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EXECUTIVE SUMMARY

The Ben Tre coasts have been extensively used for aquaculture and agriculture purposes for many decades resulting in widespread mangrove degradation and deforestation in the province. The loss of coastal mangroves contributed significantly to severe coastal erosion in Binh Dai, Ba Tri and Thanh Phu in 2009 becoming more serious between 2012 and 2013. Severe coastal erosion has caused in the Ben Tre shoreline to be squeezed significantly and mangroves to be lost. Since local agriculture is extremely vulnerable to coastal erosion, farmers have been losing crops and revenues.

Between 2008 and 2013, there were a number of failed attempts to restore mangroves, despite there being technical guidelines in place and a favourable legal and policy environment. In July 2014, a survey was undertaken employing participatory action research methods to recommend options for sustainable coastal management and development at preselected sites in three coastal Districts of Ben Tre province *(Ba Tri, Binh Dai and Thua Duc).*

This report presents the underlying causes of coastal erosion, evaluates the current policies and plans for coastal protection in Ben Tre Province, records local initiatives in coastal protection and recommends options for sustainable coastal management and development in Ba Tri, Binh Dai and Thua DucDistricts. While land tenure conflicts resulted in poor mangrove management and further mangrove degradation, poor pond construction and operation and inadequate farming techniques contributed greatly to mangrove loss and coastal erosion. The planting of a single species *(Rhizophora apiculata)* weakened the protection provided by coastal mangroves against erosion and increased the vulnerability to sea level rise and storm surge. Planting without proper protection, especially on eroding areas did not assist in establishing the mangrove belt in Ben Tre province.

The current strategies employed by the Ben Tre province have had limited success mainly because these strategies only dealt with symptoms and had insufficient local involvement in planning. While various local initiatives in coastal protection worked temporarily, many naturally vegetated coastal locations have been found to be effective in minimizing the negative impacts of coastal erosion, sea level rise and storm surge.

I. INTRODUCTION

The project: Building Resilience to Climate Change Impacts in Coastal Southeast Asia, funded by the European Union, has been implemented by IUCN in 2011 in eight coastal provinces of Thailand, Cambodia and Vietnam. The project aims to plan for minimizing climate change impacts and to develop adaptation strategies for future climate risks.

In Vietnam, Ben Tre was selected to be a project site due to its vulnerability to climate change and sea level rise. In Ben Tre province, the coasts of Ba Tri, Binh Dai and Thanh Phu Districts were severely eroded many years ago, resulting in mangroves being degraded and local livelihoods being damaged. IUCN Vietnam cooperated with Vietnamese government agencies *(the Vietnam Administration of Seas and Islands of the Ministry of Natural Resources & Environment, the Institute of Tropical Biology of Ho Chi Minh City, Can Tho University and Ben Tre Provincial People's Committee)* and the international nongovernmental agencies operating in Vietnam *(World Wide Fund for Nature and German Agency for International Cooperation)* in developing strategies for strengthening local ability and piloting adaptation plans to reduce vulnerability to climate change.

II. OVERVIEW OF THE SURVEY

This survey focuses on recommending options for sustainable coastal management and development at the preselected sites of three coastal Districts of Ben Tre province *(Ba Tri, Binh Dai and Thanh Phu).*

The main objectives of the survey are:

- To understand the land tenure situation;
- To profile existing human uses in the preselected coastal sites;
- To evaluate the current policies and plans for coastal protection in Ben Tre Province;
- To record local initiatives in coastal protection;
- To evaluate areas naturally protected against coastal erosion and natural regeneration;
- To document local concerns and aspirations; and
- To recommend options for sustainable coastal management and development.

III. SURVEY METHODS

The survey acquired information from a variety of resources including: (a) provincial staff, (b) field observations; (c) provincial documents and other legal records and (d) local partners and communities. Various methods were adopted to achieve the objectives of this survey:

i) *Conducting secondary data analysis (a desk review) of coastal erosion available by reviewing the data, any related activities / measures on mangrove restoration and management that have been conducted in the research sites;*

ii) *Organizing field visits to cross-check and / or update the information provided by local communities and by scientific reports;*

iii) *Observing potential areas that would benefit from future coastal planning and providing additional information on these areas;*

iv) *Conducting participatory community meetings to promote local involvement and social leaning process to share local knowledge and lessons related to coastal management / development and erosion; and*

v) *Organizing semi-structured interviews to assist in understanding the causes of coastal erosion and mangrove degradation.*

IV. SURVEY ORGANIZATION

The survey was scheduled between 27 June and 30 September 2014 and included two tasks: field trips and data analysis and reporting.

Field trips, undertaken between 27 June and 21 July 2014, were organized with assistance provided by the IUCN Field Coordinator in Ben Tre and two staff from the Department of Agriculture & Rural Development of Ben Tre province and divided into two phases. The first phase from 27 June to 1 July 2014 was used to make contacts with IUCN and governmental staff in Ben Tre province. The second phase commenced between 13 and 21 July 2014 and consisted of official meetings with the departmental agencies in Ben Tre province, field trips and participatory community meetings.

During the field trip period, five meetings were organized with various governmental agencies in Ben Tre province *(Department of Agriculture & Rural Development and the Department of Natural Resources & Environment, the District People Committees of Ba Tri, Binh Dai and Thanh Phu)*. The meetings aimed to gain insight of climate change adaptation measures by the government and Ben Tre province. Seven field trips were organized to six eroding sites to understand coastal erosion conditions. Three participatory community meetings were held at three different communes *(An Thuy, Thua Duc and Thanh Phu)* to share local knowledge lessons learnt related to coastal management / development and coastal erosion. Several semi-structured interviews were undertaken to understand further the causes of coastal erosion and mangrove degradation.

Areas surrounding the preselected sites were also surveyed to assist in understanding the causes of coastal erosion and mangrove degradation and to search for existing coastal erosion measures or any possible adaptation measures in place.

Data analysis and writing occurred in Australia between 21 July and 30 September 2014. The first draft technical report was completed and submitted to the IUCN office in Ho Chi Minh City on 25 August 2014. Final report was submitted on 30 September 2014. A debriefing was organized at IUCN office Ho Chi Minh on 3 October 2014.

V. FINDINGS

5.1. Land tenure situation

Land cover in Ben Tre until 2012

Land cover has changed significantly between 2005 and 2012. The changes were caused by aquaculture and agriculture operations, resulting in mangroves being degraded and deforested over time. Aquaculture, the largest land use in Ben Tre province, occupied 44.5% of the area. Thick and diverse mangroves were only found in the Thanh Phu Wetland Nature Reserve, while degraded coastal mangroves and deforested areas were located along the coasts of Ba Tri and Binh Dai Districts *(figure 1) (Department of Agriculture & Rural Development of Ben Tre Province, 2011)*. Aquaculture, degraded and / or deforested mangroves made the Ben Tre coastline vulnerable to coastal erosion, storm surge and sea level rise.

