REQUEST FOR PROJECT/PROGRAMME FUNDING FROM THE ADAPTATION FUND

Enhancing the resilience inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta in Viet Nam

UN-HABITAT
FOR A BETTER URBAN FUTURE

The Adaptation Fund Board Secretariat
1818 H Street NW
MSN P4-400
Washington, D.C., 20433
U.S.A
Fax: +1 (202) 522-3240/5
Email: afbsec@adaptation-fund.org

PROJECT/PROGRAMME PROPOSAL TO THE ADAPTATION FUND

PART I: PROJECT/PROGRAMME INFORMATION

Project/Programme Category:	Regular
Country/ies:	Viet Nam
Title of Project/Programme:	Enhancing the resilience inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta in Viet Nam
Type of Implementing Entity:	Multilateral
Implementing Entity:	United Nations Human Settlements Programme (UN-Habitat),
Executing Entity:	
Amount of Financing Requested:	$ 6,347,190

Project Summary

The main objective of the proposed project is **"to enhance the resilience, inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta in Viet Nam."** To align with a government request to promote sustainable eco-human settlement in Viet Nam, this project aims to improve the poor and vulnerable communes that climate change impacts have affected the most. It is structured around the following components:

Component 1: Institutional and community capacity building toward eco-human settlement development for supporting enhance local climate response actions (USD 800,000 / **15.11**%)

Component 2: Action plan and strategy development for eco-human settlement, and integrating into planning and policy with participatory approach (USD 600,000 / **11.33**%)

Component 3: Sustainability built through small-scale protective infrastructure (USD 3,694,068 / **69.78**%)

Component 4: Awareness Raising and Knowledge Management (USD 200,000 / **3.78**%)

A. Project Background and Context:

Project approach – problem statement

This project proposal focuses on dealing with saltwater intrusion and coastal erosions in Mekong Delta, which are the major impacts from the climate change. Along with the water resource management and coastal erosion issues, the lack of vertical and horizontal coordination has been bottlenecked for the community to reflect their needs to the provincial and national level policies.

In the Mekong Delta, river water and ground water levels are decreasing, while sea levels, flood tides and salt intrusion are on the rise, the demand for water has also increased in production and daily activities due to industrialisation and population growth. The extraction of groundwater has increased rapidly over the past decades and forms one of the main causes of saltwater intrusion into the groundwater. This intrusion has been accelerated by the on-going sea level rise. Saltwater intrusion of groundwater in the Mekong Delta is a highly complex issue as it heavily depends on varying factors, including changes in water supplies, rising water demands, and the impact of climate change especially sea level rise, drought, and rising temperature. Because of saltwater intrusion of the groundwater, a growing number of provinces in the Mekong Delta are also experiencing depleted and degraded freshwater supplies for drinking and domestic use especially in dry season. The solution for the saltwater intrusion is, however, very limited and most of them are not cost-effective nor applicable for certain condition of area.

In addition, there is a growing threat along the coastal zone in Mekong Delta regarding the coastal erosion issues due to several causes. Rapid expansion of aquaculture (shrimp farming) in the Mekong Delta has contributed to economic growth and poverty reduction, but has been accompanied by rising concerns over environmental and social impacts. The lack of an integrated approach to sustainable management, utilisation and protection of the coastal zone and economic interests in shrimp farming have led to the unsustainable use of natural resources, thus threatening the protection function of the mangrove forest belt. The coastal zone is also affected by the impacts of climate change. Climate change is predicted to cause an increased intensity and frequency of storms, floods and rising sea levels.

In the case of the Mekong Delta, where water resources management and the coastal erosion are particular challenges, the project aims to establish a holistic approach policy framework balancing the gap between local and national level government and managing climate change risks by providing community-scaled hard interventions with the soft interventions. By providing the community-scaled hard interventions supported with the soft interventions, the overall adaptive capacity of the population in commune will be raised to cope with the impact of climate change.

Socio-Economic Context related to Climate Change

Despite its rapid growth on both economic and social context, Viet Nam is one of the world's most vulnerable countries to climate change impact, including but not limited to; sea level rise, longer and more severe droughts, flooding and tropical cyclones; as is typical with climate change in this region the poorest are the most exposed. By 2050, a 1–3% loss in real GDP is predicted from climate change impacts. Natural disasters have caused average annual economic losses estimated to be at 1–1.5% of GDP over the last two decades, while more than 70% of the population is already exposed to significant natural hazard risk. Ongoing climate disaster events and climate change effects can also set back development gains, particularly as safety net programs have not yet been adapted to support the poor and vulnerable in response to natural hazard shocks.

Mekong Delta is, however, the largest producer of agricultural and aquaculture product in Viet Nam and is suffering the most in economic loss due to Climate Change Impact. The Labor force found in Mekong delta is around 10.3 million (out of a total national labor force of 54.5 million). It is also responsible for more than 13% of national GDP solely for the fishery industry (Viet Nam net, 2016). The Mekong Delta currently has an increasing economic rate of around 11% of GDP annually. In this

economic context, climate change issues have a major effect on economic activities in the region, while local residents are exposed to climate change threats it has also presented new opportunities, especially in the coastal region of the Mekong delta.

Environmental Context related to Climate Change

Drought and saltwater intrusion:

In 2016 and 2017 dry season, a record drought in the Mekong Delta region, followed by saltwater intrusion, cost Viet Nam VND 15 trillion ($669 million) due to the heavy toll on agricultural production. It also caused dire humanitarian and other economic impacts: almost half a million households lacked fresh drinking water and experienced food shortages and thousands of affected people had to migrate to urban areas in search of jobs.

Most of the affected provinces of the Delta have begun to secure freshwater by all measures available to them. In many vulnerable communes in Hau Giang, Ben Tre, and Tien Giang provinces, farmers have used water tanks to collect rain-water and drilled wells to extract groundwater. They also have reduced the annual rice crop and switched to cash crops that require less water.

The drought and saltwater intrusion may make it harder for Viet Nam to meet its targets under the Socio-economic Development Plan (SEDP) 2016–2020. These targets include a gross domestic product (GDP) growth rate of 6.5–7.0% a year, and a reduction in the share of poor households by an average of 1.0–1.5% a year. The impact of adverse climate conditions on the economy is already evident: in the first half of 2016, GDP growth was recorded at 5.5%, much lower than the 6.5% average growth in 2015. The World Bank accordingly lowered its 2016 growth projections from 6.5% down to 6.2 percent. The average GDP growth was recorded at 6.2% for 2016, below the government's 6.7% target.

Like past floods and typhoons, the prolonged drought and saltwater intrusion of 2015–2016 have hurt people's livelihoods and assets, making it difficult for affected households to bounce back and recover. Although disasters do not discriminate, poor and near-poor households are often more exposed to and disproportionately affected by the impacts of disasters. Other disproportionately affected groups include women and ethnic minorities.

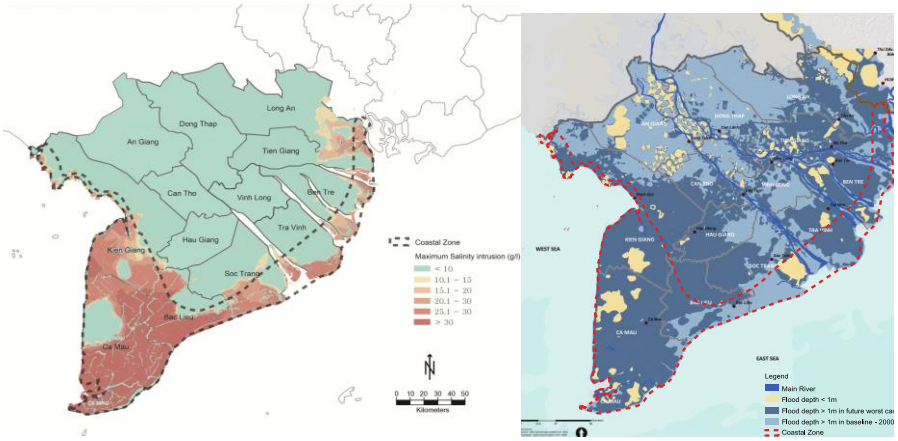


Figure 1. Saltwater intrusion and flooding maps

Table 1. Overview of Damage Impact of 2015-2016 Drought and saltwater intrusion in Viet Nam

Region	Number of Severely affected Provinces	Production area affected (ha)			Number of Household lacking access to water for consumption and daily use	# of livest ock lost	Total Economic loss (billion VND)
		Rice	Crop	Aquaculture			
National	18	243,762	168,064	69,008	457,796	-	15,023
South Central Coast	3	10,776	15,000	-	43,482	5,126	1,457
Central	5	17,541	141,756		72,060	494	6,004

Highlands							
Mekong Delta	10 out of 13 (Including Tra Vinh and Bac Lieu	215,445	-	68,916	342,254	933	7,517

Source: MARD 2016

Coastal erosion:

Viet Nam is one of the world's most vulnerable countries to sea-level rise. Without adaptation an estimated 12 million people face permanent inundation on higher emissions pathways, primarily concentrated in the nation's two low lying mega-river deltas. It is estimated that the Mekong Delta may lose up to half of its land to erosion due to current rampant levels of sand exploitation. 562 erosion locations have been identified with a total length of 786 kilometers in the Mekong Delta. This includes 55 critically endangered locations that are 173 kilometers in length, 140 endangered locations at 97 kilometers in length, and 367 normal erosion spots 516 kilometers long.

Due to rising sea levels, provinces in the coastal zone are highly affected by saltwater intrusion and flooding. Saltwater intrusion varies according to micro-climate conditions such as water flow intensity. The provinces affected with a maximum salinity concentration of 10g/L are all provinces situated in the coastal zone: LongAn, TienGiang, BenTre, TraVinh, KienGiang, SocTrang, BacLieu, CaMau (source: The World Bank, 2016). Moreover, flooding issues continually change the quality and quantity of water sources, leading to changes in ecosystem and increases in the overall number of migrating people.

Figure 2. The images of land degradation in the Mekong Delta

Climate Change Projections and Expected Impacts

Climate Change Projections:

Climate change projections for Viet Nam from IPCC report (2013) show that the southernmost provinces, especially the Mekong Delta Region in particular, will experience increases in temperature resulting in more droughts in the dry season and a slight increase in rain during the wet season. On the other hand, rainfall from the central or northern provinces will lead to increased flood risk in the southern provinces.

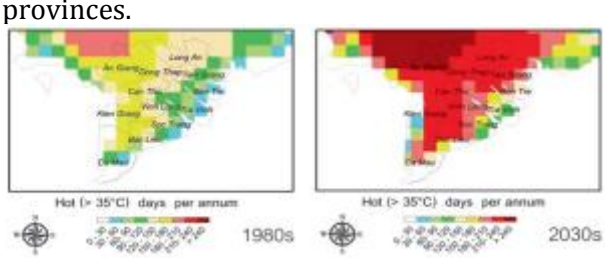


Figure 3. Hot period (number of hot days in a year) in the Mekong River Delta in the 1980s and 2030s (simulated)

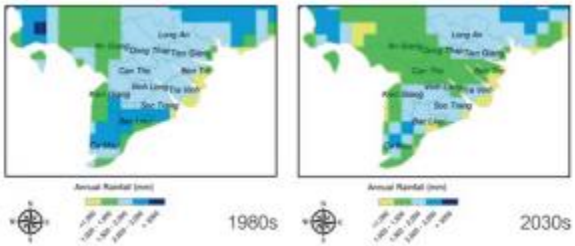


Figure 4. Annual precipitation in the Mekong River Delta in the 1980s and 2030s (simulated)

From figures 3 and 4, it can be observed that the changes in the average temperature and annual rainfall in Mekong Delta vary from province to province. This will increase the frequency of extreme weather events such as floods and droughts and result in rising sea levels with the potential to inundate land or increase salinity.

- ❑ According to the RCP4.5 scenario, the average annual temperature will likely increase by 1.3 to 1.4°C in the mid-21st century and by 1.7 to 1.9°C at the end of the 21st century;
- ❑ According to the RCP8.5 scenario, the average annual temperature will likely increase by 1.8 to 2o C in the mid-21st century and 3.4 to 3.6 at the end of the 21st century;
- ❑ The average maximum temperature increases higher than the average minimum temperature and the increasing trend gradually reduces from northern to southern regions of the Mekong Delta;
- ❑ Annual precipitation is likely to decrease by 10–20% in the future throughout the Delta area;

Table 2. Climate Change Projections in Bac Lieu and Tra Vinh

Province	Climate Change	RCP 4.5 scenario			RCP 8.5 scenario		
		2016-2035	2046-2065	2080-2099	2016-2035	2046-2065	2080-2099
Bac Lieu	Change in average annual Temperature	0.7	1.4	1.8	0.8	1.8	3.3
	Change in annual rainfall (%)	9.6	11.0	13.6	11.8s	16.5	18.0
	Change in spring rainfall (%)	8.4	-5.8	9.9	-0.5	-0.1	2.0
	Change in winter rainfall (%)	2.2	3.8	7.8	5.7	9.6	12.7
Tra Vinh	Change in average annual Temperature	0.7	1.4	1.8	0.8	1.9	3.4
	Change in annual rainfall (%)	10.9	15.7	17.7	11.4	14.6	18.2
	Change in spring rainfall (%)	10.9	0.9	7.9	4.9	1.6	2.0
	Change in winter rainfall (%)	4.2	3.6	5.2	6.8	8.5	11.2

Table 2 shows the climate change projections for change in average temperature and change in annual rainfall trends in Bac Lieu and Tra Vinh in Mekong Delta Region, and this would be one of the main causes of drought and flood. Figure 5 also shows that the change in annual precipitation in the Mekong Delta will decrease by 10-20% in average. Bac Lieu and Tra Vinh province are predicted to be highly affected by drought in the future that can lead to saltwater intrusion, main cause of water shortage.

According to figure 5 below, the figures of Tra Vinh and Bac Lieu province show the high risk of land erosion as sea-level rises by different levels in each province. Both provinces are expected to experience the severe challenges from sea level rise.

Figure 5. Land degradation map for Bac Lieu and Tra Vinh

Bac Lieu

Tra Vinh

<u>Expected Impacts:</u>

Due to extreme natural hazards from the impact of climate change, human settlement and ecosystem in Viet Nam are becoming devastated, securing access to clean water is becoming an urgent priority. Climate change impacts such as rising temperature, changing rainfall patterns and sea level rise are posing new and bigger risks to human settlement and the environment in this region. The result is that human settlement will be increasingly vulnerable to climate change and extreme natural hazards as they are generally located in high risk areas, typically along riverbanks and in costal lands. The issues of climate change due to increase of temperature and decrease of rainfall has caused the further degradation of several environmental problems including floods, drought, rainfall pattern change, and saltwater intrusion. Based on the projections in Mekong Delta

Region in Viet Nam, both provinces are expected to experience temperature rise, rainfall decrease, and sea level rise. Those climate change impact will intense the natural hazard including saltwater intrusion, drought, coastal erosion, and flood. Among the number of losses and damage caused from natural hazards, our project team concluded through consultation with local government and field mission that lacking of freshwater due to saltwater intrusion and coastal erosion is the most severe among other damages and losses.

Focus of Proposal

To deal with the challenges at the project site related to lack of awareness and capacity to the impact of climate change, water resource management, and coastal erosion, the project will focus its actions by providing both hard and soft intervention on highly vulnerable human settlements in the selected project sites. Based on the request from the Viet Nam government and the analysis on relevant projects in Mekong Delta, Bac Lieu and Tra Vinh are selected as the most vulnerable provinces in the Mekong Delta. In these provinces, a number of communes have been identified as targeted project sites to enhance the resilience in the commune level (Vinh Trach Dong with 4,336 of direct beneficiaries/ Hoa Minh and Long Hoa with 24,457 direct beneficiaries). The target areas chosen for the project are characterised by high levels of exposure to severe climate change risks, especially sea-level rise, saltwater intrusion, drought, land erosion and rainfall pattern change. Climate sensitivity is underpinned by rapid urbanization and population growth, underlying vulnerabilities (poverty, limited access to basic services, gender inequalities, weather dependent livelihoods, environmental and ecosystem degradation) and limited adaptive capacity at household, community and governance level. The following will include the specific challenge each commune is facing from the impact of climate change, socio-economic barriers to adapt to the climate change, natural hazard that each project site is exposed, and the possible interventions the project will implement to improve the resilience capacity.

1. Bac Lieu province

1) *Key challenges to be addressed:* Based on the socio-economic barriers and exposure to the natural hazard in the project site, the team found that there are specific challenges including the water management and lack of social inclusion for the planning related to climate change action plan in Bac Lieu. Especially for the resettled area[1], where people moved to the site by the government's order in 2013, the project team considered that ensuring the fresh water for drinking should be addressed as the priority in order to secure the quality of life of the population.

Table 3 Information of target areas in Bac Lieu province

2) Location	Number of Residents (households)	Households lacking access to clean water	Water Quality	Water consumption
1) Resettlement Area	3,185 households	1,564 households (49.10%)	TDS: 1,130 mg/L Turbidity: 2.95 NTU	-
2) Truong Tieu Hoc Ngo			TDS: 1,109 mg/L Turbidity: 2.57 NTU	4.3 m^3/day
3) Troung Thcs Nguyen Hue			TDS: 1,129 mg/L Turbidity: 2.18 NTU	4.2 m^3/day
4) Kindergarten (Troung Mau Vang Anh)			TDS: 1,129 mg/L Turbidity: 2.18 NTU	3.9 m^3/day

[1] Due to the climate change impact, especially sea level rise and land erosion, inhabitants in the coastal areas have moved to resettled area 5 to 6 years ago.

Figure 6. Map of target areas in Bac Lieu province

3) *Socio-economic barriers to adapt to the climate change impact:*

Figure 7. Location of Vinh Trach Dong commune in Bac Lieu

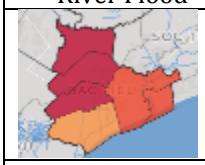
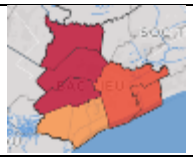
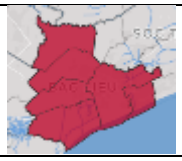
Vinh Trach Dong commune in Bac Lieu is located in the coastal zone in Mekong Delta in Viet Nam as seen in figure 7. As the project team conducted the field mission while developing the concept, the people's committee of Bac Lieu province recommended Vinh Tach Dong commune as our project site. The total population of Vinh Trach Dong is 13,977 and almost 70% of the population is composed of ethnic minority group (Khmer) with 9,728 people. Most of them are suffering from the climate change impact as they are exposed to the impact strongly because they are socially isolated from the community and the accessibility to the basic infrastructure is low compared to other communities according to the local government especially for the water.

As mentioned above, one of the key characteristics of the project site is that population in the area is mostly ethnic minority group who moved to the resettlement area in 2013 by the government's resettlement plan. Through the several consultations with local people and local government, project team found out that the ethnic minority group did not get offered new livelihood resources from the newly settled area so that they still have to commute around an hour to the coastal area. From the focus group interview during the consultation workshop with the women union in Vinh Trach Dong, key challenge they are facing is that women and children are mainly involved for ensuring the household economic status instead of getting proper education. In addition, the water treatment system in the area has not been established properly enough to provide the adequate clean water for domestic use and drinking. The public buildings in Vinh Trach Dong commune using the groundwater for their domestic use also have a difficulty due to unstable electricity supply.

4) *Exposure to natural hazard:* Based on the projection of climate change in Mekong Delta, Bac Lieu is also expected to experience the severe drought due to temperature rise and the rain pattern

change. For the current status, the natural hazards with the worst effects on the region are river flood, urban flood, coastal flood, cyclone, wild fire. Extreme heat is classified as medium level hazard while earthquake, tsunami and water scarcity are defined as low level hazard. From the local government, the most problematic climate hazard from the project site is saltwater intrusion and extreme heat event during the dry season. Due to saltwater intrusion of the ground water, people are suffering from the lack of fresh water for drinking especially for the dry season.

Table 4. Exposure to natural hazard in district of Bac Lieu

River Flood	Urban Flood	Coastal Flood	Earthquake	Tsunami
				
Volcano	Cyclone	Water Scarcity	Extreme Heat	Wild Fire
				

5) *Possible interventions to cope with the challenges*: For the challenges addressed above in the targeted site especially for the water management, the proposed project aims to provide with the possible intervention on both soft and hard to help the community to adapt to the climate change impact. The soft intervention aims to involve local people to make their own action plan by revising the current social economic development plan to deal with the climate change and reduce the impact to the actual victim from their point of view to ensure the social inclusion of the ethnic minority in the targeted area. For the hard intervention, rainwater harvesting system will be applied as an alternative for water resources. Also, to raise the accessibility to the freshwater for drinking, the water treatment system will be implemented in Vinh Trach Dong.

2. Tra Vinh province

1) *Key challenges to be addressed*: Combined the socio-economic barrier to adapt to the climate change impact and exposure to natural hazard from the project site, the team has identified key challenges to be addressed in Long Hoa and Hoa Minh. Due to the geographic characteristic of both communes and saltwater intrusion, lack of fresh water for drinking, and serious coastal erosion issue are key challenges. Along with the challenges mentioned above, lack of knowledge on climate change impact could have accelerated the impact of climate change allowing people to cut the mangrove plants that were initially provided to cope with the coastal erosion issue in the island.

2) Table 5. Information of target areas in Tra Vinh province

3) Location	Number of households	Households lacking access to clean water	Water Quality	Water consumption
1) Long Hoa Secondary School	2,547 households	2,182 households (85.67%)	TDS: 783 mg/L Turbidity:0.38NTU	3~4 m^3/day
2) Truong Tieu Hoc Long Hoa			TDS: 669 mg/L Turbidity: 1.43NTU	3~4 m^3/day
3) Truong Tieu Hoc Long Hoa A			TDS: 731 mg/L Turbidity: 4.54 NTU	3~4 m^3/day
4) Truong Mam Non Long Hoa			TDS: 836 mg/L Turbidity: 13.8 NTU	3~4 m^3/day
5) Truong Mau Giao	3,309 households	1,166 households	TDS: 1,240mg/L Turbidity: 1.33 NTU	2~3 m^3/day

6) School Complex		(35.24%)	TDS: 1,109 mg/L Turbidity: 2.18 NTU	2~3 m^3/day

Figure 8 Map of target areas in Tra Vinh

4) *Socio-economic barriers to adapt to the climate change impact – Long Hoa and Hoa Minh*:

Figure 9. Location of Long Hoa and Hoa Minh commune

Long Hoa and Hoa Minh in Tra Vinh is located along the coastal line of the Mekong Delta. Tra Vinh is one of the provinces belong to the part of delta estuary. Long Hoa and Hoa Minh have been identified as our project sites due to their geographically isolated characteristics. In 2018, Long Hoa has a population of 10,280 and the population is relatively young compared to Hoa Minh, with only 2.9 percent of the resident s are over 60-year-old while Hoa Minh commune shows 7.9 percent of the residents are over 60-year-old among 14,177 of the total population. Unemployment rate from both communes are high (38% for Long Hoa and 42% for Hoa Minh).

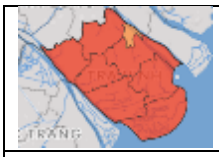
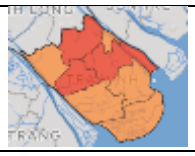
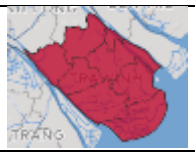
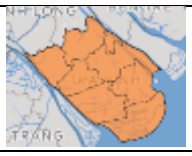
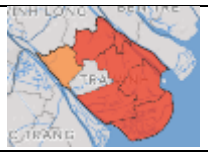
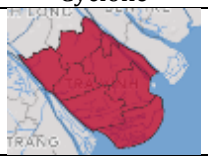
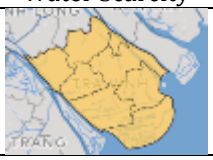
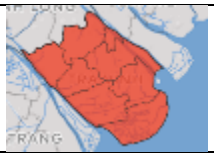
In Long Hoa and Hoa Minh, people are suffering from lacking of fresh water for drinking and living especially in the dry season (see annex1). First, considering the consultation with the local government, there is severe issue related to low accessibility for hygienic rainwater storage system because of lack of financial and technological capacity. Second, people also use water pumps in their own household, but the quality of water from the ground is not sufficient for using as drinking water or water for living due to saltwater intrusion to the groundwater.

For coastal erosion related issues, through the field visit, it has been identified that cutting off the mangrove plants from the local people is one of the main causes accelerating the coastal erosion. Lack of knowledge to the climate change impact and the function of the mangrove plant might make them cut it for the instant benefit, and lack of regulation regarding the issue could have also impacted the population. Since both communes are located in the island, the importance of prevention to the coastal erosion should be highlighted from the policy level. Mangrove plantation is not sufficiently provided in the area to protect the coast and river banks from erosion.

5) *Exposure to natural Hazard*: In Tra Vinh, the natural hazards with the greatest effect on the region are **coastal flood, cyclone, and wild fire**. River Flood, urban Flood, tsunami and extreme heat are classified as medium level hazard while earthquake and water scarcity are defined as low level hazard. To find out and confirm the level of natural hazard in Tra Vinh, the project team has consulted with the local government. The most problematic climate hazard from the area is identified as saltwater intrusion and coastal erosion mainly due to the geographic location of both communes.

Table 6. Exposure to natural hazard in district of Tra Vinh

River Flood	Urban Flood	Coastal Flood	Earthquake	Tsunami

				
Volcano	Cyclone	Water Scarcity	Extreme Heat	Wild Fire
				

6) *Possible interventions to cope with the challenges*: For the challenges addressed above especially for the water management and coastal erosion, the proposed project aims to provide with the possible intervention on both soft and hard to help the community to adapt to the climate change impact. To reduce the main impact of identified challenges in both communes, the project will include the main hard interventions – water treatment system and coastal erosion prevention system. Along with the hard intervention, soft intervention such as capacity building will be applied to the local people to improve the awareness to climate change impact and enhance the overall capacity dealing with the expected impact in the future.

B. Project Objectives:

The main objective of the proposed project is **"to enhance the resilience, inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta in Viet Nam."** To align with the request from the national and local governments to promote the sustainable eco-human settlement in Viet Nam, the project takes a comprehensive and holistic approach which combines a number of horizontally and vertically interrelated resilience approaches towards the strengthening of institutions, communities, ecosystems and physical, natural and social assets. It is structured around the following components below.

C. Project Components and Financing:

Table 7 Project Components

Project Components	Expected Outcomes	Expected Concrete Outputs	Amount (US$)
1. Institutional and community capacity building toward eco-human settlement development for supporting to enhance local climate response actions	**1.1** Increase awareness on resilience of human settlements and ecosystem as a result of enhanced institutional capacity **1.2** Strengthen knowledge of climate change adaptation	**1.1.1** National induction workshop **1.1.2** Guidance and training materials development for vulnerability and risk assessment at the local levels **1.1.3** Planning toolkits and training materials development for planning approach, strategy and action plan development on climate change resilience **1.1.4** Project team (facilitators) training enabling facilitation of eco-friendly settlement strategy and action plan development (for supporting Component 2.1.1 and 2.2.2) **1.2.1** Training workshops enabling national/provincial/district/commune to set up eco-human settlement strategy and action plan development for climate change adaptation	800,000 (15.11%)

In line with Adaptation Fund outcome 1 and 2			
2. Action plan and strategy development for eco-human settlement, and integrating into planning and policy with participatory approach	**2.1** Develop provincial/district/commune level's action plan and strategy for eco-human settlement based on local people's needs **2.2** Develop policy framework for integrating climate action and strategy into planning	**2.1.1** Action plan and strategy development for eco-human settlement (provincial, district, and commune level) **2.2.1** Policy framework development for integrating local people's action plans and strategies for eco-human settlement into planning (provincial level) **2.2.2** Integrating developed/revised action plan and strategy into the relevant/existing planning and policy (provincial level)	600,000 (11.33%)
In line with Adaptation Fund outcome 3 and 7			
3. Sustainability built through small-scale protective infrastructure	**3.1** Increase community adaptive capacity with climate resilient and development sectors, and increase ecosystem resilience in response to climate change **3.2** Enhance local people's capacity for management and operation of provided infrastructures	**3.1.1** Prevention of the saltwater intrusion and protection of the ground water through water treatment system and rainwater harvesting **3.1.2** Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system: elastocoast[2] **3.2.1** Capacity building to a working group for the sustainable operation and management of provided hard interventions *for more detailed information for the hard intervention, please see Annex 1	3,694,068 (69.78%)
In line with Adaptation Fund outcome 4, 5, and 6			
4. Awareness Raising and Knowledge Management	**4.1** Enable conditions for scaling up and replicating the project related to enhancing the climate change adaptation capacity	**4.1.1** Lessons learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms **4.1.2** Regional advocacy and replication for developing the effective policy framework	200,000 (3.78%)
In line with Adaptation Fund outcome 3			
5. Project Activities			5,294,068
6. Project/Programme Execution cost			555,877
7. Total Project/Programme Cost			5,849,945
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (if appreciable)			497,245
Amount of Financing Requested			**6,347,190**

Table 8. Project Calendar

[2] Elastocoast is mentioned in the UNFCCC as the new technology for climate change adaptation which protects the dikes by absorbing the force of the breaking waves and slowing down the water masses.

Milestones	Expected Dates
Start of Project/Programme Implementation	06-2020
Project/Programme Closing	06-2023
Terminal Evaluation	01-2023

PART II: PROJECT / PROGRAMME JUSTIFICATION

A. The Project Components

The components of the project support the integrated approach to improving knowledge of climate-resilience and strengthening the protective infrastructure through improved institutional capacity, better local-level planning and community-level implementation.
The action taken by this project will be targeted to benefit the most vulnerable people in the region. To do this, a combination of soft and hard measures is proposed to ensure that resilience at the household and commune level is strengthened sustainably through enhancing the adaptative capacity that responds to current and future needs.
Soft measures include institutional and community capacity building and action plans. These are designed to target the most vulnerable settlements, and to design and implement the most necessary actions in order to improve the adaptive capacity at commune and district level.
Hard measures will comprise of investments on the small-scale protective infrastructure and eco-friendly intervention designed to increase the resilience of the project site.
With a strong mix of the soft and hard interventions, it is anticipated that local resilience at household, community and human settlement level will be sustainably strengthened.
The specific needs of women, elderly, people with disabilities, ethnic minorities: Khmer and youths will be considered at all stages of the project. This will be achieved through engaging representatives of these vulnerable groups in community and stakeholder consultations in the planning process, through a community-based approach and through the people's process – where community groups are formed and sustained throughout all stages of the project and through which communities participate in project implementation and monitoring[3].

Component 1: Institutional and community capacity building toward eco-human settlement[4] development for supporting to enhance of local climate response actions
Principal purpose of component 1 is to contribute to the development of the holistic planning and strategies for eco-human settlements against the impact of climate change. Thus, this component will focus on 1) increasing the awareness on resilience and ecosystems as a result of enhanced institutional capacity and 2) strengthening the knowledge of climate change adaptation through the framework development and orientation of institutional capacity building. Component 1 is expected to support the capacity building of government officials and practitioners in order to enable them to set up an eco-human settlement strategy and climate change action plan.
The institutional capacity could be achieved through national induction workshop, guidance, planning toolkits and training materials development for vulnerability and risk assessment, and planning approach, strategy, and action plan and training.
The training workshop will be held at the national and provincial level for enhancing the institutional capacity. It could enhance the horizontal (climate change is a crosscutting issue) and

[3] Development driven by people/Support Paradigm: when people stays at the center of development planning process, the resource can be optimized with greater utility impacting larger number of people: http://sopheapfocus.com/wp-content/uploads/2010/06/Picture-31.png People's process of development can be witnessed through the evolvement of people's desire to improve their lives. Humans developed their settlement from living in caves, then building shelters, and now home. Along this settlement evolution, they had also established certain norms, standards, and a mutual understanding surrounding their community. That is called the people's process of development.
[4] "Promoting sustainable human settlements development" is the subject of Chapter 7 of Agenda 21, which calls for 1) providing adequate shelter for all; 2) improving human settlements management; 3) promoting sustainable land-use planning and management; 4) promoting the integrated provision of environmental infrastructure: water, sanitation, drainage and solid waste management; 5) promoting sustainable energy and transport systems in human settlements; 6) promoting human settlements planning and management in disaster-prone areas; 7) promoting sustainable construction industry activities; and 8) promoting human resource development and capacity-building for human settlements development.

vertical coordination to deal with the climate change impact. Training workshop enables nation, province, district, and commune to set up eco-human settlement strategy and action plan development for climate change adaptation.

Component 2: Action plan and strategy development for eco-human settlement, and integrating into planning and policy with participatory approach

Component 2 will support the development of holistic planning for eco-human settlement. This component will focus on 1) developing provincial/district/commune level's action plan and strategy for eco-human settlement based on local people's needs 2) developing policy framework for integrating climate action and strategy into planning. It might lead that local's demand can be integrated into planning at the policy level for climate change adaptation.

Action plan and strategy for eco-human settlement will be developed at the local level through dialogues and training workshops in order to identify the challenge and needs of the climate change adaptation. For example, the green and blue network will be developed. More specifically, the role of the 'Green Network' is to protect ecosystems and coastal erosion against the impact of climate change such as flooding, and storm surge. The 'Blue Network' is a part of planning for protecting water related impacts from climate change and natural hazards. These networks will be included in the planning for the integrated development strategies and climate change action plans. It will then result in the outcome of "mainstreaming climate change adaptation into the eco-human settlement planning". To reflect the needs of local people for climate change adaptation into planning and policy at the provincial and national level, policy framework development will be necessary. It might support the increase of resilience capacity of local people.

The proposed intervention will be presented as part of the integrated planning for eco-human settlement strategy and action plan development. To ensure awareness and ownership over the project, stakeholders and locals from the targeted areas will participate in all steps (training, planning, implementation, monitoring, etc.) of the project. The integrated planning for resilience capacity will be based on the component2. UN-Habitat's P4CC[5] approach ensures that activities are feasible, effective and acceptable to communities, and this ensures a solid framework for the participatory approach. District and commune levels' trainings and workshops will be conducted. These will help local people understand the impacts of climate change and the importance of forwarding planning. Also, the demand for support will be identified and a sectoral approach can be applied to it.

Component 3: Sustainability built through small-scale protective infrastructure

The component aims at enhancing climate resilient infrastructure systems in human settlements. Due to the projected climate change impacts and disasters already occurring in coastal areas, ecosystem and human settlement can only be protected through physical intervention (with the support of the soft interventions above). This component will increase resilience through hard measures as follows:

- Prevention of the saltwater intrusion and protection of the ground water through appropriate water treatment system
- Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system: elastocoast[6]

The project will be both innovative and efficient by using, where possible, the People's Process as a means to implement activities. The People's Process mobilises local people from the affected/target areas to take decisions regarding their resilience, to play an active role in the implementation of the

[5] P4CC's principles are to be strategic; meaning implementation should make the best use of the resources (financial, human and time) available, values-based; meaning that actions should be based on what matters most to com-munities, participatory; that the project should engage as many different stakeholders as possible throughout the project cycle, and integrated; meaning it should align with other plans and policies insofar as possible.

[6] Please see Footnote 1 and 5

measures and support them in implementing this process. Through this process communities/beneficiaries will have greater ownership of the process of building resilience, and will result in reduced implementation costs. This will be also supported by the capacity building of operation and management to local people for the sustainability. The detailed explanations for the adopted technologies are elaborated in below.

Water Resource Management System

1) Rainwater harvesting system (RWH)

(1) Background

Rainwater harvesting (RWH) is defined as a method for inducing, collecting, storing and conserving the rainwater for reuse on-site rather than allowing it to run off. By using rainwater one can increase water availability and reduce water demand from the water supply network, can mitigate urban flooding and can improve the quality of groundwater. Also RWH helps to reduce the fluctuation of water supply between rainy season and dry season by enabling the community people to effectively store rainwater.

Commonly used RWH constitutes of catchments, transportation, first flush and storage facility. The catchment area is the area where the rainfall or water runoff is initially captured and the technology adopted in this project will use roof-top of a house as a catchment area.

In the roof-top method, water from rainfall is collected in vessels at the edge of the roof or channeled to a storage system via gutters and pipes. Tiled roofs, or roofs sheeted with corrugated mild steel are preferable, since they are the easiest to construct and give the cleanest water. Roof-top collection is suitable for household or school level application and can provide freshwater for domestic purposes and small-scale farming.

(2) Design (See F.S report Section 2 for more detailed information)

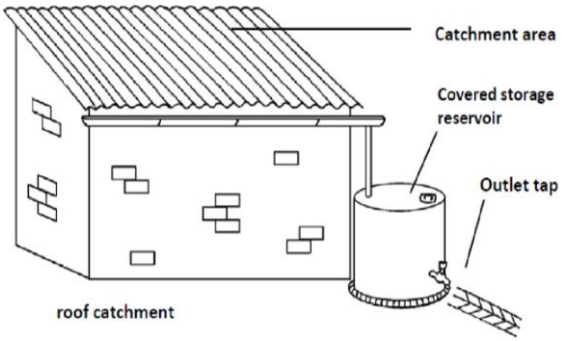


Figure 9. Design of roof-top rainwater harvesting

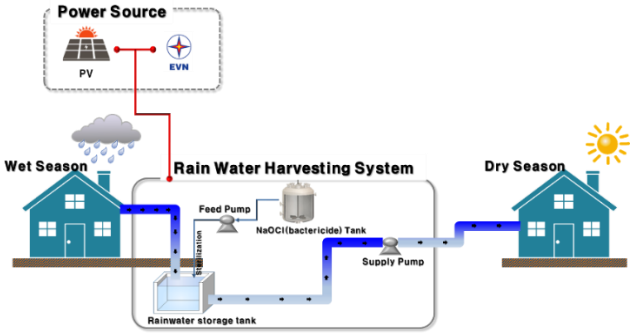


Figure 10. Mechanism of rain water harvesting system

2) Water Treatment System

(1) Background

A membrane is a thin layer of semi-permeable material that separates substances when a driving force is applied across the membrane. Membrane processes are increasingly used for removal of bacteria, microorganisms, particulates, and natural organic material, which can impart color, tastes, and odors to water and react with disinfectants to form disinfection byproducts. The membrane system, which is going to be applied for this project mainly focuses on produce fresh water from salt water of the ocean or brackish water, and can effectively remove all inorganic contaminants from water as shown below.

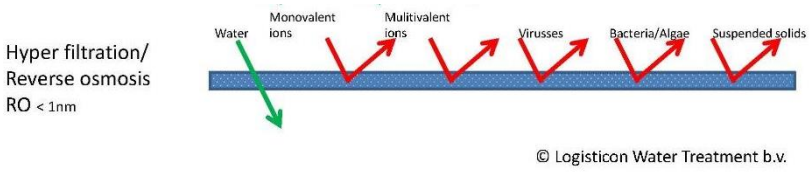


Figure 11. Reverse Osmosis Membrane Technique

(2) Design

Water treatment is consisted of intake pump, storage tank, cartridge filter, and membrane. The electricity power needed for the operation of the system will be partially mobilized from photovoltaic (solar) and grid which make the system both environmentally and economically sustainable. The mechanism of the technology is described specifically below.

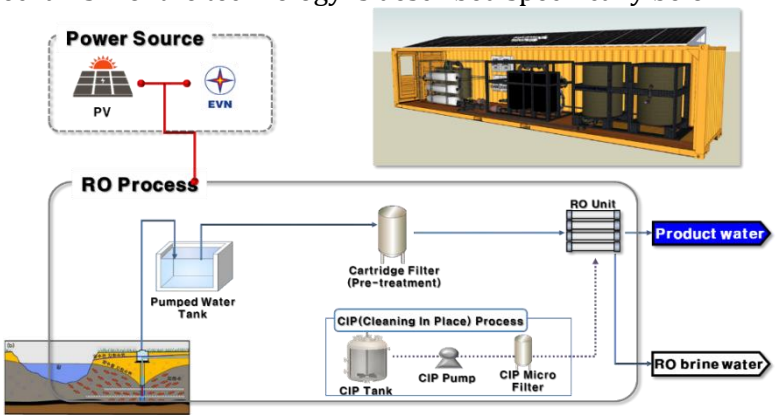


Figure 12. Mechanism of the water treatment system

3) Adopted Technologies and details by location

Province	Commune	Location	Water Source	Technology Type	Capacity
Bac Lieu	Vinh Trach Dong	Truong Tieu Hoc Ngo	Rain water	Rainwater harvesting system	4.3 m^3/day
		Troung Thcs Nguyen Hue			4.2 m^3/day
		Kindergarten (Troung Mau Vang Anh)			3.9 m^3/day
		Resettlement Area	Ground Water	Water treatment system	22.7 m^3/day
Tra Vinh	Long Hoa	Long Hoa Secondary School	Ground Water	Water treatment system	15 m^3/day
		Truong Tieu Hoc Long Hoa			15 m^3/day
		Truong Tieu Hoc Long Hoa A			9.4 m^3/day
		Truong Mam Non Long Hoa			9.4 m^3/day
	Hoa Minh	Truong Mau Giao			22.7 m^3/day
		School Complex			11.2 m^3/day

Table 10. Adopted technologies and details by location

Coastal Erosion Preventive System

1) Design

The general designs for the elastocoast[7] (also referred to as bio-coast) is depicted in the below figure 1.1. As shown in the figure, elastocoast (porous-coast) will be applied on the shore area which would be the between the mangrove trees and the land. The section design is described in the figure 1.2 which shows the structure of layers for the elastocoast.

[7] Elastocoast is mentioned in the UNFCCC as the new technology for climate change adaptation which protects the dikes by absorbing the force of the breaking waves and slowing down the water masses.

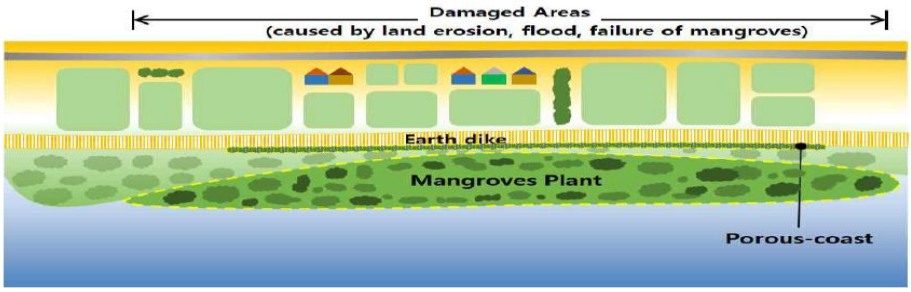


Figure 13. Thematic design for the technology implementation

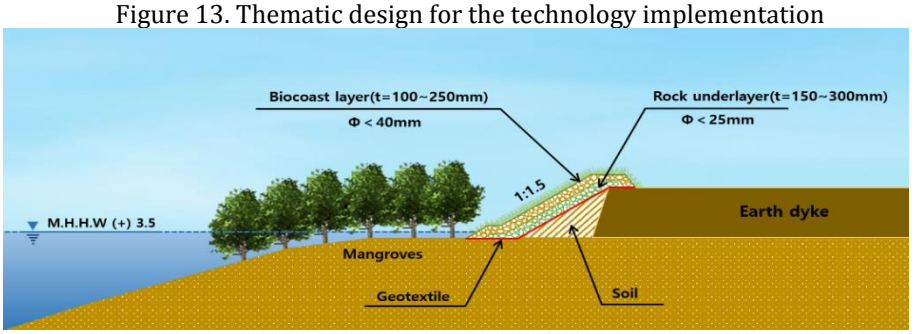


Figure 14. Section design for the elastocoast

2) Description

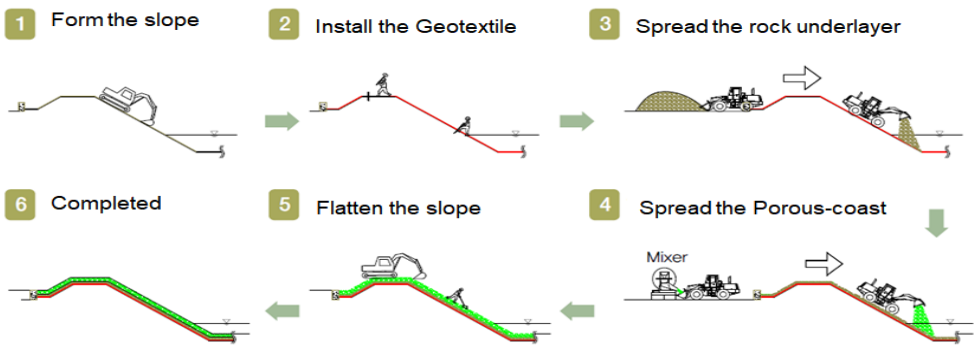
There are 9 expected locations for the technologies to be applied, which are selected under the criteria of vulnerabilities for coastal erosions. The detailed information on protection technologies applied in each specific location are described in the following table. The total area for the mangrove plantation would be 8,240 ㎡, 540m for the length of Elastocoast, and 860m for the total protected coastline of the island.

Zone	Coastal Protection Facility Plan		Protected Coastline (m)
	Mangrove Plant area (㎡)	Elastocoast length (m)	
SOC-R01	870	80	80
SOC-R02	600	60	60
SOC-R03	980	-	80
SOC-R04	400	-	50
SOC-R05	1,550	150	150
SOC-R06	500	-	70
SOC-R07	670	-	60
SOC-R08	780	-	60
SOC-R09	1,890	250	250
SUM	8,240	540	860

Table 11. Description for the coastal protection facilities

3) Installation Process

The process for the installation of the elastocoast would be as follows:



Component 4: Awareness Raising and Knowledge Management

This component will ensure that project implementation is fully inclusive, that all stakeholders are informed of products and results and that they have access to these for replication. Moreover, this component will also contain specific activities to further replicate and scale up the project. This will be done by:

- Lesson learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms; and
- Regional advocacy and replication;

Lessons regarding increasing the resilience of communities against climate change impact need to be captured, and local government officials need to be trained to ensure the sustainability of this project and effective replication of the best practices. All knowledge products generated will be made available on a digital format in English and Vietnamese.

B. Economic, Social, and Environmental Benefits:

By implementing a combination of soft and hard intervention, this project is expected to provide reductions in future climate related economic, household and livelihood losses, and reduction in vulnerabilities of women, indigenous people and youth, and reduction in environmental degradation. For example, through providing the appropriate measures related to water management, the project is expected to achieve the provision of fresh water for drinking. Moreover, the project will bring numerous social benefits. Women and youth specifically will be involved in the planning, assessment and implementation of all components. In the consultation process, focus group interviews will be conducted with women and youth unions in order to encourage them to fully participate in the project.

Table 12. Overview of Economic, Social and Environmental Benefits

Type of Benefit	Baseline	With/After Project
Economic	Climate change is already leading to economic and livelihood losses, especially caused by sea level rise and floods, but also by droughts. Less capacity for livelihood strategy and resources in the communities No planning (action plan and strategy) for livelihood strategy and resources Locals face high damage and financial losses as a result Low quality of drinking water Fluctuation of the water price depending on the seasons (wet/dry) Lack of knowledge sharing platform and financing capital	Reduction in economic and household losses due to increased resilience of institutions, communities and physical and natural assets, ecosystems and livelihoods. High economic costs of natural hazard caused by damage on infrastructure and assets can be mitigated; Labour intensive works will bring more job opportunities for youths and women and reduce unemployment rate; New climate-resilience infrastructure and service contributes to economic benefits Community participation in infrastructure projects will ensure local ownership and sustainability while benefiting the community and livelihood strategy is also to primarily be sourced from the community. Additionally, resilient technologies will be imparted and provide new livelihood opportunities. The technology using the renewable energy will bring more affordable priced water with the business model developed by the project; Create environment for development partners to invest for scale-up and replication

Social	Poor quality infrastructure in the target areas further drive vulnerability, and create additional challenges such as a lack of safety. Natural hazards can increasingly be considered as drivers of poverty and lead to financial losses, and compound social problems such as sanitation, food security, community safety issues especially for women, elderly, disabled people and youth Increasing inequality in the resettled areas shows that the poorest are not sharing in the proceeds of the country's rapid economic growth Lack of accessibility of fresh water for drinking;	Reduction in climate induced poverty, fatality rates, diseases and food security and safety issues due to increased resilience of institutions, communities and physical and natural assets, ecosystems and livelihoods. Health benefits can be leveraged; community involvement brings ownership of the intervention and a higher probability of sustainability; Capacity development directs involvement in adaptation actions, increases the resilience capacity of the most disadvantaged in the provinces. New climate-resilience infrastructure and service contributes to social well-being. The benefit of the project will ensure that actions target the poorest and most vulnerable, including women, youth ethnic minorities and the elderly. Social inclusion and accessibility will be increased;
Environmental	Severe environmental degradation has taken place throughout the coastal area of Viet Nam Climate change is already leading to negative environmental impacts, especially differences in temperature and precipitation, leading to floods and droughts, which in turn leads to above factors and erosion, ecosystem degradation, etc Ecosystem degradation leads to reduction of livelihood options and health issues and flood risks Saltwater intrusion leads to the fresh water shortage, health issue, and low productivity of agriculture	This project will contribute to the reduction in climate and human induced environmental degradation and losses; Rainwater harvesting will provide alternative water source to local people and groundwater can be protected; Coastal erosion protective system will support the recovery of the ecosystem and also reduce the impact of sea level rise; The development of the coastal erosion protective system will participate in the reduction of the impact of natural hazards such as storm; Promotion of ecosystem-based adaptation in the communities, leading to environmental benefits

The total estimated beneficiaries for the water treatment system would be 10,148 people and key beneficiaries are described in the below table:

Table 13. Beneficiaries for each intervention

Province / Commune	Site	Direct Beneficiaries	Indirect Beneficiaries	Description & Rationale
Tra Vinh / Long Hoa	Long Hoa Secondary School	1,496 people	2,182 households	Beneficiaries will be provided with clean fresh water for their drinking and domestic use.
	Truong Tieu Hoc Long Hoa			
	Truong Tieu Hoc Long Hoa A	944 people		
	Truong Mam Non Long Hoa			
Tra Vinh / Hoa Minh	Truong Mau Giao	2,252 people	1,166 households	
	School Complex	1,120 people		
Bac Lieu / Vinh Trach Dong	Truong Tieu Hoc Ngo	842 people	1,564 households	
	Troung Thcs Nguyen Hue	551 people		
	Kindergarten (Troung Mau Vang Anh)	279 people		
	Resettled Area (Huu nghi)	2,664 people		

*Direct beneficiaries: Residents living within 1 km radius
*Indirect beneficiaries: Households lacking access to clean water

As for the beneficiaries of elastocoast, the whole population of two communes in Tra Vinh, 25,199 people would be regarded, in that the protection of coastal areas of the island will provide the safe human settlements for local people in the long-term period. Furthermore, the locals living adjacent to the coastal line of the island would be the expected direct beneficiaries considering the vulnerability of their residential area due to the constant erosions of soil.

Protected Area	Estimated Quantity	Descriptions & Rationale
Protected coastline length (m): Red line	860 m	Total length of coastline protected by the preventive technologies including the mangrove plantation
Mangrove plantation protected area (ha); Yellow line	8 ha	Total estimated area will have Mangrove restoration
Protected aquaculture pond area (㎡)	61,490 ㎡	Total estimated area of local aquaculture pond protected through the technology applied in the coastlines

C. Cost-Effectiveness of the Project:

When the project undertakes action planning, cost effectiveness, adaptation-cost effectiveness, 'time to adaptation benefits' and 'no-regret' will all be factors in prioritising investments. This is standard practice according to UN-Habitat's well-established 'Planning for Climate Change' methodology. Also, the technical partner of KEITI conducted feasibility study for hard infrastructure implementation in Component 3. Thus, business model, cost-benefit analysis, site specification, technological design, estimated budget, number of interventions, beneficiaries, socio-economic and environmental benefits were identified and analysed in the feasibility study.

Cost effective investment

Table 14 Beneficiaries and budget for the hard intervention

Project site	Water Treatment System			Rainwater Harvesting System			Elastocoast/Mangrove plantation		
	# of intervention	# of beneficiary	Budget (USD)	# of intervention	# of beneficiary	Budget (USD)	# of intervention	# of beneficiary	Budget (USD)
Vinh Trach Dong, Bac Lieu	1	2,664 (indirect: 15,925)	383,652	3	1,672 (indirect: 15,925)	695,348	-	-	
Hoa Minh, Tra Vinh	2	3,372 (indirect: 14,177)	701,130	-	-		Red: 860m Yellow: 8,260m	25,199	1,070,200
Long Hoa, Tra Vinh	4	2,440 (indirect: 11,022)	507,913	-	-				
TOTAL	7	8,476 (indirect - 41124)	1,592,696	3	1,672 (indirect: 15,925)	695,348	9,120	25,199 (Including indirect)	1,070,200

Table 15. Brief Cost Effectiveness Analysis of Proposed Adaptation Options

Proposed Action	Cost Effectiveness Criteria		Alternative Action	Cost Effectiveness Criteria	
3.1.1 Constructing new and restoring old water related system and infrastructure in	Future cost of climate change	✓	Building sea walls for protecting saltwater intrusion and sea level rise	Future cost of climate change	✓
	Project efficiency	✓		Project efficiency	×
	Community involvement	✓		Community involvement	✓
	Cost/Feasibility	✓		Cost/Feasibility	×

highly saltwater intrusion locations (Blue Network)	Environmental and social safeguarding risks	✓		Environmental and social safeguarding risks	More Risk
3.1.1 Rain water harvesting (Blue Network), especially water supply, to drought location.	Future cost of climate change	✓	Extending the water supply network (piped water) and construct wells for underground water	Future cost of climate change	×
	Project efficiency	✓		Project efficiency	×
	Community involvement	✓		Community involvement	✓
	Cost/Feasibility	✓		Cost/Feasibility	×
	Environmental and social safeguarding risks	Less Risk		Environmental and social safeguarding risks	More Risk
3.1.2 Prevention of coastal erosion with green (eco-friendly) rehabilitation and control system	Future cost of climate change	✓	Building sea wall and dykes	Future cost of climate change	×
	Project efficiency	✓		Project efficiency	×
	Community involvement	✓		Community involvement	×
	Cost/Feasibility	✓		Cost/Feasibility	×
	Environmental and social safeguarding risks	Less Risk		Environmental and social safeguarding risks	More Risk

According to Section B, the project, especially hard infrastructure investment, will result in numerous economic, social and environmental benefits to locals. However, the prevention of saltwater intrusion has limited solution, and building sea wall has more vicious challenges. Thus, in this project, UN-Habitat and the government of Viet Nam focus on the development of solution for local communities. This would lead to more community participation and the increase of local ownership. Moreover, the benefits to socio-economic and environmental factors have been accounted for the analysis of cost-effectiveness. For example, renewable energy will be implemented for 3.1.1 hard infrastructures and this will lead cost-effectiveness in sustainable operation and management.

Selection of cost-effective investments

While the two primary infrastructure investments proposed by this project have a high initial financial cost, they are cost effective because they will benefit a large number of people. The total number of beneficiaries of the investments is 41,129 people, of whom 51% and 53% are women in Bac Lieu and Tra Vinh Provinces respectively. That means that the cost per beneficiary of the hard investments is US$89. Furthermore, the maintenance costs are relatively low at up to US$5,544.9 per year per water treatment facility, and rainwater harvest system does not require the maintenance costs, because of using solar energy. Also with investment/business model, further investments can be established for the other vulnerable areas to the climate change impact.

Cost effectiveness for the 'Hard' with 'Soft'

The project focuses on maximizing the size of the hard/tangible component (68.85%) to benefit the most vulnerable populations. Where the project makes investments in soft activities, these will either a) directly support the hard investments (i.e training in installation or operation and maintenance), or b) invest in strengthening commune/district level planning – which will help to sustain and replicate the benefits of the project. For example, the costal erosion can be interrelated with mangrove deforestation. Due to the lack of policy and compliance, the investment of mangrove forestation became useless. Thus, the project can contribute to the development of policy framework based on the gap between hard and soft intervention.

Cost effective operation through community contribution

UN-Habitat will implement the hard components of the project through the People's Process where possible. The project will be implemented in close partnership with communities and local government institutions. This implementation approach has been shown to reduce implementation costs by 20-30% over the life of the project by using community labour instead of external contractors, procuring local materials where they are available. Moreover, the capacity of operation and management can be improved with community participation. With the support of MONRE and provincial/commune governments, the teams of operation and management, and monitoring will be established at local level (See section J. Sustainability). Also, the investment/business model for sustainability was developed with community and governments (public agencies)' participation, and this would financially support for sustainable operation and management. Furthermore, each provincial government has a plan to contribute counterpart funds for developing environment toward achieving sustainable operation and management.

D. Project Consistency with National or Sub-National Sustainable Development Strategies:

This project is consistent with national and sub-national development strategies of Viet Nam on Socio Economic Development Plan, Climate Change Adaptation, and Sustainable Development. The Socio-Economic Development Plan (SEDP) is the main plan for socio-economic development in Viet Nam and thus action plan and strategy need to be integrated into SEDP to obtain the support of national and provincial government. This helps all levels of society in Viet Nam to participate in the planning of their province, district and commune. This is a driving factor in reform of local planning which can include climate-related action.

In the 2016 -2020 Socio Economic Development Plan, there are two development plans for dealing with environmental issues and it addresses the response to climate change. Along with international climate policy grounded in the UNFCCC, Viet Nam has developed its own strategies through government policies and strategies to achieve the Sustainable and Climate Change Adaptation goals. ***Resolution 24/NQ/TW (2013) on Responding to Climate Change by Central Party Committee*** has taken on the role of the mainstream agency on policies for climate change adaptation.

As shown in Figure 8, National Climate Change Strategy and National Green Growth Strategy are under ***Resolution 24/NQ/TW (2013) on Responding to Climate Change by Central Party Committee*** to support national policy in achieving the adaptation goal against climate change in Viet Nam.

The National Climate Change Strategy (NCCS, 2011) states that Mekong Delta is one of the world's three most vulnerable deltas (together with the Nile Delta in Egypt and the Ganges Delta in Bangladesh) to rising sea levels. According to climate change scenarios, in late 21st century, Viet Nam's yearly mean temperature will go up by 2-3 degrees. The total amount of yearly and seasonal rainfall increases while the rainfall in dry seasons will decrease. Sea level is estimated to rise by 75 cm to 1 m compared to the 1980-1999 period. To cope with the challenges from climate change impact, Viet Nam has been trying to improve public awareness and capacity of responding to climate change.

Based on NCCS, the National Target Program to Respond to Climate Change (NTP-RCC) has been developed as the umbrella program for guiding the framework for the Government of Viet Nam's efforts in adaptation and mitigation of climate change risk. The Ministry of Natural Resources and Environment developed the program and is responsible for its implementation.

