CLIMATE CHANGE AND IMPACTS ON SUSTAINABLE SOCIO-ECONOMIC DEVELOPMENT IN THE COASTAL AREA OF CA MAU PROVINCE

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Abstract: *The Mekong Delta has seven coastal provinces, including Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, Ca Mau and Kien Giang. Typically, Ca Mau province has a coastline of 254 km along both the East and West sea. In the recent years, the province has been severely influenced by climate change. Nearly 10,000 ha of land and coastal forests, infrastructure and properties of local people have been eroded and seriously damaged. Production activities are vulnerable to sea level rise and other hydro-meteorological hazards. The life of coastal communities mainly depends on agricultural production. Main incomes are from rice, forestry, aquaculture, and fishing. This paper demonstrates a situational analysis on how climate change and natural disasters affect the livelihoods of the coastal communities in Ca Mau province and a case study is conducted for Phu Tan district. Study results are considered valuable inputs to propose urgent measures for sustainable socio-economic development in the province, adapting to climate change in the future.*

Keyword: *Risk, climate change, livelihood, coastal community, Ca Mau province*

1. BACKGROUND

Ca Mau province is one of thirteen provinces in the Mekong Delta which is the southernmost province of the country. The province has a geographical location from 8º30' to 9º10' North latitude and from 04º80' to 105º5' East latitude. It borders with the East and West seas to the South-East and West, respectively. In land, the province has borders with Bac Lieu and Kien Giang provinces. The total length of the coastline of Ca Mau province is 254 km (100 km in the East Sea and 154 km in the West Sea). Characterized by a special geographical location, Ca Mau province is also affected by two different tidal regimes (diurnal tides in the West Sea and irregular semi-diurnal tides in the East Sea) and is the most vulnerable province to extreme weather events in recent years and the trend to increase in the coming time. Ca Mau province is facing many challenges: climate change – sea level rise (CC-SLR), land subsidence and erosion of river banks and coasts. These challenges will alter hydrometeorology, flow, mud, landslides and directly affects the lives of people in the region.

Climate change – Sea level rise (CC-SLR) has caused a strong impact on the socio-economic life of coastal areas, on the mangrove ecosystem of Vietnam, including the coastal area of Ca Mau province. Especially, during the highest tides of the year (October to December), the sea level rise was highest in stormy days combined with high tides that cause great damage to properties of coastal communities and make eroded coastlines including areas with protective mangroves. Besides, livelihood activities also increase the vulnerability to climate change and sea level

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rise in coastal areas of Ca Mau province. The destruction of mangroves, the widespread embankment of shrimp ponds in the intertidal zone has prevented the movement of tides, thereby, greatly affecting the growth and development of mangroves specie, losing the nutritional place of seafood and animals in the intertidal zone, changing the flow, reducing the dispersion of water in the tidal plain and coastal area. The use of groundwater to regulate the salinity in large shrimp farming ponds as well as the excessive use of water for domestic purposes has led to a serious decline in groundwater resources affecting the geological structure of the coastal zone [1].

2. CLIMATE CHANGE CONTEXT AND THE EXPOSURE OF COASTAL AREA IN CA MAU PROVINCE

CC-SLR are great threats and challenges to natural resources, environment and social development of the Mekong Delta, of which Ca Mau province is the most vulnerable area because it is a place with low terrain compared to the sea level. Under the impact of climate change, the coastal area of Ca Mau province is affected by natural disasters with increasing frequency, intensity and scope (especially storms, floods, droughts,…) has changed the mode of production and business activities as well as human habitation activities.

According to experts from the Vietnam Academy of Water Resources, there is an indirect link between climate change and mangrove ecosystems through changes in sea level [2]. Sea level rise along with monsoons, storms, high tides have eroded the coast. In the East of Ca Mau, the Northeast monsoon (gusty winds) along with high tides have eroded many kilometers from Ganh Hao to Dat Mui village, each year there is a loss of 20-30m in width, such as Bo De estuary, Rach Goc, Khai Long areas spilling mangrove trees, including many perennial Avicennia marinas. Sea level rise also prevents the accretion of tidal flats, preventing the natural regeneration of pioneer mangrove species such as Avicennia marinas, Sonneratia caseolaris, etc. Sea level rise has created conditions for some mangroves species to encroach deep into inland soils, agricultural production lands. Wherever the saltwater, brackish water go into, then bring the mangroves along with the water inland to go there. Some freshwater flora and fauna species have been lost and replaced by brackish water species, thereby affecting food production and biodiversity.