QUY HOẠCH CHI TIẾT NUÔI TÔM CHÂN TRẮNG TRÊN ĐỊA BÀN TỈNH BẾN TRE ĐẾN NĂM 2020

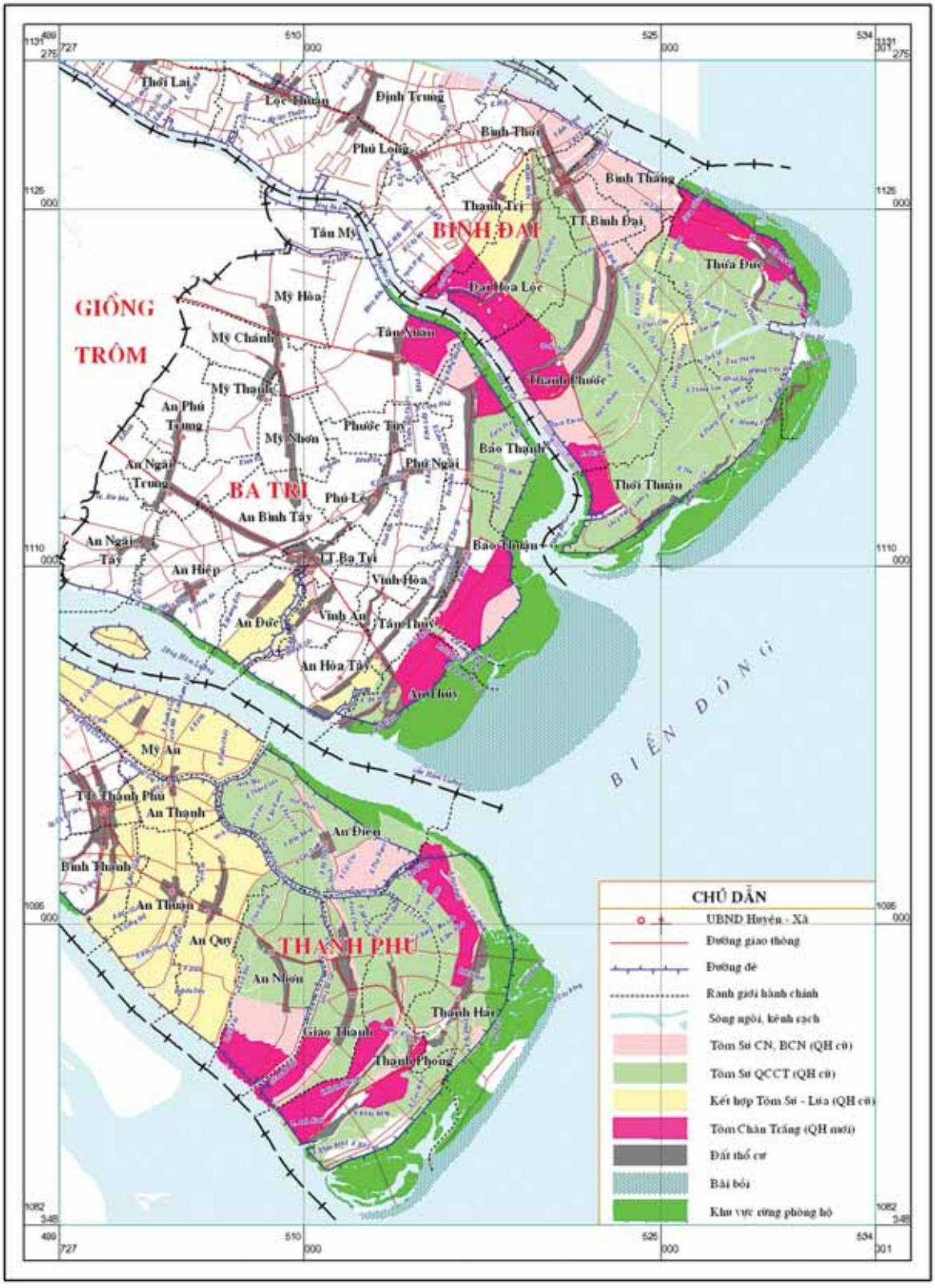

Figure 1: *The map indicated types of land use, the sea dyke system and the Coastal Mangrove Protection Area and Special Use Forest with degraded, thin coastal mangrove areas along the coastline. Source: Department of Agriculture & Rural Development of Ben Tre, 2012*

Early migration to the Ben Tre coast: Mangroves converted into aquaculture ponds and agricultural production land

In1945few people migrated to the coastal areas in Ben Tre clearing mangroves and coastal areas for aquaculture ponds and agricultural production. Ponds were constructed for fish and shrimp production while. Agricultural products included water melon, cassava, and peanuts. In 1994, the Ben Tre population was boosted by a record migrant influx to the coasts of Ba Tri, Binh Dai and Thanh Phu Districts. Migrants established various clusters of houses, aquaculture ponds and agricultural production areas along the coasts of Ben Tre province. While the minority of the migrants were issued formal land use right certificates *(red books)*, the remaining population especially those who migrated to the areas after 1995 have not been issued with red books.

The Ben Tre coasts have been extensively exploited for aquaculture and agriculture purposes for many decades. Mangroves were reported to have been thick and diverse with many species *(Nypa fruticans, Avincennia alba and Avicennia marina, Rhizophora apiculata, Exoecaria agallocha, Lumnitzera racemosa, Xylocarpus granatum, Sonneratia alba and Acanthus ilicifolius, etc.)* in the past. The migrants built aquaculture ponds by clearing coastal mangroves, manually constructing thin pond dikes and pond gates close to the sea water. Ponds were constructed for shrimp and fishes. Ponds were operated by opening pond gates in high tides to collect natural larvae of fish, shrimp and crabs from the sea. Wild larvae were trapped inside ponds by gates being closed in low tides. Shrimps, fish and crabs were harvested three months after pond gates were closed.

During the Vietnam War, coastal mangrove areas in Ben Tre province were defoliated, resulting substantial areas of coastal mangroves in Ben Tre province being destroyed.

In the 1980s, strong waves in high tides broke up weak and thin pond dikes and simply constructed pond gates, causing severe coastal erosion in many sections along the coasts of Ba Tri, Binh Dai and Thanh Phu Districts. As a consequence, the shorelines were squeezed, with a minimum loss of 500 meters. Remnants of pond dykes are still found along the coasts in low tides, especially in An Thuy commune *(Figure 7)* and Thua Duc commune *(Figure 8)*. However, the same aquaculture construction and operation are still applied in some locations in three Districts.

The establishment of the Coastal Mangrove Protection Area and Special Use Forest

In 1999, the Coastal Mangrove Protection Area was established by a decree issued by Ben Tre Provincial People's Committee. The establishment was undertaken by claiming coastal areas in Ba Tri, Binh Dai and Thanh Phu Districts, including aquaculture ponds and agricultural production areas operated by local residents. The estimated total area was 7,833 ha. The Coastal Mangrove Protection Area aims to maintain, protect and develop coastal mangroves and promote integrated aquaculture - mangrove models.

Also in 1999, 4,510 ha of the Coastal Mangrove Protection Area, rich in biodiversity, historical and cultural values, were formally established as the Thanh Phu Wetland Nature Reserve by decision No. 1026 / QD - TTg, dated 31 November 1998. The Thanh Phu Wetland Nature Reserve belongs to the Vietnamese nation system of protected areas. Since then, the Coastal Mangrove Protection

Area has been officially named: the Coastal Mangrove Protection Area and Special Use Forest of Ben Tre province.

