Chapter 7

Climate Change Adaptation in Fisheries Livelihoods Associated with Mangrove Forests in Xuan Thuy National Park, Vietnam: A Case Study in Giao An Commune, Giao Thuy District, Nam Dinh Province

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7.1 Introduction

Giao An, a commune located in the southeast of Giao Thuy District, Nam Dinh Province in Vietnam, is one of five communes in the buffer zone of Xuan Thuy National Park with a history associated with the development of the Red River Delta. About 300 to 400 years ago, this land was comprised of pristine beaches with lots of reeds and mudflats. Over time, the people of Giao An built dikes, encroached on the sea, and leveled the land. By the end of 1860, Giao An was established, comprising Trung Uyen, Hanh Thien, Xuan Hy, Thuy Nhai, Hoanh Lo, Tra Huong, and Tra Lu villages (divided into 16 hamlets). The period from 1960 to 1985 was characterized by continued expansion of arable land by building dikes under the motto, “Rice encroached on sedge, sedge encroached on *Bruguiera* (genus of mangrove plants), *Bruguiera* encroached on the sea”. At this stage, the commune had reclaimed approximately 300 ha of land from the sea, close to the foot of Ngu Han dike, and established six hamlets in the Dien Bien New Economic Zone Area (from hamlet 16 to hamlet 22). The period from 1985 to 1995 was characterized by the adoption of the marine economic development strategy under the motto “*Bruguiera* encroached on the sea, shrimp encroached on *Bruguiera*”, which created thousands of hectares of shrimp ponds in Bai Trong and Con Ngan. Due to economic development, the natural mangrove forests in Giao An Commune decreased, especially in Bai Trong.

However, realizing the important role of mangroves in coastal area protection, the local government has implemented numerous solutions, simultaneously, such as planting more than 1000 ha of mangrove in Con Ngan and a part of Con Lu from 1997 to 2003. In addition, Giao An has pioneered the development of climate

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change (CC) adaptive fisheries livelihood models, taking advantage of mangroves which are improved extensive shrimp farming and community-based mangrove management. These models have not only improved resilience and response to CC, but they have also stabilized the incomes of local people as well as developed the area by making economic activities more sustainable.

The study used the following three approaches to investigate CC adaptation in fisheries livelihoods associated with mangrove forests in Giao An Commune: (1) systematic, interdisciplinary approach; (2) combined top-down and bottom-up approach; and (3) Department for International Development's sustainable livelihoods approach. Furthermore, tools from sociological research methods (e.g., questionnaires for households) and Participatory Rural Appraisal (in-depth interviews as well as establishment of seasonal calendars and a calendar of events) were used. One hundred households and twenty-four civil services were interviewed to collect relevant information.

7.2 Results and Discussion

The average annual temperature fluctuated between 23 °C and 24 °C. In 30 years, it tended to increase by about 1.0 °C (Fig. 7.1). In particular, from 1989 to 1998, the average annual temperature increased by 0.4 °C, while from 1999 to 2008, the temperature decreased by 0.2 °C, and the remaining period from 2009 to 2018 it increased by 0.6 °C per annum.

Moreover, the total annual rainfall of Nam Dinh Province from 1989 to 2018 fluctuated in the range of 1750–1800 mm. 2007 was the year with the lowest annual rainfall (1086 mm) and 1994 was the year with the highest total annual rainfall (2988 mm) (Fig. 7.2).

All surveyed households confirmed that the natural disasters in Giao An Commune in recent years have been atypical, with “typhoon”; “tropical depression”; “lightning”; “heavy rainfall”; “extreme hot weather”; “extreme and damaging cold” and “hoarfrost” being considered to be the main natural disasters in the study area (Table 7.1). The frequency of most of these above natural disasters was rated as “rare”, but the intensity was “stronger” than before.

