

Integrated Coastal Management for Climate Change

**Plan for Erosion Management,
Mangrove Restoration and Coastal Livelihood
for Kien Giang Province**



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Foreword

This document was prepared by the AusAID funded GIZ “**Conservation and Development of the Kien Giang Biosphere Reserve Project**” at the request of the Kien Giang Provincial People’s Committee (KGPC). The document answers calls of the government - Decree No. 25/2009/NĐ-CP dated 6 March, 2009 on Integrated Management of the Natural Resources and Environmental Protection of the Sea and Islands; Plan No. 59/KH-UBND (dated 29 September, 2010) on Implementation of Decision No. 373/QĐ-TTg of the Prime Minister approving the Program on Management, Protection and Sustainable Development of Vietnam’s Sea and Islands; and particularly, the current Decision No. 01/QĐ-UBND dated 3 January, 2012 of the Kien Giang People’s Committee which approved a detailed proposal plan on integrated coastal management plan 2011-2015 in Kien Giang.

The document summarises and builds on a project report prepared by Michael Russell (2012). It incorporates the field study, consultation meetings with relevant departments such as DARD, DONRE and conclusions of a consultation workshop hosted by Kien Giang People’s Committee (KGPC) to discuss a draft plan prepared by the project.

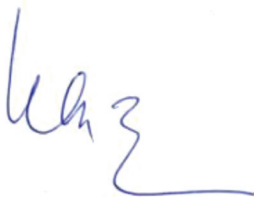
The document incorporates decisions from a consultation workshop that discussed a draft plan. The workshop was held 13.11.2012 and was chaired by Mr. Tran Thanh Nam - Vice Chairman of PPC. 57 participants included leaders of DOST, DARD, DONRE, DPI, DOF, Forest Protection Sub-department, Forest Protection Management Board, Irrigation Sub-department (DARD), Sub-department of sea and island (DONRE), Women's Unions, Farmer Association, 5 coastal districts and 16 coastal commune representatives, GIZ project chief technical advisor, Dr Sharon Brown and Mr. Chu Van Cuong, project manager.

This integrated coastal management plan is largely based on a detailed data set that describes the current condition of the coastline collected in 2009 and again in 2012 using an innovative method of coastal monitoring developed by the University of Queensland in 2009. It also uses the results of a series of studies and reports commissioned by the Kien Giang Provincial People’s Committee (KGPC), the Project, the Asian Development Bank (ADB), Mekong River Commission and other donors. All documents can be accessed on the project web site.

<http://www.kiengiangbiospherereserve.com.vn/>

The overall findings of the draft plan were discussed and confirmed by the consultation group. The coastline is eroding due to the combined effects of climate change and man-made change, and the protective mangrove belt is being lost through erosion and overuse of the natural resources by poor families living along the coastal fringe. The group unanimously agreed that action to protect the coastline needs urgent attention and that the Province will seek funding assistance to undertake this task.

This document is officially endorsed by GIZ Kien Giang Project Management Board.



Mr. Luong Thanh Hai

Vice Director

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1. Summary

This plan provides context for the approach being applied for coastal management. It outlines an evidence based assessment of the current condition of the coastline and establishes the key pressures on this resource, with particular focus given to erosion conditions and influencing factors. The plan also provides recommended actions for erosion management, mangrove restoration and sustainable livelihood development. These recommendations are refined to include the extent and location of actions, as well as the priority for actions for erosion management, mangrove restoration and vulnerable communities.

The requirements for substantial infrastructure for the entire province are relatively modest, with 20 km of concrete reinforcement of the mud dykes, 25 km of double melaleuca fence and a further 28.6 km of single fence required. If a 50 meters wide strip of seedlings are planted along the required 49.8 km of coastline, around 249 ha of seedling planting is required. However, it must be noted that as the fencing reduces erosion and stabilizes sediments, further fencing and planting will be required to extent the mangrove forest. In-filling of existing forests will require the establishment of nurseries in suitable sites and active seed collection from existing patches of diverse forest.

Based on the experience and costing developed by the GIZ project in Kien Giang, approximate cost for all identified works (based on September, 2012) is presented in Table 1. This data will be used to inform the KGPC and donors of the extent of investment needed in the different sectors to make them resilient to climate change.

Table 1. Estimated cost for actions needed to protect the Kien Giang coastline against climate change

Items	Units	Unit cost (USD)	Total (USD)
Wave break (double) fence	25 km	30,000	750,000
Sediment trap (single) fence	28.6 km	15,000	429,000
Concrete dyke	20 km	2,000,000	40,000,000
Rock wall at back of beach	1.9 km	1,300,000	2,470,000
Plant seedlings	249 ha	1,000	249,000
Plant mangroves in existing forest for biodiversity (Enrichment planting)	203 ha	500	101,500
Livelihood—assistance for capacity building for forest protection management boards (FPMB); awareness for local people	2 FPMB	15,000	30,000
Livelihood – assistance to communes build sustainable models	20 priority communities	20,000	400,000
Total			44,429,500

2. Background

This plan is intended for use by the Kien Giang Provincial People's Committee, as well as existing and potential donors and respective delivery agents, as a ready source of evidence based, strategically identified activities requiring investment. Collectively, these works contribute to Decree No. 25/2009/NĐ-CP of the Government on Integrated Management of Natural Resources, Environmental Protection of Sea and Islands; Decision No. 172/2007/QĐ-TTG approved the National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020; Decision No. 158/2008/QĐ-TTG of the Prime Minister on approval of the National Target Program to Respond to Climate Change; Decision No. 405/KTN of the Prime Minister approved Master Plan for Mangrove Management and Protection in Vietnam (2008-2015); Decision No. 667/QĐ-TTG in 2009 of the Prime Minister approved Program to Strengthen and Upgrade Sea Dyke System from Quang Ngai to Kien Giang; Decision No. 25/2011/QĐ-UBND of the Kien Giang PPC on Regulation for Mangrove Management and Development in Kien Giang Province and the Provincial Mangrove Rehabilitation Plan for 2011-2020.

A spatial view of the key pressures on the mangrove resources for the entire mainland coastline of the province shows that exposure to erosion by waves and currents is related to the geomorphology of the coastline, which has a large influence on exposure to due to strong wind events generated by the predominant SW and NE monsoon winds.

Regional scale coastal processes

The predominant regional scale coastal processes include:

- Wave refraction and tidal currents drives movement of sediment as suspended plumes and bottom sediment around Ca Mau Cape;
- Transport of material fine materials and colloidal sediments along the West coast of the Ca Mau Peninsular and Southern shore of Rach Gia Bay;
- On shore entrapment of sediments in coastal fringing mangroves, and movement landwards - a result of swell induced transport; and
- Erosion and inundation due to heavy swell and rough seas generated by monsoonal storms and typhoons that can carry increased quantities of sand and silt alongshore as well as offshore.

Sea level rise and climate change

The National Meteorology and Hydrology Centre (IMHEN) projects a sea level rise for Vietnam of 15 cm by 2030, 30 cm by 2050, 50 cm by 2070, and 100 cm by 2100 under high emissions climate change model scenarios (MONRE 2009). A study by IMHEN, CMPPC and KGPPC (2011) showed that the most important effects of sea level rise in Kien Giang relate to; the corresponding changes in flooding and drainage; its relative effect on salinity in the canal and river system; increased coastal erosion; proneness to inundation; and storm surge vulnerability. The major effects of a rise in sea level are that storm surge effects are increased and larger waves are able to penetrate further into the coast. The most substantial impacts of changes to the climate on Kien Giang are also expected to be increased erosion due to more energetic wave conditions and intense monsoonal conditions and storms. This increases the erosive power of the waves and consequently increases the amount of

sediment that is removed. Changes in coastal sedimentation and erosion patterns are also projected to occur.

Typhoons

An analysis of typhoon trends showed that while the frequency in the East Sea increased slightly, the frequency of typhoon landings in Vietnam has no clear trend. However, typhoon landings have moved toward the South and the frequency of very strong storms (> level 12) has increased, (IMHEN 2010). The analysis also showed that the typhoon season ends later.

The Institute of Coastal and Offshore Engineering (ICOE) modeling showed that during a typhoon, water surface in Kien Giang could be elevated by up to 2 m high and combined with 4 - 5 m waves will result in severe damage to coastal protection dykes, as well as fishing villages in estuaries and canal mouths along the entire coast.