A management board was established in 1999 to manage the Coastal Mangrove Protection Area and Special Use Forest of Ben Tre province. This management board is under direct management of the Department of Agriculture & Rural Development of Ben Tre province. However, the boundaries were not demarcated on the ground and the management board has not been issued with a red book over the entire area of the Coastal Mangrove Protection Area and Special Use Forest of Ben Tre province since the establishment. It was explained that the red book will not be issued until its boundaries are clearly demarcated on the ground.

5.2. Human uses of the Ben Tre coast

District coastal development

Despite being located within the Coastal Mangrove Protection Area and Special Use Forest, the coasts of Thua Duc, Thanh Hai and Bao Thuan communes have been intensively used for coastal development. Coastal development included construction of restaurants and coffee shops and tourism resorts. Simple stilt houses have been constructed as restaurants and coffee shops near the Lyrate Asian hard clam *(Meretrix lyrata)* farming areas operated by the Bao Thuan Cooperative (*Figure 2)*, a series of restaurants were also constructed along the shoreline of Thua Duc coast *(Figure 3)* and on Con Bung beach of Thanh Phu District *(Figure 4)*. High tides reach the floors of these restaurants and coffee shops. These coastal developments attract local tourists, especially on weekends.

A large coastal area was reserved for constructing a tourism resort on Thua Duc coast *(Figure 5)*. The foundation was constructed by clearing the vegetation and constructed with many concrete poles. Next to the tourism resort on the south, a large area was planned to construct a shooting ground, to be operated by the Army *(Figure 6)*. The shooting ground construction was started by compensating those who cultivated crops on the areas.

Figure 2: *Simple stilt houses constructed onshore as restaurants and coffee shops to welcome local tourists on Bao Thuan coast. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project 2014*

Figure 3: *Many restaurants were constructed along the shoreline of Thua Duc coast to serve weekend local tourists. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 4: *Many restaurants were constructed on Con Bung beach of Thanh Phu District to welcome local tourists. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 5: *A large coastal area has been reserved for constructing a tourism resort on Thua Duc coast. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 6: *A large coastal area has been designated to construct a shooting ground for national defence purpose on Thua Duc coast. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 7: *Remnants of pond dykes are visible on Den Chop area of An Thuy commune. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 8: *Remnants of pond dykes remain seen on Cong Be Lon area of Thua Duc commune. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Intensive shrimp farming

Intensive shrimp farming has recently become more common in Ben Tre, especially in Thanh Phu District. Sand dunes located among the coastal mangroves were illegally exploited for constructing ponds that were used for intensive shrimp farming *(Figure 9)*. In some areas, saline water was pumped into ponds. Wells were drilled to obtain underground saline water to be supplied to ponds located further inland from the sea.

Figure 9: *A sand dune area was exploited for constructing shrimp ponds in Thanh Hai commune. Electricity engines were used to start paddles to aerate shrimp farming pond water. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Agricultural production land

Agricultural land was created by clearing coastal mangroves and constructing bunds where agricultural crops were grown. Agricultural crops included water melon, sweet potatoes, cassava and corns. Bunds were covered with plastic sheet to retain humidity and to stop weeds *(Figure 10)*. Land behind the coastal mangroves, especially sand dunes was also used for growing agricultural crops. Vegetation clearance for growing agricultural crops, either along the coasts or on sand dunes caused the coastal areas to be likely vulnerable to erosion and sand accumulation onshore. Many mature trees of *Sonneratia alba, Avicennia alba* and *Avicennia marina* were killed by their breath roots covered by sand in An Thuy and Thua Dua communes *(Figures 11 and 12)*. At present, agricultural land, especially water melon fields are exposed to the sea due to increased coastal erosion and loss of mangroves. The exposure caused the local residents a substantial loss of crops and revenues, especially during coastal erosion, abnormally strong waves and high tides.

Local farmers only cultivated three crops a year, leaving their land uncultivated for four calendar months *(September, October, November and December)* to avoid inundation by strong waves and high tides.

Figure 10: *Bunds covered with plastic sheet were used to grow water melon on Den Chop area of An Thuy commune. The bunds are exposed to the sea. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 11: *Mature trees of Sonneratia alba died on Den Chop area of An Thuy commune because their breath roots were covered by sand. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 12: *Mature trees of Sonneratia alba and Avicennia marina died on Cong Be Lon area of Thua Duc commune because their breath roots were covered by sand. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Planting programs

Between 1993 and 1995, propagules of Rhizophora apiculata were planted along the Ben Tre coasts under the 661 afforestation Program. Rhizophora apiculata was selected because this species was easy to plant and could be commercially harvested. In planting, other mangrove species *(Avicennia, Bruguiera, Rhizophora, Sonneratia, etc.)* were removed and replaced with Rhizophora apiculata. Today, Rhizophora apiculatahas become the dominant species along the coasts of the three Districts.

In 1997, shrimp died of unknown causes, resulting in many shrimp ponds being abandoned in Thanh Phu District. In addition, coastal mangroves along Thanh Hai coast, especially Rhizophora apiculata were massively destroyed in 1997 by the severe Tropical Storm Linda. Vegetation loss due to the storm combined with the abandoned ponds increased the vulnerability for coastal erosion. In Thua Duc and Thanh Hai coasts were actively eroded in 2009 and the problems became more serious between 2012 and 2013 *(Figures 13, 14 and 15)*.

Figure 13: *The coast of Cong Be Lon is actively eroding.*
Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014

Figure 14: *Cay Dua area of Thanh Hai commune is actively eroding with many mature trees of Rhizophora apiculata uprooted by strong waves. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 15: *Many mature trees of Rhizophora apiculata were also uprooted by deficit of sediment around their roots on Cay Dua area of Thanh Hai commune under the influence of strong waves in high tides. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Burrows of brackish water fiddlers and coastal erosion

It was found that Avicennia species could develop strong root systems in the soil, assisting in holding the soil in place, while Rhizophora species spread their roots on the surface of the soil *(Figure 20)*. Pure stands of Rhizophora apiculata functioned as a nursery ground where organic and inorganic nutrients were provided to commercially important fish, prawn, especially brackish water fiddlers *(Ucaminax) (in Vietnamese Ba Khía)* in Thanh Hai commune. Brackish water fiddlers thrived and dug burrows at high density around root areas of Rhizophora apiculatafor making nests and protecting themselves from their predators *(Figures 16 and 17)*. Strong waves during high tides spread into burrows, weakening the coastal soil structure and making it susceptible to collapse. Over time this has led to the coast being collapsed massively *(Figures 18 and 19)*.

