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# Climate Change Adaptation and Resiliency of Coastal Communities in the Red River Delta Biological Reserve, Vietnam

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This case study assessed the climate change adaptation and resiliency of coastal communities in Giao Thien and Giao Xuan in Giao Thuy District, Vietnam. Methods used include survey, key informant interview, and review of documents of which 194 households served as the sample size. A pretested interview schedule was used to gather data. Descriptive statistics was done to describe the data. Inferential statistics was employed in determining the relationship between climate change adaptation and resiliency. Result revealed that majority prepared materials to shield their houses, prepared food, and monitored weather bulletin. The communities received help from various organizations and have talent and skills to adjust to climate change. Majority observed that the ecosystem has worsened because of environmental pollution and lack of awareness in environmental protection. Communities perceived that the mangrove forests have the full ability to protect the environment. Coastal communities have limited knowledge on climate change adaptation. The most common plan in preparation for climate change is on house renovation. Infrastructure in the communities is not enough to cope with climate change. Natural resources have decreased because of mining, destructive fishing, and pollution which also contribute to climate change. The mangrove forest resources have the capability to combat climate change. The relationships among the climate change adaptation and resiliency variables have positive linear association, but all are found to have weak association.

**Keywords:** climate change adaptation, resiliency, knowledge

## INTRODUCTION

Vietnam is one of the most vulnerable countries to climate change impacts (Dasgupta et al., 2007). It has 28 provinces, which consist of numerous small fishing communities (Han, 2007). The provinces are bordered by the sea which makes it vulnerable to typhoons, tornados, and flooding (Dasgupta et al., 2007). Recent research reveals that, by 2050, sea level will rise up to 33 centimeters more and, by 2100, it will rise up to one meter. This scenario may lead to a reduction in the country's Gross Domestic Product (GDP) by about 10% (Dasgupta, 2007). This implies that the livelihood of the coastal communities will be highly affected by climate change. Thus, it is imperative to conduct an in-depth study in the Red River Delta, particularly on climate change adaptation and resiliency due to the environmental, economic, and social importance of the area.

Adaptation to climate change and resiliency are development issues that should be taken into account. Resiliency refers to the patterns of positive adaptation reflecting to the process of adaptation, capacity to adapt, or the outcome of successful adaptation despite the presence of challenging or threatening circumstances (Masten, Best, & Garmezy, 1990, as cited in Yates & Masten, 2004). On the other hand, climate change adaptation pertains to the ability of ecological, social, or economic systems to adjust to climate change including climate variability and extremes (Easterling et al., 2007).

According to OECD (2010), there is a need to identify how coastal communities adapt to climate change to determine the productivity and sustainability of the systems in place and for framework purposes. Lagos and Wirth (2009) indicated that many Least Developed Countries (LDCs) and small islands have a limited capacity to respond to the challenge of adaptation. In this regard, it is timely to document the resiliency of the coastal communities to adapt to climate change to serve as models for countries that have limited capacity to adapt to climate change.

One of the adaptation strategies to climate change is the strengthening of community capacity. In the context of climate change, community capacity is the ability of the communities to adapt to real and potential impacts. The common goal is to reduce the vulnerability of the community while increasing its resiliency to the effects of climate change. Communities can increase their resilience to the adverse impacts, as well as take advantage of opportunities that may result from climate change by preparing for the

future in a locally meaningful and policy-relevant way (Sharmalene, Mills, & Yantz, 2003).

Because of the vulnerability of the coastal communities to the effects of climate change, community development is highly needed. Community development, according to the Budapest Declaration (2004), is a way of strengthening civil society by prioritizing communities' actions and their perspectives in developing social, economic, and environmental policies. It seeks to empower the local communities, communities of interest or identity, and communities organizing specific themes or policy initiatives. It also strengthens the capacity of people as active citizens through their community groups, organizations, and networks. Even the institutions and agencies are being capacitated to work in dialogue with citizens to shape and determine changes in their communities. Thus, community development plays a vital role in supporting active democratic life by promoting the autonomous voice of disadvantaged and vulnerable communities.

