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HOUSEHOLDS' VULNERABILITY TO CLIMATE CHANGE IMPACTS IN SELECTED COASTAL COMMUNITIES OF BAYBAY CITY, LEYTE

Eulaine Marie D. Mangaoang[1] and Maria Hazel I. Bellezas[1*]

[1]*Department of Economics, Visayas State University, Visca, Baybay City, Leyte*

The study investigates households' vulnerabilities to climate change impacts in selected coastal communities of Baybay City, Leyte. Personal interviews were conducted among 152 randomly selected respondents. Principal Component Analysis was used to estimate the vulnerability index. Results of the study show that more than 80% of households experienced flooding in their homes, usually due to heavy rains, or a combination of heavy rains and high tide. However, households were indirectly sensitive to climate change impacts because more depend on non-natural resource-based income. Living in houses made up of light materials, make them more vulnerable to natural hazards. More than the geographic location and physical features, these communities are potentially vulnerable to climate change owing to the prevailing socio-economic conditions in the area as well as the capacity of households to adapt to climate-related hazards. Policies such as establishment of mangrove forests or physical infrastructures like dikes or breakwaters, capacity development on the conduct of seminars about climate change and different adaptation strategies are suggested to improve the adaptive capacity and resilience of the selected coastal communities in Baybay City, Leyte.

Keywords: exposure, sensitivity, adaptive capacity, principal component analysis

1. INTRODUCTION

The impacts of climate change on natural and human systems have received great attention from various stakeholders across the globe. Of primary concern are its potential negative impacts in developing countries as their exposure to extreme weather events is amplified by their fragile geographic characteristics and their weak socio-economic conditions (Arias et al., 2014). Given

[*]Corresponding author: Dr. Maria Hazel I. Bellezas, Department of Economics, Visayas State University, Visca, Baybay City, Leyte, Philippines. Email: hazel.bellezas@vsu.edu.ph

its location in the tropics, the Philippines is particularly vulnerable to devastating impacts of climate change on both terrestrial and marine environments. The Philippines, being an archipelago has a total discontinuous coastline of 32,400 kilometers. About 70% of the country's 1,500 towns and cities share the coast, deriving numerous benefits and opportunities offered by the coastal zone and near-shore areas (Predo, 2010). The Philippines is the 9th out of 193 countries most keenly affected by the adverse effects of climate-related events, based on Maplecroft's Climate Change Vulnerability Index (2014). According to Yusuf and Francisco (2009), the Philippines is one of the climate hazard hotspots in Southeast Asia with a scale of 0.39 to 1.00, 1.00 being highest in the level of climate change vulnerability. The hazards mostly experienced by the Philippines are cyclones, floods, landslides and droughts. Data from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) indicated that the Philippines has experienced a total of 106 tropical cyclones from 2010-2015, 19 tropical depressions, 41 tropical storms (three of which are severe), and 46 typhoons (five of which are destructive ones).

Vulnerability assessment studies to climate change are usually performed to assess the effects of climate-related hazards to households and infrastructures, and to be able to adopt strategies of adaptation to lessen the potential effects of the climate-related hazards. An assessment by the Intergovernmental Panel on Climate Change (IPCC) as cited by the US-Environmental Protection Agency (EPA), 2016 reveals that coastal areas are highly vulnerable to extreme events, such as storms, which inflict substantial costs on coastal communities. Coastal areas are sensitive to sea level rise, changes in the frequency and intensity of storms, increased precipitation and warmer ocean temperatures. Rising atmospheric concentrations of carbon dioxide are causing the oceans to absorb more of the gas and become more acidic. This increase in acidity can have significant impacts on coastal and marine ecosystems (EPA, 2016).

Among the 590 vulnerable regions in Southeast Asia, Leyte is at 111th place and 40th in the ranking of vulnerable regions in the Philippines (Yusuf & Francisco, 2010). Sajise et al., (2012) stated that coastal sites were described as receptors of inland environmental degradation or the typical upstream-downstream externality problem. With climate change that is evidently occurring nowadays, the problem has turned from the coast towards inland which is especially true since major climatic hazards such as typhoons and sea level rise come from the sea. Coastal areas are said to be "sandwiched" by climatic hazards.