Figure 16: *High burrow density was found around mature trees of Rhizophora apiculata in Cay Dua area, Thanh Hai commune. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 17: *Burrows at a high density were found around mature trees of Rhizophora apiculata in Cay Dua area, Thanh Hai commune. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 18: *The coast of Cong Be Lon was massively collapsed by strong waves propagating into burrows with force. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 19: *Strong waves propagated into burrows over time, resulting in the coast being collapsed. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

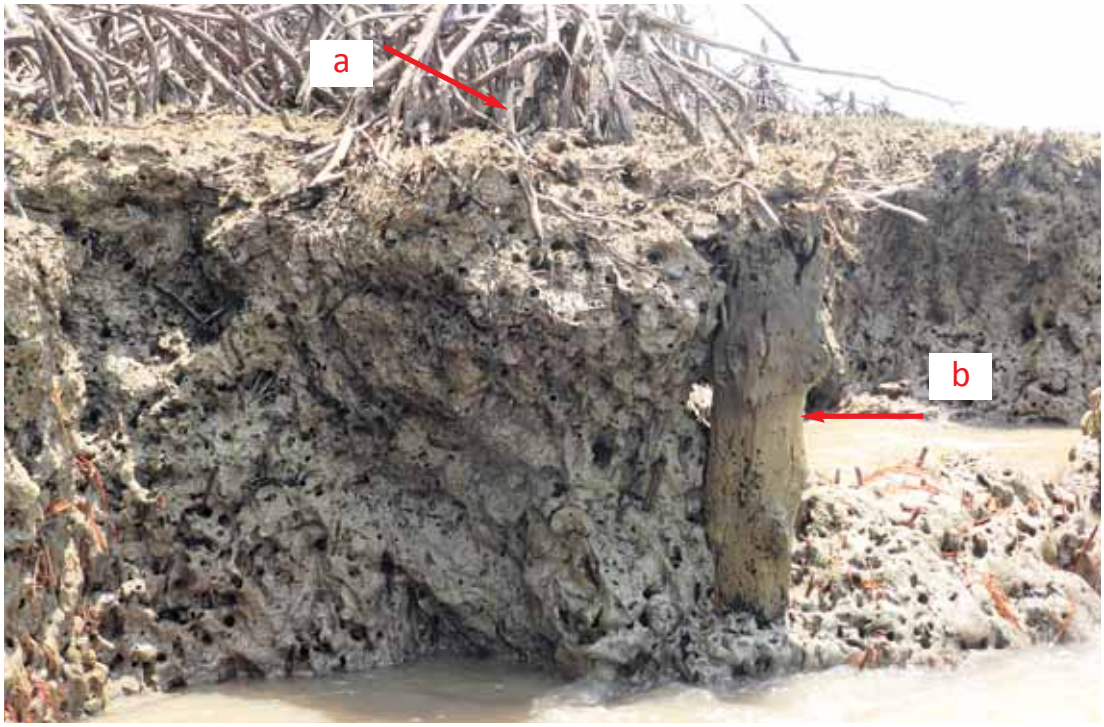

Figure 20: *The photo showing a significant difference in holding sediment by two different mangrove species, a) a remnant of root of Avicennia species developing well into sediment that assisted in grasping sediment, b) roots of Rhizophora apiculata spread their roots on the surface of the soil. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014.*

Sea water surface leased for aquaculture purposes

Sea water surface along the coasts has been leased under contract for aquaculture purposes for many years. The ten Cooperatives currently farming Lyrate Asian hard clam *(Meretrix lyrata)* are Rang Dong *(Figure 21)* and Dong Tam *(Binh Dai District)*, Bao Thuan, An Thuy and Tan Thuy *(Ba Tri District)*, Thanh Loi, Thanh Loc, Doan Ket, Hai Dong and Binh Minh *(Thanh Phu District)*. The Ben Tre Provincial People's Committee authorized the provincial departments to sign contracts with individuals and local organizations for aquaculture farming. Since 2014, the Department of Finance has been authorized to negotiate and sign contracts. In 2014, contracts were renewed for farming Lyrate Asian hard clam *(Meretrix lyrata)* for six cooperatives *(Rang Dong and Dong Tam in Binh Dai District, Bao Thuan and An Thuy in Ba Tri District, Thanh Loi and Thanh Loc in Thanh Phu District)*. The Cooperatives have been evaluated to have contributed greatly to poverty reduction and hunger eradication in Ben Tre province.

Figure 21: *The post says that Lyrate Asian hard clam (Meretrix lyrata) on Bao Thuan open sea water is currently managed by Bao Thuan Cooperative. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

5.3. The current government policies and plans for coastal protection

The Ben Tre coast was actively eroding in 2009. The coastal erosion became serious between 2012 and 2013. Since the 1990s, Ben Tre province has taken concrete steps in mitigating adverse negative impacts of coastal erosion on agricultural production and aquaculture activities. The steps included administrative coastal management and planning techniques, engineered solutions and ecological engineered solutions.

Administrative coastal management and planning techniques

Administrative coastal management and planning techniques are usually provided by the government legislation and regulation and can be policies, legislation, regulations and enforcement. The techniques are established to address coastal problems to ensure adequate natural environment management and to manage the activities of multiple stakeholders *(Kay and Alder, 2005)*.

In 1995, Ben Tre Provincial People's Committee issued a decision to establish the Coastal Mangrove Protection Area. The Thanh Phu Wetland Nature Reserve was established in the same year by the decision made by the Vietnamese Prime Minister in 1999. The Coastal Mangrove Protection Area and Special Use Forest was established to achieve a balance between needs for coastal protection and management and demands for socio-economic development.

In 2011, Ben Tre Provincial People's Committee approved the action plan for adaptation to climate change and sea level rise in Ben Tre province until 2020. In this action plan, steps were identified to expand the coastal mangrove and special use forest areas, protect coastal environment, control coastal erosion, promote sedimentation along the coasts, develop mangrove ecosystems, and to gradually reduce shrimp farming areas located within the Coastal Mangrove Protection Area and Special Use Forest and promote shrimp mangrove production models.

Also in this action plan, various projects were prioritized to be implemented to deliver solutions and adaptation to climate change and protection of coastal natural resources & environment in Ben Tre province. Priority projects included:

- Interpretation and education on climate change adaptation and mitigation and environmental protection
- Active climate change adaptation strategies. The strategies included surveys that aimed to:
    - Measure negative impacts of climate change on agriculture and aquaculture;
    - Update climate change scenarios, to develop inundation maps, to identify coastal zones where construction is prohibited;
    - Adjust land use planning that integrates climate change effects, coastal erosion and sea level rise;
    - Manage effectively coastal ecosystems, coastal wetland reserves;
    - Expand aquaculture techniques;
    - Manage onshore fishing in an integrated way;
    - Develop high value aquaculture species;
    - Strengthen research and apply research results into developing adaptive climate change strategies;

- Complete the concrete sea dyke system in Binh Dai, Ba Tri and Thanh Phu Districts;
- Complete the fresh water irrigation system in the northern area of Ben Tre province, the Sap bridge system, Cai Quao bridge and the river sea dyke and sluice gate system that serves water regulation, inundation regulation and active irrigation purposes;
- Develop disaster plans and environmental warning system to be used for aquaculture; and
- Protect coastal mangrove ecosystems and coastal wetlands.

In addition, the Climate Change Adaptation Board and the Climate Change Program Office was established. The Climate Change Adaptation Board, chaired by a deputy chairman of Ben Tre Provincial People's Committee is primarily responsible for developing climate change adaptation measures and policies, coordinating and integrating climate change adaptation strategies developed by the provincial departments into socio-economic development plans. The Climate Change Program Office is in charge of developing implementation action plans and programs and implementation of approved action plans and programs and report synthesis and recommending solutions to rising issues related to climate change and protection of natural resources & environment.