In this light, it is worth knowing the resiliency of the coastal communities to adapt to climate change. This can serve as baseline information for the Vietnam government in conducting environmental planning, specifically in identifying appropriate projects/programs, formulating policies, and recommending strategies to make coastal communities resilient to climate change.

## **MATERIALS AND METHODS**

The study utilized a case study approach using various methods such as survey among households in coastal communities, key informant interview, and review of documents. The study was conducted in the biological reserve of Red River Delta, particularly in Giao Thuy District under Nam Dinh province located in the easternmost province of Nam Dinh adjacent to South and East China Sea.

Giao Thien and Giao Xuan communes in Giao Thuy District were chosen as study sites because they are the most adjacent to the sea and bear all the direct effects of climate change. Their sources of income are agriculture and fishing. It can be implied that these communities are the ones who will be highly affected by climate change.

The sample population was computed using Slovin's formula at 10% margin of error. Out of the 5,721 households, 194 households served as

the sample size. Simple random sampling was used in selecting household heads that would serve as respondents of the study. To ensure validity and reliability of the research instrument, it was pretested to households in other communes in the biological reserve. The information was categorized into preparation activities and preventive measures to adapt to climate change. Descriptive statistics such as frequency distribution, percentages, means, and standard deviations was done to describe the data. Inferential statistics was employed in determining the relationship between climate change adaptation and resiliency of coastal communities.

## RESULTS AND DISCUSSION

### Climate Change Adaptation

**Knowledge on climate change adaptation.** By studying the effects of both inherent and gained knowledge of the people in a community and relating it to the ability of a community to adapt to climate change, results revealed that majority (63.4%) of the respondents considered themselves knowledgeable on how to adjust to climate change. They acquired information through trainings and workshops (61.8%); media (19.5%) such as television, radio, and newspaper; and self-learning and diffusion of folk experience (14.6%). The knowledge obtained from trainings/workshops included methods and techniques on how to cultivate plants, raise livestock with strong resistance against diseases, and ways to treat the diseases (27.6%). Information gathered also included raising awareness on environmental protection through the use of organic matter and planting more trees (26.3%). Knowledge can be heightened by sharing and exchanging information on adopted adaptation strategies. The “Sister-Commune” relationships could be established to enable the commune to exchange information to strengthen local adaptation practices such as those found in Ky Ninh and Vinh Hien communes (MONRE & UNDP, 2009).

**Adaptation planning.** Adaptation planning involves responding to the impacts of climate change, both proactively and reactively. It includes preventive measures to slow down the progression of climate change and also mitigation measures to reduce its effects. It is not a domain of a specific department or agency but requires cooperation and interrelationship among concerned institutions. The commendation of climate change adaptation

plan will find its way into other communities' planning documents such as emergency measures plan, energy strategy, transportation plan, strategic plan, community land use plan, economic development strategy, public work plan, and other significant community planning endeavors (Bowron & Garry, 2011).

Because of their high level of awareness on climate change, majority (84%) of the respondents had personal plans on how to adapt to climate change. The plans of the respondents vary; however, most (20.2%) of them plan to acquire equipment for mobilization and build solid and firm infrastructures and/or facilities. Relevant to this is the study on vulnerability of households by Shen et al. (2011) which revealed that it is necessary to build houses that are strong enough to withstand typhoons. Policies of Vietnam government focused on the assessments of all sectors and on hard adaptation measures such as building of sea dikes, reinforced infrastructure, and durable buildings (World Bank, 2010).

Among the 194 respondents, only 155 have plans to coordinate with various agencies in preparing for disaster-related incident due to climate change. Most of the respondents also plan to coordinate with Women's Union and Youth Union (22.7%) and with different organizations and local government for storm prevention (20.6%). Meanwhile, other respondents have no plans at all regarding this matter (20.1%).

**Preparedness.** In a case study conducted by Predo (2010) in Ormoc and Cabalian, Philippines, natural disasters affected the households' welfare and the natural resources where they obtain their livelihood. This implies that it is important to identify the impacts of climate change on the livelihood of the households particularly those who belong to the low socioeconomic status.

