerical and small-scale physical modelling of wave transmission by wooden fences. <i>Journal of Coastal and Hydraulic Structures</i> .

name Ms. Nguyen Thi Thu Ha (Ha, N.T.T)

<i>MSc education</i>	Civil Engineering University, Hanoi.
<i>PhD education</i>	Delft University of Technology, Delft 2022
<i>Present position</i>	Assistance professor, Civil Engineering University, Hanoi
<i>Research expertise</i>	Wave, Coastal and Ocean Engineering
<i>Publication #1</i>	Wave Overtopping Discharge for Very Gently Sloping Foreshores. <i>Water (Switzerland)</i> , 12(6), [1695].
<i>Publication #2</i>	The evolution of spectral wave periods at the structure toe over very gentle foreshores under extreme conditions

name Ms. Do Thi Kim Anh (Anh, D.T.K)

<i>MSc education</i>	Da Nang University, Da Nang.
<i>PhD education</i>	Delft University of Technology, Delft 2019
<i>Present position</i>	Postdoc researcher at CEREMA, France
<i>Research expertise</i>	Coastal engineering, Morphodynamics and Hydrodynamic of coastal region.
<i>Publication #1</i>	The estimation and evaluation of shoreline locations, shoreline-change rates, and coastal volume changes derived from Landsat images. <i>Journal of Coastal Research</i> 35 (1), 56-71
<i>Publication #2</i>	Beach evolution adjacent to a seasonally varying tidal inlet in central Vietnam. <i>Journal of Coastal Research</i> . 34 (1), 6-25

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<i>MSc education</i>	Civil Engineering, TU Delft
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<i>Present position</i>	Professor Emeritus at TU Delft
<i>Research expertise</i>	Hydraulic Engineering
<i>Publication #1</i>	Managing mangroves and coastal land cover in the Mekong Delta. Ocean and Coastal Management. 219, 17 p., 106013.
<i>Publication #2</i>	Nature-based solutions for coastal engineering and management. Water (Switzerland). 13, 7, 976.

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<i>PhD education</i>	Universiteit Utrecht
<i>Present position</i>	Associate professor hydrology at Delft University of Technology
<i>Research expertise</i>	Civil engineering and geosciences
<i>Publication #1</i>	Effects of dynamic changes of desiccation cracks on preferential flow: experimental investigation and numerical modeling, Hydrology and Earth System Sciences. 27, 3, p. 783–808 26 p.
<i>Publication #2</i>	On the Management of Nature-Based Solutions in Open-Air Laboratories: New Insights and Future Perspectives

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<i>MSc education</i>	Physical geography, Universiteit Utrecht
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<i>Present position</i>	Specialist at Deltares and TU Delft
<i>Research expertise</i>	Tides, sediment transport and morphology
<i>Publication #1</i>	The impact of channel deepening and dredging on estuarine sediment concentration, Continental Shelf Research 95, 1-14
<i>Publication #2</i>	Human impacts on morphodynamic thresholds in estuarine systems, Continental shelf research 111, 174-183

<i>name</i>	<i>Bas Hofland</i>
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<i>PhD education</i>	Delft University of Technology, Delft
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<i>Research expertise</i>	Coastal Structures
<i>Publication #1</i>	Wave Damping due to Wooden Fences along Mangrove Coasts, Journal of Coastal Research, p. 1317-1327
<i>Publication #2</i>	Numerical and Small-scale Physical Modelling of Wave Transmission by Wooden Fences

<i>name</i>	<i>Ellen Minkman</i>
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<i>Research expertise</i>	Water governance
<i>Publication #1</i>	Mismatches between policy planning and implementation on the actively living with flood approach in the Vietnamese Mekong Delta, Water International. 47, 2, p. 297-320 24 p.
<i>Publication #2</i>	From national vision to implementation: governance challenges in sustainable agriculture transitions in the Vietnamese Mekong Delta region, Regional Environmental Change. 22, 2, 35.

<i>name</i>	<i>Leon Hermans</i>
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<i>Research expertise</i>	Delta management
<i>Publication #1</i>	Evaluating behavioural changes for climate adaptation planning, Journal of Environmental Planning and Management. 66, 7, p. 1453-1471 19 p.
<i>Publication #2</i>	Assessing the societal adoptability of participatory water management: an application of the Motivation and Ability (MOTA) framework, Water Policy. 24, 5, p. 729-746 18 p.

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<i>PhD education</i>	Wageningen University & Research
<i>Present position</i>	Senior expert water and climate adaptation
<i>Research expertise</i>	Climate change adaptation
<i>Publication #1</i>	Assessing management regimes in transboundary river basins: do they support adaptive management?, Ecology and Society 13 (1), 14
<i>Publication #2</i>	Adaptation to climate change: challenges for transboundary water management, The Economic, Social and Political Elements of Climate Change, 523-541

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<i>Present position</i>	Project manager water
<i>Expertise</i>	Project coordinator of the OKP Climate Proof Vietnam project
<i>Experience</i>	More than 8 years of experience in Vietnam
<i>Role</i>	Project coordinator

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<i>MSc education</i>	Development economics and international land and water development, Wageningen University
<i>Present position</i>	Director of The Green Village, field lab for sustainable innovation
<i>Expertise</i>	Expert in the development of livings labs and international research projects
<i>Experience</i>	More than 20 years of relevant experience in Vietnam in the field of water management and education
<i>Role</i>	Project director

<i>name</i>	<i>Paul Erfteijer</i>
<i>MSc education</i>	Biology, Radboud University Nijmegen
<i>PhD education</i>	Radboud University Nijmegen
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<i>Research expertise</i>	Marine science
<i>Publication #1</i>	Successful mangrove establishment along an artificially created tidal creek at Port Hedland, Western Australia
<i>Publication #2</i>	Parameterization of an optical model to refine seagrass habitat requirements in an urbanized coastline
<i>Publication #3</i>	Increasing coastal resilience through mangrove afforestation in the Mekong Delta: International examples and lessons learnt

<i>name</i>	<i>Charlotte Struijk</i>
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