In 2011, the management board of The Coastal Mangrove Protection Area and Special Use Forest developed a plan for coastal mangrove protection between 2011 and 2014. The ultimate goal of the plan is to protect the current mangrove belt, improve forest coverage, control coastal erosion and adapt to climate change and sea level rise. The extremely vulnerable and vulnerable mangrove areas and the protected coastal mangrove areas must be conserved and expanded through additional planting to create more forest coverage.

In 2013, the Ben Tre People's Council issued a resolution No. 3, dated 11 July 2013 regarding the approval of the master plan for forestry management and development in Ben Tre between 2012 and 2020. The resolution stipulates clearly that the current forests in Ben Tre need to be effectively protected and managed in a sustainable way. Additional planting is strongly needed.

In 2014, Ben Tre Provincial People's Committee developed an action plan for climate change and increased protection of natural resources and environment. The action plan focused on the following issues:

- Increased education, interpretation and awareness of climate change, sea level rise;
- Promotion of uses of scientific research results in adaptation to climate change and sea level rise and environmental protection;
- Strengthened governmental administration related to adaptation to climate change and sea level rise and environmental protection;
- Improved and reformed institutional issues and financial policies;
- Diversified resources to be used for adaptation to climate change and sea level rise; and

- Strengthened international cooperation and integration in regard to climate change and protection of natural resources and environment.

In 2014, Ben Tre Provincial People's Committee issued a decision No. 16, dated 2 July 2014 regulating monetary support to local households living in areas subject to natural disasters *(coastal erosion, land subsidence, cyclones, flash floods, frequent inundation, storm surge and sea level rise)* and the areas location within special use forest. Support includes costs of resettlement, transporting goods and luggage and constructing houses. In detail, a household who is voluntarily resettled in the planned areas is supported with 20,000,000 VND. A household who is intentionally resettled within Ben Tre province is provided with an amount of 23,000,000 VND. Any household who is voluntarily resettled outside Ben Tre province will be compensated with an amount of 25,000,000 VND. In case, a household whose house and agricultural land were lost by natural disasters will be provided with 12 months of rice with 30 kg of rice per head per month, in addition to monetary support provided. If no land is available for resettlement, households locating in natural disasters will be provided with assistance in stabilizing their lives and production in natural disaster areas, with support of 10,000,000 VND for each household. This monetary support will be used for renovating houses, purchasing boats and equipments for disaster prevention and mitigation.

In 2014, under the direction of the Ben Tre Provincial People's Committee, the Department of Agriculture & Rural Development worked with the Department of Natural Resources and Environment in demarcating the boundaries of the Coastal Mangrove Protection Area and Special Use Forest. The demarcation aimed to resolve land tenure conflicts. The boundary demarcation was reported to be completed by the end of July 2014.

The Centre for Forestry and Aquaculture Extension under direct management of the Department of Agriculture & Rural Development of Ben Tre province was responsible for planning and conducting regular trainings / workshops in the local communities to circulate advanced technology and solutions to improving local aquaculture techniques.

Engineered solutions

Engineered solutions involve uses of structures to protect coastal development and infrastructure from erosion, to mitigate and stop coastal erosion *(Weigel, 2002)*. The engineered solutions include shoreline structures, offshore or detached offshore structure *(Dugan et al., 2011).*

Engineered solutions were used in Ben Tre province to protect local properties from coastal erosion, storm surge and temporary inundation and to stop saline intrusion into agriculture production areas. Engineered solutions included the sea dyke and sluice gate system and river dyke system *(Department of Agriculture & Rural Development of Ben Tre Province, 2011)*. The Ba Lai sluice gate was constructed in July 2000 with a budget of 1,230 billion VND over the Ba Lai river to stop saline intrusion and to accumulate fresh water for irrigation and was put into operation in 2002. When sluice gates are closed to store fresh water for irrigation purposes or to stop saline intrusion, the water of the Ba Lai river is redirected to My Tho river through Giao Hoa river

(Ky, 2005). There have been no specific studies of the sluice gate operation in Ben Tre until now. In a similar situation, in Kien Giang, sediment is observed to deposit behind the gates during the dry season. When the sluice gates are opened sediment is washed out and transported offshore because the coastline has no vegetation cover to assist in trapping sediment and build up the shoreline. As a consequence, the coastline is gradually eroded under the influence of natural factors and anthropogenic activities *(Nguyen, et al., 2014)*. Sediment deficit caused by the sluice gate construction and operation is supported by the findings by IUCN (2013) that silt and clay particles only accounted for a small percent of sediment samples analyzed at pre-selected coastal sites of Ben Tre coastline.

Under the decision No. 667 by The Vietnamese Prime Minister in 2009, sea dyke systems from Quang Ngai to Kien Giang provinces shall be reinforced and / or upgraded in response to climate change, sea level rise and coastal erosion *(Vietnamese Prime Minister, 2009)*. Earth sea dykes are believed to stop coastal erosion, mitigate negative impacts of climate change and sea level rise in Ben Tre province. Earth sea dykes were mechanically constructed in Ba Tri and Binh Dai Districts by excavating sediment on the landward side. Gravels were laid on the surface of sea dykes. The gravel surface sea dykes in Ba Tri and Binh Dai are being used as rural roads. The construction of sea dykes in Ba Tri and Binh Dai resulted in a long deep channel running in parallel to the gravel surface earth sea dykes. Sluice gates have been planned to be constructed over rivers to connect the entire earth sea dyke system in Ben Tre province.

Earth sea dykes were planned for Thanh Phu District. Community meetings were held to discuss locations of sea dykes, compensation for and resettlement of those living in planned sea dyke areas. The sea dyke construction was planned to be started in 2014 in Thanh Phu District.

However, sediment excavation would cause the earth sea dykes to become more susceptible to erosion, especially during the rainy season and during strong waves in high tides. Sediment excavation within the sea dyke protection corridor *(5 m of the dyke toe on the landward side)* violated Article 7 and Article 23 a and b of the Vietnamese Law of Dykes *(Vietnamese National Assembly, 2004)* and the Design Guideline on the Sea Dyke System and Sea Dyke Protection Woks *(Ministry of Agriculture & Rural Development in 2002).*

Use of the gravel surface earth sea dykes as rural roads is likely in contradiction to the decision No. 667 *(Vietnamese Prime Minister, 2009)*. The decision states that rural roads should only be constructed within sea dyke protection corridors and rural roads should meet requirements and standards regulated by traffic and transport sector.

Land use decisions are critical to sustainable coastal development and management. Among the many controversial land use decisions are the locations of the earth sea dykes. Some sea dyke sections were planned or have been built within pure mangrove stands *(Rhizophora apiculata)* in Thanh Phu and Ba Tri Districts, while the remaining sea dyke sections have been exposed to the sea in Binh Dai District and some northern parts of Thanh Phu District. Further, pure mangrove stands *(Rhizophora apiculata)* in Thanh Phu were uprooted, resulting in failure to control coastal erosion. At the same time, coastal mangroves have been significantly degraded since 2005 *(Department of Agriculture & Rural Development of Ben Tre province, 2011)*. All the above noted

factors have threatened the safety and integrity of the sea dyke system in Ben Tre province. In addition, in the most vulnerable sea level rise scenario in Ben Tre *(100 cm)* by 2020 *(Ben Tre Provincial People's Committee, 2011)* where Ba Tri and Binh Dai Districts are completely inundated, the coastal areas of Thanh Phu District will remain above the sea level. Therefore, locations of sea dykes, especially in Thanh Phu District are strongly recommended to be studied thoroughly in consideration of negative impacts by sea level rise, storm surges and coastal erosion.

