Assessment of Climate Impacts, Vulnerability, and Adaptation Strategies in the Coastal Areas of San Juan, Batangas, Philippines

Shaneil Ramos-Dipasupil, Imelda Delos Reyes, and Frank Ilustrado

Published by WorldFish (ICLARM)– Economy and Environment Program for Southeast Asia (EEPSEA)
EEPSEA Philippines Office, SEARCA bldg., College, Los Baños, Laguna 4031 Philippines
Tel: +63 49 536 2290 loc. 4107; Fax: +63 49 501 3953; Email: admin@eepsea.net

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ISBN: 978-621-8041-32-5

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Suggested Citation: Ramos-Dipasupil, R.; I. Delos Reyes; and F. Ilustrado. 2017. Assessment of Climate Impacts, Vulnerability, and Adaptation Strategies in the Coastal Areas of San Juan, Batangas, Philippines. EEPSEA Research Report No. 2017-RR2. Economy and Environment Program for Southeast Asia, Laguna, Philippines.

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Shaneil Ramos-Dipasupil
Imelda Delos Reyes
Frank Ilustrado

January, 2017

Comments should be sent to: Dr. Shaneil Ramos-Dipasupil
#46, Hanseo 1-ro, Haemi-myeon, Seosan-si, Chungcheongnam-do, South Korea
Phone: +82 41-660-1144
Email: s_dipasupil@yahoo.com

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EEPSEA is supported by the International Development Research Centre (LDRC); the Swedish International Development Cooperation Agency (Sida); and the Canadian International Development Agency (CIDA).

EEPSEA publications are also available online at http://www.eepsea.net.

ACKNOWLEDGMENTS

The authors wish to acknowledge the following individuals and institutions that made valuable contributions to this research project:

The Economy and Environment Program for Southeast Asia (EEPSEA) for the encouragement and support that they have been providing to young researchers through the years;

EEPSEA Director, Dr. Herminia Francisco for her support and guidance during the course of this research;

EEPSEA resource persons, Dr. David James and Dr. Nancy Olewiler, for their invaluable comments and suggestions;

The World Fish Country Program Manager-Philippines, Dr. Maripaz L. Perez, for her inspiration and guidance all throughout the conduct of this study;

Dr. Hernando B. Perez, President of University of Batangas, for his trust and confidence in our capabilities;

Dr. Florencio V. Reyes and Atty. Jesus Victor V. Mayo, for their encouragement and support;

The local government of San Juan, Batangas headed by its mayor, Hon. Rodolfo H. Manalo; the members of the Municipal Council, particularly Mrs. Tess Ilustrado, Mrs. Fe Acompanado; the staff of Municipal Agriculture Office; and officers and staff of the planning division, engineering division, and health office for providing valuable data necessary for the completion of this study;

Hon. Captain Eulogio A. Japlit of Brgy. Catmon as well as Honorable Captain Fernando A. Sulit of Brgy. Hugom, for the kind assistance and warm hospitality extended to us during the conduct of this study;

Dr. Asa Sajise, Mr. Paul Joseph Ramirez, Ms. Kim Bayani and Ms. Glaiza Zamora, for all the assistance and expertise shared for the completion of this study;

Mr. Robert S. Dipasupil, for his great assistance during the focus group discussions and for the insights in the economic analysis;

The faculty and staff of Waldorf School International of University of Batangas as well as of the College of Business and Accountancy for their support and encouragement;

The staff of the Student Affairs and External Program of the University of Batangas for their support;

The friendly people of San Juan, Batangas for the very warm accommodation and for the time and patience extended to us during the survey;

And to all others who made this study possible.

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ASSESSMENT OF CLIMATE IMPACTS, VULNERABILITY, AND ADAPTATION STRATEGIES IN SELECTED COASTAL AREAS IN SAN JUAN, BATANGAS, PHILIPPINES

Shaneil Ramos-Dipasupil, Imelda Delos Reyes, Frank Ilustrado

EXECUTIVE SUMMARY

People living in coastal areas are considered one of the most vulnerable groups to the impacts of climate change. About 60% of the Philippine population lives along the coasts and primarily depend on marine-based resources; thus, it is highly necessary to identify possible adaptation options that would save them from the hazards of a changing climate such as coastal erosion, flooding, and typhoon. This research aimed to identify the impacts of climate change, assess the vulnerability of the residents of the chosen coastal sites, and analyze the economic values of their adaptation strategies. Primary data collected through surveys, key informant interviews, and focus group discussions as well as secondary data were used in the study. A total of 300 respondents were interviewed in the municipality of San Juan, Batangas province, Philippines.

Coastal erosion, flooding, and typhoon events have wreaked havoc to the coastal areas of San Juan. Historical data and anecdotal reports showed that the most severe occurrence of typhoon and flooding have caused an estimated damages to livelihood, health, and other assets amounting to PHP 800,000, while the aggregated damage cost caused by coastal erosion was about PHP 400,000. The respondents likewise highlighted the significant decrease in their catch per unit of effort from 40–50 kg 20 years ago to only 4–5 kg in 2011. Apart from physical damages, these hazards also brought emotional and financial stress to the local residents. Coastal erosion has dislocated several families and forced them to migrate inland.

The cost-effectiveness analysis showed that among the planned adaptation options, mangrove reforestation would prevent coastal erosion at the least possible cost. On the other hand, in order to meet the objective of saving households from the effects of typhoon and flooding, the combined option of setting up an integrated drainage and flood control system as well as diversifying the livelihood options of the residents proved to be more cost effective than the other adaptation options.

The most preferred autonomous adaptation of the respondents during and immediately after flooding and typhoon event is to improve or modify their houses to make them more resilient to typhoons. Those against coastal erosion prefer preparing for evacuation.
The respondents preferred relocating permanently should efforts to improve their houses against the adverse impacts of climate change prove to be futile.

Local government officials assert their knowledge of the impacts of climate change, and accordingly formulate policies and programs to cope up with its effects. However, it was found out that they find such policies and programs to be difficult to implement due to inadequate financial resources and lack of cooperation from community residents (which emanate from their lack of understanding of climate change and its adverse impacts). Also, local officials find environment-related programs difficult to monitor and implement consistently.

1.0 INTRODUCTION AND RATIONALE

The Philippines is an archipelago located in the Indo-China of the Western Pacific with a land area of more than 300,000 km^2. It consists of 7,107 islands and comprises over 17,000 km of coastline. The Philippines is both geographically and meteorologically one of the world's natural hazard "hot spots" where tropical cyclones, storm surges, floods, and droughts are already part of the country's history and culture.

Today, climate change is the global challenge of our time. Although the Philippines is at the low-end of the greenhouse gas emitters of the world, it still remains one of the most vulnerable to the impacts of climate change. Thus, climate change adaptation (CCA) is the most feasible thing to do in the face of this challenge. However, each adaptation option needs to be evaluated for its appropriateness, particularly for its economic viability and sociopolitical soundness. Since there is no "one cure for all," each CCA options need to be studied in order to encourage maximum engagement among the community stakeholders at all levels. Each CCA strategy must be tailored to fit the uniqueness of the community that will implement it. Accordingly, using local knowledge is a good starting point when proposing CCA strategies.

The municipality of San Juan, Batangas is known for its beautiful and diverse natural landscape. It is a coastal town with 42 *barangays* (villages) with a total land area of 27,340 ha and a population of 91,344 individuals (San Juan Municipal Government 2010). Nearly 70% of this population is engaged in agriculture while 14% is into fishing and tourism.

San Juan has a 33-kilometer coastline that includes 16 coastal barangays, all of which rely on fishing as a major source of livelihood. In recent years, the white, sandy beaches and intact marine environment in San Juan have been attracting both local and foreign tourists. It is an ideal place to observe marine ecosystem as there are beaches, mangrove, sea grasses, and coral reefs. San Juan is also a part of the recently declared "Center of the Center" of marine-shore fish biodiversity, the Verde Island Passage. It has approximately 496 ha of thick mangrove forests that act as an effective buffer against storm surges. These are the primary reasons why efforts to sustain and protect the marine resources of San Juan are close at hand.

1.1 Local Setting

San Juan is a 1st class municipality in the province of Batangas, Philippines. It is situated at the southern tip of Batangas along the Batangas-Quezon boundary. It is approximately 43 km east of Batangas City (provincial capital), about the same distance southwest of Lucena City (capital of Quezon province), and about 120 km south of Metro Manila (national capital). North of San Juan is the neighboring town of Candelaria in Quezon province, with Malaking Ilog (Big River) defining its geographical boundary. Tayabas Bay lies east, and the hills lie on the western portion that separates San Juan from the towns of Lobo and Rosario of the same province. Directly south is the Verde Island passage, a sea lane for interisland vessels plying the Batangas-Marinduque route (Figure 1).