Changes in regional scale sediment loads

One of the key findings from the coastal modeling is the dramatic reduction in sediment loads in the Mekong mainstream (and the Bassac River in particular) and its effects on sedimentation and deposition on the Ca Mau Peninsula and the Kien Giang coastline. However, some preliminary conclusions can be drawn:

- A net decline in sedimentation of this magnitude will most likely lead to a destabilisation of the coastal erosion and sedimentation patterns on both the East and West coasts;
- A 60% reduction in sediment loads over the next 20 years will most likely lead to a shift in the rates of sediment deposition and replenishment in coastal sea grass and mangrove systems; and
- There could be localized loss of nutrients and sediment to support agriculture, aquaculture and marine capture fisheries in coastal areas.

Human system vulnerability

The interaction of humans has also caused a number of pressures on the mangrove system and the influence of projected climate change impacts on the extent and potential increase in human pressure is also examined. The effects of storm surge are enhanced by the human pressures on mangrove systems such as fuel-wood and timber cutting that is contributing to the loss of mangroves and resource collecting methods that are interfering with natural regeneration. The mangrove fringe is often used by natural resources dependant poor households who construct illegal dwellings behind the mangrove fringe of coastal towns and cities and along low lying coastal areas of islands. The direct consequence of storm surge is loss of housing compounded by a loss of resources due to damage to mangroves and associated natural vegetation and fisheries. The population density of each coastal commune can be used to as a measure of pressure on mangrove resources.

Vulnerability mapping by IMHEN, CMPC, and KGPC (2011) projected that the Agriculture and Livelihood systems of all of the districts except Ha Tien will be highly vulnerable to climate change. This vulnerability is likely to put significant pressure on the remaining mangroves.

An analysis of the condition of control measures in place to protect agricultural infrastructure showed that improvements in the current control measures will be required in the medium term (10 – 20 years) and in the long term (20+ years). Management plans for all districts will require the incorporation of improvements to reduce rates of poverty and provide sustainable livelihood.

Consequences of climate change in Kien Giang

The projected coastal erosion will lead to:

- Loss of mangroves and other erosion buffers leading to exposure of large areas in An Minh, Hon Dat and Kien Luong resulting in damage and loss of agricultural land and urban settlements and infrastructure.
- Increased overtopping of existing sea dyke systems wall along settlements, decrease in buffer zone between wave action and infrastructure. Potential surface overflow over land with subsequent ponding, particular in basin profile locations.
- Changes in livelihood systems due to flooding and salt water intrusion resulting in increased pressure on mangrove resources.

3. Approach and findings

This plan applies a best practice approach that sets out a stepped and consistent method. It also follows a number of guiding principles.

Adaptation strategy approach

The development of this plan uses a coastal hazard adaptation strategy approach developed by Standards Australia/Standards New Zealand (2009).

1. Spatially identify areas at risk, preferably through local-scale hazard mapping
2. Identify current and known future 'assets' at risk (residential, commercial, community) and assess their vulnerability to coastal hazards to the year 2100
3. Identify potential adaptation options
4. Consult the community about the potential adaptation options
5. Undertake a cost-benefit analysis of adaptation options
6. Select preferred adaptation option(s)
7. Develop an implementation program and financial plan
8. Engage in community consultation on the draft adaptation strategy
9. Develop a process for reviewing and updating the adaptation strategy

Guiding principals

This plan also follows a set of guiding principles developed by the State Government of Queensland, Australia (DERM, 2012) where strategies:

1. Reflect locally-specific objectives;
2. Are considered a 'living' document to deal with changing risks, uncertainties and innovation;

3. Integrate the range of coastal hazard risks are integrated across the inshore, foreshore and hind-shore areas;
4. Note that risks from coastal hazards will vary along the coastline affected by topography, sediment type and coastal processes, as well as local adaptive capacity. This makes adapting to coastal hazards a clear case for thinking regionally, but analyzing and acting locally;
5. Are based on the best available science and information; and
6. Are based on the precautionary principle to mitigate coastal hazards to the year 2100, taking into account the long-term environmental, social and economic factors.

Use of companion documents

A companion document to this plan is a report to the GIZ Conservation and Development of the Biosphere Reserve of Kien Giang Province Project titled '*Shoreline and Mangrove Resource Condition of the Mainland Coastline of Kien Giang Province, Vietnam: Key Pressures and Restoration Requirements*' (by Dr Michael J Russell, 2012). Other key documents also form the basis of this report and are referenced at the back of this document.

Current coastline condition

The current coastline condition of the Kien Giang coastline was assessed by Shoreline Video Assessment method (SVAM) and assessment of the gazetted reserved protection forest was conducted from satellite images. Key findings are listed below. For full details see the companion document by Russell (2012).

- **50% of the total coastline is eroded or eroding**
- **74% of the shoreline supports mangrove forests**
- **58% of forests show evidence of pressure through cutting**
- **25% of the mangrove coastline (30 km) is experiencing active mangrove loss due to erosion**

Gazetted mangrove protection forests

An Minh District has the largest area of mangroves gazetted into protection forests (2,289 ha). However, this is not all high quality forest cover, with 40% classed as non-continuous (either scattered or fragmented).

Hon Dat District has 800 ha of protection forest with 30% classed as non-continuous.

An Bien District has 900 ha of protection forests with 12% classed as non-continuous.

Kien Luong District has 678 ha of protection forest and only a small amount classed as non-continuous.

Ha Tien has 133 ha of protection forest designated and **Rach Gia** has 24 ha.

Chau Thanh District has mangrove forests in the Cai Lon Estuary, but they are not classified as protection forests.

Most districts have a moderate amount of the existing mangrove canopy classed as having moderate or high amount of biomass.

4. Key pressures in Kien Giang

A summary of the key pressures on the mainland coastline of Kien Giang is provided here, with full details contained in the companion document by Russell (2012).

Many of the coastal areas of Kien Giang are potentially threatened by a combination of human pressures, climate change and sea-level rise, with future changes in monsoonal conditions and increases in extreme weather events.

The most substantial impacts of changes to the climate on Kien Giang are expected to be increased erosion due to more energetic wave conditions and intense monsoonal conditions and storms. Combined with higher sea level, this will result in the degradation of coastal protection works and progressive loss of coastal land.

Coastal modeling suggests that during a typhoon, sediments will be eroded from the near-shore areas along much of the coast. This will steepen the offshore profile leading to greater penetration of wave energy onshore in subsequent strong monsoon episodes.

The first line of defense from the effects of wave action on the coast is mangroves. In the past the mangrove ecosystem was up to 2 kilometers wide. Behind the mangroves, protection of crops and urban structures was achieved through the construction of earth sea dykes. The conversion of mangroves into aquaculture ponds has made considerably more infrastructure potentially exposed to storm surge.

In many areas of the Kien Giang coast the band of fringing mangroves is relatively thin (<100 m) or non-existent and the sea dyke forms the major protection from storm surge. Larger waves will penetrate through a thin line of mangroves and erode earth dykes. Earth dykes that have been exposed by mangrove removal or erosion will be breached within a single wet season. In districts where agriculture occurs behind the sea dyke (e.g. Hon Dat District), significant waves that overtop a dyke, or flow through breached dykes, can destroy houses and farm infrastructure. Salt water that comes through breached dykes will inundate crops and fish ponds. In aquaculture areas, sea water will breach pond walls and wash away stock.

As dykes are eroded, aquaculture ponds are exposed and breached. This leads to saline intrusion into ponds, and abandonment. As a result the regular line of fringing wave tolerant mangroves (*Avicennia* spp.) is fragmented, exposing less robust species to wave action resulting in further mangrove loss. The fragmented mangrove system allows waves to penetrate to the back of the abandoned pond advancing erosion in steps of 50 to 100 meters. These mangrove: aquaculture areas are often assigned by the District Forest Protection Management Boards under the Kien Giang 7:3 policy where landholders must maintain 70% of the assigned land as mangrove forest. **The PPC proposes that assistance is needed to help landholders to establish a sustainable management system for these areas through better pond design and mangrove planting regimes.**

5. Coastal sectors as management units

The coastline of Kien Giang is made up of several different landform types: a straight section of coastline in the south, a large embayment leading into a large estuary of the Cai Lon River in the centre of the provincial coastline, and in the north, limestone or granite headlands interspersed by small embayments, Figure 1.

While much of the coast is lined with mangroves, the mangrove forests are of varying condition. In addition, the complex coastline combined with the SW/NE monsoon climate means that exposure to waves and currents also varies throughout the year. The northern part of the coast is protected from SW winds to some extent by the island of Phu Quoc.