Ecological engineered solutions

Ecological engineered solutions attempt to combine engineered principles with ecological processes to reduce negative environmental impacts caused by built infrastructure *(Bergen et al., 2001)*. Ecological engineered solutions include beach replenishment, sand dune stabilization, beach drainage, mangrove planting or a combination of mangrove planting and engineered solutions *(Nordstrom, 2000; Bergen et al., 2001; Woodroffe, 2002).*

Ecological engineered solutions have been applied in Ben Tre province through various planting programs started since 2010. Under the planting programs, propagules of Rhizophora apiculata were planted along the coast. Wild seedlings of Avicennia alba and Avicennia marina were also used for planting and seedlings of Casuarina were provided by the District level Forest Protection Units for planting. Local farmers living inside the Coastal Mangrove Protection Area and Special Use Forest were employed under contract *(service contract)* to plant species of Rhizophora, Avicennia and Casuarina. They were paid for their planting and caring services. Seedlings were planted in straight lines without any protection, especially in severely eroding areas. In 2010, 141 ha were planted with Rhizophora apiculata, Avicennia alba, Avicennia marina and Casuarina. In 2014, 20 ha were planned for planting *Rhizophora apiculata, Avicennia alba, Avicennia marina and Casuarina*. However, the planting has had only limited success. While Casuarina is growing well in Thua Duc coast, Bao Thuan experienced many mature Casuarina being uprooted by strong waves. There were few surviving plantings Rhizophora and Avicennia species along the coasts, especially in eroding areas.

In 2012, the Department of Agriculture & Rural Development cooperated with World Wide Fund for Nature in Vietnam in developing a program that aimed to tackle coastal erosion in Thua Duc commune, Binh Dai District, Ben Tre province. This program was based on practical experience of coastal erosion control from Soc Trang and Kien Giang provinces. The program involved construction of two types of triangle shaped bamboo fences and planting of six month seedlings of *Avicennia officinalis* and *Sonneratia alba* with a density of 5,000 seedlings / ha. The construction of two types of triangle shaped bamboo fences and the planting of seedlings was undertaken in late October 2012. Seedlings were planted in straight lines and were not well protected. However, the bamboo fences were seriously damaged and the seedlings were washed away by strong waves in high tides. Reasons for the failure included 1.that the bamboo fences were too simply structured with bamboo sticks to survive when exposed to strong waves; 2.the seedlings were stressed in planting and did not have sufficient time to develop their root systems because they were nursed in a different environment *(potted by using compost and fertilizers, irrigated with fresh water and*

tended for six months in a local nursery) and 3. the construction and planting were undertaken in the wrong month, when strong waves were dominant.

A study was undertaken between 13 and 16 November 2013 to consider the feasibility of applying T-shaped bamboo fences for coastal erosion control along the coastline in Ben Tre province. Although reported to be successful in trapping sediment in Soc Trang, T-shaped bamboo fences were less feasible in Ben Tre province. Reasons given were eroding situations, logistics, high construction costs, and lower urgency. Integrated coastal erosion strategies have been strongly recommended *(IUCN, 2013)*.

5.4. Local initiatives in coastal protection

Nypa leaf fences

Fences were constructed by using Nypa leaves to protect local agricultural production land on Den Chop area of An Thuy commune, Ba Tri District, Ben Tre province. The Nypa leaf fences worked temporarily and were replaced every three months. The fences were weighed down by strong waves in high tides and in storms. The Nypa leaf fences were ineffective in the agricultural production land because they were not able to dissipate the energy of strong waves in high tides *(Figure 22).*

Figure 22: *Nypa palm fence was weighed down by strong waves in high tides on Den Chop Area, An Thuy Commune. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Beach replenishment

The local farmers experienced their land becoming actively eroding over time. They dealt with coastal erosion by replenishing their production land with sand. However, this method was effective for only a short period. It was substantially costly and time consuming because local farmers paid labour costs and transportation of sand onshore themselves.

Concrete piles

Concrete piles with diameter of 1 m were constructed to stop erosion and to protect local properties *(restaurants and agricultural land)* in Thua Duc coast *(Figure 23)*. However, the concrete piles are now broken and sunk into sand and are no longer providing any benefit.

Figure 23: *Broken and sunk concrete piles were seen ineffective in protecting local restaurants on Cong Be Lon area, Thua Duc commune, Binh Dai District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Gabion revetments

Gabion revetments were constructed by using granite rocks with protection provided by iron wires in Bao Thuan coast *(Figure 24)*. Gabion revetments were constructed to protect local restaurants and public construction from erosion. However, gabion revetments were extremely expensive to construct and costly to maintain. It is unclear if gabion revetments will survive strong waves without any protection provided by other engineered or ecological engineered solutions.

Figure 24: *Simply constructed but expensive gabion revetments are unsure in protecting local properties in Bao Thuan commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Sand bag fences

Sand bag fences are another example of coastal erosion control in Bao Thuan commune and Con Bung area of Thanh Hai commune. In Bao Thuan, bags filled with sand were piled up to construct fences to protect agricultural land. In some areas, sand bag fences were reinforced by constructing a huge soil bund on the landward side, with grasses grown on top to assist in stabilizing the soil *(Figure 25)*. In Con Bung area, sand bag fences were constructed to protect restaurants from erosion *(Figure 26)*. However, sand bag fences worked temporarily because the coasts in Bao Thuan and Thanh Hai have been extremely vulnerable to erosion and sand bag fences could not assist in solving coastal erosion problem themselves without any additional protection provided by other control means.

Figure 25: *The photo showing sand bag fences, a) sand bag piled up to construct a fence, b) grasses were grown on topsoil behind the sand bags to reinforce the fence in Bao Thuan area. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 26: *Bags filled with sand were piled up to construct fences to protect restaurants from erosion on Con Bung coast, Thanh Hai commune, Thanh Phu District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Double brush fences

Double brush fences were constructed by using two rows of dried brushes of *Rhizophora apiculata* in parallel to the coast in Bao Thuan to protect agricultural land *(Figure 27)*. Double brush fences did not adequately protect the land as sand was eroded by strong waves in high tides. Another form of double brush fences is reinforced double brush fences. Reinforced double brush fences were constructed by using two rows of dried brushes of *Rhizophora apiculata* with sand bags placed between two rows of dried brushes of *Rhizophora apiculata (Figure 28)*. Reinforced double brush fences were also constructed in parallel to the Bao Thuan coast. These two types brush fences could not function properly without any further protection provided by other control measures.

Figure 27: *Fences constructed by using two lines of dried brushes of Rhizophora apiculata to protect agricultural land in Bao Thuan commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 28: *Double brush fences were reinforced by using sand bags placed between two lines of dried brushes of Rhizophora apiculata to protect agricultural land in Bao Thuan commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

5.5. Areas naturally protected against coastal erosion

Various areas naturally protected against coastal erosion were identified during field trips along the Ben Tre coasts. Naturally protected areas could be coastal areas that were intentionally reserved for specific purposes or areas which were left as waste land or areas that were not fertile any more for agricultural production.

