COMMUNITY-BASED MANGROVE MANAGEMENT IN BANG LA, DAI HOP COMMUNES, AND TIEN LANG DISTRICT IN HAI PHONG VIETNAM

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ABSTRACT

Mangrove is a type of coastal swamps forest found in the tropics and sub-tropics typically between latitude 25 degrees N and -25 degrees S with fines and salty sediments that flooded by tides and abounded by salt-tolerant trees or shrubs. Intact and healthy mangrove forests have the potential for sustainable revenue-generating initiatives including eco-tourism, sport, fishing, and other recreational activities in recent years, a big conversion occurred due to the phenomenal growth of aquaculture. Shrimp farming is one of the major sectors in Vietnam. Meanwhile, mangrove forests have extreme socio-economic importance where a big community depends on the local resources for livelihood as well as mangrove ecosystem diversity and physical importance considering climatic and environmental circumstances. In this study, Landsat and Sentinel-2 data were used to evaluate the spatiotemporal changes in mangroves' cover status and focused on 1994, 2001 2010, 2015, and 2018, and decadal changes. Results revealed that the biggest expansion of mangroves occurred during 1994-2001 due to the support of the mangrove plantation project 'Planting mangroves, preventing disasters'. Bang La and Dai Hop communes were found to be well-managed by local communities, while Tien Lang area was found to be vulnerable to natural disasters and human activities, due to its management and extensive practices of aquacultures. At the initial stage, the officials in Tien Lang did not cooperate with us to the mangrove area due to the security issues, despite this social-survey have been carried out to answer this question, how the mangrove management system being held by local communities in the study area.

Keyword: - *Aquaculture1, mangrove conservation2, mangroves management3, mangrove plantation4, mangroves cover status5, socio-economic condition6, Spatio-temporal changes7,*

1. INTRODUCTION

Mangrove grows along the sea and estuaries where freshwater mixes with seawater throughout the tropics and subtropics [1]. They are usually located in regions crucial for ensuring stable food supply in coastal regions, with good conditions for the development of supplementary economic activities, relates to the enormous potential of aquaculture, capture fisheries, port economy and industries that develop in part on the basis of material resources and geographic strength [2], [4].

Experts say aquaculture industries are mostly responsible for mangrove deforestation. Due to agricultural practices, salt beds overuse, and other reasons, mangrove areas in Southeast Asia experienced enormous loss over the 30 years ranging from 25% in Malaysia to 50% in Thailand [5]. Similarly, recent studies show that economic benefit and mining in mangrove areas in Vietnam caused an extensive reduction of freshwater inflow and actively increased salinity, and waste-water land, which has extremely affected the biodiversity of the mangrove [6].

According to previous studies, along with the development of the country's economy and society, the coastal zone of Hai Phong province had many changes over the past 2 decades [7], [8]. A study by Hien et al., (2018) mentioned that not only mangrove biodiversity is threatened by aquaculture expansion and other developmental activities in Hai Phong province, the land use is also confronted with many economic functions.

Despite having benefited from mangroves they are severely threatened on the planet. The unregulated development like mega-tourism projects, polluting industries, large scale shrimp farming and other aquaculture poses a great threat to the mangrove ecosystem. There is an urgent need to develop a scheme to protect and restore mangrove functions, which is why, spatial analysis is necessary to assess the land use land cover changes, particularly long-term analysis. Besides, GIS and Remote Sensing application is the most popular technology that has the capability to detect mangroves extents.

Land cover has been changing due to climate change and human activities and it is our enormous concern to think seriously. This research will contribute to come up with recommendations and probable solutions. The concentration of this study is to analyze; what is the current scenario of mangroves and its management in Hai Phong, Vietnam? What is the socio-economic condition of the case study area? How much mangrove vegetation has changed in selected years?