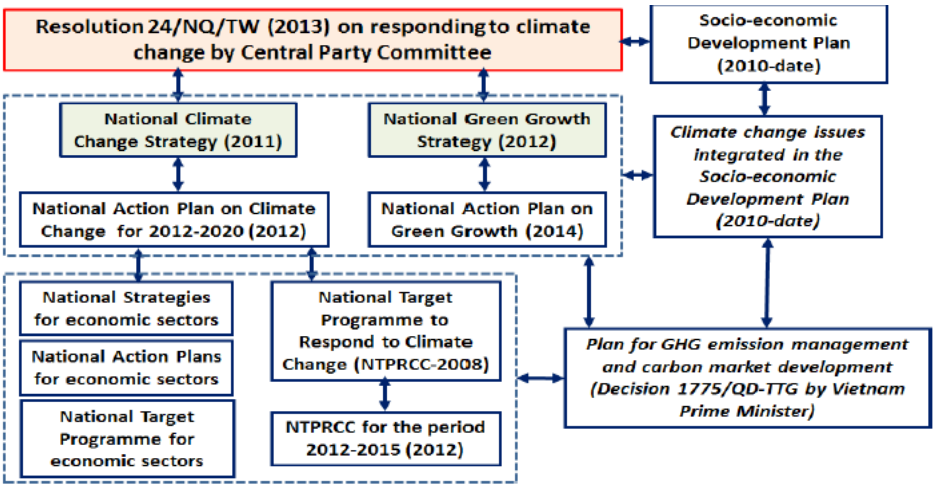


Figure 15. Evolution of Climate Change Policies in Viet Nam

The Viet Nam Green Growth Strategies (VGGS, 2012) as a means to achieve a low carbon economy and to enrich natural capital, will become the principal direction in sustainable economic development; While GGS suggested overall strategies to achieve sustainable development goals in mitigation, some of the components related to climate change adaptation.

In November 2017, the Government Resolution 120/NQ-CP on Sustainable and Climate-Resilient Development of the Mekong Delta of Viet Nam was signed by PM Nguyen Xuan Phuc in a conference on sustainable development in the Mekong Delta. The principal solutions in Resolution 120 are well fit to the activities in the proposed project. Through the Mekong Delta Workshop in June, 2019, the Viet Namese government released 'joint statement from development partners in Mekong delta working group'. In the statement, the importance of water security to adapt to the climate change impact in Mekong Delta has been highlighted along with the integrated water resource management.

Implementation of the Paris Agreement (PIPA) tries to be suitable to development circumstances of Viet Nam and the level of international support received; Needs to follow direction from Parties, Government and inherit viewpoints, undertaking activities for climate change response and green growth which have been and are being implemented, and take advantage of opportunities presented by the Paris Agreement. Adaptation continues to be the main focus of the implementation of the Paris agreement in Viet Nam

Table 16. Project Alignment with Government Priorities

Measure	Resolution 24/NQ/TW (2013) on Responding to Climate Change by Central Party Committee	Green Growth Strategy (GGS)	National Climate Change Strategy (NCCS)	National Determined Contribution (NDC)	National Target Program to Climate Change (NTP)	National Action Plan on Climate Change in 2012-2020	Sustainable Development Strategy (SDS) for 2011-2020	Plan for Implementation of the Paris Agreement (PIPA)
❑ Institutional and community capacity building toward eco-human settlement development for supporting to enhance local climate response actions		Δ		✓	✓			✓

❑ Action plan and strategy development for eco-human settlement, and integrating into planning and policy with participatory approach		✓	✓		✓	✓	✓	
❑ Sustainability built through small-scale protective infrastructure	✓	∆	✓	✓			∆	
❑ Awareness Raising and Knowledge Management	✓	∆	✓		✓			✓
✓: sufficient support /∆: need more support /: no support								

Table 16 shows how the proposed project aligns with policies, strategies and plans of the Vietnamese government. Accomplishing main four components above, the proposed project will support national development goal based on the assessment of national strategies of Viet Nam and also provide additional support on the other components related to climate change adaptation.

E. Compliance with Relevant National Technical Standards:

All project activities are in compliance with existing rules, regulations, standards and procedures endorsed by the government, as shown in the following table. In addition, compliance with tools are discussed below:

Table 17. Project Compliance

Expected Concrete Outputs / Intervention	Relevant rules, Regulations, Standards and Procedure	Compliance, Procedure and Authorizing Offices
1.1.1. National Induction Workshop	**Res 120 3d**: Coordinate investment activities in a uniform, inter-regional, inter-sectoral and targeted manner/ **Prime Ministers Decision No. 1393/QĐ-TTg** Establishment of Green Growth Strategy for Viet Nam	Prime Minister, MPI, MOC, NCC, MOFA, PPC, MARD, MONRE will be involved; Engage government officials to share knowledge;
1.1.2. Guidance and training materials development for vulnerability and risk assessment	**UN-Habitat Planning for Climate Change/ Res 120 3a**: The Mekong Delta development model must be human-centered, serve people and narrow the gap between the rich and the poor; in the context of climate change and the impact of extraction and use of water on the Mekong River upstream / **Circular No. 27/2015/TT-BTNMT MONRE** on strategic environmental assessment, environmental impact assessment and environmental protection plans. **Circular 08/2016/TT-BTNMT MONRE**, Article 5: Assessment of the impact of Climate change/ Article 7: Assessment of National Climate	Maximize use of existing VA tools/guidelines to minimize tool fatigue and to build on experiences in-country, where possible Ministry of Planning and Investment (MPI), NCC, MONRE, MARD ministries and relevant local authorities, PPC Develop the guidance and training materials in compliance with the policy, laws, guidelines and draft strategy;
1.1.3. Planning toolkits and training materials development for planning approach, strategy and action plan development on climate change resilience	**Decree No. 18/2015/ND-CP** of the Government concerns Environment protection planning, Strategic environmental assessments / **Circular No. 27/2015/TT-BTNMT** MONRE on strategic environmental assessment and protection plans / **Res 120 4d**: Formulate a master plan for sustainable and resilient	MONRE, MPI, MOC, MARD will be involved; Provide planning tools and training materials for a comprehensive and holistic climate change adaptation

	development of the Mekong delta / **Res 120 5b**: Review, complete and prepare the planning for land use, use of water resources, environmental protection, extraction and sustainable use of bank natural resources of the Mekong Delta. **Decision No. 2139/QD-Ttg Prime minister**, Approving the National Strategy for Climate Change **Prime Ministers Decision No. 1474/QD-Ttg**, Establishment of National Action plan on Climate change in the period 2012-2020 **Decision No. 672/QĐ-BTNMT MONRE** in 2017 on Establishment of Action plan for responding to climate change of MONRE period 2016-2020. **Decision No. 811/QD-BXD MOC** in 2016 Establishment of Action plan for responding to climate change of MOC period 2016 -2020 **Circular 08/2016/TT-BTNMT MONRE**, Regulating the impact assessment of Climate change and National climate assessment/ Article 6: Assessment of Climate change Adaptation and Mitigation solutions.	strategy according to the environmental protection law and in compliance with Government development planning approach.
1.1.4. Project team (facilitators) training enabling facilitation of eco-human settlement strategy and action plan development (for supporting component 2.1.1 and 2.2.2	**Res 120 3d**: Coordinate investment activities in a uniform, inter-regional, inter-sectoral and targeted manner/ **Prime Ministers Decision No. 1393/QĐ-TTg** Establishment of Green Growth Strategy for Viet Nam	Prime Minister, MPI, MOC, NCC, MOFA, PPC, MARD, MONRE will be involved; Engage government officials to share knowledge;
1.2.1. Training workshops, enabling national/provincial/ district/commune to set up eco-human settlement strategy and action plan development for climate change adaptation	**Res 120 3d/Res 120 4d**: Continue to complete the mechanism for coordinating the development of the region and ecological sub-region the focus shall be given to smart management of Viet Nam and the Mekong Delta/ **Prime Ministers Decision No. 1393/QĐ-TTg**	MONRE, MOC, MARD, and MPI will be involved; Local government (provincial departments, district and commune PCs) will participate Achieving this output is aligned to the Government's priority of boosting region's economy as well as strengthening climate change resilience;
2.1.1 Action plan and strategy development for eco-human settlement (province, district, commune levels)	**Res 120 2d/UN-Habitat Planning for Climate Change/ Res 120 5g**: - Review, amend and implement the planning for regional construction planning, urban and rural planning, rearrangement of population and relocation of houses along rivers, canals and ditches to minimize the risk of erosion. Keep houses safe from natural disasters/ **Decree No: 16/2003/QH11 Construction Law / Resolution No. 51/2001/QH10;** **Law on Urban Planning** **Law on Organization of Local Government, No. 77/2015/QH13**	MONRE, DONRE and other provincial departments, and district and commune PCs, will be involved; Comply with all urban planning laws, while also aiming to develop local capacity through involvement in the planning process, allowing better local understanding of how to benefit from project implementation in

		the long term;
2.2.1 Policy framework development for integrating local peoples' action plans and strategies for eco-human settlement into planning	**Res 120 4d** **Res 120 5g** **Decision No. 672/QĐ-BTNMT MONRE** Article 1: Building and Improving institutions, policies and legal documents on climate change in Viet Nam **Decision No. 811/QD-BXD MOC** Article 2.2: Review, edit and add legal documents, standards, technical construction guidelines related to climate change and sea level rise.	MONRE, MARD, PPC, will be involved;
2.2.2 Integrating developed/revised action plan and strategy into the relevant/existing planning and policy	**Res 120 2d/Res 120 3c:** Switch the development model according to the ecosystems to ensure suitability for natural conditions, people and natural laws/**Prime Ministers Decision No. 1393/QĐ-TTg** Establishment of Green Growth Strategy for Viet Nam/ **Law on Water Resources (LWR) Order No. 15/2012/L-CTN** of July 2, 2012, on the promulgation of law **Prime Ministers Decision No. 1474/QD-Ttg** Article 5: Strengthen management capacity and developing policy mechanism on climate change	MONRE, MARD, PPC, will be involved; Communities by holding workshops to improve community actions to climate change adaptation. MONRE and PPC will support these workshops.
3.1.1 Prevention of the saltwater intrusion and protection of the ground water through water treatment system and rainwater harvesting	**Res 120 3b/Res 120 3c /Prime Ministers Decision No. 1393/QĐ-TTg** **Establishment of Green Growth Strategy for Viet Nam / Decree No. 201/2013/ND-CP** Detail regulations for implementing some articles of the Water Resources Law **Circular 39/2016/ TT-BTNMT MONRE** on Technical regulations on monitoring and investigation on saline intrusion areas. **Circular No. 47/2017/TT-BTNMT MONRE** on Supervision of the extraction and usage of water resources **Circular No. 27/2014/TT-BTNMT MONRE** on Regulating the registration for groundwater extraction form of dossier for issue, extension, modification, re-issue of water resource permit. **Circular 75/2017/TT-BTNMT MONRE** prescribing the protection of groundwater in drilling and excavation activities and groundwater exploration and exploitation. **Decree No. 167/2018/NĐ-CP Government** Prescribing the restriction on groundwater extraction **National Technical regulation No. QCVN 07-1:2016/BXD MOC** on Infrastructure works – Water supply infrastructure	MONRE, DONRE and relevant departments in PPC, and commune PC will be involved; (DOH, DARD) Improve structure for water management in compliance with Government resolution of water as a core element;
3.1.2 Prevention of coastal erosion with green(eco-friendly) rehabilitation and control system: elastocoast	**Res 120 5g / Decree No: 16/2003/QH11 Construction Law / Decree No. 43/2014/ND-CP detailing the implementation of some articles of the Law on Land/ Law on Water Resources (LWR) Order No. 15/2012/L-CTN of July 2, 2012, on the promulgation of law** **Decision 106/2004/QĐ-TTg,** Approving the list	MONRE, DONRE and relevant departments in PPC, and commune PC will be involved Improve climate-resilience infrastructure according to national policy and law on

	of communes in coastal spits and islands, which meet with exceptional difficulties **Decision 79/2002/QĐ-BNN,** Promulgating amendments and supplements to spending norms of the project on protection and development of coastal submerged land areas in south Viet Nam **Decision 09/2002/QĐ-BNN,** Promulgating the regulation on organisation of the implementation of project for afforestation on coastal sandy areas of southern central Viet Nam **Decision 668/TTg,** On the natural disaster reduction orientation and measures and the programs for key socio-economic development of coastal cent **Decision 172/2007/QĐ-TTg,** Approving the national Strategy on natural disaster prevention, fighting and reduction till 2020 **Decision 193/2006/QĐ-TTg,** Approving the Program on population distribution in natural disaster- and special difficulty-hit areas, border regions, islands, areas inhabited by free migrants, and important and very important areas of protective forests and strictly protected zones of special-use forests in the 2006-2010 period, and orientations up to 2015	land, and in compliance with Government resolution of keeping properties safe from floods, droughts, storms and sea level rise; Respect all prohibited actions under LWR;
3.2.1 Capacity building to a working group for the sustainable operation and management of provided hard intervention	**Res 120 4d / Res 120 5g** **Decision No. 672/QĐ-BTNMT MONRE** Article 3: Raising awareness and training human resources on climate change adaptation **Decision No. 811/QD-BXD MOC** Article 3.5: Propaganda and dissemination of knowledge; training for awareness raising and capacity building	MONRE, DONRE and relevant departments in PPC, and commune PC will be involved; Organize working group for the management; Consider Res 120 5g when implementing the planning for management;
4.1.1. Lesson learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms	N/A	N/A
4.1.2. Regional advocacy and replication for developing the effective policy framework	N/A	N/A

F. Other Funding Sources:

Analysis took places of the listed projects and programmes in Mekong delta to avoid overlapped projects in the same region and interventions. The table below lists relevant projects, either recently completed, ongoing or about to start in the Mekong Region, that UN-Habitat can complement and synergise with the proposed project. They have been identified based on in-depth consultations with the national and local governments and international agencies from targeted regions and through desk research.

There are many projects and programmes in Mekong Delta Region for climate change adaptation (e.g. by the World Bank, USAID, UNDP, SECO, GIZ and among others). None of the projects, however, is focusing solely on enhancing the climate adaptation capacity in the commune level targeted by this project with bottom-up approach from the local level to the national level through both hard and soft interventions.

Most of the projects in Mekong Delta Region have focused on community level capacity building or else policy and institutional level capacity building without providing the hard intervention while the proposed project would like to focus on providing hard environmental-related infrastructure in small scale with suitable capacity building for the ownership of the community. Several projects, however, were identified for providing complimentary potential with this project. An analysis of lessons learned from these projects is as below (Table 18).

Table 18. Relevant Projects and their Complimentary Potential

Relevant Project/ Programme	Relevant Interventions and Lessons Learned	Complimentary and Duplication Potential
Bac Lieu Province		
UNDP/Expanding models of rice-shrimp cultivation for efficient management and sustainable use of alkaline lands in Bac Lieu (June 2015 - June 2018)	*Relevant Interventions:* Community awareness raising and capacity building to manage land as well as water resources; effective exploitation of saline-alkaline lands for rice cultivation; development and expansion of rice-shrimp farming model using rice variety, all of which contribute to poverty reduction and new rural development of the region; *Lessons Learned:* Raising awareness should be included for the sustainability of the project	*Non-Duplication:* UNDP Project was in same targeted area but in different scale (provincial level) and also focused only on soft intervention *Complimentary:* Through component2 (integrated planning), the proposed project will make synergy by developing the integrated planning against climate change impact
The World Bank/Scaling-Up Urban Upgrading Project (Approval Date: 30 May 2017 Closing Date: 31 Dec 2023)	*Relevant Interventions:* Improving access to infrastructure in priority city areas and improve urban planning in the participating cities; *Lessons Learned:* The World Bank tried to give the training after the hard intervention for the ownership to the community for the facilities	*Non-Duplication:* Different targeted area/ The World Bank project targeted urban area in Mekong delta regions *Complimentary:* The proposed project will take this project as an example for the framework to implement component 2 and 3;
GIZ/Sustainable Development of Coastal Protected Forests (Wetlands) in Bac Lieu Province (Oct 2008 - Oct 2011)	*Relevant Interventions:* Activities to restore coastal forests have been supported, including the afforestation of 100 hectares of coastal strip incorporating biodiversity considerations; about five hectares were planted with rare endemic mangrove species; *Lessons Learned:* The project generated alternative sources of income for coastal communities, which do not damage the coastal forests.	*Non-Duplication* GIZ project focused on protecting the biodiversity in coastal zone *Complimentary:* Through the consults, UN-Habitat identified several areas for potential cooperation including providing with the data in the region for installation of component 3 from GIZ;

USAID/Enhanced Capacity of the Viet Nam Red Cross (2017-2019)	*Relevant Interventions:* Project activities include developing hazard risk reduction and disaster preparedness plans *Lessons Learned:* USAID utilized a community-based approach to help communes better prepare for and increase their resilience against disaster	*Non-Duplication:* USAID project focused on disaster risk reduction and disaster response. Only soft intervention is taken. *Complimentary:* The proposed project will use community-base approach through components 2 and 3 for developing the action plan
Tra Vinh Province		
ICCG/Strengthening capacity of Khmer women in adapting to climate changes in Tra Vinh province, Viet Nam (20-Apr-2017 - 20-Dec-2017)	*Relevant Interventions:* The goal is to strengthen quality of human resources of Khmer women in the Tra Vinh province, to mitigate and adapt to climate change impacts. *Lessons Learned:* The outcome of this project will be increased adaptive capacity of community in the Tra Vinh province to climate change	*Non-Duplication:* ICCG project focused only on soft intervention through community level capacity building *Complimentary:* Through component2 (integrated planning), the proposed project will make synergy by developing the integrated planning against climate change impact; considering minority group for the project
IFAD/Rural Development: Project for Adaption to Climate Change in the Mekong Delta in Ben Tre and Tra Vinh Provinces (11- Dec- 2013 - 30-Mar-2020)	*Relevant Interventions:* Building the capacity for climate change adaptation with participating communities, institutions and provinces for the agriculture and rural development sector; Investing in sustainable rural livelihoods by providing the financial means and facilities to scale up the results of community-based research and development in this sector *Lessons* Learned: Involving community could be the key element to implement the project successfully	*Non-Duplication:* IFAD focused on providing sustainable livelihood resource *Complimentary:* From the consult, UN-Habitat figured out IFAD is planning to start the new project from 2020 and both agencies agreed on future collaboration;
Mekong Delta Region		
USAID/Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin (2011-2016)	*Relevant Interventions:* Improvements to canal networks including an emphasis on maintenance are required to cope with more intense flood events, particularly to ensure effective drainage of fields and waterways *Lessons Learned:* USAID highlighted ways of applying scientific findings at a community level that are helping to raise awareness	*Non-Duplication:* USAID project targeted provinces of Chiang Rai, Gia Lai, Kien Giang, Khammouan, Mondulkiri uplands *Complimentary:* The proposed project will apply scientific findings through Feasibility Study to help raising awareness through component 4;
USAID/Smart Infrastructure for the Mekong (SIM) (2013-2018)	*Relevant Interventions:* Sustainable Infrastructure for the Mekong will provide Lower Mekong partner governments with rapidly deployable technical assistance from the U.S. Government's premier scientists and engineers to mitigate potential negative social and environmental consequences from large infrastructure projects. *Lessons Learned:* USAID could include peer review consultations and technical training for policy makers, however it only provided with facilitators	*Non-Duplication:* USAID project only focused on soft intervention (training, consultations) and it targeted whole Mekong region in collaboration between 4 different countries. (Viet Nam, Cambodia, Laos, and Thailand) *Complimentary:* The proposed project will include consults along with the training for policy makers through component2;
USAID/Improving	*Relevant Interventions:* The water links alliance	*Non-Duplication:* USAID project only

Water and Sanitation Services in Asia (2013-2015)	seeks support from private sector and development partners to expand positive impact to urban water service *Lessons Learned:* USAID and Water Links collaborated with development partners including international development agencies, civil society groups	targeted water access of urban communities. *Complimentary:* The proposed project will also collaborate with international agencies and civil society for the scale-up project through knowledge management on component 4;
IUCN/Building Resilience to Climate Change Impacts-Coastal Southeast Asia - Ben Tre (Jan-2011 - Dec-2014)	*Relevant Interventions:* community working groups developed through the BCR project had contributed to the improvement of natural-resource management and use. Workshop teams discussed alternative solutions and methods of community involvement, which IUCN will use as valuable feedback for its work in the future *Lessons Learned:* Bottom-up approach through community working group would be the key to achieve sustainable management	*Non-Duplication:* IUCN project was carried out in Thanh Hai and Thanh Phong communes of Ben Tre province. *Complimentary:* Through component 3, the proposed project will also have community working group to achieve sustainable management
Netherlands Embassy/The Mekong Delta Plan (2015-2025)	*Relevant Interventions:* The Delta Plan contains guidelines for government, donors and international financial institutions on moving from planning to implementation and placing investment projects in a long-term context. *Lessons Learned:* Delta Plan contains guidelines for government, donors and international agencies for climate change information on Mekong Delta	*Non-Duplication:* Different scale *Complimentary:* The Mekong delta plan can be the milestone for the proposed project in overall components; Knowledge platform could be formed with the collaboration with the Mekong delta plan (Component4)
GIZ/Integrated coastal and mangrove forest protection Mekong provinces to adapt to climate change (June 2011- July 2018)	*Relevant Interventions:* the scope of the interventions and the cooperation system are well defined and aimed at achieving the impact identified at the results level as well as by the programme objective indicators. *Lessons Learned:* The monitoring system developed by GIZ is excellent and can be used on our monitoring stage	*Non-Duplication:* GIZ project was carried out in five provinces, which are An Giang, Kien Giang, Ca Mau, Bac Lieu and Soc Tran. *Complimentary:* The monitoring system can also be applied to the proposed project; Through the consults UN-Habitat identified several areas for potential cooperation; GIZ also provided with the data in the region for component3;
JICA/Ben Tre Water Management Project	*Relevant Interventions:* The project will provide saltwater intrusion control facilities in Ben Tre Province in southern Viet Nam, where saltwater intrusion is damaging crops. *Lessons Learned:* JICA only provided the facilities in big-scale for the whole province, thus it was hard to cover the small communes for the drinking water	*Non-Duplication:* JICA project targeted Ben Tre province. *Complimentary:* The facilities provided by JICA for saltwater intrusion can collaborate with the small-scale water desalination and purification system(component3); Through consults, JICA and UN-Habitat found the area that both agencies can make synergies in the future;
Netherlands Embassy/Water Treatment Project	*Relevant Interventions:* The project will deliver sanitation for residents and industries whose wastewater is currently discharged and	*Non-Duplication:* Different scale. This project included the construction of huge pumping

(July - 2017 - Dec-2019)	untreated, resulting in high levels of environmental pollution. *Lessons Learned:* The environmental benefits will be visible in a significantly improved water quality	stations, and pipeline network, while the proposed project will carry out small infrastructure intervention. *Complimentary:* The case from Netherlands embassy could be the example for installation of component3 (hard intervention);
Netherlands Embassy (PPP)/Climate Change and Water Supply in the Mekong Delta, Viet Nam (Apr-2013 – Mar-2017)	*Relevant Interventions:* The public private partnership (PPP) will improve drinking water supply by increasing availability and reducing climate change effects on three water companies in or adjacent to the Mekong Delta *Lessons Learned:* PPP approach could be the option for the up-scale the project in the future	*Non-Duplication:* Netherland Embassy project targeted Soc Trang Province *Complimentary:* PPP approach could be the option for the up-scale the project in the future through component 4 with the business model provided from feasibility study;

G. Capturing and Disseminating Lessons Learned:

A dedicated component (4) addresses awareness raising, knowledge management, and communication. While this provides the cornerstone for capturing and disseminating lessons learned, other project components directly contribute to knowledge management mechanisms and dissemination of lessons learned from local to national and to international levels.

At the local level, a participatory approach involving communities, local authorities and will lead to increased local knowledge on planning, constructing and maintaining resilient infrastructure. Project demonstration sites will contribute to sharing lessons and training through local disseminators and tools and guidelines, this will take place from the beginning of the project and throughout its implementation. The project will also use a participatory monitoring process, which will enable the beneficiary communities under component 4.

At the national level, this project will allow other vulnerable regions in Viet Nam to draw on this framework and lessons learned through replication and scale-up of good practice. Information obtained through this project will be consolidated in reports, then tools and guidelines will be developed for resilient and sustainable urban communities for developing and upgrading human settlement. The partnering departments of the various ministries at the regional level will directly link with the ministries at the national level to facilitate national wide dissemination.

As part of the sustainability/exit strategy, the project will develop participatory monitoring processes, which will trigger institutional learning processes, participation from local groups, knowledge exchange and replication and scale-up of good practices.

At the international level, projects related to climate change, especially for eco-human settlement and community level infrastructure may benefit from the proposed project. UN-Habitat is plugged into a number of international mechanisms. The Knowledge Centre on Cities and Climate Change (K4C) provides a knowledge management platform for Climate Change Adaptation and Human Settlement Interventions. It is proposed to use this platform to disseminate the lessons learned from this project.

Table 19 Project Outputs and Related Learning Objectives, Indicators and Products

Expected Concrete Outputs / Intervention	Learning Objectives (LO) And Indicators (I)	Knowledge Products
1.1.1. National Induction Workshop / Project team (facilitators) training	(LO): Improved awareness and local vulnerability and strategies sharing (I): Number of participating government	*Workshop report and documentation (Concept note, Agenda and*

enabling facilitation of eco-human settlement strategy and action plan development	officials, Number of strategies shared Number of local plans reflecting climate change adaptation/resilience	*List of Participants)*
1.1.2. Guidance and training materials development for vulnerability and risk assessment at the local level	(LO) Develop the guidance and training materials for mainstreaming climate change adaptation into the planning (I) Number of guidance and training materials Quality of participants on the development of materials Pilot workshop with practitioners	*Training materials, guidelines for vulnerability and risk assessment at the local level*
1.1.3. Planning toolkits and training materials development for planning approach, strategy and action plan development on climate change resilience	(LO) Develop the planning tools and training materials for planning approach, strategy, and action plan for comprehensive and holistic climate change adaptation (I) Number of guidance and training materials Quality of participants on the development of materials	*Planning toolkits and training materials, comprising of planning approach, resilient infrastructure, and technical standards, environmental and social safeguards*
1.1.4. Project team (facilitators) training enabling facilitation of eco-human settlement strategy and action plan development (for supporting component 2.1.1. and 2.2.2)	(LO): Improved Climate Change awareness and enhanced knowledge of government officials at all levels and trainers for development of action plan and strategy (I): Number of trainers/ participants Project tools for planning approach and guidance Number of workshops	*Training report and training materials* *Guidelines comprising of assessment and planning approach, resilient infrastructure, and technical standards, environmental and social safeguards and community action planning*
1.2.1. Training workshops enabling national/provincial/district/commune to set up eco-human settlement strategy and action plan development for climate change adaptation	(LO): Improved Climate Change awareness and enhanced knowledge of government officials at all levels and trainers for development of action plan and strategy (I): Number of participating national and local government officials Project tools for planning approach and guidance Number of workshops	*Training report and training materials* *Guidelines comprising of assessment and planning approach, resilient infrastructure, and technical standards, environmental and social safeguards and community action planning*
2.1.1. Action plan and strategy development for eco-human settlement (Provincial, district, and commune level)	(LO) Develop community based eco-human settlement planning and strategy Revise the climate change adaptation action plan through the workshop (I) Number of action plan and strategy development work shop Number of revised eco-human settlement strategies and action plans Number of developed eco-human settlement strategies and action plans	*Community based eco-human settlement strategy and planning* *Revised action plan and strategies for climate change adaptation* *Revised action plan and strategy for climate change adaptation* *Revised community planning for climate change adaptation*
2.2.1. Policy framework development for integrating local people's action plans and strategies for eco-human settlement into planning (provincial	(LO) Integrated planning with eco-human settlement action plan and strategy for climate change adaptation (I) Number of integrated planning Number of workshop and meeting at local levels	*Integrated planning with eco-human settlement action plan and strategy for climate change adaptation* *Provincial SEDP that included climate change*

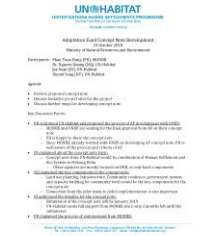
level)	(LO): Improve local action for climate change adaptation and planning Integrate climate change action plan and strategy into community planning (I): Number of local action workshop Number of local plans reflecting climate change adaptation / resilience	*action plan and strategy from local levels*
2.2.2. Integrating developed/revised action plan and strategy into the relevant/existing planning and policy (Provincial level)	(LO): Develop the policy framework for integrating of planning Revise policy framework for integrating Develop policy for climate change adaptation with the action plan and strategy at local levels (I): Number of dialogue event Number of meeting with local government Guidance for revising policy framework Number of integrated planning with eco-human settlement for climate change adaptation	*Guidance for revising policy framework* *Revised policy framework for integrating action plan and strategy into planning* *Integrated planning with eco-human settlement for climate change adaptation*
3.1.1. Prevention of the saltwater intrusion and protection of the ground water through water resource management system: water purification and rainwater harvesting	(LO) Improve the physical infrastructure for water management (I) Number of hard infrastructures in communities Feedback report	*Technology for water management system* *Implementation plan and report*
3.1.2. Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system: elastocoast	(LO) Improve the green (eco-friendly) erosion rehabilitation and control system (I) Number of hard infrastructures in communities/ feedback report	*Technology for green (eco-friendly) erosion rehabilitation and control system Implementation plan and report*
3.2.1. Capacity building to a working group for the sustainable operation and management of provided hard intervention	(LO) Improve locals' capacity of operation and maintenance/ Enhance implementation arrangement and governance (I) Number of manuals and video clips for operation and maintenance Number of training workshop Number of meeting with working group and appointed agencies	*Workshop feedback report* *Manual and video clips for operation and maintenance* *Governance for operation and maintenance* *Monitoring plans*
4.1.1. Lesson learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms	(LO): Sharing of lessons learned and best practices for other regions in Mekong Delta (I): Number of platforms used for sharing Number of workshops for sharing experience and best practices	*Dissemination through regional organisations and websites* *Sharing experience and best practice materials* *Workshop and feedback report*
4.1.2. Regional advocacy and replication for developing the effective policy framework	(LO): Scaling up the good practices to the policy level and other funds (I) Number of knowledges sharing workshop at local level Number of further investment and cooperation meeting	*Reports of dialogue and knowledge sharing workshop* *Meeting minutes and partnership documents for further investments*

H. The Consultation Process:

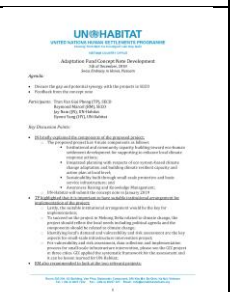
All the consultation processes took place to effectively investigate the current status of the project site and develop the strategies for the project. The idea of the project started from the field mission to the coastal region of the Mekong Delta between 10 and 14 September 2018. In the field mission, the impact of climate change was specifically identified at provincial and district level. In the meetings with provincial level government officials, current status of the impact of climate change was discussed, and economic, social and environmental related issues were also considered. In the first meeting with the national designated entity, Ministry of Natural Resources and Environment (MONRE), the possibility of cooperation between UN-Habitat and MONRE for the project development was identified. National level consultation meeting was held on 7th of November with various stakeholders and experts. The additional meetings at the national level focused primarily on alignment with national priorities (as identified in Section D) and coordination with other development partner initiatives (outlined in Section F). Coordination with the relevant agencies was mainly about synergizing with other projects, avoiding overlaps and identifying lessons from the projects in Mekong Delta.

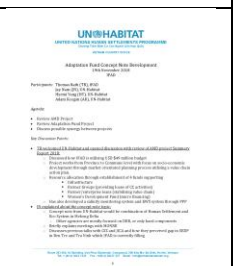
Community level consultation was held in December 2018 and June 2019 with vulnerability and risk assessment and gender issues' assessment. In the community consultations women, indigenous people, elderly, and youth have been part of the consultation process. The objective was to understand the local climate change impact/effects per community, individual communities' adaptive capacity, the demand for resilience capacity building and barriers to building resilience, specific resilience building needs and interests and concerns regarding the proposed project in general. The meetings at the local level considered the thematic and geographic focus and the pre-identified target communities.

Table 20 Stakeholder Consultation Meeting Held

Agency	Consultation objective	Outcome	Conclusion	Photo
MONRE (Oct. 23rd, 2018)	Show the interest of AF project development and implementation / Confirm focal point willingness/ Establish preferred target areas/Ensure coordination with other ongoing adaptation activities and policy alignment	MONRE coordinated for consultation meeting and supported UN-Habitat for administration MONRE decided to support UN-Habitat to organize the consultation workshop at local level MONRE also promised to support to find the most vulnerable communities for the AF project development	Set up the consultation meeting on 7 November 2018 Shared the experience that MONRE support UNEP's AF project development UN-Habitat received the full support of MONRE for project development	
MONRE (Nov. 7th, 2018)	Collect the feedback of the project from government officials and experts Discuss the potential project sites for the project Find the gap	Various departments in MONRE and experts participated in the consultation meeting Shared the experience and knowledge about the current local situation Reviewed the developing project and its draft of the concept note	Narrowed down for the project locations: Bac Lieu and/or Tra Vinh Components and activities in the draft would be revised Collected the data about ongoing and planned projects in the Mekong Delta	

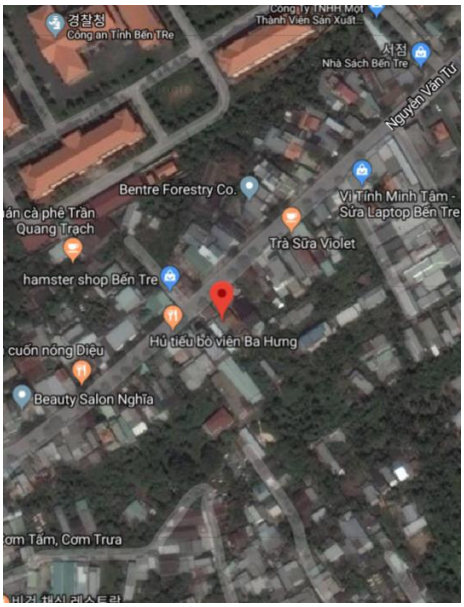
	between existing and UN-Habitat projects		Collected data for identifying the gap between existing UN-Habitat projects	
Province officials in two provinces (Dec. 5th – 11th, 2018)	Agree on target sites/Understanding climate change vulnerability, integrating climate change action into urban planning/highlight possible adaptation investments	Data collection, possible project sites were introduced and visited Understanding of current status of the impact of climate change, provincial priorities for climate change adaptation, and the level of awareness of climate change	Identified the needs from the locals for the project through their feedbacks Collected the socio-economic and environmental data from communes	
Commune officials in two provinces (Dec. 5th – 11th, 2018)	Agree on the target sites/Understanding climate change vulnerability, integrating climate change action into urban planning/highlight possible adaptation investments/understanding community coping mechanisms/Barriers to building resilience	Data collection, possible project sites were introduced and visited Understanding of current status of the impact of climate change, district and commune levels priorities for climate change adaptation, and the level of awareness of climate change	Locals understood about the project and benefits from the implementation Identified the real needs from locals and obtained the feedback about the projects recognized the challenges that locals face because of the impact of climate change checked the awareness on the impact of climate change and climate change adaptation	
GIZ (Nov. 1st, 2018)	Ensure synchronicity with the GIZ integrated Coastal Management Project in the Mekong Delta	For site selection process, GIZ supported their new information system from ICMP Their ICMP was not focused on Bac Lieu and Tra Vinh, thus AF project can fill the gap. GIZ could provide data of MD when UN-Habitat develops its concept note for Adaptation Fund.	Project site could be overlapped, but we should focus on how we make the synergy within the same project site through proper cooperation GIZ also suggested to focus on river erosion since the informal settlement along the river accelerates the river bank erosion. The resettlement of the informal sector along the river is urgent issue for the government.	

JICA (Nov. 2nd, 2018)	Ensure synchronicity with the JICA Ben Tre Water Management Project and share the data from JICA's Feasibility study, vulnerability assessment, and climate change projection	Identified the gap between JICA's and UN-Habitat's AF project in terms of geography and context: JICA project mainly focuses on hard infrastructure, and not including planning component. JICA's project is a big scale infrastructure construction project, thus they cannot cover the whole region by community level. Thus, they only can cover the around of Ben Tre City and upper area of the province.	JICA and UN-Habitat do not share the same project site, however the proposed technologies from both agencies are related to water treatment system JICA will share the information as the project from JICA will be implemented in Ben Tre in 2019	
SECO (Dec. 4th, 2018)	Gain experience from SECO on the implementing modality for multi-lateral climate finance projects Synergize with other projects, avoiding overlaps and identify lessons learned	Having suitable institutional arrangement for implementation of the project is the key; To succeed on developing the project in MDR, reflection of the local needs is important; Identifying local's demand and vulnerability and risk assessment are the key aspects for small-scale infrastructure intervention project;	SECO suggested the relevant projects with the proposed project: WB project in urban climate resilient project in Can Tho could be the good reference for developing the small-scale infrastructure; GIZ project in Anh Giang, Kien Giang, and Cau Mau on sustainable drainage system link to green infrastructure	
NISTPASS (Oct. 29th, 2018)	Gain knowledge and practices for environmental technology application at local level	Data collection Possible project sites were introduced and potential environment related technology would be introduced with understanding of current status of the impact of climate change, district and commune levels Priorities for climate change adaptation, the level of awareness of climate change	clarifying how to transform outputs to outcomes is essential to ensure a real change Having a dialogue events for integration needs to be applied at local level	
ISPONRE (Oct. 31st, 2018)	Find the gap in the Viet Namese context and seek advice for project site selection	Noted that there is also a need to prove more resilience for activities. Added that the component of knowledge sharing should be	Revising the planned activities Considering about ecosystem approach with agricultural base	

		scalable for the implementation.		
IFAD (Nov. 19th, 2018)	Review AMD Project and Adaptation Fund Project, and discuss possible synergy.	Notes the agencies challenges, such as the lack of details. Offers to share useful of IFAD reports for the project implementation. Notes the need of communication with PPC for further details.	The gaps perceived in Ben Tre and Tra Vinh are being filled by IFAD.	
Stakeholder's Meeting (March. 7th, 2018)	Discuss on the implementation arrangement with the various stakeholders for the sustainable management of each component	The three options of the frame for the implementation arrangement were suggested to the stakeholders Through the discussion with MONRE, DONRE of Bac Lieu and Tra Vinh, and observers (JICA, GIZ, and KEITI), one of the options has been selected	The further discussion on the implementation arrangement will be taken place along with more involvement of the local government such as DOC, DARD for the working group	
National Consultation Workshop (June 4th, 2019)	Get comments and feedbacks from the various stakeholder's including international donors, local experts, and government officials	53 participants attended Comments and feedback for the hard intervention regarding on the background and bottlenecks were discussed from NAWAPI, GIZ, ISPONRE, CARE international, and WWF were shared on the stage	Based on the comments and feedbacks from the participants, the project team is trying to consult with the fountaine1001 and GIZ	 
Meeting with Bac Lieu/Tra Vinh (June 6th -7th, 2019)	Ensure the sustainable operation and management from the local government (organizing the working group)	DOC, DARD, and DOH in each province participated in the meeting as the potential working group members Commune leaders understood the concept of the project	Tentative roles and procedures of each activities have been discussed. Once the project gets approved, more detailed roles and responsibilities for each government department will be discussed	

<u>Willing to pay study: Case Study of Ben Tre (DANIDA Project)</u>

Water purification facility of Nguyễn Văn Tư (Address: 31d Nguyễn Văn Tư, Phường 7, Bến Tre)



The project implemented by DANIDA (Danish International development agency) installed the RO (Reverse Osmosis) filter for the purification to provide the clean water in the Mekong Delta. The project was completed at the end of 2017 and the project cost was about 220,000 USD. The capacity of the facility is 8m3/hr, 200tons/day. The power is provided from the solar system with retrofitting the existing water treatment plant. 17 PV panels expected 13kW and the installed main pump capacity 12kW.

I. Justification of Funding Request:

The proposed project components, outcomes and outputs fully align with national and local government/institutional priorities/ identified gaps and with the needs of the target communities and vulnerable groups as identified through project analysis. It will also align with the Adaptation Fund's seven outcomes as stated in the Adaptation Fund results framework. This alignment has resulted in the design of a comprehensive approach in which the different components strengthen each other and in which outputs and activities are expected to fill identified gaps of Viet Nam's climate change response. UN-Habitat is well placed to execute the proposed project based in its human settlements related climate change work in the Asia-Pacific Region and its strong presence in Viet Nam. It has a history of strong partnerships with national and sub-national government agencies, a wide range of other stakeholders and most importantly communities with vulnerabilities.

Whilst the planned interventions are strongly rooted in national and local priorities the reshaped global development and climate change agenda provide further guidance. In particular, sustainable development Goal (SDG) 11 (and several of its targets); Make cities and human settlements inclusive, safe, resilient and sustainable, and Goal 6, (and its targets), Ensuring availability and sustainable management of water and sanitation for all will be addressed by the project. The New Urban Agenda emerged as an outcome of the Third United Nations Conference on Housing and Sustainable Urban Development (Habitat III, in Quito, October 2016) will also be utilised as a framework to guide this project.

The project aims to maximize the funding amount for the local investment component (component 3); funding allocation of the 'soft' components is required for complementarity/support for component 3 in order to achieve sustainability and quality assurance of the project.

Table 21 Overview of Impact of AF funding compared to no funding (baseline) related to expected project outcomes

Project Objectives	Baseline (without AF)	Additional (with AF)	Comment / Alternative Adaptation Scenario
Institutional and community capacity building toward eco-	There are no detailed plans for human settlement and ecosystem	There will be detailed plans for human settlement and ecosystem Public can understand the	Local people will adapt to the impact of climate change and the local government could revise the plan by themselves.

human settlement development for supporting to enhance local climate response actions	Lack of awareness on climate change impact No support plans for local climate response actions in terms of human settlement and ecosystem	climate change impact Develop the plans for local climate actions in terms of human settlement and ecosystem	However, it would not be the well-structured adaptation and will not be efficient and effective without the intervention. The enhancement of adaptive capacity will be limited in terms of eco-human settlement planning
Action plan and strategy development for eco-human settlement, and integrating into planning and policy with participatory approach	Lack of integration of climate action plans and strategies into provincial, district and commune level plans Community level demand is not reflected into the plans	Will Identify the demand from community level This demand can be developed to local climate response actions This action plans will be integrated into the socio-economic development plans. Green and Blue network can be set up and support local people to strengthen climate-resilience	Planning will be developed, but it would not be the comprehensive one. No holistic approach will be implemented for responding the climate change Without the intervention, the opportunity to reflect the impact of climate change at local level into provincial and national level planning will be limited, and the actual challenges and financing mechanism for climate change related projects will not be captured
Sustainability built through small-scale protective Infrastructure	National government and local authorities could not adapt to climate change impacts through the proper infrastructure due to lack of funding source and technological capacity. Also, it is hard to identify which infrastructures are necessary at local level, and to allocate the resources effectively	Project site will be facilitated for water management and coastal erosion prevention based on the local level consultations conducted. Local government and community can utilize the infrastructures for strengthening climate-resilience through capacity building on the operation and management	Without undertaking actions through the People's Process, adaptation actions would not be participatory ensuring local ownership or generate the levels of local ownership achieved by this project
Awareness Raising and Knowledge Management	Local levels (district and communes) have limited knowledge of resilient planning and protection of human settlement Less coordination of vertical governance and knowledge management	Local government will be aware of climate change and its impact. Knowledge will be increased and the likelihood of follow up finance for additional investment will be increased Experience and practice sharing platform will be developed Limited resources at local can be effectively allocated with the platform	Without these interventions, the chances of wider knowledge generation and follow-up financing would be severely limited

J. Sustainability of the Project:

Institutional Sustainability

The project will pave the way for the national government and local authorities in Viet Nam to sustain and up-scale the project to vulnerable settlements in other regions, by utilising the planning tool equipped through the proposed project and sharing lessons learned from the project. The project will strengthen the strategies and plans to cope with climate change adaptation in Viet Nam at multiple levels.

Moreover, for infrastructure operation and maintenance, working group will be organized along with project office at provincial level. With the consultation of local authorities, DONREs in the provinces will lead the project implementation with cooperation of relevant departments and agencies.

Economic Sustainability

Adaptation is a highly important economic activity in the targeted areas. In most of the targeted settlements, people rely on tanker-supplied or bottled water, which is expensive. This project will enable people to access water in a sustainable manner at much lower cost. Also, water treatment system will be installed with renewable energy, which is solar power and this will lead to the decrease of maintenance and operation cost, and the water price as well. In addition, the investment/business model was set up with the support of communities and public/private agencies (See J. Sustainability). Setting up the business model and using renewable energy will result in much higher sustainability for maintenance and operation after the project termination.

Technological sustainability

Hard infrastructures were designed and constructed using resilience and build back better principles. This will enhance the durability/sustainability significantly. With the principles, feasibility study for hard infrastructures in water and eco-friendly infrastructures for coastal erosion was conducted with experts from KEITI. The detailed information is attached as Annex 1. For achieving technological sustainability, UN-Habitat and F.S. teams had several consultation meetings with local governments and locals in order to identify the demand for the infrastructures and difficulties of locals in operation and maintenance. As a result, operation and maintenance agencies and mechanism were appointed before the project start and discussed with commune PCs about trainings for operation and maintenance. By implementing the project through the People's Process methodology, people will take ownership for the design and construction of the infrastructures.

Social Sustainability

In implementing the project, communities will gain greater awareness of climate change and adaptation, and vocational skills to build and maintain infrastructure. Also, ethnic minorities in target areas were considered as the priority of the project.

Environmental Sustainability

The project will make use of local materials in line with environment safeguards, where possible. The project will be implemented in the Mekong Delta and as such, activities undertaken in this area will make special consideration of the delicate environment. The project will also make provisions for the protection of the environment through its safeguarding procedures. As shown in Section K, below, the project will ensure the protection of natural habitats, conservation of biological diversity, prevention of emissions that cause climate change, and prevent pollution and promote resource efficiency.

Scale up and Replication

In Component 4, the policy framework for sharing the experience and practices will be developed and it would contribute that Viet Nam government can continuously support the project after the termination of the project. In terms of institutional, economic and technological sustainability, the project considers the scale up and replication in the Mekong Delta region. Also, Component 2 will support 'mainstreaming climate change adaptation into planning' at local level, and for this process, the project supports to develop policy framework for national and provincial governments. Thus, this will lead scale up and replication of the project in Viet Nam.

Community led Business Model for Sustainable Operation and Management

For sustainable operation and management, this section proposes a visible business strategy for saltwater treatment system. After the discussion with 1001 Fountain (O-We in Viet Nam), which is a NGO for producing water to the public in Cambodia and Viet Nam, they are also developing similar business model with same technology in Viet Nam.

The project aims to promote such solutions/technologies that are socially and culturally acceptable and economically affordable for the poor households and communities. At the same time these solutions should be commercially profitable by the markets so after the project exhausts its designed life, the technologies are mainstreamed.

Economic feasibility study considering the business model for scale up is performed to evaluate the feasibility as investment project after the project funded from Adaptation Fund. In this business model concept, the construction cost is considered as investment cost which is the most different factor from the analysis of grant model.

1. Grant model

The Grant model assumes that financing for the system were granted by Adaptation Fund and this only considers the sustainable operation and management.

Table 22 Basic assumptions

Category		Description
Project duration	Reference date	Jan, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul.2020 ~ Jun. 2040)
	Annual operating days	Water supply: 365 days
Financing	Funding ratio	Public sector: 100.00 %
		Private sector: 0%
Revenue and cost	Operating revenue	Production cost: satisfying 10 % of O&M cost
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0% assumed
	Corporate tax	20.0% (single tac rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Table 23 Result of economic feasibility study for grant model

	Operating cost (USD/year)	Sales (USD/year)	Production cost (USD/ton)	B/C (before tax)	B/C (after tax)
Long Hoa Secondary school	11,211	12,333	2.3	1.03	1.03
Truong Tieu Hoc Long Hoa A	10,010	12,111	3.5	1.03	1.03
Truong Mau Giao	15,829	17,412	2.1	1.03	1.03
School Complex	12,701	13,971	3.4	1.03	1.02
Replacement Aarea	15,955	17,551	1.8	1.03	1.03

As a result of analysis, B/C ratio from all cases is over 1.0, accordingly, all systems with grant model is economically feasible. This means that the cost of operation and management can be covered by sales, and this will lead the increase of sustainability.

2. Investment model (Business model)

Investment model will consider about the sustainability of the project after the AF project completed. This business model will contribute the scale up and replication of the project to other Mekong Delta region, and also support policy framework development for climate change adaptation with appropriate technology.

1) Estimate of total investment coast and financing structure

Estimate of total investment cost

The total project cost including construction cost, test operation was estimated 269,524USD and the total investment cost including contingency (price index) and construction interest was estimated at 274,064 USD. Revenue will be 35,000 USD; thus, the return of Investment will be 7.8 years.

Table 24 Breakdown of total investment cost

Category	Amount (USD)	Ratio (%)	Remarks
Construction cost	215,806	78.7	
Incidental cost	53,718	19.6	Transport, test & commissioning
Contingency	2,919	1.1	Inflation rate
Construction interest	1,621	0.6	
Total investment cost	274,064	100.0	

Table 25 Breakdown of construction cost by facility

Category	Amount	Ratio (%)	Remark
Desalination system	215,806	100.0	
Total	215,806	100.0	

Table 26 Quarterly financing plan

Category	Total	Q1, 2020	Q2, 2020	Ratio	Remarks
Equity	54,813	54,813	-	20.0	
Borrowed	219,251	92,630	126,621	80.0	
Total	274,064	147,443	126,621	100.0	

2) Estimate of operating revenue and cost

Operating revenue in this project consists of the revenue from water supply through the desalination system.

Table 27 Basic assumption for operating revenue

Category	Water supply	Days	Production cost	Inflation
Revenue from water supply	9.4 ton/day	365 days	10.1 USD/ ton	3.0%

Production cost was estimated considering 10% of project earning rate and estimated sales during the operation period was 976,910 USD and average annual sales during the operation period is **48,846 USD.**

Estimate of operation cost

Operation cost consists of labor cost, electric power cost, general expenses and maintenance cost. Annual inflation rate of 3% was applied.

Table 28 Breakdown of operating cost

Category	Amount	Ratio (%)	Remarks
Labor cost	6,614	60.1	2019 constant price
Electric power cost	630	5.7	
General expenses	1,624	14.7	
Maintenance cost	2,143	19.5	
Total	11,010	100.0	

The total operating cost occurring from the facilities during the operating period was estimated at 309,290 USD, which corresponds to approximately 31.7% of the total sales. In detail, labor cost accounts for 60.1% of the total electric power cost 5.7%, general expenses 14.7% and maintenance cost 19.5%.

Community Affordability

The water price from the newly built infrastructure will be lower than the prices in the market, thus there is no issue about community affordability, and the proposed business model can support sustainability of the water treatment system.

Strategy for Post Project Sustainability

For maintaining sustainability after the project, UN-Habitat cooperated with National Centre for Water Resources Planning and Investigation (NAWAPI) under MONRE (See Annex 2). NAWAPI has experience to deal with technology and Mekong Delta Centre. For maintenance, selected water technology company will provide technology transfer to NAWAPI during implementation period, and NAWAPI will have responsibility of maintenance after implementation. NAWAPI Mekong Delta centre will also be in charge of capacity building for local communities. For operation, local communities should have ownership, thus capacity building will be conducted by NAWAPI Mekong Delta Centre and O-We (See Annex 3 for more detailed information).

The maintenance plan for water technology was set up by NAWAPI and the maintenance costs were calculated for maintenance to keep post project sustainability.

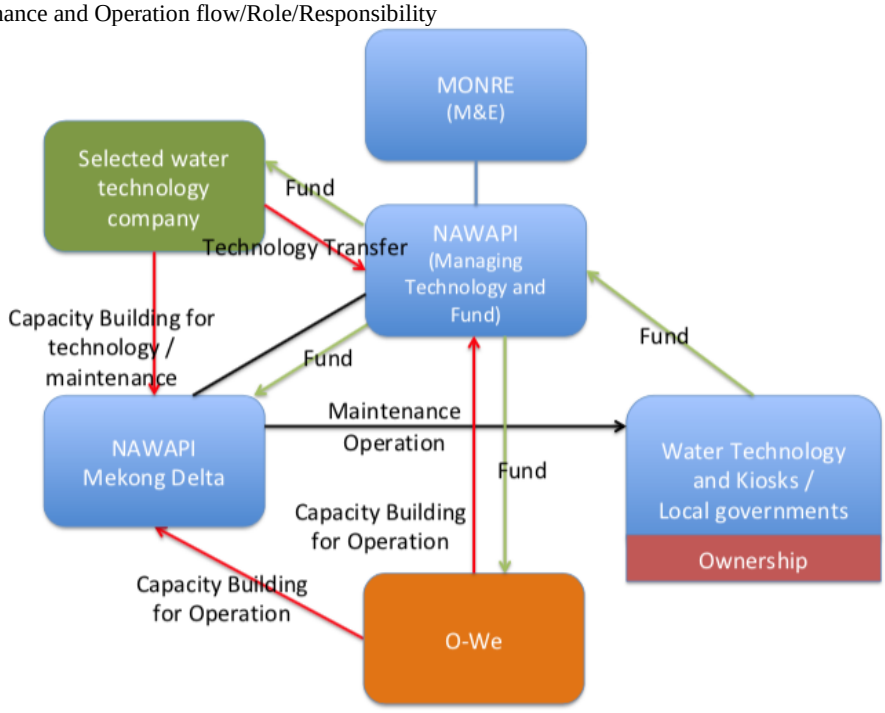
Table 29 Maintenance plan and cost (annual)

	Item	Description	Hour	Daily	Weekly	Monthly	3months	6months	1year	2years	3years
Maintenance Schedule	Water Quality	Check Instruments		√							
		Sample analysis					√				
	A/C Filter	Backwashing		√							
		Replacing									√
	UF Membrane	Backwashing	√								
		Cleaning						√			
		Replacing									√
	Micro Filter	Check		√							
		Replacing				√					
	RO Membrane	Cleaning									
		Replacing									
	UV Sterilizer	Check			√						
		Replacing							√		
	Drinking Foundation	Check			√						
	Piping	Check			√						

Site	Description	Unit	Unit Price (USD)	Replacement Cycle(year)	Consumption (1 year)	Maintenance Cost (USD/1 year)	Remark
Bac Lieu Vin Track Dong Replacement Area	Chemical(NaOCL)	Kg	2	-	503.7	1,007.4	
	Chemical(Antisclant)	Kg	10	-	54.75	547.5	
	Cartridge Filter	Ea	5	1month	40	200	
	UF Membrane)	Ea	2,000	3	1	2,000	
	RO Membrane	Ea	350	3	5	1,750	
	A/C Filter	kg	2	3	60	120	
	UV Lamp	ea	20	1	1	20	
	Power Consumption (PV)	Kw	0.06	-	28,174	-	50% Use PV(Solar)
	Total					5,544.9	

A pro-poor tariff will be implemented by NAWAPI, and NAWAPI will cooperate with local communities for operation and maintenance after implementation (See Annex 2).

Figure 16 Maintenance and Operation flow/Role/Responsibility



This figure (Figure 16) shows that how all stakeholders cooperate for post project sustainability. During project implementation, all stakeholders will work for enhancing the locals' capacity of operation and maintenance, and after implementation, specialized agencies such as NAWAPI and O-We will keep cooperating with locals to provide sustainability of the project. Especially, O-We will support to local communities to build community based business models while NAWAPI contributes enhancing local communities' capacity for maintenance.
According to the economic feasibility study, this project would be 'profitable business' (See the 2. Investment model). Thus based on the decision of working group, re-investment will be conducted and it contributes the replication of the project to the vulnerable areas in the Mekong Delta.

K. Environmental and Social Risk and Impacts:

The proposed project seeks to fully align with the Adaptation Fund's Environmental and Social Policy (ESP). Outlined below is a summary of the findings of the preliminary screening and assessment process that has been carried out to evaluate the environmental and social impacts and risks of the entire project. There is also a categorization of the project and a completed risk and impacts checklist.

UN-Habitat conducted a project screening of environmental and social risks in accordance with the Vietnam's EIA related laws and regulations as well as according to the 15 principles outlined in the AF's Environmental and Social Policy based on analyzing information available at the project design stage. The potential risks identified and preventive or mitigation measures planned are presented below (Table 30).

The project has been designed to generate positive economic, social and environmental impacts. It will achieve this by using inputs from local authorities and by incorporating best practices from other projects, while also placing specific priority on inputs from women and marginalized and vulnerable groups in target communities. The adaptation measures proposed in the proposal were selected together by the communities and local authorities, making sure they are culturally and locally appropriate.

As shown in Table 30 the project is in full alignment with Adaptation Fund's Environmental and Social Policy (ESP) and screened according to UN-Habitat's Environmental and Social Safeguards policy. This section briefly describes the initial analysis of environmental and social impacts of the project based on the ESP (See Annex 5 for more comprehensive examination).

Activities under Component 1, 2 and 4 have been categorized as low risk (Category C). Despite this, steps will be taken to ensure that no environmental or social impacts can occur. This includes the use of quota systems that ensure active representation of women and marginalized and vulnerable groups in the planning processes and ensuring transparency of the execution of all activities, such as posting attendance lists and outcomes of meetings and trainings.

As such, the activities under component 3 are to fit into medium risk (Category B) or low risk (Category C). This is due to the scope of the proposed numerous interventions; they are characterised by their small scale and very localized nature, they will be co-managed by communities where possible, who have a stake in avoiding environmental and social impacts. Also the project is categorized as 'B" in environmental and social risks level as per review of the concept note by the AF. Thus UN-Habitat contacted the MONRE/DONRE for the risk categorization per Vietnam's EIA laws and regulations, and the risks for each intervention were determined by Viet

Nam's EIA laws and regulation (See Annex 6). Upon the submission for formal screening request, an official letter confirming that the project does not require an EIA (See Annex 6).
In addition, Adaptation Fund and UN-Habitat policy and guideline were also analyzed for ESMP development. For developing ESMP, the team developed and implemented screening process (See Annex 5). Thus risks and impacts were identified, and mitigation measures were set up for establishing monitoring plan, probability of risks, and mitigation action plans (See Annex 5).