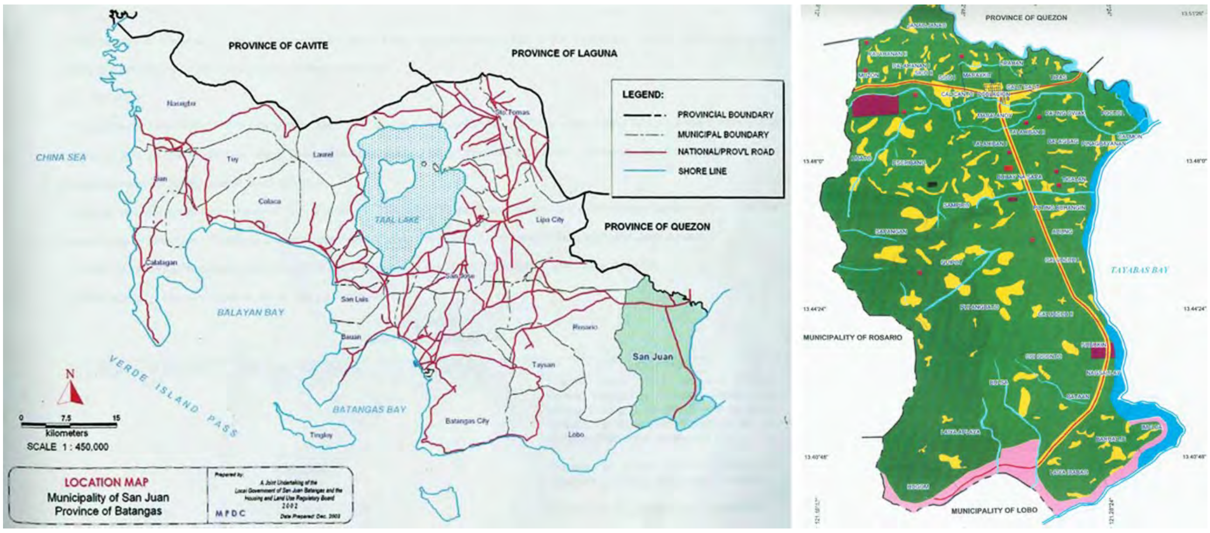

Figure 1. Map of San Juan, Batangas

The topography of the municipality varies from low flatlands on the eastern portion (specifically along Tayabas Bay), slightly rolling on the midsection, to highlands on the western side bordering along the Rosario and Lobo municipal boundaries. On the east lay the shores of Tayabas Bay where the shorelines are laced with swamps and marshlands. These shorelines are located in Barangays (villages) Imelda, Bataan, Nagsaulay, Subukin, Calub-cub 1 and 2, Pinagbayanan, and Catmon. The southern shorelines bordering the Verde Islands passage (a seawater lane) are long stretches of white, sandy beaches; picturesque coves; and wonderful marine resources. Likewise, there are prominent forested mountains and hills on the western side. These are at the foot of the mountainous boundaries of Lobo and Rosario. The resulting view is a magnificent nature feature, which is considered for world-class tourism. These are found in the portions of Barangays Imelda, Hugom, Barualte, and in the portions of the Laiya areas of Aplaya and Ibabao.

Several rivers pass through the municipality, namely, Malaking Ilog River, Lawaye River, Calub-cub River, Abung River, Bolbok River, Putingbuhangin River, Quipot River, and Laiya River. Laiya River empties at Sigayan Bay in the Verde Island passage, which is on the northern tip of the municipality. A number of creeks—notably, the Libato and Mapagong creeks—branch from these bodies of water, then flow to the other parts of the municipality. These water bodies significantly help in the agricultural activities of the municipality. Meanwhile, the national, provincial, and barangay road network, which link settlement areas in the municipality and its neighboring urban centers, is a notable man-made topographic feature of the area.

The slopes of San Juan range from 0%–3% and above. Majority of the land area (71% of total land area) has a slope of 0.3%, which makes farming a major activity and agricultural production as the major land use. These are the barangays along the northeastern part bordering near Quezon province. The highest elevated areas are located on the southwest portion of the municipality, bordering the Lobo and Taysan towns of Batangas, and have slopes of 15% and above. These areas are in Barangays Bulsa, Pulang Bato, Quipot, and parts of Sapangan and Laiya Aplaya. A portion of Barangay Hugom, central portions of Laiya Aplaya, and a portion of Coloconto have slope of 8%–15%.

San Juan has two pronounced seasons: dry period from February to May and then wet the rest of the year. Maximum rainfall usually occurs between the months of September and October. From 2006 to 2010, the average annual rainfall was recorded to be 2,960.7 mm. Extreme weather events that occur in the area include occurrence of typhoons, floods, and droughts.

Table 1 shows the rainfall data from PAGASA from 2006–2010. Based on the data, there was no significant difference in the average temperature in San Juan in the years 2006–2010. The coldest months were from December to February, while the hottest months were from April to June. Meanwhile, Tables 2 and 3 present the data on the maximum and minimum temperature from 2006 to 2010.

Of the total land area (27,340 ha) of San Juan, 72% is classified as agricultural. About 21% is forested, 2.6% is used for tourism, while the rest is for industrial, agro-industrial, and residential purposes. The mangrove forests cover 496 ha of the seven barangays with designated mangrove forest conservation areas.

For the fishery resources, the municipality has a 33-kilometer coastline, a total of 97.5 ha of inland fishponds, and an established nine marine protected areas located at the municipal waters adjacent to Barangays Catmon, Ticalan, Putingbuhangin, Abung, Calubcub 1, Imelda, Laiya Ibabao, Laiya Aplaya, and Hugom. The water resources in the municipality include several river systems, namely, Malaking Ilog, Lawaye River, Calub-cub River, Abung River, Bolbok River, Putingbuhangin River, Quipot River, and Laiya River. In addition, the creeks branch from these water bodies to drain to other parts of municipality. These water bodies play an important role in the economic activities of the residents.

According to the 2010 census, the total population of San Juan, Batangas was 91,344 with 18,264 households and a population growth rate of 1.53% per year. Employment rate was 89%, and the major sources of income and livelihood in were farming, fishing, tourism, business, and foreign employment. About 12,348 households in the municipality had income below the poverty/food threshold or income below PHP 6,374.15 (poverty threshold in both urban and rural). On the other hand, about 8,000 households had income above the poverty threshold.

The language/dialects used in San Juan are Tagalog, English, Visaya, and Bicol. The major religions in the area include Roman Catholic, Iglesia ni Cristo, Protestant, Baptist, and Born Again. In terms of education, literacy rate was 89%.

1.2 Study Sites

In this study, two coastal barangays were chosen as the study sites, namely, Barangays (Brgy.) Catmon and Hugom in the municipality of San Juan. Brgy. Catmon has a total land area of 91 ha. It is home to a total population of 1,378 (as of November, 2011) with 238 households, 87 of whom are seniors while around 200 are children ages 0–71 months old. With regard to their livelihood, 95% are dependent on fishing; 5% are working on construction, commercial *sari-sari* store (retail store), and some are OFWs. About 95% of those engaged in fishing are male, with ages ranging from 14 to 60 years. Most of the fishers in the village use net gears to catch fish and have average annual production of 900 kg. The village has no aquaculture production and produces very minimal agricultural products, except for some coconut trees. Generally, housewives in the village are not generating any income. There are also no existing cooperatives in the village. Although San Juan is known as a tourist spot, the residents of Catmon do not benefit from any tourism-related activities. Among the different impacts of climate change, typhoon, and coastal erosion pose the greatest challenge to the villagers.

Table 1. Monthly total and annual climatic data rainfall amount (in millimeters)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2006	266.9	122.8	91.2	0.5	276.7	265.8	261.3	74.4	486.3	168.2	344.2	546.9	2,905.2
2007	169.2	129.0	31.2	81.7	106.4	146.1	93.9	170.2	182.5	333.9	473.2	495.6	2,412.9
2008	310.4	204.2	61.3	157.2	227.0	460.1	136.1	175.0	238.4	455.5	379.7	2.4	2,807.3
2009	120.0	164.9	253.5	911.3	232.9	296.0	155.2	100.9	327.3	344.2	400.3	119.3	3,425.8
2010	145.9	16.8	120.3	41.0	38.1	159.4	513.7	100.3	286.5	733.6	474.7	622.0	3,252.3
Total	1,012.4	637.7	557.5	1,191.0	881.1	1,327.4	1,160.2	620.8	1,521.0	2,035.4	2,072.1	1,786.2	14,803.5
Mean	202.5	127.5	111.5	238.3	176.2	265.5	232.0	124.2	304.2	407.1	414.4	357.2	2,960.7

Source: PAGASA

Table 2. Monthly mean and annual climatic data maximum temperature, in °C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2006	28.4	28.5	30.8	32.8	31.8	31.8	30.2	31.0	31.2	29.7	30.5	28.1	30.4
2007	27.9	28.9	30.6	32.5	32.7	32.7	32.0	31.0	31.6	30.7	29.3	28.6	30.7
2008	28.2	27.6	29.8	31.6	31.0	31.7	31.5	31.3	31.6	31.2	30.2	30.2	30.5
2009	26.8	28.9	30.8	30.8	30.4	31.2	31.3	31.7	30.4	30.5	29.8	28.2	30.1
2010	27.5	30.1	30.0	32.1	34.2	33.1	31.7	31.4	31.4	30.6	29.4	28.0	30.8
Total	138.0	144.0	152.0	159.0	160.0	160.0	156.0	156.0	156.0	152.0	149.0	143.0	152.5
Mean	27.8	28.8	30.4	32.0	32.0	32.1	31.3	31.3	31.2	30.5	29.8	28.6	30.5

Source: PAGASA

Table 3. Monthly Mean and annual climatic data minimum temperature, in °C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2006	22.7	22.3	23.3	24.4	24.4	24.0	23.5	23.4	23.0	22.7	23.5	22.2	23.3
2007	21.5	21.6	22.0	23.2	23.6	24.2	23.8	23.7	23.0	23.3	22.7	22.2	22.9
2008	21.8	20.8	21.8	23.7	22.2	23.6	23.4	23.0	23.4	23.1	22.9	21.2	22.6
2009	20.3	21.3	22.4	22.9	23.1	23.0	23.3	24.0	23.3	22.6	22.8	20.9	22.5
2010	20.4	20.8	21.5	22.9	24.3	24.1	23.3	23.2	22.9	22.8	22.6	22.2	22.6
Total	106.0	106.0	111.0	117.0	117.0	118.0	117.0	117.0	115.0	114.0	114.5	108.0	113.8
Mean	21.3	21.4	22.2	23.4	23.5	23.8	23.5	23.5	23.1	22.9	22.9	21.7	22.8

Source: PAGASA

Brgy. Hugom, on the other hand, lies at the southern part tip of San Juan. Hugom is considered as the center of the tourism activities of the municipality, and thus needs to take a balancing act between environmental conservation and economic development. The village has a total land area of 486 ha and has a total population of 1,498 (San Juan Municipal Government 2010) with 203 households. About 70% of the residents are engaged in fishing, 25% are engaged in tourism-related activities, and the remaining 5% are into agriculture. Flooding and typhoon are the most commonly experienced hazards among the residents of Hugom. Table 4 presents the sociodemographic characteristics of the two barangays under study.