1.1 Literature Review

Mangrove forests have extreme socio-economic importance where a big community depends on the local resources for livelihood as well as mangrove ecosystem swatches prodigious diversity in their physical importance considering climatic and environmental circumstances [9], [10]. Not only they provide basic needs and protect from natural calamities but also contribute to economic growth through various resources [9], [11]. For example, all over the world, mining has been a big support for the progress of economic activities. At the same time, it has an unalterably adverse impact, in terms of environmental damages [12].

The coal mining area that growing rapidly in the Ha Long city of Quang Ninh province has a negative impact on the loss of mangrove forests. The Land Use Land Cover in the coal mining area is proportional to annual coal production, where all types of lands of Ha Long city affected by mining [13].

Another research was conducted by Umroh, using Landsat imageries and GIS techniques to detect mangrove distribution in Pongok Island. As a result, showed that mangroves are highly densely and protected by local people as well as they are aware of mangrove conservation and they do not allow any mining activities around [14].

A paper named, 'Climate change and coastal vulnerability assessment: scenarios for integrated assessment' by Nicholls (2008) was published in the Integrated Research System for Sustainability Science and Springer study was carried out based on non-climatic drivers that caused coastal vulnerability, where they found the necessity of integrated assessments for non-climatic drivers [15].

An attempt has been taken to know the links between the environment, the economy, and society by Peter Saenger [16] with the School of Environment, Science, and Engineering, titled, 'Sustainable management of mangroves' was published in Southern Cross University Library. The author discussed the problems with current systems of mangroves management and the framework of integrated coastal zone management; including:

(i) Encouraging community regulation;

(ii) Zoning mangrove ecosystems;

(iii) Developing mangrove management plans;

(Nguyen, McAlpine et al.) Reassessing the value of mangroves;

(v) Improving community information and

(vi) Rehabilitation of degraded mangroves.

Another study, 'The Relationship of Spatial-Temporal Changes in Fringe Mangrove Extent and Adjacent Land-use: A Case study of Kien Giang coast, Vietnam' by Nguyen et al., (2013). This paper covers the details about spatial-temporal changes using Landsat TM images in the extent and width of fringe mangroves over 20 years, the result showed that the increases of deforestations were significantly correlated to shrimp farming, crops production, and urban areas. The positive outreach of this study is about identifying the main drivers of mangroves changes that

informed the department of planning and information development in order to implement appropriate preservation planning and management [17].

A report, 'Observatoire des mangroves Dans la zone Indo-Pacifique' published in the University of Nouvelle-Caledonia, they have observed issues such as environmental problems, laws and economic conditions; although mining received much attention globally due to socio-economic development and it's not directly involved with mangroves, but neighboring ecosystems are still affected by the release of pollutants and sediments from mining. By cause of their toxicity and metals perform an extensive threat to mangrove biodiversity and human health [18].

Mangroves have a unique ecosystem which only found in tropics and subtropics [19], [20]. Directly and indirectly, mangroves protect a range of wildlife and supply commercial products and ecosystem services [21], [22]. We all have to formulate a set of best practices and blend them with the mining, tourism, and agricultural activities for producing better quality products, improving the environmental quality and mangrove forests productivity, and achieving improved performances related to sustainable mangrove development. So, the study has put forward a holistic approach to review the status of unwanted activities in the mangroves to have a better environment.

1.2 Importance of Mangrove

Mangrove plays an incredible role in the ecosystem. They provide invaluable ecosystem services with a strong foundation for an immensely productive and biologically complete ecosystem [1], [9], [23]. Although mangrove accounts for less than one percent of all tropical forests worldwide, they are regarded as one of the most valuable ecosystems. Not only do mangroves provide ecosystem services but also, they are beneficial to mankind [9], [24]. For example, they provide productive fishing grounds, carbon storages, enhances tourism and recreation, limiting soil erosion, and protect from destructive tropical storms [23].