Sandy areas covered with beach morning glory

In Bao Thuan and Thua Duc, various large areas were left as waste land where beach morning glory *(Ipomoea pes-caprae)* flourished and spread their long runners on all parts of sand dunes *(Figure 29)*. The morning glory vegetation assisted in stabilizing dunes and sandy coasts. These areas were well protected against strong waves and coastal erosion. If combined with other strategic coastal erosion measures, areas covered with beach morning glory could possibly function as coastal buffer zones / protection zones in reclaiming sandy coasts, trapping sand and protecting mangroves, sea dykes or agricultural lands.

Weeds assisting in stabilizing sandy areas

On Den Chop area of An Thuy commune, a coastal area was actively eroding with many mature trees of Nypa fruticans, Avincennia alba and Sonneratia alba being uprooted on the coast edge *(Figure 30)*. Vegetation loss possibly resulted in sand being accumulated onshore by strong waves

in high tides in the rainy season. An area close to the river was seen stabilized by weeds growing on sand. Weeds established a thick layer of protection, which assisted in dissipating the energy of strong waves and trapping sand and fine mud *(Figure 31)*.

Figure 29: *Beach morning glory (Ipomoea pes-caprae) was seen effective in stabilizing the coast in Bao Thuan commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 30: *: Many mature trees of Nypa fruticans were uprooted by actively coastal erosion on Den Chop area of An Thuy commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 31: *Naturally grown weeds effectively assisted in stabilizing the eroding coast on Den Chop area of An Thuy commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Areas fully protected by a combination of rich mangroves, planted Casuarina, beach morning glory and sand dunes

On Cong Be Lon area of Thua Duc, a large coastal area is fully protected against coastal erosion by different zones, including sand dunes near the coast, beach morning glory area, planted *Casuarina* and natural mangroves *(Nypa fruticans, Avincennia alba and Avicennia marina, Rhizophora apiculata, Exoecaria agallocha, Lumnitzera racemosa, Xylocarpus granatum and Acanthus ilicifolius)* and production land / waste land and earth sea dyke. These are as possibly form effective coastal erosion profiles in the province *(Figures 32, 33 and 34).*

Figure 32: *An area in Cong Be Lon of Thua Duc is well protected by three layers of protection, a) beach morning glory, b) planted Casuarina and c) mixed mangroves. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

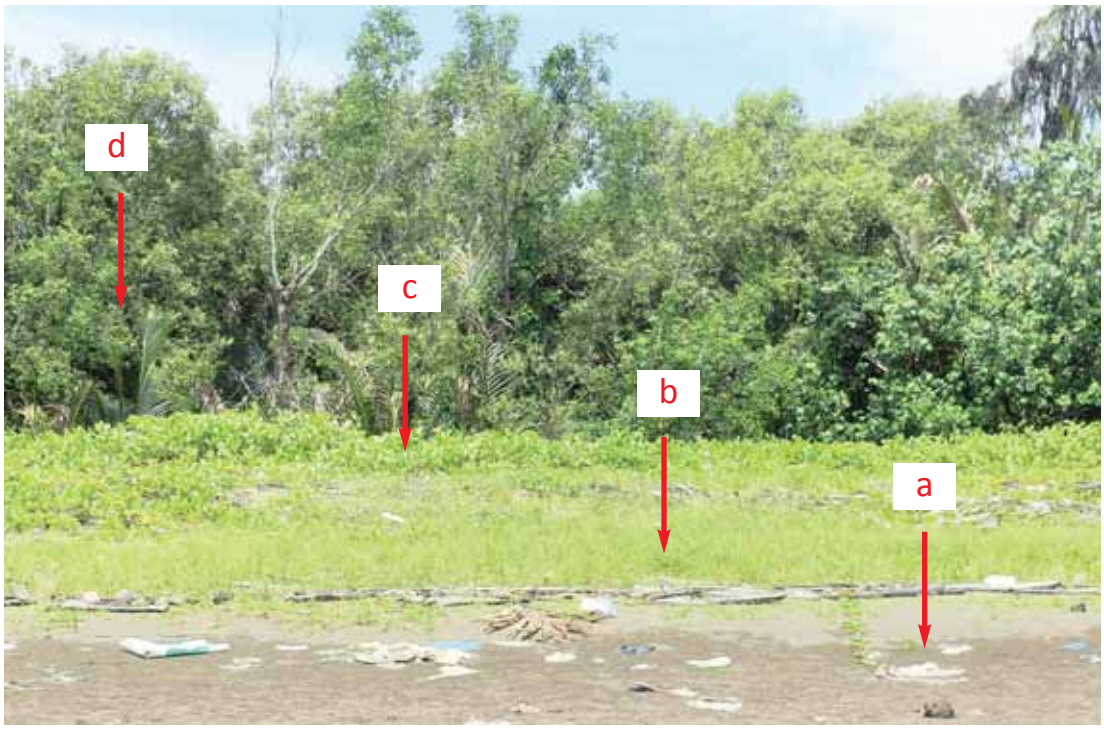

Figure 33: *Another area in Cong Be Lon of Thua Duc is well protected by four layers of protection, a) sand dune, b) naturally grown weeds, c) beach morning glory, and d) mixed mangroves. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