In order to facilitate management of this complex coastline each district has been divided into a number of sections that are similar in; land form type, mangrove resource condition or erosion risk. The sectors are shown geographically in Appendix 1. and each sector is described in Tables 2 and 3. While sectors can span a number of communes, where appropriate the sectors are divided at a commune boundary in order to increase the management continuity.

The map (Figure 1) shows the 19 sectors covering the mainland coast. The map also shows the extent of gazetted forest resources along the Kien Giang coast. These forests are mainly mangrove forests except on headlands in sectors 11, 14, 16, and 19.

A more detailed description of the condition of the mangroves coastline of each of the nineteen mainland coastal sectors is given in Russell (2012).

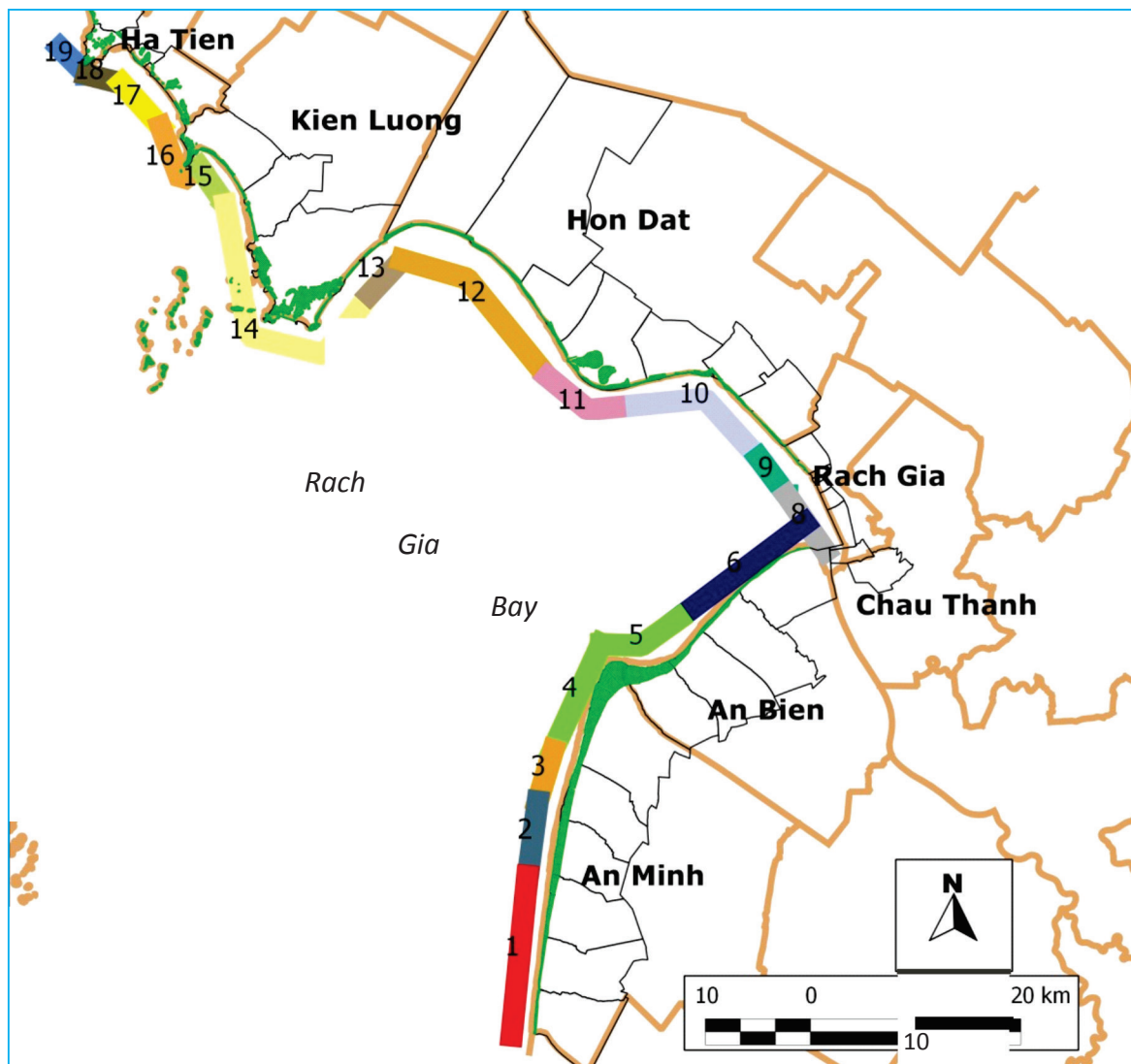


Figure 1. Geographical representation of the 19 management sectors

Table 2. Detailed description of the Kien Giang fore-shore of each of the coastal sectors

No	District	Coast type	Width of mangrove belt	Mangroves (km)	Communes
1.	An Minh	Straight eroding mangrove	Thin or non existent <250 m	14	Van Khanh Tay Van Khanh Dong Van Khanh
2	An Minh	Straight prograding mangrove	Moderate >250 m	7	Dong Hung A
3	An Minh	Straight stable mangrove	Moderate >250 m	2	Tan Thanh
4	An Minh	Prograding mangrove cape	Thick >500	11	Thuan Hoa
5	An Bien	Prograding mangrove cape	Thick >500	8	Nam Thai A Nam Thai
6	An Bien	North facing straight stable mangrove	Thin <300 m	13	Nam Yen, Tay Yen
7	Chau Thanh	Estuarine mangroves	Thin <100 m	1	Kim Hoa Hiep
8	Rach Gia	Rock or concrete sea wall		0	An Hoa, Rach Soi Vinh Lac, Vinh Bao Vinh Thanh Van Vinh Quang
9	Rach Gia	Straight remnant mangrove	Remnant <100 m	4	Vinh Quang
10	Hon Dat	Remnant mangrove bight	Remnant <200 m	17	Soc Son, Son Binh My Lam
11	Hon Dat	Granite outcrops. Development. Mangrove	Thin	7	Tho Son
12	Hon Dat	Remnant mangrove	Remnant <200 m	22	Linh Huynh Binh Giang Binh Son
13	Kien Luong	South facing remnant mangrove	Remnant <100 m	4	Binh An
14	Kien Luong	Limestone outcrops Development Mangrove bays	Scattered	10	Binh An, Kien Luong
15	Kien Luong	Eroding mangroves	Thin <200 m	7	Duong Hoa
16	Kien Luong	Remnant mangrove /Limestone headlands	Thin <100 m	1	Duong Hoa
17	Ha Tien	Offshore sand bank with beach mangroves	Thin <100 m	3	Thuan Yen
18	Ha Tien	Rock or concrete sea wall		1	To Chau, Phao Dai
19	Ha Tien	Limestone headlands	Remnant <100 m	1	My Duc

NA – No gazetted mangrove forests, ND – No satellite imagery available

Table 3. Detailed description of fore-shore erosion and hind-shore land use of each of the coastal sectors

No	District	Description of coast	Landuse of hinterland
1	An Minh	Actively eroding with erosion scarp, broached aquaculture ponds, rhizophora plantations, dykes protecting ponds	Rice
2	An Minh	Stable/active prograding, successful seedlings	Aquaculture
3	An Minh	Eroded with low erosion scarp	Aquaculture
4	An Minh	Prograding cape successful seedlings	Aquaculture
5	An Bien	Prograding cape successful seedlings	Aquaculture
6	An Bien	Stable/eroded poor seedling success	Rice
7	Chau Thanh	Estuarine mangroves	Perennial fruit trees
8	Rach Gia		Urban
9	Rach Gia	Remnant mangroves actively eroding	Rice
10	Hon Dat	Remnant actively eroding	Rice
11	Hon Dat	Mangrove bays interspersed with granite outcrops and development	Aquaculture
12	Hon Dat	Remnant actively eroding	Aquaculture
13	Kien Luong	Remnant actively eroding	Aquaculture
14	Kien Luong	Mangrove bays interspersed with limestone outcrops and large scale development	Aquaculture/ Forested hills Harbour
15	Kien Luong	Remnant actively eroding mangrove bight	Aquaculture
16	Kien Luong	Remnant mangroves bays between limestone headlands	Forested hills
17	Ha Tien	Sandy coast in North with development in Central section and thin band of mangroves in Southern section	Perennial fruit trees
18	Ha Tien		Urban
19	Ha Tien	Thin band of mangroves in Northern section	Fruit trees/ Headlands/Tourism

6. Present status of infrastructure

The data collected as part of the *Shoreline and Mangrove Resource Condition Report* (Russell, 2012) was used to describe the coastline, including the present erosion protection infrastructure (see Table 4). This information will be used for monitoring by DARD.