Mangroves have tremendous values in feeding, nursing, and breeding for aquatic species [25]–[27]. Mangrove ecosystems are home to other valuable fauna species belonging to marine mammals and seabirds [28], [29]. An approximate calculation of the mangrove forest area in Vietnam was about 400,000 ha at the beginning of the 20th century [30]. Mangrove forests in Vietnam have been used for various purposes. A study by Nguyen et al. (2013) indicates that mangroves are one of the most essential elements for coastal areas as they provide protection for a shoreline from erosion, whence fight against climate change [17].

2. METHODS

2.1 Study Area

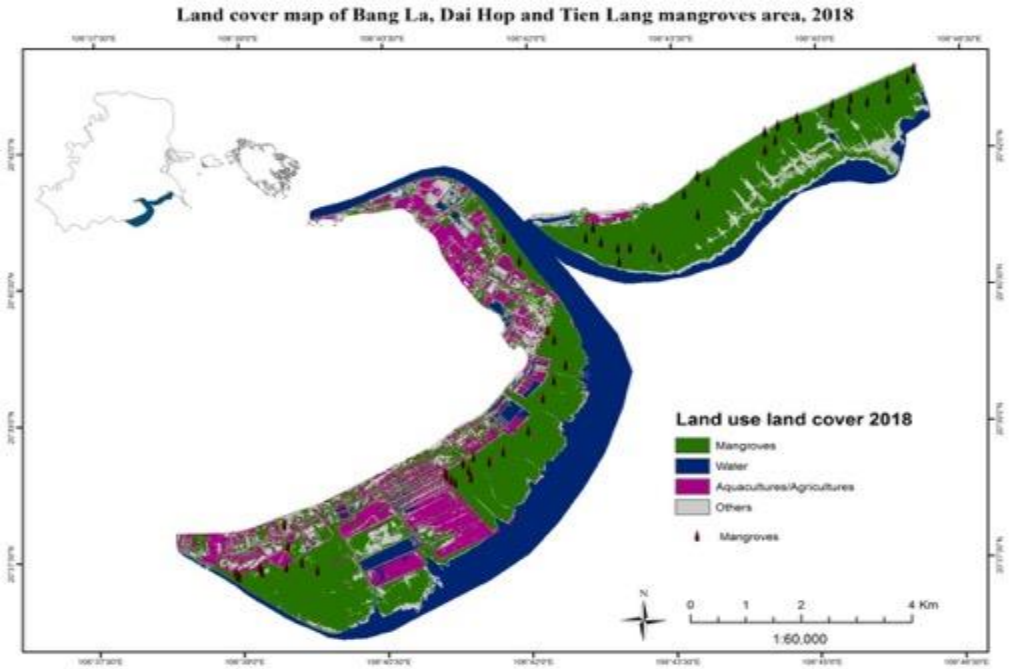

Fig -1: Geographic map Study area; (a) Vietnam Provinces map, (b) Hai Phong Province, and (c) Case study site: Tien Lang, Bang La, and Dai Hop.

It is situated between longitude 106º 23'to 107º 08' east and latitude 20º 30' to 20º 01' north. The area is characterized by a tropical monsoon climate. The length of the Hai Phong coastal is about 125km (Dat and Yoshino 2013). Case Study areas; Bang La, Dai Hop, and Tien Lang are the county of Hai Phong. Where the mangrove forest is adjacent to two wards; Bang La and Dai Hop.
In the observation, it had been seen that the flow characteristics in the study areas; Bang La and Dai Hop coastal area are relatively shallow due to the topography of the mangrove forest and oscillations of tidal water level and cause direct impacts on the hydrology condition. On the contrary, the coastal areas of Tien Lang, in particular, are in areas with a high frequency of cyclone and tropical depression.