Table 4. Profile of the chosen barangays

Indicator	Catmon	Hugom
Population	1,378	1,498
Average household size	4	4
Children 0–5 years old	2.7%	2.1%
Children 6–12 years old	4.3%	2.3%
Members of the labor force	87.3%	91.4%
Household living in makeshift houses	31.0%	10.3%
Household without access to safe drinking water	22.0%	15.3%
Household without access to sanitary toilet facilities	67.5%	25.1%
Children 6–12 years old not attending elementary	22.1%	20.3%
Children 13–16 years old not attending high school	52.5%	47.8%
Households with income below poverty threshold	76.6%	38.9%
Household with income below food threshold	58.4%	21.7%
Unemployed members of the labor force	4.3%	3.1%

Source: San Juan Municipal Government (2010)

1.3 Climate Risk to Address

San Juan has often experienced climate-related hazards like typhoon, storm surges, and flooding. Anecdotal reports from the residents indicated that for the past 20 years, the sea has been encroaching inland as a result of the rising sea level. In particular, the sea level surrounding the Verde Island Passage has been increasing at 0.5–1.0 mm per year over the last 10 years. Consequently, this could lead to inundation of low-lying wetland and dryland areas, erosion, saltwater intrusion, increased risk of flooding, and storm damage. These physical changes may also cause substantial socioeconomic losses in coastal structures, dislocation of the population, and change in livelihood. The same physical changes may also have certain ecological consequences such as destruction of coral reefs, reduction in biological diversity, and changes in the biophysical structures of the coastal areas. The local coastal communities in San Juan highly depend on the marine resources for their livelihood and other needs. Thus, the geophysical impacts of the confluence of these hazards need to be addressed in order to minimize its adverse effects.

Specifically for the two barangays, the climate risks that need to be addressed are coastal erosion, typhoon, and flooding. With coastal resources serving the majority of the community’s t needs, it is critical that something should be done in order to address the geophysical impacts of the confluence of these hazards in order to minimize its adverse effects.

1.4 Objectives of the Study

The study aimed to identify the impacts of climate change, assess the vulnerability of the residents at the chosen site, and analyze the economic values of the adaptation strategies in the coastal areas of San Juan, Batangas. Specifically, the study aimed to

1. validate and assess the impacts of climate change on the selected coastal areas of San Juan, Batangas;
2. asses the vulnerabilities to climate change of residents in the coastal areas of San Juan, Batangas;
3. measure the economic loss/benefits due to climate change in the selected coastal areas;
4. assess the adaptation strategies being pursued in the selected coastal areas; and
5. develop and recommend management adaptation strategies for coastal areas in San Juan, Batangas.

2.0 LITERATURE REVIEW

There is an equivocal scientific consensus that the changes brought by climate change are already occurring and will intensify in the future. This could significantly alter coastal ecosystems, create coastal hazards, and change the lifestyle of fishers, coastal resource users, waterfront property owners, and coastal communities (CRC 2016).

The IPCC 4th Assessment Report cites that Southeast Asia is expected to be seriously affected by the adverse effects of climate change since most of the countries in the region are relying on agriculture and natural resources. Southeast Asia is annually affected by climate change impacts, particularly flooding, droughts, and tropical storms as large areas of the region are influenced by monsoons. Such climatic impacts will severely threaten the livelihoods of poor people living in the rural coastal areas who have limited adaptive capacity. Moreover, tropical cyclones/typhoons could exacerbate the impact of sea level rise with its strong winds and heavy rains, which result in massive flooding in coastal settlements. It is projected that typhoons will become more frequent and more intense due to climate change, and this would accordingly worsen coastal flooding and erosion and can cause mud slides in the future.

According to Chiotti (1998), the small island nations are most vulnerable to the effects of climate change due to the sea level rise associated with the phenomenon. Poor countries are also highly vulnerable due their low adaptive capacities to respond to climate-related disasters. The ability to respond effectively to the impacts of climate change depends on the nature and the characteristics of the human system to sustain environmental shocks and stresses. Climate change will also have different impacts on different regions, countries, and communities because of the widely differing physical, natural, economic, social, cultural, and historical factors and influences. Each community has a different history, people, and skills. A community's adaptive capacity depends on how all of these different elements interact (Handmer, Dovers, and Downing 1999).

The Philippines recognizes the vulnerability of its local communities to the dangerous consequences of climate change; thus, it cooperates with the global community to resolve climate change issues, including disaster risk reduction (R.A. 9729, Climate Change Act of 2009). Accordingly, it is now pursuing different action programs to adapt to these impacts.

The ability of communities to resist or adapt to the effects of climate change depends on their vulnerability to change, resilience, and adaptive capacity. Vulnerability to change is described as the exposure to threats that can negatively modify the status quo. Environmental threat, in turn, threatens the socioeconomic basis of communities (Sutherland 2004; Broersma 2003).

A community may be vulnerable to the effects of climate change for a variety of biophysical and socioeconomic reasons. The same weather event can have different effects on different communities due to a multitude of socioeconomic conditions within individual communities (Ford and Smit 2004; Chiotti 1998; Wall and Marzall 2006; Smit and Pilifosova 2003; Klein et al. 1998). Accordingly, adaptation is necessary because there is no assurance that the projected climate change can be mitigated (IPCC 2007). In developing adaptation strategies, planners must consider the contribution of social networks and access to resources and other assets of households and community to reduce social vulnerability (Bin et al. 2007).

Adaptation measures are very specific to a particular location and situation; what may work in one place or within one socioeconomic group may not work or be feasible elsewhere. Thus, each measure should be tailor-made for each case and circumstance. This means that it is essentially impossible to specify or develop appropriate and applicable adaptation measures without detailed knowledge of the system or community for which the adaptation is intended. This knowledge would need to include the nature of the vulnerability and how it is presently being dealt with in order to avoid proposing naively inapplicable or maladaptive measures (Bosello, Carraro, and de Cian; El-Raey, Dewidar, and El-Hattab 1999).

Successful adaptation also requires planners to recognize the necessity to adapt and to have knowledge about the available adaptation options, the capacity to assess them, and the ability to implement the most suitable measure. All of these factors rely on the wide availability of information and skills (Frankhauser and Tol 2005). The ability to adapt often depends on the effectiveness of social networks and infrastructures (Preston, Yuen, and Westaway 2011). Similarly, adaptation is related to the stability and the capacity of institutions to manage risks associated with climate change and other conditions (Olmos 2001). It is also widely recognized that adaptive capacity is greater if social, cultural, and political institutions ensure that the allocation of power and access to resources are distributed equitably (Adger et al. 2003; Benioff and Warren 1996).

The search for cost-effective adaptation strategies should begin with assessing the threats posed by climate change that local communities and institutions face (Francisco 2009). Accordingly, the cost effectiveness analysis (CEA) is the appropriate method to be used if the benefits cannot be measured in a reliable manner, as is the case often with environmental goods and services. It principally involves costing of different options that have the same objective, and comparing those in order to find out how a well-defined objective can be reached in a least cost way (Niang-Diop et al. 2004).

3.0 METHODOLOGY

Various participatory research methods were used in this study to gather information and to understand a range of perceptions at the local level. The methods used include focus group discussions (FGDs), participatory-mapping activities (e.g., hazard mapping and community mapping), and historical timelines. These methods were used to assess the local and sectoral vulnerabilities and adaptive capacities of the research participants. Since the community members had been engaged since the initial stages of the project, this study also aimed to instill to the community a sense of ownership of the project, and to promote a collaborative effort among the members of the community. This way, the local community participants, who are likely to benefit the most from the findings of this project, would find it easier to accept and support the recommended actions of this study.

In order to obtain insights into the target audience's awareness and perceptions of climate change and to probe deeply into their needs, problems, beliefs, and reasons for choosing certain adaptation practices, several FGDs were conducted. The participants in these FGDs consisted of representatives of the different sectors of the community, which include fishermen, youth, women's groups, barangay health workers, school principal, barangay officials, and senior citizens. An FGD guide was used in order to facilitate the discussion. The results of the FGDs were also used as guides in the development of the more structured household survey instrument.

With regard to the FGD conducted with the local government officials, the participants consisted of 90% male ages 45–55 years old. They are the department heads of different offices such as planning, agriculture, health, engineering, and social welfare. It also consisted of the members of the *Sangguniang Bayan* (municipal council) and the Municipal Mayor. An FGD guide was used in order to facilitate the discussion. The results of the FGDs were also used as guides in the development of the more structured household survey instrument.

The community residents themselves mapped the layout and infrastructure of the village, which helped to depict detailed information of the village. This participatory nature of the method was important in identifying the important livelihoods and resources in the community and in identifying who had access and control over them. In addition, the map was useful in identifying the areas and resources that were at risk from climate hazard as perceived by the residents.