Fig. 7.1 Trend in average annual air temperature in Nam Dinh Province in the period 1989–2018. Source: Department of Natural resources and Environment of Nam Dinh Province (2019)

Fig. 7.2 Trend in total annual rainfall in Nam Dinh Province in the period 1989–2018. Source: Department of Natural resources and Environment of Nam Dinh Province (2019)

Table 7.1 Assessment of survey respondents about natural disasters that have occurred in Giao An Commune in recent years

Types of natural disasters	Valid percentage (%)	Types of natural disasters	Valid percentage (%)
Typhoons	97.0	Hail	4.0
Tropical depressions	98.0	Drought	30.0
Whirlwinds	56.0	Hoarfrost	82.0
Lighting	94.0	Other	20.0
Heavy rainfall	78.0	- acid rain	1.0
Inundation	32.0	- showers	1.0
Sea level rise	19.0	- fog	1.0
Saltwater intrusion	19.0	- change in weather	16.0
Extreme hot weather	95.0	- humidity	1.0
Extreme and damaging cold	60.0		

During the survey, in addition to in-depth interviews with local people and authorities, the impacts of natural disasters were reported as follows (Table 7.2).

In addition, agriculture and fisheries were the main livelihood activities accounting for a large proportion of the local economy (67%) (People’s Committee of Giao An Commune 2017). In terms of fishery production, two activities are very important: aquaculture and capture fisheries (or called community-based mangrove management). The entire commune utilized an aquaculture area of 669.2 ha, which comprised a freshwater area of 59 ha and a shrimp pond area of 610.2 ha. The total aquatic production in 2019 was estimated at 2200 tons (People’s Committee of Giao An Commune 2019).

a. Aquaculture

Peaks in aquaculture production coincided with the different types of natural disasters. Consequently, without careful preparation, the risk to aquaculture households was quite large. The natural disasters markedly affected these activities in the Giao An Commune, especially “typhoon”, “tropical depression”, “heavy rainfall”, “saltwater intrusion”, “extreme hot weather”, “extreme and damaging cold”, “hoarfrost” and “other”, which comprised changes in climate and weather. Together, these phenomena “reduced productivity”, “changed the water environment”, which can lead to “lost all aquaculture products”. Table 7.3 shows the valid percent of

Table 7.2 Calendar of natural disasters in Giao An Commune

Year	Types of natural disasters	Damage
2010	Extreme and damaging cold lasting 38 days	100% of the areas of vegetables, rice seeds, and rice were damaged; many aquaculture households were affected.
2011	Extreme and damaging cold	Newly transplanted rice fields died or were poorly developed.
2012	Typhoon son Tinh (typhoon no. 8)	<ul style="list-style-type: none"> - 60% of pure rice which had not been harvested was damaged. - 100% of vegetable areas were damaged - 50% of clam farming was damaged. - 100% of auxiliary works were damaged. - more than 80% of freshwater aquaculture areas were damaged. - the roofs of 100% of corrugated iron houses were destroyed. - 3 houses collapsed.
2013	Typhoon no. 1, 3, and 6	Vegetable and rice areas were affected.
	Extreme hot weather	Shrimps grew slowly due to reduced natural food intake and hot weather; clams experienced severe heat stress and died on hot days.
2014	Heavy rainfall	Salt concentration in aquaculture areas fell below 10.0‰ leading to shrimps and clams dying and growth retardation.
2015	Northeast monsoon and damaging cold	Impacted on production activities, with aquaculture and fishing households severely affected.
2016	Extreme and damaging cold	Affected production activities.
	Typhoon no. 1	<ul style="list-style-type: none"> - 100% of vegetable and transplanted rice field, as well as aquaculture ponds were damaged. - many cattle and poultry died. Total losses amounted to 26.7 billion VND.
2017	Typhoon no. 2, 4 and 10	Tropical depression caused heavy rain in combination with the water from Hoa Binh hydropower reservoir to create floods in the river, which adversely affected agricultural production in Giao an.
2018	Typhoon no. 4 combined with lightning	<ul style="list-style-type: none"> - adversely affected production activities and daily life of the people. - some household TVs were broken by lightning.
2019	Typhoon	Affected production activities and daily life of the people.

impacts of natural disasters on aquaculture households that are engaged in fish, shrimp, and clam farming.

b. Capture fisheries

Capture fisheries were exploited regularly depending on the health of the participants, weather conditions as well as the tidal calendar. However, surveyed households emphasized that weather and climate were reasons for the decline in aquatic capture production. Not only that, if “typhoon”, “tropical depression”, “heavy rainfall”, “extreme hot weather” or “extreme and damaging cold” occurred, households would temporarily also stop production activities (Tables 7.4 and 7.5).