2.1 Investigation of the status of current mangrove management schemes

This study reviews secondary data and mangrove management activities conducted by the central and local governments. The map was constructed for the purpose of assessing the current status of the area. Landsat 5, Landsat 7, and Sentinel 2A/B were used to process the mapping. Preprocessing was performed using ArcGIS 10.3.1. A group of students from the Vietnam National University of Forestry (VNUF) has done vegetation Surveys in the fieldwork for 20 days.

Data and Preprocessing

Historical Landsat 7 and Landsat 5, Sentinel 2A/B data were analyzed (see **Table 1**) to detect changes in coastal land use cover in general, and changes in the mangrove area.

Table - 1: Remotely Sensed data used in the study

No	Image codes	Date	Spatial Resolution (m)	Path/ Row
1	LT51260461994357BKT00	24/11/1994	30	126/45-46
2	LE71260462001320SGS00	16/11/2001	30	126/45-46
3	LT51260462006102BJC00	12/04/2006	30	126/45-46
4	LT51260462010337BJC00	12/03/2010	30	126/45-46
5	S2A_OPER_MSI_L1C_TL_EPA__20150810T033949 _20160909T110117_A000687_T48QXH_N02_04_02	10/08/2015	10	Sentinel
6	L1C_T48QXH_A005435_20180322T032727	22/03/2018	10	Sentinel

Source: *Earthexplorer.usgs.gov, Glovis.usgs.gov*

Normalized Difference Vegetation Index (NDVI)

Satellite images were enhanced before classification using vegetation indices (NDVI) to identify the current scenario of mangroves in the study area. Land Use Land Cover classification was required to detect the temporal changes of mangroves areas. As a result, mangrove vegetation is classed as a value of 1, 2 is water bodies, 3 is other cover types including other plants, residential areas and bare/wet soils 4 is agriculture and aquacultures. The highest NDVI value represents higher densities of mangroves. NDVI values equal to or close to -1 represent non-vegetation (Water or bare/wet soils, Table 1) and +1 value indicates denser vegetation.

$$NDVI = NIR–RED/NIR + RED$$ (Pervin et al., 2016; Nguyen, 2017)

Where: NIR is near-infrared, RED is (visible) Red

Social survey

A semi-structured social survey was conducted to collect information on historical records based on the experiences and practices of the local commune near to mangrove areas. It helped us to determine the structure, to review their

various conditions, current and previous management systems, and investigate the environmental factors that have an effect on the study area. The interview was taken to citizens aged 40 to 70 years old; especially those people who have experienced this mangrove plantation and management, and living there for more than three decades or more along with the government officials, community managers, local persons, apiculturists, and fishermen.
In order to carry out the task as presented, a field survey has been conducted to collect data on socio-economic conditions and natural resources of the study area. The information about income sources from the collection of mangrove forest products (firewood, shrimp, fish, and crab) was obtained from the household questionnaire and their price was obtained using the key informant interviews.

3.1 Current Scenarios of Mangroves

Vegetation

The average height of mature trees is more than 10 meters with diameters of 60-80cm and some are nearly 3-6 meters tall with the Diameter at breast height (DBH) of 7-18cm. There are mainly nine types of plants found in the study areas; *Avicennia Marina* and *Sonneratia Caseoloris* (Mangrove Apple) have been found in a more mature stage compared to other plants. Other plants are *Aegiceras Corniculatum, Rhizophora Apiculata, Rhizophora Stylosa, Kandella Candel, Bruguiera Gymnorrhiza, Acanthus Ilicifolius*, seagrasses, and sand-binders. Although they are plantation forests, some species already have started to regenerate naturally in many locations.
In comparison to Dai Hop, plant diversity in Bang La is highly rich as well as the observed height of trees in closed canopies. This observed difference is due to the difference in plantation periods.