This study was conducted on selected coastal communities of Baybay City, Leyte. These households are exposed to the negative effects of climate change, particularly strong winds, big waves and storm surges brought about by more frequent and intense typhoons. It aimed to seek information related to the vulnerability of these communities to the negative effects of climate change and the damages they had experienced in the past ten years. According to Sajise et al. (2012), there is very little information on the impacts of climate change in the coastal areas, and thus it is one of the sectors that climate-related studies need to focus on more. Hence, this study tried to evaluate the vulnerability of the households of four (4) selected coastal communities in Baybay City, Leyte. Specifically, it aimed to 1) determine the households' exposure to various climate-related hazards as well as their effects on the households' socio-economic living condition; 2) assess the vulnerabilities of the coastal households using the vulnerability index (VI) as a measure; 3) identify the adaptation strategies performed by the households against the negative impacts of natural hazards; and 4) recommend improved adaptation strategies to minimize households' vulnerabilities to the negative impacts of climate change.

This study envisioned to contribute to the baseline information about the vulnerability level of households in coastal communities and their adaptation strategies to minimize risk as a consequence of climate change as well as suggest improved and doable adaptation strategies to help coastal communities lessen their susceptibility to climate change.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

Vulnerability is defined as the susceptibility to disturbances determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt (Piya et al., 2012). In this study, the theoretical framework of Parry et al. (2007) was used to assess household vulnerability to climate change impacts, wherein the three (3) major indicators are factored-in in measuring the vulnerability of a given household to climate change impacts namely, exposure, sensitivity, and adaptive capacity (Figure 1).

Exposure refers to the degree of a household's exposure to natural hazards brought about by climate change (Parry et al., 2007). The degree of exposure, is based on three (3) climate change extreme events: a) typhoon, indicating the number of typhoons, tropical depressions and super typhoons experienced; b) flood as the number of flood events experienced; and c) sea-level rise, indicating the number of sea-level rise experienced in the area. Sensitivity refers to the degree to which a given household is affected, either beneficially or adversely, by climate change and the degree to which a change in climate would affect its current form

(Parry et al., 2007). Sensitivity, as a factor, consists of four (4) components, namely: a) human, which refers to the ratio of dependent person(s) (non-earning members) to earning household members; b) livelihood, referring to percentage of annual income generated from fishing and/or farming activities to total income, and percentage of annual income generated from non-natural based remunerative income to total income; c) distance, indicating the distance of a household from the coastline; and d) financial, indicating the percentage debt of household to household income. Exposure and sensitivity indicate a response to climate change impacts, but these two indicators do not necessarily indicate vulnerability.

Another variable, adaptive capacity, also affects vulnerability of households to climate change impacts, as it modulates exposure and sensitivity (Yohe and Tol, 2002). Parry et al. (2007) defines adaptive capacity as the ability of an area or a given household to adjust successfully to climate change impacts as well as climate change variability, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Adaptive capacity in this study consists of seven (7) subcomponents: a) infrastructure, indicating the type of materials the house of the household is made of; b) awareness, which indicates the household's knowledge of climate change; c) economic, referring to the total household income, debt and cash remittance made per year; d) technology, indicating the number of communication (e.g., phone lines and mobile phones) and transport facility owned per household; e) social capital, which refers to the number of contacts the household can ask for financial help; f) human capital, as the number of working household members and the level of education of the head of household; and g) strategies, as the number of adaptation strategies made to lessen the risks brought about by climatic hazards.

The conceptual framework based on the abovementioned indices is presented in Figure 1 below.

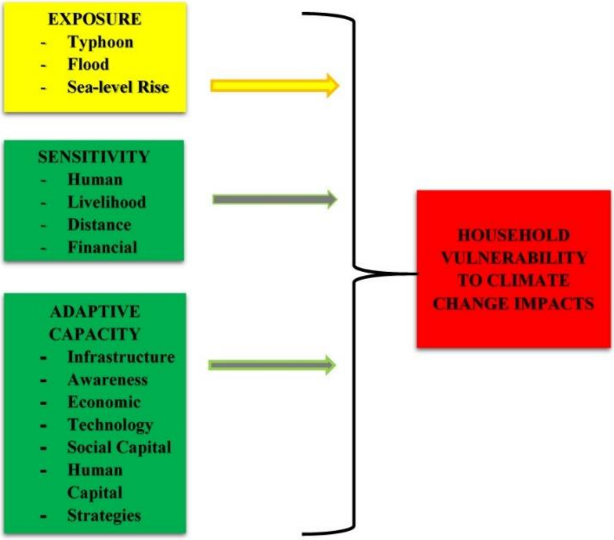

Figure 1. Conceptual model of household vulnerability to climate change impacts (Arias et al., 2014; and Piya et al., 2012)