The insights gained from the participatory research methodologies that had been conducted were used to develop the household survey instrument. After the standardized questionnaire had been finalized, it was translated to the local dialect such that the interviewees and respondents could understand them better. After the instrument had been validated and accordingly revised, a final version of the instrument was used in the household survey.

The survey instrument was composed of 20 modules and discussed the following topics: (1) household information; (2) water use; (3) information on dwelling place; (4) household consumption; (5) farming activities; (6) fishing activities; (7) aquaculture or marine culture activities; (8) gleaning activities; (9) processing activity; (10) income from other sources; (11) asset ownership; (12) livestock ownership; (13) history, impacts, and adaptation to typhoon and flooding; (14) history, impacts, and adaptation to coastal erosion and sea level rise; (15) history, impacts, and adaptation to saltwater intrusion; (16) other general impacts; (17) social capital; (18) awareness and perception of climate change; (19) disaster preparedness and early warning system in the community; and (20) community coping mechanism and adaptation responses.

The study used a proportional stratified random sampling strategy to select the participants of the survey. The 300 respondents were divided into two; each identified barangay had 150 respondents each. The respondents from each barangay were chosen based on their level of vulnerability (i.e., their distance from the shoreline).

CEA was used to evaluate the planned adaptation strategies since not all of the expected benefits of the planned adaptation strategies could be monetized. To compute for the household vulnerability index, the researchers used the vulnerability as expected poverty (VEP) in the analysis. This was based on the assumption that climate extremes (i.e., climatic shocks or hazards) would affect the probability that household's consumption will fall below a minimum consumption threshold level.

4.0 COMMUNITY-BASED HAZARD AND PHYSICAL VULNERABILITY MAPPING

4.1 Historical Timeline Analysis of Bio-geophysical Impacts

The residents of Catmon and Hugom identified the important events in their community from 1990 to 2011. These events consisted of changes and developments in the political, environmental, economic, and peace and order situation in the area (Table 5).

Based on the historical timeline analysis, the residents experienced several calamities and peace and order problems during the period under study. Results also showed that among the climate-related hazards, typhoon was the most commonly encountered. This hazard posed great burden on the residents, especially on the residents of Catmon who found it hard to recover from the financial and emotional stress caused by their experiences in surviving the typhoons.
In Hugom, on the other hand, the residents were able to recover more easily because aside from fishing, they had other alternative sources of livelihood, which enhanced their adaptive capacity.

Table 5. Historical timeline of Brgy. Catmon and Brgy. Hugom

Year	Event
Brgy. Catmon	
2011	Residents became more aware of environment-related problems. The barangay had five suspected dengue cases. The residents took part in the various tree-planting activities
2010	Another typhoon hit the barangay, which caused light to moderate damages to the houses.
2009	A nongovernmental organization (NGO) conducted a medical mission in the area.
2007	A new barangay captain was elected. The roads were paved.
2006	The bridge was damaged due to a very heavy typhoon. Relief goods were then distributed to the barangay residents
2005	The first construction of public toilet. There was proliferation of sand quarrying in the area.
2003–2004	Fish farmers' harvest of don pilas/tamban (sardinella) increased during the period.
2000	The elementary school was built in the barangay.
1997	There was observed increase in sea surface temperature, which the residents associated with the massive forest fire in Indonesia. Plenty of sardinella harvest.
1994	A strong typhoon hit the area. Several houses were moderately damaged.
1992	Electrification was put into operation.
1991	Insurgency problems beset the community; "agaw armas" was rampant.
1990	An earthquake occurred, which caused the sea to rise from knee to chest. The residents started to notice that the sea was slowly moving inland.
Brgy. Catmon	
2010	A new barangay captain was elected.
2009	An NGO conducted a handicraft-making training among the barangay residents.
2008	The elementary school was established.
2006	Typhoon Caloy caused four fatalities and damaged 15 boats in the area. Four tourists drowned on four separate occasions during the year.

Table 5 continued

Year	Event
Brgy. Catmon	
2005	Various resorts started to be constructed in Brgy. Hugom and a nearby barangay (i.e., Laiya).
2000	A women's group was organized.
1998	Electrification in the barangay was completed.
1994	Several marine protected areas (MPA) were established.
1990	An illegal recruiter killed several recruits from the barangay. More than five residents became victims of the said massacre.
1980	A landslide occurred in the area, which damaged several houses.

4.2 Hazards Ranking

Table 6 shows the result of the participatory hazards ranking made during the FGDs with the barangay residents. The participants were asked to rank the climate-related hazards in terms of the severity of their impacts, with the score of 1 having the most severe impact. The residents of Catmon ranked *typhoon* as the most detrimental among the climate-related hazards they had experienced, followed by *coastal erosion*. *Flooding* came in third; the residents reported that these incidents had not caused that much damage to their households. According to them, the floods would normally persist for a few hours, and then subside after the residents open their floodgates to let the water go to the sea. *Drought* was ranked fourth. *Increased sea surface temperature* had the least impact. On the contrary, the residents recalled how the fish farmers in the area had caught a huge number of sardinella in 1997—the time when the residents noticed that the sea temperature was its highest.

On the other hand, the residents of Brgy. Hugom viewed typhoon as the most damaging climate-related hazard. According to them, the typhoons had caused them around PHP 2–3 million worth of damages to their boats, houses, and cottages. Second in rank was flooding, with an estimated damage cost of PHP 1,000–3,000 per flood incident. Landslide came in next, although it only happened once in their area (in the early 1980s). Coastal erosion ranked fourth among the climate-related hazards, whereas drought was the least damaging.

Table 6. Comparative ranking of hazards as perceived by the residents of Catmon and Hugom

Ranking of Hazards	Brgy. Catmon	Brgy. Hugom
1	Typhoon	Typhoon
2	Coastal erosion	Flooding
3	Flooding	Landslide
4	Drought	Coastal erosion
5	Increased sea surface temperature	Drought

4.3 Vulnerability Matrix

The FGD participants were also asked to rank the different sectors in their community in terms of their vulnerability to the different climate-related hazards, with the score of 1 as the most vulnerable. The hazards in each column were ranked according to severity of impact (result of Table 6). Then, to get the relative vulnerability of each sector to all of these hazards, a weighted score was assigned by getting the sum of the product of the rank of each sector with the ranking of the severity of the hazards. The sector with the lowest score was interpreted as the most vulnerable, thus first in the rank.

Another way of describing the vulnerability of the sectors to the impacts of climate change-related hazards is to identify which among these sectors are highly, moderately, and slightly vulnerable to each of the hazards. A matrix is then presented to show the residents' perception of the extent of the vulnerability of the different sectors.

Tables 7 and 8 show how the residents of Brgy. Catmon perceived the impact of climate-related hazards on each sector. In particular, they viewed *fishing*—which is a main source of livelihood—as a highly vulnerable sector. In terms of the quantity and variety of fish stocks, the participants commented back in the 1990s, they could still catch a variety of fish, which includes *tulingan* (bullet tuna), *alumahan* (short mackarel), *hiwas* (moon fish), *dalagang bukid* (lunar fusilier), *dilis* (shorthead anchovy), and *dulong* (lacustrine goby).

Likewise, around the same time, fish could already be caught at about 1 km from the shoreline. In recent years, however, they could only catch alumahan most of the times, and it would take them 5 km from the shore before they could catch any fish. In addition, their catch per unit of effort (CPUE) has continuously declined since the 1990s. Before, average CPUE was 40–50 kg as compared to the present 4–5 kg. When asked whether they perceive this to be caused by climate change or due to overfishing, they agreed that both factors have contributed to the decline in fish catch.

Table 7. Vulnerability ranking as perceived by the residents of Brgy. Catmon

Hazard Sectors	Typhoon (1)	Coastal Erosion (2)	Flooding (3)	Drought (4)	Increased Sea Surface Temp (5)	Weighted Score	Rank
Agriculture	7	4	7	3	6	78	5
Health	5	6	2	2	2	41	3
Fishing	1	2	5	1	1	29	1
Transport	4	7	4	7	7	93	7
Commercial services	6	5	6	6	5	83	6
Infrastructure	3	3	3	5	4	58	4
Housing	2	1	1	4	3	38	2

Table 8. Vulnerability matrix as perceived by the residents of Brgy. Catmon

Hazard Sectors	Typhoon	Coastal Erosion	Flooding	Drought	Increased Sea Surface Temperature
Agriculture	Slightly	Moderate	Slightly	Moderately	Slightly
Health	Moderately	Slightly	Moderately	Highly	Moderately
Fishing	Highly	Highly	Moderately	Highly	Highly
Transport	Moderately	Slightly	Moderately	Slightly	Slightly
Commercial services	Slightly	Slightly	Slightly	Slightly	Slightly
Infrastructure	Moderately	Moderately	Moderately	Moderately	Slightly
Housing	Highly	Highly	Highly	Moderately	Slightly

Housing was another sector perceived to be highly vulnerable to the hazards of climate change. Since their houses were made mostly of light materials, with roofs built from nipa shingles, they were highly at risk during typhoons. Their houses were also threatened by the impacts of coastal erosion. The residents revealed that there had been a minimum of four families who had migrated further inland because their houses had been encroached by the sea. Further, the residents estimated that around 30 houses may need to move inland after soon due to coastal erosion.

Health and *infrastructure*, on the other hand, were moderately vulnerable to most of the hazards. In terms of health, the residents revealed that diarrhea cases had been rampant among children after a flood incident. Since most of the residents in the barangay consisted of children and the elderly, their health was very much susceptible to the changing weather conditions. Infrastructure was also moderately vulnerable to the impacts of typhoon, flooding, and coastal erosion.