Fig - 2: Mangroves vegetation in Bang La (left) and Tien Lang (right). *Photo by Amena Easmin (2018)*

Current status of mangroves (1994-2018)

Table - 2: Mangroves Changes in Tien Lang from 1994-2018 (ha)

Year	1994	2001	2006	2010	2015	2018
Tien Lang	420.12	820.89	965.61	842.67	1122.48	1139.32
Bang La and Dai Hop	63.63	159.84	404.19	459.99	539.74	807.9

By comparing classified images from two different adjacent time points, the area mangroves changed was identified (fig 3.4). Overall, from 1994s to 2018s mangroves forest areas shows the increasing trend. However, in the part of Bang La and Dai Hop, signs of mangrove vegetation growth are showing that, in the past and still now, the growth has been increasing continuously. This growth was possible due to a short-term project for mangrove plantation Vietnam was applied by the Japanese Red Cross Society with the help of the Vietnamese government, where citizens from many stages such as government staff from provincial, district and ward levels, local communities and citizens had participated.
Maps were constructed Based on the NDVI classification, to show the status of the mangrove for 1994, 2001, 2006, 2010, 2015 and 2018:

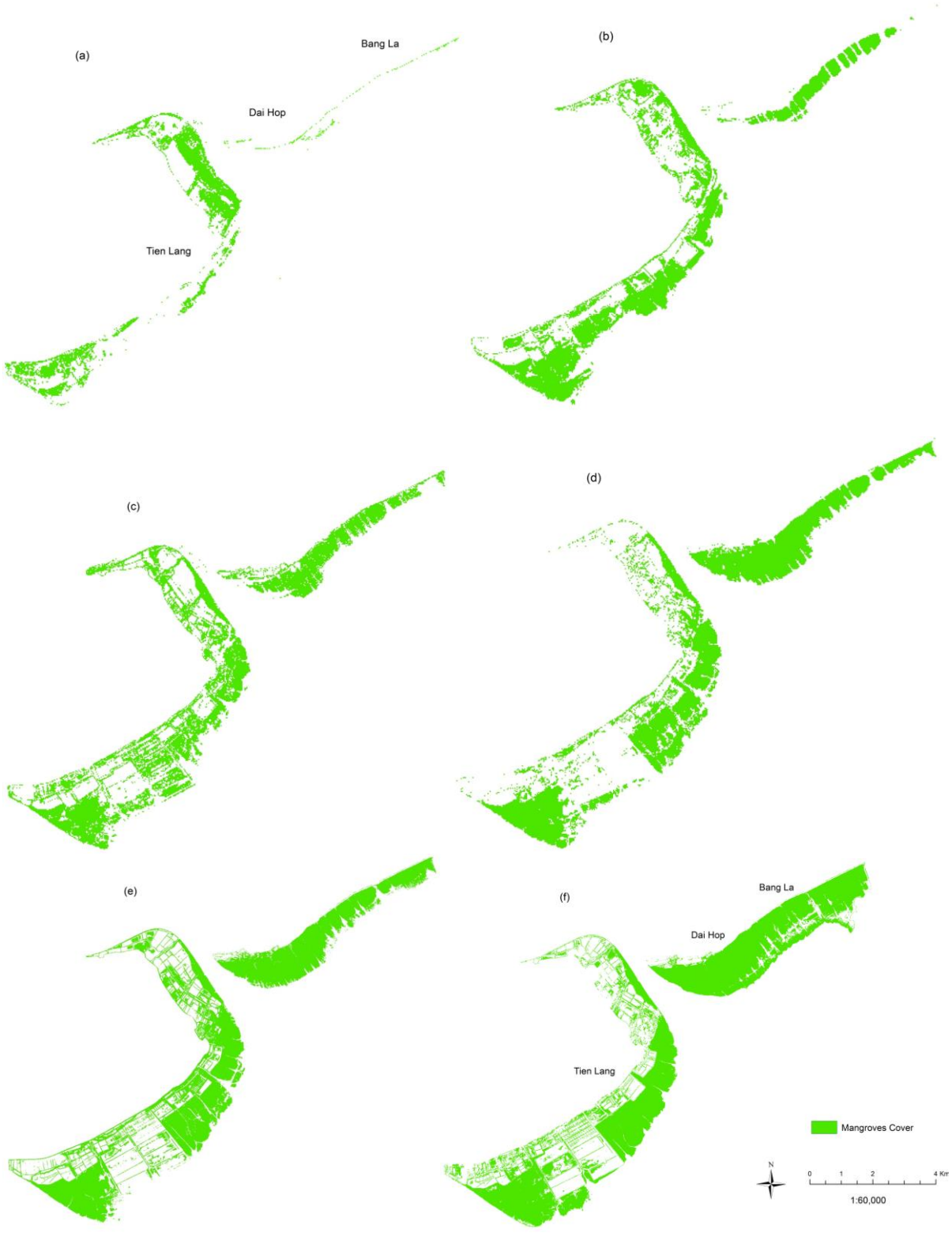

Fig - 3: Current status of mangrove forests in Bang La, Dai Hop, and Tien Lang.

After the construction of thematic maps for selected periods, dynamic maps for three different decades were drawn as in figure 4.

Table – 3: Dynamic of mangrove extent in three decades (ha).

Year	Tien Lang	Bang La and Dai Hop
1990-2001	-557.64	-110.97
2001-2010	-21.78	-300.15
2010-2018	-296.65	-347.91

Fig - 4: Decadal changes in mangrove extent in Tien Lang, Bang La, and Dai Hop coastal area during (a) 1990-2001, (b) 2001-2010, and (c)2010-2018.

Some future risks for Tien Lang include; increasing inundation due to heavy rain and slow drainage increased environmental pollution caused by flooding, and increased salinity intrusion, affecting water intake for irrigation, increasing drought.

Pollution

Oil pollutions have been noticed in the Bang La area, it seems these oils split from the fishing boats and mixed with seawater and floating over the entire mangrove area and seashore. Oil pollution could be the most serious damage to the entire mangrove ecosystems. Such spilling may cause harm and mortality to the population of fish, mammals, crabs, mollusks, and other seawater organisms. Another major threat to the study areas is plastic pollution. Huge amounts of plastics were seen during the survey.