Due to the above impacts and the complexity of CC, Giao An deployed several CC adaptive fisheries livelihood models taking advantage of mangroves. These

Table 7.3 Assessment of the effects of natural disasters and CC impacts on aquaculture

							(Units: %)
Types of natural disasters	Slow growth	Reduced productivity	Changes in water environment	Numerous diseases	Difficulty eating	Lost all aquaculture products	Dead aquatic species
Typhoons	3.6	39.3	7.2	0.0	0.0	14.3	0.0
Tropical depression	0.0	17.9	0.0	0.0	0.0	7.2	0.0
Heavy rainfall	0.0	32.1	32.1	0.0	0.0	0.0	0.0
Sea level rise	0.0	0.0	39.3	0.0	0.0	21.4	0.0
Extreme hot weather	10.7	0.0	0.0	10.7	10.7	7.1	42.9
Extreme and damaging cold	0.0	0.0	0.0	0.0	0.0	39.3	32.1
Hoarfrost	0.0	0.0	0.0	0.0	0.0	39.3	14.3
Other	0.0	0.0	0.0	0.0	0.0	7.2	3.6

models improved extensive shrimp farming and community-based mangrove management.

c. Improved extensive shrimp farming

Since the 1980s, the wetlands of Giao Thuy District (formerly Xuan Thuy district) had been converted into fishing and shrimp ponds. Giao An was a leading commune in this movement. By the mid-1990s, due to declining natural aquatic resources, people began to develop improved extensive shrimp farming. This model started to become more widely implemented at this time.

The basic technique of the model is described as follows: Black tiger shrimp are stocked in small ponds that are built inside the main ponds where they are fed a certain amount of industrial feed. Then, when the weight reaches 35,000 shrimp/kg, or after about 1 week, feeding is stopped and only food from nature is used. In the process of raising shrimp, farmers still can exploit other aquatic species from the wild. Typically, the value obtained from natural resources accounts for about 50% of the total income. When implementing this model, it is necessary to ensure that the mangrove forests cover an average of 30% of the total aquaculture area.

The improved extensive shrimp farming model associated with mangrove forests in Giao An Commune was assessed to “increase resilience to weather and CC” (87%); “improve life for local people” (72%) and “stabilize income of participating households” (71%) (Fig. 7.3). Compared with the traditional extensive shrimp farming model (without adding food during aquaculture), this model has higher productivity and economic efficiency. For the current intensive whiteleg shrimp

Table 7.4 Seasonal calendar in fisheries activities of households in Giao An Commune (according to the lunar calendar)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
I. Fisheries activities												
1. Capture fisheries	x	x	x	x	x	x	x	x	x	x	x	x
2. Extensive shrimp farming ^a	x	x	x	x	x	x	First harvest	x	Harvest all	Renovate pond	Renovate pond	Renovate pond
II. Natural disasters												
1. Typhoon, tropical depression						x	x	x	x	x		
2. Heavy rainfall						x	x	x	x			
3. Extreme hot weather					x	x	x					
4. Hoarfrost									x	x	x	
5. Extreme and damaging cold	x										x	x

^a Depending on the households, shrimp can be stocked once or several times

Table 7.5 Summary of impacts of natural disasters due to CC on the fisheries livelihoods of Giao An Commune

Types of natural disasters	Impacts on fishery
Extreme hot weather	- the temperature of water supply for aquaculture will increase, which causes aquatic species to die; - Worker’s health is affected (by heatstroke).
Heavy rainfall concentrated during the rainy season (inundation)	- dikes and embankments of aquaculture ponds are destroyed or degraded; - the water environment is changed; - productivity reduced; - production loss in aquaculture.
Extreme and damaging cold	The temperature of water supply for aquaculture is cold, which causes aquatic species to die.
Hoarfrost	- productivity reduced; - production loss in aquaculture.

