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Vulnerability Assessment to Climate Change of Households from Mabacan, Sta. Cruz and Balanac Watersheds in Laguna, Philippines

ABSTRACT

The Province of Laguna has been identified as one of the most vulnerable to climate change. Despite the various efforts of the local government unit, the province still suffers massive damages brought about by typhoons, flooding and landslides. This signals the need for a better strategy to manage climate change related hazards. As a first step, it is necessary to characterize the vulnerability of households in the province. This study contributed towards this end a descriptive analysis of household exposure to impacts of climate related hazards and estimating a household's vulnerability index using the Vulnerability as Expected Poverty (VEP) approach. The mean VEP for a per capita monthly poverty threshold of US$1.25 is 37%, 41% for US$1.5 and 46% for US$2.0. Among the different sectors, those dependent on aquaculture/fishery had the highest incidence of vulnerability followed by those dependent on employment in the manufacturing sector. In terms of geographical location, households in the coastal areas were found to have the highest incidence, followed by those in the lowland and lastly those in the midland to highland areas.

Key words: *Climate Change, Laguna, Vulnerability*

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INTRODUCTION

Climate change is expected to bring about varying weather patterns and rainfall variability at increasing frequency and intensity. The adverse impact of this phenomenon can be substantial. In Asia, as warned by the International Panel for Climate Change (IPCC) in its 2001 report, an increase in frequency and intensity of these events is already being realized. Severe weather events are becoming prevalent in the region and are causing a huge burden for the economy.

In the Philippines, the increasing occurrence and intensity of typhoon and flooding is widely apparent. Parts of the country, like the provinces in Mindanao that are rarely exposed to natural hazards are now battered by severe weather events and heavy precipitation. The country, on the average, experiences 20 typhoons per year, causing substantial damages in properties, agricultural crops, health, and even resulting in a number of fatalities (*United Nations 2007 and NEDA 2008*). *Yusuf and Francisco* (*2009*) states that all the regions of the Philippines are vulnerable to climate change. This finding is supported by other studies. For instance, the Philippines was ranked 10th among the countries with extreme risk to the impact of climate change by the *Maplecroft's Climate Change and Environment Risk Atlas* (*2012*) due to the country's increasing exposure to extreme weather disturbances, growing population and low adaptive capacity to combat the adverse impact of climate change.

Despite efforts of the local government in Disaster Risk Reduction and Management (DRRM), the province of Laguna still experienced great losses from recent typhoons, flooding and landslides. This signals the need to identify a more refined strategy to minimize effects and damages of future hazards. One way to do this is by building the overall resilience of the province, from the level of local communities down to its smallest unit - the household. A necessary first step toward this goal is to assess the vulnerability of households to climate change related hazards. This study explores this by estimating a household climate change vulnerability index. Vulnerability indices are important tools in policy making. The *United Nations Framework Convention on Climate Change* (*2014*) identified several of its uses: (1) for intervention targeting and prioritization; (2) as a basis or framework for evaluating specific adaptation measures; and (3) as an input in monitoring efforts.

METHODOLOGY

Data Collection Method

Laguna was selected as the study site because of two reasons. First, it was identified to be among the top ten provinces that are vulnerable to climate related risks including risks to typhoons, droughts, change in rainfall and increase temperature (*Center for Environmental Geomatics-Manila Observatory 2005*). Over the last 10 years, it has been visited by several strong typhoons, which include, TS Xangsane (Milenyo), TS Durina (Reming), TS Ketsana (Ondoy) and TS Mirinae (Santi). The most recent typhoons, Ondoy and Santi have lingered in the minds of most Laguna folks as they left many of coastal municipalities inundated for months affecting the livelihood activities as well as endangering the health condition of the people especially the children and older folks. The second reason relates to the province having made headway in DRRM[1]. However, despite this, the province still experienced substantial impacts from heavy rains and strong typhoons that bring about flash floods and landslides.

The survey site was narrowed down to 12 municipalities situated in three major watersheds in the province which represents lowland, midland and highland areas. The survey was undertaken from June to September 2011 wherein interviews were conducted using a pre-tested survey questionnaire written in the local dialect (Filipino-Tagalog). It included questions about the respondent's characteristics, household characteristics, exposure indicators, adaptive capacity indicators, awareness and perception regarding climate change issues, coping mechanism and adaptation practices, as well as impacts of typhoon and flooding.