Fig - 5: Oil splitting (left) and plastics (right), *Photo: Amena Easmin, 2018*

3.2 Mangrove management

The early history of mangroves implementation in the study area

With the support of the Government of Japan, communities of Tien Lang district and the commune of Dai Hop and Bang La has implemented the reforestation and development of mangrove forests. As mangroves are growing birds, mammals and marine fauna started coming back to live there and help to develop biodiversity. Also, mangroves with strong root systems help prevent shoreline erosion and flooding.

In the early 1980s, the mangroves in the commune were severely damaged; leading to coastal erosion (Government officer Mr. Tien, May 31, 2018). As a result, it turned into sandy bare land and grasslands accompanied by a depletion of marine resources. Without mangroves, when storms were strong, waves directly hit the dikes, which caused the breakage of dikes and huge damage to the dwellers and property. In order to recover damages, the local government undertook a plantation project in the study area together with local citizens. Although it was not successful, the local community found the essential inspiration to re-build the mangrove forests.

Thereafter, the Japanese Red Cross Society came forward to help with the mangrove plantation project in 1998 (Government officer Mr. Tien, May 31, 2018). From the beginning until the end, the local citizens were directly involved with the project and actively supported to re-build the mangrove forest and fight against climate change.

Mangroves management in Bang La and Dai Hop

However, mangroves management in Bang La and Dai Hop created a remarkable example among Vietnam mangroves management experiences.

According to the head of the village and team leader of the mangrove management (Mr. Chuan, June 2, 2018) integrated coastal mangrove management has been applied in Bang la and Dai Hop. A 10-years of short-term mangrove protection model has been implemented and this approach is being applied successfully in the commune.

The activities and responsibilities of protecting Bang la and Dai Hop mangrove forests in the commune have divided into 3 different tasks; plantation team, protection team, an observation team.