In Component 3, small-scale water resource management system built to provide clean and safe water for drinking and coastal erosion prevention system and elatocoast for protecting land erosion were considered as hard infrastructure intervention, which the screening and examination are necessary for social and environmental risks and impacts. Our initial assessments indicate that the potential for direct impacts is small and localized, that there can be few indirect impacts, and that transboundary impacts are highly unlikely. Given this, cumulative impacts are also unlikely.
Table 30-1 (right below) summarises the necessity of further assessment for each of the 15 principles: Table 30-2 (far below) provides more details:

Table 30-1. Checklist of Environmental and Social Principles: Summary

Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks – further assessment and management required for compliance
Compliance with the Law		X
Access and Equity		X
Marginalized and Vulnerable Groups		X
Human Rights		X
Gender Equity and Women's Empowerment		X
Core Labour Rights		X
Indigenous Peoples		X
Involuntary Resettlement		X
Protection of Natural Habitats	X	
Conservation of Biological Diversity		X
Climate Change	X	
Pollution Prevention and Resource Efficiency		X
Public Health		X
Physical and Cultural Heritage	X	
Lands and Soil Conservation		X

Table 30-2. Possible risks and mitigation measures

AF environmental and social principles	No further assessment required for compliance	further assessment and management required for compliance	Possible Mitigation Measures

Compliance with the Law		Possible conflicts over land ownership Failure to comply with laws relating to procurement procedures Construction works of coastal erosion and installation of water treatment system may be on private land or public land which may restrict to some kind of construction activities. Since the technology transfer to local people to establish water treatment system is not a community owned business model as private company or cooperative to manage the operation.	Only citing infrastructure on public land. Engagement with Department of Natural Resources and Environmental for land use and Department of Construction for approval Integrating legal compliance into all training - Consult the legal procedures to establish a community owned business model
Access and Equity		That certain groups are denied access to infrastructure, or that preferential access is given to others - There is possible dispute with existing drinking water suppliers in the area when treatment system installed since the price is 70% of the market price. So, there is a risk that the project's objective to provide fresh water for drinking the price will increase after the project finished and the marginalized and poor may not be able to access to that water source. - Since the water treatment plan is located in school or kindergarten there are two possible related to the safety of schoolchildren if people come to collect the water - In all community's households lacking access to clean water is more than 80 % but the project water plan can only provide clean water for limited number of people (e.g. only 1,500/10,200 people in Long Hoa commune). There is a potential risk of conflict when it comes to water shortage in long time and other water plans are not there yet.	Community management with rules ensuring that equal access is guaranteed - New business model to make sure the price stable for the poor and marginalized over time - Mechanism for safety of children should be put in place with respective authorities and communities - Consult with local stakeholders to develop criteria for selection of most suitable user groups/water users in order to reduce risk of conflicts among water users in the area.
Marginalized and Vulnerable Groups		There would be small number of vulnerable groups to access to livelihood resources. Particularly during the construction work to strengthen coastal erosion areas using elastocoast, the access to coastal areas when local people may cultivate agriculture. See Access and Equity category in the table	Community co-management with rules ensuring that equal access is guaranteed The People's Process operational tools ensures equal access and will be established from the project inception through due community participation including vulnerable groups

Human Rights		Human rights breaches can arise from denying access to water and other basic services, or from land conflicts, for example Construction work to upgrade sea dykes may be given to strong and skilled workers, women and unskilled workers may not be able to participate in the construction work. See Access and Equity category in the table	In line with UN-Habitat's Project Management Cycle and Work Flow policy, the project screened for its adherence to three cross-cutting issues which are: gender, human rights and climate change. The Human Rights Officer of UN-Habitat will ensure that the project actions are implemented to respect and adhere to the requirements of all relevant conventions on human rights.
Gender Equity and Women's Empowerment		Women could be denied access to infrastructure, or excluded from making critical decisions Women and children are in charge of collecting water in prolonged drought seasons in rural areas which put an extra burden into their shoulder. There will be low risk that women could be denied to access to water infrastructure. However, if it is the case the impact will be significant	The project design will ensure that gender considerations are included in all project interventions, with a specific focus on capacity building on the all levels as well as activities on the ground. The Gender Officer of UN-Habitat will monitor to ensure that the project follows best-practice guidelines. - Involving women and Local Women Union along process and especially after project finish - The activities under Component 3 will create employment enabling some marginalized and vulnerable groups including unemployed youth and women to access employment.
Core Labor Rights		Labour rights may not be respected when contracting communities Despite the fact that the chemical for elastocoast does not have any harmful components, Labour can be affected by chemicals[8].	All community contracts must be scrutinized to ensure they comply with both Vietnamese law and international standards. The relevant national labour laws guided by the ILO labour standards will be followed throughout project implementation. The safety manual and instruction will be provided.

[8] Biopolymer will be applied. Biopolymers are polymers produced by living organisms; in other words, they are polymeric biomolecules. Biopolymers contain monomeric units that are covalently bonded to form larger structures. It is organic compound. This chemical for bio-coast has been tested by BASF and ARCADIS. Please see BASF (2019) Safety data Sheet. For more detailed information about safety of bio-coast and its chemical, the test report for safety can be provided upon request.

Indigenous Peoples		The certain minority group can be denied access to infrastructures and excluded from the process of decision making - In both Tra Vinh and Bac Lieu, a major percentage is Kinh people, followed by the Khmer and Chinese ethnic (e.g in Tra Vinh, over 29% of the population is ethnic Khmer, 5-6% is ethnic Chinese and a small Cham population). There is a possible risk that the minorities are excluded from consultation process and might have limited access to infrastructure. That can cause social conflict if no measure puts in place to manage risk	Community management (UN Habitat' Peoples Process ensures) with rules ensuring that equal access is guaranteed and participating in the process of decision making - Identify how many percent of project beneficial is minorities - Involving the minorities in the consultation process especially gate keepers from minority communes and in the management of hard infrastructure constructed by projects or infrastructure existing in the region.
Involuntary Resettlement		Possible eviction arising from conflicts over land ownership	There will be no involuntary resettlement, because the land for target intervention areas are owned by public and governments
Protection of Natural Habitats	X	N/A	N/A
Conservation of Biological Diversity		While damage to natural habitats and threats to biological diversity are unlikely, there is a possibility that construction work undertaken or reforestation measures may adversely impact on local biodiversity Mangrove reforestation is a good measure not only conserving the biodiversity loss due to aquaculture activities but also protecting community from soil erosion. However, there are potential risks: - The plantation areas are not suitable for mangrove - The planted mangrove species are not indigenous ones which might decrease the survivor rate of new planted.	.- Community consultation and involvement in identifying the plantation areas and originated mangrove species Community co-management mechanism is in place to ensure the survivor of new planted. Site location shall be aligned with the local land use and development plan, in consultation with the local government and other relevant authorities in Vietnam such as Engagement with Department of Natural Resources and Environmental for land use and Department of Construction for approval (if required) for construction works
Climate Change	X	N/A	This project is inherently an adaptation project and as such no maladaptation is foreseen. The project will not provide or install infrastructure or appliances that result in increased emissions Solar power will be used as a part electric source to operate the water purification system which reducing cost and emission.

Pollution Prevention and Resource Efficiency		Construction of infrastructure generates waste There are potential chemical substances used in elastocoast materials can be released into the water which might affect the aquatic and mangroves	Incorporating waste management and disposal into design. Strictly follow the handling procedure when mixing chemicals with gravels. Chemical residues must be collected and stored in safe places before transferring to hazard/chemical waste treatment facilities. The environmental effects of chemicals used in elastocoast (bio-coast) are analyzed by private sectors[9], mentioning the compounds pose no threat to the aquaculture environment and the components are non-toxic and naturally degradable.
Public Health		The technology for water treatment system in this project is membrane processes. which is for removal of bacteria, microorganisms, particulates, and natural organic material, and inorganic contaminants from water. There is a low risk in term of human health effects due to contamination. However, the test for the effectiveness of RO in removing organic and non-organic materials have done in other places. Since there is potential risk of releasing chemical substance in Elastocoast.	No public health issues are foreseen, and improving public health is a secondary impact area of this project. - To mitigate the possible risk even though it is low, the test of effectiveness of water treatment system should be done at the project sites to show the evidence to local authorities who are in charge of local public health. - In order to mitigate the potential risks to public health, user guideline/procedure provided by supplier company should be followed and onsite environmental management plan is deployed during the construction phase.
Physical and Cultural Heritage	X	N/A	No physical or cultural heritage impacts are foreseen

[9] This chemical for bio-coast has been tested by BASF and ARCADIS. Please see BASF (2019) Safety data Sheet and ARCADIS (2010), Polyurethane Bonded Aggregate Revetments Design Manual. For more detailed information about safety of bio-coast and its chemical, the test report for safety can be provided upon request.

Lands and Soil Conservation		The physical demarcation of areas at risk for limiting urban development will seek to protect risk areas and critical natural habitats from urban development Since project will not be able to cover all the vulnerable areas of soil erosion there is potential risk that the change of water dynamic and flow may affect other areas which are not protected by Elastocoast. (e.g. 136 households in Con Phung village – Long Hoa commune needs resettlements due to tide destroyed the shore of 69 shrimp ponds, and 650m of dyke is in risk of land erosion). Elastocoast will cover limited number of dykes.	Soil conservation will be enhanced through afforestation components as protective measures for land erosion control. - Careful calculation and anticipated impacts of Elastocoast intervention to find best place to introduce the intervention - Monitoring erosion rate of the upgraded area and the surrounding locations.

PART III: IMPLEMENTATION ARRANGEMENTS

A. Describe the arrangements for project / programme implementation.

The following mechanisms for project execution, coordination and oversight have been agreed in close consultation with Ministry of Natural Resources and Environment (MONRE), as the national designated authority to the Adaptation Fund; Departments of Natural Resources and Environment in province as critical implementing partners; and provincial stakeholders in Bac Lieu and Tra Vinh provinces.

The project will be executed at three levels: 1) national, 2) Provincial (with support from the districts) and 3) commune. At the national level, the overall coordination of the project's execution will be led by the Ministry of Natural Resources and Environment, who will be the signatory of the project MoU and AoC with UN-Habitat. The MONRE will also ensure that the project is executed in a timely manner, chair the Project Steering Committee and coordinate inter-ministerial activities. The MONRE will work directly with Project Management Unit (PMU) for the execution of Component 1,2 and 4, and the Working Group and Project Office at local level will execute Component 3.

UN-Habitat is the multilateral implementing entity of the project and will then provide project management support, oversight, management of fund flow and executing partners' delivery, and secretariat of the Project Steering Committee. UN-Habitat will have Agreement of Cooperation (AoCs) with PMU under the MONRE.

Legal and Financial Arrangements

UN-Habitat and MONRE already have a Memorandum of Understanding (MOU). Thus a legal commitment to implement the project will be added in the existing MOU.
UN-Habitat will sign Agreement of Cooperation (AoCs) with MONRE, and provincial and commune governments,. This is legal basis to transfer funds to be invested under the project. The Agreements will be reviewed by the PSC and will specify in significant detail the activities to be implemented by the project, the timeframe and deliverables required. The Director General of

MONRE will authorize the payments against the contractual agreements, upon recommendation from the project manager. The UN-Habitat country office for Viet Nam will provide an oversight function, as well as guidance upon request from the executing entities.

Project Governance

At the national level, the project will be supported by a Project Management Unit (PMU). The PMC will be formed to oversee and keep abreast of project progress and facilitate the implementation of the project, including overseeing and cooperating with the project team, the technical advisory group, the Working Group and the project oversight group.

The Project Steering Committee (PSC) will be chaired by the Vice Minister of MONRE, and vice-chaired by Vice chairpersons in the provinces. A representative of UN-Habitat Viet Nam will also be a member of the PSC. Other members of the PSC are as follows: technical level representative of MONRE and KEITI, and two observers from JICA and GIZ. As Korea Environmental Industry & Technology Institute (KEITI) provided with the technical advice through feasibility study especially for component 3 and contributed also financial support for developing the project and, KEITI will also support the project implementation as the member of PSC of the project.

The PSC will: (1) approve annual workplan and review key project periodical reports; (2) will review and approve the contractual agreements, including workplans, with a particular emphasis on environmental and social safeguards, budgets and payment schedules; (3) review any deviations and consider amendments to workplans and contractual agreements.

The PSC will meet at least once per year throughout the project implementation and whenever needed to fulfill the above functions. The PSC will also convene and meetings to address serious Environmental and Social safeguard risks it there arises.

Project Oversight

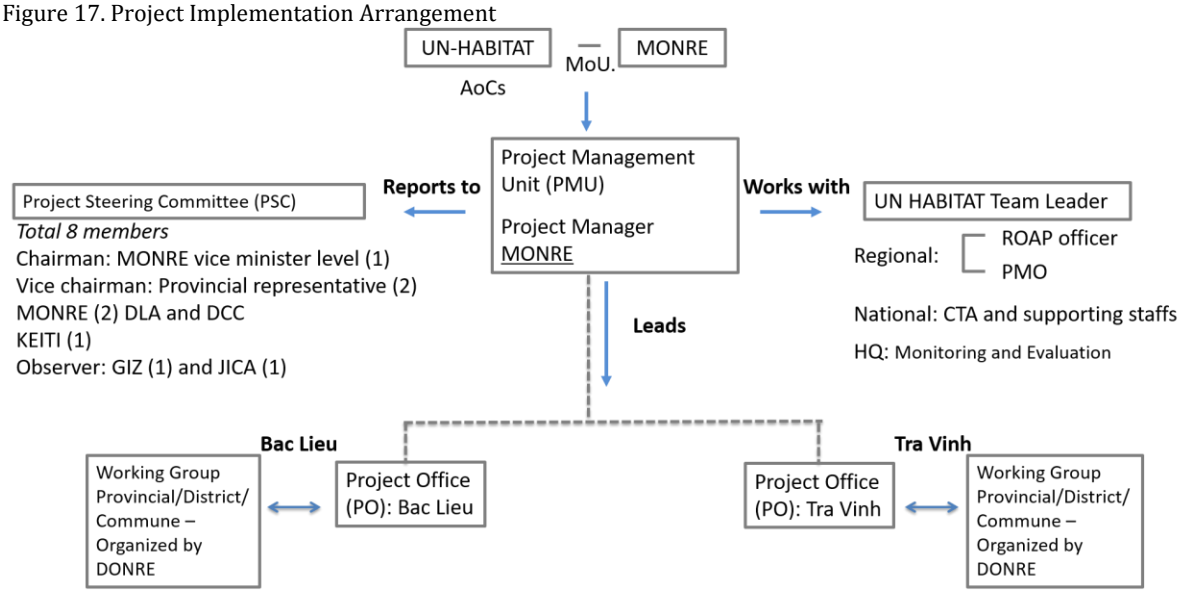
Project oversight is incorporated into the Project Management Unit (PMC), is led by the responsible officer in UN-Habitat' Regional Office for Asia and the Pacific (ROAP) under the guidance of the Regional Director and supported by Project Management Officers (financial management and administration) and Monitoring and Evaluation Unit and Programme Division including Climate Change Planning Unit and the External Relations Division, in particular the Advocacy, Outreach and Communication, in the UN-Habitat's Headquarters (HQ) will ensure project management compliance in accordance with UN-Habitat and AF's standards and requirement, particularly with regard to financial management, timely delivery and the Environment and Social Management Plan.

The national level Project Team will be comprised of the Project Manager (who will be recruited by MONRE) and two-project officer at provincial level (who will recruited by MONRE and DONRE). The Project Team will be responsible for managing project activities and ensuring compliance with all commitments contained in the project document, Environmental and Social Policy (Management Plan) with 15 principles of Adaptation Fund, as well as providing day-to-day support to the executing entity. The project team will develop a Monitoring and Evaluation Plan during the project inception phase, which will be distributed to targeted stakeholders, and

reported to the PSC. Moreover, the project team takes the lead in monitoring through periodic visits to the intervention sites in Bac Lieu and Tra Vinh Provinces.

There will be a project office in each province (2x PO in total), which will be located in DONRE at provincial level. This office will manage day-to-day execution of activities in the field sites. This office will be especially active in implementing the activities under Component 2 and 3 of the project. There will also be a Working Group in each province (2x WG in total). This unit will be chaired by Director General of DONRE and relevant departments and local communes will be participated in Working Group for providing advisory service, technical assistance, monitoring, and coordinating between departments. The Working Group will target 30% female representation including the Women and Youth association at local levels. In this Working Group, the role of local communes is important to implement the activities effectively and efficiency. Also women union will be represented as one of members for working groups.

Figure 17. Project Implementation Arrangement



Role of the PO: partially independent from WG and takes the direct role from PMU through work plan and budget; PO might revise a bit from the work plan and budget;

This implementation arrangement could lead the increase of community-based ownership, because communes and districts will be able to participate in working group. Also this working group can act as a monitor for sustainability.

Table 31. Implementation arrangement of Infrastructure

Infrastructure	Lead agency	Working Group	Implementation Agency
Water resource management system	Department of Natural Resources and Environment	Department of Agriculture and Rural Development Department of Health EVN SPC	Commune and District People's Committees Water Resource Management Agency under DARD
Rain water harvesting		Department of Construction EVN SPC	Commune and District People's Committees Head of public buildings
Costal erosion rehabilitation		Department of Agriculture and Rural Development	Commune and District People's Committees

B. Describe the measures for financial and project / programme risk management.

Table 32 Possible risks and mitigation measures

	Category and risk	Impact/ Probability 1: Low 5: High	Management/ Mitigation Measure
1.	**Environmental/Social** Current climate and seasonal variability and/or hazard events result in infrastructure construction delays or undermine confidence in adaptation measures by local communities	Impact: 4 Probability: 2	❑ Current climatic variability has been taken into account in the planning and design of the project activities, particularly in the design of the infrastructure built under componen3 through feasibility study: detailed technology design and information provided in annex 1 and 2; ❑ Both water treatment system and coastal erosion prevention system have been extensively consulted with communities, local officials, government staffs at the national and local level. MONRE and DONRE Viet Nam especially has been closely involved;
2.	**Institutional** Loss of government support (at all levels) for the project (activities and outputs) may result in lack of prioritization of AF project activities.	Impact: 4 Probability: 1	❑ The overall participatory project design has ensured ownership at the national, provincial, district, and commune level, and thus it will enhance government support for the project implementation; ❑ UN-Habitat is planning to make legal binding with MONRE(PMU) through MoU and AoC to ensure that PMU will deliver all project activities and outputs in a timely manner;
3.	**Institutional** Capacity constraints of local institutions may limit the effective implementation of interventions	Impact: 3 Probability: 1	❑ The project has a strong capacity building and training component, particularly under output 1.2.1. and 3.2.1., designed to promote effectiveness and sustainability at the national, provincial, district, and commune level for the implementation of interventions; ❑ Direct financial transfers to the local government (commune level) imply a high-level risk (as identified in consultation meeting with various international development partner, especially in Mekong Delta Working Group in Viet Nam). Therefore, commune level activities will be executed and monitored by working group and project steering committee;
4.	**Institutional/Social** Lack of commitment/buy-in from local communities may result in delay at intervention sites.	Impact: 2 Probability: 1	❑ Community stakeholders have been consulted extensively during the concept note and full-size project development phase to ensure their willingness and ownership of this project; ❑ Bottom-up approach integrating the community into the AP project's implementation phases – including community contracting in line with the People's Process – will be followed; ❑ Where possible, the community will have an active role through the 'People's Process' that ensures ownership of the project particularly through community participation in project implementation and monitoring;
5.	**Institutional/Social** Disagreement amongst stakeholders with regards to adaptation measures	Impact: 2 Probability: 1	❑ The adaptation measure (infrastructure) proposed mainly in component 3 of the project was selected through in-depth feasibility study from the technical team; ❑ Participatory approach will be applied to the

	(infrastructure) and site selection		construction of the infrastructure under component 3, through the People's Process, which employs the beneficiaries directly in the construction of the infrastructure;
6.	**Institutional** Communities may not adopt activities during or after the AF project, including infrastructure maintenance	Impact: 4 Probability: 1	❑ The project has consulted with the local government several times to find out their needs and applied it into the both soft and hard interventions; ❑ Capacity building and training will be undertaken to improve the awareness of the climate change impact and the importance of adaptation to the current phenomenon; ❑ Community members in each commune will be involved in the project implementation and decision making as part of working group;
7.	**Financial** Complexity of financial management and procurement. Certain administrative processes could delay the project execution or could lack integrity	Impact: 2 Probability: 1	❑ UN-Habitat's control framework, under the financial rules and regulations of the UN secretariat, ensure documentation of clearly defined roles and responsibilities for management internal auditors, the government body, other personnel and demonstrates prove of payment / disbursement; ❑ Procurement will be done by the executing entities as agreed through AoC. The project manager and the project team have a certifying role. All expenditures/costs/payments will be documented in USD;
8.	**Institutional** Delays in project implementation, and particularly in the development of infrastructure interventions	Impact: 3 Probability: 2	❑ The participation from the national and local government was high during the project preparation phase which will reduce the risk of delay; ❑ The project includes extensive planning and capacity building under component 1 and 2. While the investments under component 3 have been fully identified, improved planning capacity will help to make the implementation smoother and reduce the risk of delays;
9.	**Institutional** A lack of coordination between and within national government Ministries and Departments	Impact: 2 Probability: 2	❑ To minimize the risks of coordination between and within national government ministries and department, working group will be organized with different department from local government; ❑ MONRE and DONRE will lead the working group with support from Province People's Committee (PPC) and other departments under PPC;
10.	**Legal** Delays or barriers in gaining approval for infrastructure and housing due to delays in the development process or due to land tenure issues.	Impact: 4 Probability: 1	❑ No legal issues are foreseen. See Part II, section E for more detailed information; ❑ The project teams are tasked to ensure close collaboration with the provincial line department of natural resources and environment (DONRE) departments of construction (DOC), agriculture and rural development (DARD), and public health (DOH) for the further process of the project;

C. Measure for the management of environmental and social risks and compliance with the gender policy of the Adaptation Fund

Part II, Section E and Section K outline the screening and assessment process that has been done based on analysis of the law and consultations to identify the project's potential for risks. Part II, Section H describes the consultation process that has been undertaken to ensure inter alia inclusion of potentially marginalised groups, including women and indigenous people. These consultations and analysis are reflected throughout the project design.
Based on a screening against the principles environmental and social policy of the Adaptation Fund, the project has been categorised as a "B" category project in terms of the environmental and social risks it poses. An Environmental and Social Risk Management Plan (ESMP) has been developed (See Annex 4) to ensure that risks are avoided and that, where this is not the case, they are identified and mitigated in a timely manner. The ESMP identifies all the potential risks and the preventative and mitigation measures that the project proposes to take to reduce potentially adverse environmental and social risks to acceptable levels. The plan also identifies roles and responsibilities for monitoring risks. The ESMP also covers risk management arrangements, risk reduction and the project's grievance mechanism.
Also initial assessment for gender issues (See Annex 6) was conducted for compliance of AF gender policies and it was reflected to project activities and will be monitored by M&E arrangement and plans.

D. Monitoring and evaluation arrangements and a budgeted M&E plan.

This project will comply with formal guidelines, protocols and toolkits issued by the Adaptation Fund, UN-Habitat and the government of Viet Nam. The Monitoring and Evaluation (M&E) of progress in achieving project results will be based on targets and indicators established in the Project Results Framework (see below in part E). Besides that, the status of identified environmental and social risks and the Environmental Social Risks Management Plan (ESMP), including those measures required to avoid, minimise or mitigate environmental and social risks, will be monitored throughout the project (6-months field mission reports, annual project progress and performance reports, mid-term and terminal evaluation reports). The same applies to the financial and project management risks and mitigation measures.

UN-Habitat would involve local people for the training on the sustainable operation and management of each intervention in the project site. This will allow the beneficiary communities directly work with the monitoring and evaluation process of the project with support from National Project Manager to strengthen the sustainability of the project components.

Table 33 Outline Monitoring and Evaluation Plan

Type of M&E Activities	Responsible Parties	Time Frame for reporting	Reporting Format	Budget (USD)
Inception workshop	Project Manager Project Steering Committee UN-Habitat ROAP Government representatives	Within first quarter from the project period	Inception workshop report	5,000.00 (From PE) 5,000.00 (From PCM)
Measurements of means of verification (baseline assessment and M&E plans)	Project Manager; Project team	First quarter of year 1	M&E Plans / Result frameworks	10,000.00 (From PE)
Project progress and performance reviews	Project Manager Project Steering Committee	Yearly	The annual project progress and performance reports	10,000.00 (From PE)

Community consultations/ workshops/trainings audit	Project Manager; Project team	Following week after each event	Documentations	5,000.00 (From PE)
Direct Project Monitoring and Quality Assurance including progress and financial reporting, project revisions, technical assistance and risk management	UN-Habitat Regional Office. Project Manager; With inputs from Project team; Provincial and district-level government, community level monitoring	Quarterly, half Yearly and annually	The quarter, half year, annual project progress and performance reports	60,000.00 (40,000 from PE / 20,000 from PCM)
Field missions to project site	Project Steering Committee UN-Habitat ROAP Government representatives	Every six months	Field mission reports	30,000.00 (10,000 from PCM / 20,000 from PE)
The Mid-term Evaluation	Project Manager Project Steering Committee UN-Habitat ROAP External Consultant	After 18 months of the project period	Midterm evaluation report	10,000.00 (5,000 from PE / 5000 from PCM)
The Terminal Evaluation	Project Manager Project Steering Committee UN-Habitat ROAP External Consultant	Six months before the end of the project period	Terminal evaluation report	30,000.00 (15,000 from PE / 15,000 from PCM)
Total budget for Monitoring and Evaluation				**165,000.00**

Guided by the UN-Habitat and PSC, the project manager will coordinate in developing **M&E Plans** during the project's inception phase through the workshop, which will be distributed and presented to all stakeholders during the first community workshop. The emphasis of the M&E Plan will be on (participatory) outcome/result monitoring, project risks (financial & project management and environmental & social), learning and sustainability of the project. Periodic monitoring will be conducted through field mission to the intervention sites every six months.

UN-Habitat will ensure that the executing partners are fully briefed on the M&E requirements to ensure that baseline and progress data is collected through the established PSC. A connection between the component 4 (knowledge management) and M&E is established for sustainability of the project after the termination. The different contractual agreements to be prepared will reflect these aspects as well.

Annual **Project Progress and Performance Reviews** (PPRs) will be prepared to monitor progress since the project start and in particular for the previous reporting periods. The PPRs will include, but will not be limited to as follows:

- Progress on the project's objective and outcomes – each with indicators, baseline data and end-of-project targets (cumulative);
- Project outputs delivered per project outcome (annual);
- Lessons learned/good practice;
- Annual work plan and expenditure (i.e. annual financial reports);

- Annual management;
- Environmental and social risks (i.e. status of implementation of ESMP, including those measures required to avoid, minimise, or mitigate these risks); the reports shall also include, if necessary, a description of any corrective actions that are deemed necessary; and
- Project financial and management risks (same as per above);

Independent mid-term evaluation and a terminal evaluation will be conducted in accordance with the UN-Habitat Evaluation Policy and norms and standards for evaluation in the UN system. UN-Habitat will lead the evaluation process in consultation with implementing partners and national stakeholders as a participatory process.

The mid-term evaluation will take place after 18 months of project implementation as is UN-Habitat practice for projects with 3 years or more duration. The mid-term evaluation will assess implementation progress and achievements so far, verify the validity of the intervention logic and provide practical recommendations for follow-up during the remaining period of the project.

The terminal evaluation will take place as the last activity before the operational closure of the project in accordance with AF guidance and following UN-Habitat standard practices for project. The terminal evaluation will focus on the delivery of the project's results, as initially planned and then reflected in the M&E framework, including the implementation of environmental and social mitigation measures. The terminal evaluation will assess the impacts and sustainability of results, including their contribution to capacity development and the achievement of adaptation benefits.

The reports that will be prepared specifically in the context of the M&E include: (i) Inception workshop report (ii) M&E Plans (iii) The annual project progress and performance reports (iv) documentation from every event including community consultations, workshops and training (v) Field mission reports (vi) Mid-term evaluation report (vii) Terminal evaluation report.

E. Include a results framework for the project proposal, including milestones, targets and indicators.

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
Project Component 1: Institutional and community capacity building toward eco-human settlement development for supporting to enhance local climate response actions							
Outcome 1.1. Increase the awareness on resilience and ecosystem as a result of enhanced institutional capacity	Level of capacity at national level increased	There is limited understanding about the relationship between climate change adaptation/resilience and ecosystem at all levels	100 National and provincial level government officials, experts and practioners **(At least 40% of whom female)**	R: Limited resources for developing guidance, training materials for vulnerability and risk assessment, planning toolkits for planning, strategy and action plan with Vietnamese contexts A: There will be well-archived data and documents with Vietnamese context for vulnerability and risk assessment, and planning, strategy and action plan development	Institutional review report, review of framework of vulnerability and risk assessment, review of planning approach, strategy and action plan development	On completion	UN-Habitat and executing entity (MONRE)

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
Outcome 1.2 Strengthened knowledge of climate change adaptation	Level of knowledge capacity at all levels	There is constrained condition and capacity to strengthen knowledge for climate change adaptation	200 government officials, experts and practioners at all levels **(At least 40% of whom female)**	R: Time constraints means government staffs have to priorities other day to day tasks, and less inter-ministerial coordination, especially, MPI and MONRE A: There will be continued governments support for new adaptation project	Training reports, and Task reports for workshops	Baseline, mid-term, and end	UN-Habitat and executing entity with support from target provinces, districts and communes
Output 1.1.1. National induction workshop	Number of participants		100 government officials, experts and pratitioners at all levels **(At least 40% of whom female)**	R: Less inter-ministerial coordination A: There will be continued governments support for implementing new adaptation project	Task report for workshop	On completion	UN-Habitat and executing entity
Output 1.1.2 Guidance and training materials development for vulnerability and risk assessment at the local levels	Developed guidance and training materials for vulnerability and risk assessment at local	There is less and not compressive guidance and training materials for vulnerability and risk assessment a	1 guidance and 1 training materials	R: Less supporting documents for developing guidance and training materials, less participation of government officials to identify the gap and less	Review reports	On completion	UN-Habitat and executing entity

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
	levels	all levels		inter-ministerial coordination A: There will be continued governments support for developing guidance and training materials			
Output 1.1.3 Planning toolkits and training materials development for planning approach, strategy and action plan development on climate change resilience **(At least 40% of whom female)**	Developed planning toolkits and training materials for planning, strategy and action plan development	There is less and not holistic planning toolkits and training materials for planning, strategy and action plan development	3 planning toolkits for all levels (national, provincial and district+ commune) and 3 training materials for all levels	R: Less supporting documents for planning toolkits and training materials development, and less inter-ministerial coordination A: There will be continued governments support for planning toolkits and training material development	Review reports	On completion	UN-Habitat and executing entity
Output 1.1.4 Project team (facilitators) training enabling facilitation of eco-friendly settlement strategy and action	Number of trained facilitators	There is very limited capacity at all levels to provide trainings to locals	20 facilitators will be trained **(At least 40% of whom female)**	R: Limited participants for facilitator trainings and less understanding about the eco-friendly human	Training reports Baseline assessment reports	mid-term	UN-Habitat and executing entity

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
plan development (for supporting component 2.1.1 and 2.2.2)				settlement strategy and action plan development A: There will be continued broad support for TOT and governments support to develop the environment enabling facilitation of eco-human settlement a strategy and action plan development			
Output 1.2.1. Training workshops enabling national/ provincial/ district/ commune to set up eco-human settlement strategy and action plan development for climate change adaptation	Number of training workshop	Less vertically integrated training workshops at all levels and limited number of training workshops for practioners, and locals	200 government officials, experts and practioners at all levels will be trained **(At least 40% of whom female and women union will be represented)**	R: Time constraints means government staffs have to priorities other day to day tasks, and less inter-ministerial coordination A: There will be continued governments support and willingness for new adaptation project	Training reports Baseline assessment reports	mid-term	UN-Habitat and executing entity

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
Activities 1.1.1, 1.1.2 and 1.1.3 Define trainee group and baseline assessment 1.1.4 Define shortlist of facilitators and baseline assessment 1.2.1 Prepare the exact nature of the training materials based on the specific requirements of the trainees group				**Milestones** Activities begin by month 3, guidance and training materials complete by month 12 all training complete by month 24			
Project Component 2: Action plan and strategy development for eco-human settlement, and integrating into planning and policy with participatory approach							
Outcome 2.1 Develop provincial/ district / commune level's action plan and strategy for eco-human settlement based on local people's needs	Number of action plans and strategies developed Number of training workshop	Local people's needs is barely applied to the action plan and strategy	4 dialogue workshops 4 policy framework development workshops **(At least 40% of whom female and women union will be represented)**	R: Communities ignore they have been given / Time constraints for training and less priority A: Capacity building efforts proposed in the project will be sufficient to ensure for increased adaptive capacity	Training reports Workshop reports Developed action plans and strategies Baseline assessment reports	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments DONRE and Working Group including communes)
Outcome 2.2 Develop policy framework for integrating climate action and strategy into planning	Number of dialogues workshops Number of integrated action plans and strategies into planning	Climate action plan and strategy is not properly integrated into provincial level plan	8 training workshops 10 dialogue workshops **(At least 40% of whom female and women union will be represented)**	R: Local governments need to know how to integrate / Political issues between inter-department / less vertical and horizontal coordination A: There will be continued government	Dialogue workshop reports Training reports Reports of policy framework development	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
				support for policy framework development and will continue to be willing to take responsibility for it			
Output 2.1.1 Action plan and strategy development for eco-human settlement (provincial, district, and commune level)	Number of action plans and strategies developed Number of training workshop	Lack of action plan and strategy based on local people's needs	4 dialogue workshops 4 policy framework development workshops **(At least 40% of whom female and women union will be represented)**	R: Communities ignore they have been given / Time constraints for training and less priority A: Capacity building efforts proposed in the project will be sufficient to ensure for increased adaptive capacity	Training reports Developed action plans and strategies Baseline assessment reports	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments
Output 2.2.1. Policy framework development for integrating local people's action plan and strategies for eco-human settlement into planning (provincial level)	Number of integrated action plans and strategies into planning Number of dialogue workshop Number of	There is limited framework for integration of local people's action plan and strategies into provincial level planning	8 training workshops 8 dialogue workshops **(At least 40% of whom female and women union will be represented)**	R: Local governments need to know how to integrate / Political issues between inter-department / less vertical and horizontal coordination A: There will be continued government	Dialogue workshop reports Reports of policy framework development	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
	report for policy framework development			support for policy framework development and will continue to be willing to take responsibility for it			
Output 2.2.2. Integrating developed/ revised action plan and strategy into the relevant/existing planning and policy (provincial level)	Number of dialogues workshops Number of integrated action plans and strategies into planning	There is limited integration of local people's action plan and strategies into provincial level planning	2 dialogue workshops **(At least 40% of whom female and women union will be represented)**	R: Time constraint mean government activities will take priority / Channing priorities in the planning system result in adaptation getting lower priority A: Continued willingness exists to plan for and implement climate change adaptation / There will be continued government support and willing to take responsibility for it	Training reports of integrating (-ed) planning	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
Activities 2.1.1. Define trainee group/ baseline knowledge assessment / Training materials preparation / Training workshops / Monitoring 2.2.1. Dialogue workshop /baseline assessment/ dialogue workshop / Make recommendation / Perform institutional review 2.2.2. Dialogue workshop in provincial level with the various stakeholders / baseline assessment				**Milestones** Baseline assessment completed by month 12 All training materials prepared by month 18 Training conducted by month 36 Action plan and strategy development complete by 36 months Policy framework development complete by 36 months Revised action plan and strategy integrate into provincial level policy by 48 months			
Project Component 3: Sustainability built through small-scale protective infrastructure							
Outcome 3.1 Increased community adaptive capacity with climate resilient and development sectors, and increase ecosystem resilience in response to climate change	Number of people that benefit from climate change resilient infrastructure	There are no those kinds of facilities / Number of people who suffers from the impact of climate change, especially saltwater intrusion to groundwater and coastal erosion	Implementing technology of water treatment system and rainwater harvesting / of elastocoast	R: Delay in implementing infrastructure A: Agreement of Cooperation will stipulate timeframe for implementing infrastructure / Working Group at local will provide continuous support for implementing infrastructure	Field site inspection photos documentation and community monitoring reports	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments
Outcome 3.2 Enhanced local people's capacity for management and operation of provided infrastructures	Number of people who trained / Number of training workshop / Number of management and	There are less capacity for operation and management and currently no trainings for it	Develop operation and management guidance and manuals / Conduct the training for sustainable operation and	R: People do not utilize the training their own future infrastructures A: People will use their skills productively and for more sustainable operation and	Training reports and feedback task reports Guidance and manuals materials	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
	operation guidance materials		management	management			
Output 3.1.1 Prevention of the saltwater intrusion and protection of the groundwater through water treatment system and rainwater harvesting	Number of people who benefit from the prevention system	4912 households (approximately 25,000) have been vulnerable to saltwater intrusion to ground water	Install 7 water treatment system and 3 rain water harvesting system	R: Construction delay / People are unwilling to pay for water A: There will be community-led business model for lowering water price and cost for water treatment system / Awareness workshop and training will be sufficient to ensure for sustainability	Field site inspection photos documentation and community monitoring reports	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments
Output 3.1.2 Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system: elastocoast	Number of people who benefit from the prevention system	25199 people have been vulnerable to coastal erosion / 61490 affected agricultural ponds	8,240 m2 Mangrove plantation / 540m length for elastocoast / 860 m length for coastal protection / 61490 m2	R: Plantation failure / construction delay / illegal cutting A: Cooperating with local communities for plantation and make them understand the long-term benefits	Field site inspection photos documentation and community monitoring reports	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
			aquaculture pond protection	of mangroves			
Output 3.2.1 Capacity building to a working group for the sustainable operation and management of provided hard interventions **(At least 40% of whom female and women union will be represented)**	Number of people who trained / Number of training workshop / Number of management and operation guidance materials	There are less capacity for operation and management and currently no trainings for it	Training workshop with NAWAPI and O-We in Long Hoa, Hoa Minh, and Vinh Trach Dong with 50 technical people (in charge of operation and management of the facilities) for 3 years)	R: People do not utilize the training their own future infrastructures A: People will use their skills productively and for more sustainable operation and management	Training reports and feedback task reports Guidance and manuals materials	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments
Activities 3.1.1 and 3.1.2 Site reconfirmation and finalization / technical drawing and revised budget and further detail provided / procure the necessary construction works and materials / Undertake the construction work during the dry season 3.21 Baseline knowledge assessment / develop materials for guidance and manuals / training workshop / monitoring and feedback				Milestones Construction complete by month 48 Baseline assessment complete by month 24 Material development for guidance and manuals complete by 36 Operation and management training complete by 48			
Project Component 4: Awareness Raising and Knowledge Management							

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
Outcome 4.1 Project implementation is fully transparent. All stakeholders are informed of products and results and have access for replication;	Number of dialogue workshops / Number of report for policy platform development	There is limited chance of knowledge sharing for lesson learned and best practices due to absence of policy platform	10 dialogue workshops / Policy Platform development	R: Limited capacity to consume and share all the lessons and practices through the project due to absence of policy platform A: There will be numerous workshops and trainings to ensure the local people get involved and digest all the material	Workshop reports Policy Platform development report	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments
Output 4.1.1 Lessons learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms	Number of dialogue workshops	There is limited chance of knowledge sharing for lesson learned and best practices	10 dialogue workshops	R: Limited capacity to consume and share all the lessons and practices through the project A: There will be numerous workshops and trainings to ensure the local people get involved and digest all the materials	Workshop reports	Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments

Expected Result	Indicators	Baseline Data	Targets	Risks & assumptions	Data collection method	Frequency	Responsibility
Output 4.1.2 Regional advocacy and replication and replication for developing the effective policy framework	Number of report for policy platform development Number of practices and experience sharing workshop	There is no proper policy platform for regional advocacy and replication	Policy Platform development	R: Policy platform might not work properly as expected A: The project team will try to scale up and replicate the project through PPP and business model provided	Workshop reports Policy platform development report	On completion / Baseline, mid-term, and end	UN-Habitat, executing entity, and the local governments
Activities 4.1.1. dialogue workshop 4.1.2. Policy platform development				**Milestones** Dialogue workshop for knowledge sharing complete on the last year of the project Policy platform development complete on the last year of the project			

Output	Year 1				Year 2				Year 3				Year 4			
Output 1.1.1. National induction workshop	x															
Output 1.1.2 Guidance and training materials development for vulnerability and risk assessment at the local levels		x	x													
Output 1.1.3 Planning toolkits and training materials development for planing approach, strategy and action plan development on climate change resilience		x	x													
Output 1.1.4 Project team (facilitators) training enabling facilitation of eco-friendly settlement strategy and action plan development (for supporting component 2.1.1 and 2.2.2)			x	x	x	x										
Output 1.2.1. Training workshops enabling national/ provincial/ district/				x	x	x										

commune to set up eco-human settlement strategy and action plan development for climate change adaptation																
Output 2.1.1 Action plan and strategy development for eco-human settlement (provincial, district, and commune level)							x	x	x	x	x	x				
Output 2.2.1. Policy framework development for integrating local people's action plan and strategies for eco-human settlement into planning (provincial level)								x	x	x	x	x				
Output 2.2.2. Integrating developed/ revised action plan and strategy into the relevant/existing planning and policy (provincial level)													x	x	x	x
Output 3.1.1 Prevention of the saltwater intrusion and protection of the groundwater through water treatment system and rainwater harvesting					x	x	x	x	x	x	x	x	x	x	x	x
Output 3.1.2 Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system: elastocoast					x	x	x	x	x	x	x	x	x	x	x	x
Output 3.2.1 Capacity building to a working group for the sustainable operation and management of provided hard interventions					x	x	x	x	x	x	x	x	x	x	x	x
Output 4.1.1 Lessons learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms													x	x	x	x
Output 4.1.2 Regional advocacy and replication and replication for developing the effective policy framework													x	x	x	x

F. Demonstrate how the project / programme aligns with the Results Framework of the Adaptation Fund

Project Outcome(s)	Project Outcome Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amount (USD)
Outcome 1.1. Increase the awareness on resilience and ecosystem as a result of enhanced institutional capacity **(At least 40% of whom female)**	Level of capacity at national level increased	Outcome 3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	2.1. Capacity of staff to respond to, and mitigate impacts of, climate-related events from targeted institutions increased 3.1. Percentage of targeted population aware of predicted	**380,000**

		Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses	adverse impacts of climate change, and of appropriate responses 3.2. Percentage of targeted population applying appropriate adaptation responses	
Outcome 1.2 Strengthened knowledge of climate change adaptation **(At least 40% of whom female)**	Level of knowledge capacity at all levels	Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses Outcome 3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	2.1. Capacity of staff to respond to, and mitigate impacts of, climate-related events from targeted institutions increased 3.1. Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses	**420,000**
Outcome 2.1 Develop provincial/ district / commune level's action plan and strategy for eco-human settlement based on local people's needs **(At least 40% of whom female and women union will be represented)**	Number of action plans and strategies developed Number of training workshop"	Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses Outcome 3: Strengthened	3.2. Percentage of targeted population applying appropriate adaptation responses	**500,000**

		awareness and ownership of adaptation and climate risk reduction processes at local level		
Outcome 2.2 Develop policy framework for integrating climate action and strategy into planning **(At least 40% of whom female and women union will be represented)**	"Number of dialogue workshops Number of integrated action plans and strategies into planning"	Outcome 7: Improved policies and regulations that promote and enforce resilience measures	7. Climate change priorities are integrated into national development strategy	**100,000**
Outcome 3.1 Increased community adaptive capacity with climate resilient and development sectors, and increase ecosystem resilience in response to climate change	Number of people that benefit from climate change resilient infrastructure	Outcome 4: Increased adaptive capacity within relevant development sector services and infrastructure assets Outcome 5: Increased ecosystem resilience in response to climate change and variability-induced stress	4.2. Physical infrastructure improved to withstand climate change and variability-induced stress 5. Ecosystem services and natural resource assets maintained or improved under climate change and variability-induced stress	**3,358,244**
Outcome 3.2 Enhanced local people's capacity for management and operation of provided infrastructures **(At least 40% of whom female and women union will be represented)**	Number of people who trained / Number of training workshop / Number of management and operation guidance materials	Outcome 3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	3.2. Percentage of targeted population applying appropriate adaptation responses	**335,824**
Outcome 4.1 Project implementation is fully transparent. All stakeholders are informed of products and results and have access for replication; **(At least 40% of whom female and women union will be represented)**	"Number of dialogue Workshops Number of report for policy platform development"	Outcome 1: Reduced exposure to climate-related hazards and threats Outcome 7: Improved	1. Relevant threat and hazard information generated and disseminated to stakeholders on a timely basis 7. Climate change priorities are	**200,000**

		policies and regulations that promote and enforce resilience measures Outcome 8: Support the development and diffusion of innovative adaptation practices, tools and technologies	integrated into national development strategy 8. Innovative adaptation practices are rolled out scaled up, encouraged and/or accelerated at regional, national and/or subnational level.	
Project Output(s)	**Project Output Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount** (USD)
Output 1.1.1. National induction workshop **(At least 40% of whom female)**	Number of participants	Output 2.1: Strengthened capacity of national and subnational centers and networks to respond rapidly to extreme weather events	2.1.2 No. of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale)	**40,000**
Output 1.1.2 Guidance and training materials development for vulnerability and risk assessment at the local levels	Developed guidance and training materials for vulnerability and risk assessment at local levels	Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and disseminate knowledge and learning	3.2.2 No. of tools and guidelines developed (thematic, sectoral, institutional) and shared with relevant stakeholders	**100,000**
Output 1.1.3 Planning toolkits and training materials development for planing approach, strategy and action plan development on climate change resilience **(At least 40% of whom female)**	Developed planning toolkits and training materials for planning, strategy and action plan development	Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and	3.2.2 No. of tools and guidelines developed (thematic, sectoral, institutional) and shared with relevant stakeholders	**120,000**

		disseminate knowledge and learning		
Output 1.1.4 Project team (facilitators) training enabling facilitation of eco-friendly settlement strategy and action plan development (for supporting component 2.1.1 and 2.2.2)	Number of trained facilitators **(At least 40% of whom female)**	Output 2.1: Strengthened capacity of national and subnational centers and networks to respond rapidly to extreme weather events	2.1.1. No. of staff trained to respond to, and mitigate impacts of, climate-related events (by gender)	**120,000**
Output 1.2.1. Training workshops enabling national/ provincial/ district/ commune to set up eco-human settlement strategy and action plan development for climate change adaptation	Number of training workshop **(At least 40% of whom female)**	Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and disseminate knowledge and learning	3.2.1 No. of technical committees/associations formed to ensure transfer of knowledge	**420,000**
Output 2.1.1 Action plan and strategy development for eco-human settlement (provincial, district, and commune level) **(At least 40% of whom female and women union will be represented)**	"Number of action plans and strategies developed Number of training workshop"	Output 2.2: Increased readiness and capacity of national and sub-national entities to directly access and program adaptation finance Output 3.1: Targeted population groups participating in adaptation and risk reduction awareness activities	2.2.1 No. of people benefitting from the direct access and enhanced direct access modality 3.1.1 No. of news outlets in the local press and media that have covered the topic	**140,000**
Output 2.2.1. Policy framework development for integrating local	"Number of integrated action	Output 3.2: Strengthened capacity	3.2.1 No. of technical committees/associations formed	**360,000**

people's action plan and strategies for eco-human settlement into planning (provincial level) **(At least 40% of whom female and women union will be represented)**	plans and strategies into planning Number of dialogue workshop Number of report for policy framework development"	of national and subnational stakeholders and entities to capture and disseminate knowledge and learning Output 7: Improved integration of climate-resilience strategies into country development plans	to ensure transfer of knowledge 3.2.2 No. of tools and guidelines developed (thematic, sectoral, institutional) and shared with relevant stakeholders 7.2. No. of targeted development strategies with incorporated climate change priorities enforced	
Output 2.2.2. Integrating developed/ revised action plan and strategy into the relevant/existing planning and policy (provincial level) **(At least 40% of whom female and women union will be represented)**	"Number of dialogue Workshops Number of integrated action plans and strategies into planning"	Output 7: Improved integration of climate-resilience strategies into country development plans	7.1. No. of policies introduced or adjusted to address climate change risks (by sector) 7.2. No. of targeted development strategies with incorporated climate change priorities enforced	**100,000**
Output 3.1.1 Prevention of the saltwater intrusion and protection of the groundwater through water treatment system and rainwater harvesting	Number of people who benefit from the prevention system	Output 4: Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts, including variability	4.1.2. No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by sector and scale)	**2,299,044**
Output 3.1.2 Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system: elastocoast	Number of people who benefit from the prevention system	Output 4: Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts,	4.1.2. No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by sector and scale)	**1,070,200**

		including variability		
Output 3.2.1 Capacity building to a working group for the sustainable operation and management of provided hard interventions **(At least 40% of whom female and women union will be represented)**	Number of people who trained / Number of training workshop / Number of management and operation guidance materials	Output 3.1: Targeted population groups participating in adaptation and risk reduction awareness activities Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and disseminate knowledge and learning	3.1.1 No. of news outlets in the local press and media that have covered the topic 3.2.1 No. of technical committees/associations formed to ensure transfer of knowledge	**335,824**
Output 4.1.1 Lessons learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms **(At least 40% of whom female and women union will be represented)**	"Number of dialogue workshops"	Output 1.2: Targeted population groups covered by adequate risk reduction systems	1.2.1. Percentage of target population covered by adequate risk-reduction systems	**160,000**
Output 4.1.2 Regional advocacy and replication and replication for developing the effective policy framework **(At least 40% of whom female and women union will be represented)**	"Number of report for policy platform Development Number of practices and experience sharing workshop"	Output 7: Improved integration of climate-resilience strategies into country development plans	7.1. No. of policies introduced or adjusted to address climate change risks (by sector)	**40,000**

Table 34 Possible risks and mitigation measures

Adaptation Fund Core Indicators	Indicative Targets	Comments
1. Number of Beneficiaries	4,912 (households) / 25,199 beneficiaries (including both direct and indirect), Average 51% of whom are women	The beneficiaries include both direct and indirect from the result of the project.
2. Early warning system	0	The project does not target early warning system.
3. Assets produced, developed, improved, or strengthened	Water treatment system: 8 Coastal erosion prevention system: 33,910m	The project strengthens 8 water treatment system and covers 33,910m of coastal erosion prevention system by providing both elastocoast and mangrove plantation.
4. Increased income or avoided decrease in income	All beneficiaries	All beneficiaries will have access to affordable clean water for drinking. There is a huge fluctuation of the bottled water price in project site during the dry season. The project will stabilize and lower the price of water at the same time.
5. Natural Assets protected or rehabilitated	540m of elastocoast 33,910m of mangrove plantation	The project will also strengthen and protect the coastal line of the project site by providing both elastocoast and mangrove plantation.

G. Include a detailed budget with budget notes, a budget on the Implementing Entity management fee use, and an explanation and a breakdown of the execution costs.

Outcome	Output	Activity	Total Budget	Year 1	Year 2	Year 3	Year 4
1. Institutional and community capacity building toward eco-human settlement development for supporting to enhance local climate response actions							
1.1. Increase awareness on resilience and ecosystem as a result of enhanced institutional capacity in development of eco-human settlement strategy and action plan **(Female government staff must be represented, and 40% of female trainers will be participated)**	1.1.1. National induction workshop	National induction workshop for one day in HN, HCMC, or CT	40,000	40,000	-	-	-
		Organize TF team for developing the toolkit, guidance, and training materials					
	Output 1.1.1. total		***40,000***	40,000	-	-	-
	1.1.2. Guidance and training materials development for vulnerability and risk assessment at the local level	Technical meetings and dialogue workshops	100,000	70,000	30,000	-	-
		Field visit to the project site					
	Output 1.1.2. total		***100,000***	70,000	30,000	-	-
	1.1.3. Planning toolkits and training materials development for planning approach, strategy and action plan development	Technical meetings and dialogue workshops	120,000	80,000	40,000	-	-
		Field visit to the project site					
	Output 1.1.3. total		***120,000***	80,000	40,000	-	-
	1.1.4. Project team (facilitators) training enabling facilitation of	Training for trainers with the materials developed through	120,000	80,000	40,000	-	-

	eco- human settlement strategy and action plan development	1.1.2 and 1.1.3					
	Output 1.1.4. total		***120,000***	80,000	40,000	-	-
1.2. Strengthened knowledge of adaptation and climate risk reduction **(40% of female will be participated and women union will encourage them to attend)**	1.2.1. Training workshops enabling national/provincial/district/commune to set up eco-human settlement strategy and action plan development for climate change adaptation	National workshop (in HN or CT for 100 participants)	60,000	30,000	30,000		
		National + provincial workshop (in Bac Lieu and Tra Vinh/ 50 participants)	120,000	60,000	60,000		
		Provincial + district + commune level workshop (in Long Hoa, Hoa Minh, Vinh Trach Don, and Vinh Hau/ 50 participants)	240,000		120,000	120,000	
	Output 1.2.1. total		***420,000***	90,000	210,000	120,000	-
Component 1 total			**800,000**	360,000	320,000	120,000	-
2. Action plan and strategy development for eco-human settlement and integrating into planning and policy with participatory approach							
2.1. Provincial/district /commune level's action plan and strategy for eco-human settlement will be developed based on local people's needs **(women union leaders will be participated)**	2.1.1. Policy framework development for integrating local's action plans and strategies for eco-human settlement into planning (Provincial level)	Dialogue workshop	60,000		30,000	30,000	
		Policy framework development	80,000		40,000	40,000	
	Output 2.1.1. total		***140,000***		70,000	70,000	

2.2. Policy framework for integrating climate action and strategy into planning will be developed **(40% of female will be participated and women union will encourage them to attend)**	2.2.1. Action plan and strategy development for eco-human settlement (Provincial, district, and commune level)	Training workshop	180,000		40,000	100,000	40,000
		Dialogue workshop	180,000		40,000	100,000	40,000
	Output 2.2.1. total		***360,000***		80,000	200,000	80,000
	2.2.2. Integrating developed/revised action plan and strategy into the relevant/existing planning and policy (Provincial level)	Dialogue workshop in provincial level with the various stakeholders	100,000		50,000	50,000	
	Output 2.2.2. total		***100,000***		50,000	50,000	
Component 2 total			**600,000**	-	200,000	320,000	80,000
3. Sustainability built through small-scale protective infrastructure							
3.1. Increased community adaptive capacity with climate resilient and development sectors, and increase ecosystem resilience in response to climate change	3.1.1. Prevention of the saltwater intrusion and protection of the ground water through appropriate water treatment system	Install 5 of ground-water purification system	1,592,696		552,696	840,000	200,000
		Install 2 of rain harvesting system in public and private building	695,348		195,348	250,000	250,000
	Output 3.1.1.		***2,288,044***		748,044	1,090,000	450,000
	3.1.2. Prevention of coastal erosion with green (eco-friendly) erosion rehabilitation and control system	Install 860 km of eco-friendly infrastructure	1,070,200		100,000	700,000	270,200
	Output 3.1.2.		***1,070,200***		100,000	700,000	270,200
3.2. Enhanced locals' capacity for	3.2.1. Capacity building to a working group for	Training workshop with NAWAPI and O-	335,824		110,000	110,000	115,824

management and operation of provided infrastructures **(40% of female will be participated and women union will encourage them to attend)**	the sustainable operation and management of provided hard interventions	We in Long Hoa, Hoa Minh, and Vinh Trach Dong with # technical people (in charge of operation and management of the facilities) for 3 years					
	Output 3.2.1.		***335,824***		110,000	110,000	115,824
Component 3 total			**3,694,068**		958,044	1,910,000	826,024
4. Awareness raising and knowledge management							
4.1. Project implementation is fully transparent. All stakeholders are informed of products and results and have access for replication **(Female government staff must be represented)**	4.1.1. Lessons learned and best practices regarding resilient urban community development/housing are generated, captured and distributed to other communities, civil society, and policy-makers in government appropriate mechanisms	Dialogue workshop	160,000				160,000
	Output 4.1.1.		***160,000***				160,000
	4.1.2. Regional advocacy and replication and replication for developing the effective policy framework	Policy platform development	40,000				40,000
	Output4.1.2		***40,000***				40,000
Component 4 total			**200,000**				**200,000**
TOTAL COST (Project Activity)			**5,294,068**	**360,000**	**1,478,044**	**2,350,000**	**1,106,024**

Programme execution	**Project Manager**	340,000	72,500	97,500	97,500	72,500
	Office staff and technical support	100,000	20,000	30,000	30,000	20,000
	Office facilities	55,877	10,000	18,000	17,877	10,000
	Travel related to execution	40,000	10,000	10,000	10,000	10,000
	Mid-Tem Evaluation	5,000		5,000		
	End-Term Evaluation	15,000				15,000
Execution Cost Total		**555,877**	**112,500**	**165,500**	**160,377**	**127,500**
Total Project / Programme Cost		**5,849,945**	**472,500**	**1,643,544**	**2,510,377**	**1,233,524**
Project / Programme Cycle Management Fee	**PSC 7.1 Percent (on total operational budget including components below)**	417,245	33,520	117,040	178,885	87,800
	Evaluation Support Cost (HQ)	15,000	2,000	4,500	4,500	4,000
	Project Support Costs (ROAP) - Project Management Committee Meetings	65,000	3,000	3,000	3,000	3,000
	- IE staff salary / supervision of reports etc. - Project supervision missions		5,000	16,000	16,000	16,000
Total Project / Programme Cycle Management Fee		**497,245**	**43,520**	**140,540**	**202,385**	**110,800**
Amount of Financing Requested		**6,347,190**				

H. Include a disbursement schedule with time-bound milestones.

	Year 1	Year 2	Year 3	Year 4
	1st Disbursement -upon agreement signature	2nd disbursement - One year after project start	3rd disbursement - Two years after project start	4th disbursement -Third years after project start
Reporting		Upon First Annual Report Upon financial report indicating disbursement of at least 70% of funds	Upon Second Annual Report Upon financial report indicating disbursement of at least 70% of funds	Upon Third Annual Report Upon financial report indicating disbursement of at least 70% of funds
Milestone (By the end of year)	• Induction workshop complete (1.1.1) • List of trainees develop (1.1.1) • Training materials and planning toolkits develop (1.1.2/1.1.3) • Training of trainers (ToT) 50% complete (1.1.4)	• Training of trainers (ToT) complete (1.1.4) • Training workshop complete (1.2.1) • Policy framework 50% develop (2.1.1) • Action plan and strategy 50% develop (2.2.1) • Groundwater purification system installation 30% complete (3.1.1) • Rainwater harvesting system installation 30% complete (3.1.1) • Eco-friendly	• Policy framework development complete (2.1.1) • Action plan and strategy development complete (2.2.1) • Groundwater purification system installation 60% complete (3.1.1) • Rainwater harvesting system installation 60% complete (3.1.1) • Eco-friendly infrastructure for coastal erosion installation 60% complete (3.1.2)	• Revised action plan and strategy integrate into provincial level policy (2.2.2) • Groundwater purification system installation complete (3.1.1) • Rainwater harvesting system installation complete (3.1.1) • Eco-friendly infrastructure for coastal erosion installation complete (3.1.2) • Training workshop complete for management of

		infrastructure for coastal erosion installation 30% complete (3.1.2)	• Training workshop for management of facilities installed in each commune 50% complete (3.2.1)	facilities installed in each commune (3.2.1) • Dialogue workshop (4.1.1) • Policy platform development complete for knowledge management (4.1.2)
Schedule date	**April 2020 or Upon Signing**	**Apr-21**	**Apr-22**	**Apr-23**
Project Funds (USD)	360,000	1,478,044	2,350,000	1,106,024
Programme Execution	110,000	163,000	157,877	125,000
Programme Cycle Management	43,520	140,540	202,385	110,800
Total	513,520	1,781,584	2,710,262	1,341,824

PART IV: ENDORSEMENT BY GOVERNMENT AND CERTIFICATION BY THE IMPLEMENTING ENTITY

A. Record of endorsement on behalf of the government[10]

H.E Dr. Tran Hong Ha, Minister, Ministry of Natural Resources and Environment	Date*: 20 2020 January*

SOCIALIST REPUBLIC OF VIET NAM
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

Hanoi, 17 January 2020

To: The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Subject: Endorsement for "Enhancing the resilience, inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta"

Dear Sir or Madam
In my capacity as the National Designated Authority for the Adaptation Fund in the Socialist Republic of Viet Nam, I confirm that the aforementioned project proposal is in accordance with the government of Viet Nam's national priorities in implementing climate change adaptation actions to reduce the impacts, caused by adverse effects of climate change in the coastal region of the Mekong Delta, Socialist Republic of Vietnam.

Accordingly, I am pleased to endorse the aforementioned project and request the Adaptation Fund to give it due consideration. If approved, the project will be implemented by United Nations Human Settlement Programme (UN-Habitat) and executed by Ministry of Natural Resources and Environment of Viet Nam and the national partners.

Yours sincerely,

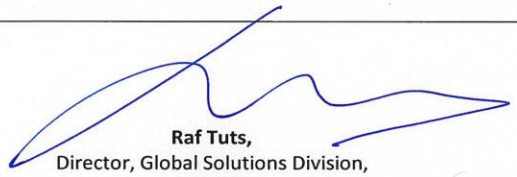
Dr. Tran Hong Ha
Minister of Natural Resources and Environment
Socialist Republic of Viet Nam

Address: 10 Ton That Thuyet street, South Tu Liem district, Ha Noi, Viet Nam
Tel: +84 4 37956868, Fax: +84 4 38359221, E-mail: icd-monre@monre.gov.vn, Website: http://www.monre.gov.vn

6. Each Party shall designate and communicate to the secretariat the authority that will endorse on behalf of the national government the projects and programmes proposed by the implementing entities.