In the study site, majority (73.2%) of the respondents have no plans of learning alternative livelihood aside from the one which they are currently engaged in. Only 26.8% have plans on preparing for climate change. Opening a small-scale business was the most cited answer (11.3%) while other respondents will still look for other sources of livelihood (10.3%).

Aside from having alternative sources of income, most of the respondents had plans to build infrastructures that can withstand the effects of climate change such as stronger typhoons. Majority have plans to use steel to reinforce their houses (42.3%), solidify and repair their respective houses (27.8%), and build two-storey houses that cannot be reached by flood (10.3%).

The respondents had also experienced typhoons for several times. The activity of the majority (62.4%) prior to the occurrence of typhoon included preparing materials such as bamboo, wooden pillars, and sandbags that can be used to shield their houses while others built concrete houses (12.4%). In the study of Predo (2010), the most cited adaptation strategies by most households include the transfer to evacuation area temporarily, restructuring of housing unit, and permanently moving to a safe place. Many (75.7%) of them also cited that they prepare food, particularly rice, dried fish, noodles, and water in anticipation of the possible effects of a strong typhoon. The data obtained show that the highest priority of the respondents during a typhoon is to ensure that there will be available food since they are not certain of how long a typhoon will last and a flood will subside. By reserving food at home, they are assured that they will not get hungry even if they cannot go out of their respective houses to purchase food. There are also some (11.9%) who store water in containers and place it in a high area in the house.

There are also respondents (19.6%) who prepare batteries, kerosene, and candle whenever they learn that a typhoon is coming. Thirty-seven respondents (19.1%) prepare batteries for lighting and listening to radio for news.

In a study conducted by Peñalba et al. (2008), households generally prepare alternative lighting materials and cooking fuel at the onset of the rainy season because power loss is common during that time. The common adaptation strategies done by households include preparing candles, lamps with rechargeable batteries, and kerosene lamps as well as charcoal-fueled stove. This adaptation strategy is further emphasized by the Buenos Aires program on the need for preventive measures, planning, preparedness, and management of disasters relating to climate change, as well as for contingency planning, particularly for droughts and floods and extreme weather events (UNFCCC, 2005).

**Community practices.** Whenever a storm threatens to hit the study sites, a number of respondents (24.7%) evacuate the elderly and children first and then collaborate with concerned organizations for assistance. Another 16.5% cited that, before the typhoon, they prepare necessary materials, solidify sea dikes, and mobilize people and organizations involved in typhoon responses. Few (12.9%) pertain to the activities of the Board of Administration such as meetings, information dissemination to all villages, preparation of foods, and evacuation of people. In Vietnam, the goal of the

natural disaster risk management is to enhance the resilience concerning the impacts brought by natural hazards. The recent economic and human toll of natural disaster events in Vietnam served as an avenue to prioritize investment on this aspect when factoring in climate change (UNDP, 2010).

In the study of Peñalba (2008), households employed temporary adaptive measures such as placing their appliances and furniture on the second floor of their houses or on stilts when anticipating the occurrence of flood.

In a related study conducted by Shen et al. (2011) in Zhejiang province of China, 52% of the households move to a safer place whenever a typhoon will come. On the other hand, 28% evacuate as recommended by their government. Majority of the respondents (67%) of the households find these measures as effective.

Also, in the same study, 77 % of the households purchased and stored food, drinking water, and other basic necessities. Most of the households opted to resort to this practice since it was a common practice in the community. On the other hand, 9% adhered to the habit because it was a routine taught by their ancestors or elders. Majority (70%) of the households found this option as effective.

**Information needs.** Among the 194 respondents, most of them answered the need to collect information concerning flood and typhoon (30.9%) and monitor weather information through television (13.4%). Based on the study conducted by Ligasan (2011), information and technology are used during disasters. Broadcast media such as radio and television ranked second and bulletin information ranked third as sources of information on the adverse effects of disasters. Data showed that the respondents are concerned with the occurrence of flood and drought which can affect their primary source of income which is agricultural production.