Fig. 7.3 Effectiveness of implementing improved extensive shrimp farming model (%)

farming, the improved extensive shrimp farming has a higher ability to adapt to CC as well as being less harmful to the environment, despite the lower profit (Table 7.6).

d. Community-based mangrove management

Giao An Commune is a pilot locality for a community-based mangrove management model being funded by the Centre for Marinelife Conservation and Community Development (MCD). Up to now, there have been 27 individuals/households participating in this model with a total management area of 567.2 ha that was divided into 14 plots. The participants can harvest some aquatic species under the mangroves, such as mollusks and fish, but must not affect the ecological balance of the area. At the same time, they must strictly comply with regulations on environmental resources protection in the buffer zone of Xuan Thuy National Park, such as not cutting trees or causing forest fires; not changing the landscape; not polluting the environment, not exploiting, destroying, and depleting aquatic resources; not hunting, trapping or chasing other wild animals and birds.

Compared with similar models being implemented in other areas, the new feature of these models is that in Giao An Commune there are linkages for mutual development in production activities. The improved extensive shrimp farming households in Giao An have links with traders. The linkage method is as follows: households record their shrimp production before traders transfer all of those goods to Hanoi. After the calculations, traders will reimburse households (Fig. 7.4).

Table 7.6 Comparing improved extensive shrimp farming model and industrial shrimp farming model (intensive whiteleg shrimp farming)

	Improved extensive shrimp farming model	Industrial shrimp farming model (intensive whiteleg shrimp farming)
Input cost	Lower From 50–150 million VND/pond/year	Higher About 200 million VND/pond/year
Profit	Medium	Large
Payback period	Slow, unfocused	Quick, one time
Stocking density	Lower	Higher and thicker
Type of land used	Tidal mudflat with mangrove	Tidal mudflat without mangrove
Disease	Little, easy to handle	Many, difficult to handle
Food for shrimp	Most food is from nature	All feed is industrial
Water sources	Supplied by nature - tidal resources	Supplied by human
Waste sources	Little Does not affect the environment too much	Requires water treatment
Labor	Part-time	Full time
Adaptation to CC	Higher because of having mangroves	Lower
Long-term future	Sustainable and effective (poly-culture)	Unsustainable (mono-culture) After 2 or 3 crops, must be suspended to limit disease

a. A stocking pond inside improved extensive shrimp farming pond.

b. Mangrove trees in improved extensive shrimp farming area.

Fig. 7.4 Some pictures related to improved extensive shrimp farming in Giao An Commune

In capture fisheries, there is a self-governing team. The team was established in 2015 under the leadership of Mr. Pham Van Bong (head of the hamlet 18). As of 2019, 17 ships and boats were operating near the shore participating in this group, including some of the ships in Giao Thien Commune. Each month, the team holds a meeting. The purpose of the team is to support each other with production, and to perform rescues if the boats experience difficulties at sea. In addition, the team is

entrusted by the Border Guard to manage the mangrove forests. Every day, in addition to fishing, the team members will patrol the area to check for acts of harming the environment. From there, they notify the forest rangers, the local police, border posts, and local authorities to handle every situation. Moreover, the group also plays a role in loan clubs, with each member contributing two million VND/month. Borrowers must pay the initial amount plus the interest rate of 0.5%/month. This fund is mainly to support the team members if they need to repair ships or equip new fishing grounds.

Community-based mangrove management model not only “protects and restores mangrove forests” (82%); “restricts unsustainable exploitation of forest resources” (80%) but also “creates livelihoods for local people” (77%) and “stabilizes income for participants” (75%) (Fig. 7.5). According to the survey, the average income from this activity ranges from 200–300 thousand VND/day/person.