B. Implementing Entity certification

Implementing Entity Certification

I certify that this proposal has been prepared in accordance with the guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans, including Vietnam's National Strategic Development Plan, its National Climate Change Strategy and Sector Action Plans, its Second National Communication to the UNFCCC. Subject to approval by the Adaptation Fund Board, I commit to implementing the project/programme in compliance with the Environmental and Social Policy of the Adaptation Fund and on the understanding that the implementing entity will be fully (legally and financially) responsible for the implementation of the project/programme.	
 **Raf Tuts,** Director, Global Solutions Division, UN-Habitat	
Date: 17th January 2020	Tel.: +254-20-762-3736; E-Mail: raf.tuts@un.org
Project Contact Person: Laxman Perera, Human Settlements Officer, Regional Office for Asia and the Pacific	
Tel +81-92-724-7121	
Email: laxman.perera@un.org	

Annex 1
Technical Feasibility Study on enhancing the resilience inclusive and sustainable eco-human settlement development through small-scale infrastructure interventions in the coastal regions of the Mekong Delta

JULY 2019

Ministry of Environment

KEITI
Korea Environmental Industry & Technology Institute

1. Analysis of current situation of the project site

1.1 Tra Vinh Province

Tra Vinh Province is located on the Mekong River Delta region, with Ben Tre, Vinh Long and Soc Trang provinces at its borders. It also has 65km of coastline and is surrounded by Tien and Hau rivers. Tra Vinh has a total area of 2,341 square kilometres and a population of over one million people, with 59% of them at working age and distributed through 7 districts: Cau Long, Cau Ke, Tieu Can, Chau Thanh, Tra Cu, Cau Ngang and Duyen Hai. Over 29% of the population is ethnic Khmer. There are also a number of ethnic Chinese (5-6% of the population), and a small Cham population. The number of "poor" households earning less than 90,000d/person/month is 33,545, of which 11,525 households earn less than 60,000/person/month. There is a group of people who are considered the "static poor", they are trapped in a type of poverty that will be difficult to reverse: many of them are landless and in debt to government lending programs and/or private moneylenders. As a result, they are not eligible for any new loans and they must repay with interest.

The economy is predominantly based on agriculture, fish and shrimp breeding. Over 80% of the population are dependent on the agricultural sector. Định An is one of eight key marine economic areas nationwide, with favorable conditions to develop a sea-based economy, electricity, petrochemicals, shipbuilding, navigation services and tourism.

However, Tra Vinh faces challenges related to the low prices of items obtained from agriculture and aquaculture, such as shrimp, dried coconut, vegetables, and more. Although people have invested in the development of shrimp farming, particularly in the districts of Duyen Hai and Tra Cu, almost 100% of shrimp harvests failed completely. Most people survive through small-scale subsistence farming, handicrafts, and services, but recently have to find other income generating activities. However, demand for labour is limited even in the high season: on average a person can expect to work only 10-15 days in a month, for between 10,000 and 30,000 VND per day. The official unemployment rate is around 10%. In addition, disbursement of capital for infrastructure development is slow and the progress of many licensed investment projects have been delayed.

Tra Vinh province is located in a tropical monsoon region. Dry season is between December to April and the rainy one is between May and November. The annual average temperature is 26C. In this area, ground-water is pumped inland to irrigate farms with upland crops due to the rapid exhaustion of freshwater ponds. Irrigation was previously done during midday without measuring the amount of water used, hence a large portion of the water evaporated before entering the soil.

The soil in the province, however, is becoming increasingly poor in terms of water-holding capacity and nutrients, and is severely affected by acidity and salinity. Recently, the salinity level of the canal system was reported to be as high as 25%, while the optimum salinity level for shrimp is between 12-15%. Due to this the production and growth of shrimp was reduced, with dead shrimp accounting for 25-30% of the total production. To monitor this situation, the farmers measure the pH and base levels every day and district extension workers also monitor salinity levels from 11 salinity monitoring stations.

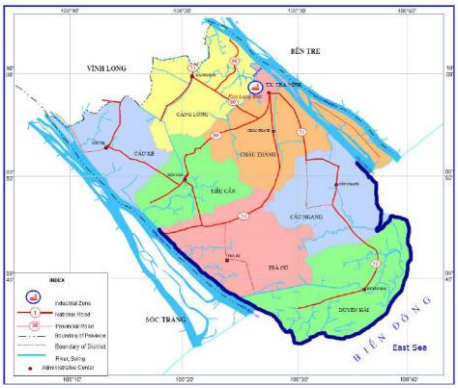


Figure 1. Map of Tra Vinh Province

1.1.1 Long Hoa commune

- Direct Beneficiary (number of household): 10,280people (2,547 households)

- Infrastructure level: low, detailed in the contents
- Livelihood Resources: Agriculture-aquaculture 81.26%
- Income level: 37.5 million VND/year per capita
- Poverty rate: 12.21%
- Households lacking access to clean water: 2,182 (85.67%)
- Drinking water: Bottled water(10,000VND/20L)
- Periods of saltwater intrusion: 6~7month
- Feature: 136 households in Con Phung village needs resettlements; 2 houses have been destroyed and 5 houses lost their roofs because of tornadoes; water level rise, combined with tide destroyed the shore of 69 shrimp ponds, and 650m of dyke is in risk of land erosion

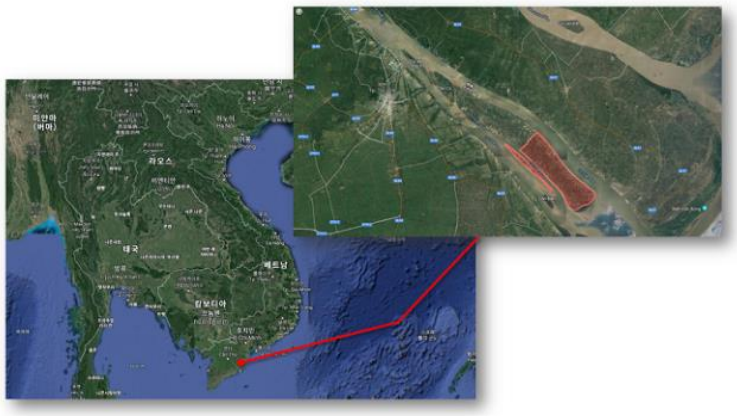


Figure 2. Location of Long Hoa commune

Water Management

Water used by country residents of Long Hoa can be divided into water supplied from the water purification plant, water taken from the ground water pump, and rain water stored in the rainy season. Most drinking water uses bottles, and some households store rainwater and use it as drinking water.

Figure 3. Intake pump for ground water / Rain water storage

TDS and turbidity were measured in three Long Hoa households. Turbidity was measured as 0.300 ~ 1.34NTU and TDS (TDS: Total Dissolved Solids) was measured as 700 ~ 800mg / L.

Table 1. Result of water quality test (Long Hoa commune)

			
TDS	797mg/L	861mg/L	791mg/L
Turbidity	0.67NTU	1.34NTU	0.36NTU

Water Treatment plant

The capacity of the Long Hoa water treatment plant is 10m^3/hour, supplying about 265 households (about 1,000 people) with treated water. Ground water is used as a source of water, and the treatment process consists of sedimentation + activated carbon + chlorine disinfection. The TDS of the raw water entering the water treatment plant was measured to be 732 mg/ L, and the TDS of the water treatment plant water was measured to be 737 mg / L.

The period of salinity intrusion in groundwater is 6 ~ 7 months a year. The tariffs of provided water by water treatment plan are 5,900 VND/m^3 for domestic use and 7,000 VND/m^3 for commercial use

Figure 4. Water Treatment Plant in Long Hoa

Long Hoa Secondary school

Long Hoa Secondary school has 400 students and uses 60m^3 / month of domestic water. Drinking water is usually purchased separately by students. The domestic water is supplied from the Long Hoa water treatment plant, and the water is stored in a small water tank at the school and used when necessary.

Figure 5. Secondary school (Long Hoa)


Figure 6. Rain water collection system in Secondary school (Long Hoa)

The TDS of water supplied from Long Hoa Secondary School was 783mg / L and the turbidity was 0.38NTU.

There are about 316 households (1,264 people) within a 1km radius of the school, and about 800 households (3,200 people) live within a 2km radius.

Figure 7. Location of Secondary school

1.1.2 Hoa Minh commune

- Direct Beneficiary (number of household): 14,919 people (3,309households)
- Infrastructure level: low, detailed in the contents
- Livelihood Resources: Agriculture - aquaculture (82%)
- Income level: 41.8 million VND/year per capita
- Households lacking access to clean water: 2,182 (85.67%)
- Drinking water: Bottled water (10,000VND/20L)
- Periods of saltwater intrusion: 6~7month
- In the Hoa Minh area, public health centers, schools, and markets with a large floting population are concentrated within a radius of 500m from the water purification plant. The water source of the water purification plant uses ground water and is used by sharing the water source with the Long Hoa water purification plant. The TDS of this area was measured as 1,095 ~ 1,239 mg / L and is relatively high.

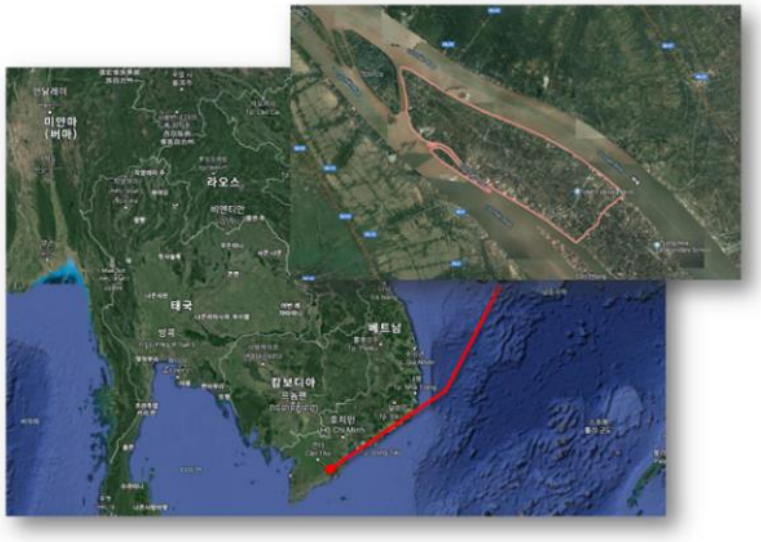


Figure 8. Location of Hoa Minh commune

Water Treatment plant

The capacity of Hoa Minh Water treatment plant is 30m^3/hr, supplying 1,768 households and the process consists of 1st filtration + sediment + 2nd filtration + disinfection by chlorine. The ground water source for raw water is away 6 km from water treatment plant.

It uses groundwater as raw water for treatment. The total length of water supply coverage area is about 75 Km.

The period of salt water intrusion is about 6~7 month, from December to June or July. Tariffs of supplied water are 5,900 VND/m^3 for domestic use and 7,000 VND/m^3 for commercial use and Operation and Management cost for is around 80,000,000 VND/month is approximately equivalent with 3,500 USD/ month. According to the survey, around 50 % of Operation and Management cost is covered by tariff. Water quality test for treated water is usually conducted by every 3 months

Figure 9. Water Treatment Plant in Hao Minh commune

Long Hoa commune is operating the monitoring system for real-time salt water intrusion named as “MEKONG” as shown below; this system was set up by MY LAN group which is Vietnamese company.

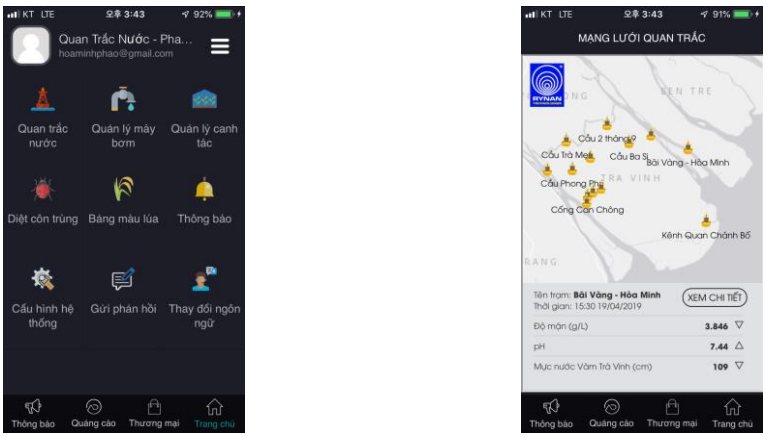


Figure 10. Monitoring system for Salt water in Hoa Minh

Figure 11. Location of main buildings in Hoa Minh commune

Table 2. Result of water quality test (Hoa Minh commune)

	Heath care center	Truong Mau Giao	Market
TDS	1,095mg/L	1,240mg/L	1,239mg/L
Turbidity	NTU	1.33NTU	1.30NTU
Picture			

1.2 Bac Lieu Province

Bac Lieu province, located in the Mekong Delta, has an equatorial monsoon climate regime, with two distinct seasons: the rainy season, with average temperature of 25.2 - 29.1°C, and the dry season, with an average temperature of 24.3 and 29.7°C. The temperature amplitude between the months is not significant (1-2°C) but the temperature amplitude between day and night is quite large (dry season: 8-10°C, rainy season: 6-7°C), which is favorable for plant growth and development.

The rainy season starts from May to November, and the dry season lasts from December to April. The annual average rainfall is 1,801.5 mm, and average number of rainy days is about 110-120 days/year. The average air humidity is 82.6%, and around 76–80% in the dry months.

Bac Lieu has numerous rivers, canals and ditches such as Bac Lieu river, Cau Xang Canal, that meet the water demand for agriculture, aquaculture and drainage in urban areas. Recently, the completed maintenance of dikes and sluice gates helps to prevent saltwater intrusion along Highway 1A and Bac

Lieu river, in this area the saltwater – freshwater regulation is gradually being improved to serve agricultural and aquaculture practices.

Regarding the terrain characteristics, Bac Lieu is located in the region of the East Sea affected by a semi-irregular tide. Due to the completion of the sluice gates that were built to prevent saltwater intrusion and because the tidal acreage is shrunk, the tidal level is now higher than before, this has the effect of leaching saltwater into shrimp and salt producing areas. To address this issue, it is necessary to dredge the irrigation and dike systems in order to regulate water resources to effectively serve farming and aquaculture. While in the dry season the salinity in the rivers and shrimp ponds increases, during the rainy season the salinity decreases fast for both.

Natural resources in Bac Lieu are distributed as follows:

- Land is divided in 3 main groups: sandy soil (10.08% of the natural area of the city), saline soil (62.25%) and acid sulfate soil land (18.43%).
- Water: salt water (comes from the sea and is mixed with rainwater. It is not suitable for freshwater crops and livestock but is the valuable resource for aquaculture development), groundwater (4 hydrological formations), and surface water (in rainy season freshwater is dominant, but by the end of rainy season water is often acidic and in dry season water is affected by saltwater intrusion).

Bac Lieu is composed by 10 administrative units of wards (wards 1,2,3,5,7,8, and Nha Mat ward) and 3 communes (Hiep Thanh, Vinh Trach and Vinh Trach Dong). By the end of 2015 the population was 155,194 people, with a major percentage of Kinh people, followed by the Khmer and Chinese ethnic minorities. There is an equilibrium between female and male ratio. According to the People's Committee of Bac Lieu Province, both genders have right to give comments, make decisions and discuss problems.

Regarding health issues, the main diseases are related to environmental pollution (41.7%), crowded housing (8.5%), poor diet (11.2%), flies and pests (30.0%) and 27.1% as other causes (such as living habits, low awareness of the community on prevention, care and treatment).

Career opportunities are related directly to the educational background of the people. Most of the people (93.2%) have attended school and university. However, there is still a 6.7 % illiteracy rate in the region, mainly concentrated in poor households in Nha Mat ward and ward 2. Indeed, there is a clear gap between poor households and rich households in the area. The income per capita of rich households (5,182,903VND/person/month) is 8.7 times the income per capita of poor households (594,593VND/person/month). The latters income generally coming from low-paid, instable and seasonal jobs, while rich households mainly generate revenue from salaries and business activities. Most employment in this region comprises of labour force jobs (44.0%), but there are also people working in the service sector (15.4%), and in state-owned enterprises (13.0%). The percentage of unemployment is at approximately 7.5%.

According to the Peoples Committee of Bac Lieu province, the city reached an economic growth rate of 16.63% in 2015, which is comparatively high growth rate in comparison with other cities in Vietnam. The economic structure of Bac Lieu city in the same year comprised of 45.57% services, 42.04% industries and construction, and 12.39% agriculture and fisheries. Industrial production and small handicraft of Bac Lieu city are being developed based on market demand.

Bac Lieu's agricultural production includes rice, fruits, vegetables, cattle and poultry. Aquaculture and fishery increased gradually from 2012-2015. However, it faces problems such as asynchronous irrigation systems, lack of investment funds for production, prolonged sunny and hot conditions that have negative impacts on shrimp farming due to increasing salinity levels.

The service sector continues to grow. One on hand, Bac Lieu city has opened Bac Lieu shopping center and Hiep Thanh market in Hiep Thanh commune which have relatively stable prices for goods and good compliance of the sellers with regulation on price listing. Tourism has also increased and visitors are increasing the demand for accommodation services.

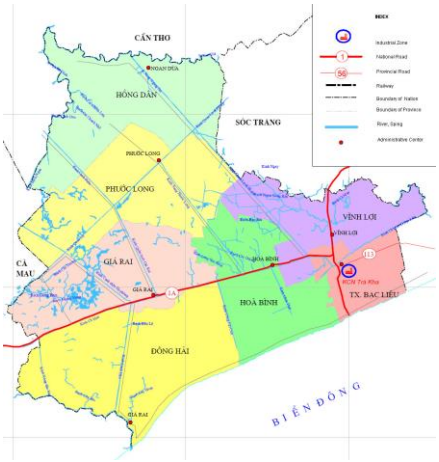


Figure 12. Map of Bac Lieu Province

1.2.1 Vinh Trach Dong commune

- Direct Beneficiary (number of household): 4-500people (80-100 households)
- Minority group: Majority of population is Khmer (Ethnic minority)
- Infrastructure level: low, detailed in the contents
- Livelihood Resources: Agriculture-aquaculture 81.26%
- Income level: low
- Poverty rate: 12.21%
- Education level: elementary school or secondary school

Figure 13. Location of Vihn Trach Dong commune

Water Management

In Huu Nghi hamlet, a public water tank and water drainage system has been facilitated, however, the quality of water is not secured with TDS 1,100. According to the government official in Bac Lieu, once they installed the public water tank, there was no proper management of the facility, due to the lack of the management, the water tank no longer functions adequately.

Figure 14. Resettlement area of Huu Nghi hamlet

Figure 15. Water Treatment Plant at resettlement area in Huu Nghi hamlet, Bac Lieu

Infrastructure in resettlement Area

The storm water drainage system in Huu Nghi hamlet is covered by waste or exposed to the air. The water from each household flows through this water drainage without any treatment. Especially, storm water drainage system in these conditions will be very vulnerable to flooding. Accordingly, rehabilitation of infrastructure system such as storm water drainage system, water treatment plant and supply pipe line is very urgent.

Figure 16. Infrastructure in Resettlement area of Huu Nghi hamlet

2. Design & Technology

2.1 Saltwater Intrusion

Saltwater intrusion is a major concern in coastal regions all over the world such as Mekong Delta in Vietnam. In these regions, the aquifers are in hydraulic contact with the sea water. Under normal conditions the freshwater flows into the sea. However, the rise of sea level caused by climate change or depletion of groundwater caused by over-pumping may result in inversion of groundwater flow from the sea towards the inland causing salinity intrusion. Mixture of a small quantity (2 %) of salt water with the groundwater can make freshwater not potable.

Sea level rise has many effects on coastal regions on the long term such as increase in coastal erosion and sea water intrusion. Climatic change has already caused changes in the sea level during the last decade.

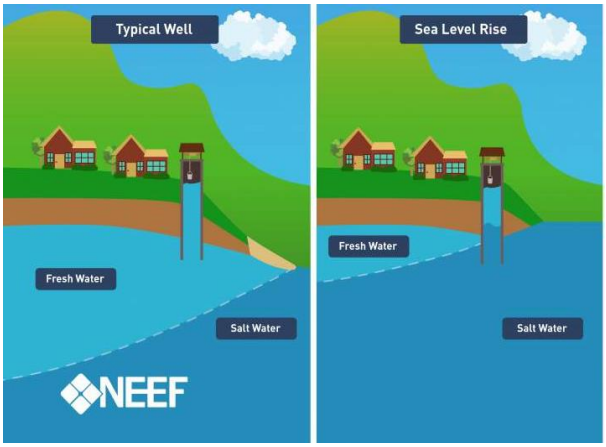


Figure 17. Saltwater Intrusion

Note) NEEF: The National Environmental Education and Training Foundation

A number of different measures have been studied and used to control seawater intrusion and to protect the groundwater resources.

- Reduction of the abstraction rates
- Relocation of abstraction wells
- Subsurface barriers
- Natural recharge
- Artificial recharge
- Abstraction of saline water
- Combination of injection and abstraction systems.

However, these aforementioned methods for controlling saltwater intrusion have many limitations. Most of these methods are costly and some of them might not be applicable in certain cases. Furthermore, they are generally temporary solutions and with the population growth and increasing demand the intrusion will be increased.

Classification of Saltwater

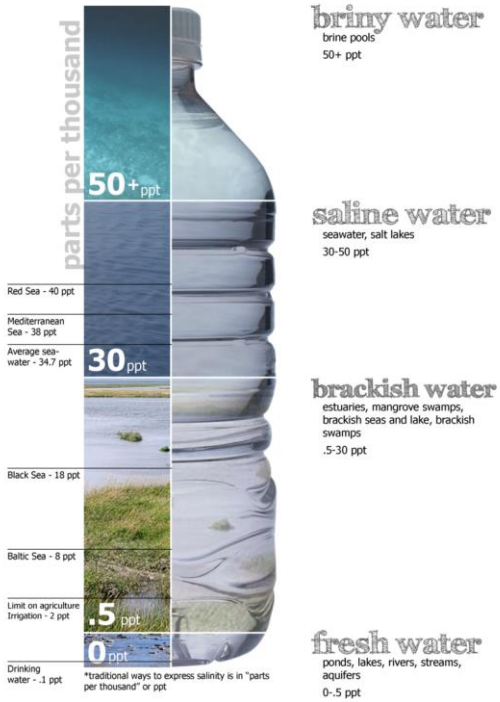


Figure 18. Level of salt water

source) https://commons.wikimedia.org/wiki/File:Water_salinity_diagram.png#metadata

Salt water is water that contains a high concentration of dissolved salts which means usually NaCl which is called as a sodium chloride.

As per the concentration of salt, it is classified in three categories. (1) slight salt water with the concentration of salt from 1,000 to 3,000 ppm, (2) moderate salt water with the concentration of salt from 3,000 to 10,000 ppm, (3) high salt water with the concentration of salt from 10,000 to 35,000 ppm. Normally, sea water has a salinity about 35,000 ppm.

In terms TDS, US EPA has established National Primary Drinking Water Regulations(NPDWR) that set mandatary water quality standards for drinking water contaminants. These are enforceable standards called "maximum contaminant levels (MCLs) which are established to

protect Public Health.

2.2 Water Treatment Technology

2.2.1 Reverse Osmosis (RO)

A membrane is a thin layer of semi-permeable material that separates substances when a driving force is applied across the membrane. Membrane processes are increasingly used for removal of bacteria, microorganisms, particulates, and natural organic material, which can impart color, tastes, and odors to water and react with disinfectants to form disinfection byproducts.

The membrane processes usually divided by following 4 types (1) Micro-filtration (MF), (2) Ultra-Filtration (UF), (3)Nano-Filtration (NF), and (4) Reverse Osmosis (RO).

Reverse Osmosis which is going to be applied for this project can effectively remove all inorganic contaminants from water. Accordingly, Reverse Osmosis membranes are used to produce potable water from ocean or brackish water.

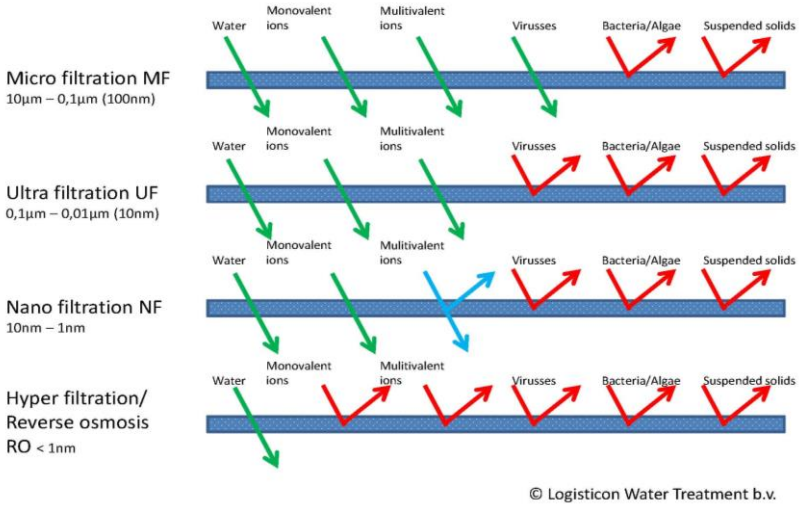


Figure 19. Comparison of Membrane Techniques

In reverse osmosis, the constituents targeted for removal are truly dissolved solutes (ions and molecules such as sodium, chloride, calcium, magnesium, dissolved NOM, and synthetic organic chemicals) as shown below. Reverse osmosis membranes are used to produce potable water from ocean or brackish water, to soften hard waters (remove calcium and magnesium ions), reduce the concentration of NOM to control disinfection by-product (DBP) formation, and to remove specific dissolved contaminants (e.g., pesticides, pharmaceuticals, arsenic, nitrate, radionuclides)

Mechanism of RO Membrane

Reverse osmosis differs from filtration in that the mechanism of fluid flow is by osmosis across a membrane. The predominant removal mechanism in membrane filtration is straining, or size exclusion, where the pores are 0.01 micrometers or larger, so the process can theoretically achieve perfect efficiency regardless of parameters such as the solution's pressure and concentration. Reverse osmosis instead involves solvent diffusion across a membrane that is either nonporous or uses nanofiltration with pores 0.001 micrometers in size. The predominant removal mechanism is from differences in solubility or diffusivity, and the process is dependent on pressure, solute concentration, and other conditions. Reverse osmosis is most commonly known for its use in drinking water purification from seawater, removing the salt and other effluent materials from the water molecules.

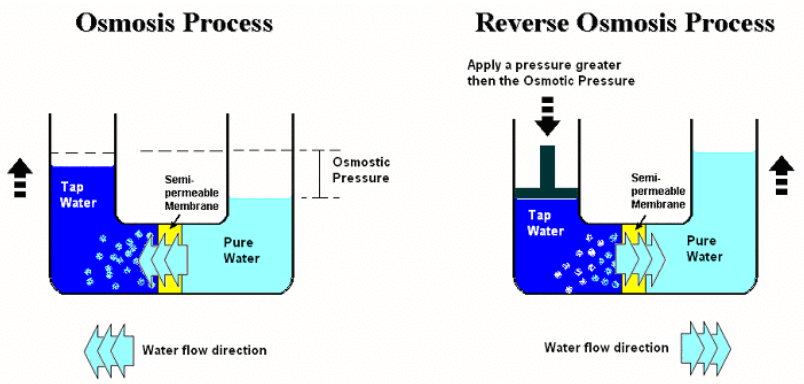


Figure 20. Mechanism of RO Membrane

BWRO and SWRO

RO is a pressure-driven process in which a pressure is applied to a membrane to separate salt and other minerals from water. The quantity of fresh water that penetrates the membrane depends on the difference between the applied pressure and the osmotic pressure of the feed salt water. The osmotic pressure is directly related to the salt concentration in the saline water. The discharge brine from an RO unit ranges from 20% to 70% of the flow feed water, depending on salinity of the feed water, applied pressure, and type of membrane. The usual quality of the fresh water produced from a single-stage seawater RO unit is less than 500 ppm. An RO plant is cheap to build, needs less capital investment, is simple to operate, and can be built with a system capacity that ranges from a few liters to hundreds of thousands of m^3 per day. It also has a high production /space ratio, low energy consumption, and there is no need to shut down the whole plant when there is a problem or for routine maintenance due to the modular design of the plant. The main disadvantages of an RO system are the following:

High maintenance cost resulting from replacing the membrane (usually every two years or more); bacterial growth on the membrane, which can bring odors and bad tests of the product water; and expectation of some mechanical failure in system equipment due to the system's high pressure. A number of devices have been developed to recover the energy from the membrane reject stream and to return it to the feed of the RO process. Implementation of efficient energy-recovery devices into the RO desalination technologies boosted the growth of RO plants worldwide. The major types of ERDs are the turbocharger, pressure exchanger, Pelton wheel, and Francis turbine. Specific energy consumption is largely dominated by two factors—the amount of trans-membrane pressure difference required to achieve the necessary permeate flow rate at various mass-transfer conditions, as well as the design and efficiency of the feed water pump in combination with the respective energy-recovery system installed to recover the available hydraulic energy in the discharge brine. The energy consumption of a salt water RO (SWRO) unit ranges from 4~6 kWh per m^3 of desalinated water. For a brackish water RO (BWRO) unit, the consumption ranges from 1.5~2.5 kWh per m^3 of desalinated water. An RO system performs similarly if it is used for brackish or sea water; however, there are some differences between the two cases. These include, for a BWRO system, a lower pressure needed on the membrane, lower energy requirement, and high recovery rate. In addition, there is a considerable difference in the pre-treatment of both types of water.

Considering quality of water source which range from 500 ~ 1,500 mg/L as TDS, , O&M cost, and energy cost, BWRO is applied for this project.

Table 3. Comparison of BWRO and SWRO

Process	Electrical Consumption (kWh/ m^3)	Total Consumption (kWh/ m^3)	Product Water Quality (TDS mg/L)

SWRO	4~6	4~6	200~500
BWRO	1.5~2.5	1.5~2.5	10~100

The concept of applied RO system to deal with aforementioned underground water is as below;

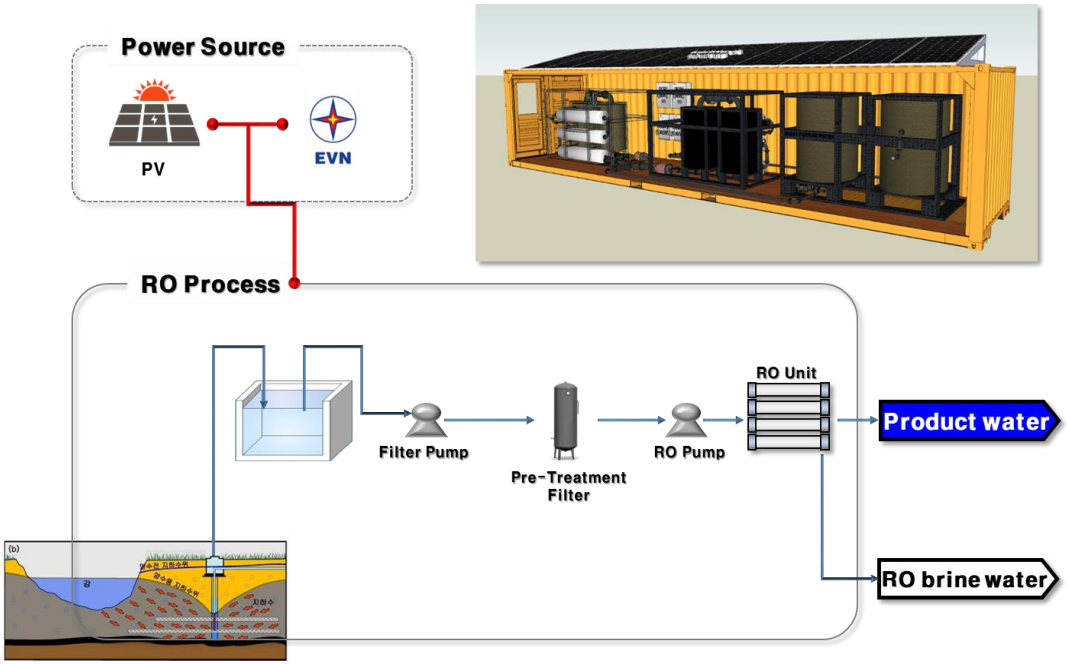


Figure 21. Concept of RO Membrane system

General Considerations

The following are typical examples of the important factors to be considered when designing a groundwater reverse osmosis process.

Applied Pressure: As the salt concentration of groundwater is normally between 300~3,000 mg/L, osmotic pressure is approximately 1. 5 Mpa

Concentration Factor: When fresh water is separated from seawater, concentrated seawater which is called brine is retained on the surface of the RO membrane. The osmotic pressure of the concentrated seawater increases proportional to the salt concentration, thus the effective pressure is reduced. As the upper limit of applied pressure is fixed, this means that there is also an upper limit to the concentration of the brine which normally is between 1.6 and 2.5 times that of normal seawater.

Recovery Ratio: One of the performance indexes for RO equipment is the recovery ratio (production volume/feed water volume). In the case of a seawater RO unit, as there is an upper concentration limit, the recovery ratio of normal seawater is limited to $4 \times 10^{-1} \sim 6 \times 10^{-1}$.

Feed Temperature: The water flux of RO membranes increases as water viscosity is lowered, and water viscosity decreases as water temperature is raised. Thus the higher the temperature, the better the flux. However, the RO membrane is made of polymers and the membrane becomes more compact due to applied pressure as temperature rises. In order to reduce the effects of temperature to a minimum, the acceptable upper limit is 40℃. RO systems are usually designed to operate at 25 C and water flux falls by 20~25 per cent when water temperature is lowered by 10℃.

Removal of Suspended Matter: One of the most important factors in maintaining the stable performance of RO membranes is to remove suspended matter in feed water as much as possible. Normally, the treated seawater by coagulation-filtration is supplied to RO equipment and the upper limit of suspended matter content is considered to be 4 on the Silt Density Index. (SDI).

pH Range : The pH of normal seawater is 8~8.5, but in order to reduce chemical deterioration of the RO membrane and scaling on the surface, pH is regulated at 5~7.

Disinfectant Dosing Rate: Chlorine gas, NaOCl, or $Ca(OCl)_2$ is added to feedwater in order to attain a residual chlorine content of 0.5~1.0 mg/L for sterilization purposes. Alternatively, 0.5 mg/L of $CuSO_4$ may be added in place of chlorine. If the amount of disinfectant is too little, sterilization effect is minimal; however, on the other hand, if too much is added, then membrane materials may deteriorate through oxidation. So the regulation of disinfectant quantities is extremely important. As some kinds of membrane material are not resistant to chlorine, a reducing agent, such as sodium bisulphite ($NaHSO_3$), should be added in the pre-treatment stage in order to remove the residual chlorine.

Feed Flow Rate and Brine Flow Rate: If the linear velocity of seawater supplied to the RO membrane module is high, then the concentration polarization on the surface of the membrane can be held at a low level and the salt rejection rate of the membrane can be maintained at a high level. However, pressure loss in the membrane module increases due to high velocity and energy efficiency is reduced. Therefore, feed water supply volumes are determined according to the size of each membrane module. Normally, each module consists of 3~6 membrane elements and the linear velocity of the downstream elements is respectively reduced. Normally the minimum brine flow rate of the latest membrane module is fixed. If this lower limit cannot be maintained, the concentration polarization on the surface of the membrane will increase and lead to damage such as scaling on the surface of the membrane.

Feed Flow Rate and Brine Flow Rate: If the linear velocity of seawater supplied to the RO membrane module is high, then the concentration polarization on the surface of the membrane can be held at a low level and the salt rejection rate of the membrane can be maintained at a high level.

Configuration of RO System

The process of typical reverse osmosis plant, as shown in Figure 34, is composed of the following facilities:

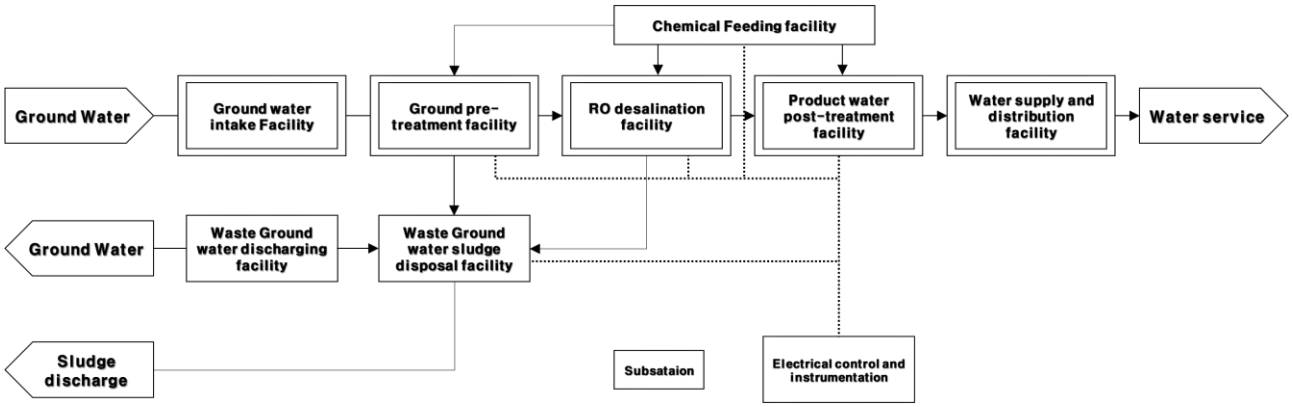


Figure 22. Composition of typical RO system

***Feed water Supply Facility*:** The feed water supply facility may include an intake port off the seacoast other than supply pipe network. In this case, more attention must be paid to the location of the intake port for stable supply of feed water and to prevent earth and sand from entering. In order to inhibit the growth of shellfish within the intake pipe a limited amount of chlorine is also routinely injected into the pipeline.

***Pre-treatment Facility*:** The feed-water supply facility may include an intake port off the seacoast other than supply pipe network. In this case, more attention must be paid to the location of the intake port for stable supply of feedwater and to prevent earth and sand from entering. In order to inhibit the growth of shellfish within the intake pipe a limited amount of chlorine is also routinely injected into the pipeline.

***Reverse Osmosis Facility*:** When suspended matter has accumulated on the surface of the reverse osmosis membrane, separation performance declines, i.e. the membrane permeation flux and salt rejection rate gradually decrease. In order to prevent these phenomena, suspended matter and microorganisms in feedwater are removed by coagulation-filtration in the pre-treatment facility. This concentrated seawater, which is still under a pressure of 5.2–6.7 Mpa, then passes on to an energy recovery facility.

***Post Treatment Facility*:** The fresh water that has been provided from the reverse osmosis module has a salt content of less than 500 ppm; however in some cases, various minerals are added to make it suitable for potable use. The pH is adjusted to prevent corrosion in water supply pipes and chlorine is injected for sterilization.

***CIP (Clean In Place) Process*:** CIP stands for clean-in-place and the CIP process aids in cleaning the membranes in a way that is not harsh, which is to say damage to the system is not likely. Cleaning methods that inflict any damage to the membrane is not going to be very helpful to say the least. The membranes cannot perform their required tasks correctly if this is the case. When a membrane cannot remove all the salt in the correct manner, what use is it? CIP cleaning devices are capable of chemically cleaning and overall sanitizing a RO system. The chemicals selected do have to be chosen wisely though. Harsh chemicals can actually cause corrosion necessitating repairs or, worse, the replacement of the overall system.

2.2.2 Applied design

The process of applied RO membrane system for this project is shown below. Considering the saline underground water as source water, the process is mainly composed of intake pump, storage tank and RO unit.

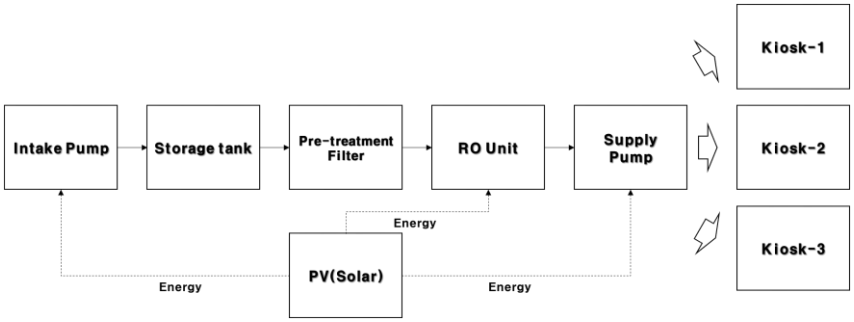


Figure 23. Process of applied desalination system

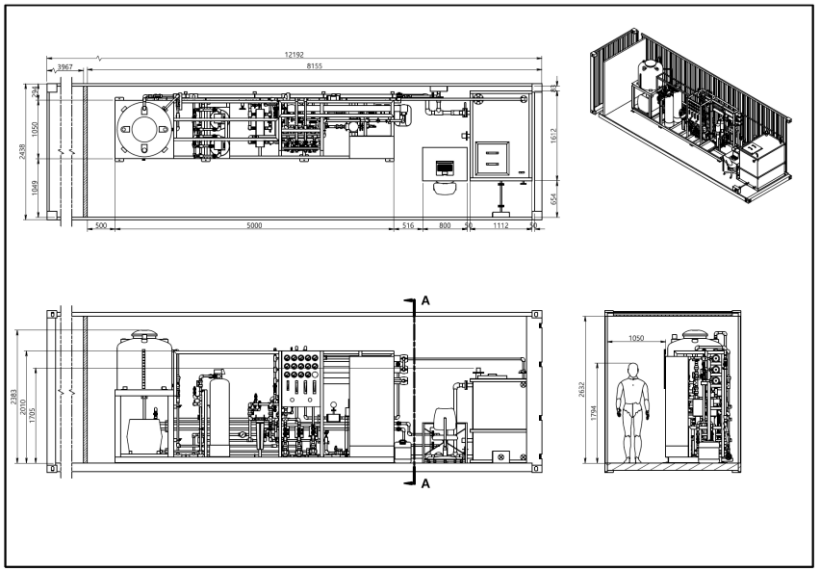


Figure 24. Typical Drawings of applied RO system

***Cartridge filter*:** Generally, string-wound polypropylene filters are used to remove particles of 1~5 μm diameter.

***RO Unit*:** RO unit consists of a pressure vessel with a membrane that allows feedwater to be pressed against it. The membrane must be strong enough to withstand whatever pressure is applied against it. Reverse-osmosis membranes are made in a variety of configurations, with the two most common configurations being spiral-wound.

Only a part of the saline feed water pumped into the membrane assembly passes through the membrane with the salt removed. The remaining "concentrate" flow passes along the saline side of the membrane to flush away the concentrated salt solution. The percentage of desalinated water produced versus the saline water feed flow is known as the "recovery ratio". This varies

with the salinity of the feed water and the system design parameters: typically 20% for small seawater systems, 40% ~ 50% for larger seawater systems, and 80% ~ 85% for brackish water. The concentrate flow is at typically only 3 bar / 50 psi less than the feed pressure, and thus still carries much of the high-pressure pump input energy.

PV (Solar): A solar-powered desalination unit produces potable water from saline water by using a photovoltaic system that converts solar power into the required energy for reverse osmosis. Due to the extensive availability of sunlight across different geographies, solar-powered reverse osmosis lends itself well to drinking water purification in remote settings lacking an electricity grid. Moreover, solar energy overcomes the usually high-energy operating costs as well as greenhouse emissions of conventional reverse osmosis systems, making it a sustainable freshwater solution compatible to developing contexts.

Simulation of RO membrane system

Simulation is performed by using O + project Software 3.0 which is made by LG chem. The input data and the result of simulation is as below

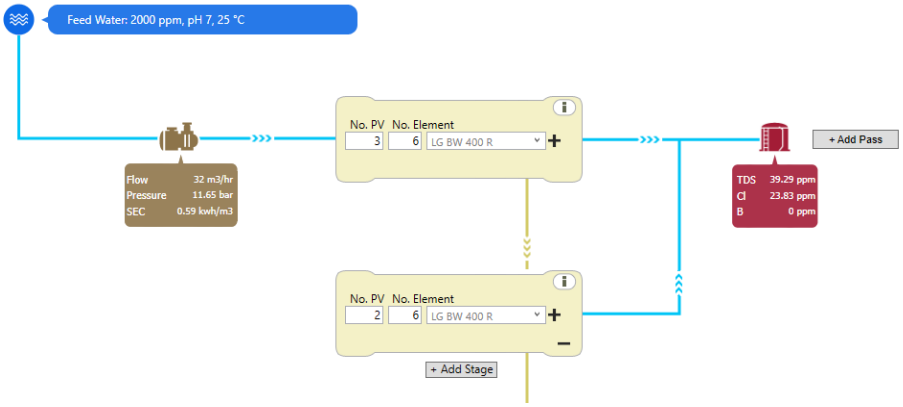


Figure 24. Input data for simulation

LG Chem — Q+ Projection Software v3.0 (v3.0.1.0)

Project name:		Water type:	NaCl, 2,000 ppm	Membrane age:	3
Customer:		Flux loss per year:	7.00%	Safety factor:	1
Username:		Salt passage increase:	7.00%		

Permeate flow:	22 m3/hr	Average flux:	19.73 lmh	Temperature:	25 °C
RO feed flow:	32 m3/hr	Water source:	Surface Water (SDI<5)	Average NDP:	5.96 bar
Concentrate flow:	10 m3/hr	Feed TDS:	2000 ppm	Specific energy:	0.59 kWh/m³
Recovery:	68.75 %	Feed osmotic pressure:	1.6 bar	Feed pressure:	11.65 bar
Number of elements:	30	Concentrate osmotic pressure:	3.65 bar	Permeate TDS:	39.29 ppm
ERD type:	None	Pump efficiency:	80 %	Fouling factor:	0.8
Recirculation:					

	# of vessels	# of elements	RO feed flow	Permeate flow	Concentrate flow	RO feed pressure	Concentrate pressure	Vessel DP	Boost pressure	Back pressure	Average flux	Perm. TDS
			m3/hr	m3/hr	m3/hr	bar	bar	bar	bar	bar	lmh	ppm
Stage 1	3.00	6.00	32.00	15.31	16.69	11.65	10.59	1.05	0.00	0.00	22.89	23.99
Stage 2	2.00	6.00	16.69	6.69	10.00	10.59	9.84	0.76	0.00	0.00	15.00	74.30

Water Analysis - Pass1

Species	Raw water	Adjusted feed	Concentrate Stage1	Concentrate Stage2	Concentrate Composite	Permeate Stage1	Permeate Stage2	Permeate Composite
Ammonium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sodium	786.79	786.79	1,500.04	2,483.76	2,483.76	9.44	29.23	15.46
Potassium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calcium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluoride	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chloride	1,213.21	1,213.21	2,313.03	3,829.90	3,829.90	14.55	45.07	23.83
Sulfate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbonate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bicarbonate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boron	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bromide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TDS	2,000.00	2,000.00	3,813.07	6,313.66	6,313.66	23.99	74.30	39.29
pH	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00

Figure 25. Result of simulation

2.3 Water Demand Forecasts

Usually, for the selection of water treatment plant capacity in urban area, water demand is projected by the following procedures. 1) selection of water supply coverage area 2) selection of water supply coverage rate 3) projection of future population in horizon year 4) projection(or selection) of unit water demand for domestic use. After the projection of above procedure, daily peak factor which usually varies from 1.1 to 1.5, is considered.

Unit water demand

Based on the experience from other projects, per capita consumption for drinking and cooking is 10 LPCD, while water for bathing and washing is about 50 LPCD. About 4 ~ 16 LPCD will be

required to operate a pour-flush toilet, so per capita consumption for a typical household with pour flush toilet is estimated at 64 ~ 76 LPCD, and according to the WHO, between 50 and 100 LPCD of water are needed to ensure that most basic needs are met and few health concern raises. As mentioned in the objective, the main purpose of this project is to provide clean and safe drinking water for inhabitants suffering from lack of potable water coming from salt water intrusion. Accordingly, 10 LPCD is selected as unit water demand for the design of proposed RO plant.

Water supply coverage area

According to WHO recommendation for the human rights to water and sanitation, the water source has to be within *1,000 meters* of the home and collection time should not be *30 minutes.*

2.4 Rainwater Harvesting

Rainwater harvesting (RWH) means to the collection and storage of rainwater for reuse on-site (usually) rather than allowing it to run off. It is a practice used from ancient times and is suitable for areas with annual average rainfall of more than 400 mm.

Modern rainwater harvesting systems (if it is properly managed and maintained) are completely safe and yield good quality water. By using rainwater one can increase water availability and reduce water demand from the water supply network through its subsequent use for non-potable applications, such as toilet flushing, irrigation, car washing, etc., increase soil moisture levels for urban greenery, mitigate urban flooding and improve the quality of groundwater.

Access to safe drinking water is limited in the Mekong Delta region of Vietnam including project area. Rainwater harvesting (RWH) at household level is among the primary sources of drinking water in the region and is widely practiced throughout project sites which was surveyed by field mission.

Throughout the field mission, we found that rainwater was the most common water source for all domestic activities in the rainy season; however, it was reserved for high-value uses in the dry season. Residents ranked color, perceived safety, smell, taste and reliability of rainwater very highly compared to other water sources. Most households practice daily first-flush and/or boil water before drinking. Storage capacity seems to be a major barrier to RWH providing an adequate supply of domestic water year-round.

Type of Rainwater harvesting technology

Rainwater harvesting is defined as a method for inducing, collecting, storing and conserving local surface runoff (rain or surface water flow that occurs when soil is infiltrated to full capacity) for agriculture in arid and semi-arid regions (Boers and Ben-Asher, 1982). Both small and large-scale structures are used for rainwater harvesting collection and storage including water pans, tanks, reservoirs and dams. Commonly used rainwater harvesting systems are constructed from three principal components:

The catchment area is the area where the rainfall or water runoff is initially captured and is in most cases either the roof-top of a house or building, ground surface or rock surface.

- Roof-top method

In the roof-top method water from rainfall is collected in vessels at the edge of the roof or channeled to a storage system via gutters and pipes. Roofs can be constructed with a range of materials including galvanised corrugated iron, aluminum cement sheets, and tiles and slates. Thatch or palm leafed roofs can provide a low-cost alternative but can be difficult to clean and can taint the runoff. Tiled roofs, or roofs sheeted with corrugated mild steel or other materials are preferable, since they are the easiest to construct and give the cleanest water (WaterAid, no date).

Roof-top collection is suitable for household or school level application and can provide freshwater for domestic purposes and small-scale farming.

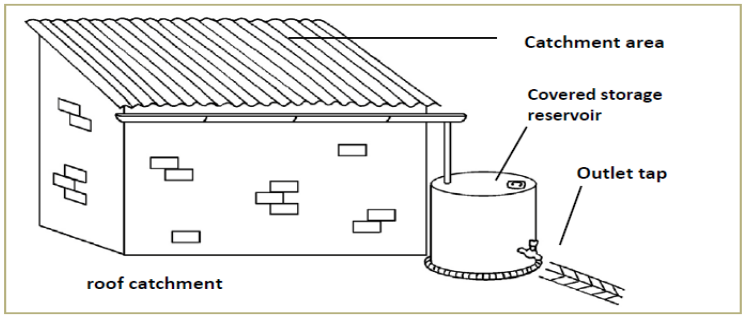


Figure 26. Roof-top method

- Ground-surface method

In the ground surface method water flowing along the ground during the rains is usually diverted toward a tank below the surface. There is greater possibility of water loss than the roof-top system due to infiltration into the ground. The water is generally of lower quality than that collected directly from rainfall. Techniques available for increasing runoff within ground catchment areas include: i) clearing or altering vegetation cover, ii) increasing the land slope with artificial ground cover, and iii) reducing soil permeability by the soil compaction and application of chemicals (UNEP, 1982). Impermeable membranes can also be used to facilitate run-off. Ground catchment is applicable for low topographic areas and is suitable for large-scale agricultural production as it allows for in-situ storage and usage of fresh water for irrigation

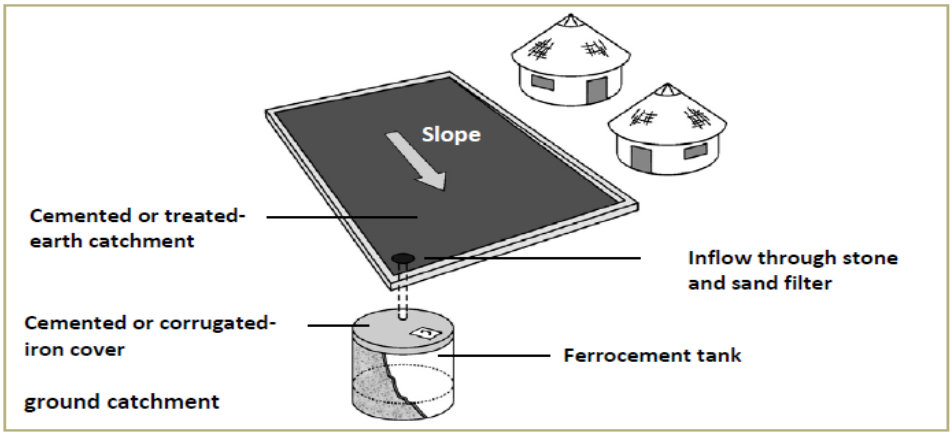


Figure 27. Ground-surface method

- Rock-surface method

Rock surfaces can also be used as collection catchments. Bedrock surfaces found within rocky top slopes or exposed rock outcrops in lowlands often have natural hollows or valleys which can be turned into water reservoirs by building a dam. Developing a rock catchment area typically involves clearing and cleaning the site from vegetation and marking out the catchment area to be enclosed with gutters. Rock surfaces should not be fractured or cracked, as this may cause the water to leak away to deeper zones or underneath the dam. As with ground catchments, water is generally of lower quality than direct rainfall collection.

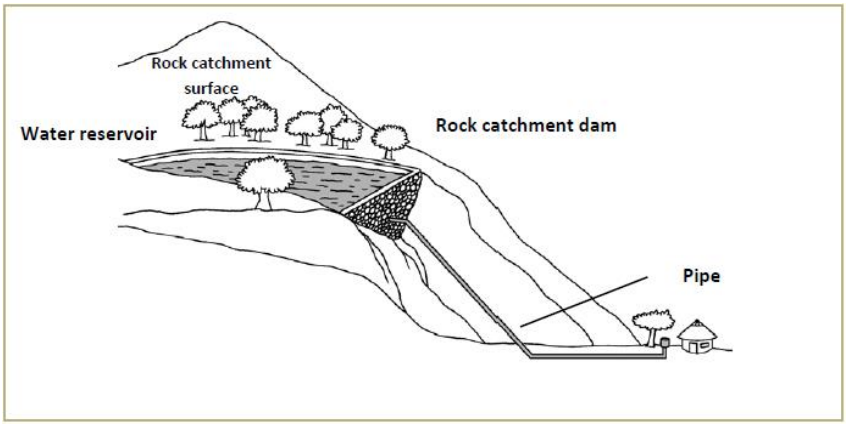


Figure 28. Rock-surface method

Components of Rainwater harvesting technology (roof-top method)

The system mainly constitutes of following sub components Catchments, Transportation, First flush, storage facility and First flush diverter.

- Catchments

The surface that receives rainfall directly is the catchment of rainwater harvesting system. It may be terrace, courtyard, or paved or unpaved open ground. The terrace may be flat RCC/stone roof or sloping roof. Therefore the catchment is the area, which actually contributes rainwater to the harvesting system.

- Transportation

Rainwater from rooftop should be carried through down take water pipes or drains to storage/harvesting system. Water pipes should be UV resistant (ISI HDPE/PVC pipes) of required capacity. Water from sloping roofs could be caught through gutters and down take pipe. At terraces, mouth of the each drain should have wire mesh to restrict floating material.

- First Flush

First flush is a device used to flush off the water received in first shower. The first shower of rains needs to be flushed-off to avoid contaminating storable/rechargeable water by the probable contaminants of the atmosphere and the catchment roof. It will also help in cleaning of silt and other material deposited on roof during dry seasons Provisions of first rain separator should be made at outlet of each drainpipe.

- Storage facility

There are various options available for the construction of these tanks with respect to the shape, size, materials of construction and the position of tank.

The shape of storage facility is as follows: Cylindrical, square and rectangular. Reinforced cement concrete (RCC), masonry, are used for the storage tank materials. Position of tank depends on land space availability these tanks could be constructed above ground, partly underground or fully underground. Some maintenance measures like disinfection and cleaning are required to ensure the quality of water stored in the container.

- First Flush Diverter

The first flush system collects the initial rainwater that falls during a storm. The purpose of this is to lead the initial debris and sediment that is collected from the roof into the first flush pipes rather than into the tank. After these pipes are full, relatively clean water will flow into the tank.

2.4.1 Design of Rain harvesting system

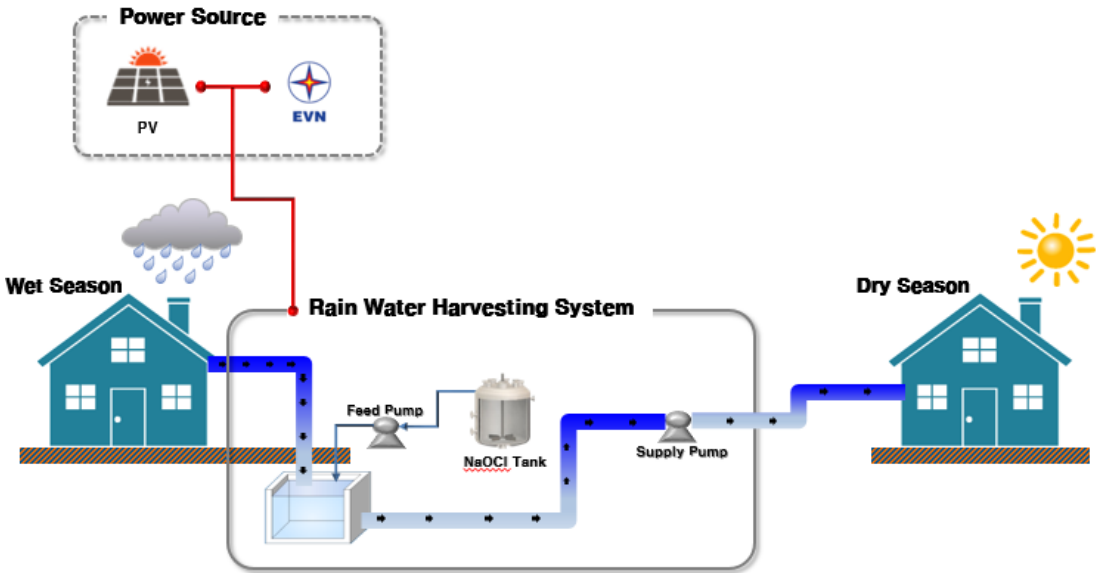


Figure 29. Concept of Rain water harvesting system

➢ Determination of water storage volume

The volume of rainwater that can be harvested over a given period depends upon the amount of rainfall in that period, the catchment area and the runoff coefficient. The characteristics of the catchment area determine the storage conditions. Rainwater yield varies with the size and texture of the catchment area. All calculations relating to the performance of rainwater catchment systems involve the use of a runoff coefficient to account for losses due to spillage, leakage, infiltration, catchment surface wetting and evaporation, which will all, contribute to reducing the amount of runoff. This is determined as follows:

Water harvesting potential = Rainfall (mm) x Area of catchment x Runoff coefficient

Or

Water harvesting potential = Rainfall (mm) x Collection efficiency

The collection efficiency accounts for the fact that all the rainwater falling over an area cannot be effectively harvested, because of evaporation, spillage etc. Factors like runoff coefficient.