According to monitoring data, sea level survey in recent years conducted by the Department of Agriculture and Rural Development of Ca Mau province, shows that the high tides in the following year are higher than the previous year, and along with that, the damage also increases, as seen in the following table.

Table 1: The extent of damage to Ca Mau province due to high tide

Year	Peak tide (m)	Damaged area (ha)	Notes
2007	+1.5	4,886	
2008	+1.6	10,632	
2009	+1.8	14,795	
2010	+1.85	15,832	
2011	+2.1	19,653	Monitoring at Ganh Hao

(Source: the Department of Agriculture and Rural Development of Ca Mau province)

In 2012: damage of 2,833.8 hectares; in 2013: damage of 59.15 hectares and in 2014 due to the influence of high tide (water rise) combined with cold air intensifying to the

south, making the already higher tide peak, overflowing on a large area (total length of spillway 194,769 m, of which: spilled 194,598.5m, broken bank 170,5m), affected area 6,028.8 hectares; locally flooded about 2,360 residential houses [3]. In the first months of 2019, due to the strong influence of the southwest monsoon, many areas in the province appeared heavy rain accompanied by thunderstorms, lightning, tornadoes combined with high tides, causing about 51 billion VND, damage of people, property and production in the province. If the water level continues to rise as it is now, in the coming time, it will directly affect over 26,000 coastal households and 90,000ha of agricultural land at risk of flooding, especially the coastal areas of Phu Tan, Tran Van Thoi, Nam Can and Ngoc Hien districts.

According to Ministry of Agriculture and Rural Development (MARD) statistics, annual landslides are taking place strongly both on rivers and in the coastal areas of the Mekong Delta, the area of land loss because of landslides is about 500 hectares. In the coastal area of Ca Mau province, landslides have taken place seriously in many places such as the West Sea and the East Se, causing great damage to property and destabilizing people's production. In the climate change condition, the possibility of storms increases in both intensity and frequency; sea level rise; excessive groundwater extraction; Intensive aquaculture hinders the sedimentation in the field plots to compensate for subsidence leading to an increased risk of flooding and landslides. Many mangrove areas have gradually lost their protective function; erosion is increasingly encroaching inland at a rate of 30-50 m/year [4]. The weather is becoming more and more unfavorable and unpredictable, especially in the rainy and stormy season, the sea area of Ca Mau province often rise, combining rain, thunderstorms and waves with strong intensity, most likely protective forests to protect the coast will be destroyed; Sea waves directly affect the body of the dike, there is a very high risk of breaking the West Sea dike, greatly affecting production, daily life, houses and people's lives, with a length of 57 km in U Minh, Tran Van Thoi and Phu Tan districts.

The western sea dike route in Ca Mau province starts from Tieu Dua to Kenh Nam canal with a length of 93 km, of which the section from Tieu Dua to Cai Dai Vam is about 76 km long the dike route is about 150÷2,000 meters from the sea, which has been built since Typhoon Linda in 1997, up to now, it is being upgraded with the scale of: the top of the dike +3m, the dike surface is 7.5 m wide (particularly the 5.5 m wide structural road to meet the requirements of grade V plain roads) to ensure the task of preventing salinity, preventing natural disasters to protect about 26,160 households and about 80,000 hectares of arable land in districts: Phu Tan, Tran Van Thoi and U Minh [5].

In addition, the negative impact of the current climate change on Ca Mau province is one of the reasons why the production of people in both coastal and inland areas faces many difficulties and occurs almost in the seasons of the year. Inland areas are often affected by natural disasters in the dry season. Due to being divided by a system of rivers and canals with a total length of over 10,000 km, there are 87 estuaries to the sea. In the dry season, prolonged drought, no additional fresh water sources. Lower water level in the field causes saltwater intrusion inland and salinization of groundwater, adversely affecting agricultural production and freshwater resources, increasing the risk of forest fires. For coastal areas, both the dry season and the rainy season are affected. In the rainy season, the storm surges with increasing intensity causing great damage to production, property and life of the coastal areas. people, and at the same time caused severe destruction of coastal protection forests. In the dry season, due to the lack of additional fresh water sources from the inside of the field, there are many “freshwater” areas deposited sediment, limiting the ability to exchange water sources for production, leading to the phenomenon of subsidence, river bank and coastal erosion.