A two stage stratified random sampling was applied in this study. The population of households was stratified by municipality and then by settlement type: rural or urban. A stratified random sample of 600 households was then obtained using proportionate sampling, i.e., the size of each stratum in the sample was proportionate to the size of the stratum in the population. The households making up the sample were randomly selected from a list of households provided by the local government units and the Barangay Integrated Development Approach for Nutrition Improvement of the University of the Philippines Los Baños (BIDANI-UPLB). Whenever a selected household cannot be located or refused to participate, a replacement household was selected randomly from the same stratum. A total of 167 households in the original sample were replaced, 160 of which cannot be located and 7 refused to participate.

Analytical Method

To describe the exposure and impacts of households to climate related hazards, descriptive statistics (such as computing for frequency, means and cross-tabulation) was undertaken. For the computation of the vulnerability index, the Vulnerability as Expected Poverty (VEP) was used. The VEP is an econometric approach in measuring the vulnerability of households. In the VEP framework, vulnerability is defined as the probability that households or individuals will move to poverty in the future or fall below a minimum consumption threshold level, given certain shocks (*Chaudhuri 2003*). These shocks may include the occurrence of climate extremes or climate variability.

The analytical procedure followed the work of *Chaudhuri*, *Jalan and Suryahadi* (*2002*) and *Deressa, Hassan and Ringler* (*2009*). First, it is assumed that the stochastic process that generates the consumption of a household is given by:

$$lnc_h = X_h\beta + e_h \qquad (1)$$

Where the variable is per capita consumption expenditure, is a vector of observable household characteristics, is a vector of parameters, and the variables/characters pertaining to the equation were omitted is a mean-zero disturbance term, which captures shocks. As proxy for consumption, the household monthly expenditure was used. The explanatory variables were sex and number of years of schooling of the household head, household size, livelihood dependence on natural resources (estimated as the ratio between agriculture, fishery and forestry income to total income), a dummy variable for land ownership, and a dummy variable for household with members who are chronically ill or with disabilities. To capture climate-related indicators, the number of typhoons categorized as signal number 3 or stronger, and the maximum flood height over the last 10 years were included. Also, a dummy is included for households who have experienced drought and with livelihoods that are natural resource dependent. The model assumes that the variance of is given by:

$$\sigma^2_{e,h} = X_h\theta \qquad (2)$$

ß and *Ɵ* were estimated using the three-step feasible generalized least squares (FGLS) method (*Amemiya 1977*). Using the estimates of *ß* and *Ɵ*, the expected log consumption for each household h was computed:

[1]For instance the Laguna Provincial Agriculture Office conducted Farmer's Field Schools, Techno Clinics, and Techno Updates which introduces new technology for rice production as well as flood-tolerant crops. One of the upland municipalities, Rizal, has an ordinance that requires the participation of youth in their flood and landslide mitigation projects. Municipalities conduct information, education campaign, trainings and seminars on DRRM and capability building for barangay volunteers, senior citizens, and people with disabilities. Core Shelter Assistance Programs have been started for families living in frequently inundated areas.

$$\hat{E}[lnc_h \;\; X_h] = X_h\hat{\beta} \quad (3)$$

As well as the variance of log consumption:

$$\hat{V}[lnc_h \;\; X_h] = \hat{\sigma}^2_{e,h} = X_h\hat{\theta} \quad (4)$$

By assuming that consumption is log-normally distributed, the above equations were used to estimate the probability that a household with the characteristics, X_h, will be poor (which is essentially the household's vulnerability level) using:

$$\hat{v}_h = \widehat{Pr}(\ln c_h < \ln z | X_h) = \Phi\left(\frac{\ln z - X_h\hat{\beta}}{\sqrt{X_h\hat{\theta}}}\right) \quad (5)$$

Where Φ denote the cumulative density of the standard normal distribution and ln z is the log of the minimum consumption level, below which a household would be called vulnerable. Three threshold consumption levels were used, the World Bank minimum of US$ 1.25 per capita per day, US$ 1.50 per capita per day, and US$ 2.00 per capita per day. The analysis was based from the assumption that climate extremes or climate shocks, particularly, typhoon, flood and drought will have an influence on the probability that households' consumption will fall below a given minimum level (*Deressa, Hassan and Ringler 2009*).

RESULTS AND DISCUSSION

Study Site

Laguna is located 30 km southeast of Manila. It is bounded by Laguna de Bay and the province of Rizal on the north, by Quezon Province on the east, by Batangas on the south, and by Cavite on the west (**Figure 1**). It is the third largest province in Region IV with a land area of 1,759.7 km^2 of which 50% is used for agricultural activities. Laguna is part of the CALABARZON Region, with the provinces of Cavite, Batangas, Rizal and Quezon.