Runoff coefficient is the factor which accounts for the fact that all the rainfall falling on a catchment cannot be collected. Some rainfall will be lost from the catchment by evaporation and retention on the surface itself. The Runoff coefficient (Cr), for any catchment is the ratio of the volume of water that runs off a surface to the volume of rainfall that falls on the surface. It is calculated as follows :

Runoff coefficient (Cr) = Volume of runoff/volume of rainfall

The Runoff coefficient accounts for losses associated with leakage, evaporation and overflow for a roof catchment system. It is normally taken to be 0.8 for metal roofs, but can have higher values if the roofs and gutters are well constructed. It has lower values for most other types of roofing material. For natural ground catchments, it is less than 0.3 and actual figures depend on various characteristics of the catchment. Some typical values are given in table 11.

Table 4. Runoff Coefficient

Type of Catchment	Runoff Coefficient
Roof Catchments	
Corrugated metal sheets	0.7~0.9
Tiles	0.8~0.9

Ground Surface Covering	
Concrete	0.6~0.8
Brick pavement	0.5~0.6
Untreated Ground Catchments	
Soil on slope less than 10%	0.0~0.3
Rocky natural catchments	0.2~0.5
Green area	0.05~0.1

- First Flush Diverter

To calculate the amount of water that the first flush should collect, first measure the surface area of the roof. For every 100 square meters of roofing, use 4 meters of 110mm PVC pipe for storage. If you use PVC pipe with a diameter larger than 110mm, you can use a shorter length of pipe. The first flush system is connected to the gutters in a way that is similar to the connection to the tank (the galvanized gutter downspout must be converted to PVC pipe). Then a 110mm to 50mm eccentric reducer can be connected to the downspout. A system of 110mm PVC pipe and 90 degree bends are then connected ad designed so that the pipes can run along the wall of the building. Holderbats are necessary to secure the pipe to the wall so that the gutters do not bear the weight of the water. Next, a small ball is used as the manual valve for the first flush. As the pipes fill up with water, the ball rises until it hits the eccentric reducer, at which point the pipes are blocked and clean water can flow into the tank. If the first flush pipes extend along the ground, it is important to ensure that the ball is prevented from entering these ground pipes. You can use a screen, a piece of wire drilled across the diameter of the pipe, or a piece of glued plastic across the diameter of the pipe to stop the ball. Figures 43 depict how the first flush mechanism works.

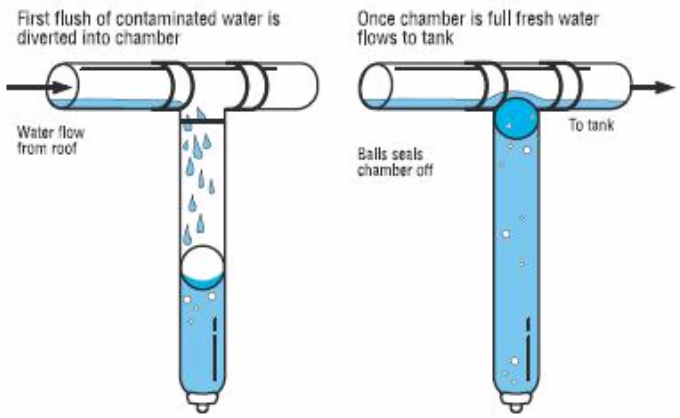


Figure 30. First Flush diverter with floating ball

At the end of the first flush, there is a screw-off end cap so that the cap can be easily removed for cleaning. The cap should not be screwed on tightly so that it can allow for water to drain slowly. This prevents the build- up of pressure in the pipes. Another possible method of slow draining is to drill tiny holes in the first flush pipes.

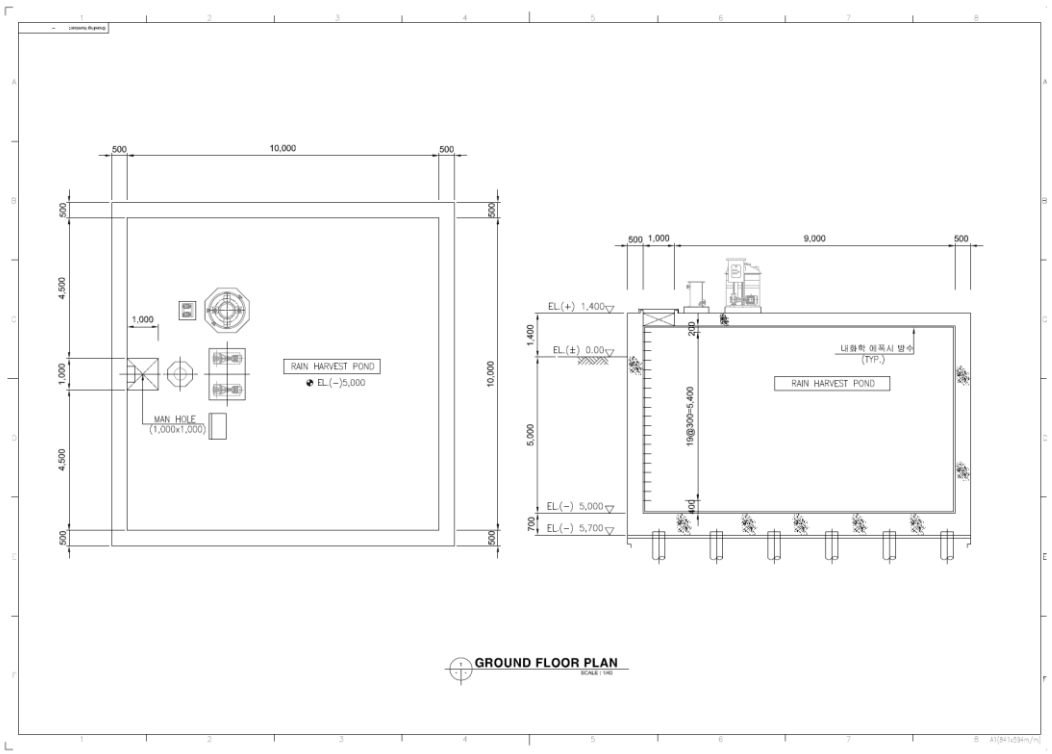


Figure 31. Typical Drawings of Rainwater harvesting system (V = 500m³)

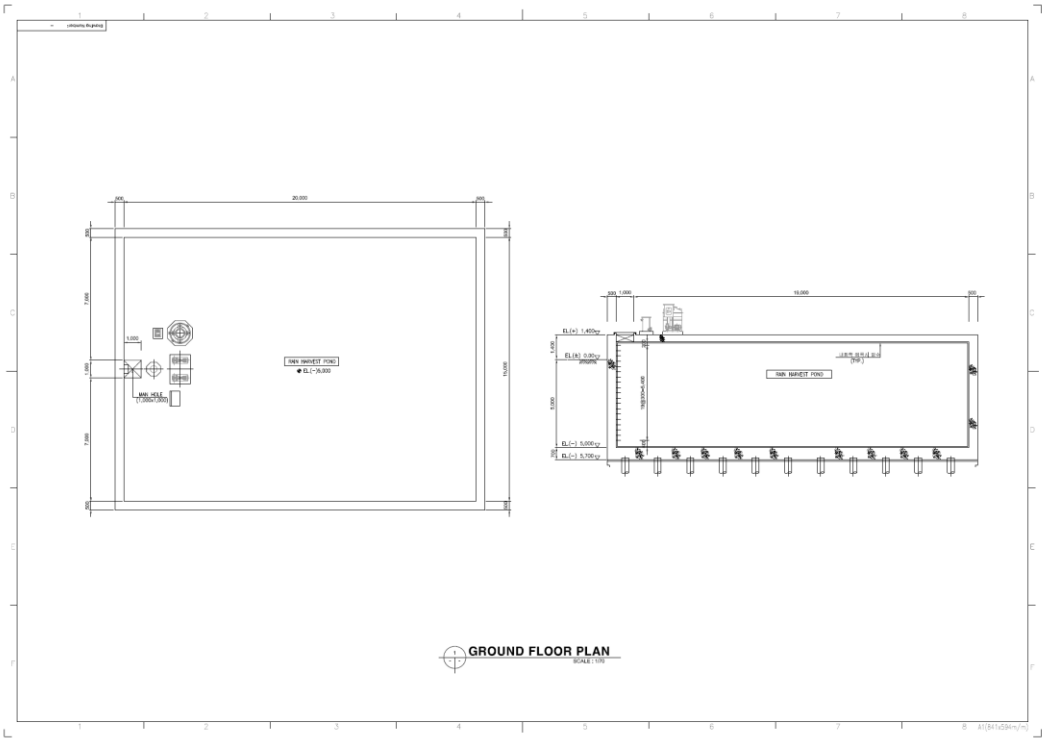


Figure 32. Typical Drawings of Rainwater harvesting system (V = 600m³)

2.5 Design of Water Treatment Plant & Rainwater harvesting intervention

2.5.1 Tra Vinh Province

Long Hoa Commune

Figure 33. Location of project site in Long Hoa Commune

1). Long Hoa Secondary school : Desalination system

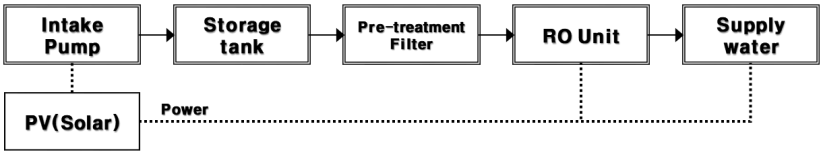
The basic condition and design indicator for Long Hoa secondary school are show in table 12.

Table 5. Status of Long Hoa secondary school

Category		Content
Location(coordinates)		9.885788, 106.499280
Number of water supply population	Student	400person
	Educational personnel	30person
	Total	1,496person
Water supply within 1km radius		1,496person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		3~4 ㎥/day
Water Quality	TDS	783 mg/L
	Turbidity	0.38NTU

Table 6. Summary of Design for Long Hoa secondary school

Category	Content
Type	Drinking Water / Desalination system
Water Source	Ground Water

Capacity	15 m³/day
LPCD (Liters Per Capita per day)	10
Treated water quality (TDS)	< 50mg/L
Process	

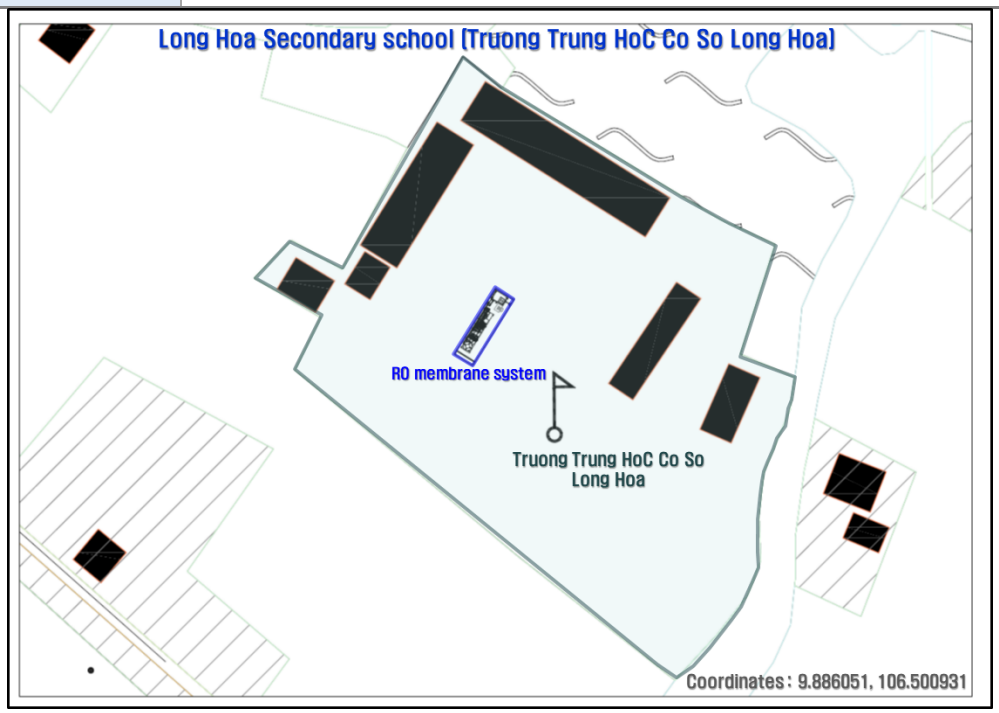


Figure 34. The proposed location of Desalination system in Long Hoa secondary school

Budget

The estimated price for the water Purification facility would be as follows:

Table 7. Cost estimation of Desalination system in Long Hoa secondary school

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Construction works	1	14,415	14,415
2. Water Treatment system(AC+RO, 15 m³/day)	1	123,802	123,802
3. PV(photovoltaics, 10kWh)	1	13,991	13,991
4. Transportation	1	12,380	12,380
5. Intake(100m)	1	16,959	16,959
6. 20L-Auto capper	1	16,959	16,959
7. Kiosk	2	6,783	13,567
8. Installation	1	24,760	24,760
9. Commissioning	1	15,263	15,263
Total			25,099

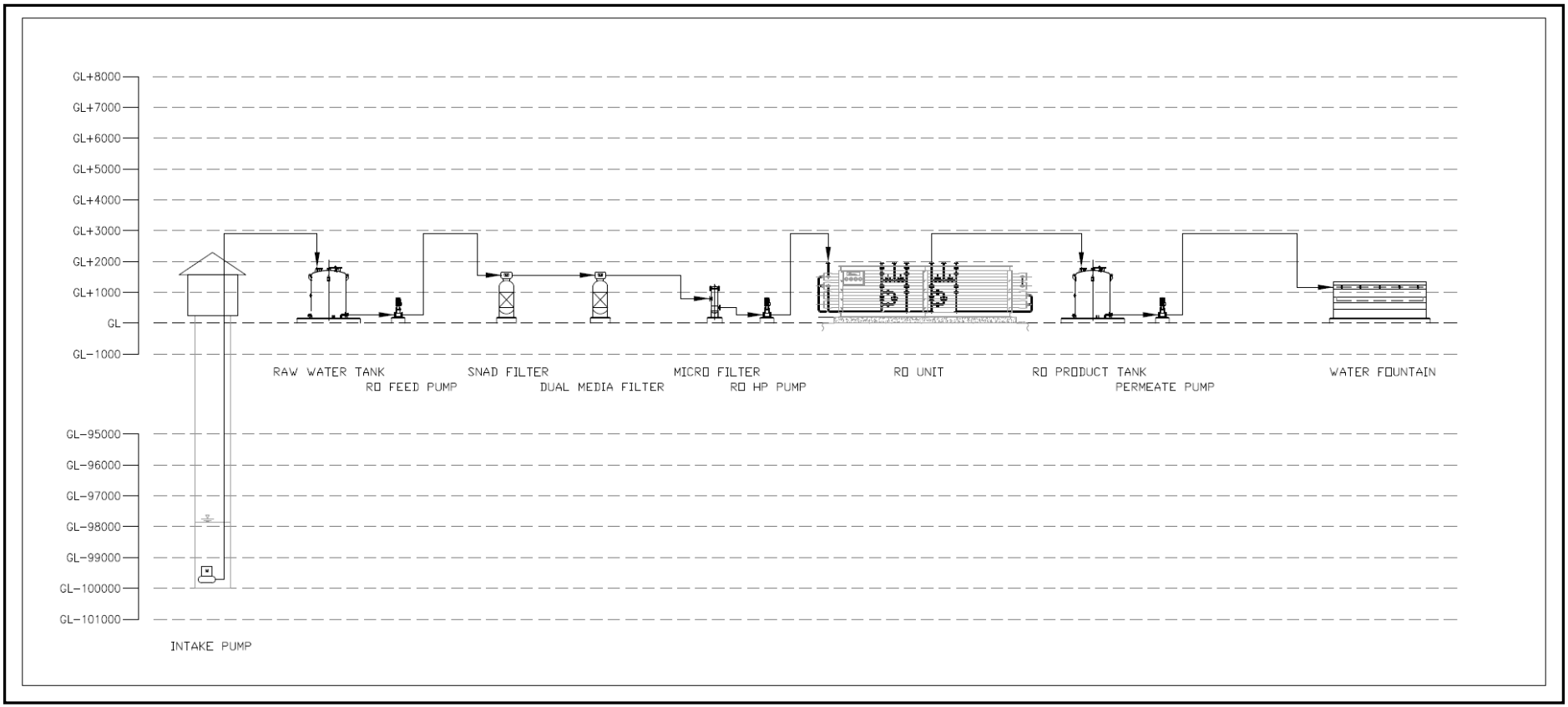


Figure 35. Hydraulic profile of applied Desalination system in Long Hoa Secondary school

2). Truong Tieu Hoc Long Hoa

Troung Tieu Hoc Logn Hoa sit is not selected for this project because, as shown below table, the water quality at Truong Tieu Hoc Long Hoa, is 669 mg/L as TDS, 1.43 NTU as Turbidity and the distance from Long Hoa secondary school is less than 100 m.

Table 8. Status of Troung Tieu Hoc Long Hoa

Category		Content
Location(coordinates)		9.883524, 106.501271
Number of water supply population	Student	300person
	Educational personnel	31person
	Total	331person
Water supply within 1km radius		1,496person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		3~4 ㎥/day
Water Quality	TDS	669 mg/L
	Turbidity	1.43NTU



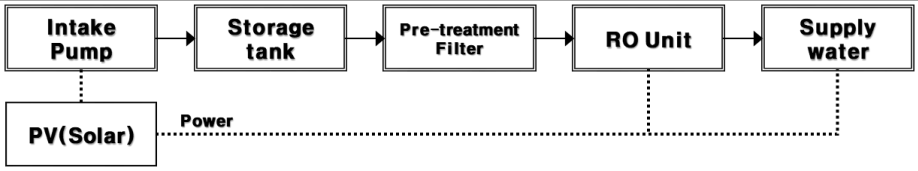
3). Truong Tieu Hoc Long Hoa A : Desalination system

The basic condition and design indicator for Truong Tieu Hoc Long Hoa A are show in table 16 below.

Table 9. Status of Troung Tieu Hoc Long Hoa A

Category		Content
Location(coordinates)		9.863839, 106.517995
Number of water supply population	Student	200 person
	Educational personnel	33 person
	Total	233 person
Water supply within 1km radius		944 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		3~4 ㎥/day
Water Quality	TDS	731 mg/L
	Turbidity	4.54 NTU

Table 10. Summary of Design for Troung Tieu Hoc Long Hoa A

Category	Content
Type	Drinking Water / Desalination system
Water Source	Ground Water
Capacity	9.4 ㎥/day
LPCD (Liters Per Capita per day)	10
Treated water quality (TDS)	< 50mg/L
Process	

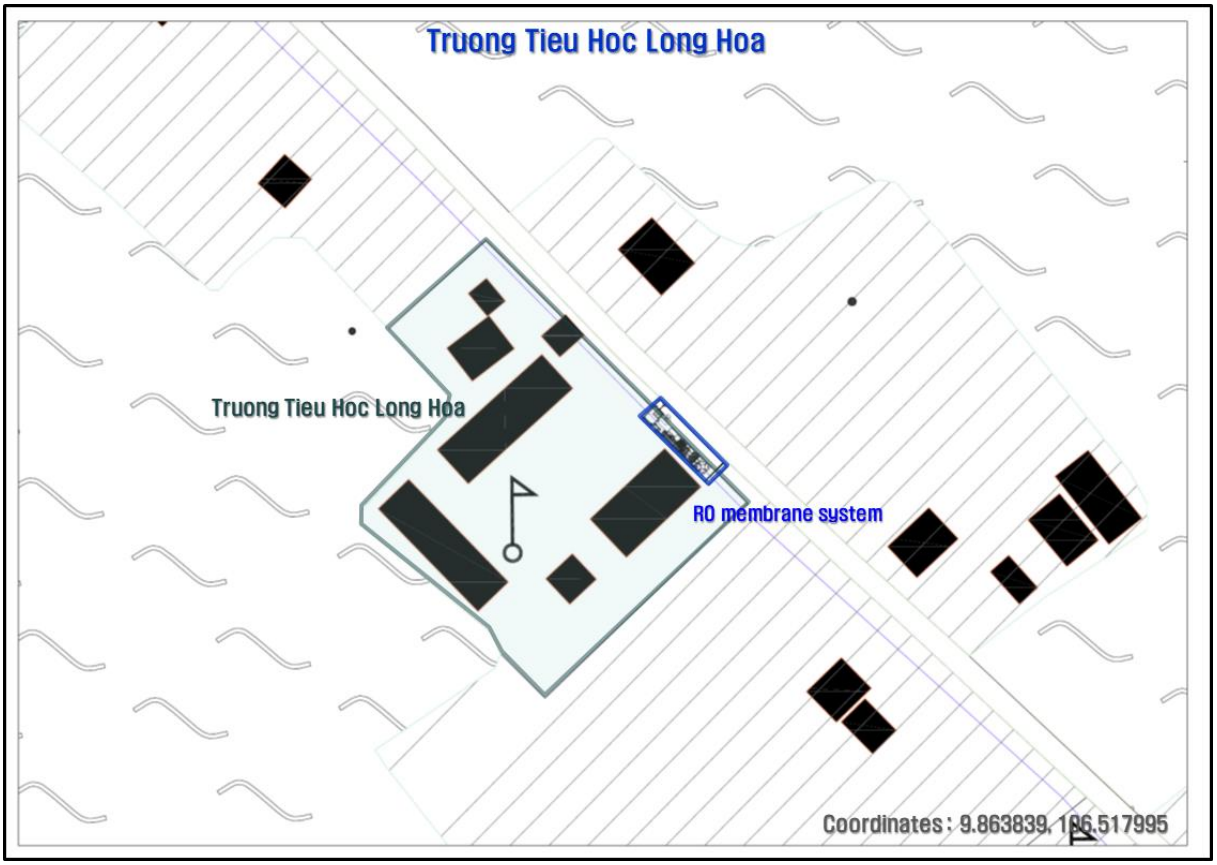


Figure 36. The proposed location of Desalination system in Truong Tieu Hoc Long Hoa A

Budget

The estimated price for the water Purification facility for Truong Tieu Hoc Long Hoa A would be as follows:

Table 11. Cost estimation of Desalination system in Tieu Hoc Long Hoa A

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Construction works	1	14,415	14,415
2. Water Treatment system(AC+RO, 10 m^3/day)	1	121,258	121,258
3. PV(photovoltaics, 6kWh)	1	8,395	8,395
4. Transportation	1	12,126	12,126
5. Intake(100m)	1	16,959	16,959
6. 20L-Auto capper	1	16,959	16,959
7. Kiosk	2	6,784	13,567
8. Installation	1	24,252	24,252
9. Commissioning	1	15,263	15,263
Total			243,195

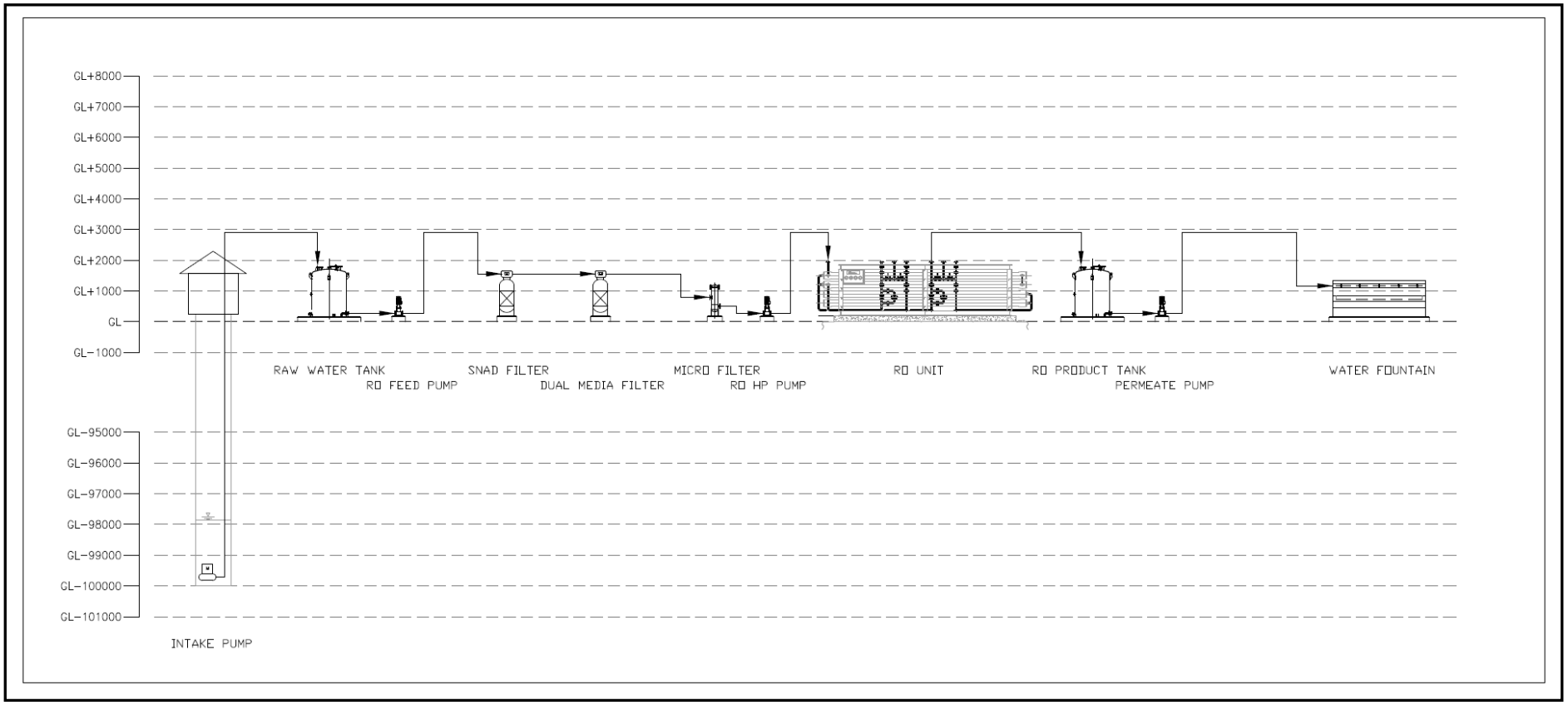


Figure 37. Hydraulic profile of applied Desalination system in in Truong Tieu Hoc Long Hoa A

4). Truong Mam Non Long Hoa

Truong Mam Non Long Hoa is not selected for the project site as the similar reason as Troung Tieu Hoc Logn Hoa. It is less than 100 m from Troung Thie Hoc Long Hoa A which is selected as project site as shown in the picture 45.

Table 12. Status of Troung Non Long Hoa

Category		Content
Location(coordinates)		9.863087, 106.518954
Number of water supply population	Student	100 person
	Educational personnel	4 person
	Total	104 person
Water supply within 1km radius		944 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		3~4 ㎥/day
Water Quality	TDS	836 mg/L
	Turbidity	13.8 NTU



Hoa Minh Commune

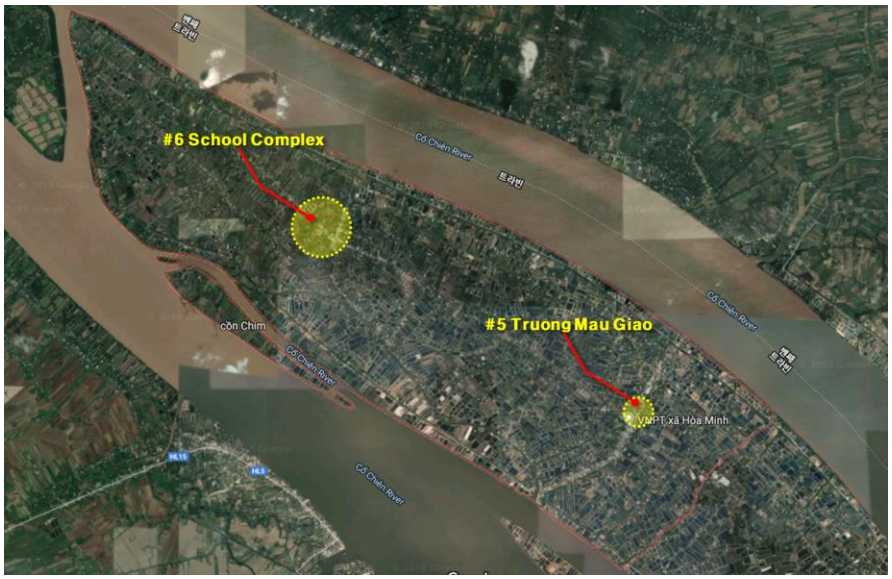


Figure 38. Location of project site in Hoa Minh Commune

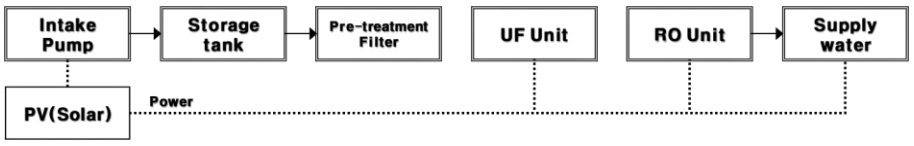
5). Truong Mau Giao : Desalination system

Troung Mau Giao Kindergarten is located at the core area of Hoa Minh Commune where people's committee of Commune, market and religious facilities are located.

Table 13. Status of Troung Mau Giao

Category		Content
Location(coordinates)		9.907801, 106.472332
Number of water supply population	Student	250 person
	Educational personnel	20 person
	Total	260 person
Water supply within 1km radius		2,252 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		2~3 ㎥/day
Water Quality	TDS	1,240mg/L
	Turbidity	1.33 NTU


Table 14. Summary of Design for Troung Mau Giao

Category	Content
Type	Drinking Water / Desalination system
Water Source	Ground Water
Capacity	22.7 ㎥/day
LPCD (Liters Per Capita per day)	10
Treated water quality (TDS)	< 50mg/L
Process	

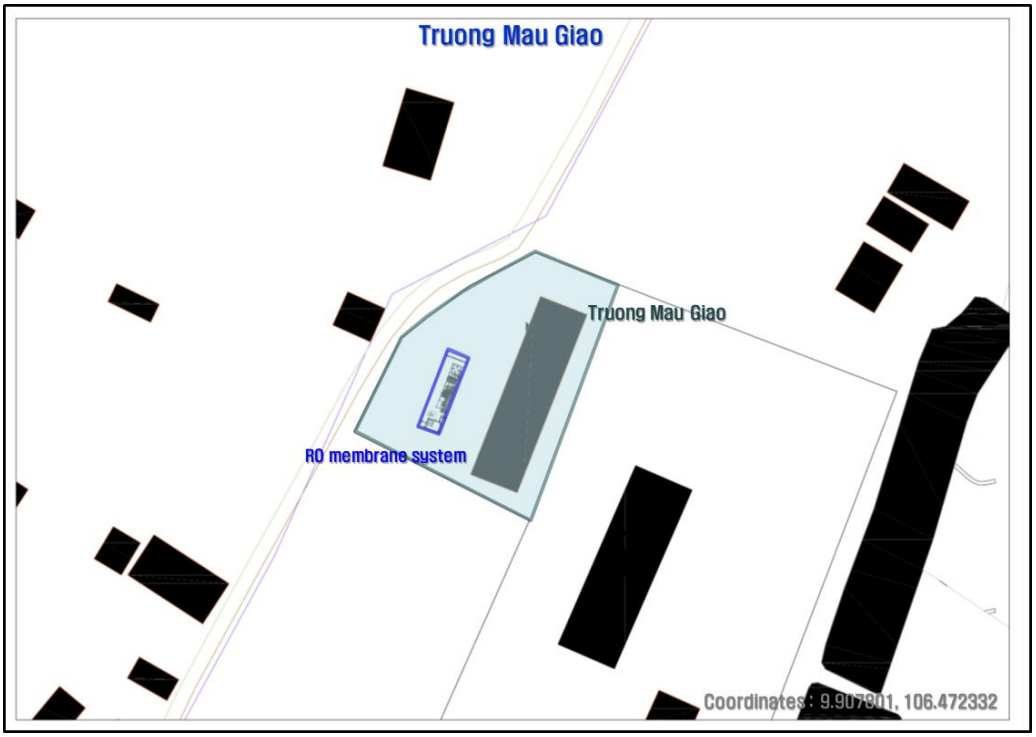


Figure 39. The proposed location of Desalination system in Truong Mao Giao Kindergarten

Budget

The estimated price for the water Purification facility for Troung Mao Gia would be as follows:

Table 15. Cost estimation of Desalination system in Troung Mao Giao

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Construction works	1	25,439	25,439
2. Water Treatment system(UF+AC+RO, 23 m^3/day)	1	198,423	198,423
3. PV(photovoltaics, 20kWh)	1	27,983	27,983
4. Transportation	1	19,842	19,842
5. Intake(100m)	1	16,959	16,959
6. 18L-Auto capper	1	16,959	16,959
7. Kiosk	2	6,784	13,567
8. Installation	1	39,68	39,68
9. Commissioning	1	15,263	15,263
Total			374,120

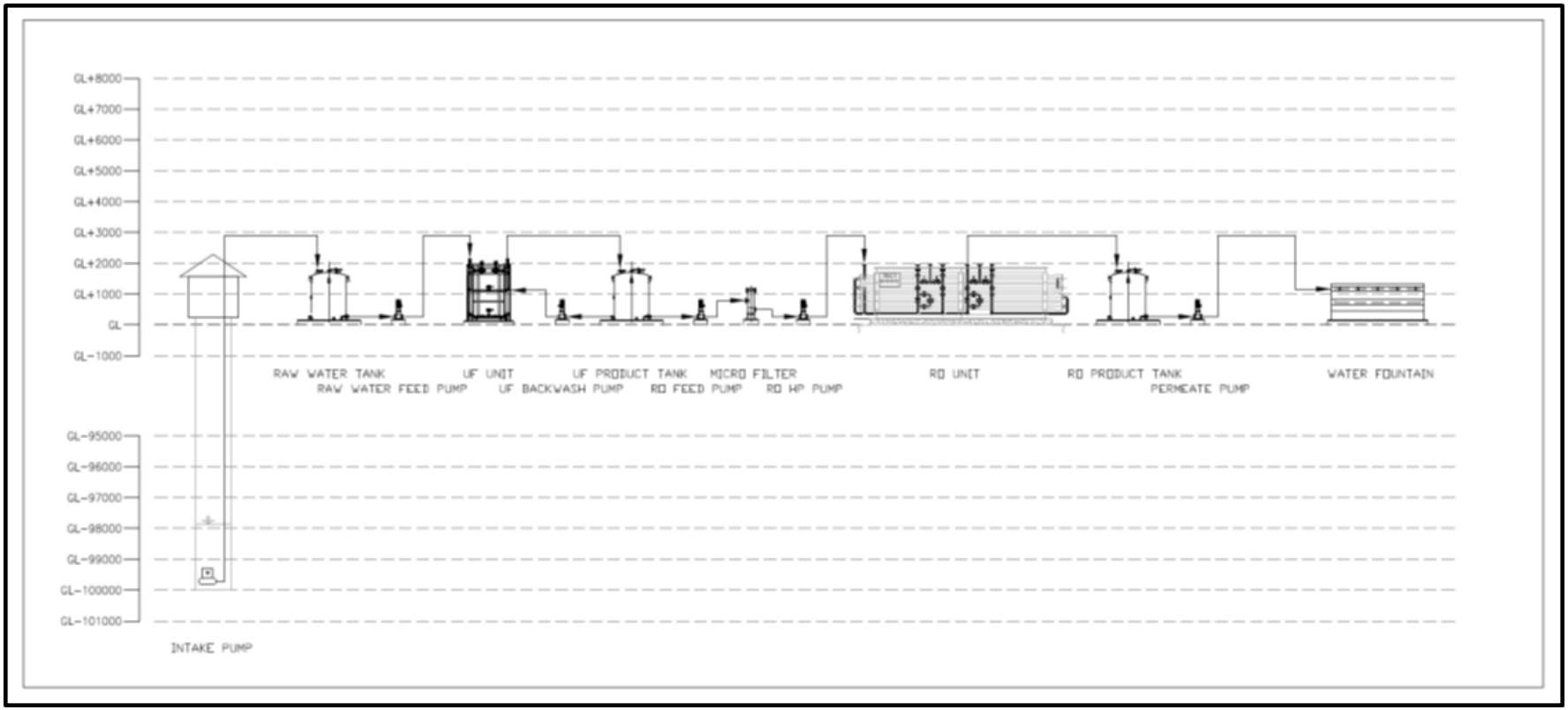


Figure 40. Hydraulic profile of applied Desalination system in Toung Mao Giao

6). School Complex : Desalination system

This project site is named as school complex because it is composed of 4 institutions with kindergarten, elementary school, middle school and health care center with the same Desalination system. The detail status of each institutions are described as below from table 21 to table 24.
For the water supply of these 4 institutions, the Desalination system will be placed at the around of main entrance of Troung Toung Hoc Co So Hoa Minh B and water distribution facility,which is called Kiosk,will be connected to each institution.

Table 16. Status of Troung Toung Hoc Co So Hoa Minh B

Category		Content
Location(coordinates)		9.928539, 106.435637
Number of water supply population	Student	510 person
	Educational personnel	40 person
	Total	550 person
Water supply within 1km radius		1,120 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		5 ㎥/day
Water Quality	TDS	1,109 mg/L
	Turbidity	2.18 NTU

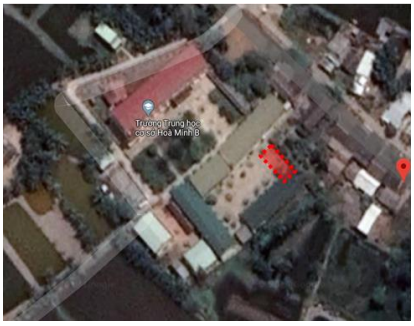


Table 17. Status of Truong Tieu Hoc Hoa Minh C

Category		Content
Location(coordinates)		9.927832, 106.436698
Number of water supply population	Student	270 psrson
	Educational personnel	27psrson
	Total	287 person
Water supply within 1km radius		1,120 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		2~3 ㎥/day
Water Quality	TDS	1,109 mg/L
	Turbidity	2.18 NTU


Table 18. Status of Kinderten

Category		Content
Location(coordinates)		9.927623, 106.437051
Number of water supply population	Student	140 person
	Educational personnel	3person
	Total	143 person
Water supply within 1km radius		1,120 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		1 ㎥/day
Water Quality	TDS	1,109 mg/L
	Turbidity	2.18 NTU


Table 19. Status of Health Care Center

Category		Content
Location(coordinates)		9.928207, 106.437058
Number of water supply population	Student	5 person
	Educational personnel	7person
	Total	12 person
Water supply within 1km radius		1,120 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		1 ㎥/day
Water Quality	TDS	1,109 mg/L
	Turbidity	2.18 NTU

Table 20. Summary of Design for Scholl Complex

Category	Content
Type	Drinking Water / Desalination system
Water Source	Ground Water
Installation	Truong Trung Hoc Co So Hoa Minh B(9.928539, 106.435637)
Method of supply	Kiosk
Capacity	11.2 ㎥/day
LPCD (Liters Per Capita per day)	10
Treated water quality (TDS)	< 50mg/L
Process	Intake Pump → Storage tank → Pre-treatment Filter → UF Unit → RO Unit → Supply water; PV(Solar) → Power

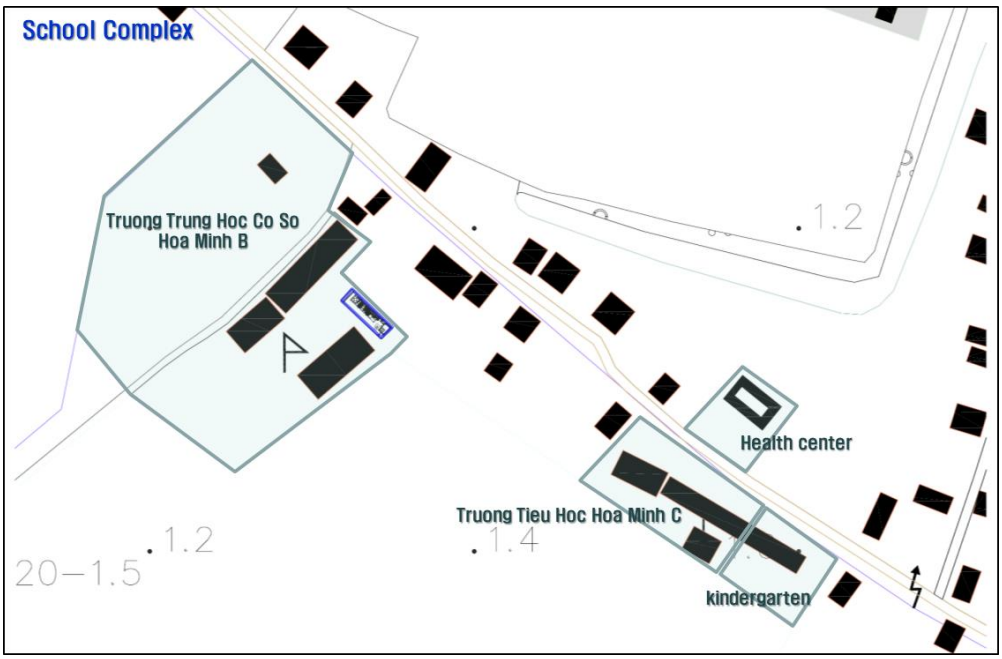


Figure 41. The proposed location of Desalination system in school complex zone

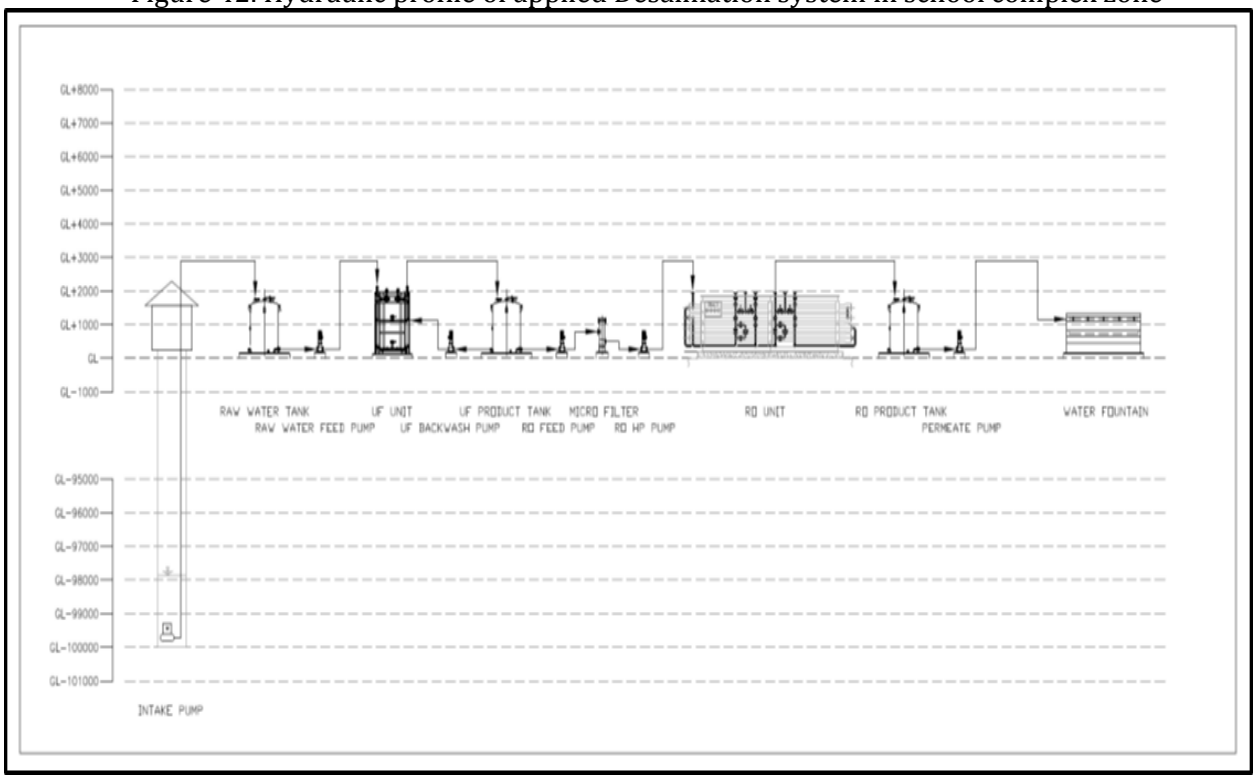
Budget

The estimated price for the water Purification facility would be as follows:

Table 21. Cost estimation of Desalination system in school complex

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Construction works	1	25,439	25,439
2. Water Treatment system(UF+AC+RO, 11 m^3/day)	1	154,329	154,329
3. PV(photovoltaics, 10kWh)	1	13,991	13,991
4. Transportation	1	15,433	15,433
5. Intake(100m)	1	16,959	16,959
6. 20L-Auto capper	1	16,959	16,959
7. Kiosk	3	6,784	20,351
8. Installation	1	30,866	30,866
9. Commissioning	1	15,263	15,263
Total			309,590

Figure 42. Hydraulic profile of applied Desalination system in school complex zone



Bac Lieu Province
Vinh Trach Dong Commune

Figure 43. Location of project site in Vinh Trach Dong Commune

1). Resettlement Area at Vin Trach Dong Commune : Desalination system

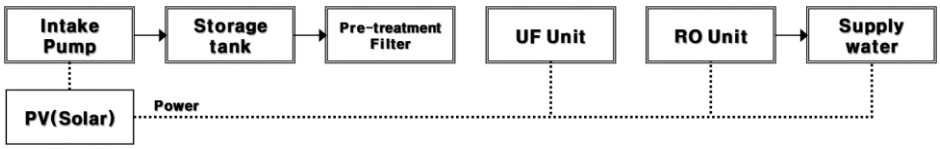
This area is newly developed town for the resettlement of people who moved to this area from sea shore area due the sea level of climate change. Even though there is exiting water treatment plant next to the resettlement area, the water quality of this facility is not potable as shown in the below table. Thus, it is planned to set up Desalination system using same water source to supply potable water to the people who is the most vulnerable to climate change.

Table 22. Status of Resettlement Area

Category		Content
Location(coordinates)		9.249952, 105.801311
Number of water supply population	Student	-
	Educational personnel	-
	Total	-
Water supply within 1km radius		2,664 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		-
Water Quality	TDS	1,130 mg/L
	Turbidity	2.95 NTU



Table 23. Summary of Design for Resettlement Area

Category	Content
Type	Drinking Water / Desalination system
Water Source	Ground Water
Capacity	22.7 ㎥/day
LPCD (Liters Per Capita per day)	10L/day·person
Treated water quality (TDS)	< 50mg/L
Process	

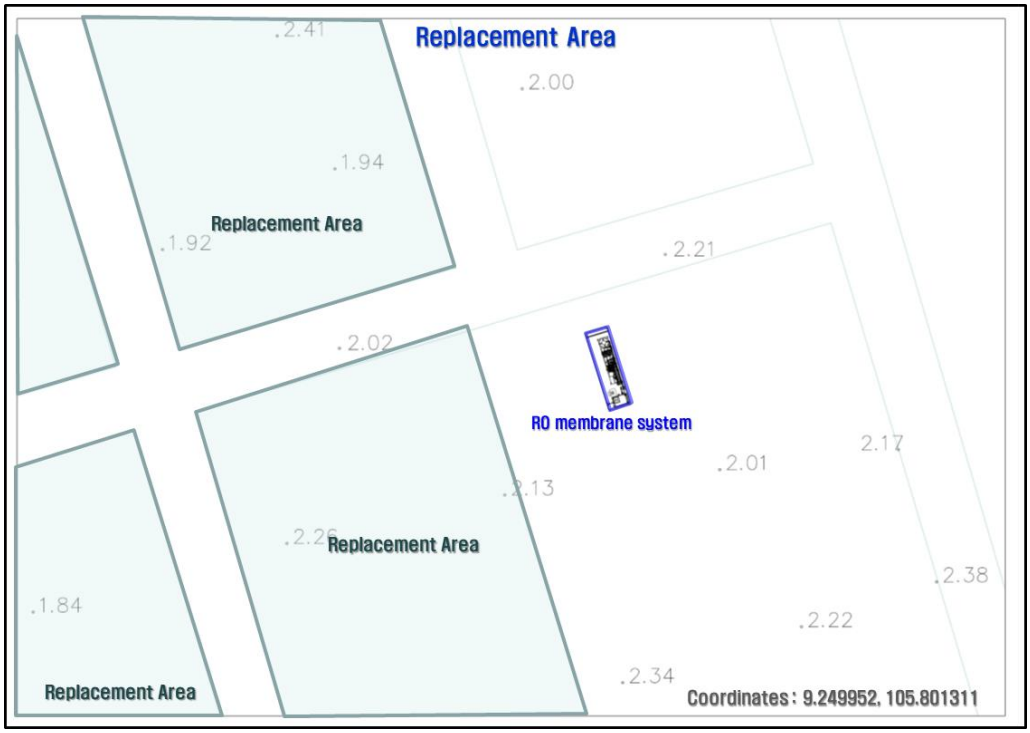


Figure 44. The proposed location of Desalination system in Vinh Track Dong resettlement area

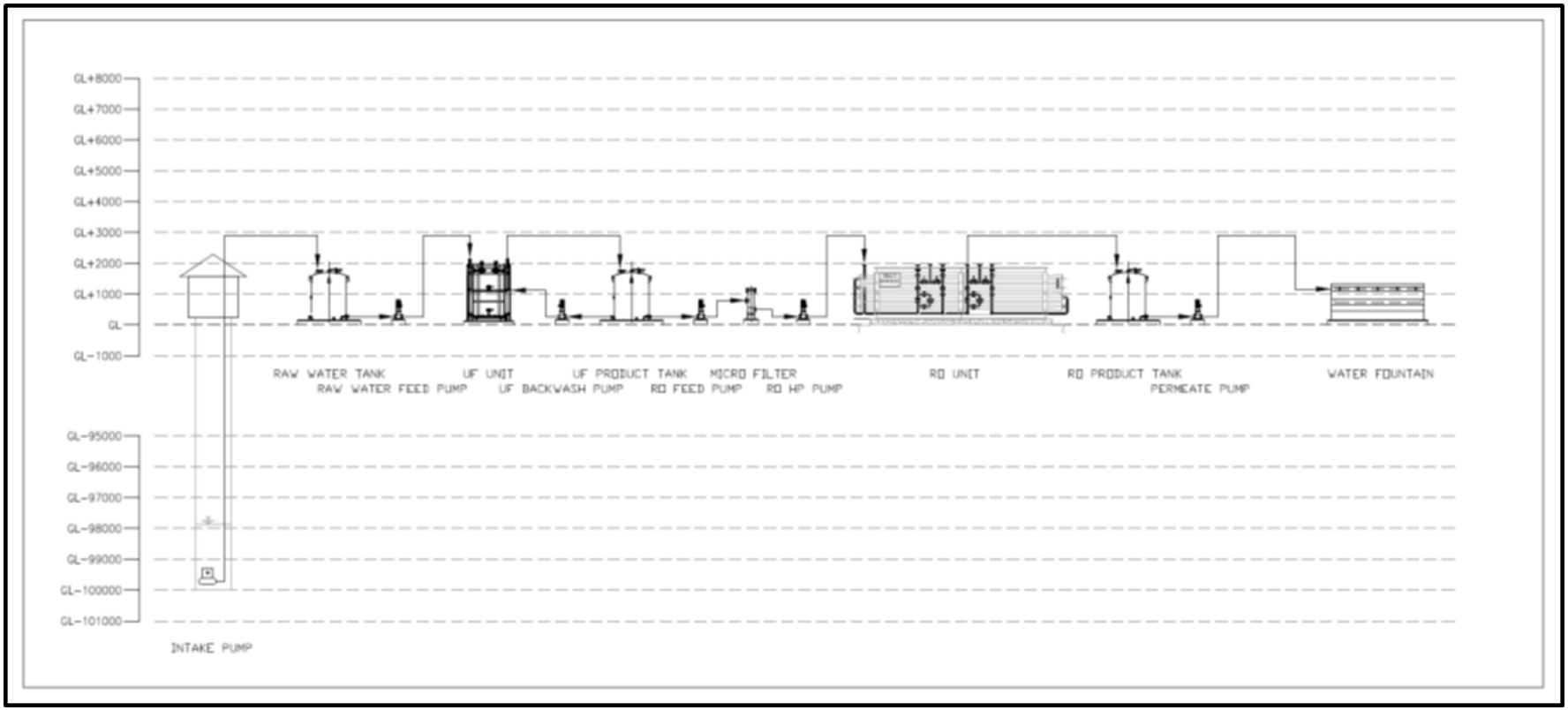


Figure 45. Hydraulic profile of Desalination system in Vinh Track Dong

Budget

The estimated price for the water Purification facility would be as follows:

Table 24. Cost estimation of Desalination system in Vinh Track Dong

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Construction works	1	25,439	25,439
2. Water Treatment system(UF+AC+RO, 27 m³/day)	1	198,423	198,423
3. PV(photovoltaics, 20kWh)	1	27,983	27,983
4. Transportation	1	19,842	19,842
5. Intake(100m)	1	16,959	16,959
6. 18L-Auto capper	1	16,959	16,959
7. Kiosk	2	6,784	13,567
8. Installation	1	39,685	39,685
9. Commissioning	1	15,263	15,263
Total			374,120

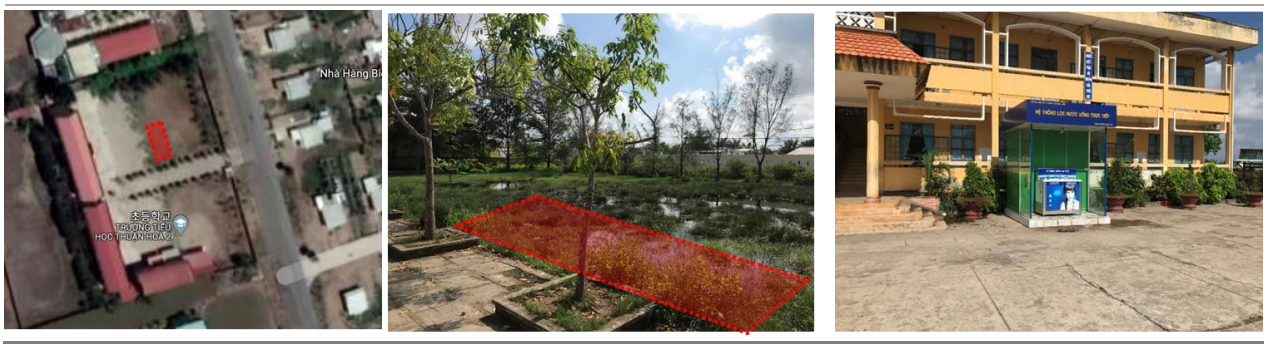
2). Truong Tieu Hoc Ngo Quyen : Rainwater Harvesting system

Rainwater harvesting system is planned for the Troung Tieu Hoc Ngo Quyen. Rainwater which is collected by this system will be used for toilet water and gardening. Now underground water and treated water is being used for these purposes.

The existing Desalination system is being operated for the potable water supply for the students and teachers which is shown below table.

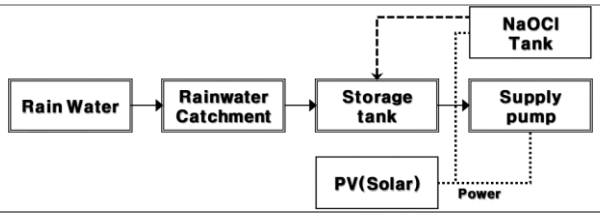
Table 25. Status of Truong Tieu Hoc Ngo

Category		Content
Location(coordinates)		9.249759, 105.799523
Number of water supply population	Student	806 person
	Educational personnel	36 person
	Total	842 person
Water supply within 1km radius		2,664 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		4.3 ㎥/day
Water Quality	TDS	1,109 mg/L
	Turbidity	2.57 NTU



According to the calculation result which is mentioned aforementioned chapter, the volume of rainwater storage tank is 600 m^3 and the available roof area for collecting rainwater is 1,213 m^2.
For the power supply, main source of power supply is the PV(solar) and grid will be connected for the emergency case, and regarding disinfection, NaOCl will be added at storage tank by automatic pump with the dosage of 2 mg/L.