Groundwater extraction is one of the main causes of subsidence in the Mekong Delta, the average subsidence rate in the Mekong Delta is about 1.6 cm/year and with sea level rise, then the resonant effect of two factors, the topography of the Mekong Delta may be lower than the present from 0.42m to 1.54m by 2050 [4]. If we do not have timely solutions, the challenges of high tides, floods, landslides and saltwater intrusion will be very serious for the Mekong Delta.

The risks from climate change – sea level rise, the people's livelihood activities in the areas also make coastal erosion and sedimentation on canals increasingly complicated. In the past (from 2000 and earlier), the west coast of the province has always been deposited by silt, but in recent years, especially since 2008, most of the west coast has not been deposited as before, but landslides have frequently occurred inland. Erosion occurs both along the East and West coasts (average erosion in the West Sea is from 20÷25 m/year, in particular places up to 50 m/year; in the East Sea, the average landslide is from 45÷50 m/year, especially in places where landslide are 60 m/year). In recent years, erosion occurs with severity and regularity, there are some fairly strong landslides, landslides close to the foot of the West sea dike route. According to statistics since 2008, 80% of the coastline has been eroded, with an area of about 450 ha/year of vital coastal protection forest lost. Adverse impacts of climate change and sea level rise have the risk of breaking the West Sea dike, greatly affecting the lives and properties of people as well as public works with a length of 57km on the West sea dike route and about 20km east coast. To solve this problem, the province has to spend hundreds of billions of VND annually to reinforce, protect the coast and invest in dredging the canal system [6].

In order to minimize landslides and the risk of subsidence, it is necessary to have appropriate technical infrastructure, combined with good management of mangroves, water resources and flexible livelihoods that will bring economic efficiency and stabilize people's lives, contribute to coastal protection (anti-erosion), increase water efficiency. Limiting subsidence by generating livelihoods from silt (eco-shrimp extensive aquaculture), limiting the use of groundwater will both promote regional advantages and reduce risks in the future.

The western coast of Ca Mau province is an ecologically diverse region, which plays a great role in the economic development of the province. However, the economic potential of the region has not been adequately exploited, unstable development, potential risks due to natural disasters are obstacles to socio-economic development in the region. To exploit natural resources to serve sustainable socio-economic development, protect the ecological environment, especially to limit and mitigate natural disasters caused by climate change-sea level rise; to ensure national defense and security for the West Coast region, besides investing in the West sea dyke in combination with solutions for sustainable livelihood development in the current period, it is a very urgent and important issue.

In the West sea area of Ca Mau province, Phu Tan and Tran Van Thoi districts, the terrain is low, only less than 1m above sea level. According to climate change-sea level rise scenario in 2016 [7] of Ministry of Natural Resources and Environment (MONRE), if there is no sea dyke route and constructions to protect and restore protection forest, then the risk of the entire area of this area being completely submerged may occur in the near future.

Table 2: Risk of flooding due to sea level rise by climate change

Location	Area (ha)	Flood rate corresponding to sea level rise (% of area)					
		50cm	60cm	70cm	80cm	90cm	100cm
Ca Mau	528,870	8.47	13.7	21.9	30.3	40.9	57.7
Entire area of Mekong Delta	3,969,550	4.48	8.58	14.7	21.0	28.2	38.9

(Source: Climate change-sea level rise scenario in 2016 – MONRE)

The results of flood map analysis when integrating both subsidence and sea level rise factors in the current situation (without sea dykes), then the flood level due to sea level rise is very large, with the sea level rise scenario up to 50 cm in 2025, up to 95.84% of the natural area of Ca Mau province will be flooded.

Figure 1: Image of landslide in My Binh estuary, Phu Tan commune, Phu Tan district, 2017

Figure 2: Current image of shoreline erosion at Sao Luoi estuary, Nguyen Viet Khai commune, Phu Tan district, June 2018

Figure 3: Current images of coastal erosion at Go Cong estuary, Nguyen Viet Khai commune, Phu Tan district, June 2018