To get information about typhoon, most of the respondents monitor the weather through the daily weather bulletin (50.5%), listen to the FM radio for daily typhoon updates (18%), and get information on typhoon via radio and TV and from commune officers (17.5%). In the locality of the Red River Delta, most communes have loudspeakers. This radio system managed by the commune People's Committee emphasizes the role of information and communication on the social and cultural as well as local production activities such as weather information, seasonal calendar, plant pest information, and others.

## Coastal Communities' Resilience to Climate Change

**Social capital.** Schneider (2002) pertains to social capital as social relationships and patterns of trust, which enable people to gain social networks. It is good to note that almost all of the respondents (94.3%) join meetings/consultation with the local government. The level of participation was high since majority (66.1%) attended the meetings very often. Their participation ensures that the people are informed, that discussions are being done, and that the activities of the Government of Vietnam are being monitored relative to democracy.

Majority of the respondents (70.1%) received help from the local government and other organizations. This reflects a positive situation for most of the respondents since only 29.9% revealed that they have not received any help at all. The kinds of help extended include food (46.4%), agricultural training (30.9%), cash aid (16.5%), and health security (10.8%). This only implies that a strong social network may allow greater access to resources and reduce the psychological stress caused by climatic disturbances, hence, may strengthen adaptive capacity (Ospena & Heeks, 2010). In terms of networks, almost all the respondents (95.4%) are members of organization/s. Among the 185 respondents, 63.9% of them are members of a farmers' association. With regard to the nature of their respective organizations, most of them (29.8%) help each other by providing technical support and inputs in agricultural production.

Building and maintaining resilience requires different actors with complementary capacities and skills. Through partnerships and drawing on diverse networks, communities, civil society, academic research institution, government, and the private sector can strengthen the ability of vulnerable populations to improve people's well-being and capacity to adapt to change (Frankenberger et al., 2012).

Many of the respondents (70.6%) also received help from other various organizations. Among the 137 respondents who answered yes, most (19.7%) of them cited that they received assistance in the form of disaster prevention, fortification of house structure, and helping in evacuating and evading the strong typhoon. Few (18.2%) received assistance in mangrove reforestation and environmental protection.

It is evident in this study that social capital can ameliorate resiliency. Ritchie and Gil (2010) also stressed that social capital enhances



a community's ability to work toward collective goals, which is necessary for disaster recovery. It contributes to resilient recovery by enhancing sense of belonging and by strengthening bonds between individuals and groups. Bridging social capital affords connections needed to solicit and leverage external support. Social capital also facilitates access to other forms of capital essential to recovery such as human, financial, political, and cultural capital. However, World Bank reported (2010) that the Vietnam government does not give much attention to soft adaptation measures such as social capital and the role of collective action in building resilience.

**Economic capital.** Data gathered through the survey revealed that majority (71.6%) experienced an increase in their annual income since 2005. For some (17.5%), there was no change in the level of income. Vietnamese farmers in general and the farmers in the Red River Delta prioritize rice production to ensure consumer demand and the sustainability of food for the family. Although they are living in coastal areas, their main income-generating activity was rice production even if other activities (i.e., aquaculture, fishing) could bring higher income than agricultural production.

Agriculture will be highly affected by climate change. Thus, the respondents should imitate the farmers in Trieu Van commune by applying different drought-tolerant crop varieties and local breeds; applying integrated production model, intercropping bean and sweet potato, rotational cultivation, and diversifying crops; adjusting seasonal calendar; and applying soil management measures and adjusting farm inputs including fertilizers and pesticides as adaptation measures (Phuong, 2011). It is good to note that most of the respondents (53.6%) have savings which could be accessed in time of disasters. These savings were kept in homes (34.6%), the Mutual Loan Club (31.7%), and the bank/commune fund or in the form of gold reserves (25.0%).

The Mutual Loan Club ("Hui") is a convenient scheme for raising capital and saving money. In the past, when the Vietnamese banking system was still new and underdeveloped, the Mutual Loan Club was popular among the common people. Even after the development of banking, where the banks usually had many loan requirements and borrowing procedures were difficult, the Vietnamese people specifically the farmers continued to patronize the Mutual Loan Club. Other businessmen and wage-earners also subscribed to the Mutual Loan Club.