Table 26. Summary of Design for Truong Tieu Hoc Ngo

Category	Content
Type	Water for living / Rain water harvesting
Water Source	Rain water
Capacity	4.3 m^3/day
Storage Tank	600 m^3
Roof area	1,213 m^2
Process	

The storage tank of rainwater harvesting system will be located underground of play yard at school as shown below;

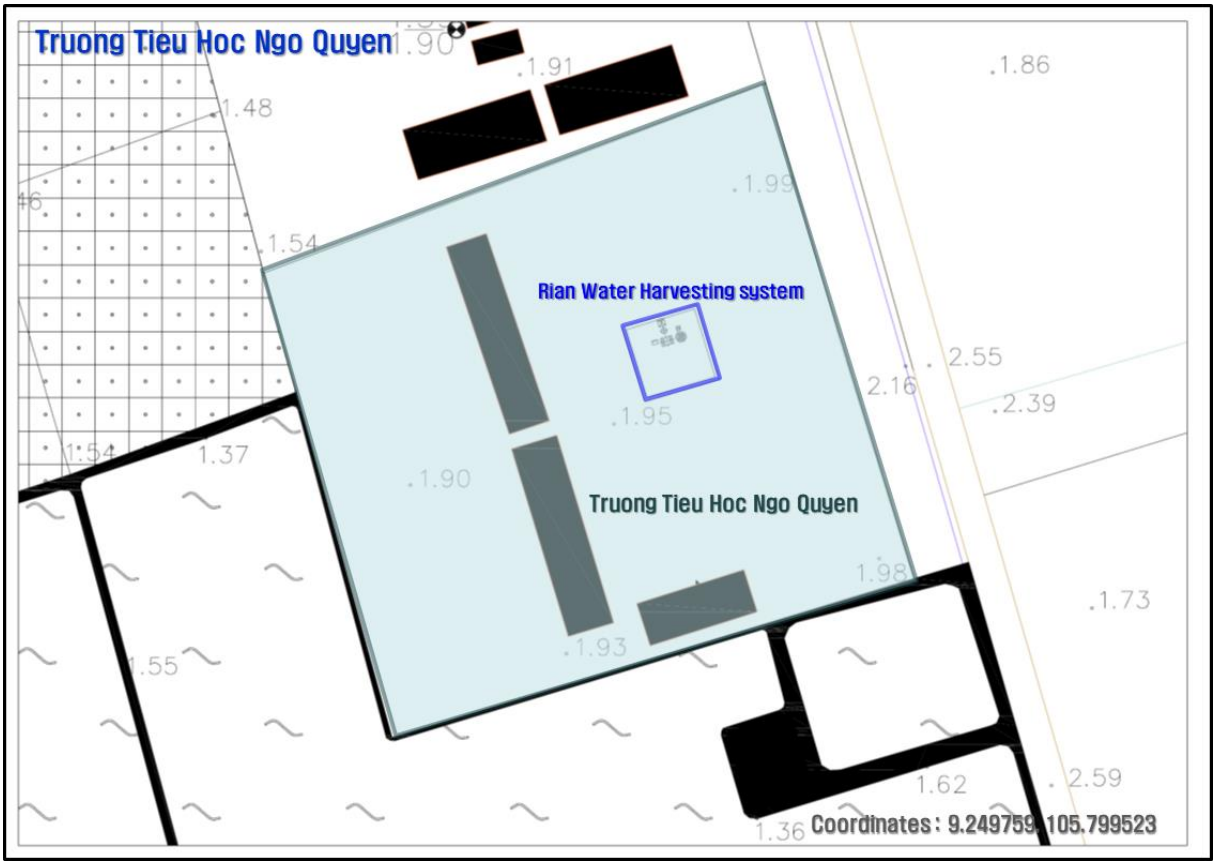


Figure 46. Proposed location of Rainwater harvesting system in Truong Tieu Hoc Ngo Quyen

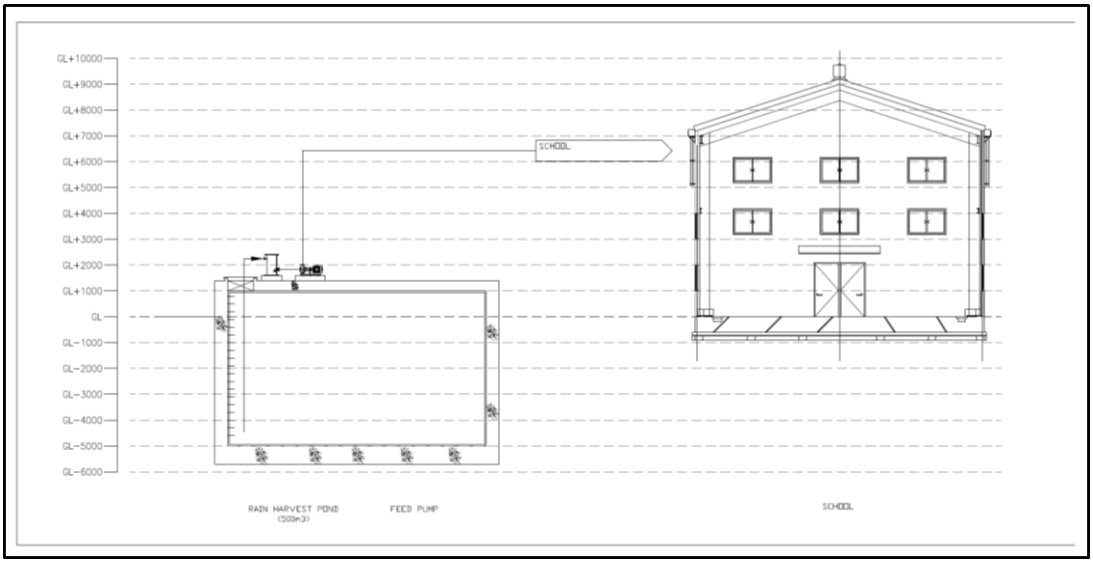


Figure 47. Typical section drawings of Proposed Rainwater harvesting system

Budget

The estimated price for the rainwater harvesting system would be as follows:

Table 27. Cost estimation of rainwater harvesting system in Truong Tieu Hoc Ngo Quyen

Description	Quantity	Unit Price(USD)	Cost(USD)

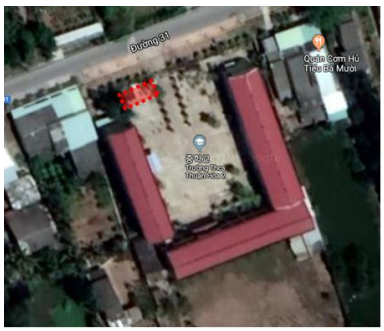
1. Rain water storage tank	1	152,633	152,633
2. Sterilization system	1	5,088	5,088
3. PV(photovoltaics, 3kWh)	1	4,240	4,240
4. Transportation	1	890	890
5. Roof improvement work	1	10,176	10,176
6. Rainwater harvesting first flush system	3	4,240	12,719
7. Rainwater catchment system(pipe)	1	14,839	14,839
8. Installation	1	30,527	30,527
9. Commissioning	1	5,088	5,088
Total			236,199

3) Troung Thcs Nguyen Hue : Rainwater Harvesting system

The same rainwater harvesting system which is proposed for Truong Tieu Hoc Ngo Quyen is planned for Troung Thcs Nguyen Hue. Main condition of Truoung Thcs Nguyen Hue is almost same as Troung Tieu Hoc Ngo.

Table 28. Status of Truong Thcs Nguyen Hue

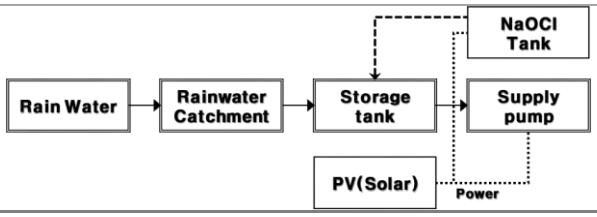
Category		Content
Location(coordinates)		9.247434, 105.784917
Number of water supply population	Student	516 person
	Educational personnel	35 person
	Total	551 person
Water supply within 1km radius		2,664 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		4.2 ㎥/day
Water Quality	TDS	1,129 mg/L
	Turbidity	2.18 NTU



According to the calculation result which is mentioned aforementioned chapter, the volume of rainwater storage tank is 600 m^3 and the available roof area for collecting rainwater is 1,182 m^2.
For the power supply, main source of power supply is the PV(solar) and grid will be connected for the emergency case, and regarding disinfection, NaOCl will be added at storage tank by automatic pump

with the dosage of 2 mg/L.

Table 29. Summary of Design for Truong Thcs Nguyen Hue

Category	Content
Type	Water for living / Rain water harvesting
Water Source	Rain water
Capacity	4.2 ㎥/day
Storage Tank	600 ㎥
Roof area	1,182 ㎡
Process	

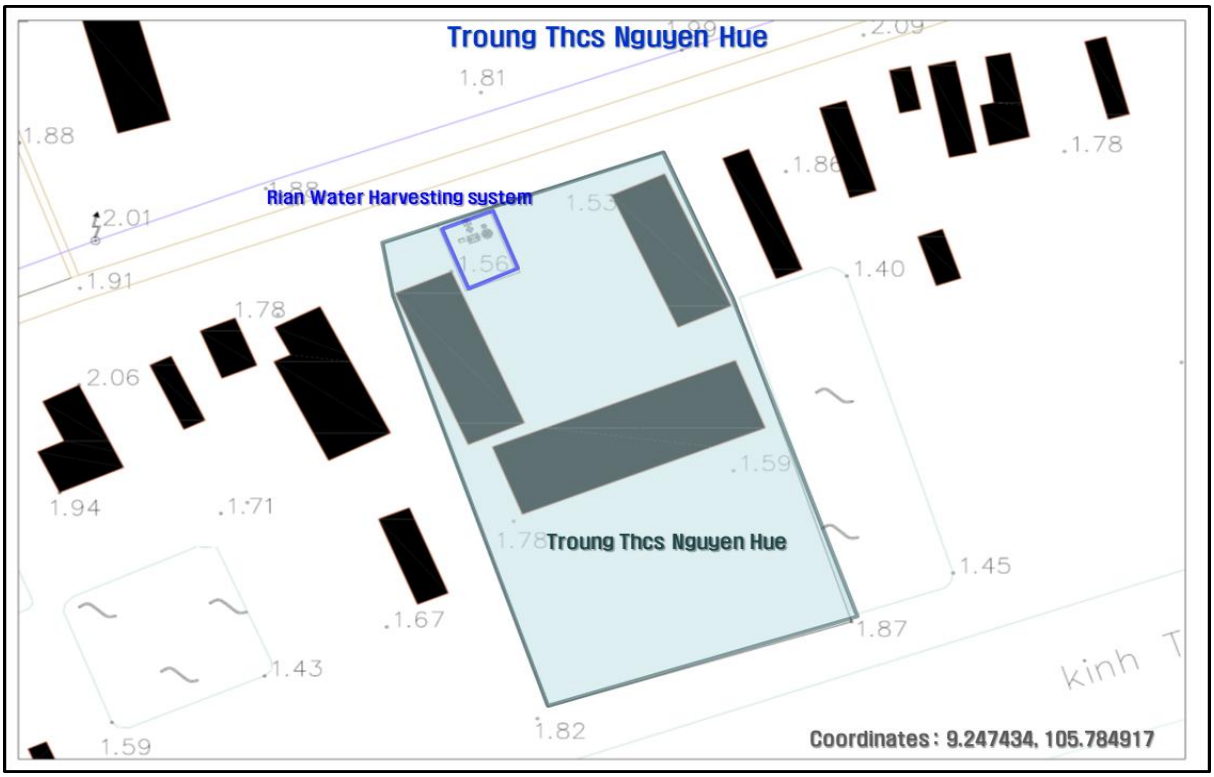


Figure 48. Proposed location of Rainwater harvesting system in Troung Thcs Nguyen Hue

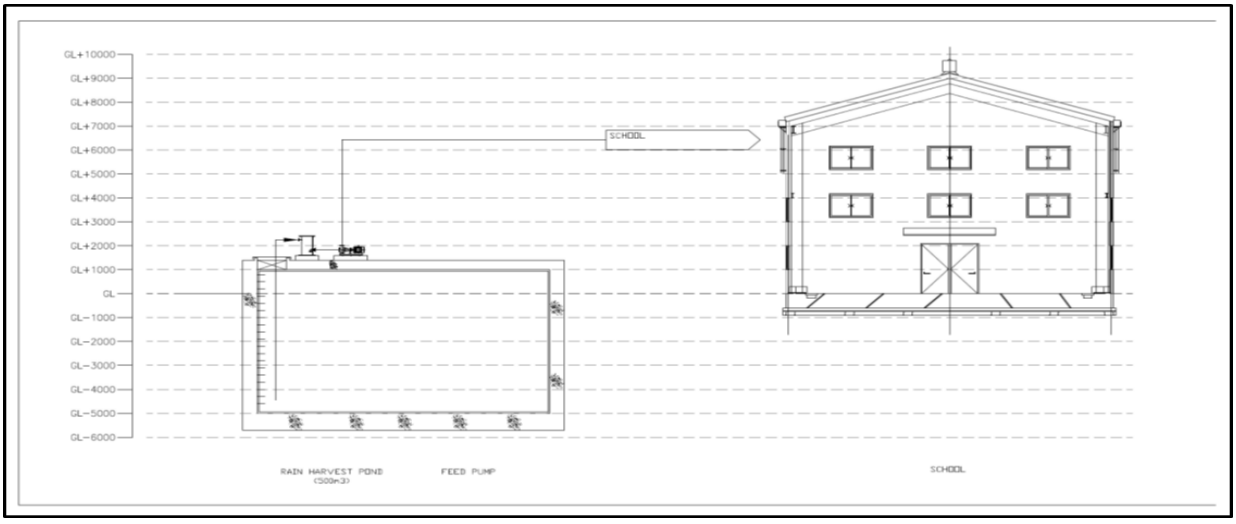


Figure 49. Typical section drawings of Proposed Rainwater harvesting system

Budget

The estimated price for the rainwater harvesting system would be as shown below:

Table 30. Cost estimation of rainwater harvesting system in Troung Thcs Nguyen Hue

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Rain water storage tank	1	152,633	152,633
2. Sterilization system	1	5,088	5,088
3. PV(photovoltaics, 3kWh)	1	4,240	4,240
4. Transportation	1	890	890
5. Roof improvement work	1	10,176	10,176
6. Rainwater harvesting first flush system	3	4,240	12,719
7. Rainwater catchment system(pipe)	1	14,839	14,839
8. Installation	1	30,527	30,527
9. Commissioning	1	5,88	5,88
Total			236,199

4) Troung Mau Vang Anh Kindergarten (Rainwater Harvesting)

Table 31. Status of Kindergarten (Truong Mau Vang Anh)

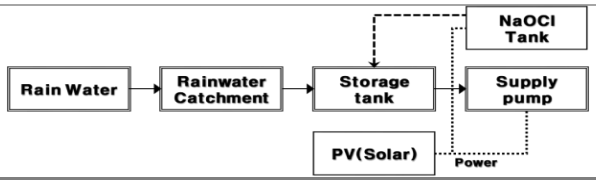
Category		Content
Location(coordinates)		9.249962, 105.792872
Number of water supply population	Student	252 person
	Educational personnel	27 person
	Total	279 person
Water supply within 1km radius		2,664 person
Source of water supply	Drinking Water	Bottled water
	Water for living	Ground Water & Water treatment plant
Water consumption		3.9 ㎥/day
Water Quality	TDS	1,129 mg/L
	Turbidity	2.18 NTU



According to the calculation result which is mentioned aforementioned chapter, the volume of rainwater storage tank is 550 m^3 and the available roof area for collecting rainwater is 1,093 m^2.

For the power supply, main source of power supply is the PV(solar) and grid will be connected for the emergency case, and regarding disinfection, NaOCl will be added at storage tank by automatic pump with the dosage of 2 mg/L.

Table 32. Summary of Design for Kindergarten (Truong Mau Vang Anh)

Category	Content
Type	Water for living / Rain water harvesting
Water Source	Rain water
Capacity	3.9 ㎥/day
Storage Tank	550 ㎥
Roof area	1,093 ㎡
Process	

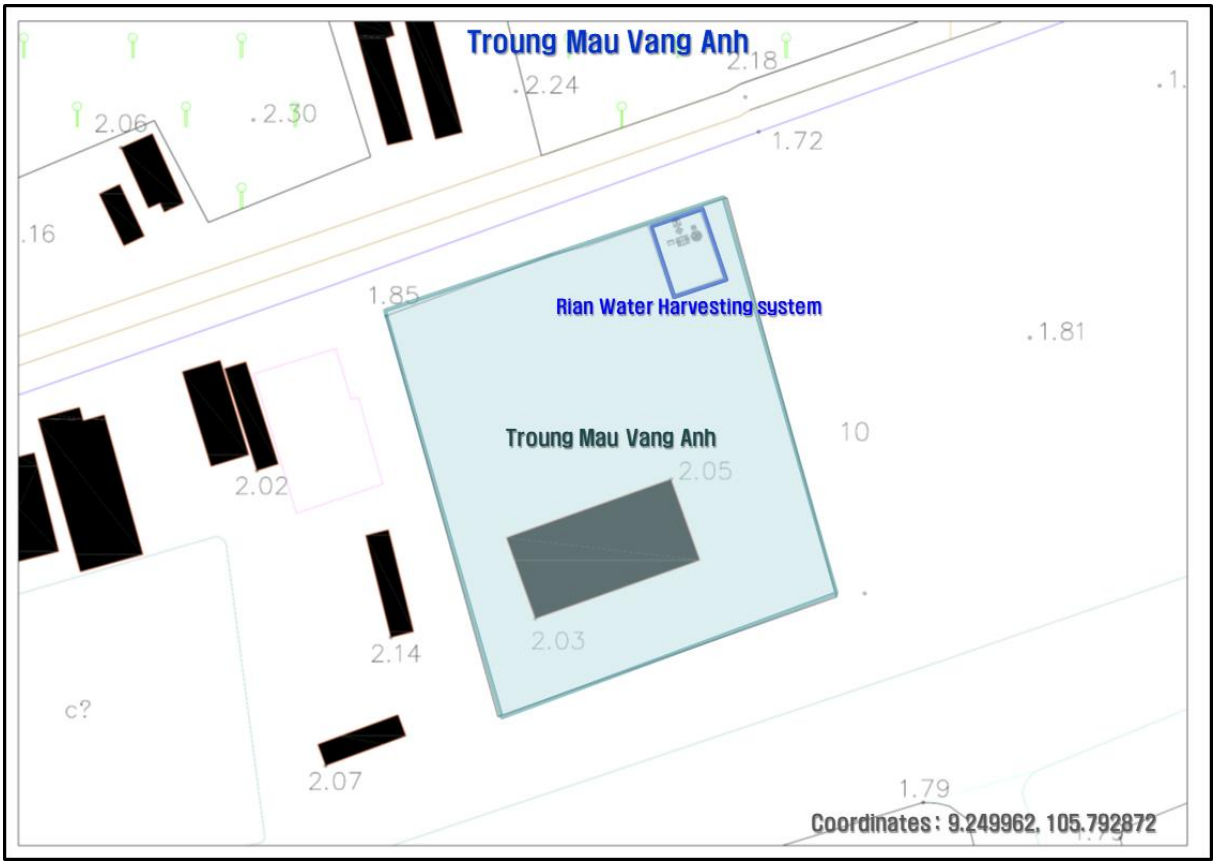


Figure 50. Proposed location of Rainwater harvesting system in Troung Mau Vang Anh

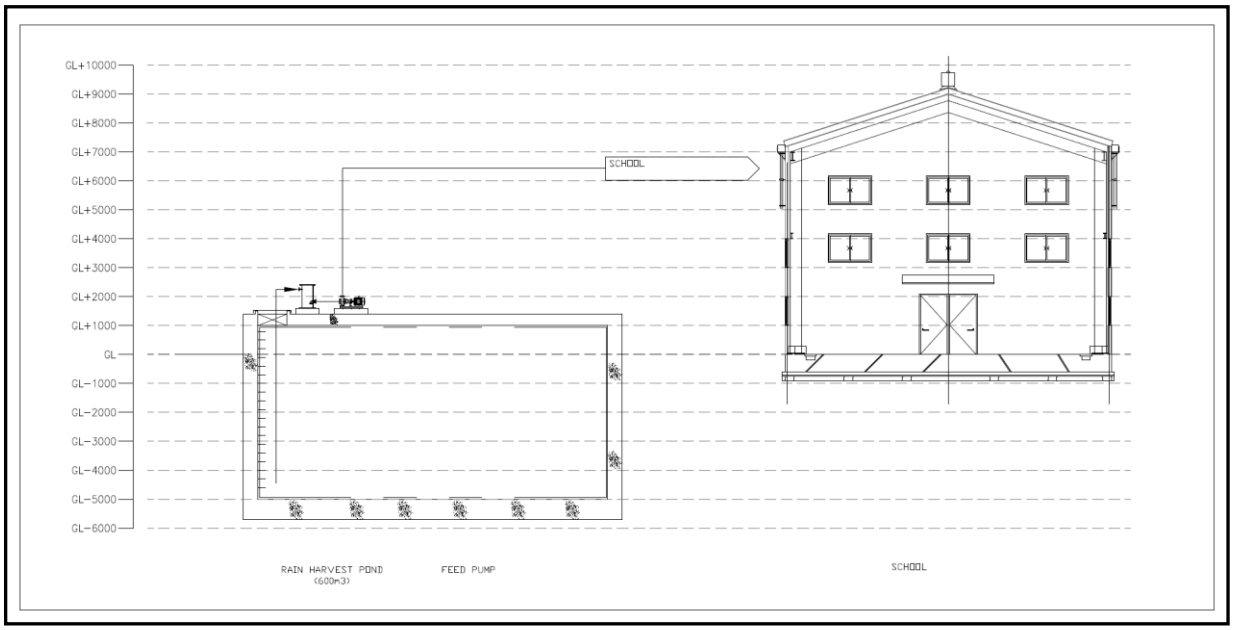


Figure 51. Typical section drawings of Proposed Rainwater harvesting system

Budget

The estimated price for the rainwater harvesting system would be as follows:

Table 33. Cost estimation of rainwater harvesting system in Troung Mau Vang Anh Kindergarten

Description	Quantity	Unit Price(USD)	Cost(USD)
1. Rain water storage tank	1	127,194	127,194
2. Sterilization system	1	5,088	5,088
3. PV(photovoltaics, 3kWh)	1	4,240	4,240
4. Transportation	1	890	890
5. Roof improvement work	1	10,176	10,176
6. Rainwater harvesting first flush system	3	4,240	12,719
7. Rainwater catchment system(pipe)	1	14,839	14,839
8. Installation	1	25,439	25,439
9. Commissioning	1	5,088	5,088
Total			205,673

4.6 Estimation of Total Project cost

Table 34. The summary of Cost Estimation for the project

Province	Commune	Site	Type	Capacity (Q or V)	Cost (USD)
Tra Vinh	Long Hoa	1. Long Hoa secondary school	Desalination System	15m³/day	252,099
		2. Truong Tieu Hoc Long Hoa A		9.4m³/day	243,195
	Hoa Minh	3. Tuong Mau Giao		22.7m³/day	374,120
		4. School Complex		11.2m³/day	309,590
Bac Lieu	Vin Track Dong	5. Replacement Area		26.6m³/day	374,120
		6. Truong Tieu Hoc Ngo Quyen	Rain Water Harvesting	600m³	236,199
		7. Truong Thcs Nguyen Hue		600 m³	236,199
		8. Truong Mau Galo Vang Ang		550 m³	205,673
Total					2,231,195

4.7 Permission and Implementation Procedure

To arrange the implementation of project management, the meeting was held 2 times with all related stake holders during the project period. Details of meeting results are shown from annex 1 to annex 3.

Structure of Project Implementation is shown below. Project Management Unit (PMU), whose manager from MONRE, will play a key role in this project such as distribution of RFP, decision making with PSC and so on.

The main decision such as selection of company for construction, selection of bidding procedure and budget execution will be approved by Project Steering Committee.

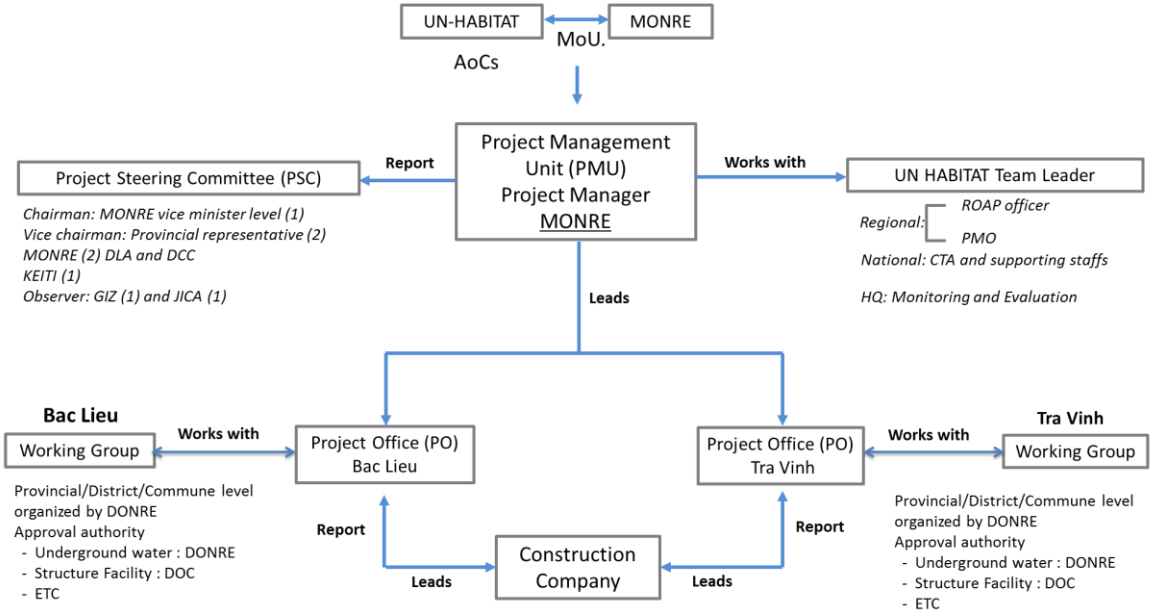


Figure 52. Structure of project implementation

At the construction stage, related permissions for the commencement of construction, for extraction of groundwater will be approved by working group via Project Office (PO) of each province.

5. Economic Feasibility Study

5.1.Overview

The aim of economic feasibility analysis is to estimate and compare the project cost and operating cost necessary for the project as well as the economic benefit resulting from the project in order to analyze and determine whether the benefit exceeds the cost.

Final conclusion shall be made, taking into account measurable economic benefit as well as non-economic benefit or non-monetary benefit. But given the difficulties of estimating the social benefit or cost numerically, social benefit and cost were excluded from the analysis in this study and economic feasibility was evaluated through IRR and NPV analysis.

Basic assumption

1) Prerequisite

- Construction period: Jan. 2020 ~ Jun. 2020 (6 months)
- Operation duration: Jul. 2020 ~ Jun. 2040 (20 years of operation period was assumed)

2) Estimate of project cost and operation cost

- Project cost includes construction cost for Desalination System and Rain Harvesting facilities

and ancillary facilities and contingency, while operation cost includes labor cost, electric power cost, general expenses and maintenance cost.

3) Estimate of benefit

- Estimated measurable benefit from the project includes revenue from water supply.

4) Inflation

- Annual inflation rate of 3% was applied to water supply and operating cost.

5) Exchange rate

- 1USD=1,179 KRW as of July 10, 2019 was applied.

5.2 Business model scenario

Economic feasibility study considering the business model for scale up is performed to evaluate the feasibility as investment project after the project funded from Adaptation Fund. In this business model concept, the construction cost is considered as investment cost which is the most different factor from the analysis of grant model.

To analyze this model, four types of model was set as below;

5.2.1 Case Ⅰ: Worst financial scenario: Desalination system for 1 place

1) Estimate of total investment cost and financing structure

Estimate of total investment cost

The total project cost including construction cost, test operation was estimated 269,524 USD and the total investment cost including contingency (price index) and construction interest was estimated at 274,064 USD.

Table 35. Breakdown of total investment cost

Category	Amount (USD)	Ratio (%)	Remarks
Construction cost	215,806	78.7	
Incidental cost	53,718	19.6	Transport, test & commissioning
Contingency	2,919	1.1	Inflation rate
Construction interest	1,621	0.6	
Total investment cost	**274,064**	**100.0**	

2) Estimate of operating revenue and cost

Estimate of operating revenue

Operating revenue in this project consists of the revenue from water supply through the Desalination System.

Table 36. Basic assumption for operating revenue

Category	Water supply	Days	Production cost	Inflation
Revenue from water supply	9.4 ton/day	365days	10.1 USD/ton	3.0%

Production cost was estimated considering 10 % of project earning rate and estimated sales during the operation period was 976,910 USD and average annual sales during the operation period is 48,846 USD.

Estimate of operating cost

Operating cost consists of labor cost, electric power cost, general expenses and maintenance cost. Annual inflation rate of 3% was applied.

Table 37. Breakdown of operating cost (Unit: USD/ year)

Category	Amount	Ratio (%)	Remarks
Labor cost	6,614	60.1	2019 constant price
Electric power cost	630	5.7	
General expenses	1,624	14.7	
Maintenance cost	2,143	19.5	
Total	11,010	100.0	

The total operating cost occurring from the facilities during the operation period was estimated at 309,290 USD, which corresponds to approximately 31.7% of the total sales. In detail, labor cost accounts for 60.1% of the total, electric power cost 5.7%, general expenses 14.7% and maintenance cost 19.5%

3) Economic feasibility analysis

Basic assumptions for economic feasibility analysis

Basic assumptions for economic feasibility analysis are as follows.

Table 38. Basic assumptions

Category		Description
Project duration	Reference date	Jan 1, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul. 2020 ~ Jun. 2040)
	Annual operating days	Water supply : 365 days
Project scale	Total project cost	269,524 USD
	Total investment cost	274,064 USD
Financing	Funding ratio	Equity : 20.0 %
		Borrowed : 80.0 %
Revenue and cost	Operating revenue	Production cost : 10.1 USD/ton
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0 % assumed
	Corporate tax	20.0%(single tax rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Result of economic feasibility study

Table 39. IRR and B/C ratio

	Before Tax	After Tax
IRR	10.00 %	9.48 %

B/C Ratio	1.00	0.98

Production cost to achieve the earning rate of 10.0% was estimated 10.1 USD/ton and the estimated B/C ratio on the assumption of production cost 10.1 USD/ton was 1.00 for before tax and 0.98 for after tax respectively.

5.2.2 Case Ⅱ-1: Desalination system for one province (Tra Vinh Province: 4 sites)

1) Estimate of total investment cost and financing structure

Estimate of total investment cost

The total project cost including construction cost, test operation for 4 places of Desalination system was estimated 1,305,212 USD and the total investment cost including contingency (price index) and construction interest was estimated at 1,327,264 USD.

Table 40. Breakdown of total investment cost

Category	Amount (USD)	Ratio (%)	Remarks
Construction cost	1,058,170	79.7	
Incidental cost	247,042	18.6	Transport, test & commissioning
Contingency	14,090	1.1	Inflation rate
Construction interest	7,961	0.6	
Total investment cost	**1,327,264**	**100.0**	

2) Estimate of operating revenue and cost

Estimate of operating revenue

Operating revenue in this project consists of the revenue from water supply through the Desalination System.

Table 41. Basic assumption for operating revenue

Category	Water supply	Days	Production cost	Inflation
Revenue from water supply	58.3 ton/day	365days	7.8 USD/ton	3.0%

Production cost was estimated considering 10 % of project earning rate and estimated sales during the operation period was 4,658,637 USD and average annual sales during the operation period is 232,932 USD.

Estimate of operating cost

Operating cost consists of labor cost, electric power cost, general expenses and maintenance cost. Annual inflation rate of 3% was applied.

Table 42. Breakdown of operating cost (Unit: USD/ year)

Category	Amount	Ratio (%)	Remarks
Labor cost	26,456	52.1	2019 constant price
Electric power cost	2,784	5.5	
General expenses	8,617	17.0	
Maintenance cost	12,895	25.4	
Total	50,751	100.0	

The total operating cost occurring from the facilities during the operation period was estimated

at 1,425,691 USD, which corresponds to approximately 30.6% of the total sales. In detail, labor cost accounts for 52.1% of the total, electric power cost 5.5%, general expenses 17.0% and maintenance cost 25.4%

3) Economic feasibility analysis

Basic assumptions for economic feasibility analysis

Basic assumptions for economic feasibility analysis are as follows.

Table 43. Basic assumptions

Category		Description
Project duration	Reference date	Jan 1, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul. 2020 ~ Jun. 2040)
	Annual operating days	Water supply : 365 days
Project scale	Total project cost	1,305,212 USD
	Total investment cost	1.327.264 USD
Financing	Funding ratio	Equity : 20.0 %
		Borrowed : 80.0 %
Revenue and cost	Operating revenue	Production cost : 7.8 USD/ton
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0 % assumed
	Corporate tax	20.0%(single tax rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Result of economic feasibility study

Table 44. IRR and B/C ratio

	Before Tax	After Tax
IRR	10.00 %	9.48 %
B/C Ratio	1.00	0.98

Production cost to achieve the earning rate of 10.0% was estimated 7.8 USD/ton and the estimated B/C ratio on the assumption of production cost 7.8 USD/ton was 1.00 for before tax and 0.98 for after tax respectively.

5.2.3 Case Ⅱ-2: Desalination system for one province (Bac Lieu Province: 1 site)

1) Estimate of total investment cost and financing structure

Estimate of total investment cost

The total project cost including construction cost, test operation for 1 place of desalination system was estimated 416,921 USD and the total investment cost including contingency (price index) and construction interest was estimated at 424,002 USD.

Table 45. Breakdown of total investment cost

Category	Amount (USD)	Ratio (%)	Remarks

Construction cost	339,015	80.0	
Incidental cost	77,906	18.4	Transport, test & commissioning
Contingency	4,473	1.1	Inflation rate
Construction interest	2,609	0.6	
Total investment cost	**424,002**	**100.0**	

2) Estimate of operating revenue and cost

Estimate of operating revenue

Operating revenue in this project consists of the revenue from water supply through the Desalination System.

Table 46. Basic assumption for operating revenue

Category	Water supply	Days	Production cost	Inflation
Revenue from water supply	26.6 ton/day	365days	5.4 USD/ton	3.0%

Production cost was estimated considering 10 % of project earning rate and estimated sales during the operation period was 1,480,839 USD and average annual sales during the operation period is 74,042 USD.

Estimate of operating cost

Operating cost consists of labor cost, electric power cost, general expenses and maintenance cost. Annual inflation rate of 3% was applied.

Table 47. Breakdown of operating cost (Unit: USD/ year)

Category	Amount	Ratio (%)	Remarks
Labor cost	6,614	41.5	2019 constant price
Electric power cost	837	5.2	
General expenses	3,228	20.2	
Maintenance cost	5,277	33.1	
Total	15,955	100.0	

The total operating cost occurring from the facilities during the operation period was estimated at 448,215 USD, which corresponds to approximately 30.3% of the total sales. In detail, labor cost accounts for 41.5% of the total, electric power cost 5.2%, general expenses 20.2% and maintenance cost 33.1%.

3) Economic feasibility analysis

Basic assumptions for economic feasibility analysis

Basic assumptions for economic feasibility analysis are as follows.

Table 48. Basic assumptions

Category		Description
Project duration	Reference date	Jan 1, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul. 2020 ~ Jun. 2040)
	Annual operating days	Water supply : 365 days
Project scale	Total project cost	416,921 USD

	Total investment cost	416,921 USD
Financing	Funding ratio	Equity : 20.0 %
		Borrowed : 80.0 %
Revenue and cost	Operating revenue	Production cost : 5.4 USD/ton
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0 % assumed
	Corporate tax	20.0%(single tax rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Result of economic feasibility study

Table 49. IRR and B/C ratio

	Before Tax	After Tax
IRR	10.00 %	9.48 %
B/C Ratio	1.00	0.98

Production cost to achieve the earning rate of 10.0% was estimated 5.4 USD/ton and the estimated B/C ratio on the assumption of production cost 5.4 USD/ton was 1.00 for before tax and 0.98 for after tax respectively.

5.2.4 Case Ⅲ: Desalination system for multi-provinces (Tra Vinh + Bac lieu : 5 sites)

1) Estimate of total investment cost and financing structure

Estimate of total investment cost

The total project cost including construction cost, test operation for 5 places of desalination system was estimated 1,722,133 USD and the total investment cost including contingency (price index) and construction interest was estimated at 1,751,266 USD.

Table 50. Breakdown of total investment cost

Category	Amount (USD)	Ratio (%)	Remarks
Construction cost	1,397,185	79.8	
Incidental cost	324,948	18.6	Transport, test & commissioning
Contingency	18,563	1.1	Inflation rate
Construction interest	10,570	0.6	
Total investment cost	**1,751,266**	**100.0**	

2) Estimate of operating revenue and cost

Estimate of operating revenue

Operating revenue in this project consists of the revenue from water supply through the Desalination System.

Table 51. Basic assumption for operating revenue

Category	Water supply	Days	Production cost	Inflation
Revenue from water supply	84.9 ton/day	365days	7.1 USD/ton	3.0%

Production cost was estimated considering 10 % of project earning rate and estimated sales during the operation period was 6,139,477 USD and average annual sales during the operation period is 306,974 USD.

Estimate of operating cost

Operating cost consists of labor cost, electric power cost, general expenses and maintenance cost. Annual inflation rate of 3% was applied.

Table 52. Breakdown of operating cost (Unit: USD/ year)

Category	Amount	Ratio (%)	Remarks
Labor cost	33,070	49.6	2019 constant price
Electric power cost	3,620	5.4	
General expenses	11,845	17.8	
Maintenance cost	18,172	27.2	
Total	66,707	100.0	

The total operating cost occurring from the facilities during the operation period was estimated at 1,873,906 USD, which corresponds to approximately 30.5% of the total sales. In detail, labor cost accounts for 49.6% of the total, electric power cost 5.4%, general expenses 17.8% and maintenance cost 27.2%.

3) Economic feasibility analysis

Basic assumptions for economic feasibility analysis

Basic assumptions for economic feasibility analysis are as follows.

Table 53. Basic assumptions

Category		Description
Project duration	Reference date	Jan 1, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul. 2020 ~ Jun. 2040)
	Annual operating days	Water supply : 365 days
Project scale	Total project cost	1,722,133 USD
	Total investment cost	1,751,266 USD
Financing	Funding ratio	Equity : 20.0 %
		Borrowed : 80.0 %
Revenue and cost	Operating revenue	Production cost : 7.1 USD/ton
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0 % assumed
	Corporate tax	20.0%(single tax rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Result of economic feasibility study

Table 54. IRR and B/C ratio

	Before Tax	After Tax
IRR	10.00 %	9.48 %
B/C Ratio	1.00	0.98

Production cost to achieve the earning rate of 10.0% was estimated 7.1 USD/ton and the estimated B/C ratio on the assumption of production cost 7.1 USD/ton was 1.00 for before tax and 0.98 for after tax respectively.

5.3 Grant project scenario for desalination system

Description

This chapter briefly shows the result of feasibility study not for the business model but for the grant model which is going to be implemented with Adaptation Fund.

The biggest difference with aforementioned business model is the financing source which comes from public sector. Accordingly, in this study, the only 10% of O&M cost is considering to estimate the production cost. The details of assumption is shown below table.

Table 55. Basic assumptions

Category		Description
Project duration	Reference date	Jan 1, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul. 2020 ~ Jun. 2040)
	Annual operating days	Water supply : 365 days
Financing	Funding ratio	Public sector : 100.0 %
		Private sector : 0 %
Revenue and cost	Operating revenue	Production cost : satisfying 10 % of O&M cost
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0 % assumed
	Corporate tax	20.0%(single tax rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Result of economic feasibility study

Table 56. Result of economic feasibility study for grant model

	Operating cost (USD/year)	Sales (USD/year)	Production cost (USD/ton)	B/C (before tax)	B/C (after tax)
Long Hoa secondary school	11,211	12,333	2.3	1.03	1.03
Truong Tieu Hoc Long Hoa A	10,010	12,111	3.5	1.03	1.03
Truong Mau Giao	15,829	17,412	2.1	1.03	1.03
School Complex	12,701	13,971	3.4	1.03	1.02
Replacement Area	15,955	17,551	1.8	1.03	1.03

As a result of analysis, B/C ratio from all cases is over 1.0, accordingly, all systems with

grant model is economically feasible.

5.4 Grant project scenario for rainwater harvesting system

1) Estimate of total investment cost and financing structure

Estimate of total investment cost

The total project cost including construction cost, test operation was estimated 678,072 USD and the total investment cost including contingency (price index) and construction interest was estimated at 685,681 USD.

Table 57. Breakdown of total investment cost (Unit: USD)

Category	Amount	Ratio (%)	Remarks
Construction cost	660,137	96.3	
Incidental cost	17,934	2.6	Transport, test & commissioning
Contingency	7,610	1.1	Inflation rate
Construction interest	-	-	
Total investment cost	685,681	100.0	

2) Estimate of operating revenue and cost

Estimate of operating revenue

Operating revenue in this project consists of estimated reduction of water supply fee by the rainwater harvesting system.

Table 58. Basic assumption for operating revenue (Unit: USD)

Category	Days	Sales price (constant)	Inflation
Revenue from reduction of water supply fee	365days	500 USD/year	3.0%

Estimated sales during the operation period was 14,046USD and average annual sales during the operation period is 702 USD.

Estimate of operating cost

Operating cost consists of labor cost, electric power cost, general expenses and maintenance cost. Annual inflation rate of 3% was applied.

Table 59. Breakdown of operating cost (Unit: USD/ year)

Category	Amount	Ratio (%)	Remarks
Labor cost	763	44.8	2019 constant price
Electric power cost	429	25.2	
General expenses	358	21.0	
Maintenance cost	153	9.0	
Total	1,703	100.0	

The total operating cost occurring from the facilities during the operation period was estimated at 47,837 USD, which corresponds to approximately 340.6% of the total sales. In detail, labor cost accounts for 44.8% of the total, electric power cost 25.2%, general expenses 21.0% and maintenance cost 9.0%.

3) Economic feasibility analysis

Basic assumptions for economic feasibility analysis

Basic assumptions for economic feasibility analysis are as follows.

Table 60. Basic assumptions

Category		Description
Project duration	Reference date	Jan 1, 2019
	Construction period	6 months (Jan. ~ Jun. 2020)
	Operation period	20 years (Jul. 2020 ~ Jun. 2040)
	Annual operating days	Water supply : 365 days
Project scale	Total project cost	678,072 USD
	Total investment cost	685,681 USD
Financing	Funding ratio	Public sector : 100.0 %
		Private sector : -
Revenue and cost	Operating revenue	500 USD/ year
	Operating costs	Labor cost, electric power cost, general expense, maintenance cost
Other assumptions	Discount rate	10.0 % assumed
	Corporate tax	20.0%(single tax rate)
	Inflation rate	3.0% assumed
	Exchange rate	KRW/USD = 1,179 assumed

Analysis of B/C ratio

Table 61. B/C ratio

B/C ratio (after tax)	B/C ratio (before tax)
0.98	0.98

5.5 Conclusion

1) Result of economic feasibility study for Business model

Table 62. Summary of economic feasibility study for Desalination system

	Production cost (USD/ ton)	Earning rate (before tax) (%)	Earning rate (after tax) (%)
Case Ⅰ	10.1	10.00	9.48
Case Ⅱ	7.8	10.00	9.48
Case Ⅲ	5.4	10.00	9.48
Case Ⅳ	7.1	10..0	9.48

2) Result of economic feasibility study for grant model

Table 63. Summary of economic feasibility study for Desalination system

	Operating cost (USD/year)	Sales (USD/year)	Production cost (USD/ton)	B/C (before tax)	B/C (after tax)
Long Hoa secondary	11,211	12,333	2.3	1.03	1.03

school					
Truong Tieu Hoc Long Hoa A	10,010	12,111	3.5	1.03	1.03
Truong Mau Giao	15,829	17,412	2.1	1.03	1.03
School Complex	12,701	13,971	3.4	1.03	1.02
Replacement Area	15,955	17,551	1.8	1.03	1.03

3) Result of economic feasibility study for Rainwater harvesting system

Table 64. Summary of economic feasibility study for rainwater harvesting system

	Revenue from reduction of water supply fee (constant)	B/C ratio (after tax)	B/C ratio (before tax)
Rainwater harvesting system	500 USD/year	0.98	0.98

Application in Can Tho region

As mentioned in this feasibility study, condition in project area for climate change is almost the same as in the rest of Can Tho region. Accordingly, similar type of desalination system can be applied in Can Tho region.

Chapter 1. Overview

1.1 Background

◦ Coastal erosion in Mekong Delta is derived from diverse aspects including artificial impact caused by human activities as well as natural effect from climate change.

◦ Based on the current condition of coastal erosion in Mekong Delta, 562 erosion locations were identified across 786 km. The number includes the following; 55 cases in serious danger (173 km), 140 endangered cases (97 km), 367 normal erosion cases (516 km).

◦ Especially, Ca Mau Peninsula shows 12.2 m of erosion rate for a year and 70% of its coastal area is being threatened by erosion. In addition, as socioeconomic and environmental change have been dramatic they are accelerating more environmental problems (UN-Habitat, 2019).

◦ The continuous sea level rise as a result of climate change has accelerated erosions in coastal areas, and the problems are continuously affecting the livelihoods of local residents. Therefore, proper strategies should be prepared to overcome the crisis.

Figure 1.1 The images of coastal erosion in the Mekong Delta

1.2 Purpose

◦ This study is aimed at establishing a small-size pilot project as reviewing an eco-friendly coastal protection method for Mekong Delta which is facing serious damage of coastal erosion.

1.3 Location

◦ Long Hoa commune, Hoa Minh commune (Chau Thanh District, Tra Vinh Province, Vietnam)

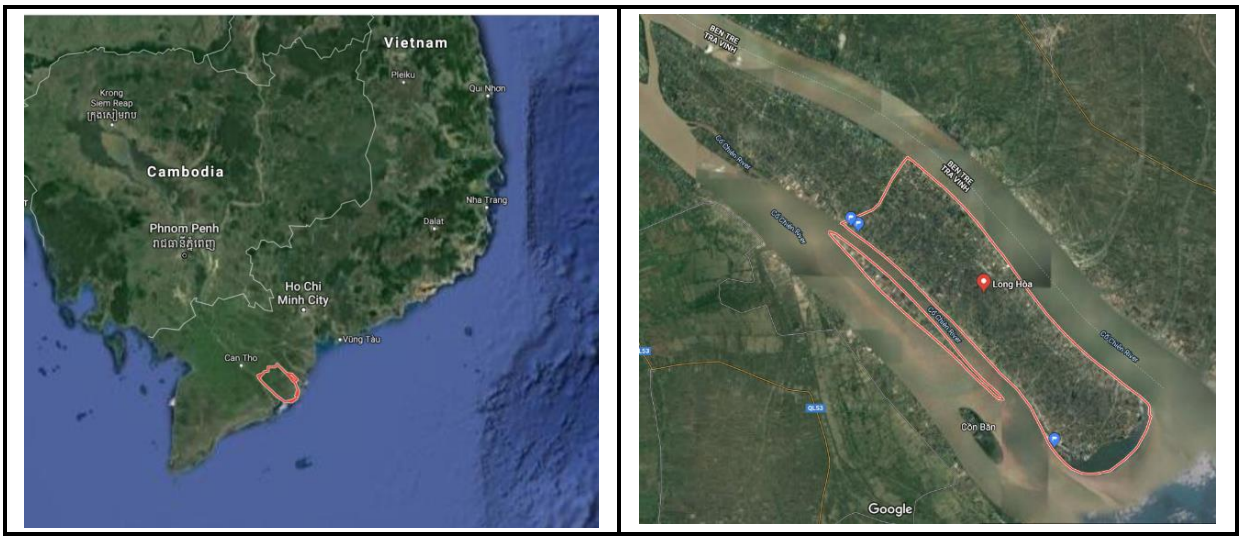


Figure 1.2 Location of Long Hoa and Hoa Minh

1.4 Work Scope

◦ Review on existing data and analysis on current status

◦ Field survey

◦ Review on validity to apply the eco-friendly coastal protection method

◦ Conceptual design (Typical section drawing, Layout plan, Roughly estimated cost, etc.)

Chapter 2. Climate and Field Data

2.1 Tide

◦ The tide data are analyzed that observed at Vung Tau and Con Dao which are located near the target coast.

◦ Harmonic and non-harmonic constants were described in Table 2.1, which were analyzed for the tide in Vung Tau and Con Dao.

◦ Mean sea level (M.S.L) is 214.6 cm, 212.0 cm, and mean high tide level is 324.5 cm, 320.0 cm.

◦ Previous study material about monthly average of sea-level change showed a trend that sea-level rises from October to April (Thomas et al., 2010).

Figure 2.1 Location of tidal data stations

Table 2.1 Harmonic and non-harmonic constants

Station name		**Vung Tau**		**Con Dao**	
Latitude		10°18' 18.0″N		8°39' 21.6″N	
Longitude		107°05' 09.6″E		106°35' 34.8″E	
		Amplitude (cm)	Phase (º)	Amplitude (cm)	Phase (º)
Harmonic Constant	M2	79.2	65.1	80.0	81.1
	S2	30.7	111.0	28.0	142.0
	K1	59.5	327.7	59.0	333.7
	01	45.2	276.4	45.0	290.4
Non-Harmonic Constant	Approximate Highest High Water (A.H.H.W.)	429.2	cm	424.0	cm
	Mean High Water Springs (M.H.W.S.)	324.5	cm	320.0	cm
	Mean High Water (M.H.W.)	293.8	cm	292.0	cm
	Mean High Water Neaps (M.H.W.N.)	263.1	cm	264.0	cm
	Mean Sea Level (M.S.L.)	214.6	cm	212.0	cm
	Mean Low Water Neaps (M.L.W.N.)	166.1	cm	160.0	cm
	Mean Low Water (M.L.W.)	135.4	cm	132.0	cm
	Mean Low Water Springs (M.L.W.S.)	104.7	cm	104.0	cm
	Approximate Lowest Low Water (A.L.L.W.)	0.0	cm	0.0	cm
	Spring Range	219.8	cm	216.0	cm
	Mean Range	158.4	cm	160.0	cm
	Neap Range	97.0	cm	104.0	cm
	Tidal Form Factor (HK+HO)/HM+HS)	0.95		0.96	

* Source : Harmonic constant data refers to Hung et al. (2019)

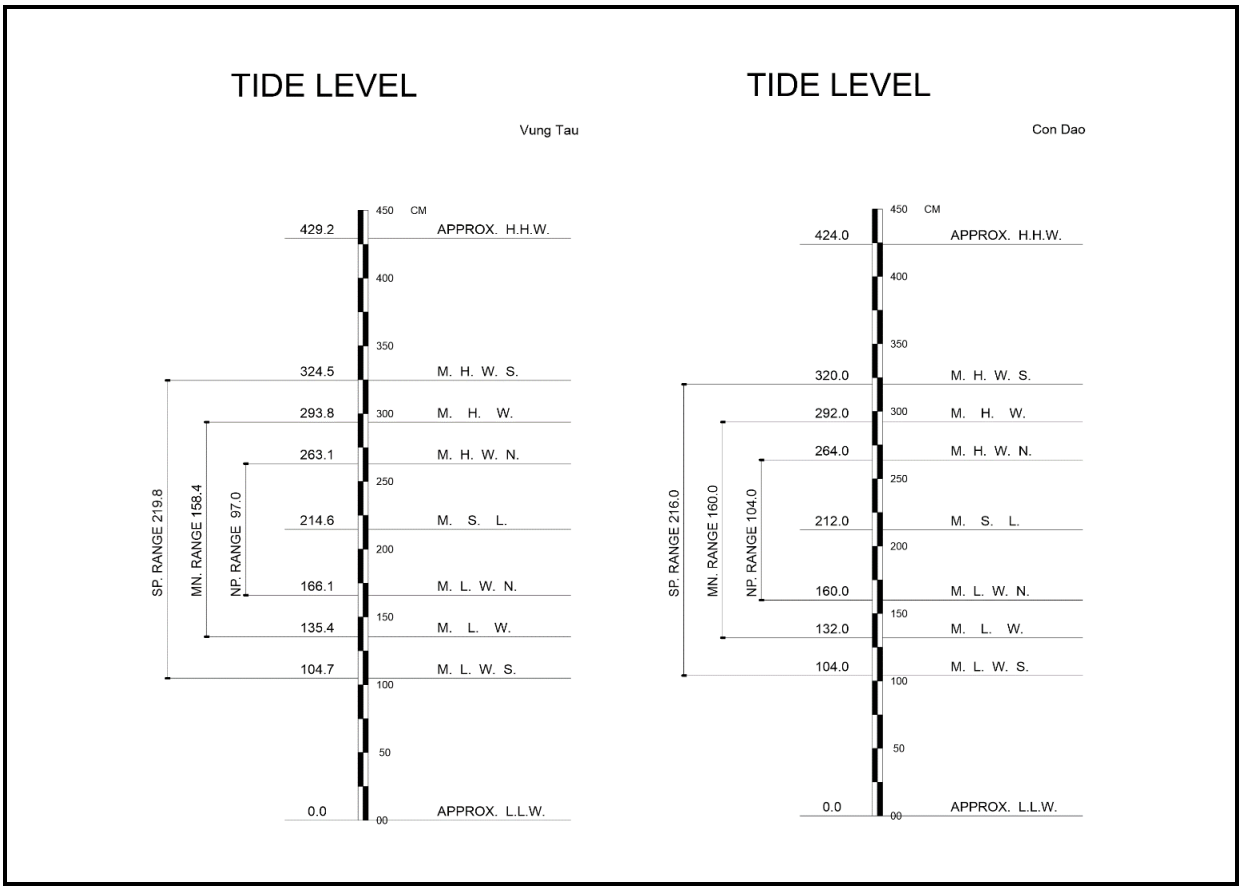


Figure 2.2 Tide level at Vung Tau, Con Dao stations

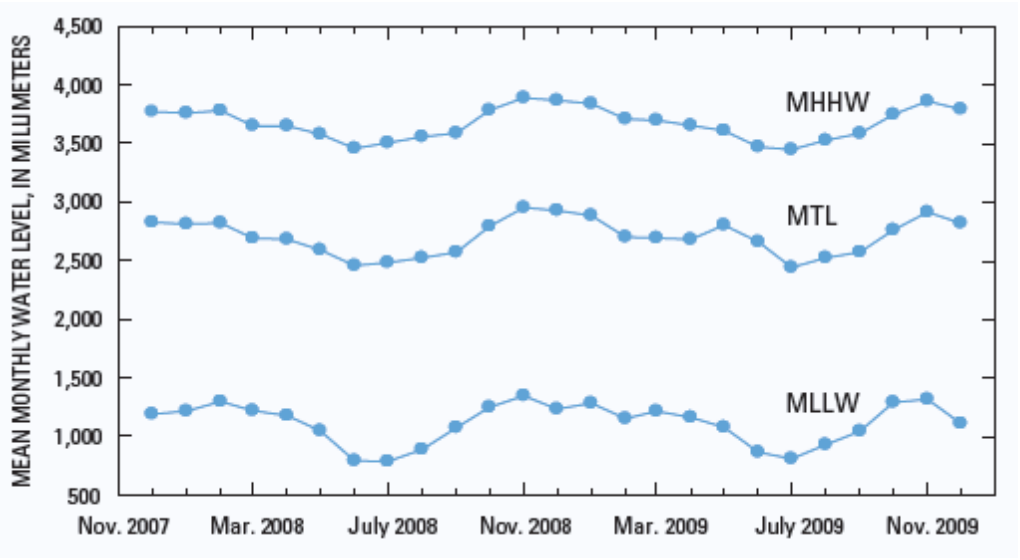


Figure 2.3 Monthly values of mean tide level (MTL), mean lower low water (MLLW), and mean higher high water (MHHW) calculated from hourly sea level readings at Vung Tau, Vietnam, for the 2007-9 period (Thomas et al., 2010)

2.2 Wind

◦ The target coastal area is affected by SW (summer season, May ~ October) and NE monsoon (winter season, November ~ October).

◦ Figure 2.4 is a wind rose map of Mekong Delta coast based on NOAA/NCEP wind data from 2011 to 2014. Bac Lieu coast and Tra Vinh coast are located on the east shore of Ca Mau Peninsula and NE monsoon may have the main impact on the two coasts.

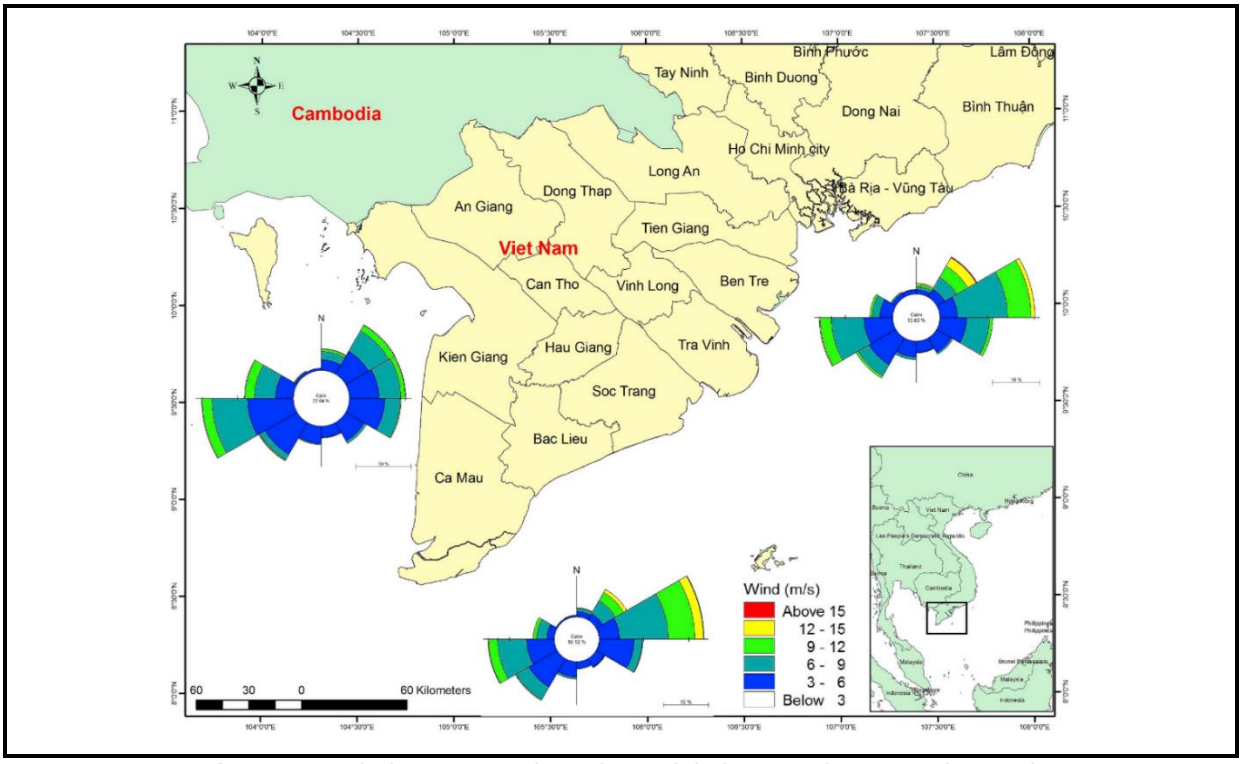


Figure 2.4 Wind rose maps in Mekong deltaic coast (Hung et al., 2019)

2.3 Wave

◦ Bac Lieu coast and Tra Vinh coast may get affected by NE waves since wind and wave have a similar direction in general.

◦ Hoang and Nguyen (2006) had a statistical analysis on storm surge data collected since 1986 at Bach Ho station, which is located near the target area. The data showed the highest frequency of NE waves from October to April while SW waves was from May to September. In the meantime, high waves over 4.0 m mainly occurs during October and March (See Table 2.2, 2.3).

◦ Conditions for deep water wave are as shown in Table 2.4 and they were estimated for each variation in return period. Waves with 50-year return period show the maximum value with 6.4 m of wave height and 9.5 sec of wave period.