Since agricultural products were not predominant in Catmon, the *agriculture* sector was perceived as only slightly vulnerable to most of the climate-related hazards. Coconut trees were the only seriously damaged agricultural products in the said barangay; at least 30 coconut trees had been damaged in the 1990s due to coastal erosion. Other backyard vegetable gardens had likewise been slightly damaged by typhoons and flooding.

Transportation was another sector that was moderately vulnerable. Damages to roads and bridges would paralyze the barangay's transport system, considering that Brgy. Catmon is 7 km away from the poblacion (town center).

Lastly, since there were very few commercial services available in the area, the residents perceived that *commercial services* were only slightly vulnerable to the different hazards of climate change.

On the other hand, Tables 9 and 10 present the vulnerability rankings of the different sectors, as perceived by the residents of Hugom. The tables show that *housing* and *tourism* are the most vulnerable to the impacts of climate-related hazards. Majority of the houses in Hugom are built of light materials. Moreover, since Hugom is one of the more well-known tourist spots in San Juan, its *tourism* industry are most likely to be negatively affected. Meanwhile, *agriculture* was assessed to be moderately vulnerable. The agricultural areas, especially in the upland part of the barangay, were more exposed to the threats of drought and landslide, whereas those at the lower ground were exposed to the risk of flooding as well as drought.

Table 9. Vulnerability ranking as perceived by the residents of Brgy. Hugom

Sectors	Typhoon (1)	Flooding (2)	Landslide (3)	Coastal Erosion (4)	Drought (5)	Weighted Score	Rank
Agriculture	4	4	3	7	1	54	3.0
Health	7	7	8	8	2	87	7.0
Fishing	2	5	5	4	3	58	4.0
Tourism	1	1	2	1	7	48	1.5
Transport	8	8	7	6	8	109	8.0
Commercial services	6	6	6	5	4	76	6.0
Infra	5	3	4	3	5	60	5.0
Housing	3	2	1	2	6	48	1.5

Table 10. Vulnerability matrix as perceived by the residents of Brgy. Hugom

Sectors	Typhoon	Flooding	Landslide	Coastal Erosion	Drought
Agriculture	Moderately	Moderately	Moderately	Slightly	Highly
Health	Slightly	Slightly	Slightly	Slightly	Highly
Fishing	Highly	Moderately	Moderately	Moderately	Moderately
Tourism	Highly	Highly	Highly	Highly	Slightly
Transport	Slightly	Moderately	Slightly	Slightly	Slightly
Commercial services	Moderately	Moderately	Moderately	Moderately	Moderately
Infrastructure	Moderately	Moderately	Moderately	Moderately	Moderately
Housing	Highly	Highly	Highly	Highly	Slightly

Fishing was likewise assessed to be moderately vulnerable. The residents reported that their fishing boats and gears had been destroyed by past typhoons. Also, other climate hazards have altered their fishing routines. Meanwhile, *infrastructure* and *commercial services* were both assessed to be moderately vulnerable. Surprisingly, the residents viewed health and transportation as only slightly vulnerable. Although they were exposed to the hazards of climate change, they commended the efforts of the health workers for being proactive in preventing any outbreak of diseases. Likewise, the various medical missions being conducted by educational institutions have made them more resilient to the adverse effects of climate change. Moreover, they felt that transportation would not be greatly affected by the impacts of climate change.

The researchers used participatory hazard mapping to assess the awareness of the local residents on the potential hazards faced by their community. Participatory hazard mapping capitalizes on the residents' high level of familiarity of the area, which consequently provides researchers more detailed information about the hazards and physical vulnerability present in the study area that plain mapping cannot provide.

Figure 2 shows that Brgy. Hugom has both coastal and upland areas, which makes it more susceptible to the hazards from the sea and from the highlands. Although compared with Catmon, coastal erosion is not yet a serious problem in Brgy. Hugom. In spite of this, the resort owners already built protective measures like dikes in their respective areas. The residents of Brgy. Hugom were also exposed to landslides, a climate-related hazard that has not yet been experienced in Catmon at the time of the study. The former had already experienced a landslide in the early 1980s, which had damaged several houses and infrastructure in the area. The map also shows that there are no mangrove areas to serve as buffer zones against the shore. The barangay has also established a 121-square kilometer marine protected area (MPA) to preserve marine biodiversity.

The map also illustrates the numerous beach resorts located at the barangay, where most of the more popular resorts are in Brgy. Hugom. Such developments offer both opportunities and challenges to the local government as it strives to strike a balance between economic development and environmental conservation. The presence of commercial beach resorts also increases the value of properties that are at risk to the impacts of climate change.

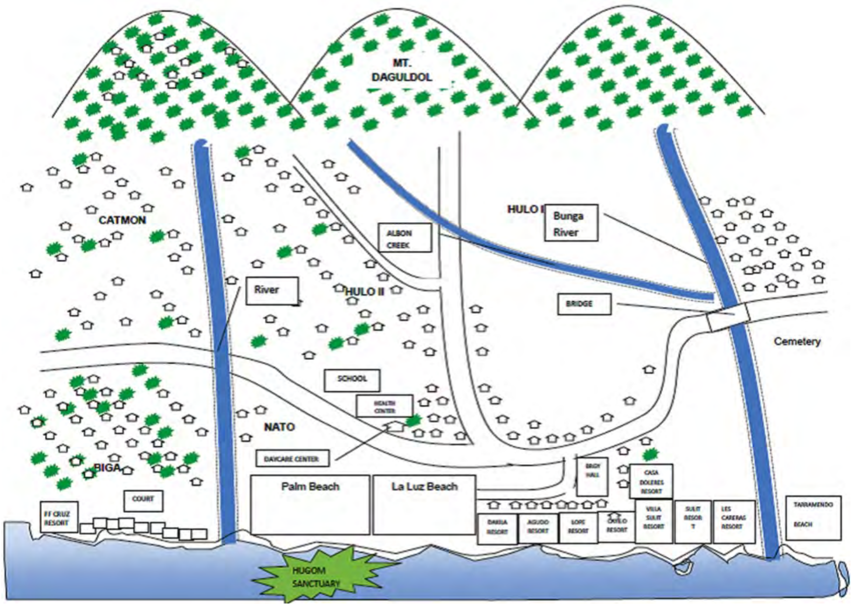

Figure 2. Hazard map of Brgy. Hugom, San Juan, Batangas

Meanwhile, Figure 3 shows the hazard map of Brgy. Catmon. The residents identified several houses that have relocated inland because their previous houses had been claimed by the sea. Likewise, they identified those that have been severely destroyed by typhoons and also those that were at risk to coastal erosion. The residents also identified the location of infrastructure that was at risk. The map also shows where the MPAs are located and highlights the natural resources present in the area. The Malaking Ilog River, which serves as the boundary between San Juan and Quezon, also poses a threat to the community since it can overflow during heavy rains, and thus cause flooding.

The map also shows that there are mangroves in the barangay that provides some protection from strong storms. It also serves as a source of alternative income for the residents of Brgy. Catmon as the mangrove trees are viable sources of timber, and serves as a shelter for other marine products that can be sold by the households.

Figure 3. Hazard Map of Brgy. Catmon, San Juan, Batangas

4.4 Household and Sectors at Risk from Bio-geophysical Impacts

Generally, the municipality of San Juan has a total coastal population of more than 30,000 individuals, who live along the stretch of the 33-kilometer coastline. The coastline also serves as docking area to about 470 fishing boats, 70% of which are motorized while the remaining are non-motorized. Among this coastal population, about 1,000 were registered fisher folk, with each fisher having an average volume of catch per day of 2.083 kg. Total income for every local fisherman was PHP 170.40 a day, with an average of 20 fishing days a month.

In Brgys. Catmon and Hugom, the households highly at risk from the bio-geophysical impacts of climate change include those living very near to the coast and those whose livelihoods primarily depend on marine resources. Also, those households that live in makeshift houses are highly at risk. In Catmon, several families who used to live a few meters away from the coastline have relocated inland because their houses had been claimed by the sea. The coconut trees that lined up the shore of Catmon have also eroded several times. Although the community had attempted to stabilize the shore by planting mangroves, the effort proved to be futile when a strong typhoon washed away all the mangrove propagules that had been previously planted.

Tourism in Brgy. Hugom is also vulnerable to the impacts of climate change, particularly to coastal erosion, typhoon, and flooding. Fishermen are also at a disadvantage when confronted with typhoon and coastal erosion. Their agricultural products are also threatened in the same way that their settlement remains unstable due to typhoon, flooding, and landslides.

Generally, Brgy. Catmon is more vulnerable to the hazards of climate change based on the given poverty indicators (Table 11). The poorer the people are, the more vulnerable they become. For this reason, the local communities at the study sites need to determine the most appropriate adaptation strategies that can be implemented so that they can enhance their resilience against the impacts of climate change.