Regarding investment for constructions to prevent waves and reduce high tides, in recent years Ca Mau province has invested in coastal landslide prevention and control embankments, mainly applying underground embankment solutions to reduce waves to cause land reclamation of protective forests in front of dikes with many supporting funds from the central and local governments. However, with a large dyke length, there are still many sea dike sections that need to have structural solutions to protect against impacts from the sea, including key sections from Doc to Bay Hap estuary such as: Doc, My Binh, Cong Nghiep, Sao Luoi, Go Cong estuary which is now under direct threat due to protected forests and increasingly eroded coastlines. In order to overcome the west coast landslides in the weak sections mentioned above, create conditions for the restoration of protective forests, protect sea dikes, production, population, and infrastructure inside the dikes, it is necessary to have solutions to build underground embankments to reduce waves to create beaches. The construction of anti-erosion embankments, restoration and development of protection forests is an effective, fundamental and sustainable solution to the problem of landslide prevention and safety for the West Sea dyke, which has been verified in recent years in Ca Mau province.

Regarding production development conditions, people's livelihoods in the western sea of Ca Mau province are mainly fisheries, forestry, agriculture and aquaculture; people's lives are still difficult, the per capita income is only 35÷40 million VND/year, most of them are poor and near-poor households [8]. Sea dikes play a particularly important role to protect production, property and people's lives. The dyke route along with the protective forest is also a shield for natural disaster prevention, creating a coastal traffic route thereby contributing to socio-economic development, creating residential areas, building new rural areas, creating jobs, increasing incomes for a large part of the rural population, contributing to poverty alleviation and ensuring national defense and security. Applying both structural and non-structural solutions to perform the tasks of natural disaster prevention, anti-erosion, mangrove restoration and development, coastal protection... are very urgent issues at present of the province. The implementation of these tasks contributes to responding to climate change, protecting and improving people's lives, and creating a sustainable development environment for the locality.

3. RESEARCH RESULTS OF SOME BIOLOGICAL MODELS IN THE COASTAL AREA OF PHU TAN DISTRICT AND EFFECTIVE SOLUTIONS FOR CA MAU PROVINCE

3.1 Research approaches and methods

In the approach to climate change, sea level rise, salinization risk adaptation to propose a suitable and sustainable livelihood model to adapt to climate change, the research team used sociological research methods, transdisciplinary approaches in developing survey tools and organizing field survey activities. Through social survey methods such as interviews and fieldwork to clarify the model's characteristics and the factors that promote the model's development, the climate change adaptation conditions. Through consultation activities, promoting the community uses of "indigenous knowledge" [9] to improve adaptability. Indigenous knowledge includes: 1) Knowledge of natural and environment (including the universe); 2) Knowledge of human (physiology, nutrition and disease treatment); 3) Knowledge of production, exploitation and rational use of natural resources; 4) Knowledge of social behavior and community management; 5) Knowledge of artistic creation [9].

3.2 Assessment results of livelihood activities of communities that are highly adaptive to climate change

3.2.1 Results of gender analysis

The assessment of gender characteristics in the area of Phu Tan district, Ca Mau province aims to consider and evaluate: Human resources and employment such as: Labor force (labour and income by gender), education and training (vocationally trained women), decision-making roles, ownership and control of assets, income and poverty. Gender status in production, livelihood development and access to resources, women in forestry, agriculture and fisheries livelihood activities.

Table 3: The division of labor by gender of household

Activity	Percentage of households that answered (%)		
	More male	More female	Equally male and female
Forestry (planting and exploiting forests)	29.2		4.2
Fisheries	73.7	5.3	15.8
Aquaculture	36.7	10.2	20.4
Raising livestock and poultry	9.1	39.4	18.2
Growing vegetables and fruit trees	12.5	25	18.8
Participate in community meeting in villages and communes	34.6	19.8	43.2
Production investment decision	66.7	11.5	11.5
Contributing to family income	68.7	9.6	21.7

(Source: Results of the field assessment of the research team, March 2020)

According to Table 3, the proportion of women participating in production activities such as forestry, fishing and aquaculture is still very limited, while men are still the main labor force such as fishing (73.7%), aquaculture (36.7%), while women mainly participate in livestock and poultry raising activities at home (39.4%), mainly chickens and ducks to serve the food needs of the family rather than the main income generating activity.

Regarding community activities, the percentage of women participating is quite high, the percentage of both men and women participating in meetings in villages and communes is (43.2%), this is partly explained due to the specific activity of the fisheries sector, men have to be away from home often or spend little time at home, so women take on the role of representing the family in meetings invited by local authorities.