3. METHODOLOGY

Location and Respondents of the Study

The study covered four (4) climate-prone coastal communities in Baybay City, Leyte namely: Kilim, Sabang, Jaena, and Punta (Figure 2). Selection of representative coastal sites was based on the existence of significant number of rural households living nearby coastal areas, relatively exposed to the sea, and accessibility. Key respondents for the survey who were the coastal households in the selected sites were identified from the list of registered households in each site's Barangay Office. Random sampling was done in the selection of household heads or able representatives who were subjected for interview. A total of 152 households for all sites were interviewed and distributed as follows: forty (40) in the coastal community of Barangay Kilim; twenty (20) in Barangay Sabang; fifty-two (52) in the most populated coastal Barangay of Jaena; and forty (40) in Barangay Punta.

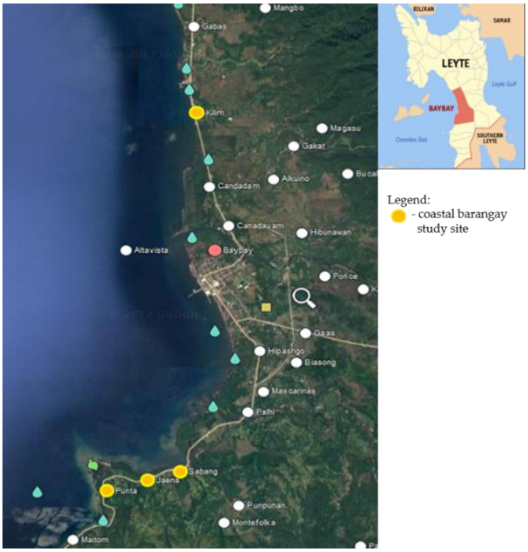

Figure 2. Map of Baybay City, Leyte showing the coastal barangay study sites. (Source: Mapcarta, 2018)

Research Design and Data Gathering

The study conducted a face-to-face household interview to determine the vulnerability of households to climatic events and the socio-economic factors influencing their vulnerability. A semi-structured survey questionnaire was developed, which contains close-ended and open-ended questions to fully examine the respondents' actual experiences, knowledge, and perceptions regarding the identified vulnerability indicators. A pre-test of the questionnaire was conducted to determine what questions are acceptable, what questions need to be eliminated or improved, and what needs to be added based on the data required in view of the objectives of the study.

Data Analysis

The construction of vulnerability index followed the principal component analysis (PCA) method by Filmer and Pritchett (2001). Normalization of data was done using the equation:

$$\text{Normalized value} = \frac{\text{Observed Value} - \text{Mean}}{\text{Standard Deviation}} \qquad (5)$$

The first components generated by PCA were used as weights for the indices. The indicators of vulnerability for each community (exposure, sensitivity, and adaptive capacity) were calculated separately using the equation, I =

$\sum_{i=1}^{k}[bi(a-x)]/s$ where I is the indicator, bi is the weight generated from first component of PCA, a is the indicator value, x is the mean indicator value, and s is the standard deviation of the indicator. The equation was used to specifically determine the details of the factors affecting households' vulnerability for each community (Piya et al., 2012):

$$V = E+S-AC \quad (6)$$

where:

V = vulnerability index
E = exposure index
S = sensitivity index
AC = adaptive capacity index

The equation does not give an absolute value, when there is a negative value of the index. This does not mean however that the community is not vulnerable at all, rather the index shows the comparative ranking of the households of a community. The higher the value of the index, the more vulnerable are the communities, and vice versa. (Piya et al., 2012).

4. RESULTS AND DISCUSSION

Socio-Demographic Characteristics of Respondents

Tables 1 shows the socio-demographic characteristics of the respondents. There were a total of 152 households interviewed from Kilim (n=40), Sabang (n=20), Jaena (n=52) and Punta (n=40) with a mean age of 47.15. Most of the respondents (76.32%) were female. In terms of educational attainment, 51.32% were elementary followed by high school and college level and/or graduate (43.42% and 3.95%, respectively). Table 1 further revealed that more of them were fisherman (32.89%) and farmer (11.84%). And, there were quite a number (22 or 14.47%) who were unemployed.