Table 11. Profile of the chosen barangays

Indicator	Catmon	Hugom
Population	1,378	1,498
Average household size	4	4
Children 0–5 years old	47.2%	52.2%
Children 6–12 years old	48.2%	38.9%
Members of the labor force	87.3%	94.1%
Household living in makeshift houses	31.0%	10.3%
Household without access to safe drinking water	22.0%	15.3%
Household without access to sanitary toilet facilities	67.5%	25.1%
Children 6–12 years old not attending elementary	22.1%	20.3%
Children 13–16 years old not attending high school	52.5%	47.8%
HH w/ income below poverty threshold	76.6%	38.9%
HH w/ income below food threshold	58.4%	21.7%
Unemployed members of the labor force	4.3%	3.1%

Source: Community-Based Monitoring System (2010)

5.0 VALUING DAMAGES FROM CLIMATE RISK

5.1 Exposure of Households to Climate Hazards

Majority of the respondents (62%) have been affected by approximately less than 10 typhoons from 2001 to 2010. These typhoons inundated their houses as a result of heavy rains, high tide, and storm surges. According to them, the highest flood-depth level they have encountered is 1.5 m, which happened in 2010. Furthermore, they revealed that it had taken them six days before they could recover from the financial impacts of the worst flood; and 1–7 days to recover from the emotional distress and to go back to their normal situation. In the latest case of flooding from 2001 to 2010, the flood-depth level that inundated their houses was from 0.5–3.5 m in 2011. Again, this was due to heavy rains and high tide. It had taken them 1–2 days to recover from the financial and emotional distress caused by the latest flood incident and to go back to the "normal" situation. Flooding in the area generally happens when the nearby rivers overflow, and not due to the extraordinary rise in sea level. However, they said that when the sea level is extremely high, the waves would normally reach their houses, especially those living 5–10 m away from the shore.

For coastal erosion/sea level rise, the respondents have noticed that the sea has slowly been moving inland. Local residents have also reported that several houses had been taken away by the sea, and several coconut trees had been eroded due to sea encroachment.

5.2 Damages to Livelihood

Table 12 shows the cost of damages to livelihood caused by typhoons, flooding, and coastal erosion. The damages consist of losses from livestock production, fishing income, income due to work stoppage, and income from tourism-related activities. The respondents revealed that their livelihoods were more vulnerable to the impacts of typhoon. For one, most of the fishermen cannot go fishing during typhoons; those who braved the tumultuous waves of the sea do not have good catch. The damages caused by a typhoon also translate to income loss due to work stoppage and loss of business from tourism-related activities. This means no income for the family for several days. According to the survey, most respondents would normally have at least six days to recover from the financial stress caused by the typhoon. In addition, damages to livelihood due to coastal erosion amount to PHP 134,430.

Table 12. Damages to livelihood

Hazard	Frequency of Occurrence	Damages to Livelihood	Value of Damages	
			PHP	USD
Typhoon/ flooding	<10 typhoon events from 2000 to 2011	Livestock	13,300.00	308.66
		Loss of fishing income	124,070.00	2,879.32
		Income loss due to work stoppage	107,750.00	2,500.58
		Income loss from tourism-related activities	61,740.00	1,432.82
		Total	306,860.00	7,121.37
Coastal erosion	40–50 m since 2000	Livestock	13,500.00	313.30
		Loss of fishing income	85,225.00	1,977.84
		Income loss due to work stoppage	35,705.00	828.61
		Total	134,430.00	3,119.75

5.3 Damages to Health

The impacts of climate-related hazards (e.g., erratic weather) make the local community more susceptible to diseases and other health problems, especially when a large percentage of the community is composed of children and the elderly. Table 13 shows the damages to health brought by typhoon and flooding. The waterborne diseases that have affected the community include diarrhea, gastrointestinal problems, dengue, and worms/helminths. The estimated total damage cost from these health-related problems was PHP 49,060, which they mostly incurred after a flood/typhoon incident. On the contrary, coastal erosion did not pose any health problems to the respondents.

Table 13. Damages to health

Hazard	Waterborne Diseases	Value of Damages to Health	
		PHP	USD
Typhoon/Flooding	Typhoid	0.00	0.00
	Diarrhea	12,700.00	294.73
	Gastrointestinal problems	10,910.00	252.96
	Malaria	0.00	0.00
	Dengue	23,000.00	533.77
	Worms/Helminths	2,450.00	56.86
	Total	49,060.00	1138.32

5.4 Other Damages

Typhoons, flooding, and coastal erosion can also cause damages to properties such as houses, boats, and other assets (Table 14). The results show that damages to houses and other properties resulting from typhoons and flooding were also significant amounting to PHP 525,450; a total damage cost of PHP 294,100 was caused by coastal erosion. These other damages account for loss/damage to houses, boats, cottages, appliances, and other household assets.

Table 14. Other damages

Hazard	Frequency of Occurrence	Other Damages	Value of Damages per Typhoon/Flooding Incident	
			PHP	USD
Typhoon/ flooding	<10 typhoons from 2000 to 2011	Loss/damage to house	328,450.00	7,622.42
		Appliances	44,000.00	1,021.12
		Other assets (boats, motorcycles, etc)	153,000.00	3,550.71
		Total	525,450.00	12,194.24
Coastal erosion	40–50 mtrs since 2000	Loss/damage to house	82,100.00	1,905.31
		Other assets (boats, motorcycles, etc)	212,000.00	4,919.94
		Total	294,100.00	6,825.25

6.0 COST EFFECTIVENESS ANALYSIS OF THE PLANNED ADAPTATION STRATEGIES

6.1 Identified Planned Adaptation Strategies

Table 15 presents the local community's top-priority objectives vis-à-vis to the impacts of climate change. The community's first-priority objective was to protect their coastline from eroding since both barangays under study have been experiencing coastal erosion. The second objective involved reducing the number of households affected by inland flooding. Inland flooding in the area has been largely due to river overflow, particularly during prolonged rains that last for several days. Lastly, the third-priority objective was to increase the number of households saved from typhoons. The table also shows the community's proposed adaptation options for each objective.

Table 15. Planned adaptation strategies

Objectives	Planned Adaptation Strategies	
	Option A	Option B
Protect the coastline from erosion	Construct sea wall	Mangrove reforestation
Reduce the number of households affected by inland flooding	Integrated drainage and flood control system	Zoning provisions according to CLUP
Increase the number of households saved from typhoon	Diversify livelihood options to increase their resiliency	Improvement of typhoon early warning system

Note: CLUP = Comprehensive Land Use Plan

6.2 Method of Selection of the Planned Adaptation Strategies

The planned adaptation strategies were developed through consultation/focus group discussion with the key officials of the community. These representatives included the municipal mayor, the planning officer, members of the municipal council, the city engineer, the municipal agricultural officer, and barangay leaders and residents.

The measures chosen were perceived to meet the identified priority objectives of the various stakeholders and were identified in terms of the following criteria:

1. Equity – will the option benefit vulnerable groups and communities?
2. Urgency – how soon does the option need to be implemented?
3. Effectiveness – will the option meet the objectives?
4. Practicality – can the option be implemented on relevant timescales? and
5. Legitimacy – is the option politically, culturally, and socially acceptable.

6.3 Assumptions for the Analysis

The list below presents the assumptions that guided the CEA of the identified adaptation strategies. The values were based on the best estimates of the key informants interviewed, namely, the Provincial Government Environment and Resource Officer, a civil engineer, an NGO official engaged in mangrove reforestation, and officers from the Municipal Agriculture Office.

1. The rate of coastal erosion is constant.
2. The cost of seawall construction is PHP 7.5 million for 1,000 linear meter.
3. There would be no benefit in the first year while the seawall is being constructed.
4. The maintenance cost of the seawall is PHP 50,000 per year.
5. The initial cost of mangrove reforestation is PHP 100,000.
6. The subsequent cost of maintaining the mangroves is PHP 5,000 per year.
7. The benefit of having the protection from coastal erosion starts in the 5th year when mangrove propagules become fully matured, grown trees.
8. The benefit of mangroves is assumed to increase through time.
9. The cost of developing an integrated drainage and flood control system is PHP 3 million, spread over two years until its full completion.
10. Total population is 500 households.
11. The maintenance cost of the drainage system is PHP 100,000 per year.
12. The cost of developing and revising the Comprehensive Land Use Plan (CLUP) is PHP 3 million.
13. A total of PHP 100,000 is allotted for monitoring and evaluation.
14. Planning horizon is 15 years.
15. An investment of PHP 5 million is allotted for livelihood projects, spread over the 15-year timeframe.
16. An initial cost of PHP 2 million is allotted for improving the typhoon early warning system; a maintenance cost of PHP 100,000 per year thereafter is allotted.
17. An additional 50 households per year will benefit from either of the project one year after the livelihood project has commenced or the warning system has been adopted.

6.4 Results of CEA Analysis

Table 16 shows the results of the CEA of the planned adaptation strategies identified by the local stakeholders. Mangrove reforestation, as an ecosystem-based adaptation strategy, is becoming popular among coastal communities. It is cost effective, and it offers other co-benefits like additional income sources and preservation of marine biodiversity. On the other hand, seawalls need to be built carefully since there have been case studies in which ineffective seawall designs have proven to be counterproductive in the long run. The integrated drainage and flood control system, as an option to reduce the number of households affected by inland flooding, addresses issues of human security against flood risks alongside sustainable development. Integrated drainage and flood control system can play an important role in sustainable development and poverty reduction. It aims to minimize loss of life and damages to properties. This strategy also considers the magnitude of the flood hazard and the community's exposure and vulnerability to it.

Table 16. Results of CEA

Objectives	Planned Adaptation Strategies	Cost Effectiveness (in million PHP)	Cost Effectiveness (in million USD)
Protect the coastline from eroding	Option A: Construct a sea wall	6.90	0.1612
	Option B: Mangrove reforestation	0.11	0.0025
Reduce the number of households affected by inland flooding	Option A: Integrated drainage and flood control system	1.39	0.0323
	Option B: Zoning provisions according to revised and updated CLUP	2.78	0.0645
Increase the number of households saved from typhoon	Option A: Diversify livelihood options to increase resiliency	0.49	0.0112
	Option B: Improvement of typhoon early warning system	1.86	0.0431

According to the *revised and updated CLUP* of the municipality, an effective implementation of zoning provisions involves the non-issuance of development permits in flood-prone lands. Accordingly, subdivision developers are required to undertake flood-proofing measures. Using land along rivers for parks or for ecological reserves also limits the exposure of the people to flood-prone areas.