3.2.2. Assessment of livelihood activities

Research and propose non-structural solutions to adapt to climate change that incorporate gender issues. Analysis, evaluation, groups of models are being carried out locally, based on resources of land, coastal forests, farming practices, production levels... including:

- Model of association of production/business, management, planting and protection of coastal forests: forest for management and care by cooperative groups, cooperatives, cooperative groups for shrimp farming and fishing seafood products and processing;

- Ecological model of aquaculture: extensive shrimp farming, brackish water fish farming, crab farming, oyster farming...

- The household-scale livestock model takes advantage of local food sources and the actual needs of the market: raising goats, cows, cattle, poultry...

- The model of fisheries services combining forest protection and rescue at sea;

- Model of women's small business and production cooperative groups, using local female laborers;
- The model of supporting the collection and storage of domestic water in the dry season in combination with shelter in the rainy season for households with difficulty conditions;
- Model of safe latrines.

The results of consultation with organizations, individuals and households show that livelihood activities are still unsustainable and small at household scale (including aquaculture, fisheries, cultivation and farming). The lack of means of production such as land, capital, machinery and technology affects the productivity and production efficiency, especially vulnerable households such as poor households, migrant households, women. The results are summarized in the following table.

Table 4: Main source of family income

Index	Average percentage (%)
Cultivation (rice, vegetables, fruit trees...)	2.4
Forestry (planting and exploiting forests)	8.4
Fisheries (fishing, aquaculture)	63.9
Industry, construction	1.2
Trading, transportation, other services	15.7
Employed in another commune, province	26.5
Local employment	18.1
Other sources of income	2.4

(Source: Results of the field assessment of the research team, March, 2020)

Aquaculture: Phu Tan is a coastal district with a natural area of 44,819.3 hectares, of which the aquaculture area is 39,072 hectares (accounting for 87.2% of the natural area), arranged according to the production structure such as: industrial shrimp, improved extensive shrimp intercropping and wild shrimp (ecological shrimp farming). Sustainable shrimp farming continues to be effective with 19,516 hectares of improved extensive shrimp farming, with 14,580 farming households, accounting for nearly 50% of the total production area. The average yield per crop is 550 kg/ha. This is a type of farming that is being encouraged by the profession to be replicated by people in the area, many farmers focus on doing it because of its low production cost, ensuring sustainability and efficiency, and can be combined with other aquatic species to increase economic efficiency, raise and diversify the income sources.

Cultivation: In Phu Tan district, there are about 2500 ha (2018 is 1,611 ha) of vegetables and fruit trees, of which: vegetables, cabbage of all kinds is 676 ha; gourd, squash, melon, herbs, onions, chives is 341 ha, fruit tree planting area is 1,300 ha (850ha of coconut and other fruit trees: red flesh dragon fruit, mango, guava, jackfruit...) The cultivation industry is not the strength of the district, but the development of cropping models to meet the local food needs, especially for households who do not have or lack land for aquaculture, creating favorable conditions for economic development, increasing income, and expanding employment.

Forest management and agro-forestry production under forest canopy: Phu Tan district has 4,348 ha of concentrated forest area, the percentage of forest cover and scattered trees increased from 13% in 2018 to 15% in 2019 and continues to have new planting in 2020. The problem of protection

forest development is affected by climate change and climate conditions, high tides in the last months; water environment is increasingly polluted; Poor quality afforestation varieties, relatively low selling prices for forest products, and limited investment capital for forest development. The pilot implementation of a livelihood model in combination with forest protection, although it has created jobs and incomes for people, especially households without productive land, has also revealed many limitations and inadequacies in the management and use of forest resources.

Cooperative economy: The collective economy has contributed an important part to the overall economic growth of Phu Tan district, reducing production costs and creating more jobs. Currently, there are 17 active cooperatives with 233 members and 124 cooperative groups with 1,355 members operating in the field of improved extensive shrimp farming; industrial shrimp farming; blood cockle production, raising cattle and poultry; knitting nets, sewing, repairing boats…

3.2.3. Research results on some livelihood models in Phu Tan district

The results of the study on livelihood models in Phu Tan district are as follows:

- Link model of knitting nets – patching nets: It is one of the models that helps people in the coastal area make a living in recent years, mainly female workers - without jobs in the locality, no capital for business or production capital involved. The cooperative groups are supported by the women's union for sharing capital to buy raw materials, orders, and assign production stages to make production activities more efficient.