The commune has actively promoted and mobilized people not to use destructive methods of fishing in order to maintain aquatic resources. This measure, coupled with community monitoring, has reduced the phenomenon of destructive fishing. The people here are hard-working, experienced in mangrove production, fighting against natural calamities, and having a sense of protection of land and protection forests. Also, commune authorities pay special attention to improving the income and quality of life of the people.

The head of the village of Dai Hop has, with the help of the district, actively planted many mangrove forest areas. Since the allocation of forest land to households, there are more than 938 hectares of forest to be protected intact and planted. At the same time, the area of mangrove forest implemented annually also increases. Management and exploitation have been more effective. No logging happened and the forest management committee raised more responsibility for forest protection. They are well aware of mangrove ecology, services, and value.

Being aware of the role of mangroves, the commune authorities have taken strict measures to protect the forest. One of the measures is to allocate forest to individual households with regular monitoring and supervision of the community and the government.

According to a member of the Dai Hop Mangrove management committee (Mr. Hoan Van Dang, male participant, May 31, 2018), though the JRCS project is over more than 9 years ago in 2010, still his team members are actively volunteering for the forest and trying hard to protect it. Bang La and Dai Hop communities have an inter-connection with Mangrove forests, as they constructed it from the starting seems like a child.

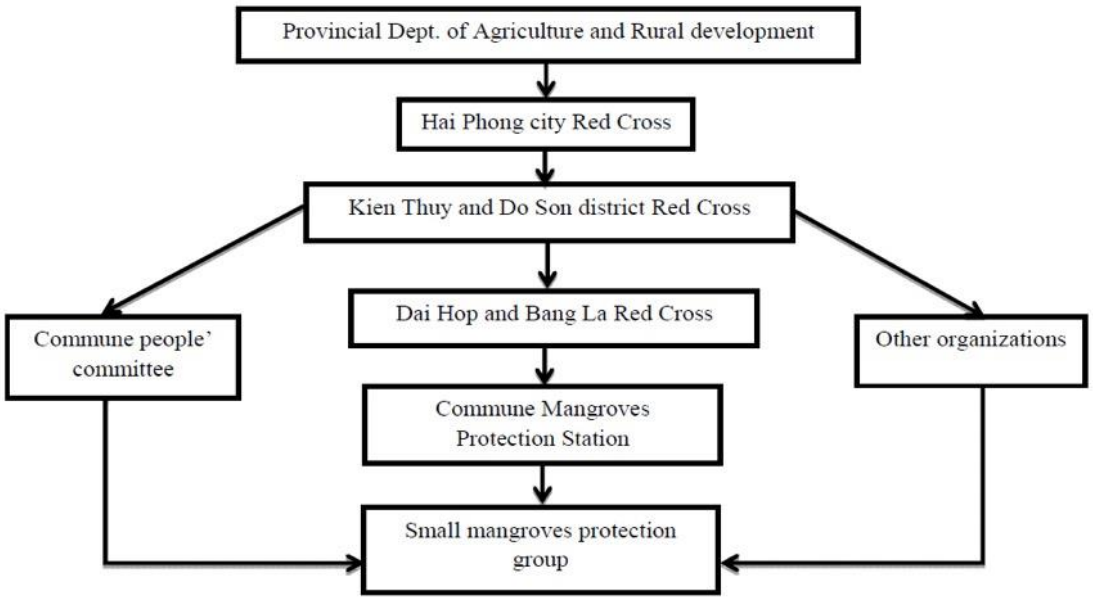

Diagram - 1: The Provincial management structure of mangroves management in Bang La and Dai Hop commune.

Adapted from: (Cuc et al., 2007; Nguyen et al., 2017)

Mangroves management in Tien Lang

There are two management roles in the Tien Lang area. One is ownership-based management and another is community-based management. Though there is a debate about mangrove protection between owners and local governments. While owners think about the income, the local government tries to increase the mangrove area. Both groups are aware of protecting nature. That's why mangroves in the Tien Lang are not as well managed as they are in Bang La and Dai Hop.