Table 2.2 Frequency (%) of wave direction in 8 directions and months at Bach Ho station

Months	N	NE	E	SE	S	SW	W	NW
I	-	100.0	-	-	-	-	-	-
II	-	79.0	19.7	0.3	0.1	0.3	0.6	-
III	0.14	63.6	27.2	4.19	3.39	1.49	-	-
IV	-	50.0	17.09	5.88	1064	15.97	0.42	-
V	0.13	15.88	18.18	5.92	8.48	38.76	11.79	0.67
VI	0.28	0.42	2.92	0.14	1.96	63.53	29.59	1.12
VII	0.34	0.51	3.54	0.17	2.05	58.68	33.22	1.34
VIII	0.55	0.41	1.37	2.05	2.05	48.89	43.85	0.83
IX	1.70	10.47	8.50	3.69	3.96	36.41	31.30	3.97
X	3.25	43.35	11.28	0.82	1.90	14.23	21.81	3.39
XI	1.12	73.99	14.04	1.12	1.39	3.90	3.32	1.12
XII	-	96.52	3.09	0.13	-	-	0.26	-

Table 2.3 Frequency (%) of wave height by intervals and months at Bach Ho station

Height intervals (m)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
0.0-0.5	0.12	7.14	28.68	37.40	38.22	9.68	11.64	9.29	40.45	17.61	2.92	-
0.6-1.0	2.56	13.62	18.67	24.93	30.69	22.30	23.78	16.53	29.89	30.62	8.62	1.34
1.1-1.5	9.56	21.03	11.37	18.35	21.27	30.75	33.05	37.57	15.72	25.34	19.89	10.90
1.6-2.0	20.19	18.49	12.45	9.38	5.56	18.23	15.68	24.18	16.01	15.04	20.71	16.42
2.1-2.5	24.90	14.22	9.34	5.18	2.01	9.37	9.11	7.92	5.10	5.83	18.72	17.36
2.6-3.0	16.96	14.67	7.35	3.92	0.81	7.43	5.40	3.69	2.26	3.79	12.10	14.00
3.1-3.5	11.84	5.60	4.46	0.84	0.81	1.40	0.67	0.68	0.57	1.22	5.56	11.31
3.6-4.0	6.33	3.78	4.06	0	0.54	0.84	0.67	0.14	0	0.41	7.65	16.73
4.1-5.0	6.19	1.21	2.44	0	0	0	0	0	0	0.14	4.75	11.71
5.1-6.0	1.35	0	0.54	0	0	0	0	0	0	0	1.60	1.48
6.1-7.0	0	0	0.13	0	0	0	0	0	0	0	0.42	1.35
>7.0	0	0	0	0	0	0	0	0	0	0	0	0.40

Table 2.4 Wave height (H, m) and wave period (T, s) of maximum significant wave

Direction	100 years	50 years	25 years	10 years	1 year
NE	7.2 m 9.7 s	6.4 m 9.5 s	5.5 m 9.2 s	4.5 m 8.7 s	3.5 m 8.1 s
E	6.2 m 9.4 s	5.4 m 9.4 s	5.0 m 8.9 s	3.8 m 8.5 s	3.0 m 7.9 s
SE	5.2 m 7.8 s	4.1 m 7.5 s	3.3 m 7.2 s	2.8 m 6.9 s	2.3 m 6.2 s
S	3.3 m 7.3 s	3.1 m 7.1 s	2.9 m 7.0 s	2.5 m 6.7 s	1.8 m 5.6 s
SW	5.5 m 8.7 s	4.8 m 8.6 s	4.4 m 8.5 s	4.1 m 8.1 s	3.0 m 7.9 s

2.4 Storm Surge

- Tropical storm has a huge impact not just on residential area and infrastructure but on the surroundings and eco system. It is complicated to quantify the damage to the eco system and to the land. Plus, the coastal erosion sometimes affects the habitability of the area in a long term.
- Storms in Vietnam take place constantly from June to November and cause serious damage derived from erosion and flooding in coastal area as they generate high wave, storm surge, and near-shore flow.
- Table 2.5 shows the calculation of storm surge height of 5 storms that had enormous effect on Vietnam. The biggest storm surge height at Mekong river estuary was estimated 0.7 m when typhoon Linda passed. In the meantime, total sea-level rise was measured 1.0 m given the estimated 0.3 m of the wave-induced setup caused by the wave (Nguyen et al., 2014).

Table 2.5 Calculated storm surge heights during the five significant tropical storms that took place in the last six decades

Stations	Tilda 1954	Lucy 1962	Thelma 1973	Linda 1997	Muifa 2004
Phan Thiet	0.07 m	**0.56 m**	0.28 m	0.36 m	0.28 m
Mekong River Mouth	0.05 m	0.30 m	0.09 m	**0.70 m**	0.39 m

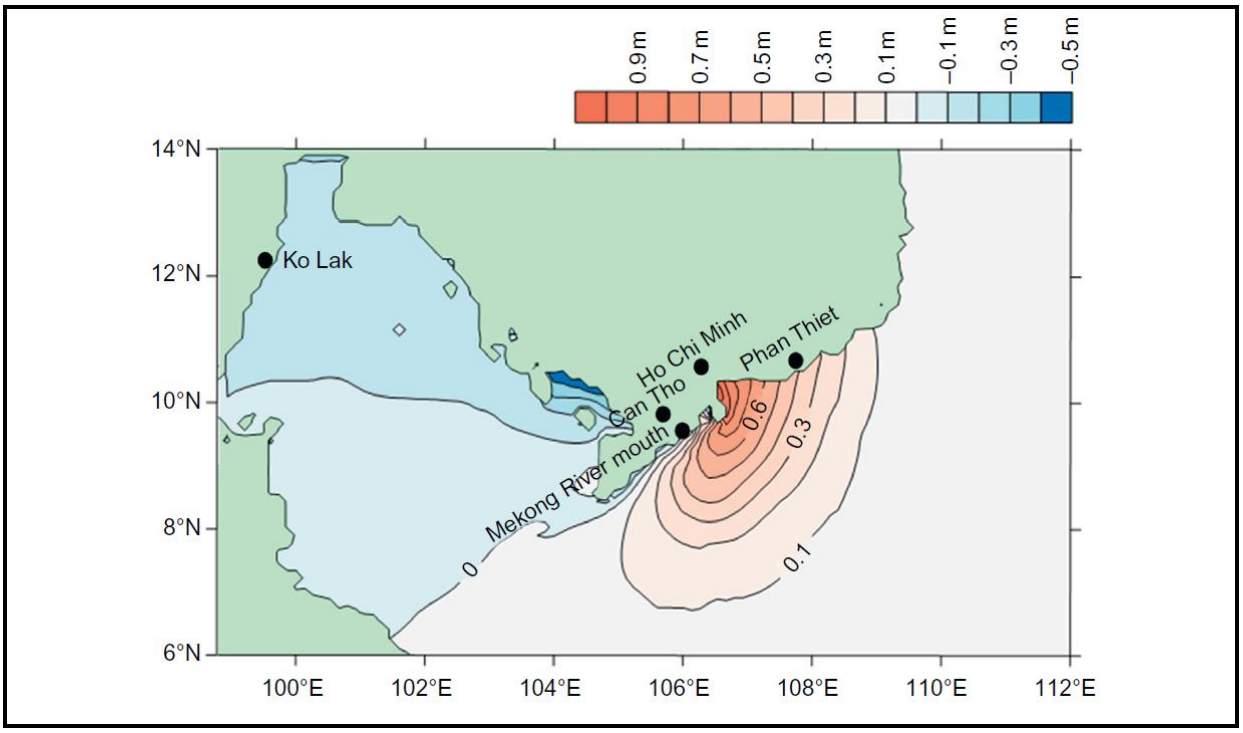


Figure 2.5 Simulated storm surge height at the moment Typhoon Linda in 1997 hit the southern coast of Vietnam (Nguyen et al., 2014)

2.5 Coastal Erosion Status

- Identified areas of coastal erosion in Tra Vinh province and Bac Lieu province are shown in Table 2.6 (Nguyen et al., 2014).
- The eroded area in Duyen Hai District, Tra Vinh province takes up to 9,688,500 ha as the biggest. It seems that the reason is the coastal line of Duyen Hai District bounds on the open sea and gets affected directly by wave and storm.
- On the other hand, Tra Cu District and Cau Ngang District has less eroded area as their coastal lines near the Mekong River.

Table 2.6 Coastal erosion districts in Tra Vinh province and Bac Lieu province

Province	District	Eroded Area (ha)
Tra Vinh	Tra Cu	551,900
	Cau Ngang	1,109,900
	Duyen Hai	9,688,500
Bac Lieu	Gia Rai	1,844,000

* Source: VAST, from the final report of project KC.09015 (2005).

Chapter 3. Wave Numerical Simulation

3.1 Simulation Overview

◦ Wave numerical simulation was carried out to estimate the design wave height of the protecting structure for coastal erosion in target area.

◦ The simulation was performed on E and SE wave, which were considered to have a large influence on the target area, of the 50-year return period waves surveyed in Chapter 2.3.

◦ The bathymetry were 15″ interval global grid data obtained from SRTM15plus(Shuttle Radar Topography Mission) provided by the Scripps Institution of Oceanography, University of California San Diego.

Table 3.1 Overview of wave numerical simulation

Contents	**Wave numerical simulation**			
Model	· SWAN (Ver.41.20AB)			
Domain	· 300 km × 270 km			
Grid	· 500 m uniform grid			
No. of grid cell	· 600 × 540			
Input condition	Dir.	Ho (m)	Tp (sec)	Wind velocity
	E	5.4	9.1	22.0 m/s
	SE	4.1	7.5	
Spectrum condition	· No. of direction bins : 72 · No. of frequency bins : 45 · Cut off frequency range : 0.03~0.6 Hz · Dir. spread coefficient : 12			
Tide level	· M.S.L(+)1.75 m (H.W.L)			

3.2 Simulation Result

◦ The water depth of near inlet of the Mekong River show a gentle slope of about 5 m depth from coastline to 10 km away, so that waves propagating in the deep sea are breaking due to depth limits and gradually decreasing in wave height.

◦ Figure 3.3 ~ 3.8 shows a large significant wave height of 2.0 m or higher in the Bac Lieu coast, and 0.8 ~ 1.2 m range in Long Hoa coast.

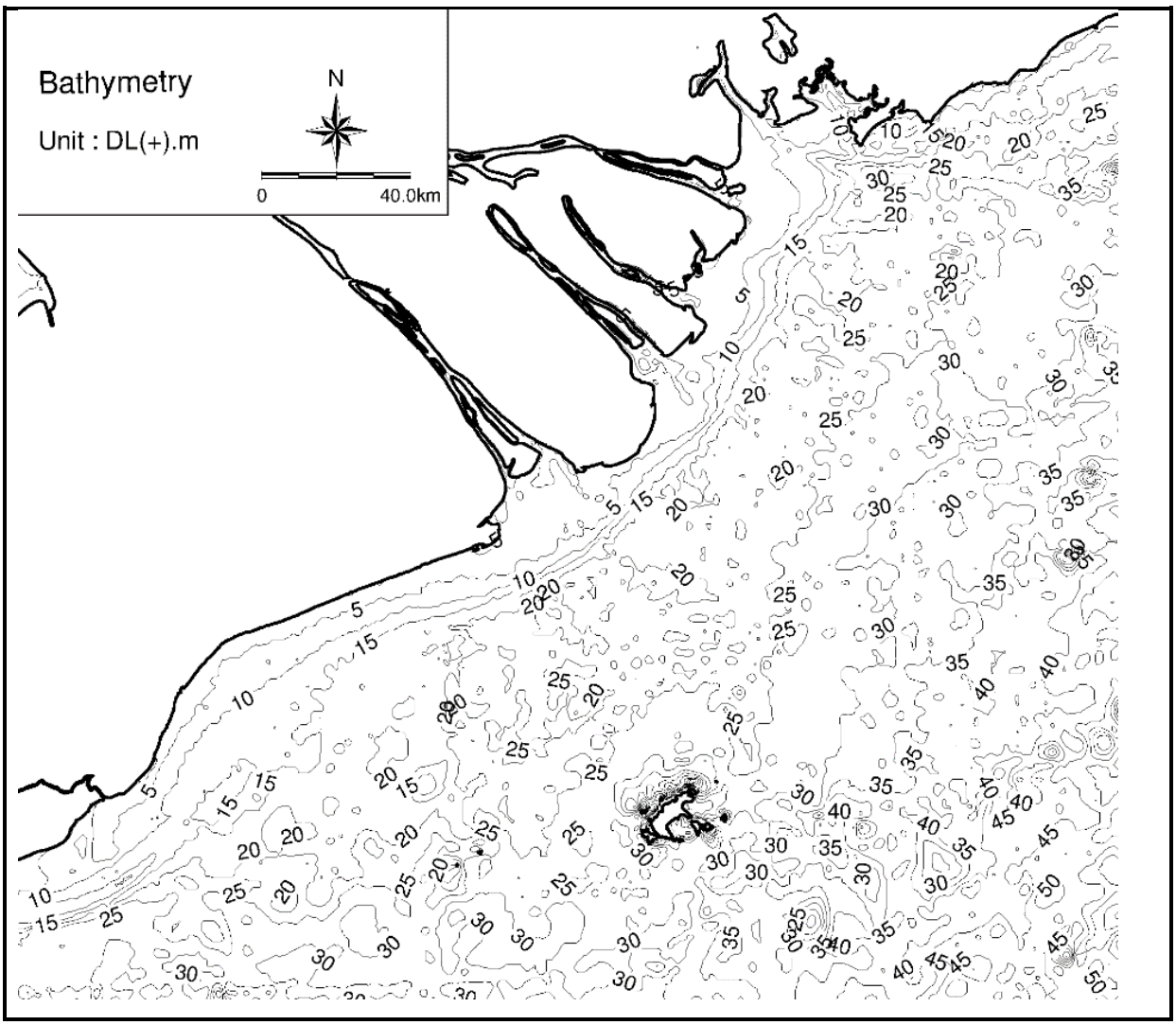


Figure 3.1 Bathymetry

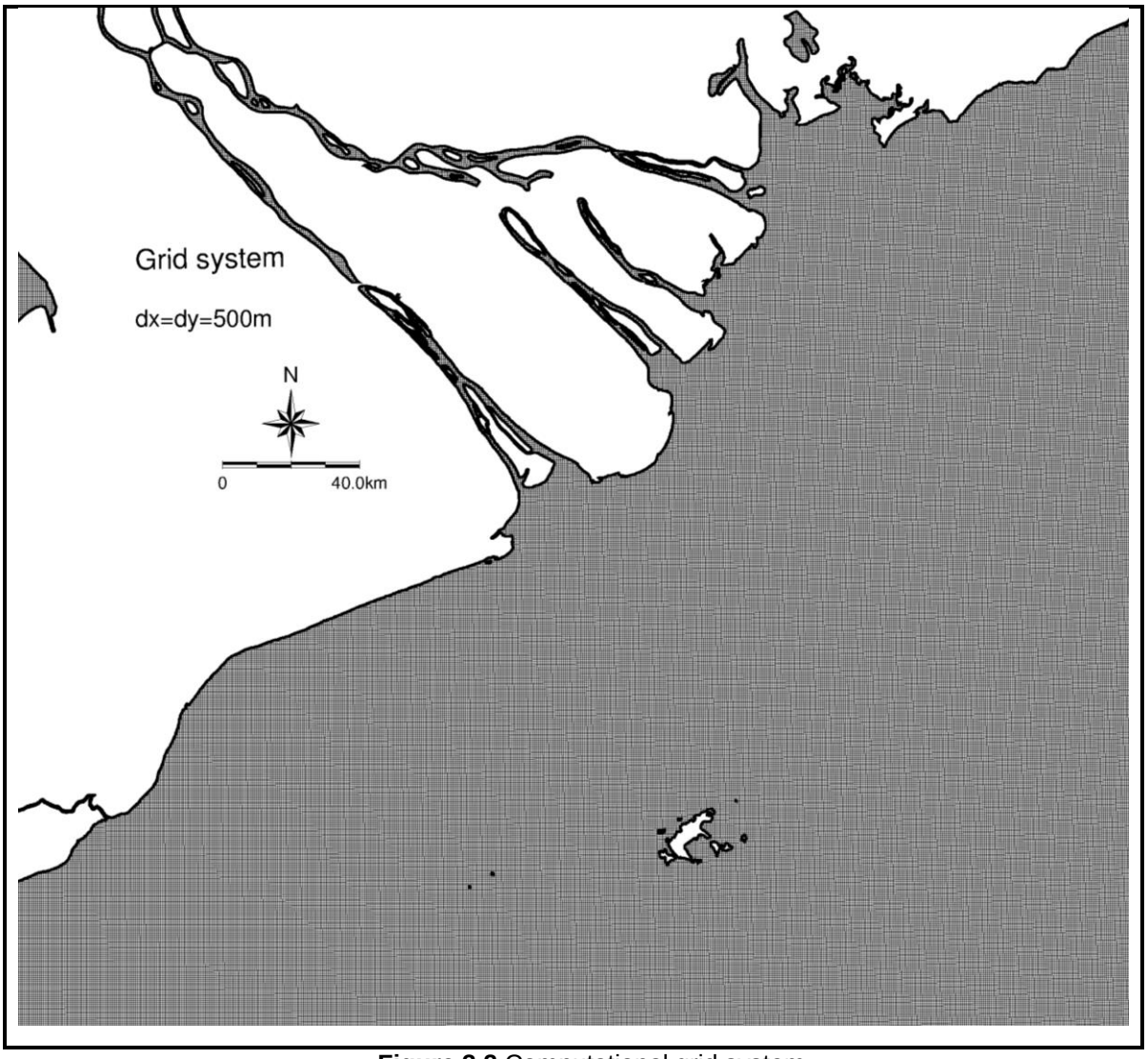


Figure 3.2 Computational grid system

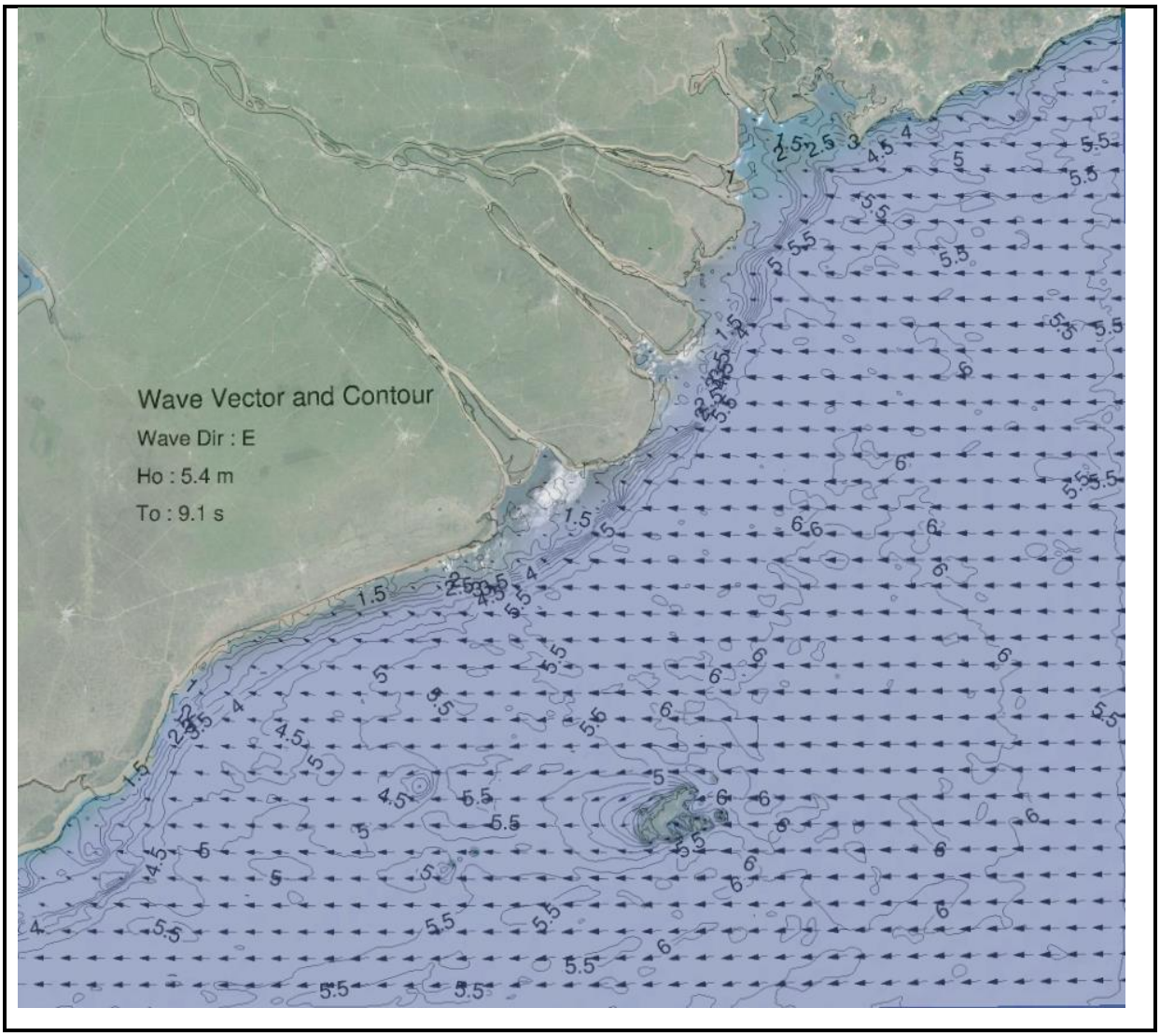


Figure 3.3 Significant wave heights (E direction)

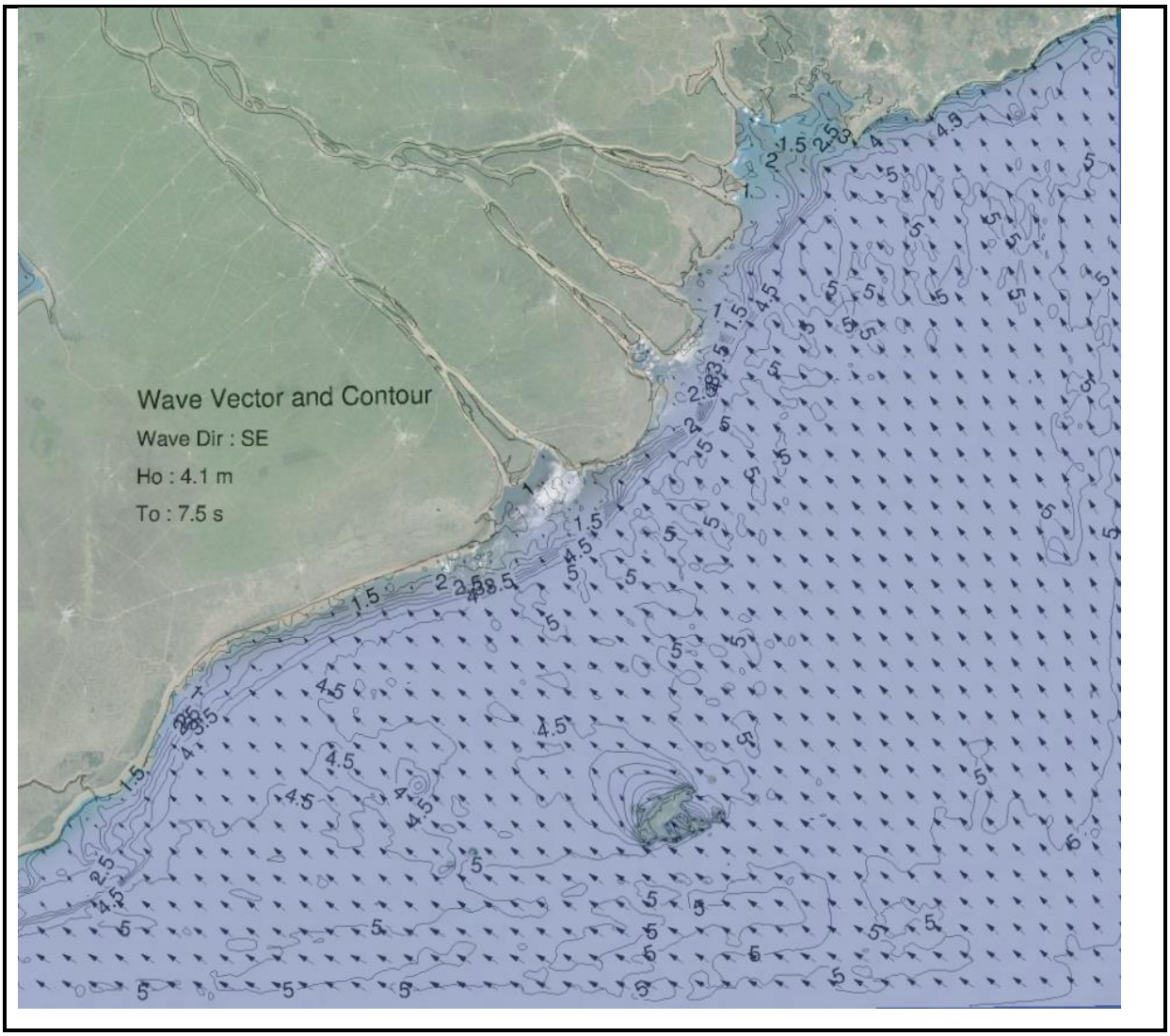


Figure 3.4 Significant wave heights (SE direction)

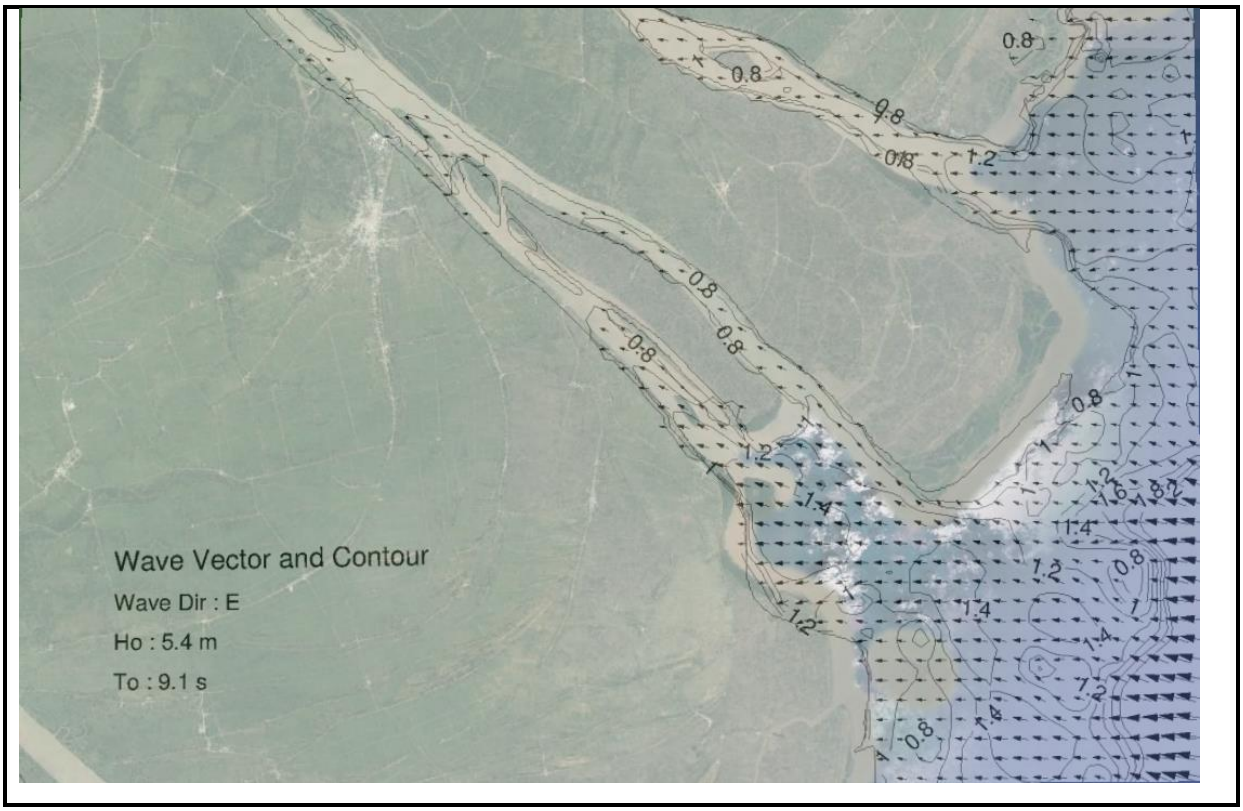


Figure 3.5 Significant wave heights around Long Hoa coast (E direction)

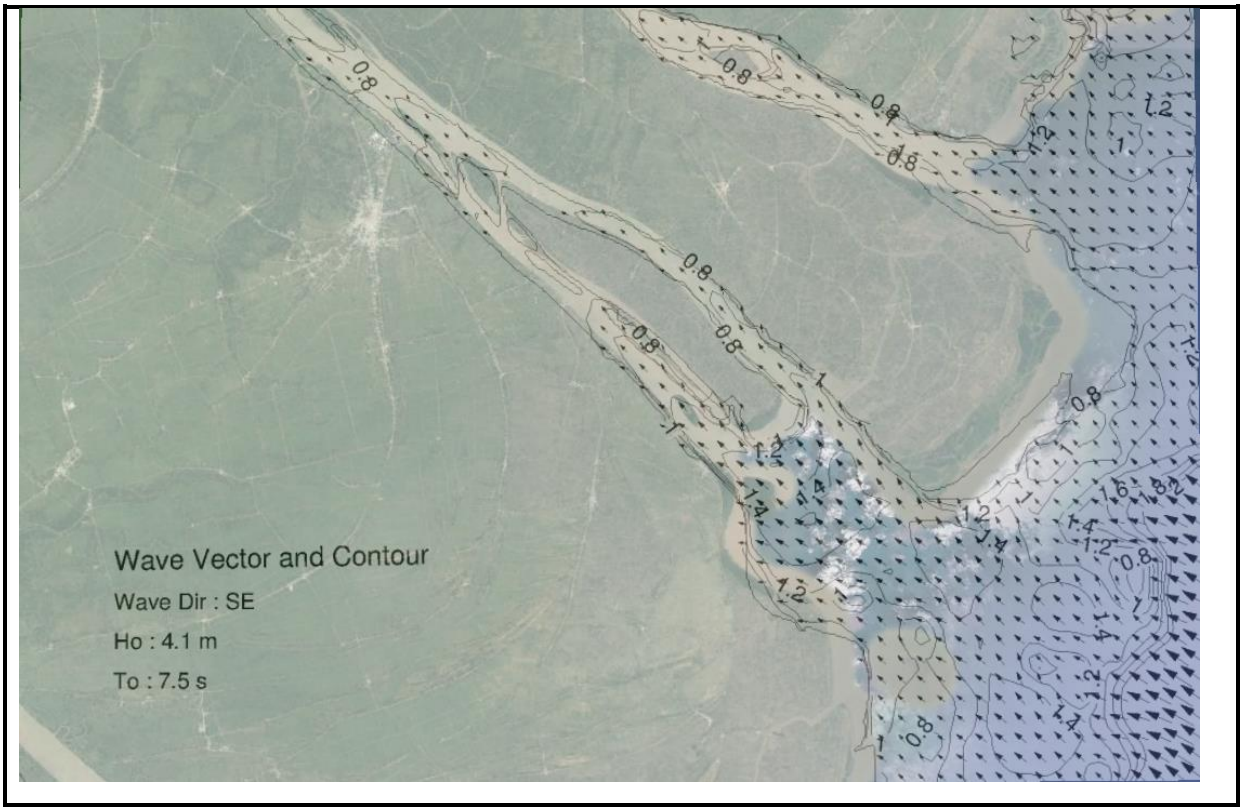


Figure 3.6 Significant wave heights around Long Hoa coast (SE direction)

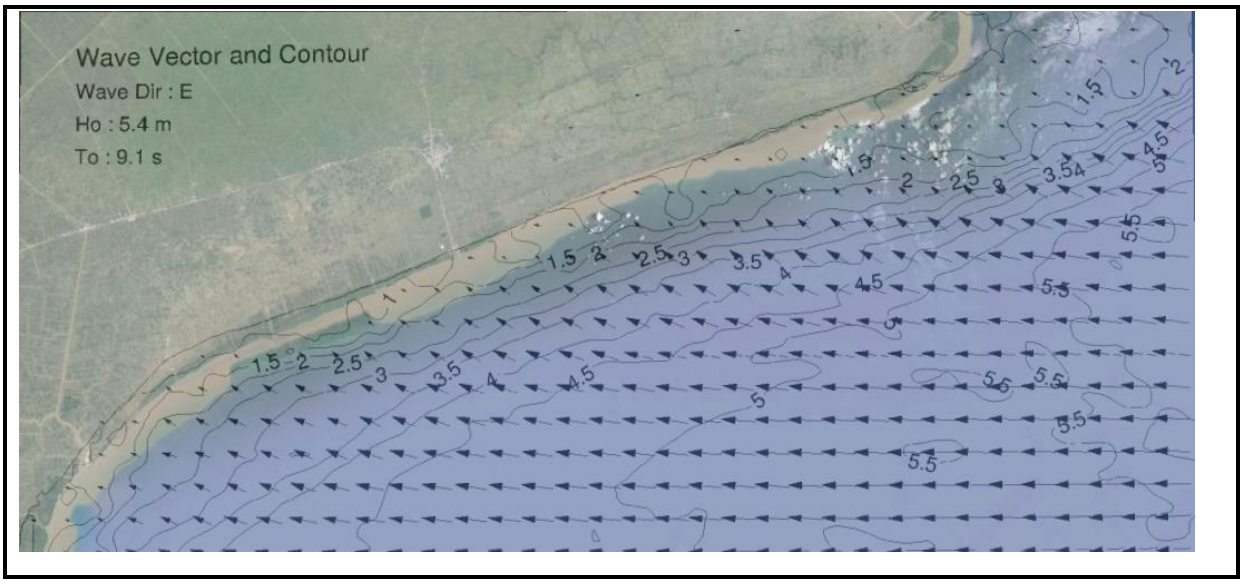


Figure 3.7 Significant wave heights around Bac Lieu coast (E direction)

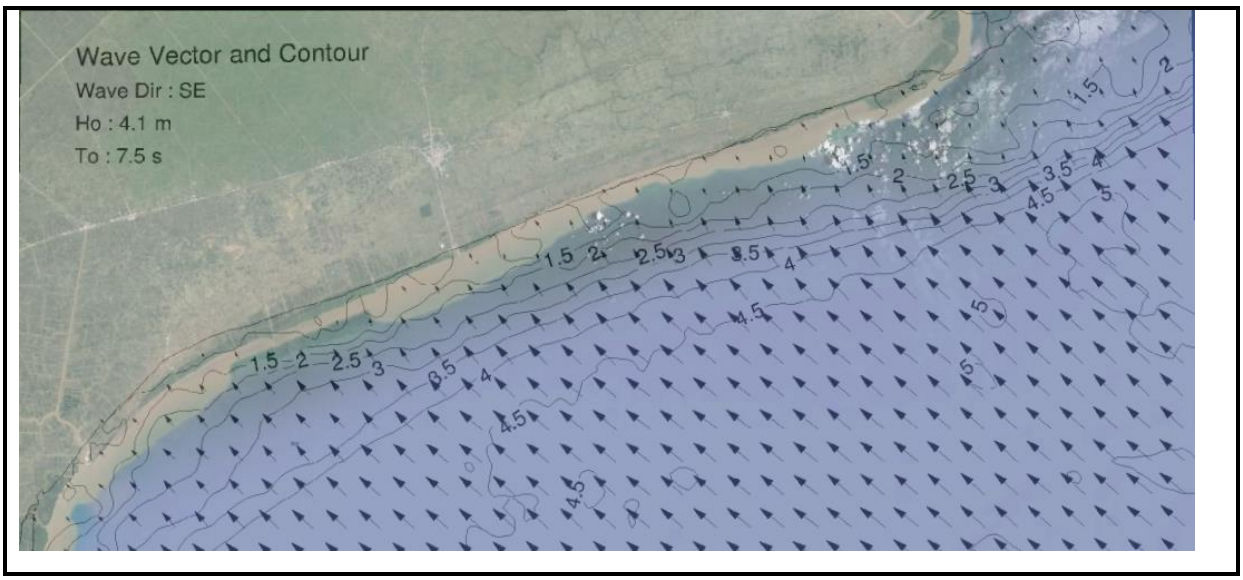


Figure 3.8 Significant wave heights around Bac Lieu coast (SE direction)

Chapter 4. Site Survey

4.1 Survey Overview

◦ Target area for the site survey covers about 20.6 km of the coastal line in Hoa Minh commune and Long Hoa commune as well as two districts in Bac Lieu recommended by local governments of Bac Lieu and Tra Vinh in need of countermeasures for the damage from coastal erosion.

◦ Date : June 5, 2019 ~ June 8, 2019

◦ Survey method: Visual survey was proceeded after government guide and onsite explanation.

◦ Survey result was applied as basic material to review eco-friendly coastal protection method for coastal erosion reduction and to prepare the conceptual design as figuring out the concrete business section.

Table 4.1 Overview of site survey

Date	Location	Remark
June 5, 2019	Vinh Trach Dong, Bac Lieu	Existing Facilities
June 6, 2019	Vinh Hau, Hoa Binh, Bac Lieu	Ground Investigation
June 7, 2019	Hoa Minh commune, Tra Vinh	Ground Investigation
June 8, 2019	Long Hoa commune, Tra Vinh	Vessel Investigation

4.2 State of Bac Lieu Coast

◦ The first survey area was Vinh Trach Dong Coast, whose mangrove forest had been already washed away and then a concrete dike with mild-slope was built to protect the coastline happened to be exposed to the open sea.

◦ The second survey was river area at Vinh Hau coast and Hoa Binh coast which are 0.5 km away toward the upper stream. Both banks of the river had mangrove forests in the past. However, the forests were destroyed and exposed to unexpected danger of flooding erosion while residential area was developed for the local people's life. Urgent actions should be taken and it is more recommended to restore the damaged mangrove forest as transplanting the community than to apply a hard protection technology just for protecting existing facilities.

Figure 4.1 Status of coast in Bac Lieu

4.3 State of Tra Vinh Coast

- Survey is conducted on 20.6 km coast located in Hoa Hoa Minh commune and Long Hoa commune, Tra Vinh Province.
- The state of the coast (SOC) is divided into three levels (red, yellow, and green) given the current coastal exposure level and protected condition (Table 4.2, Figure 4.2).
- SOC-Red section has total 4 zones with the length of 540 m, which is prone to possible danger now that the coast lost most of the mangrove and its earth dike was entirely exposed to the ocean.
- SOC-Yellow section is not directly exposed to the ocean since it has mangrove forests across the entire coast. Its mangrove forest is partly damaged – not only by natural cause, but mainly by human activities such as berthing and aquaculture pond expansion. The section has total 13 zones with the length of 8,580 m.
- SOC-Green section with total 12 zones reaching 11,500 m in length is a stable coast with low danger of exposure now that comparatively broad (wider than 20 m) mangrove forest covers the entire coast

Table 4.2 Classification for the state of the coast (SOC)

Classification	State of the Coast	Coastal length (m)
Red	Coastline directly exposed to the sea due to mangrove forest damage, and currently weak protection	540 m (4 zones)
Yellow	Coastline not directly exposed to the sea but currently insufficient protection, and locally mangroves damaged due to human activities	8,580 m (13 zones)
Green	Stable coast, low exposure (a good mangrove forest exists)	11,500 m (12 zones)

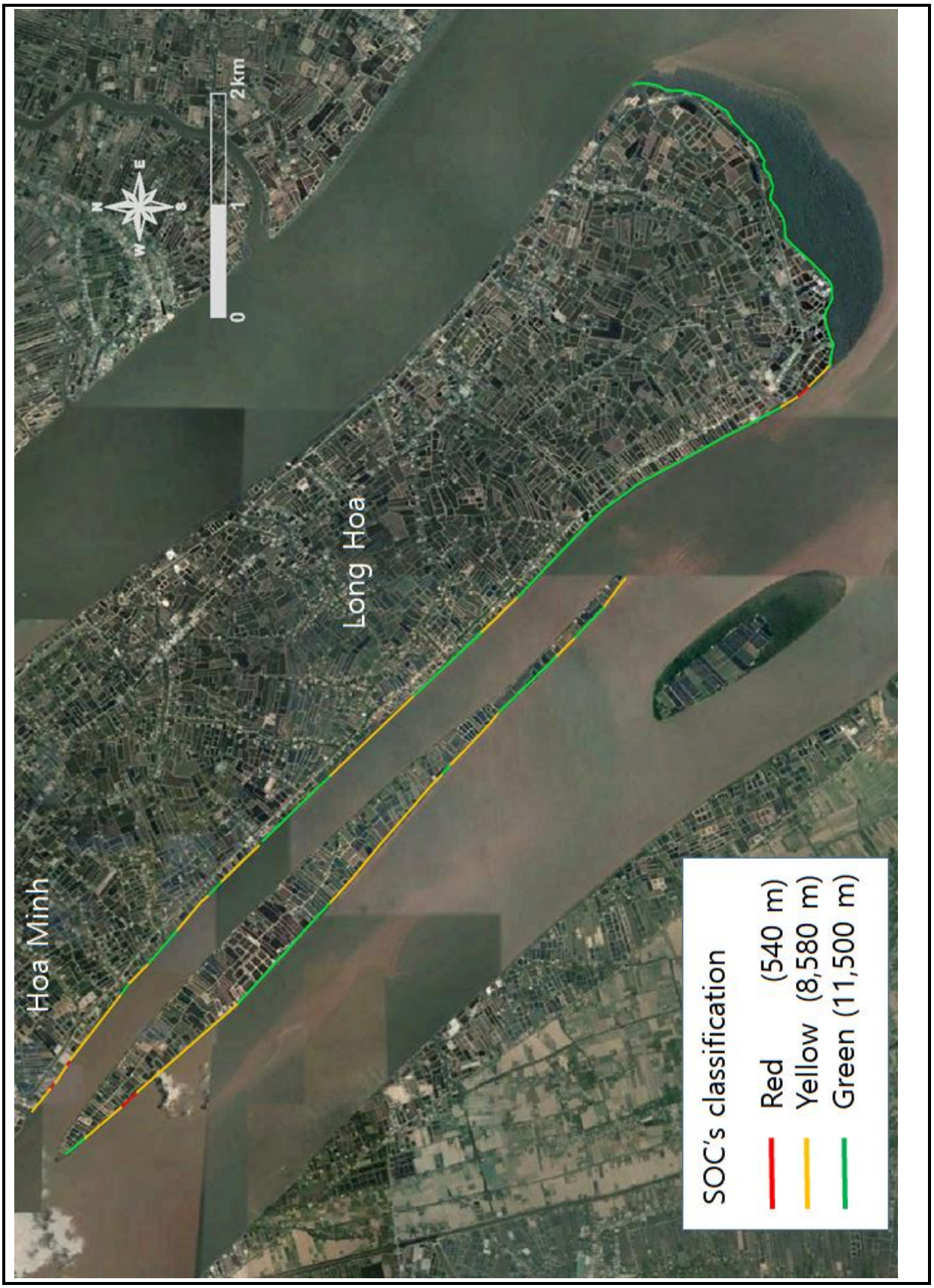


Figure 4.2 The location of site survey and SOC classification in Tra Vinh Province

◦ Location details and coastal views of SOC-Red section are described in Figure 4.3 ~ Figure 4.5.

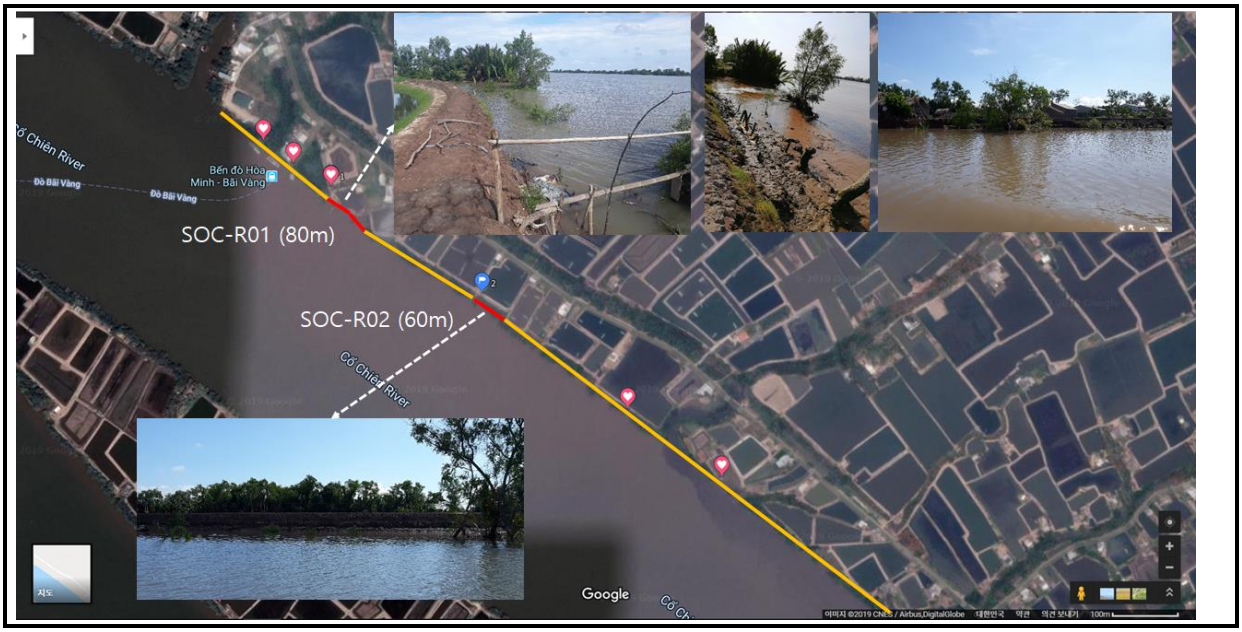


Figure 4.3 SOC-Red_01~02 zones in Hoa Minh Commune

Figure 4.4 SOC-Red_03 zone in Long Hoa Commune

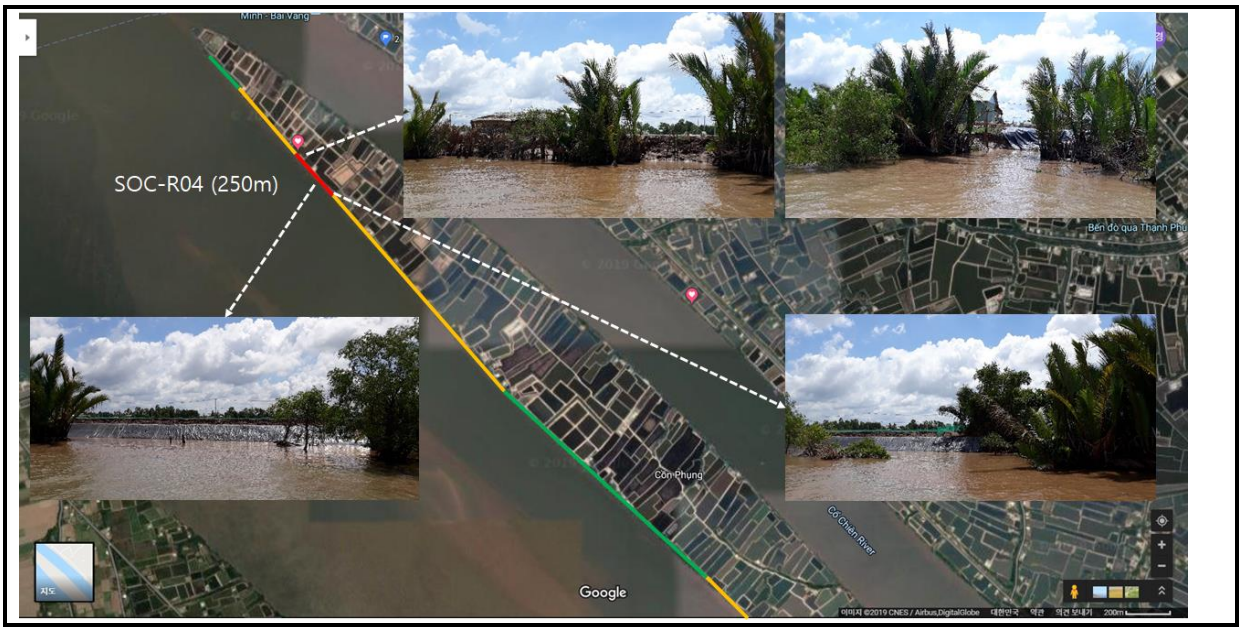


Figure 4.5 SOC-Red_04 zones in Long Hoa Commune

◦ Representative coastal views of SOC-Yellow are as in Figure 4.6.

Figure 4.6 SOC-Yellow zones

◦ Representative coastal views of SOC-Green are as in Figure 4.7.

Figure 4.7 SOC-Green zones

4.4 Recommended Action for Each Coastal State

- Protective action for each coastal condition investigated in Tra Vinh Provice is displayed in Table 4.3.
- Since the SOC-Red level coast has lost most part of its mangrove forest and its earth dike protecting the aquaculture pond is directl y exposed to the ocean, it should be urgently considered to reinforce the dike and to restore the mangrove forest.
- Regarding SOC-Yellow level coast, constant management is required including mangrove restoration to prevent possible damage in a short or mid-term perspective while not having urgency.
- It is required, aside from regular monitoring, to acquire institutional and political measurement to guarantee the safety of the hinterland in a long term – legal regulations, emigration policy, and so on to restrict human activities damaging the mangrove forests – for SOC-Green level coast.

Table 4.3 Recommendations for measure by SOC's class

SOC's class	Recommendation for measures
Red	Need urgent measure - Reinforcement for earth dike (mild seaward slopes, armoring) - Mangroves restoration
Yellow	No need urgent measure but continuous management (including mangrove restoration) is required
Green	Regular monitoring

Chapter 5. Feasibility Study on Application of Eco-friendly Coastal Protection Method

5.1 Basic Direction

◦ The study reviews the eco-friendly and sustainable method to reduce coastal erosion targeting SOC-Red area (total 4 zones and 540 m in length), which was classified in need of urgent action according to the survey result on the coasts and SOC-Yellow area (total 13 zones and 8,580 m in length), classified in possible damage in a short or mid-term perspective.

◦ The applied method was divided into two; one was reforesting mangrove forest while the other was the current method to reinforce earth dike as proposed in chapter 4.4 given the characteristics of the target coast and local condition.

5.2 Mangrove Plant

◦ Mangrove forests can be the most eco-friendly method to reduce coastal erosion as reducing ocean energy reaching the shores.

◦ The minimum width of the mangrove forest is about 150 m to damp down waves effectively. In case of the typical wave spectrum, it was reported the best reduction may be decided around 500 m (GIZ, 2018).

◦ The target coast is consisted of mangrove forest with narrow width in range from 10 m to 30 m along with the parallel coastal line to the stream as it directly meets the Mekong river in geography. The hinterland also has dike and fish farms.

◦ Under this geographical characteristic, dramatic expansion of the width of the mangrove forest toward the river may cause a negative effect on the stream flow as decreasing the stream width. It is also difficult to move the fish farms where inhabitants reside in currently and to extend the mangrove forest to that land.

◦ In accordance with the information above, it is urgent to reinforce the dike and to restore the mangrove forest in SOC-Red zone, and it is better to apply mangroves plant limitedly to restore the partially damaged mangrove forest in SOC-Yellow zone.

◦ Whether mangroves plant would be succeeded is affected by the natural factors such as water depth, soil condition, and neighboring vegetation so thorough review should be preceded. Going through consultation with the local government, it was confirmed that DONRE (Department of National Resources & Environment) secured budget and has conducted the mangroves plant, providing seedling and wage to local residents and the management system was set up by the Commune. It is encouraged to make the best use of the system.

5.3 Review on Eco-friendly Dike Reinforcement Method

◦ Land cover using the existing concrete block and riprap is the most common method as a reinforcement construction method to prevent slope erosion on existing earth dike.

◦ In the meantime, there may be a possible damage on the mangrove forest by tidal flat erosion as sediment transport is rather increased by the reflected waves.

◦ Figure 5.1 is a view of the gabion installed for sour protection as well as the concrete dike installed on the southwest coast of Long Hoa. It shows that a part of the mangrove was swept away from the front of the dike because of increased erosion by the reflected waves although the target is achieved to protect the hinterland.

Figure 5.1 Installed concrete dike in Long Hoa commune

◦ The eco-friendly earth dike reinforcement method is reviewed, setting objectives to satisfy the following functions;

- Secure dike safety: mild-slope and rock armoring
- Minimize impact on the surroundings: structure reducing reflected waves
- Coordination with the surroundings: possible vegetation on the newly structured slope

◦ Eco-friendly elements to cover land have been developed recently in advanced countries including Korea. Of them, three specific methods, Vegetation mat, Porous-coast, and Fabric stone were compared as potential eco-friendly reinforcement plan for dike slope since they had been applied in the field and had proved themselves (Table 5.1).

◦ The three methods are all eco-friendly given that they use biodegradable elements as well as natural elements such as gravel.

◦ Main application of the vegetation mat is for streams not much affected by waves since it is vulnerable in structural safety for the waves whereas it enables prompt vegetation by seed and its price is also reasonable.

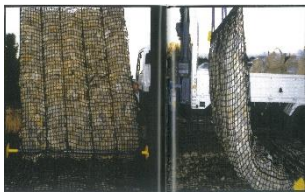
◦ Fabric stone is consisted of four fabric gabions and it varies in weight from one to two tons

depending on the size. Accordingly, the construction is at great expense since its installation requires heavy equipment. Moreover, it should be handled with care not to lose filling stones in case the fabric stone is damaged.

◦ Permeable sea-wall is a method integrating slopes to a porous structure by bonding aggregates (Φ = below 40 mm) with a natural adhesive extracted from castor oil. It is stable and leads to wave energy breakup and dissipation of the reflected energy resulted from internal pores of the constructed slopes.

◦ The best option for dike rehabilitation would be the slope reinforcement method using porous-coast given the characteristics and local condition of each methods.

Table 5.1 Comparison of eco-friendly dike-slope reinforcing methods

	Vegetation mat	Porous-coast	Fabric stone
Shape			
Material	Poly Lactic Acid 	Caster Oil Polymer + gravel(Φ=40mm or less) 	Polypropylene net + gravel(Φ=50~150 mm) 
Slope	1:1.5 or above	1:1.5 or above	1:1.5 or above
Stability	6 m/s (river velocity)	10 m/s	-
Pros	Low coast Biodegradation (15~20yrs) Easy plant growing (seed included)	Low LCC Durable to high wave and flow Naturally plant growing	Low LCC Durable to high wave and flow Naturally plant growing
Cons	High life cycle cost Vulnerable to wave action	High costs Requires cleaned gravel	High costs Vulnerable to breakage of net Requires heavy equipment

5.4 Validity for Coast Protection Using Mangrove and Porous-coast

◦ Mangrove plant would be a basic application for the SOC-Red and SOC-Yellow section since it is in need of proper actions for erosion reduction as the mangrove forests were damaged.

◦ However, a composite countermeasure is proposed here to apply mangroves plant at the front of the dike after reinforcement of the slope using porous-coast first. It should be considered that safety in the dike cannot be guaranteed since SOC-Red zones are in danger as losing most part of its mangrove forest under serious erosion and going through damage at the dike.

◦ Validity and expected effects from the suggested composite method are as follows;

- Mangroves plant and porous-coast are harmless to the ocean environment using natural elements.
- Mangroves plant contributes to restore the marine ecosystem restoring damaged mangrove forests.
- Periphery of the scenery would not be destroyed as surrounding plants take root on the surface of porous-coast.
- Porous-coast would effectively break up waves, lower reflected waves, and accordingly reduce erosion of the restored mangrove forests.
- Porous-coast guarantees stable economic activities as it protects the aquaculture ponds from waves and flows.
- It is expected at the hinterland to see mitigation of inundation damage from flood or sea level rise as porous-coast raises the current cope level of the dike.

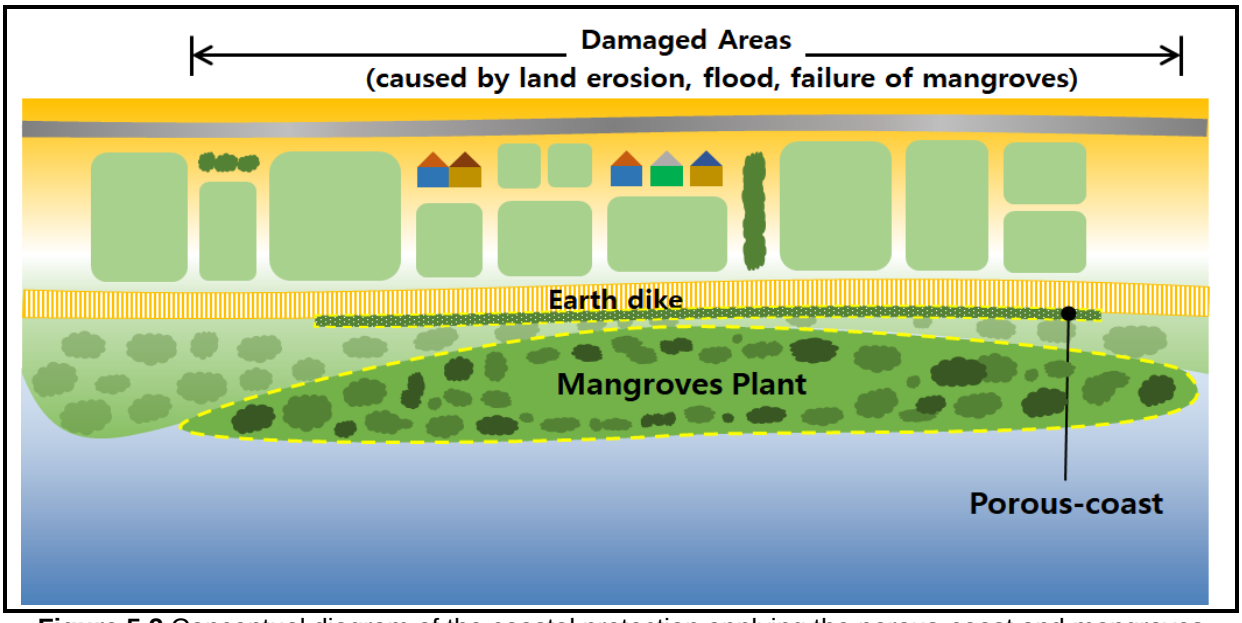


Figure 5.2 Conceptual diagram of the coastal protection applying the porous-coast and mangroves pla

Chapter 6. Conceptual Design

6.1 Overview

◦ As mentioned in Section 5.4, mangrove planting is basically applied for the restoration of forests since the mangrove forests are damaged, though the SOC-Red section and the SOC-Yellow section need erosion mitigation measures.

◦ The restoration area of the mangrove forest which can be restored within the budget of this project is estimated to be about 34,000 ㎡. This is 18% of 182,400 ㎡, total area of mangrove forest, assuming the average width of stable mangrove forest is 20 m and the total coastline of SOC-Red and SOC-Yellow is 9,120 m.

◦ Mangrove planting is highly affected by environmental conditions such as water depth, soil quality and surrounding vegetation in the target area, but there is limitation to present the kind of mangrove planting, its location and size at the present stage. Therefore, it is necessary to establish and implement a plan in conjunction with the mangrove planting plan implemented by the local government, DONRE Nature Environment Agency, on the coast.

◦ This section describes the conceptual design of the SOC-Red section to which the proposed porous-coast is applied as an erosion abatement facility.

6.2 Layout Plan

◦ The following is organized in Table 6.1; the coast erosion reduction plan applied to each SOC-Red section as well as the length of the coastline and aquaculture pond area directly protected by the plan.

◦ Porous-coast was planned to be applied to four sections, SOC-R01, SOC-R02, SOC-R03, SOC-R04, of serious erosion with total length of 540 m.

◦ After installation of porous-coast, mangroves plant would be applied to its front with total area of 4,910 ㎡.

◦ The protected coastline is 540 m and the total range of the covered aquaculture pond is 28,900 ㎡.

◦ Layout for each section is shown in Figure 6.1 ~ Figure 6.3.