Table 4. Current infrastructure in Kien Giang Province

District	Coastline Section	Coast with Reclaimed land (km)	Coast with Concrete Dykes (km)	Coast with Soil Dykes (km)	Coast with Exposed Mud Dyke (km)	Coast with Sea Wall (km)	Sluice Gates (No.)	Open Canals (No.)	Large Fishing Ports	Coast with Melaluca Fence (km)
An Minh	1			15.0	0.5		7	2	1	
	2			6.5			4			
	3			4.4		0.1	3	1	1	
	4			10.5			5			2.4
An Bien	5			8.1			6	2	1	0.5
	6			14.2	0.5		6	1		
Chau Thanh	7			1.0				1		
Rach Gia	8			0.4		6.8	4	2	3	
	9			3.5			3			
Hon Dat	10			15.6	1.8		8		1	
	11			8.7	4.8		5	1	1	
	12		1.5	21.0	5.1	0.6	18	2	3	0.5
Kien Luong	13			4.7	0.3	0.1	4	1		
	14			1.9	1.8	6.0	3	1	1	
	15			5.6	0.4		5		1	
	16					2.3				
Ha Tien	17			1.2		1.5	1		1	
	18	1.9				5.9	1	1	1	
	19					3.6	2		2	

7. Present status of coastal erosion

The data collected as part of the *Shoreline and Mangrove Resource Condition Report* (Russell, 2012) was used to develop a number of indexes that ranked: the present exposure and erosion state; the projected change to 2100; and the measured change since 2009. These indexes were combined to produce the priority for erosion management of high, medium or low, which is presented in Table 6 and displayed as color coding in Figure 2.

The largest sector of Kien Luong that covers the Limestone Headlands (Sector 14) includes a range of morphologies of rocky headlands with little or no mangrove coverage interspersed with mangrove bays and small sandy bays. There is also tourism development and considerable development of port facilities with the recent commencement of construction of a large deep port which has enclosed over 1 km of mangrove coastline. The overall management strategy of the sector requires a more detailed assessment of individual sections of the coastline and should include the management of mangroves, development and tourism.

Two Hon Dat sectors (10 and 12) are made up of two large mangrove bights on the north of Rach Gia Bay. The requirements for erosion protection and restoration varies for the coastlines of some of the communes in these sectors. However, as changes in the sediment regime within a bay will be reflected in the rest of the landform unit, any active erosion prevention strategies that are carried out in either of these two sectors must be considered as part of the management of the sector as a single unit.

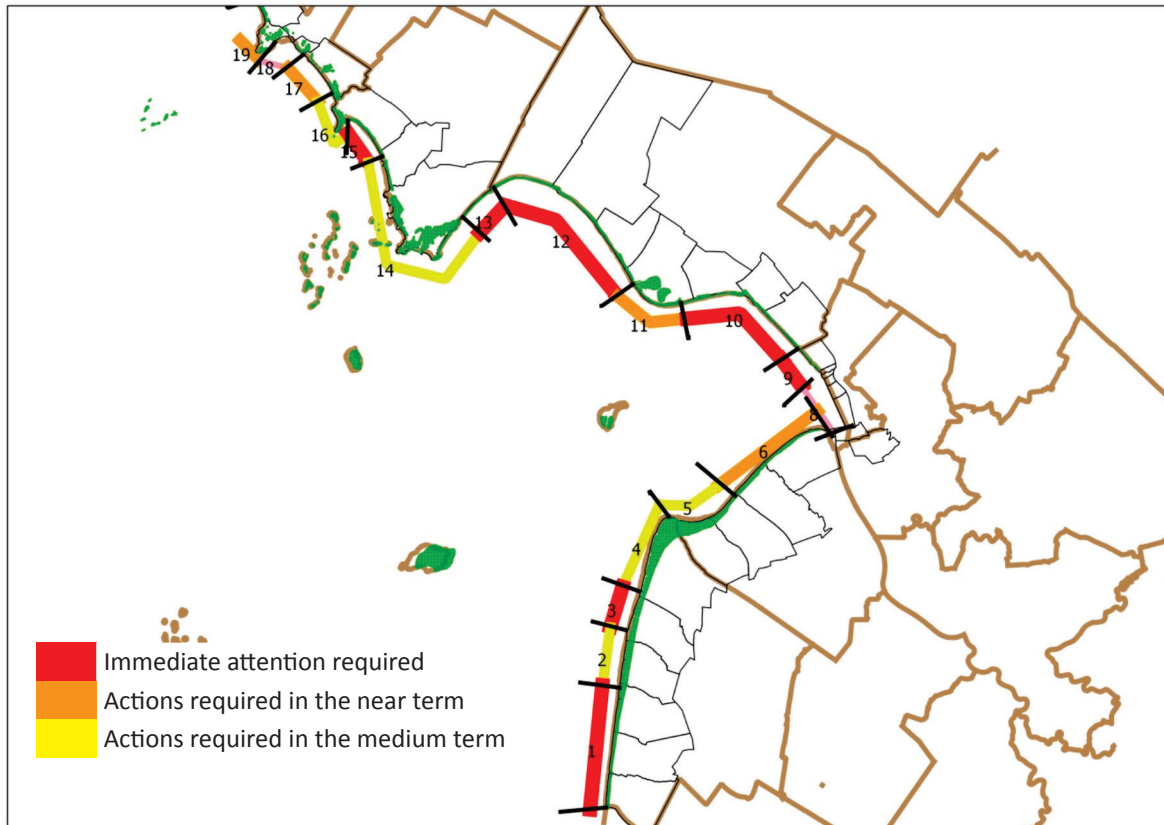


Figure 2. Index of the immediacy of the implementation of management strategies

8. Recommended erosion management actions

The appropriate erosion management activities for each sector are guided by the Kien Giang PPC and DARD (2010) report. The required erosion management actions are divided into four classes.

High erosion coasts need significant measures to protect much of the coastline. These areas will require the construction of dykes and or substantial fencing of either concrete or double melaleuca fences and improvements in the width and condition of the mangrove forest. See KGPC and DARD (2010) for a discussion of management procedures, fence effectiveness and costings, and see Russell and Michaels (2012) for a discussion of the effectiveness of melaleuca fences.

Moderate erosion areas require some protection from erosion. These areas require erosion protection using single melaleuca protection fences and substantial mangrove replanting to increase the width and condition of the mangrove forest. Some depositional areas require fence construction to develop wide mangrove strips. Sand beaches that are currently eroding require erosion protection in the form of rock walls at the rear of the beach.

A further type of erosion management is beaches that are currently eroding that require erosion protection in the form of rock walls at the rear of the beach.

Extent and location of required erosion management actions

The types and extent of the actions that will be required to stop erosion in each sector are presented in Table 5. In sectors where rock walls have been built along the coastlines, monitoring of the condition of the walls is required. Two sectors require the construction of rock walls behind the sandy beaches where erosion has removed the terrestrial material that backs the beach.

Table 5. Recommended erosion management actions for each sector.

Coastline section	Recommended action/s and extent				
	1	2	3	4	5
1			6.1 km	6.7 km	
2	×				
3				4.2 km	
4			2.4 km	5.4 km	
5	×				
6			2.0 km		
7	×				
8		6.8 km	0.2 km		
9			2.4 km		
10			7.3 km	3.1 km	
11			1.2 km	1.8 km	
12			2.2 km	0.5 km	
13			1.0 km	1.4 km	
14		5.9 km	1.3 km		
15			2.5 km	1.9 km	
16		2.3 km			0.3 km
17		1.4 km			1.6 km
18		5.9 km			
19		3.5 km			

KEY

Action	Description
1	Monitor for change in erosion
2	Monitor erosion of rock wall
3	Build melaleuca protection fence (sediment trap) (single fence)
4	Build melaleuca protection fence (wave break (double fence)
5	Build rock wall at back of beach to limit erosion

The data collected as part of the *Shoreline and Mangrove Resource Condition Report* (Russell, 2012) was also used to examine the present state of other erosion protection infrastructure. The extent of mud dykes that have been exposed to erosion due to mangrove removal was used to estimate the amount of fortification of mud dykes that is required for each sector, as presented in Table 6.