Diversifying livelihood options as a strategy to protect more households from typhoon-induced damages was an option to improve people's resiliency. When families have varied sources of livelihood, they become less dependent on coastal resources as an income source, thereby reducing their vulnerability to the impacts of climate change. Moreover, when they have more income, they can make their own adaptation strategies without the need for government support. Likewise, providing more alternative sources of livelihood addresses climate change concerns while providing co-benefits relating to their safety and overall well-being.

Improving typhoon early warning system involves improving infrastructure, (e.g., communication equipment) and developing the capacities of the residents to respond to the situation. This capacity building includes conducting trainings on risk reduction and disaster management, with actual simulations to mimic real-life situations. The early warning system should not end in the provision of warning per se, but should also involve an effective response system.

Based on the results, each adaptation option had a corresponding cost-effectiveness ratio. However, it is up to the local government and community stakeholders as to which strategy/strategies they will implement in the future considering their constraints and opportunities.

7.0 HOUSEHOLD ADAPTATION

7.1 Household Adaptation Strategies

7.1.1 Typhoon/flooding

Planned adaptation strategies are as important as those undertaken by households through their own initiative (also known as autonomous adaptation). Although considered to be more reactive than anticipatory, household adaptation strategies are more specific based on the actual needs and concerns of the households. The following sections illustrate the choice of adaptation strategies done by the households during and immediately after a typhoon/flooding incident (Figure 4).

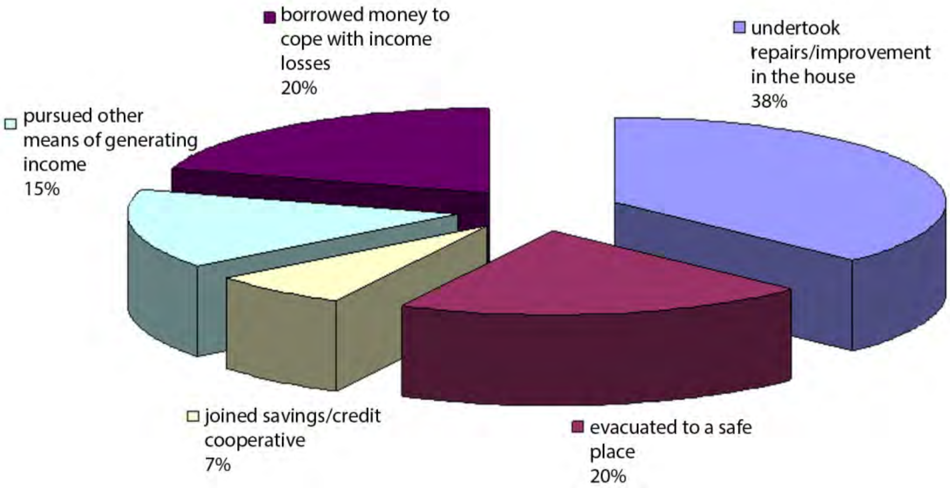

Figure 4. Household adaptation strategies during and immediately after the typhoon/flooding

Most of the respondents refused to leave their current residence permanently; instead, they *improved their houses* to make them more resilient to stronger typhoons and flooding. Some *evacuated to safer places*, while others *borrowed money* to cope with income losses. Others pursued *other means of generating additional income*. Only few of the respondents *joined savings and credit cooperatives* after the typhoon so that they can have some buffer in case another typhoon hit their barangay. This may be because most households did not have access to credit and because cooperatives in these barangays were limited.

When the respondents were asked about what they will do in the future to deal with typhoon and flooding, majority of the respondents still preferred to *modify their houses* to make them more resilient to floods and typhoons (Figure 5). This was followed by those who were open to the possibility of *relocating permanently* should flood and typhoon incidents become worse in their barangay. Another group of respondents prioritized *digging of canals* as an adaptation measure. This was followed by those who would *avail insurance* in order to protect themselves from the adverse impacts of climate change. Still, a minority number of respondents revealed *modifying their planting schedules* as a preferred future adaptation option.

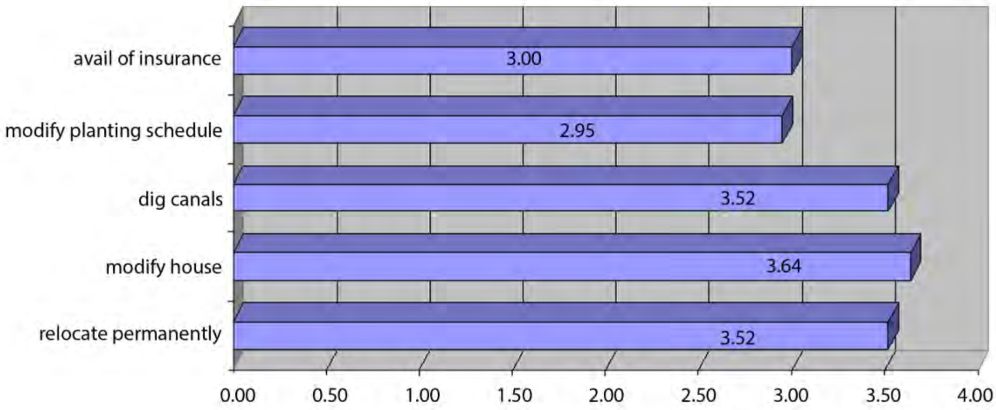

Figure 5. Household future adaptation strategies to deal with typhoon/flooding (%)

It was not surprising that most of the respondents preferred to improve their houses instead of relocating. This follows the common mentality of rural folk that where they were born is also where they will die, even in the midst of the hazards of climate change. They would first exhaust all possible means to protect themselves without relocating. Another reason for this was that they may not have the means to relocate. Relocation brings uncertainty and additional risks, not to mention spending for the direct costs of relocation. However, if after all the efforts of improving or modifying their houses to make them more resilient to the damages caused by typhoon and flooding incidents still prove to be futile, a significant number of respondents agreed to relocate permanently.

7.1.2 Coastal erosion

Figures 6 and 7 show the adaptation strategies of the respondents to deal with coastal erosion. For those who experienced coastal erosion, majority of them had *prepared to evacuate* (even though they did not really evacuate) as a means of protecting themselves (Figure 6). The option *evacuate/migrate temporarily to a safer place* was the next most preferred coping mechanism, followed by *pursued other means of generating income*. For those respondents who owned beach resorts, they *installed permanent protective structures* to protect their property from coastal erosion, while those coastal residents *installed temporary and semi-permanent protective structures*. The other respondents *joined savings and credit cooperatives* to prepare for any contingency.

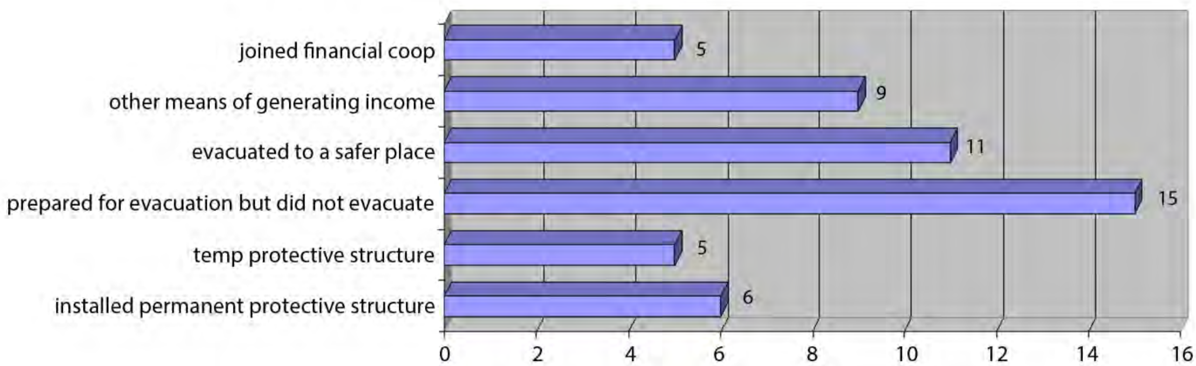

Figure 6. Household adaptation strategies to deal with coastal erosion (%)

Figure 7 presents the respondents' future adaptation strategies to deal with coastal erosion. The respondents' opinion about future adaptation strategies to adopt did not differ significantly from one another. These included planting mangrove trees, relocating permanently, installing protective structure, establishing personal savings, and digging of canals.

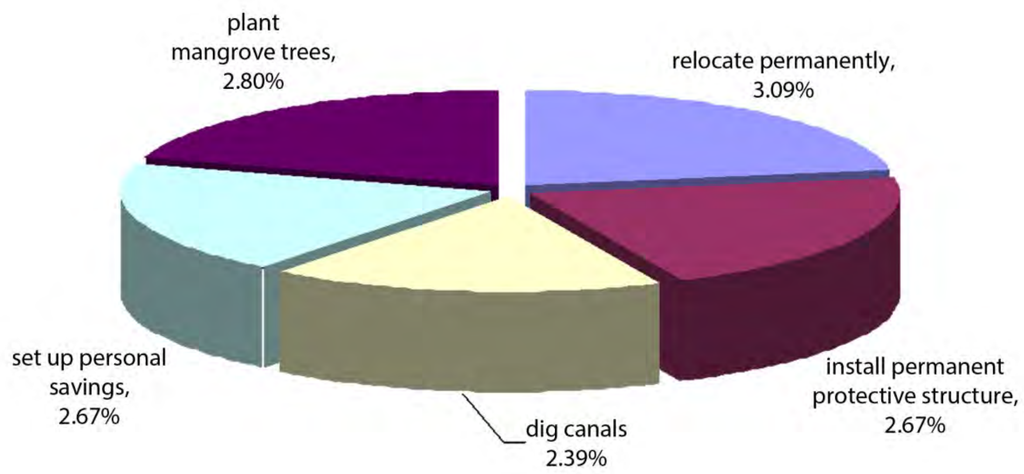

Figure 7. Future adaptation strategies to cope with coastal erosion

7.2 Social/Household Vulnerability Index

7.2.1 Gender dimension of vulnerability

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report recognizes that gender roles and relations impact on people's vulnerability and capacity to adapt to climate change. Differential power relations and access to resources between men and women often result in different levels of vulnerability and adaptive capacity to risks such as droughts, floods, and storms. This section provides a glimpse of the relationship between the number of female members of the household and their level of vulnerability.