- Model of drying all kinds (Dried fish of all kinds, dried shrimp, making fish sauce): people mainly live by fishing and aquaculture, seasonal workers... Especially female workers (for whose do not have stable jobs, and have to leave their hometown to work as hired laborers in other areas, to solve on-the-spot jobs for local women as well as self-consumption of locally produce materials, contributing to increasing women's income, helping economic development, hunger eradication and poverty alleviation.

- Model of hygienic latrines to ensure the safety of ecological aquaculture environment: Pollution of water sources in aquaculture-fishery leads to diseases for humans. Sanitary problems, water pollution affect women, with a high rate of gynecological diseases, affecting medical costs and family happiness to support these models will help improve the quality of community life, protect the environment, maintain the ecosystem to develop ecological aquaculture models.

- Model to support water tanks to collect rainwater for use in the dry season: For many years, people in the area have experienced in storing rainwater for living and eating. The model of renovating the thatched roof to collect rainwater for food and drink can be replicated through the following projects: credit support packages such as preferential loans, non-refundable grants for poor households… (Figure 4). This model can be applied as safety place for women and children during storm and flood season.

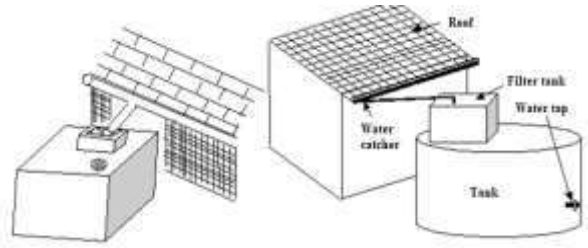

Figure 4: Rainwater collection tank, filter and rainwater collection tank from the roof

The results of consultations at all levels of the Women's Union show that: Local needs in supporting the development of models for the goal of hunger eradication, poverty reduction and development. Promoting the role of women to adapt to climate change is necessary through awareness raising activities, gender capacity building, introduction and transfer of

science and technology, propaganda and guidance for women to establish especially in aquaculture production models that combine planting and protecting mangrove forests, in the context of climate change adaptation and sea level rise.

3.2.4. Assessment of favorable and difficult conditions for community livelihood development

- *Favorable*

- Favorable geographical position, suitable climate for diversified economic development;

- Large land resources, abundant saline water;

- The dike system and infrastructure have been gradually invested in accordance with the general planning of the region as well as the inter-regional of Ca Mau peninsula. The system of canals is quite thick, which is a favorable condition to serve agricultural production. In the industry, in recent years, irrigation work has also been interested in dredging investment, so it can have enough water for production and navigation;

- People in the region have had a lot of experience in developing livelihood models related to forest production, ecological shrimp farming (shrimp-forest, shrimp-garden) and shrimp farming adapted to natural conditions (extensive shrimp farming);

- The situation of agricultural production, in which aquatic products (especially shrimp farming) are interested in development by functional sectors and local authorities because this type of model have high economic efficiency. The scale of the farming area has been expanded, and local training has been maintained and enhanced to aim at improving the quality of shrimp farming towards sustainability and high economic value;

- Other production models such as cultivation (vegetables, fruit trees) are encouraged, supported to develop and replicate in order to meet local food needs as well as for the commodity market.

- *Difficulties*

- The rate of soil contaminated with alum is high;

- The weather situation is increasingly abnormal and complicated, the water environment is increasingly polluted from untreated industrial shrimp farming activities, affecting the water environment for aquaculture and domestic use;

- Rainwater is abundant but unevenly distributed: in the dry season, there is a shortage of fresh water for production, while in the rainy season, most of the area is flooded;

- The salt water source is abundant, but the use is still difficult, not proactive in supplying salt for shrimp farming or limiting the water level to penetrate into the field;

- The coastal bank is continuously eroded due to loss of protection forest;

- The system of sea dikes, river dikes and irrigation works has not yet ensured the function of controlling tides against inundation, controlling salinity, keeping fresh water, alum drainage… flexibly in both spacial and timely manner;

- The situation of drought occurs frequently due to inadequate and asynchronous irrigation system, lack of water source control works (rainwater discharge through canals to the sea);

- Lack of measures to protect, manage, upgrade and renovate infrastructure to ensure harmonious development between economy, society and environment;

- Production activities are still unsustainable, small at household scale (including farming, fishing, raising livestock, and cultivation

activities). The lack of means of production such as land, capital, machinery and technology also affects productivity and production efficiency, especially for vulnerable households such as poor households, resettled households, women…