Table 6. Description of the state of other erosion infrastructure in each sector

District	Coastline section	Coastline with soil dykes (km)	Coastline with exposed mud dyke (km)	Coastline with sea wall (km)	Recommendations for dyke improvement - concrete
An Minh	1	15.0	3.8		3.8 km
	2	6.5			
	3	4.4		0.1	
	4	10.5			
An Bien	5	8.1			
	6	14.2	1.0		1 km
Chau Thanh	7	1.0			
Rach Gia	8	0.4		6.8	
	9	3.5			
Hon Dat	10	15.6	1.8		1.9 km
	11	8.7	4.8		4.8 km
	12	21.0	5.1	0.6	5.1 km
Kien Luong	13	4.7	1.2	0.1	0.3 km
	14	1.9	1.8	6.0	1.8 km
	15	5.6	0.4		0.4 km
	16			2.3	
Ha Tien	17	1.2		1.5	
	18			5.9	
	19			3.6	

Priority of required erosion management actions

The data collected as part of the *Shoreline and Mangrove Resource Condition Report* (Russell, 2012) was used to develop a number of indexes that ranked; the present exposure and erosion state; the projected change to 2100; and the measured change since 2009. These indexes were combined to produce the priority for erosion management of high, medium or low and are presented in Table 7.

Table 7. Erosion management priority.

District	Coastline section	Coastline section length (km)	Erosion management priority
An Minh	1	15.2	high
	2	6.5	high
	3	4.7	high
	4	10.9	medium
An Bien	5	8.1	medium
	6	14.4	medium
Chau Thanh	7	2.5	low
Rach Gia	8	7.7	low
	9	3.8	medium
Hon Dat	10	15.9	high
	11	9.1	high
	12	23.7	medium
Kien Luong	13	5.1	medium
	14	26.1	medium
	15	5.8	high
	16	7.3	high
Ha Tien	17	6.0	medium
	18	7.4	low
	19	10.1	low

9. Recommended mangrove restoration actions

The appropriate restoration activities for each sector are guided by the KGPC and DARD (2010) report. However, much of the mangrove coastline particularly in the south, requires planting of a range of different species of mangroves into the existing forest in order to promote biodiversity. This in-filling will improve the effectiveness of the mangroves in buffering the coastline from larger waves and storm surge.

The greatest amount of restoration effort is required for erosion areas that need significant measures to protect much of the coastline and to restore and expand the existing mangroves. These areas require significant replanting behind melaleuca fences to establish, or increase the condition of, the mangrove forest.

The second type of restoration effort is required for eroded areas requiring some restoration. These areas require protection from waves using single melaleuca fences in order to assist the natural recruitment of seedlings. Many of the depositional and stable areas along the coast still require the planting of *Avecinnia* seedlings to improve forest width and quality. Depositional areas require monitoring and in-filling and natural regeneration of the existing mangroves to improve forest width and quality.

Extent and location of required mangrove restoration actions

The types of restoration actions and the extent of the actions that will be required to improve the mangrove condition in each sector are presented in Table 8.

Table 8. Recommended mangrove restoration actions for each sector

District	Coastline sector	Coastline with naturally occurring mangroves (km)	Recommended action/s and extent				
			1	2	3	4	5
An Minh	1	15			15 km		10.8 km
	2	6.4		0.2 km	4.5 km		
	3	4.2					4.2 km
	4	10.5			10.5 km	2.4 km	5.4 km
An Bien	5	8.1			8.1 km		
	6	13.8		6.7 km		2.0 km	
Chau Thanh	7	1.0		2.5 km			
Rach Gia	8	0.4				0.2 km	
	9	3.2		0.8 km		2.4 km	
Hon Dat	10	15.5		0.7 km		7.3 km	3.1 km
	11	8.7				1.2 km	1.8 km
	12	22.6		8.9 km		2.2 km	0.5 km
Kien Luong	13	4.9				1 km	1.4 km
	14	10.2				1.3 km	
	15	5.6		0.4 km		2.5 km	1.9 km
Ha Tien	16	1.0	x				
	17	2.8		0.5 km			
	18	0.6	x				
	19	3.9			2.5 km		

KEY

Action	Description
1	Monitor for change in mangrove condition
2	Plant mangrove seedlings – for habitat, dyke or coastal protection
3	Plant mangroves in existing forest for biodiversity
4	Assist natural recruitment behind melaleuca protection fence (sediment trap (single fence)
5	Plant mangroves behind protection fence

Two management sectors merely require monitoring of the existing mangroves that cover a small part of the sector. Two sectors only require planting of seedlings and the northern sector only requires improvements in diversity.

Priority of required mangrove restoration actions

The data collected as part of the *Shoreline and Mangrove Resource Condition Report* (Russell, 2012) was used to develop a number of indexes that ranked the mangrove forest condition, the amount of protection forest that has been retained and the immediacy of rehabilitation. These indexes were combined to produce a list of the priority of the required mangrove restoration actions which is presented in Table 9.

Table 9. Mangrove restoration priority

District	Coastline section	Coastline with naturally occurring mangroves (km)	Mangrove management priority
An Minh	1	15.0	high
	2	6.4	low
	3	4.2	high
	4	10.5	low
An Bien	5	8.1	low
	6	13.8	medium
Chau Thanh	7	1.0	high
Rach Gia	8	0.4	low
	9	3.2	high
	10	15.5	medium
Hon Dat	11	8.7	medium
	12	22.6	medium
	13	4.9	high
Kien Luong	14	10.2	medium
	15	5.6	high
	16	1.0	high
Ha Tien	17	2.8	high
	18	0.6	low
	19	3.9	high

The most immediate attention is required for sector 1 and 3 from the An Minh Coast, Chau Thanh, the Northern section of Rach Gia, three of the sectors in Kien Luong and two sectors in Ha Tien. The next most immediate attention is required for the Eastern sector of An Bien, for the three sectors of Hon Dat and for sector 13 in Kien Luong.

A summary of the extent of erosion is presented in Table 10.

Table 10. Summary of the extent of erosion management and mangrove restoration actions required for each sector

District	Coastline section	Wave break (double) fence (km)	Sediment trap fence (km)	Concrete dyke (km)	Rock wall at back of beach (km)	Plant seedlings* (km)	Plant mangroves in existing forest for biodiversity (km)
An Minh	1	6.7	6.1	3.8		10.8	15
	2					0.2	4.5
	3	4.2				4.2	
	4	5.4	2.4			5.4	10.5
An Bien	5						8.1
	6		2	1		6.7	
Chau Thanh	7					2.5	
Rach Gia	8		0.2				
	9		2.4			0.8	
Hon Dat	10	3.1	7.3	1.9		3.8	
	11	1.8	1.2	4.8		1.8	
	12	0.5	2.2	5.1		9.4	
Kien Luong	13	1.4	1	1.2		1.4	
	14		1.3	1.8			
	15	1.9	2.5	0.4		2.3	
	16				0.3		
Ha Tien	17				1.6	0.5	
	18						
	19						2.5
Province		25 km	28.6 km	20 km	1.9 km	49.8 km	40.6 km
						249 ha (50 m wide strip)	203 ha (estimated 5 m² total/ km to infill into existing forest only)

* Includes planting behind double melaleuca fence and in front of concrete dykes.

10. Recommended sustainable livelihood development

In 2005 Kien Giang province initiated a promising approach to coastal management in the form of the 7:3 policy, a mangrove conservation and restoration initiative that allocates long-term tenure and land use rights, but requires landholders to maintain 70% of the allocated land under forest cover. This approach encourages a mix of economic development and conservation on each parcel of land.

Under the 7:3 policy, local people are given 50-year contracts that ensure rights and benefits from the land. They receive compensation for labor and investment costs and have the right to pass their contractual use rights to their heirs or transfer their rights during the period of the contract.

The Kien Giang people's committee intends to continue with this policy by a revised regulation in 2011 but recognizes the need to provide decision support mechanisms for the staff of the forest protection management board who review requests and provide contracts to the local people; to provide awareness to the local people on the need to protect the mangroves; and provide assistance in the design of the ponds and access to mangroves for biodiversity plantings.

Twenty priority communities were selected for piloting the sustainable, adaptive livelihood activities (Appendix 2).

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Appendix 1

Detailed description of the geographic location of the required erosion management and mangrove restoration actions in maps.