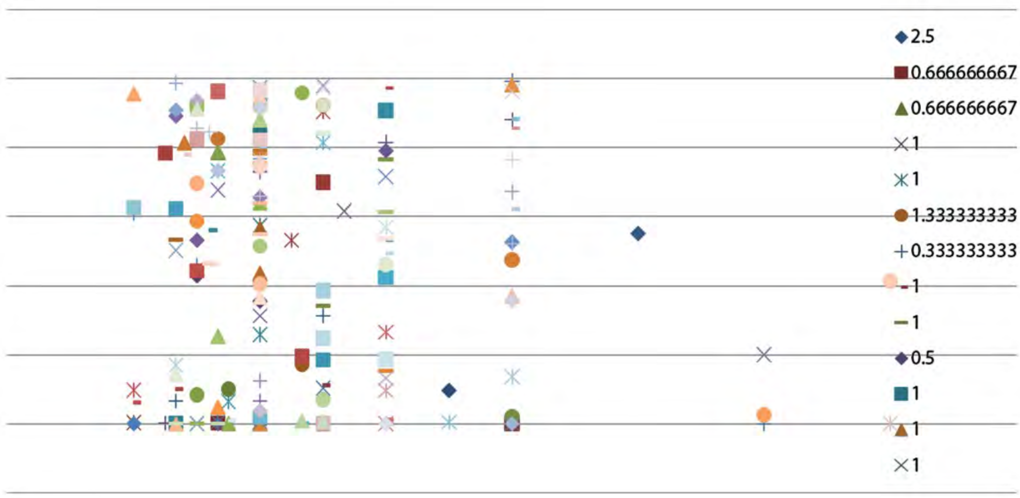

Figure 8. Scatter diagram of vulnerability index of women

The graph shows that as the number of females increase in the households, their level of vulnerability tend to decrease. With a correlation of –0.17572, an inverse relationship can be observed between the number of female members in the household vis-à-vis their level of vulnerability. This may be due to the strong involvement of women in increasing their adaptive capacity to withstand the adverse impacts of climate change.

8.0 INSTITUTIONAL ANALYSIS

8.1 Decision Making and Planning by Local Government Units and Climate Change

The local government of San Juan, Batangas recognizes the need to address climate-related issues. As part of the initial set of activities and programs that would be initiated by the local government relating to this, they have Municipal Ordinance No. 07-2006, which established the rules and regulations of San Juan, Batangas MPA and prescribing the penalties thereof.

Moreover, the Indicative Climate Change Adaptation Plan of San Juan for CY 2009–2011 was formulated in order to enhance the level of preparedness, specifically the institutional mechanisms and arrangements as well as the human and material resources to cope with contingencies and minimize damage during the climate change phenomenon.

Furthermore, one of the strengths of San Juan was their very strong linkage and partnerships with other institutions, both private and nongovernment, as well as academic institutions that have the same thrust toward protecting the environment and the welfare of the people against the adverse impacts of climate change.

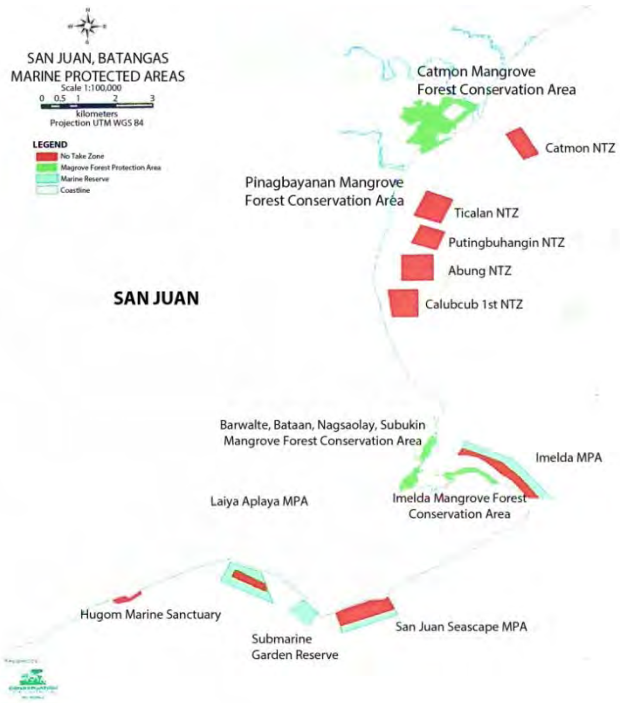

Figure 9. Map showing the location of MPAs in San Juan, Batangas

8.2 Awareness, Perception, and Constraints of LGU to Deal with Climate Change

The local government of San Juan, headed by its municipal mayor, is active in projects and partnerships that would address the threats posed by climate change. They perceived that the negative effects of climate change would get worse as time goes by. They have become more concerned because San Juan is now a booming tourist area, and they are pressured to balance environment preservation and economic development.

However, even with such a heightened awareness of the possible threats of climate change to their municipality, they are still faced with constraints in terms of implementing their plans and programs. One constraint refers to the set of values of the residents, which lead to a weak cooperation. Since most of the climate change adaptation strategies favored by the municipality would involve a trade-off between short-term satisfaction versus long-term benefits, they found it difficult to get the residents' commitment to favor activities that would meet their needs the soonest possible time.

Another foreseen barrier for effective implementation of the adaptation strategies was the consistency of the local government's efforts in monitoring and evaluation. It would take a great deal of effort to ensure that such strategies or programs would be consistently implemented in order to really achieve the desired objectives.

In addition, the local government lacks the funds to implement such strategies. Since the municipality highly depends on the Internal Revenue Allotment, only a portion of the development fund can be allocated to climate change-related activities and programs. This would then be insufficient to implement such programs effectively. Thus, they are counting on their strong partnership with private and nongovernmental institutions who can help them realize their goals and objectives, specifically those that relate to environment protection.

9.0 CONCLUSIONS, RECOMMENDATIONS, AND POLICY IMPLICATIONS

The municipality of San Juan, Batangas, specifically Brgy. Catmon and Brgy. Hugom are exposed to the impacts of typhoon, flooding, and coastal erosion. The sectors highly vulnerable to typhoon are fishing, tourism, and housing; although those highly vulnerable to the impacts of flooding include housing and tourism. Similarly, the fishing, housing, and tourism sectors are highly vulnerable to the impacts of coastal erosion.

Much of the damages to the community's livelihoods are caused by typhoons and flooding with computed amount of PHP 306,860; while those arising from the impacts of coastal erosion were computed to be PHP 134,430. Damages to health amounted to PHP 49,060. Other damages to properties (e.g., boats, houses, resorts, etc.) caused by typhoons/flooding were higher at PHP 525,450; while those arising from coastal erosion amounted to PHP 294,100.

A CEA was conducted for the planned adaptation strategies identified by the local community stakeholders. Based on the CEA, the more cost-effective adaptation strategies include mangrove reforestation, integrated drainage and flood control system, and diversification of livelihood options.

As regards to the household adaptation strategies, majority of the respondents resorted to improving their houses to make them more resilient to flooding and typhoons. In order to cope with the adverse effects of coastal erosion, the respondents preferred to undertake mangrove reforestation activities.

Based on the results of the study, the following measures are therefore recommended:

1. *Improvement of high-quality data collection, storage, and retrieval for climate change must be done through continuous monitoring and evaluation in order to aid in the planning efforts and in decision-making.*

   This would include comprehensive vulnerability maps identifying the locations that are highly vulnerable to the impacts of climate change. Other baseline information must be continuously updated to aid disaster planner and to help local communities take a proactive role in identifying appropriate and timely response mechanisms.

2. *Since there is an increasing trend for migration due to the threat of coastal erosion and income loss on fishing, the government must come up with a comprehensive action plan on how to address this emerging problem.*

   Based on the survey and focus group discussions, when the residents were asked if they would relocate as a response to the threat of coastal erosion, majority answered in the affirmative. They further revealed that they prefer to relocate in the same barangay since they want to maintain their current social ties. However, due to decreasing trend in fish catch that further drives them to poverty, they may be compelled to relocate in another barangay where they can explore other livelihood options such as agriculture or tourism-related business. Currently, the municipality has not identified a specific plan of action that would address this issue. Factors that affect their decision to migrate and the whole dynamics of retreat, as an adaptation option may be further studied.

3. *Intensify the information and education campaign of the municipality on existing environmental laws and policies as well as the effects of climate change and what can be done about it.*

   Only through in-depth understanding of the issues can the community members commit to participate and get involved in the government programs about the environment. By empowering the people through education can help them become more adaptive.

4. *With the identified vulnerabilities of the community members and the most cost-effective adaptation options presented, local government officials should further strengthen collaboration with donors, agencies, and institutions to help them in implementing such projects and programs.*

   Recognizing the inadequacy of local financial resources that the municipality has, it should utilize external social networks and linkages to generate financial assistance in the implementation of such projects.

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