3.2.5 Proposing prioritize activities for the community in adapting to climate change and natural disasters in Phu Tan district

To comprehensively exploit natural resources for sustainable socio-economic development and ecological environment protection; supporting livelihood development for coastal communities in order to increase income for the community, hunger eradication and reduce poverty, mainstream gender development in the context of climate change adaptation and sea level rise; ensuring national security for the West Coast, besides investing in sea dikes, which is a very urgent and important issue, non-structural solutions will contribute to stabilizing the life of the community, promote the ability to care and protect mangrove forests. The study has suggested specific activities for the short term as follows:

- *Measures to mitigate gender vulnerability in coastal areas of Ca Mau province*

Diversifying income sources for women as a solution to reduce risks in terms of income, livelihoods in the context of climate change, and limited access to land and credit resources: Livestock and crop production are livelihood activities that suitable for women to improve their economic ability, especially when households do not have a lot of land for aquaculture, it is difficult to access large capital sources for the development of production models, and complicated situation of climate change affecting seafood production (high risk).

Non-agricultural economic activities: include small trading activities, providing fishery services, doing traditional side jobs (knitting, drying, fish cake, sewing, patching nets...) to create jobs for female workers who not have productive land, take advantage of labor to directly serve local market needs in terms of business, trading, transportation, and pre-processing of ready-made products that locally available.

Participating in models of fisheries exploitation combined with sustainable forest management: this is a definite advantage in communes with coastal protection forests that can combine aquaculture under the forest canopy (snail, crabs...) both aim to create jobs, livelihoods and protect sustainable protection forests.

- *Raise awareness about gender equality, disaster prevention and climate change prevention*

By means of mass media, education and training programs aim to change the social perception of gender equality, thereby promoting the role of women in production activities and economic development. Raise awareness of climate change and climate risks, support the establishment of commune-level climate change response teams. Improve adaptive capacity for vulnerable groups, especially women through training activities, appropriate science and technology transfer training, knowledge and skills in household economic management, supporting small-scale credit to support diversification of income sources, ensuring life stability and reducing vulnerability to production shocks, natural disasters, and climate change. Further promote the mainstreaming of gender equality and climate change into local socio-economic development plans at all levels, especially at the commune level. Include gender equality targets in socio-economic development plans, socio-economic development programs and projects such as the target program on building new rural areas... Strengthen the organization

of capacity building activities for managers, full-time officials at all levels of government and associations in coastal areas through short-term training courses.

▪ *Proposing non-structural solutions for livelihood transformation/development associated with gender development to reduce poverty and adapt to climate change*

Vocational training and technical transfer training activities: Training and guidance on risk reduction in aquaculture and fishing in coastal areas; Apply integrated management methods for coastal areas; Training to support the development of models/ career orientation, diversifying income sources; Developing models of job creation on the spot that attracting the participation of female workers, poor households, and difficulty households in the locality; Training on food safety, carefully guiding the safe processing of seafood; Product marketing training, market access and connection.

Developing models of job creation on the spot that attracting the participation of female workers, poor households, and difficulty households in the locality: developing models of purchasing and processing seafood; developing models of knitting and patching nets to serve fishermen at the sea; developing sewing models, processing clothes, sewing foot mats. Market connection activities, credit fund building, seminars.

Developing production models in the direction of sustainable and environmentally friendly ecology: developing an improved extensive shrimp farming model (02 phases); develop a mixed aquaculture model suitable to mangrove ecological conditions in order to adapt to climate change; develop a household-scale livestock model using local food sources.

Support the development of livelihood resources and facilities to adapt to climate change: support the model of building hygienic latrines; support the model of rainwater collection for daily life in the dry season to adapt to climate change; supporting the construction of centralized water treatment and supply stations using solar energy.

4. RECOMMENDATIONS FOR SUSTAINABLE ECONOMIC - SOCIAL DEVELOPMENT IN COASTAL AREA OF CA MAU PROVINCE

In the western coastal area of Ca Mau province, livelihood activities are relatively diverse, however, the main source of income is from aquaculture and fishing activities, in which shrimp farming is the production activity accounting for a large proportion of the total income. In the field of shrimp farming, in the area, there are many models and methods of farming at different levels from natural farming, farming in combination with forests, semi-intensive farming, and super-intensive farming. Depending on the conditions of the land, and the ability to invest, the level of development with different types of farming is suitable. Currently, there is a trend of increasing the types of farming with the participation of science and technology such as semi-intensive, super-intensive, and improved extensive. However, only households with productive resources such as land and capital can develop these models. For households that do not have capital to invest in upgrading the model, it is necessary to have outside support to develop and expand.