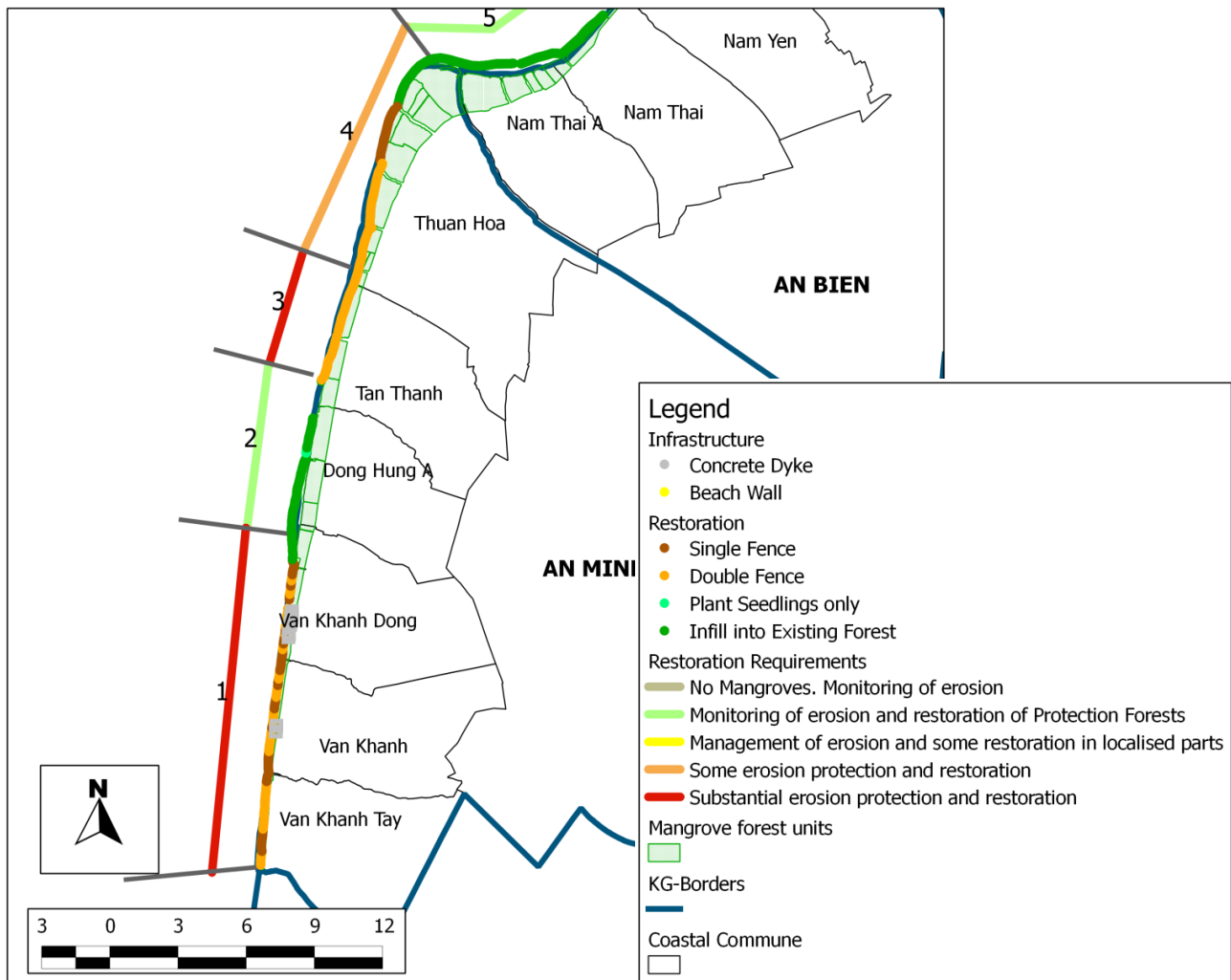


Figure 3. Classification of An Minh management sectors into management classes and the location of areas requiring erosion and mangrove restoration actions.

Two sectors covering four communes require substantial erosion protection and mangrove restoration actions. The sector in the North of the district that adjoins the Southern cape of Rach Gia Bay, requires erosion protection and mangrove restoration over two thirds of the coastline. Sector two is currently accreting and only requires restoration of the existing forests and monitoring for changes in erosion.

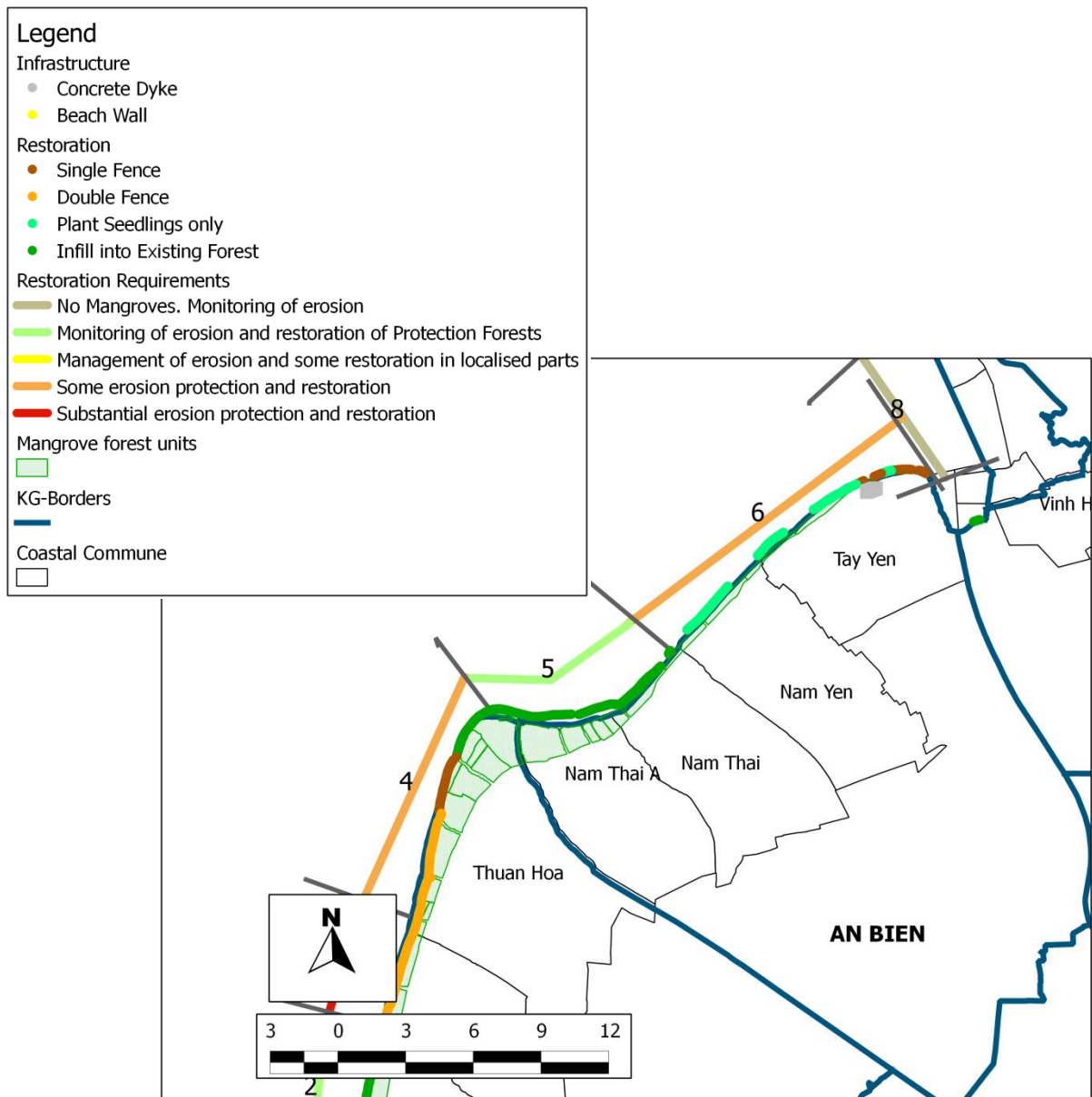


Figure 4. Classification of An Bien management sectors into management classes and the location of areas requiring erosion and mangrove restoration actions.

In An Bien, the sector in the west of the district that adjoins the southern cape of Rach Gia Bay, is currently accreting and only requires restoration of the existing forests and monitoring for changes in erosion. The Eastern sector requires planting of seedlings over its entire length and requires erosion protection and mangrove restoration actions near the mouth of the Cai Lon estuary.