Ownership based management

There were 3 interviews conducted to get information about experiences and responsibilities based on the mangroves forest.

A solider that owns an aquaculture business *(*Male participant, June 8, 2018) as well as private mangrove forest, said that he also pays local people to protect his forest. He also built a dam to protect his forest and aquaculture.
An employer in aquaculture said *(*Male participant, June 12, 2018) the owner has 2 ha of mangroves in 2919 ha of total land protected by local people and he pays them to protect his forest. He not only protects the forest but also encourages local people to raise ducks.
Another aquaculturist *(*Male participant, June 12, 2018) claimed that he doesn't want to work with the committee due to corruption in the mangrove management, that's why he manages his properties by paying local people.
Due to security issues there we couldn't conduct any interviews with the member of Tien Lang community management.

3.3 Socio-economic conditions

Mangrove dependence

Mangrove products harvested by the local people as fuelwood, fish, NTFPs, crab, and prawn are major sources of income for coastal communities throughout the tropics.
According to the household survey, 80% of families in the coastal community have more than 2 income sources but their daily job is collecting small crabs from the mangroves area based on the tide, later they sell it to households, the local market and small restaurants.
Dwellers are dependent on aquatic products such as crabs, shrimp, snails, and fishes; where the population of these areas including Bang La, Dai Hop, Tien Lang, and other neighboring wards; Tan Trao, Ngu Don, and Lai-Ha are directly involved with the mangroves area. The rest of the dwellers are involved in agriculture, jobs, other business and they are not working in forest activities but are knowledgeable about it. Agriculture activities are mainly based on chicken and duck farming, fruits, vegetables, rice, and tobacco farming.

Socio-economic features

Table - 4: Average income from mangroves resources.

No.	Products	Productivity	Price
1	Fish	2-3 kg/day	80,000VND/ kg
2	Small shrimp & crabs	5-8 kg/day	50,000VND/kg
3	Honey	10 litters/week	250,000VND /L

In this study, income was calculated in the currency of Vietnam (VND). According to the exchange rate by the Agribank of Vietnam (2020) US$ 1 is equal to about 23.209 VND. The income sources of coastal communities are agriculture, aquaculture, non-farm activities, and collection of mangrove forest products (fuelwood, fish, NTFPs, crab, and prawn). Aquaculture income from shrimp, prawn fish, or other aquaculture products. Price of aquaculture products was obtained from a wholesale and a local farmer. For non-farm income includes wage labor, trade-off, private shops.
According to social interviews, individual prices of products are given in **Table 4**. Where there are nearly 10 families that raise bees and each family has around 100 honey bee nest boxes. The price of honey per kilogram is 250,000VND. They all have started raising bees since 2002. They harvest these nest boxes weekly, it is possible to get approximately 10 liters of honey from each box. Apiculture is extremely beneficial here, the reason they don't need any flower plantations for bees is due to the mangrove forest.

3. CONCLUSIONS

Long-term, short, and mid-term solutions should be applied to deal with the natural disaster as well as climate change. Otherwise, sea level will be increased and further land will be submerged in the oceans. Heavy rainfall, soil erosion, and landslides will also increase with the tide height. Bang La, Dai Hop, and Tien Lang are the three

different wards of Hai Phong considered with average income. Livelihoods here in the study areas are well-established and several local people get a direct benefit from the mangroves. Though mangrove areas have been influenced by several factors, such as political, development, or socio-economic aspects in Vietnam coastal area, nevertheless, the government has taken many steps to come up with the solution. But many rules and policies have been developed from the top to down. And the owners here in Tien Lang also share a management system similar to Bang La and Dai Hop, but some parts are managed by owners of the land.

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