Other occupations such as farming, raising cattle and poultry, although contributing to raising incomes and diversifying livelihood sources, are not the advantages of communes in the area. Difficulties in capital, high input costs, limited disease management and competitiveness, and access to output markets for products hinder the development and expansion of the cultivation and livestock sectors.

The activities of fishing, seafood processing, fishing logistics services... are also advantages of the region such as natural conditions, taking advantage of vacant labor, taking advantage of aquaculture products. generated by the locality for preliminary processing and packaging into goods for the market. These activities also contribute to helping households without productive land have jobs, improve living standards, reduce hunger and reduce poverty.

Several livelihood models that have been implemented by investment sources from international organizations, the state budget, through mass organizations such as farmers, women... also been promoting their effectiveness. However, the results are still on a small scale, unable to attract a large number of households to participate due to difficulties in capital sources and investment conditions... Some models are experimental and ineffective because they are not suitable for the natural resources conditions of the region such as freshwater fish farming and large-scale safe vegetable cultivation. In addition, some models combined with forest protection have limitations due to the lack of strict regulations and management mechanisms, balancing the interests of the parties involved.

The coastal districts of Ca Mau province are heavily affected by the increasingly complex climate change and affect production and economic development. Therefore, it is necessary to have models of economic development and production that adapt to this climate change condition. In addition, the upgrading and construction of infrastructure such as sea dikes, breakwaters, culverts to prevent salinity, development of protection forests and production forests to ensures the safety of people and properties, and at the same time protects people and property, and support the production activities of coastal localities.

Limitations in access to land resources, family assets, fresh water, clean water, position and roles, lead to affect the status, voice, participation and health conditions of women. Although initially effective livelihood models for women have been implemented, the difficulties in capital, management capacity, skills, science and technology in production and access to the market is a barrier for women to participate in the development of local production models. These are issues that need to be solved and supported so that women can participate more, express their roles, contribute their own as well as contribute to creating jobs, generating income, and improving the lives of women in particular and the community in general.

Proposing a number of prioritize activities in the immediate period for sustainable socio-economic development in the coastal area of Ca Mau province in the context of climate risk adaptation:

- Support for livelihood transformation for coastal communities in order to diversify livelihood activities and increase income for the community; reduce dependence on fishing activities in coastal areas; contribute to the protection and restoration of coastal mangrove ecosystems, protection and restoration of aquatic resources, environmental protection, towards the development of coastal fisheries in a sustainable manner under climate change and sea level rise conditions.

- Support gender equality through supporting women to access livelihood activities, to diversify income sources; support women's groups to strengthen capacity, raise awareness of climate change, appropriate aquaculture production techniques, access to small credit

funds... to enhance women's participation in economic development of farmers.

- Technical support: Developing a sustainable integrated coastal zone management strategy (ICZM) in the coastal area of Ca Mau province and implementing the plan to respond to climate change.

- Supporting the local implementation of Project 1002 "Raising community awareness and community-based disaster risk management", through activities of Organize content dissemination to raise public awareness and management community-based disaster risk in natural disaster prevention and control for officials, public employees and individuals (belonging to subject 4 and subjects being typical individuals, reputable people in the community) participating in annual defense and security knowledge training (including members of the Commune Disaster Prevention Committee and community groups located in vulnerable areas of the coastal area).

Develop and implement a number of technical assistance activities of national, regional and long-term:

- Research on sustainable solutions for coastal protection in the context of climate change adaptation and sea level rise;

- Research and propose a model of sustainable management of mangroves with the participation of the community;

- Clarifying the causes of forest loss: assessing the effectiveness and impacts of wave reduction structural solutions; study the lack of silt that kills the forest; the subsidence of the beach makes the waves bigger, making the trees unable to withstand big waves, deepening the forest clearing;

- Assess the impact of sea dikes on the existence and development of mangrove forests and vice versa, the protective effects of forests on dikes and coastal infrastructures;

- Assess mangrove forest management, propose solutions for sustainable livelihood transformation for local communities in order to diversify livelihood activities in combination with forest protection and income enhancement; reduce dependence on fishing activities in coastal areas, towards sustainable offshore fishing.

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