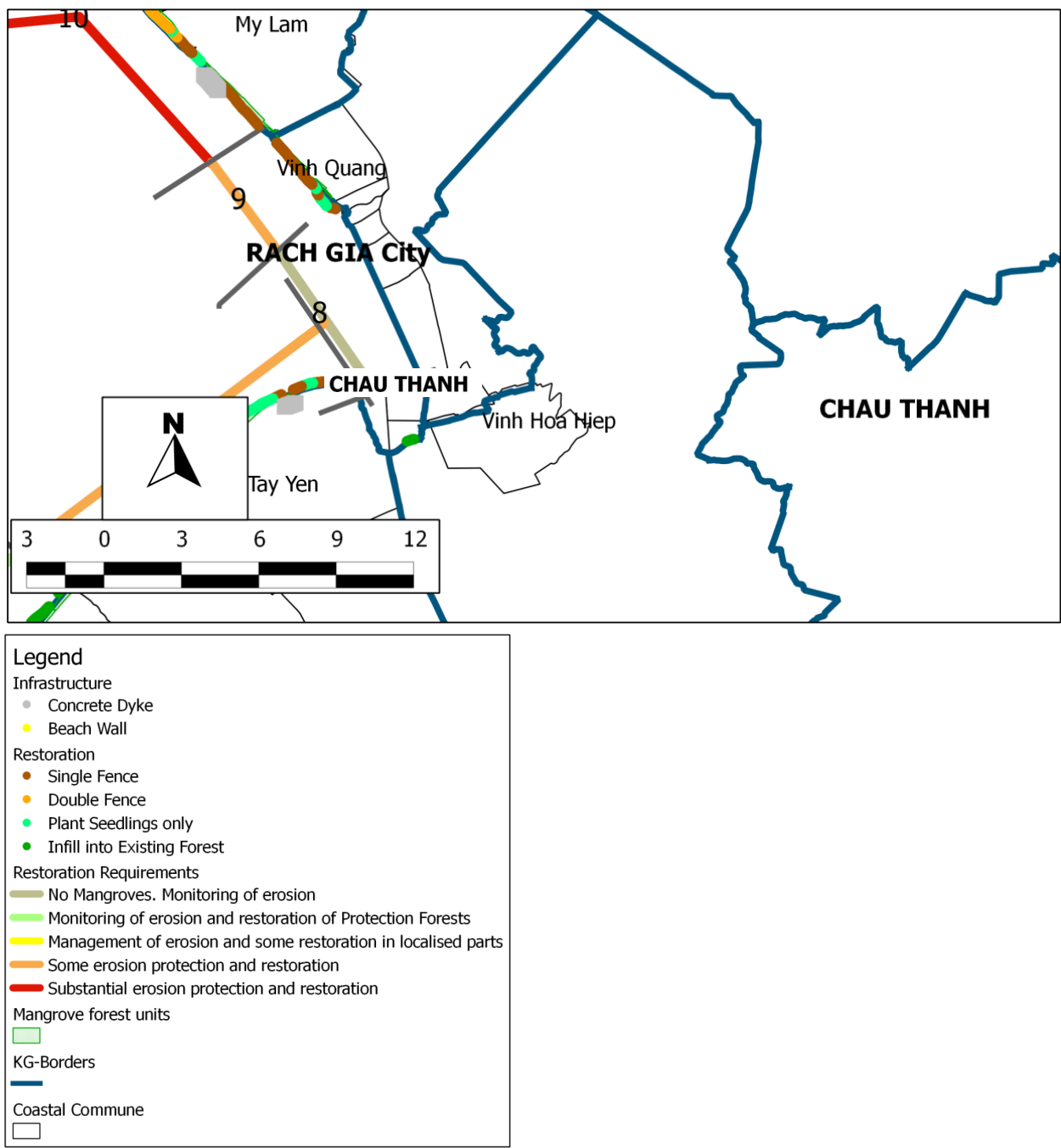


Figure 5. Classification of Chau Thanh and Rach Gia City management sectors into management classes and the location of areas requiring erosion and mangrove restoration actions.

The small section of mangroves in Chau Thanh requires some mangrove restoration. The Northern section of Rach Gia requires planting of seedlings and erosion protection by a wave break fence.

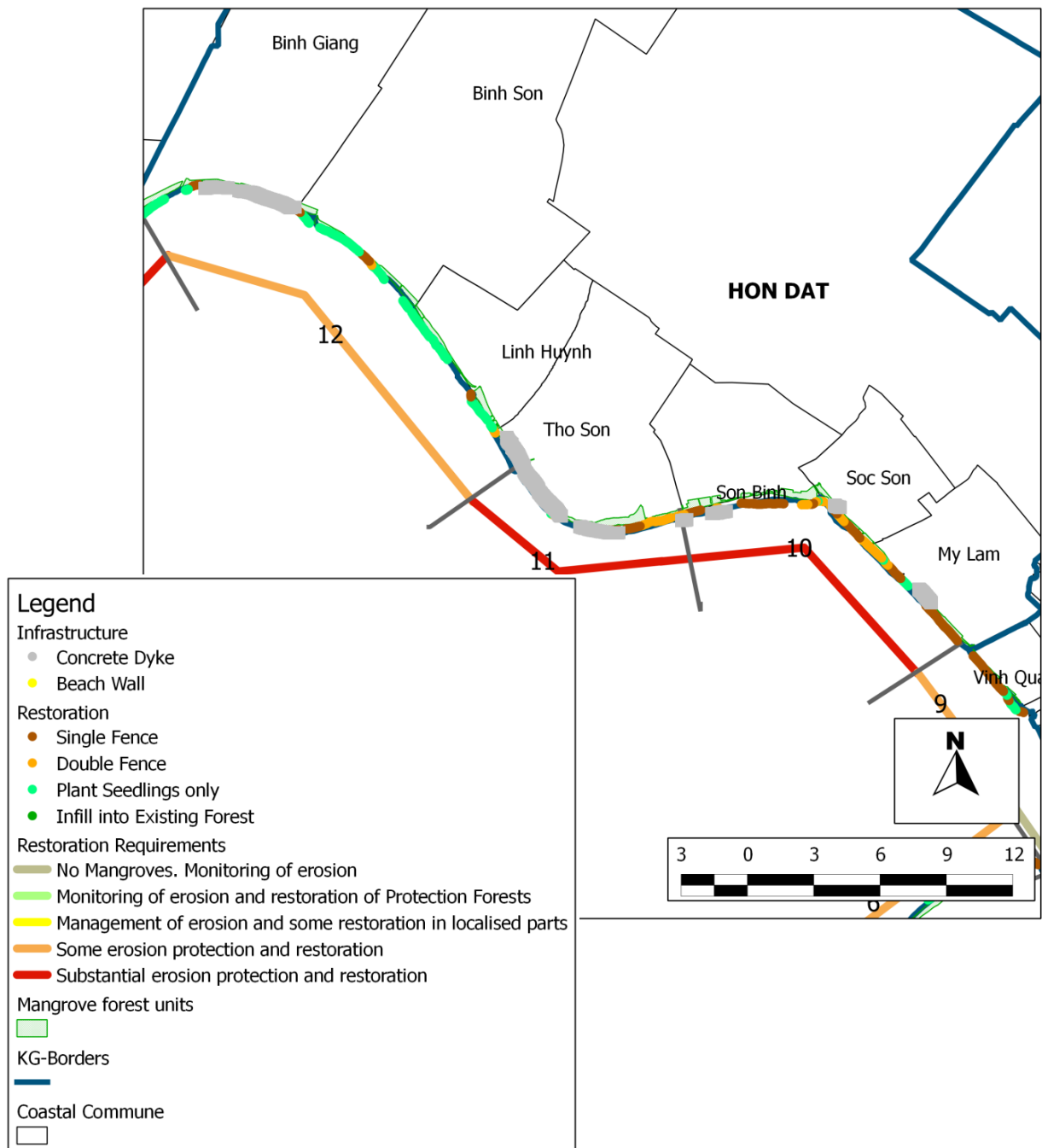


Figure 6. Classification of Hon Dat management sectors into management classes and the location of areas requiring erosion and mangrove restoration actions.

Hon Dat District requires substantial erosion protection along much of its coastline. Sector 14 requires the construction of concrete dykes along much of its length and fencing in the remainder. The Southern sector of the district, sector 10, requires fencing along much of its length with small sections of dyke requiring reinforcing. The population density of Soc Son Town and My Lam Communes indicates that pressure on mangrove resources will be high. Sector 12 in the North of the province requires mangrove restoration along its length with dyke reinforcement required for the coast of Binh Giang Commune.