Table 1. Socio-demographic characteristics of the respondents in Baybay City, Leyte

Socio-Demographic Characteristics	Frequency (n= 152)	% of Total
Mean Age	**47.15**	
Sex		
Male	36	23.68
Female	116	76.32
Educational Level		
Elementary	78	51.32
High school	66	43.42
College	6	3.95
Livelihood		
Fisherman	50	32.89
Farmer	18	11.84
Laborer	14	9.21
Unemployed	22	14.47
Others (n ≤ 8)	41	26.97

Indicators of Vulnerability

Exposure, Sensitivity and Adaptive Capacity

From the Parry et al. (2007) framework, there are three indicators of vulnerability, namely; exposure, sensitivity and adaptive capacity. On determining the level of exposure of the households, there were five (5) variables used namely: a) the number of typhoon events experienced; b) number of super typhoon events experienced; c) number of flood events experienced; d) longest duration of the flood events experienced; and e) number of high sea-level rise events experienced by the households. The time period given is within 10 years (2007-2016). For all the barangays, the maximum number of these indicators were 300 for typhoon events, 10 for super typhoon events, 100 flood events, 72 flood hours, and 50 for high sea-level rise events. Table 2 shows the descriptive statistics of the indicators for exposure. On the average, the respondents experienced 41 typhoons, 3 super typhoons, 5 flood events with 9.64 hours long and 2 high sea-level rise events.

Table 2. Indicators of exposure

Variable	Mean	Std. Deviation	Min.	Max.
Number of typhoon events	41.26	49.61	1	300
Number of super typhoon events	3.13	2.35	1	10
Number of flood events	5.31	12.37	0	100
Longest duration of flood (hours)	9.64	13.76	0	72
Number of high sea-level rise events	2.18	5.91	0	50

On the other hand, there were five (5) indicators used in determining the sensitivity of a household on climate change impacts, namely: a) the number of non-earning family members who depend on the working family members of the household (housewives, children, seniors, and/or unemployed family members); b) the percentage of natural based income (income generated from farming, fishing, forestry, and handicraft) to total household income; c) the percentage of non-natural based income (income generated from salaried jobs, non-farm skilled jobs) to total household income; d) the percentage of debt to total household income, and distance of household from the coastline where 1 is coded as very far, 2 coded as far, 3 coded as near, 4 coded as very near, and 5 coded as on the shore. Table 3 shows that on the average, respondents have a percentage share of 43.04 of natural based income and a percentage share of 39.73 of non-natural based income. Percent share of debt to total income is 12.94. At least two members in the family were non-earning.

Table 3a further shows how far households in each of the barangay were situated from the coastline. Of all the barangays, majority (46.05%) of the total households answered they are very near from the coastline, which implies that they may be vulnerable to climate change impacts like flooding, storm surges, and others. Only 3.29% of the respondents were situated very far (30 m to 39 m).

The third indicator of vulnerability is adaptive capacity. Under adaptive capacity, there were ten (10) indicators constructed. This includes the kind of construction materials of the roofing and the walls of the house, which are both coded 1 for light materials such as thatch roof, *sawali*, salvaged/makeshift materials, 2 for mixed but predominantly light materials, 3 for mixed but predominantly permanent materials, and 4 for permanent materials such as galvanized iron, aluminium tile, concrete, brick stone, and asbestos. Other indicators of adaptive capacity are the awareness of the household to climate change; the total annual household income; other sources of income, specifically the cash remittances from OFWs or relatives and/or family members outside the household; number of devices (mobile phones, radios, televisions, computer with internet) available as source of information; the number of transportation (bicycle, motor, car, *"Bangka"*, pump boat, motor cab, *"potpot")* available; number of adaptation strategies performed (undertook improvements to make house more resilient to flooding and typhoon, asked financial help, dug canals, reinforced fish cages/animal pens, etc.); number of working family members; and lastly, the highest level of educational attainment of the household head.