In addition to the positive effects, these models still have some problems related to human capital and social capital.

e. Human capital

The education level of the survey participants is low, with most people having attended secondary school being the largest group (73%) (Table 7.7). This is a major obstacle in improving the level of human capital and diversifying different types of livelihoods as well as applying science and technology to production.

Regarding training, 6% of the people were selected by the commune and were sent to training, conferences, or programs related to fisheries activities organized by the Commune Agricultural Production Steering Board/Giao Thuy Division of Agriculture and Rural Development/Department of Agriculture and Rural Development of Nam Dinh Province or Red Cross Association and Xuan Thuy National Park. The form of training was focused-training. In particular, more than half of the surveyed people wanted more knowledge, and to gain experience and learn techniques related to aquaculture.

f. Social capital

Although Giao An Commune has basic links to fishery production activities, there is not yet a close linkage or value chain in this sector. For example, in capture fisheries, only a small percentage of households participate in a Self-governing team (17 ships). Or households engaging in extensive shrimp farming have not been

Fig. 7.5 Effectiveness of implementing community-based mangrove management model (%)

Table 7.7 The educational level of survey respondents

Education level		Percentage (%)
Never been to school		2.0
Primary school	Have not completed	2.0
	Completed	4.0
Secondary school	Have not completed	55.0
	Completed	18.0
High school	Have not completed	5.0
	Completed	6.0
Primary vocational school		1.0
College	Secondary apprentice school	1.0
	College	2.0
University		3.0
Academy		1.0

Table 7.8 Surveyed participants assessed the roles of mangroves

Role	Valid percentage (%)	Role	Valid percentage (%)
Disaster prevention in cases of typhoons	87.4	Shelter for aquatic species	12.6
Stabilizing mudflats	51.7	Regulating air	9.2
Controlling rise of sea level and sea currents	17.2	Preventing soil erosion and regenerating soil	3.4
Protection of sea dykes	73.6	Limiting flooding	1.1
Protection of shrimp and clam ponds	44.8	Reducing environmental pollution, protecting the environment	10.3
Retaining sediment and creating mudflats	18.4	Developing ecotourism	3.4
Increasing income for fishermen	51.7		

proactive in setting prices because it is highly dependent on traders and market prices. Therefore, they also cannot avoid facing price squeezes.

7.3 Lessons Learned

Mangroves played an important role in the households of the Giao An Commune. In particular, the roles of “disaster prevention in cases of typhoons” (87.4%); “stabilizing mudflats” (51.7%); “increasing income for fishermen” (51.7%), and “protection of shrimp and clam ponds” (44.8%) all scored highly (Table 7.8).

Giao An has made effective use of mangrove forests to build livelihood development models which have improved extensive shrimp farming and community-based mangrove management. The new issue, compared to other localities, is the linkages

in production to promote livelihood development. These models not only bring economic value, but they also contribute to the resilience of the local people to CC as well as ensuring sustainable development in the region.

The models of fisheries livelihoods and how they can be used to adapt to CC associated with mangroves have generated positive results. To continue to develop livelihood activities as well as the models, the local authorities of Giao An Commune need to focus on two livelihood assets; human capital and social capital. For human capital: (1) Organizing training courses, short-term and long-term courses depending on the characteristics of the livelihoods to equip local people with the necessary knowledge and skills in production activities in the context of CC; (2) Organizing community events combined with contests related to CC. For social capital: Studying how to create more effective production groups, teams, and areas. For example, establishing an aquaculture farming group with the task of equipping necessary knowledge and skills in aquaculture through exchanging, sharing experiences as well as supporting and helping each other in areas of finance, mechanization, or equipment.

References

- Department of Natural resources and Environment of Nam Dinh Province (2019) Climate assessment report in Nam Dinh Province
- People's Committee of Giao An Commune (2017) Report on results of the implementation of new rural construction criteria for Giao An Commune, Giao Thuy District, Nam Dinh Province
- People's Committee of Giao An Commune (2019) Report on the implementation of socio-economic development and national defense tasks in the first six months and key tasks for the last 6 months of 2019

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