From the capital-raising mechanism of the Mutual Loan Club, many

people had new business ventures while others were able to address their financial problems immediately. Thus, the Vietnam government agreed to the existence of this scheme which later became Civil Code 2006.

In a study conducted by the Intergovernmental Panel on Climate Change (2011) regarding the social impacts of storm, results revealed that taking odd jobs, consumption reduction, and acquiring multiple loans are the commonly adopted coping strategies. The findings of the IPC corroborate with this study particularly in borrowing money through loans in case their respective houses would be affected by disasters.

**Human capital.** Human capital is one of the factors affecting the resiliency of a community to adapt to climate change. It could be further dissected into health of the people, skills, and knowledge that the people in a community have. This is consistent with the sectors and variables used in the Vulnerability-Resilience Indicators Model (VRIM) (Brenkert & Malone, 2005).

In the study sites, it is good to note that many (62.4%) of the respondents are healthy. This is because the overall health quality in Vietnam is regarded as good based on the 77 years life expectancy estimates done in 2010 (Huong et al., 2007).

In terms of skills that enabled the respondents to adapt to climate change, 44.8% of the respondents referred to swimming skills as the most important skill that can help them adapt to climate change. Other skills include the ability to make weather observations to predict storm as cited by 19.6% of the respondents. Of this, 71.1% stated that the skills have been taught by their folks.

In terms of having access to information, findings showed that almost all of the respondents (91.2%) had access to information pertaining to climate change adaptation strategies. The information came from television (82.5%), national radio stations (43.8%), and local radio stations (25.3%). The main information gathered from television and national radio stations was the weather forecasts while local radio stations feature storm preparation awareness.

For trainings as source of information, majority of the respondents (61.3%) did not have any training associated to climate change. Only 38.7% had the opportunity to attend trainings; hence, they are relatively knowledgeable on climate change.

With regard to livelihood training for the respondents in the study

sites, only few have attended such training. Among the 194 respondents, 2.6% had no opportunity to attend the training while 97.4% were able to attend trainings on straw mushroom planting, knitting, and bee keeping conducted in 2008 by the Women's Association.

**Physical capital.** Results of the survey revealed that many (70.1%) of the respondents have concrete houses and 22.2% have houses made of concrete materials and wood. For the house type, most (50.5%) of the respondents' houses are tiled; 42.3% are one-storey while 7.2% are two-storey.

Facilities are also available in the study sites. Majority (66.5%) of the respondents answered that there were available facilities where people could evacuate in the event of disasters caused by climate change. The kinds of facilities include school of communes (89), Office of the People's Committees of Commune (63), and church (52). Others cited the presence of high buildings, used trucks, temple, and Office of the Bank of Commune. With this, majority (70.6%) believed that there are enough facilities to accommodate the affected households.

**Natural capital.** Most of the residential lands of the respondents (20.1%) ranged from 1.6–2.0 sao. Most of the gardens (30.4%) ranged from 0.6–1.0 sao while 17% measured 0.1–0.5 sao. A small percentage of the respondents (14.9%) do not have a home garden at all.

The lack of gardens and ponds was because of the limited land area of the households. Majority (52.1%) do not have ponds; only two (1%) have about 6.0 sao pond. In scrutinizing the land area used for agriculture, most (25.8%) used 4.1–5.0 sao, 17% respondents cited 2.1–3.0 sao, and 15.5% adhered to 3.1–4.0 sao. Results of key informant interview revealed that a vast number of people did not experience changes in the use of agricultural lands since 2005.

Furthermore, most of the respondents agreed that there were many available coastal resources in their area. All respondents mentioned the presence of mangroves. Literature shows that, in the context of climate change, mangroves have played a vital role in preventing coastal erosion and in protecting inland areas (Chi et al., 2015). Other resources included seafood and fishes as indicated by 145 respondents (71.6%) and sea grasses (62.4%). Other coastal resources include corals, clams, crabs, and prawns. Valuing natural assets such as fisheries, coastal wetlands, and terrestrial forests and integrating these values into economic decision-making can strengthen resilience (World Bank, 2011).