Table 3. Indicators of sensitivity

Variable	Mean	Std. Deviation	Min.	Max.
No. of non-earning family members	2.38	1.81	0	9.00
% share of natural based income to total income	39.73	42.80	0	100.00
% share of non-natural based income to total income	43.04	45.18	0	100.00
% share of debt to total income	12.94	29.10	0	213.33

Table 3a. Distance of households from the coastline

Distance from Coastline	Kilim		Sabang		Jaena		Punta		Total	
	n	%	n	%	n	%	n	%	n	%
Very near (1 m to 9 m)	14	35	11	55	24	46.20	21	53	70	46.10
Near (10 m to 28 m)	17	43	5	25	15	28.90	11	28	48	31.60
On the shore	0	0	0	0	8	15.40	7	18	15	9.87
Far (20 m to 29 m)	7	18	3	15	3	5.77	1	2.5	14	9.21
Very far (30 m to 39 m)	2	5	1	5	2	3.85	0	0	5	3.29
Total	40	100	20	100	52	100	52	100	152	100

Table 4 revealed that the respondents has an annual household income of Php 81058.42; other income (cash remittances, pension, retirement income) of Php 13739.47, 2 number of devices available, 1 number of transportation available, 3 number of adaptation strategies performed, and at least 2 of the family members are working.

Table 4. Indicators of adaptive capacity

Variable	Mean	Std. Deviation	Min.	Max.
Annual household income	81,058.42	66,732.41	2,880.00	420,000.00
Other income (cash remittances, pension, retirement income)	13,739.47	34,925.89	0	240,000.00
Number of devices available	1.89	0.97	0	4.00
Number of transportation available	0.53	0.66	0	3.00
Number of adaptation strategies performed	3.05	1.69	0	10.00
Number of working family members	1.7	1.22	0	8

On the type of construction material used for the households' roof, Table 4a reveals that majority (43.42%) of the respondents used permanent construction materials while a few (13.82%) used mixed but predominantly light construction materials. For house wall, majority (48.68%) of the households utilized light construction materials and only a few (12.50%) used permanent construction materials (Table 4b). Hence, the results imply that majority of the households may be less exposed to flooding caused by heavy rains but more exposed to strong winds brought by typhoons.

Regarding awareness on climate change, there were a total of 121 households who were aware compared to 31 unaware households (Table 4c).

Adaptation strategies were asked from the respondents as follows: a) if they undertook improvements to make the house more resilient to climate change impacts; b) if they buy or prepare emergency supplies before a typhoon occurs; c) if they dug canals; d) planted water-absorbing trees; e) reinforced fish pens or animal pens; f) harvested fish or crops early; g) applied flood resilient farming or fishing methods; h) moved fishing or farming equipment; i) pursued other means to generate income; j) evacuated to a safer place; k) asked for financial help; and l) if they have savings as contingency fund in case of an emergency (Table 4d). The most common strategy adapted by respondents is evacuating to a safer place (30.02%) while the least common is planting water-absorbing trees (0.43%).

However, households also practice adaptive strategies that tend to preserve or sustain their socio-economic gains. In Kilim, for example, the respondents ventured in alternative income-generating activities. In Jaena, the respondents asked for financial assistance while in Punta, they used resilient methods for farming and fishing (Table 4d).

In terms of performing strategies to improve house resiliency, Table 4e shows that most of the households (33) used wood, 30 households used cement to improve their houses, and 24 household respondents tied ropes to their ceilings against strong winds.

Table 4a. Type of construction materials for house roof used by respondents

Construction Material	Kilim		Sabang		Jaena		Punta		Total	
	n	%	n	%	n	%	n	%	n	%
Permanent materials	11	27.5	13	65	21	40.38	21	52.5	66	43.42
Light materials	19	47.5	1	5	11	21.15	7	17.5	38	25
Mixed but predominantly light materials	6	15	3	15	11	21.15	7	17.5	27	17.76
Mixed but predominantly permanent materials	4	10	3	15	9	17.31	5	12.5	21	13.82
Total	40	100	20	100	52	100	40	100	152	100

Table 4b. Type of construction materials for house wall utilized by respondents

Construction Material	Kilim		Sabang		Jaena		Punta		Total	
	n	%	n	%	n	%	n	%	n	%
Light materials	17	42.50	11	55.00	24	46.15	22	55.00	74	48.68
Mixed but predominantly light materials	14	35.00	5	25.00	15	28.85	7	17.50	41	26.97
Mixed but predominantly permanent materials	7	17.50	1	5.00	5	9.62	5	12.50	18	11.84
Permanent materials	2	5.00	3	15.00	8	15.38	6	15.00	19	12.50
Total	40	100	20	100	52	100	40	100	152	100