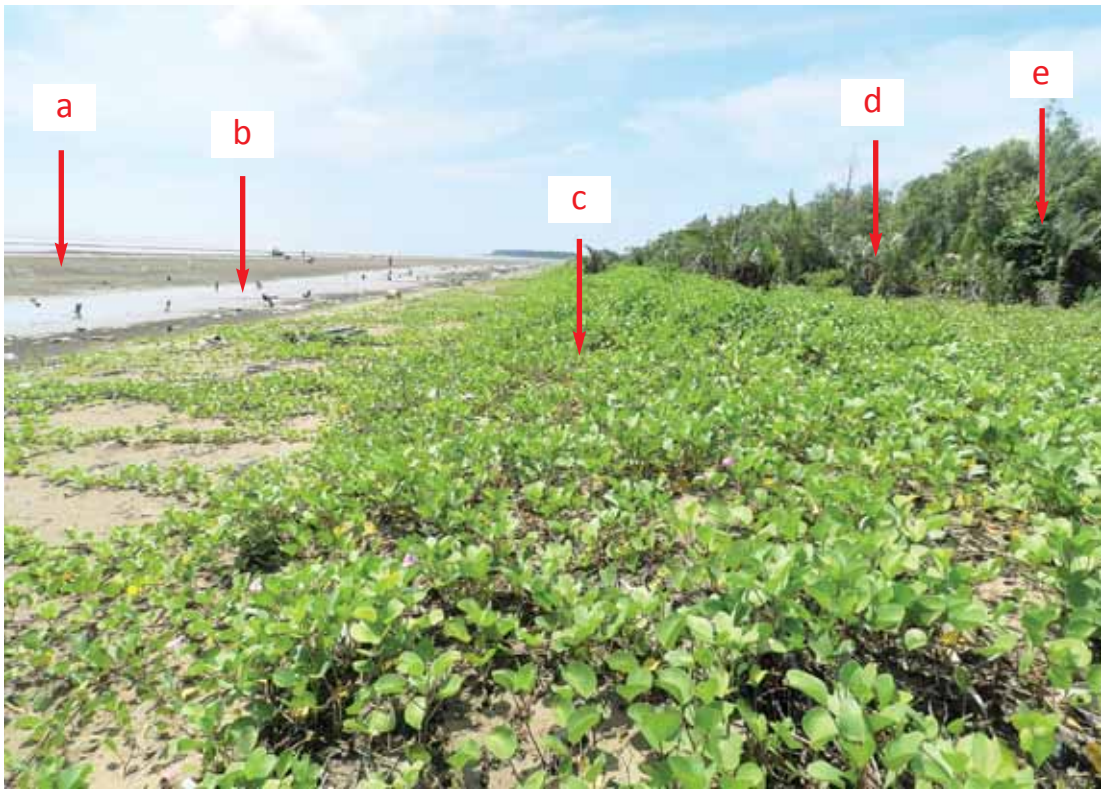

Figure 34: *A large area in Cong Be Lon of Thua Duc is well protected by five layers of protection, a) sand dune, b) shallow water area, c) beach morning glory, d) planted Nypa fruticans, and e) mixed mangroves. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Waste land covered with a thick layer of weeds

The Army's shooting ground in Thua Duc was left waste land many years ago. Weeds are growing well and have established a thick protection of the area against coastal erosion and strong waves *(Figure 35)*. Weeds were seen effective in dissipating the energy of strong waves, especially in high tides. The area was observed effective in stopping sand accumulation and mitigating negative impacts associated with coastal erosion.

Gaps in planted Casuarina filled with weeds

While many mature trees of Casuarina planted many years ago were uprooted and / or are extremely vulnerable to erosion in Bao Thuan *(Figure 36)*, Cong Be Lon area of Thua Duc has weeds growing in gaps in fragmented Casuarina areas that assisted in stabilizing the area. Fragmented Casuarina areas having gaps filled with weeds are therefore considered effective in mitigating negative impacts of coastal erosion and sand accumulation *(Figure 37).*

Figure 35: *A very thick layer of naturally grown weeds establishes a good protection and assists in stabilizing Cong Be Lon area of Thua Duc. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 36: *A large area of planted Casuarina is vulnerable to erosion in Bao Thuan. Many trees were uprooted by strong waves. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 37: *A fragmented area of planted Casuarina has been filled with naturally grown weeds that effectively assist in stabilizing the Cong Be Lon area of Thua Duc. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

5.6. Natural regeneration

Natural generation was seen during the field visits in Ben Tre. On Den Chop area of An Thuy, seeds of Nypa fruticans, Avincennia alba were seen naturally regenerated. Seeds came from surrounding areas where mother trees were ecologically present or were transported onshore by waves. Seeds were trapped by dried branches of Nypa fruticans, dried coconuts, dried tree trunks, agricultural wastes and growing weeds. Dried branches of Nypa fruticans, dried coconuts, dried tree trunks, agricultural wastes and growing weeds functioned as entrapping micro sites that promoted natural regeneration. *Avincennia alba* and *Avicennia marina* and *Sonneratia alba* were also seen naturally regenerated along the coasts in Thua Duc and Thanh Hai *(Figures 38, 39, 40 and 41).*

Figure 38: *: Seeds transported onshore were gradually trapped by dried tree branches and fruits on Den Chop actively eroding area of An Thuy commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 39: *Dried Nypa palms and branches, plastic rubbish functioned as entrapping micro-sites that assisted in trapping seeds for natural regeneration on Den Chop actively eroding area of An Thuy commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 40: *Many mangrove species were found naturally growing well on entrapping micro-sites that consisted of plastic rubbish, dried tree branch and leaves on Den Chop actively eroding area of An Thuy commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

Figure 41: *A large area where many mangrove trees are naturally regenerated was found on Den Chop actively eroding area of An Thuy commune, Ba Tri District. Ben Tre, Vietnam, Phong Nguyen, IUCN Ben Tre Project, 2014*

5.7. Local concerns and aspirations

It was revealed in various semi-structured interviews and participatory community meetings that the local farmers living on or near eroding coasts recognized the danger of coastal erosion and saw their production land and shrimp ponds being severely eroded. They lost their agricultural crops and failed to control coastal erosion. Those who are living inside the areas managed by the Coastal Mangrove Protection Area and Special Use Forest Management Board expressed their concerns that they wanted to know about red book procedures and needed technical assistance in improving aquaculture / agricultural production.

Although the local farmers were convinced that only the construction of concrete sea dykes could assist in controlling coastal erosion, they were willing to work in partnership with the management board and IUCN in developing innovative and low cost coastal erosion strategies to secure their land and lives.

VI. CONCLUSIONS

Land tenure conflicts resulted in the Ben Tre coastal mangroves not being well protected and further degraded for decades. Poor protection and further degradation have weakened the capacity and resilience of coastal mangroves in Ben Tre against climate change, storm surge and coastal erosion.

Extensive use of the Ben Tre coast for socio-economic and national defense purposes contributed greatly to mangrove loss and coastal erosion in Ben Tre province. As a consequence, the shorelines were squeezed significantly. Agricultural land and tourism resorts are directly exposed to the sea. The local residents experienced a substantial loss of crops and revenues, especially during coastal erosion, abnormally strong waves and high tides.

Planting of single species *(Rhizophora apiculata)* and removal of other mangrove species in planting in the past arguably resulted in a significant change in coastal mangrove ecosystems that weakened the protection of the mangroves against coastal erosion and increased potential risks of sea level rise and storm surge in Ben Tre province.

The current strategies employed by the Ben Tre province to deal with coastal erosion showed limited success. The strategies only dealt with symptoms, while land use conflicts, inappropriate aquaculture techniques, insufficient local involvement in planning, inadequate planting techniques and uncoordinated coastal development are the underlying causes of mangrove degradation, deforestation and coastal erosion. Because the local people were not involved in the planning stage, the strategies did not receive adequate local compliance.

Local initiatives in coastal protection worked temporarily. At the same time, many coastal sites in Ben Tre province with natural vegetation including mangroves have been observed to be effective in minimizing negative impacts of coastal erosion, sea level rise and storm surge.

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Mangroves for the Future *(MFF)* is a unique partner-led initiative to promote investment in coastal ecosystem conservation for sustainable development. Co-chaired by IUCN and UNDP, MFF provides a platform for collaboration among the many different agencies, sectors and countries which are addressing challenges to coastal ecosystem and livelihood issues. The goal is to promote an integrated ocean-wide approach to coastal management and to building the resilience of ecosystem-dependent coastal communities.

MFF builds on a history of coastal management interventions before and after the 2004 Indian Ocean tsunami. It initially focused on the countries that were worst affected by the tsunami -- India, Indonesia, Maldives, Seychelles, Sri Lanka and Thailand. More recently it has expanded to include Bangladesh, Cambodia, Pakistan and Viet Nam.

Mangroves are the flagship of the initiative, but MFF is inclusive of all types of coastal ecosystem, such as coral reefs, estuaries, lagoons, sandy beaches, sea grasses and wetlands.

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MFF is funded by Danida, Norad and Sida

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