A close examination of the water resources reveals that almost half of the respondents believed that there was an abundant supply (43.85%). There are only 18% who observed a decrease in the amount of water resources provided for domestic use. Meanwhile, there are also some (38.1%) who claim that the supply remained unchanged.

Ritchie and Gil (2010) indicated that natural capital is vital to human survival and fundamental to society. In the aftermath of a disaster, natural capital represents basic necessities that support human life, ranging from uncontaminated air to potable water to renewable resources. A community's relationship with its natural environment also influences ways in which it responds to disaster-related environmental degradation.

**Relationship Between Resilience to Climate Change and Capacity to Adapt**

Findings revealed that the coastal communities have high knowledge on climate change adaptation based on the obtained mean of 8.47. However, the obtained value on standard deviation is 1.686 only, which implies low deviation. The knowledge of the communities pertains to occurrence of more storms, floods, sea level rise, and drought which they derived from television programs.

**Table 1.** Summary score for climate change adaptation.

| PARTICULARS |                    | CLIMATE CHANGE ADAPTATION |          |              |
|-------------|--------------------|---------------------------|----------|--------------|
|             |                    | Knowledge (K)             | Plan (P) | Practice (P) |
| Giao Xuan   | Mean               | 8.40                      | 8.61     | 4.03         |
|             | Standard deviation | 1.753                     | 1.418    | 1.112        |
| Giao Thien  | Mean               | 8.55                      | 8.62     | 4.35         |
|             | Standard deviation | 1.620                     | 1.220    | 0.646        |
| Total       | Mean               | 8.47                      | 8.61     | 4.19         |
|             | Standard deviation | 1.686                     | 1.319    | 0.922        |

Meanwhile, the plan of coastal communities in terms of climate change adaptation has an obtained mean of 8.61, which is attributed to their knowledge. The standard deviation on planning, which is 1.319, implies low deviation.

With regard to applying what they know about climate change, the mean is low which is 4.19, but the standard deviation is high (0.922). The obtained mean implies that, generally, the coastal communities are not practicing what they are learning about climate change. Also, there is commonality in terms of practices of the coastal communities based on the obtained standard deviation.

**Table 2.** Summary score for resilience.

| PARTICULARS |                    | RESILIENCE          |                       |                    |                       |                      |
|-------------|--------------------|---------------------|-----------------------|--------------------|-----------------------|----------------------|
|             |                    | Social Capital (SC) | Economic Capital (EC) | Human Capital (HC) | Physical Capital (PC) | Natural Capital (NC) |
| Giao        | Mean               | 4.60                | 3.29                  | 3.69               | 1.81                  | 2.17                 |
| Xuan        | Standard deviation | 0.954               | 1.282                 | 1.211              | 1.285                 | 0.8293               |
| Giao        | Mean               | 4.46                | 3.02                  | 3.58               | 1.74                  | 1.88                 |
| Thien       | Standard deviation | 1.031               | 1.683                 | 1.306              | 1.129                 | 0.819                |
| Total       | Mean               | 4.53                | 3.15                  | 3.63               | 1.78                  | 2.02                 |
|             | Standard deviation | 0.993               | 1.498                 | 1.257              | 1.208                 | 0.836                |

On the sources of capital, the coastal communities have low social, economic, human, physical, and natural capital based on the obtained mean for each source of capital. Findings also revealed that, among the five capitals, social capital had the highest mean (4.53). As reflected in the table of statistical analysis, there was only a very slight difference on the mean of Giao Xuan (4.60) and Giao Thien (4.46). On the other hand, physical capital obtained the lowest mean (1.78).

The physical capital refers to the presence of dikes, evacuation center, and the structure of houses in the communities. Majority of the respondents have one-storey houses only; hence, it is their utmost desire to build two-storey houses to protect their belongings and their lives. In the case of the study conducted in Iloilo City, Philippines, the physical dimension likewise obtaining low score pertained to water supply, early warning, and evacuation system which may threaten the enhancement of resilience of communities. Similar result was obtained in Danang City wherein the physical dimension of resilience is threatened by the fragile warning systems (Shaw et al., 2009).