Table 4c. Number of respondents per barangay who were aware of climate change

Barangay	Unaware Households		Aware Households	
	n	%	n	%
Jaena	12	38.71	40	33.06
Punta	6	19.35	31	28.10
Kilim	7	22.58	33	27.53
Sabang	6	19.35	14	11.57
Total	31	100	121	100

Table 4d. Type of adaptive strategies performed by the households of coastal communities in Baybay City, Leyte

Adaptation Strategies	Kilim		Sabang		Jaena		Punta		Total	
	n	%	n	%	n	%	n	%	n	%
Evacuated to a safer place	38	30.65	13	17.11	48	34.02	40	32.79	139	30.02
Undertook house improvements	25	20.16	17	22.37	26	18.44	20	16.39	88	19.00
Pursued other activities to generate income	17	13.71	13	17.11	15	10.64	10	8.20	55	11.88
Have savings	12	9.67	8	10.53	12	8.51	10	8.20	42	9.07
Asked for financial help	4	3.23	7	9.21	15	10.64	7	5.74	33	7.13
Put equipment to safety	9	7.26	4	5.26	3	2.13	14	11.48	30	6.48
Reinforced fish cages/animal pens	6	4.84	5	6.58	8	5.67	1	0.82	20	4.32
Done resilient methods in farming or fishing	5	4.03	0	0.00	2	1.42	12	9.84	19	4.10
Harvest crops/ fish early	5	4.03	3	3.95	4	2.84	5	4.10	17	3.67
Dug canals	2	1.61	3	3.95	4	2.84	1	0.82	10	2.16
Prepare before a typhoon	0	0.00	3	3.95	3	2.13	2	1.64	8	1.73
Planted water-absorbing trees	1	0.81	0	0.00	1	0.71	0	0.00	2	0.43
Total	124	100	76	100	141	100	122	100	463	100

Table 4e. Different strategies done by households of coastal communities to improve house resiliency

Adaptation Strategies	Kilim		Sabang		Jaena		Punta		Total	
	n	%	n	%	n	%	n	%	N	%
Used wood to improve house	5	18.52	4	20	14	48.28	10	50	33	34.38
Used cement to improve house	11	40.74	4	20	9	31.03	6	30	30	31.25
Tying ropes to ceiling	7	25.93	9	45	4	13.79	4	20	24	25.00
Elevated their houses	2	7.41	1	5	1	3.45	0	0	4	4.17
Covered house footing with cement	1	3.70	1	5	0	0.00	0	0	2	2.08
Fencing around the house to prevent flooding	1	3.70	0	0	1	3.45	0	0	2	2.08
Covered the side of the house with rocks and cement to protect from water splash	0	0.00	1	5	0	0.00	0	0	1	1.04
Total	27	100	20	100	29	100	20	100	96	100

Vulnerability Index

In constructing the vulnerability index, the indexes for the three indicators of vulnerability – exposure, sensitivity, and adaptive capacity, were made first. The sub-indicators of vulnerability were run through Principal Components Analysis (PCA) to acquire the first components which has eigenvalues > 1. The sub-indicators were normalized/standardized with a mean of 0 and a standard deviation of 1 to turn the sub-indicators in a comparable range. The command pca X1 X2 X3...Xn and predict (newvar) score performs the mentioned methods using Stata

Tables 5, 6, and 7 show the loadings of the first components of each indicators of vulnerability. The Principal Component Analysis disregards the signs of the components. The signs only tell us how the sub-indicators contribute to the factor. In aggregate, all of the sub-indicators contribute positively to the indicators as hypothesized, except for percentage share of natural based income.

The results revealed that the highest loadings generated for exposure, sensitivity, and adaptive capacity is the number of typhoon events (0.4848), percentage share of non-natural based income (0.6652), and the annual household income (0.4787).

Table 5. Exposure: loadings from the first component.