Table 6.1 Coastal protection facility plan and directly effect

Zone	Coastal protection facility plan		Effect	
	Mangroves plant area (㎡)	Porous-coast length (m)	Protected coastline length (m)	Protected aquaculture pond area (㎡)
SOC-R01	870	80	80	2,820
SOC-R02	600	60	60	3,600
SOC-R03	1,550	150	150	8,880
SOC-R04	1,890	250	250	13,600
SUM	4,910	540	540	28,900

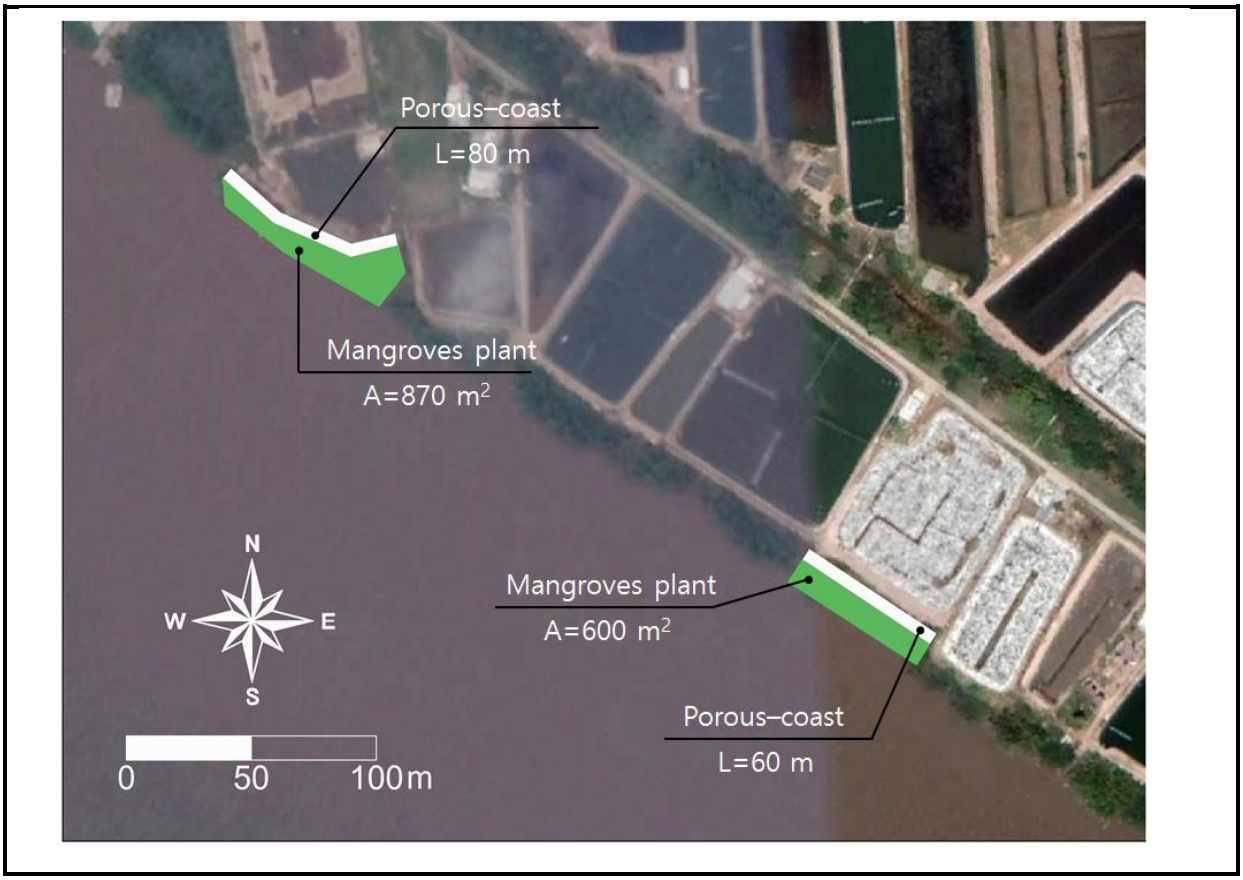


Figure 6.1 Layouts of SOC-R01 and SOC-R02 in Hoa Minh Commune

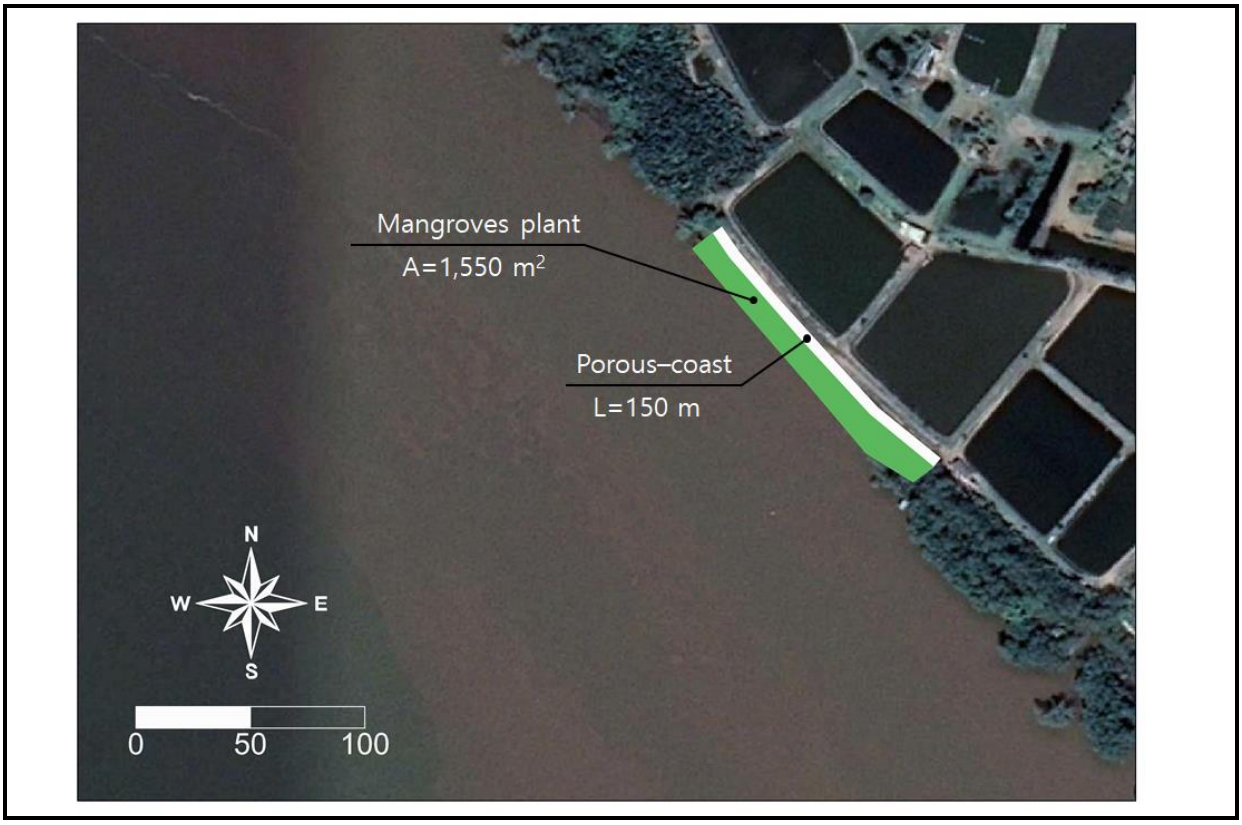


Figure 6.2 Layout of SOC-R03 in Long Hoa Commune

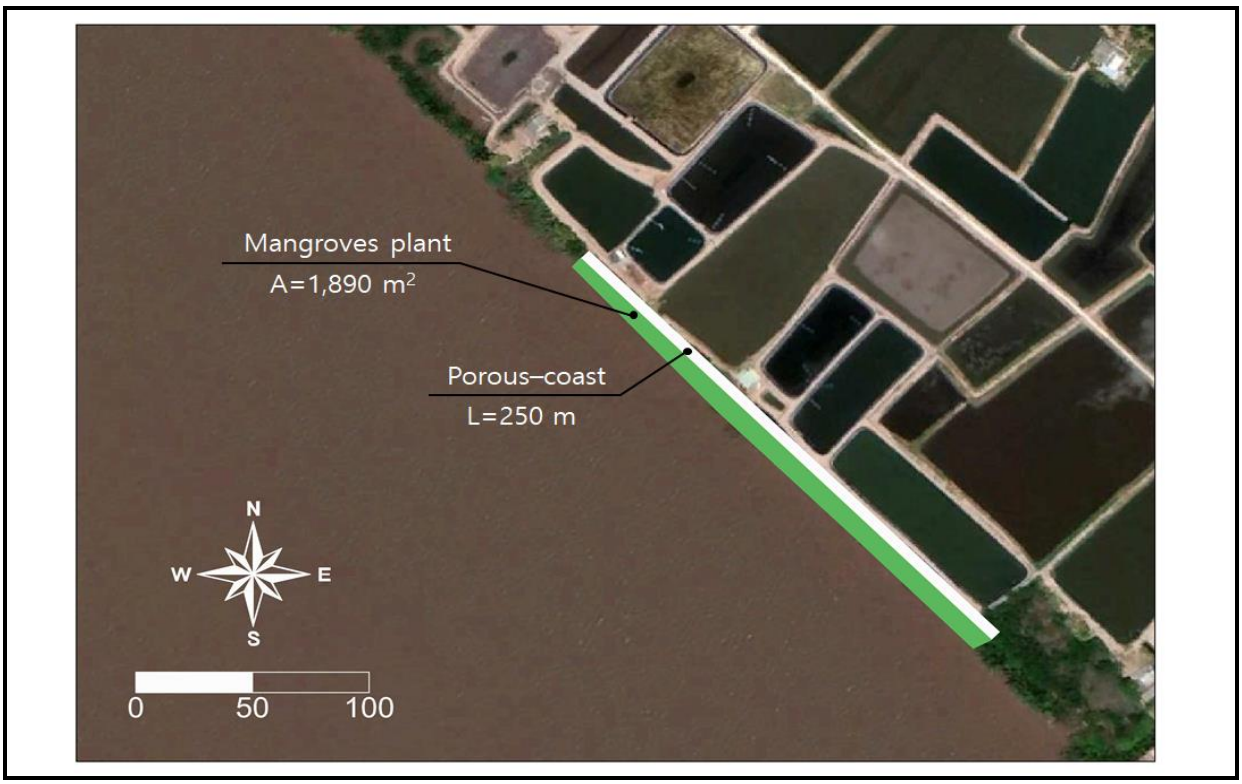


Figure 6.3 Layout of SOC-R04 in Long Hoa Commune

6.3 Sectional Plan

- Sectional plan of the porous-coast was based on tide, design wave height, and such of the target ocean area and it was designed as in Figure 6.4 referring to the design manual (ARCADIS, 2010).
- Porous-coast would be applied to the sea slope of the existing dike.
- It was planned to set bottom mats to prevent sand draft between sand layer and gravel layer which were designed to create mild slope. Porous-coast layer was planned to reach 0.15 m, the minimum thickness, to secure stability and economic efficiency for design wave height of 1.2 m at the target coast.
- In addition, on seaside end the existing dike porous-coast would be installed to increase 0.25 m from the previous cope level of the dike.
- Construction process is illustrated in Figure 6.5, and the construction would be proceeded promptly with simple work classification.

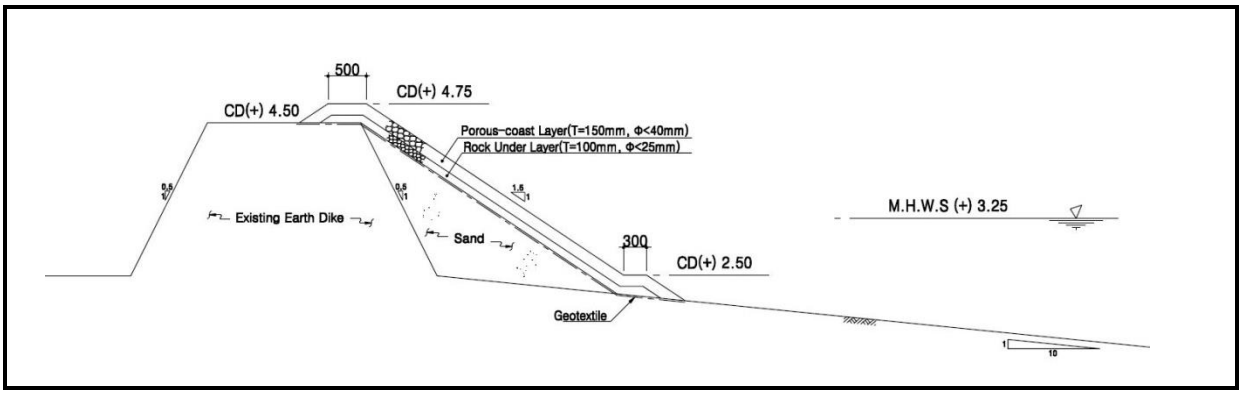


Figure 6.4 Cross-section of Porous-coast revetments

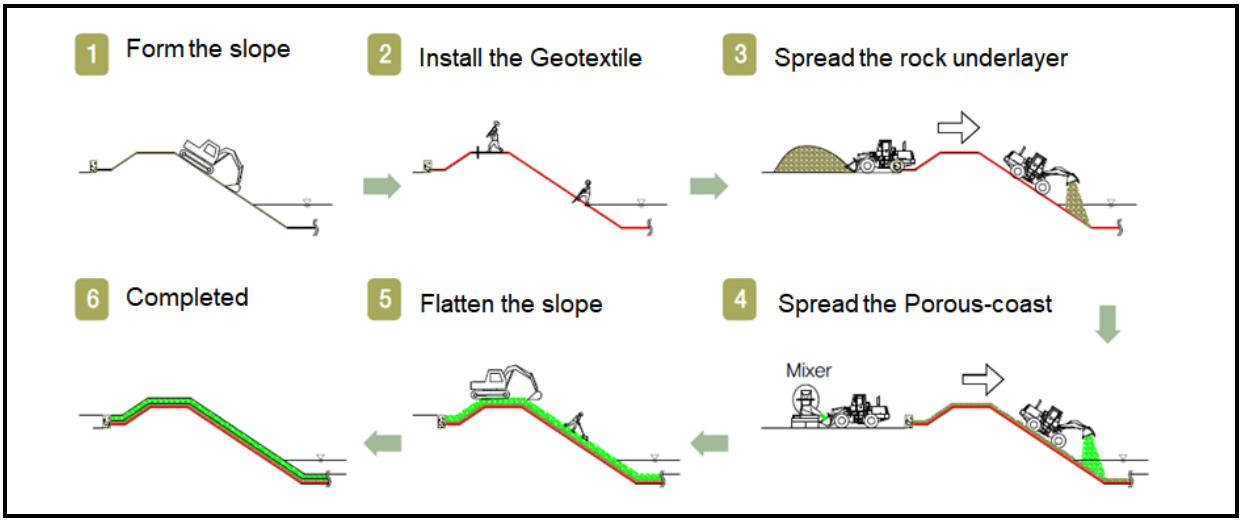


Figure 6.5 Construction process in steps

6.4 Cost Estimation

◦ Construction cost of the designed facilities was roughly estimated on the basis of the following criteria.

- Surface layer Installation of porous-coast : Standard estimate for construction 2018
- Unit price of earthwork, aggregate for base course to install porous-coast: People's Committee of TRA VINH, Facility construction Book: 5/SXD-LXD in Tra Vinh province in May 2019
- Mangroves plant: investigation by GIZ (2018) on construction cost 172,000,000 VND / ha, implemented in West Sea, Ca Mau National Park

◦ It is required to have detailed design (including detailed bill of material (BOM) and As built drawing) and construction supervision for civil construction of Porous-coast.

- Cost of the detailed design is based on standard calculation of construction cost rate, applying 7.65% of the construction cost.
- Cost of the supervision is calculated on a hypothetical situation that a professional for the porous-cost construction would reside at the site for about six months of construction period.

◦ Enforcement of coastal protection capacity of local residents reflects approximately 11% of the total cost.

◦ Total project cost was estimated at 1,200,000 USD for the coastal protection project, proposed in this work (Table 6.2).

Table 6.2 Estimated costs for coastal protection

Items	Cost, USD	Basic of calculation	Remark
1. Porous-coast	810,400	L=540 m	
2. Mangrove	25,000	SOC-Red: A=4,910 ㎡ SOC-Yellow: A=29,000 ㎡	
3. Secondary Work	81,000	10% of construction cost	
4. Detail Design	68,700	7.65% of construction cost	Including topographical survey
5. Supervision	84,000	A person * 6 months (14,000 USD/person·month)	
6. Capacity Building	130,900	11% of total cost	
Total	1,200,000		VAT excluded

※ The cost above is a tentative estimation allowing changes caused by construction work and period from the detailed design

Annex 2 Cooperation Letter from NAWAPI for Operation and Maintenance

02 January 2020

To: UN-Habitat Viet Nam office

Subject: Cooperation for UN-Habitat's Adaptation Fund project in Viet Nam

Based on the discussion on Friday, 13 December 2019 with United Nations Human Settlements Programme (UN-Habitat), and the Ministry of Natural Resources and Environment (MONRE), we would like to express our appreciation for discussing about project cooperation. The direction of the project for post-project sustainability would be well fit to the direction of NAWAPI, and we believe that we have good experience on it and enough capacity for cooperation on maintenance and operation of water treatment technology.

NAWAPI certainly understood about the direction of project and we also would like to cooperate with local governments. We will be able to keep the guidance from UN-Habitat and MONRE as well as Adaptation Fund.

1. Respect local ownership and conduct capacity building programme.
2. A pro-poor tariff will be implemented to reduce the possibility that people cannot access the services.
3. The fund from the Waste Treatment System will be managed in the manner of transparency and accountability.
4. The fund will be re-invested for other areas in the province, and will have cooperation with Local Working Group for making a decision.
5. After project periods, NAWAPI will have responsibility of maintenance and operation with cooperation of local commune governments.
6. For operation under the Viet Nam laws and regulation, NAWAPI will apply to examination of water quality for health, and consider environmental and social risk.

Accordingly, NAWAPI shall keep the above guidance and would like to cooperate with UN-Habitat and MONRE for Adaptation Fund project.

Yours sincerely,

Dr. Tong Ngoc Thanh

Director General
National Center for Water Resources Planning and Investigation (NAWAPI)
Ministry of Natural Resources and Environment
The Socialist Republic of Viet Nam

Annex 3 Introduction of O-We and its capacity/discussion to cooperate for operation

General introduction to 1001fontaines' model and its declination in Vietnam with O-We Water

About 1001fontaines

Since 2004, 1001fontaines has been a leading pioneer of the water kiosk model, a solution able to provide affordable safe drinking water in a sustainable manner. Our solution offers a unique combination of three characteristics: (i) water quality at WHO standards; (ii) affordability for the most vulnerable populations thanks to a decentralized approach reducing the costs; and (iii) sustainability of the services through a market-based model supported by franchise.

To date, 1001fontaines manages 230 water kiosks in operation in Cambodia, 15 in Madagascar (started in 2008), 2 in Vietnam (2019) and 1 in Myanmar (2019). This enables 1001fontaines to provide access to safe drinking water to approx. 2.5 million people in four different countries, with more than 650,000 beneficiaries consuming this water on a regular basis.

About O-We Water Vietnam

O-We Water Vietnam is a Vietnamese enterprise created in April 2019. The enterprise is 100% owned by a French social company called UV+Solaire. The founders of UV+Solaire are 1001fontaines, a French NGO pioneering the "*water kiosk*" model for 15 years along with Danone Communities and Colam Impact, two French social impact investing funds.

O-We Water Vietnam was launched in 2019 with the objective to reach 1,400,000+ beneficiaries within 5 years along with the full financial sustainability of its investment and operations costs within 5-7 years. O-We Water Vietnam works as a franchise network of safe drinking water producers in South Vietnam providing a bundle of services to its franchisees in order to ensure the quality of their water, and the performance of their operations.

The 4 pillars of the O-We Water standards are: (i) Entrepreneurship: how to run a small-scale water production center (ii) Sales & marketing: how to differentiate in a very saturated market (iii) Water production & quality: how to maintain a high level of water quality (iv) Finance: how to manage proper reporting.

UN-Habitat and O-We had several discussions about the support and contribution to the operation for sustainable development. Within their business model, O-We could support the project. This may help locals improve the capacity for investment/business model development. Thus the infrastructures could be operated by locals with local ownership after the implementation.

Annex 4 Demonstrating Compliance with the Adaptation Fund's Environmental and Social Policy through the Environmental and Social Management Plan

Purpose

The purpose of this overview is to demonstrate compliance of the project with the Environmental and Social Safeguards of the Adaptation Fund. It provides a summary of the measures taken in the project design phase to ensure that the project promotes positive environmental and social benefits, avoids, reduces or mitigates adverse environmental and social risks and impacts considering the 15 Adaptation Fund principles. It further details the measures put in place to uphold the principles throughout the project implementation.

Compliance Process

In line with UN-Habitat's Environmental and Social Management System and the Adaptation Fund's ESP (and Gender Policy). UN-Habitat, in partnership with MONRE, local provincial governments and KEITI completed a vulnerability and risk assessment, feasibility study and environmental impact and risk examination in the preparation of this proposal. These documents are available on request, and based on the information from VRA, FS and Environmental impact and risk examination, mitigation measure, actions, and ESMP were set up.

UN-Habitat Viet Nam country office conducted the VRA, and support and cooperate with KEITI for conducting feasibility study and environmental impact and risk examination by ensuring that consultations took place with vulnerable groups, and that additional information could be gathered to demonstrate compliance with the requirements of the AF ESP. The consultations focused on climate change related hazards, the perceptions, requirements and priorities of the poorest and most vulnerable, beneficial activities, potential risks and effective risk mitigation.

Based on compliance, examination, and AF guidance, UN-Habitat focused more on 'hard part' for assessing environmental impact and risk during the implementation (See table below), and also for mitigation of the impact and risk, monitoring plans were also included into the ESMP.

Compliance	Water Treatment Technology	Bio-coast for rehabilitation	Remarks
National (See Annex 6)	No EIA required	No EIA Required	the size (Scale) of the infrastructure / Laws and regulations
	No EPP required	EPP may required (not compulsory)	Set up the ESMP with mitigation measure and action
Adaptation Fund and UN-Habitat	Category B Medium Risk	Category B Medium Risk	Even though there is the limited size of the infrastructure (smaller in scale, less widespread), Environmental Risk and Impact Examination was initially conducted, and all risk was listed. For mitigating all listed risks and impact, the Environmental and Social Management and Monitoring Plans, and mitigation action were developed based on the examination.

Annex 5 Environmental and Social Management and Monitoring Plan

Risks management arrangements

The management arrangements are based on management structure of the Project which aims to provide assigned responsibilities for related actors. The main arrangements are below:

- In the execution of the project, UN-Habitat and PMU will be responsible for the implementation of the environmental and social risk measures through their contractors. Therefore, under the PMU there is a staff who supervises the implementation of the environmental and social risk measures and reporting to the PMU and UN-Habitat

- The UN-Habitat and PMU in collaboration with their technical counterparts will have overall responsibilities for implementing the environmental and social measures requirements and compliance with the National regulation and Standards and AF principles as well.

- The site supervision and monitoring of the ESMP implementation will be carried out by PMU, local Project offices (PO), who will also be supported by technical contractors.

- In addition, the contractor shall employ an ESM staff responsible for implementation of social/environmental requirements. This person will maintain regular contact with PMU, local PO. The contractors have responsibility to ensure that the proposed mitigation measures are properly implemented during the construction phase, particularly the application of elasto-seal solution and gravels to make elastocoast or biocoast.

- UN-Habitat and PMU will make sure that all project staff and counterpart who are involve in project implementation receive both initial and ongoing environmental and social safeguard awareness and training sufficient to ensure they are familiar with their environmental and social safeguard responsibilities under the ESMP.

- Direct management responsibility of the ESMP will be under the Project Manager. The Project Manager will have oversight/final compliance responsibility. Any changes or additional activities that are required during the project implementation, and that fall within allowable limits set by the Adaptation Fund, will need to be approved by the project team leader and presented to the Project Steering Committee, depending on the scale of the activity. This plan, as well as any changes in the risk landscape, will also be presented to the PSC.

- Management and implementation of the investments: All project activities have been screened against the AF 15 environmental and social risks areas during project preparation phase. Outcomes will be presented during the project inception to all stakeholders to confirm the management and monitoring arrangements and to agree on the detailed steps required to develop management plans for each activity covering detailed studies, but also risks mitigation measures to comply with national technical standards in line with Part II, Section E.

General environmental and social risks management reduction measures

In addition to the risk management measures identified above, the following elements will be put in place to ensure the compliance with the Environmental and Social Plan:

(i) All Memories of Understanding (MoUs) and Agreements of Cooperation with the Executing Entity will include detailed reference to this ESMP and in particular the 15 ESP Principles.

(ii) The Term of References (ToR) of Committees and Working Groups, project personnel and focal points will include detailed reference to this ESMP and in particular the 15 ESP Principles.

(iii) All key Executing Entity Partners will receive training/capacity development to understand the 15 Principles, the ESMP and in particular their responsibilities. This will include members of the Project Steering Committee, Project Management Unit, local Project Offices the Working Groups and the Communities.

(iv) A Monitoring and Evaluation Framework, including monitoring of risks and mitigation measures, will be developed by the PMU and presented for approval to the Project Steering Committee and UN-Habitat Team Leader (HQ: Monitoring and Evaluation).

(v) The UN-Habitat Human rights officers and PAG will check project compliance with the AF ESP and the Environmental and Social Safeguard System of UN-Habitat during the project (besides the project manager).

4. Grievance Mechanism

i) The grievance mechanism will apply to all the project's target areas and will be open to beneficiaries and non-beneficiaries alike. It will allow them accessible, transparent, fair and effective means to communicate with the project management (UN-Habitat and Project Steering Committee) if there are any concerns regarding the project design and implementation. All employees, executing entities and contractors and people in the target areas will be made aware of the grievance mechanism to lodge any complaint, criticism, concern or query regarding the project's implementation

ii) The mechanism considers the particular needs of different groups in the target communities. It combines anonymous mailboxes at community level, a trained local facilitator in each community who can listen to grievances while assuring anonymity and a telephone number that enables people to call anonymously. These options allow people to make their grievance in whichever language they choose, offer options for illiterate people or people with low levels of literacy, and recognize that internet penetration is still low in the target area.

iii) Project staff will also be trained to recognize grievances from community members and how to deal with grievance reports. The local facilitators in each community will also be trained on to recognize dissatisfaction and on how to report grievances. In addition, monitoring activities will also provide an opportunity for beneficiary communities to voice their opinions as they wish.

iv) All grievances will be anonymzed and presented to the Project Steering Committee.

v) The address and email address of the Adaptation Fund will be made public (i.e. project website, Facebook and mailbox) for anyone to raise concerns regarding the project:

Adaptation Fund Board secretariat
Mail stop: MSN P-4-400
1818 H Street NW
Washington DC
20433 USA
Tel: 001-202-478-7347

Screening and examination process (see the example for screening and examination in Annex 5)

ESS consultants and an ESS consultation work reviewer have conducted screening, examination and review between March and December 2019 with Feasibility Studies. The designed activities for, especially infrastructure investments, were assessed to identify the potential risk and impact. After identification, mitigation measures were set up, and risky part for social and environmental impacts were analysed, and then the revision of activities was conducted. Based on those measures, monitoring plans were arranged and probability of risk was determined. With mitigation measures, monitoring plans, and probability of risk, mitigation action plans were developed below.

AF Environmental and social principles	Environmental and Social impacts and risks / Activity	Monitoring / Probability of Risks	Mitigation measures	Mitigation Action Plans
Compliance with the Law	- Possible conflicts over land ownership - Failure to comply with laws relating to procurement procedure - **Activity 3.1.1, 3.1.2 and 3.2**	PM and PO will check the status of land use and have consultation with local communities Low	Construction works of coastal erosion and installation of water treatment system may be on private land or public land which may restrict to some kind of construction activities.	- Only installing infrastructures on public land with engagement with Department of Natural Resources and Environmental for land use and Department of Construction for approval - Consult the legal procedures to establish a community owned business model
Access and Equity	- Potential social inequality in term of access to infrastructure, or that preferential access is given to certain groups **(Activity 3.1.1)** - Potential insecurity of school children **(Activity 3.1.1)**	Consultations have and will continue to capture all issues and needs of "marginalized and vulnerable groups" and particular impacts on- and needs of marginalized and vulnerable groups will be assessed throughout the project. Medium	- There is possible dispute with existing drinking water suppliers in the area when treatment system installed since the price is 70% of the market price. So, there is a risk that the project's objective to provide fresh water for drinking the price will increase after the project finished and the marginalized and poor may not be able to access to that water source. - There is a potential risk of conflict when it comes to water shortage for long period. In all community's households lacking access to clean water is more than 80 % but the project water plan can only provide clean water for limited number of people - Since the water treatment plan is located in school or kindergarten there is possible risk related to the safety of schoolchildren if people come to collect the water (e.g by motorbike) - Particularly during the construction work to strengthen coastal erosion areas using elastocoast, the access to coastal areas will be limited when local people may cultivate agriculture/aquaculture	- New business model to make sure the price stable for the poor and marginalized over time - Pro-poor tariffs will be applied and the price will be determined by Working Group - Community management with rules ensuring that equal access is guaranteed - Make sure the effective operation of waster treatment system for the locals with capacity building from O-We and develop the mechanism to provide the service to remote areas - Mechanism for safety of children should be put in place (e.g only access to water treatment facility after school hours) - 'Business as usual' mechanism will be applied and minimize the impact on economic activities from the construction of elastocoast such as provide daily labour of construction and using alternative way to reach the livelihood areas.

Marginalized and Vulnerable Groups	- There would be small number of vulnerable groups to access to livelihood resources **(Activity 3.1.1 and 3.1.2)**	Consultations have and will continue to capture all issues and needs of "marginalized and vulnerable groups" and particular impacts on- and needs of marginalized and vulnerable groups will be assessed throughout the project. Medium	- Marginalized and vulnerable group could have lack of information about the system and pro-poor tariffs - Marginalized group can be denied to access the infrastructures - Construction work to upgrade sea dykes may be given to strong and skilled workers; women and unskilled workers may not be able to participate in the construction work. -	Community co-management with rules ensuring of equal access and information is guaranteed and community based engagement will be applied to encourage the participation from marginalized and vulnerable group Make sure that the information about the infrastructures will be announced to marginalized groups. One facility will be installed in the indigenous group community (Resettled area)
Human Rights	- Human rights breaches can arise from denying access to water and other basic services	The project will monitor that international and national human rights laws Low	See Access and Equity and Marginalized and Vulnerable group There would be no specific human rights issues	In line with UN-Habitat's Project Management Cycle and Work Flow policy, the Human Rights Officer of UN-Habitat will monitor and ensure that the project is implement to respect and adhere to the requirements of all relevant conventions on human rights.

Gender Equity and Women's Empowerment	- Women could be denied access to infrastructure, or excluded from making critical decisions **(Activity 3.1.1 and 3.1.2)**	The project will actively pursue of Gender Equity and Women's Empowerment participation in project activities and stakeholder consultation, e.g. through quota systems and /or organization of separate working groups during the implementation of Components Medium	Women and children are in charge of collecting water in prolonged drought seasons in rural areas which put an extra burden into their shoulder. Construction work to upgrade sea dykes may be given to strong and skilled workers, women and unskilled workers may not be able to participate in the construction work.	The project design considered that gender issues are included in all project interventions, with a specific focus on capacity building on the all levels as well as activities on the ground. During the implementation the Gender Officer and project manager of UN- Habitat will monitor to ensure that the project follows best-practice guidelines. - Involving women and Local Women Union along process and especially during the implementation and after the end of the project - There will be low risk that women could be denied to access to water infrastructure. - The activities under Component 3 will create employment enabling some marginalized and vulnerable groups including unemployed youth and women to access employment.
Core Labor Rights	- Labour rights may not be respected when contracting communities **(Activity 3.1.2)**	The project will monitor that international and national labour laws for any work that may be carried out in relation to the project Low	Despite the fact that the chemical for elastocoast does not have any harmful components (as mentioned in Technical book, labour can possibly be affected by chemicals However, the local labor may not have enough knowledge to understand what potential risk they are facing	- All community contracts must be scrutinized to ensure they comply with both Vietnamese law and international standards. - The relevant national labour laws guided by the ILO labour standards will be followed throughout project implementation. - The safety manual and instruction will be provided.

Indigenous Peoples	- The certain minority group can be denied to access to infrastructures and excluded from the process of decision making **(Activity 3.1.1)**	Consultations have and will continue to capture all issues and needs of all communities and particular impacts on- and needs of indigenous people and other communities will be monitored throughout the project Medium	In both Tra Vinh and Bac Lieu, a major percentage is Kinh people, followed by the Khmer and Chinese ethnic (e.g in Tra Vinh, over 29% of the population is ethnic Khmer, 5-6% is ethnic Chinese and a small Cham population). There is a possible risk that the minorities are excluded from decision-making process and might have limited access to infrastructure.	- Community management with rules ensuring that equal access is guaranteed and participating in the process of decision making process - Involving the minorities in the implementation process especially gate keepers from minority communes and in the management of hard infrastructure constructed by projects or infrastructure existing in the region. - One facility will be installed indigenous group community
Involuntary Resettlement	- Possible eviction arising from conflicts over land ownership **(Activity 3.1.2)**	No activity will be implemented where there is the possibility, however small, of forced eviction. AoCs and contracts will include standard clauses stating that target communities will not be 'involuntary resettled', also after the project Low	The project itself does not require any involuntary resettlement. While the physical relocation is very unlikely to occur, and the land acquisition from private ownership are not required (as 100% of the sites are in public land), however cases of economic dislocation may occur on the current livelihood and economic activities on the project site locations subject to the land clearing and installation / construction / mangrove planting.	- In accordance with the IFC PS and other international safeguard standards on involuntary resettlement, unregistered business holders as well as informal setters, if any, shall be provided with the appropriate compensation and livelihood restoration program. - However, while the international safeguard standards including IFC PS 5 (on Land Acquisition and Involuntary Resettlement) requires that displaced persons without titles (legal rights) to land are provided with resettlement assistance and compensated for loss of non-land assets (constructed before cut-off date), the country's 2013 Land Law does not allow compensation of land-attached assets, which are illegally established (Art.92 LL). There is no requirement to compensate unregistered businesses for income losses due to business disruption resulting from land acquisition related to the project implementation and support in re-establishing their business activities elsewhere or after the project completion or decommissioning.

Protection of Natural Habitats	- While damage to natural habitats and threats to biological diversity are unlikely, there is a possibility that construction work undertaken or reforestation measures may adversely impact on local biodiversity **(Activity 3.1.2)**	Relevant policies and guidelines to be explained to understood by project personnel prior to implementation and monitored by implementing partners Low	- The planted mangrove species are not indigenous ones which may affect existing local ecosystem	- Community consultation and involvement in identifying and protecting natural habits - The mangrove species will be tested for sustainability based on community participation
Conservation of Biological Diversity	- While damage to natural habitats and threats to biological diversity are unlikely, there is a possibility that construction work undertaken or reforestation measures may adversely impact on local biodiversity **(Activity 3.1.2)**	Relevant policies and guidelines to be explained to understood by project personnel prior to implementation and monitored by implementing partners Low	- Mangrove reforestation is a good measure not only conserving the biodiversity loss due to aquaculture activities but also protecting community from soil erosion. However, there are potential risks - The planted mangrove species are not indigenous ones, which might decrease the survivor rate of new planted.	- Community consultation and involvement in identifying the plantation areas and originated mangrove species - Community co-management mechanism is in place to ensure the survivor of new planted.
Climate Change	- This project is inherently an adaptation project and as such no maladaptation is foreseen. The project will not provide or install infrastructure or appliances that result in increased emissions	N/A Low	N/A	Solar power will be used as a part electric source to operate the water purification system which reducing cost and emission.

Pollution Prevention and Resource Efficiency	- Construction of infrastructure generates wastes **(Activity 3.1.1 and 3.1.2)**	PM and PO will set up the manual for pollution and have consultation with stakeholders for capturing the relevant issues throughout the project Medium	There are potential chemical substances used in elastocoast materials can be released into the water which might affect the aquatic and mangroves Waste from the construction of hard infrastructures	- Incorporating waste management and disposal into design and implementation process based on legal compliance - Strictly follow the handling procedure when using chemicals with gravels. - Chemical residues must be collected and stored in safe places before transferring to hazard/chemical waste treatment facilities. - The environmental effects of chemicals used in elastocoast are analyzed by BASF and ARCADIS[7], mentioning the compounds pose no threat to the aquaculture environment and the components are non-toxic and naturally degradable. (Test results were shared, will be provided upon request)
Public Health		PM and PO keep checking the data from R-O System and its disposal, which can raise public health issues throughout the project Low	The technology for water treatment system in this project is membrane processes which is used for removal of bacteria, microorganisms, particulates, and natural organic material, and inorganic contaminants from water. There is a low risk in term of human health effects due to contamination. However, the test for the effectiveness of RO in removing organic and non- organic materials have done in other places. Since there is potential risk of releasing chemical substance in Elastocoast.	- No public health issues are foreseen, and improving public health is a secondary impact area of this project. - To mitigate the possible risk even though it is low, the test of effectiveness of water treatment system should be done at the project sites to show the evidence to local authorities who are in charge of local public health. - In order to mitigate the potential risks to public health, user guideline/procedure provided by supplier company should be followed and onsite Environmental Management Plan is deployed during the construction phase.
Physical and Cultural Heritage	- No physical or cultural heritage impacts are foreseen	N/A	Although no physical or cultural heritage impacts are foreseen; however, this will have to be reviewed when the activities are being taken place on site for surrounding influence.	

Lands and Soil Conservation	- Installation of bio coast may lead to more soil erosion in other unapplied places **(Activity 3.1.2)**	Consultations have and will continue to capture all issues, and this will be monitored throughout the project. Low	Since project will not be able to cover all the vulnerable areas of soil erosion there is potential risk that the change of water dynamic and flow may affect other areas, which are not protected by Elastocoast.	- Soil conservation will be enhanced through afforestation components as protective measures for land erosion control. - Careful calculation and anticipated impacts of Elastocoast intervention to find best place to introduce the intervention Monitoring erosion rate of the upgraded area and the surrounding locations.

[Example] Screening and examination process of environmental impacts and risks by AF principles

AF PRINCIPLE	Environmental impacts and risks	Remarks
PRINCIPLE 10: Conservation of Biological Diversity	+ whether it has checked and cleared that there is no presence in or near the project area of important biological diversity → The feasible study report and review the biodiversity hotspots in Mekong Delta Region, the project locations and surrounding areas do not have important biological diversity. The biodiversity hotspots in Mekong Delta Region are located in other provinces such as Dong Thap, Ca Mau, Ben Tre and Long An but not in Tra Vinh and Bac Lieu (2 provinces that the project is working on). + Whether it has checked and cleared that there are no potential of a significant or unjustified reduction or loss of biological diversity→ Due to the fact that the project are installing small infrastructures in the non-important biological diversity location, there would be no potential of a significant or unjustified reduction or loss of biodiversity.	Based on FS and photos as well as national biodiversity database, the area that project is targeting has no important biodiversity (location identification is one type of screening to check where the project is within the biodiversity hotspots or not, in this case is not).
PRINCIPLE 12: Pollution Prevention and Resource Efficiency	1) How energy, water and other material resources are to be used for the project and how the project design ensuring to maximize the energy and water/resource efficiency? → The project deploys advance technologies for water treatment which is energy saving. Operation of these water treatment systems also uses solar energy as a supplement source beside electricity from national grid. The project is also designed in the environmentally friendly approach, particularly in upgrading riverbank by using Elasto-coast technology to reduce the application of natural gravels which can be seen as an initiative to increase natural resource efficiency. Application of elasto-coast in coastal protection is more energy efficiency and less toxicity potential and risk potential than Open Stoned Asphalt (O.S.A.) and concrete[11]. As mentioned the elastocoast is an environmentally friendly chemical solution and has been registered by	The WTS used solar energy as a supplement source beside electricity from nation grid Bio-coast is verified by UNFCCC as climate friendly materials or environmentally friendly coastal prevention solution. The technical interventions applied in this project are aiming to provide affordable drinking water using R-O membrane and low energy requirement and at small scale, and in the location with no important biodiversity

[11] Elastocoast- An innovative Technology in Coastal Protection …. Today and tomorrow (http://www.polyurethanes.basf.de/pu/solutions/elastocoast/nl/function/conversions:/publish/content/elastocoast/Elastocoast_handbuch_en.pdf

	BASF[12]. 2) What kind of waste and pollutants (incl. GHGs) are expected to be generated to what extent? What are the measures to be taken in order to prevent/minimize/ offset/control them through design/project implementation plan (e.g. wastes and pollution prevention and management plan as part of ESMP and Construction Management Plan etc.) → Both WTS and riverbank prevention upgrading are small interventions so the amount of wastes (including GHGs) generated during construction and operation phases can be a small amount. Wastes are mostly solid wastes, particularly containers of Elastocoast solution (which will be collected after use following the instruction provided by the supplying company) and domestic wastes are predicted will be in very small volume since the update of only 540 m of riverbanks and number of workers working in the construction will be small (10-20 people) 3) What domestic and international standards are being applied? To list key standards applied. Construction of infrastructure, particularly riverbank prevention upgrading using Elastocoast can generates a small amount of wastes. The technical national standards may apply to waste management of the project include: - QCVN 08-MT:2015/BTNMT: National technical standard on surface water - QCVN 06:2008/BTNMT: National technical standard on harmful elements in ambient air - QCVN 07:2009/BTNMT: National technical standard on hazardous waste threshold - QCVN 10:2008/BTNMT: National technical standard on water quality of coastal water - QCVN 26:2010/BTNMT: National technical standard on noise - QCVN 6-1:2010/BYT National technical standard for natural mineral water and bottled water The international standard maybe applied to this project on - ISO 14001 (the international standard that specifies requirements for an effective environmental management system (EMS)).	hotspots. The listed national and international standards may not require applying fully due to the fact that the project interventions are small scale then the wastes generated during construction and operation are in small amount.

[12] http://www.polyurethanes.basf.de/pu/Coastal-Defense

PRINCIPLE 13: Public Health	Impacts on human impacts during construction/installation period need to be added: Whether there is/to what extent the following impacts occurs: 1) Generation of domestic wastes: What kind of waste, in what amount? Temporary (during construction period only?) Manageable through a standard waste management practice? Building of WTS will generate normal construction waste at small amount which can be treated following Circular 08/2017 / TT-BXD (Regulations on construction solid waste management) and Decree 38/2015 / ND-CP (regarding waste and scrap management). 2) Generation of hazardous wastes (incl. what chemical substance would be released related to Elasto-coast technology application?) indicate what types of wastes to be generated during what period (during construction only? or during operation onwards? What about during decommissioning?) The chemical substance in Elastocoast (Polymer, Isocyanic acid, polymethylenepolyphenylene ester) can cause some health impacts to workers such as skin irritation, allergic skin reaction, serious eye irritation, damage to organs (respiratory system) through prolonged or repeated exposure during construction phase. There are potential risks if requirements for storage and handling are not properly followed (e.g danger of bursting when sealed gastight) 3) Temporary/permanent pollution on water - surface water? ground water? to what extent? (Size/scales of impacts) There is no potential temporary/permanent pollution on surface water and ground water from WTS intervention. There will be potential environmental impacts (ecotoxicology for both water and land/soil) if the instruction for disposal is not followed strictly The listed chemical material and its container must be disposed of in a safe way in Circulars 36/2015/TT-BTNMT regarding hazardous waste management. What concrete human health impacts may occur due to the abo ve-listed impacts? What are the scales of impacts? Would there need to be any mitigation measures to avoid/minimize human health impacts? No public health issues are foreseen if the safety instructions are strictly followed and proper disposal and improving public health is a secondary impact area of this project.	(1) As specified by those two regulations, the design shall take into account technology solutions and selection of reasonable materials to minimize the amount of waste generated. In this case, using local material should be considered at the beginning. Locations and sizes of gathering points, transfer stations and solid waste treatment facilities must be consistent with construction planning and solid waste management planning. (2) Providing workers thorough training on hazardous factors, harmful factors at the workplace and safety measures to protect themselves from any accident. The additional regime of labor protection and health care insurance should be considered if the workers are local indigenous people. (3) The disposal procedure should be documented and provide to employees, project partners, local authorities for monitoring.
PRINCIPLE 14: Physical and Cultural Heritage	Status of Vietnam's ratification and entry into force of the Convention Concerning the Protection of the World Cultural and Natural Heritage The list of World Cultural and Natural Heritage in Vietnam has been consulted and there is no such site in both	

	project provinces National and legal and regulatory framework for recognition and protection of physical and cultural heritage in Vietnam There is no Physical and Culture Heritage around the public lands (kindergarten and primary school) where WTS installed in both provinces. The primary school and kindergarten locations had been checked before their constructions to comply to The Vietnam Law on Cultural Heritage. - Inventory of the physical and cultural heritage present in the two provinces that enjoys recognition at community, national or international levels. Based on the study above-listed we could conclude: No physical or cultural heritage impacts are foreseen in the project site and adjacent areas.	

Annex 6 Letter of Clarification for Environment Impact Assessment and Environment Protection Plan on potential technologies in the Adaptation Fund project documents

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
DEPARTMENT OF LEGAL AFFAIRS

Hanoi, 6 January 2020

To: UN-Habitat Viet Nam Office
Email: info@unhanitatvietnam.org
Fax: +84 24 38 237 227

Subject: Clarification for Environment Impact Assessment and Environment Protection Plan on potential technologies in the Adaptation Fund project documents

UN-Habitat is currently developing the full size project proposal for Adaptation Fund with technology implementation. First technology is water treatment system with RO using solar energy, and second one is bio-coast for coastal erosion rehabilitation.

1. Water treatment system with RO using solar energy
As shown in row 35, Annex II of Decree No.40 on EIA, the project of extracting groundwater from 500 to 5,000 m3 per day need to do EPP. However Adaptation Fund project only extracts around 20 m3 per day, it is lower than the minimum level of requirement. Also being mentioned in Annex IV of above Decree No.40, the local government just approved EPP of the project which proposes 5 to 10 tones of sediment or solic waste per day. Adaptation Fund project produces around 1-2 tones of sediment from the water purifier system. It is allowed to be proceeded without EPP. In conclusion, we would like to confirm that AF project can run further with no request for doing EIA and EPP.

2. Bio-coast for coastal erosion rehabilitation
Under Environment Protection Law in 2014, Annex 2 in Decree 40/2019/ND-CP indicates that there is no regulation on repair the bio-coast. However, if new facility would be built over 1000m, and then Environmental Impact Assessment should be required, but if under 1000m, it requires Environmental Protection Plan. In the Adaptation Fund project with UN-Habitat, the length of bio-coast technology will be implemented is 510m, and Mangrove will be planted in total areas 34,910m^2. The length of bio-coast is under 1000m in the project. As a result, Environmental Impact Assessment is not required by Viet Nam law, but Environmental Protection Plan will be required.

Yours sincerely,

Mr. Phan Tuan Hung
Director General
Department of Legal Affairs

Annex 7 Initial Assessments Report of Gender Issues in the target areas

Initial assessment report of gender issues in
Bac Lieu and Tra Vinh Provinces / Lower Mekong Delta for preparation of Adaptation Fund project

I Introduction

The principal purpose of this assessment is to mainstream the gender issues into the Enhancing the resilience, inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta, Vietnam. project. The target areas of the project are located in Bac Lieu and Tra Vinh provinces respectively. These target areas are vulnerable to climate change impact and have relatively lower resilience capacity according to the vulnerability and risk assessment[13] in terms of high exposure to severe climate events and inadequate institutional capacity.

Thus UN-Habitat Viet Nam office conducted the assessment related to gender issues during the consultation at local level. Women in these areas are particularly vulnerable as these issues cross cut with characteristics such as low levels of education, a heavy reliance on agriculture and a lack of social protection. Social norms also play a role in vulnerabilities and usual designated tasks such as the collection of water usually falls upon women. Recognising that collecting water represents a greater burden for women, this project provides inherent adaptation benefits for them.

II Scope and Assessment Methodology

The assessment was conducted by the desk review, consultation workshops and focused group discussions from the women's groups in two provinces and women unions also supported the discussion to elaborate more critical information.

Source of literature

- Ministry of Investment and Planning, General Statistics Office (2011), National Population and Housing Census 2009. "Education in Vietnam: Analyses of Major Indicators".
- General Statistic Office (GSO) (2009), Statistical Yearbook 2009 and (2011), Multiple Indicator Cluster Survey 2010 – 2011 (MICS).
- Lien Huong (2011), Vietnam's Gender Inequality Index Ranks the 58th out of 138 Nations.http://www.hoilhpn.org.vn/NewsDetail.asp?Catid=112&NewsId=16076&lang=VN
- ADB Vietnam: Country Gender Assessment (2006)
- WB Vietnam Country Gender Assessment (2011)

Interviews/Consultations/FGDs

During the consultation work in the field in November and December 2018, and May 2019, focus group interviews were conducted with the women's unions at all sites. For the interview, the questionnaire was divided into three parts to understand the exposure to the climate change impact, 1) the general level of gender sensitivity, 2) adaptive capacity, and 3) areas for improvement needed in more details, in compliance with Gender Policy of Adaptation Fund.

Limitation

The data applied for this assessment was not up-to-date, thus there might have data gap between available data and latest status. However available data and findings were tested within this limitation, and focus more on interview and group discussion data for the assessment.

III Legal and Policy Framework in Vietnam

Gender equality is not a new element in the law of Vietnam. The Constitution of 1946 states that women and men are equal. Women's equality to men's under the law is also mentioned in the Constitution of 1959, 1980,

[13] UN-Habitat Viet Nam, Vulnerability and Risk Assessment Report, February 2019

1992 and its amendment in 2001 as well as the Constitution of 2013. Vietnam also has a law on Gender Equality. The 2006 law on Gender Equality highlights the quality of women's rights in Vietnam.
The Social Insurance Law (2006), Law on Residence (2006), the Law on Domestic Violence Prevention (2007), and the Nationality Act (2008) also contain provisions to protect the rights of women. Accordingly, some specific rights guaranteed women: equality; freedom of speech; labour rights; social security and social welfare protections; the right to vote or stand for election; the right to participate in social management, state management; freedom of religion; inviolable rights body, life, and health; the right to respect, honour, and dignity. Also, there are "National Strategy for the Advancement of Women in Viet Nam by 2010" sets labour, education, health as priority issues.

However, significant challenges still remain as highlighted in the World Bank's 2011 Country Gender Assessment, especially with regard to the wage gap between men and women and women's more limited access to formal employment opportunities and in turn limited direct access to formal social protection. Lower land certification rates, women's high time poverty and gender-based violence are also key concerns.

IV Gender Situation in Mekong Delta Region: Baseline Data

1. Income level and livelihoods of Women in Mekong Delta

In all the districts visited during project preparation noticed employment opportunities are limited. There are very few industrial facilities, and existing ones tend to be small-scale, employing a small number of workers and operate only on seasonal basis. Small-scale trading provides an outlet for local labour, yet this requires skills and access to credit and is not easily accessible. Farm work still is the main source of wage labour opportunities for local people. However, women's access to this is affected in various ways.

As shown above, women are frequently restricted by their domestic roles when it comes to wage labour or income generating activities outside the home. A number of wives of shrimp/shellfish farmers in communities used to be involved in tailoring or small trading but had to give these activities up as soon as they were married and had small children. When women do take part in wage labour, their tasks are less valued than those performed by men. This is seen in the high male-female wage differentials across all sites visited. Female wage ranges between VND 40 – 70 thousand/day whereas male wage falls between VND 65 – 100 thousand/day depending on the local wage level.

2. Access to educational opportunities among girls in Mekong Delta

According to the Multiple Indicator Cluster Survey 2010 – 2011 (MICS) conducted by the General Statistics Office, children's access to education at primary school in all areas and regions does not show any gender-based differences at all (GSO, 2011). At the junior secondary school, however, girls make up a higher proportion than boys.

However, a more detailed review of the National Population and Housing Census in 2009 (Ministry of Planning and Investment and General Statistics Office, 2011), shows a remarkable feature of the educational reality in Mekong Delta, in comparison with other areas of Vietnam. The rate of school dropouts for students aged from 15 to 18 in Mekong Delta is the highest in Vietnam. This rate is especially high in some provinces such as Bac Lieu (26.2%), An Giang (25.9%), and Soc Trang (25.8%). From the gender perspective, it is recognized that 70% of school dropouts are girls (Tran Thi Que and To Xuan Phuc, 2000). At higher levels of education, gender-based differences are shown more obviously in this region as below: of all boys aged 5 or more, the proportion of boys that finished the junior secondary or higher education is 12.4%; whereas the corresponding figure for girls aged 5 or more is stands at only 8.9%. The proportion of boys who graduated university is 2.5%; whereas the corresponding figure for girls is 1.6% (Ministry of Planning and Investment, and General Statistics Office, 2011).

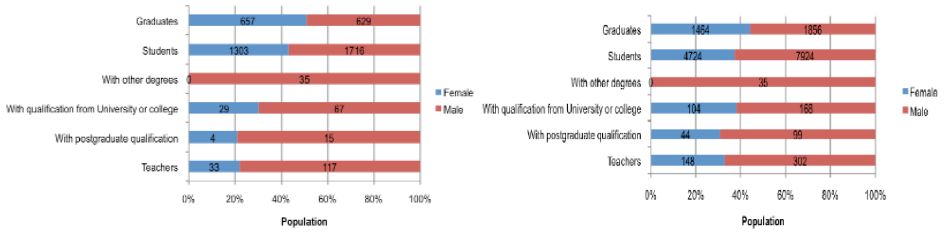


Figure1 Teachers and students in 2010 in Bac Lieu Province and the gender rate in secondary education

Management officials as well as scientists have pointed out a number of reasons why children drop out of school (i.e. Poverty prevents children from going to school during the harvest time in order to help their parents; Far distance between school and home, and inconvenient transport discourage students from going to school; Parents' low level of awareness on the importance of education is another discouragement (especially when they own farmland to live on). (Quoc Dung, 2012). In addition to the above-mentioned reasons, it is necessary to make analyses from the cultural and gender perspectives, in order to fully and precisely understand the reasons for the high rate of school dropouts.

Reflecting relatively low-income level, the higher (secondary and tertiary) school dropout rates in Mekong Delta is visibly higher than the national average and this tendency is even higher for girl students. Deteriorations of overall livelihood of the family due to the climate change-related impacts (and particularly natural disasters) are likely to affect the teenage population (particularly girls in high teens) to drop out of the schools to assist the economic activities and family livelihood. Without proper interventions it is likely that gender disparity in high education would be worsened.

3. Cultural Barriers 1: Early marriage and transnational marriage among women in Mekong Delta

It appears that remote rural area has higher level of child marriages than in urban areas. Mekong Delta region also has a higher rate of child and early marriage practices compared with the urban areas, while being lower than the Central highlands. The Law on Marriage and Family of Vietnam regulates the age of marriage. The legal age for marriage is 20 and 18, for men and women respectively. The rate of women, who marry for the first time before the age of 15 (or the so-called child-marriage) is not high (GSO, 2011). In Central Highlands, this rate is at 1.7% among female population of 15-49 age group, which is the highest in the country. Northern midlands and mountains record the second highest (1.2%) and Mekong Delta follows in rank (1.1%). Nothern midlands and mountains still show the highest rate of child marriage under the age of 18 at 18.8%, followed by Mekong Delta(16.3%), and Central Highlands(15.1%). Practices of early marriages hampers Vietnamese women's pursuance of higher education and economic activities, which in turn, leads to a life-time financial (and other types of) independence of women upon men and families. The overall weaker economic status and cultural dependence of women in Vietnam structurally generates higher vulnerability of women population (particularly female-headed (widowed or otherwise) households with low income levels in rural areas).

4. Cultural Barrier 2: Domestic violence against women in Mekong Delta

The table below shows that the acceptance or tolerance rates of domestic violence against women differ by region in Vietnam. It is noted, however, that Mekong Delta region shows the highest or the second highest rates in most of the indicators below. Prevalence of domestic violence against women in Mekong Delta region indicates the level of women's independence is low. Therefore, ensuring equal and active participation of women in decision-making process and equal sharing of the benefits of the proposed project would require awareness-raising and perception change about the important roles of girls and women in the overall consultation and participation process of the proposed project implementation. Also any type of interventions to empower and capacitate girls and women would require a long-term approach and culturally sensitive strategy.

Region	Going out without asking permission from husband	Neglecting her duty to taking care of children	Making a retort towards her husband	Refusing to have sex with her husband	Spoiling food	Any of the mentioned causes	Number of women aged 15-49
Red River Delta	7.3	19.3	16.4	2.7	0.7	27.4	2368
Northern Midlands and Mountains	18.0	33.1	27.3	11.0	5.0	43.5	1896
Northern Central and Coastal Central Vietnam	15.0	30.3	27.7	5.9	4.5	44.4	2429
Central Highlands	15.0	23.9	26.0	6.5	3.0	36.3	671
Southeastern Vietnam	5.4	16.5	9.6	2.4	0.6	21.9	2080
Mekong Delta	22.3	35.9	20.0	7.3	5.3	41.8	2220

Table 1 Rate of Women from Age group of 15-45 Yearswho believe that a husband has the Right to beat his wife/lover in following situation (Multiple Indicator Cluster Survey, GSO, 2011)

5. Women's Vulnerability to Climate Change in Mekong Delta

The inequalities in terms of economic status, education and cultural norms in combination, as mentioned above, makes the women in Mekong Delta region more vulnerable to the climate change-related hazards. It is reported that women are less represented in decision-making process within the governments that the women's concerns (such as hygiene requirements and emergency response plans particularly addressing the need of the vulnerable

groups (such as children, the elderly, the disabled and the sick etc.) during the occurrence of the natural disasters are less heeded. At local level, it is common that the commune-level decision-making and planning are made by predominantly male leaders and that the local emergency response team often are composed of men only[14].

V. Findings from Consultation Meetings and FGDs

In general, the interviewed and consulted women from the site project areas were not clearly aware that climate change would impact them more than it would the other gender but some indicated particular predicament they may face in time of natural disasters such as flooding and tornados etc.

More details of the findings are summarized as summarized below:
First, while both women and men are affected by climate change with implications on the general well-being of the households, women's subsistence activities are more severely hampered, adding to their existing domestic burdens. For instance, in dry season, the impact to the productivity of shrimp and rice cultivation, which (poor) women's livelihoods are largely dependent upon, is more intense than at other times.
Second, the poor, particularly poor women would be doubly affected as a result of direct impacts on the natural resources from which they collect and earn income as wage laborer. Since these are the cornerstones of their livelihoods, their vulnerability and poverty are further entrenched.
Third, the lack of fresh water both as a result of drought and floods results in a major impact on the life of people, especially women, in the Mekong Delta, because a number of women have to travel far from their house to obtain water. Shortage of drinking water, in particular, poses specific challenges to each of the communes. It was found that half of the consulted communes were purchasing drinking water at very high prices or using surface water for drinking (during the months when fresh water are available) although they extract underground water from boreholes due to the late rainfall. A large part of underground water in the Mekong delta is not drinkable because of its high arsenic content and people mainly rely on surface water, which is vulnerable to natural hazards and environmental problems.

It was also found that: The impact of climate change leads to a decrease in the average income in the district; Children cannot go to school, as they need to support their family with livelihood resources; Most people do not want to move to the new settlement area without proper basic infrastructure; Ethnic minorities account for 60% of population and they have lost land from climate change impact and have had difficulty finding another livelihood resource; and From the view of the local people, the geographical location is also seen as part of the threat from climate change impact as it is more prone to sea level rise and flood.

Figure 1 Consultation workshop and focused group discussion in the target areas

V. Conclusion and Recommendations

To summarize, the project team found that the existing gendered vulnerabilities are exacerbated by the likely effects of climate change. Differences in livelihood strategy between men and women result in differential exposure to those effects. For instance, women's workload increases with the need to transplant rice as a result of late rainfall, whereas men have more problems when the shrimp ponds are affected. Meanwhile, women's subsistence activities are severely hampered through negative impacts on livestock e.g. increased disease incidence and reduced availability of natural resources. Further, poor and landless women are doubly affected by shrinking natural resources and diminished wage labour opportunities resulting from climate-induced failures in agriculture and aquaculture. This adds to their existing vulnerabilities.

[14] See: 1) https://qz.com/1758547/how-vietnamese-women-are-fighting-back-against-climate-change/ & 2) https://apwld.org/women-of-the-lagoon-confronting-climate-change-in-coastal-vietnam/