Based on the respondents' perception, there is a need to build more infrastructures particularly dikes to protect the coastal communities from

the adverse effects of climate change. The existing dikes according to the respondents are no longer adequate and do not ensure safety of the coastal communities particularly when there is a strong typhoon which may lead to sea level rise.

There is also a perceived need to build evacuation centers because using schools as evacuation centers affects the students because of the noise of the evacuees. Hence, it is deemed necessary for the government to build structures that will serve as evacuation centers when disasters due to climate change happen.

The social capital which obtained the highest mean refers to the linkages to various institutions and membership of the respondents to the different organizations. Almost all of the respondents, aside from being members of the Farmer's Organization, are also members of other organizations depending on their interest.

Among the five capitals, economic capital showed low deviation based on the value obtained which is 1.498. The deviation is lower in Giao Thien (1.683) compared with that in Giao Xuan (1.282). Likewise, low values were obtained in Iloilo City, Philippines wherein the economic capital referring to budget and subsidy and savings and insurance signified the fragility of this capital (Shaw et al., 2009).

Natural capital obtained high deviation at 0.836. There is only a very slight difference on the obtained standard deviation from the two sites. One of the natural capitals being referred to is the presence of mangrove forest, which helps mitigate climate change and avoid its adverse effects. With the almost similar value obtained on standard deviation, this implies that both sites are fully aware on the value of the mangrove forests. Mangroves are known for protecting coasts during storm and tsunami events through frictional reduction of wave energy and by promoting sedimentary resilience to erosion through the root mat (Hirashi, 2008; Dahdouh-Guebas et al., 2005).

The communities have limited savings, and their livelihood was regularly affected whenever there is typhoon because majority of them are into agricultural production. Since their livelihood is affected during typhoon, sources of income are disrupted. They opt to use their savings to buy their basic necessities. However, their savings are limited. This means that there is no guarantee that the savings will be enough depending on how long a typhoon will last. Experience in other countries showed that the

ability to cope with increasing climatic hazards relies mostly on the ability to diversify income sources. Hence, access to credit, insurance, and other financial services including noncash loans is highly imperative. Building financial incentive systems into loans can lead to reduction in environmental impacts (MONRE & UNDP, 2009).

**Table 3.** Relationship between climate change adaptation and resilience.

| RESILIENCE       | CLIMATE CHANGE ADAPTATION |        |       |            |        |        |        |       |         |
|------------------|---------------------------|--------|-------|------------|--------|--------|--------|-------|---------|
|                  | Giao Xuan                 |        |       | Giao Thien |        |        | Total  |       |         |
|                  | K                         | P      | P     | K          | P      | P      | K      | P     | P       |
| Social Capital   | .127                      | .316** | .097  | -.133      | .213** | -.322* | -.006  | .260* | -.162** |
| Economic Capital | -.100                     | .024   | -.055 | -.024      | -.035  | .183   | -.068  | -.004 | .057    |
| Human Capital    | .140                      | .172   | .190  | .103       | .244** | .100   | .119   | .208* | .119    |
| Physical Capital | -.200                     | .170   | .039  | .072       | .103   | -.047  | -.231* | .131  | -.022   |
| Natural Capital  | .326**                    | .025   | -.153 | -.042      | .148   | -.119  | .124   | .089  | -.154** |

**Note:**

\*\* significant at 0.05 level

\* significant at 0.01 level

**Legend:**

K — Knowledge

P/A — Plans

P — Practice

Table 3 shows the relationship between climate change adaptation and resilience. Results revealed that a correlation exists between social capital and planning of households at Giao Xuan commune ( $r = .316$ ) at  $p = 0.05$  level of significance. On the other hand, at Giao Thien commune, results showed that a correlation exists between social capital and planning of household ( $r = .213$ ) at  $p = 0.05$  level of significance. However, even though there is a positive relationship between the two variables, the relationship is weak, which indicates that social capital is based on the planning on climate change adaptation of the households. For Giao Thien commune, the result of the correlation between social capital and practice ( $r = .322$ ) at the  $p = 0.01$  level of significance is weak, but it shows that the people in Giao Thien are practicing the knowledge that they derive about climate change adaptation.