Variable	Kilim	Sabang	Jaena	Punta	Total
	(n=40)	(n=20)	(n =52)	(n =40)	(n=152)
Number of Typhoon events	0.333	0.461	0.329	-0.098	0.485
Number of Super typhoon events	0.193	0.376	0.450	-0.333	0.469
Longest duration of flood	0.668	0.443	0.530	-0.042	0.458
Highest flood level	0.206	0.468	0.549	-0.161	0.424
Number of flood events	0.609	0.288	0.296	0.644	0.344
Number of high sea-level rise events	-0.012	0.385	0.138	0.661	0.194

Table 6. Sensitivity: loadings from the first component

Variable	Kilim	Sabang	Jaena	Punta	Total
	(n=40)	(n=20)	(n =52)	(n =40)	(n=152)
% share of non-natural based income	0.671	-0.580	0.549	0.618	0.665
% share of debt to total income	0.249	-0.283	0.090	-0.180	0.240
No. of non-earning family members	0.031	0.055	0.399	0.473	0.239
Distance from the coastline	0.051	0.437	0.475	0.147	0.133
% share of natural based income	-0.696	0.625	-0.553	-0.583	-0.652

Table 7. Adaptive capacity: loadings from the first component

Variable	Kilim (n=40)	Sabang (n=20)	Jaena (n =52)	Punta (n =40)	Total (n=152)
Construction material of house wall	0.365	0.402	0.238	0.470	0.248
Construction material of house roof	0.168	0.319	0.180	0.419	0.160
Number of working family members	0.014	0.145	-0.004	0.270	0.111
Awareness to climate change	0.058	0.069	0.004	-0.146	0.075
Annual household income	0.347	0.173	0.487	-0.024	0.479
Other income (cash remittances, pension, retirement income)	0.451	0.455	0.397	0.200	0.415
Number of devices to available	0.385	-0.392	0.381	-0.281	0.400
Highest educational attainment	0.313	-0.375	0.335	0.181	0.340
Number of transportation available	0.397	-0.397	0.349	-0.398	0.337
Number of adaptation strategies performed	0.327	-0.148	0.371	-0.445	0.323

Vulnerability of Households per Community

The scaling for overall vulnerability is based on the study of Arias, et al. (2014). The overall vulnerability and levels of the indicators ranges from 0 to 1, 0 being the lowest and 1 being the highest (Table 8). A value less than 0 would indicate a very low vulnerability (Piya et al., 2012).

Table 8. Levels of exposure, sensitivity, and adaptive capacity of the coastal community given the vulnerability indicators

Value	Exposure	Sensitivity	Adaptive Capacity	Household Vulnerability
< 0	Very low	Very low	Very low	Very low
0.0-0.5	Low	Low	Low	Low
0.5-0.79	Moderate	Moderate	Moderate	Moderate
0.8-1.0	High	High	High	High

Households' vulnerability to typhoons, super typhoons, and tropical depressions

Among the selected coastal communities, Punta is the least vulnerable while Sabang is most vulnerable to typhoon, tropical depression, and super typhoon events. This vulnerability results is shown in Figure 2. In spite of Sabang having a moderate level (0.35) of adaptive capacity, it also has a moderate level (0.51) of exposure and a low level (0.16) of sensitivity to typhoon, tropical depression, and super typhoon events. Punta which is the least vulnerable among all of them, has negative index values. This implies that the households were less exposed and not easily affected to typhoon, super typhoons, and tropical depressions resulting to a low adaptive capacity as well.

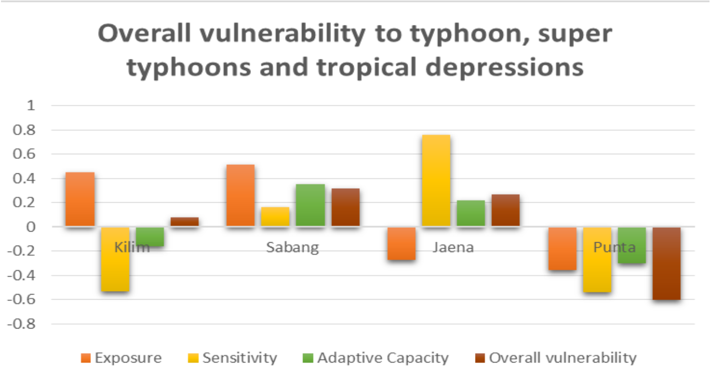

Figure 2. Graphical presentation of indices for typhoon, super typhoon, and tropical depression events

Households' vulnerability to flood and high sea-level rise events

The households of the selected communities were also asked if they were affected by flooding and high sea-level rise events within 10 years (2007-2016), and if they were able to cope with these events. Thus, the vulnerability index to flood and high sea-level rise was calculated and graphically illustrated in Figure 3. As indicated, Kilim is the least vulnerable (-0.43), having negative index values for all of the indicators while Sabang is still the most vulnerable (0.45) to flooding and high sea-level rise events, with a moderate level (0.64) of exposure, a low level (0.16) of sensitivity, and low level (0.35) of adaptive capacity. The households in Punta are exposed and are easily affected, yet they have low level of adaptive capacity.