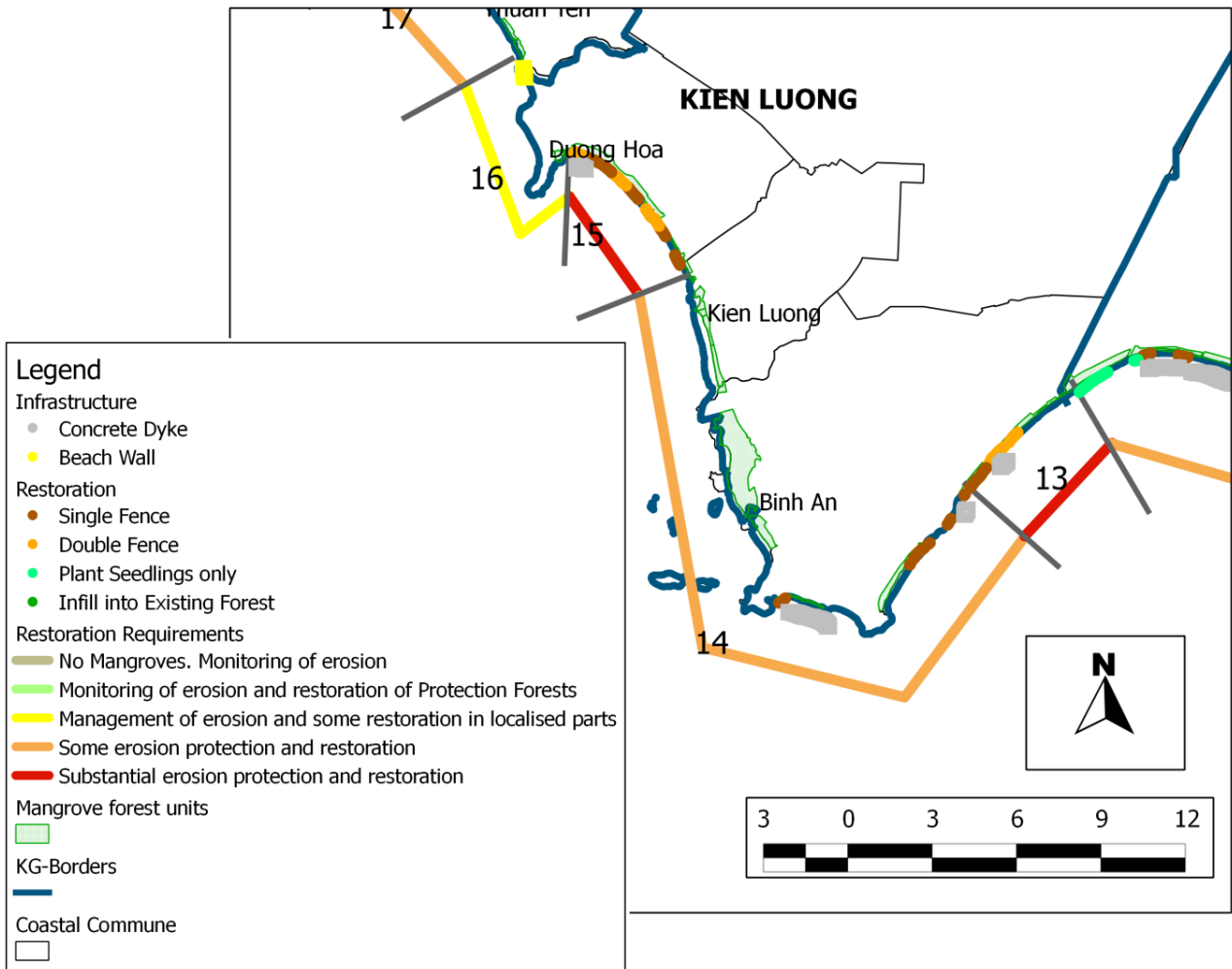


Figure 7. Classification of Kien Luong management sectors into management classes and the location of areas requiring erosion and mangrove restoration actions.

In Kien Luong District, sector 13 and the south coast of sector 14 require wave break fencing for erosion protection while concrete dyke protection is required for the southwest mangrove lined bay between Ong Thay Cape and Hon Chong Cape. The population density of Duong Hoa Commune indicates that pressure on mangrove resources in sectors 15 and 16 will be high. Sector 15 requires fencing for erosion protection with a small section of concrete dyke.

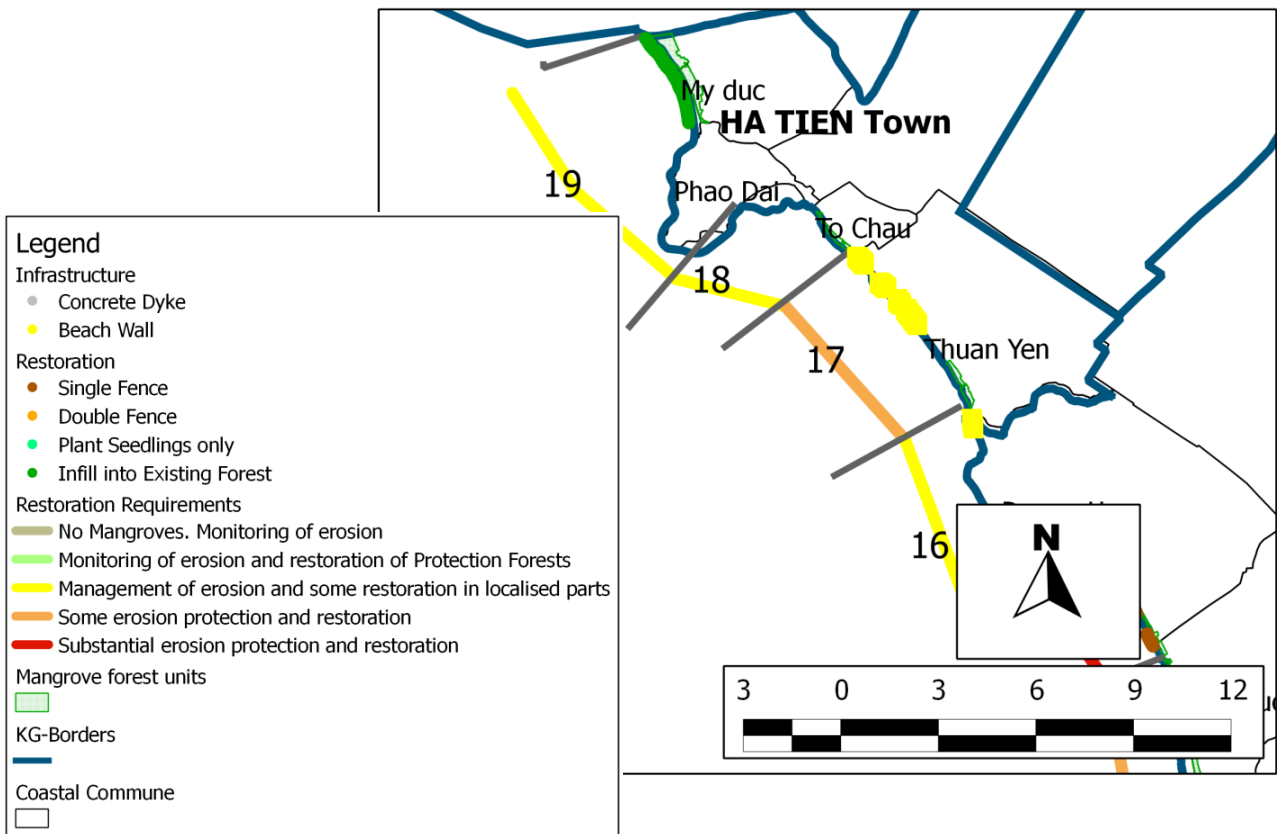


Figure 8. Classification of Ha Tien management sectors into management classes and the location of areas requiring erosion and mangrove restoration actions.

In Ha Tien District sector 17 requires substantial erosion protection in the form of a concrete or rock wall along the back of the sandy beaches. Sector 18 will require monitoring and active management of the mangroves that are now behind the reclaimed land, sector 19 also requires active mangrove restoration.

Appendix 2

List of priority communities to be supported in sustainable livelihood development

No.	Communes	District
1	Van Khanh Tay	An Minh
2	Van Khanh Dong	
3	Van Khanh	
4	Dong Hung A	
5	Tan Thanh	
6	Thuan Hoa	
7	Nam Thai A	An Bien
8	Nam Thai	
9	Nam Yen	
10	Tay Yen	
11	Vinh Quang	Rach Gia
12	My Lam	Hon Dat
13	Soc Son	
14	Son Binh	
15	Tho Son	
16	Linh Huynh	
17	Binh Son	
18	Binh Giang	
19	Binh An	
20	Kien Luong	Kien Luong