In general, there is a positive but weak linear association on social ( $r = 0.260$ ) and planning based on the obtained values at  $p = 0.01$  level of significance. Otherwise, result of the correlation between social capital and practice of household ( $r = -0.162$ ) at  $p = 0.05$  level of significance is found to

be weak, but this shows that social capital of the community was anchored on the proper planning and practice of knowledge on climate change adaptation. The climate change adaptation practices of the coastal communities were based on their obtained knowledge and acquired skills. Their practices also came from their membership to organizations, linkages with various institutions, and passing of traditional knowledge from grandparents and based on experiences.

Result of the correlation between human capital and planning of household at Giao Thien commune is found to be weak ( $r = .244$ ) at  $p = 0.05$  level of significance. Even the relationship is found to be weak. It is also entirely consistent with the results of the survey which showed that people have a positive attitude. This reflects the application of knowledge and skills in their plans to adapt to climate change in Giao Thien. Overall, the result of the study indicates the correlation between human capital and planning ( $r = .208$ ) at  $p = 0.01$  level of significance. This indicates that there is a linear relationship between human capital and planning of household in adapting to climate change. The human capital refers to the knowledge and skills of the respondents. The weak association between human capital and practice is attributed to the limited knowledge and skills of the coastal communities on climate change adaptation.

Result of the correlation revealed that there is a positive linear association on physical capital and knowledge ( $-0.231$ ) at  $0.01$  level of significance. However, even if there is a positive relationship between the two variables, the relationship is found to be weak. This implies that the coastal communities are aware of the importance of building infrastructures particularly raising the dikes considering that they live near the coastline which makes them more vulnerable to sea level rise because of climate change.

Findings revealed that social and natural capital and practice on climate change adaptation also have positive linear association based on the obtained value at  $p = 0.05$  level of significance. The practices of the coastal communities on how to adapt to climate change are based on their networks and membership and norms of reciprocity. For natural capital, the coastal communities are aware on the importance of mangrove forest in mitigating the effects of climate change; hence, they protect and conserve it and join mangrove planting activities.

The statistical analysis apparently shows that there is no relationship



between economic capital and knowledge and plans and practice of climate change adaptation. This indicates that the economy of the household does not currently meet sustainability even when natural disasters occur.

## CONCLUSIONS

Coastal communities have limited knowledge on climate change adaptation. Their knowledge basically comes from television programs and limited trainings. Climate change will have a significant impact on agricultural production because of frequent storms, sea level rise, salt water intrusion, and floods. To prepare for climate change, the most common plan of the households focused on house renovation which is not enough. It is also imperative and very important to have a sustainable means of livelihood.

The communities have limited capacities to adapt to climate change because of limited knowledge, skills, trainings, meager income, and few investments. Their traditional knowledge is limited to determining the occurrence of storm. Infrastructure in the communities is also not enough to cope with climate change. Natural resources have decreased because of mining, destructive fishing, and pollution, which can further aggravates climate change. The mangrove forest resources have the capability to combat climate change, avoid saltwater intrusion, and limit the damage caused by natural disasters.

The relationship among the variables on climate change adaptation and resiliency has positive linear association, but all are found to have weak association. This implies that climate change adaptation is not highly related with the social, natural, physical, economic, and human capitals.

## RECOMMENDATIONS

Coastal communities should be united to mitigate the effects of climate change through solid waste management, planting and protection of mangroves, and prohibition of destructive fishing activities.

It is imperative to promote a close link among the farmers, scientists, enterprises, and the government to create favorable conditions through research results endorsing new plant varieties and animal breeds that are resistant to climate change. Consequently, this will lead to sustainable livelihood; hence, it will result in resiliency among the respondents to the effects of climate change.

The government should invest in putting up early warning system in coastal communities to protect properties and human life. Budget allocation for infrastructure facilities like evacuation centers during typhoon and flood should also be prioritized. Food and clean water must be provided to the evacuees in these centers. To ensure health and safety, infrastructure for the water system should be available in the community. Decentralization in the management of mangrove resources and ecosystems is also needed to define the distinct functions of Xuan Thuy National Park and local authorities. This will prevent the overlap in the policies on conservation and management of the environment.

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