Households' vulnerability to climate change impacts

Combining the aforementioned would result to overall vulnerability of the selected coastal communities to climate change impacts. As shown in Figure 4, Sabang is the most (0.66) vulnerable among the four coastal communities in spite of having the highest adaptive capacity (0.35). This is because Sabang is highly exposed (0.85) to the impacts brought by climatic hazards and has a moderate level of sensitivity. Next in line is Jaena, which is the most (0.76) sensitive among all the barangays but despite of that, it is less vulnerable (0.16) compared to Sabang. This is because Jaena is less exposed (-0.38), and having a moderate level of adaptive capacity (0.22). Kilim ranks third place among the four (4) selected coastal communities. Despite having a moderate level of exposure (0.24), it is less vulnerable (-0.13) compared to the aforementioned barangays, since it is brought down by a very low (-0.53) sensitivity despite having low (-0.16) adaptive capacity. Lastly, Punta is the least (-0.41) vulnerable of all coastal communities selected. Despite having a very low (-0.3) adaptive capacity, the households were not that exposed (-0.17) and were not that sensitive (-0.54) compared to the other barangays.

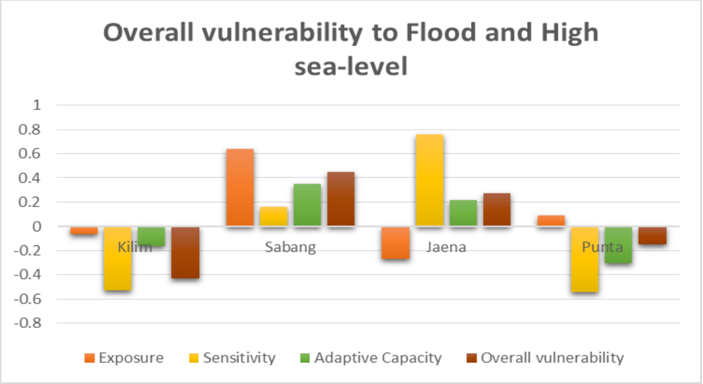

Figure 3. Graphical presentation of indices for flood and high sea-level rise events

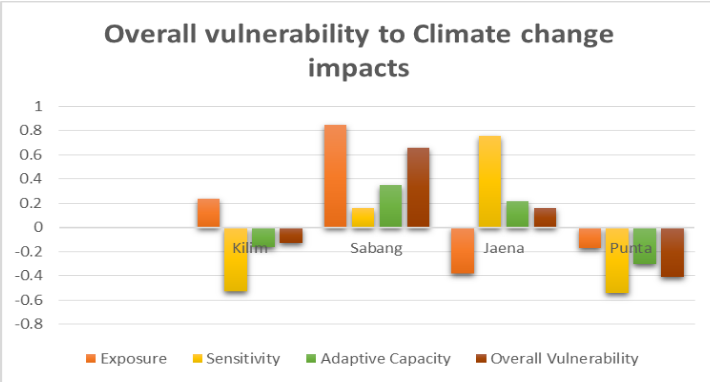

Figure 4. Graphical presentation of indices to climate change impacts per coastal community

5. RECOMMENDATIONS AND POLICY IMPLICATIONS

According to Spalding et al. (2014) mangroves play a huge role in dealing with risks at the coastal areas. Mangroves were said to reduce wave damage, damage from large storms, tsunami damage, reduce erosion and binds the soil together; and may keep up with sea level rise. Hence, it is recommended that for places suited for mangroves, mangroves should be planted. In some other cases, the building of infrastructure like dikes or breakwaters should be done to at least, cope with the risks in coastal areas. For a while, there must be an appropriate evacuation center prepared or designated for the households for them not to worry for their safety and where they would evacuate when the need arises. The implementation of alternative livelihood programs and provision of financial assistance in times of emergency will form part of their coping mechanism in addition to seminars and information campaign in relation to climate change. The No-build zone policy within 40 meters away from the shoreline should be implemented to prevent damages and loss of lives in case of storm surges or tsunamis. Albeit, the government should take the lead for the resettlement of the displaced households.

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