The study site included the 12 municipalities inside the watersheds of Mabacan, Sta. Cruz and Balanac in the province of Laguna. The watersheds' boundaries cover an estimated area of 568 km^2, which is just slightly less than a third of the Province's entire area. The municipalities included in the study are Los Baños, Bay, Calauan, Victoria, Pila, Sta. Cruz, Pagsanjan, Magdalena, Majayjay, Liliw, Nagcarlan and Rizal.

Profile of the Household Survey Respondents

Of the 600 respondents, 41% are male and 59% are female (**Table 1**). The mean age for all the respondents is 48. The average age is the same for both men and women. Seventy-seven percent (77%) are married. About 83% of the male respondents are gainfully employed, while their female counterpart has a lower employment rate of about 48%. The average number of years of schooling for both male and female respondents is nine years (**Table 2**).

Vulnerability as Expected Poverty

Eleven key variables were used in the estimation of VEP Index. (**Table 3**). The mean per capita monthly consumption is PhP 2,061, while the proportion of households dependent on agriculture, fishery and forestry livelihood is 0.1. The mean age of household head is 51, and the mean educational attainment is 9 years. The average household size is 5. The mean highest flood height is about 1 foot. Forty-three observations had chronically ill or disabled members, 67

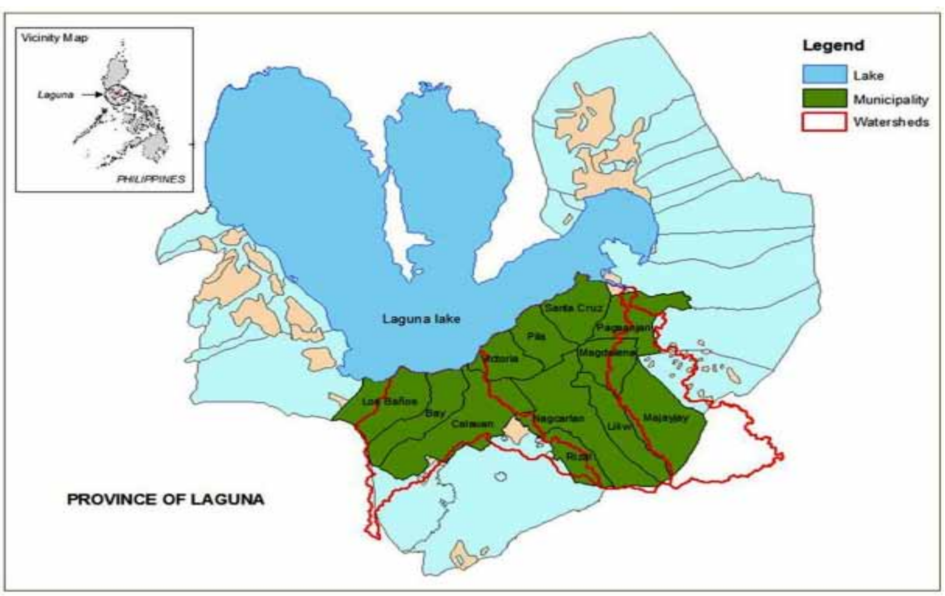

Figure 1. Map of Laguna showing the study site.

Table 1. Number of respondents per municipality.

Municipality	No. of Sampled Barangay	No. of HH Respondents	% Share	No. of Respondents			
				Female	% of Total	Male	% of Total
Bay	16	50	8	23	46	27	54
Calauan	15	60	10	38	63	22	37
Liliw	15	33	6	20	61	13	39
Los Baños	10	92	15	56	61	36	39
Magdalena	12	21	4	12	57	9	43
Majayjay	18	31	5	15	48	16	52
Nagcarlan	29	61	10	30	49	31	51
Pagsanjan	13	37	6	17	46	20	54
Pila	15	53	9	33	62	20	38
Rizal	7	16	3	10	63	6	38
Sta. Cruz	21	109	18	73	67	36	33
Victoria	7	37	6	25	68	12	32
TOTAL	178	600	100	352	59	248	41

Table 2. Summary of the socio-demographic characteristics of the respondents.

Municipality	Mean Age of Respondents			% of Respondents Married (n=600)	Mean Years of Schooling			% of Female Respondents Employed (n=352)	% of Male Respondents Employed (n=248)	% of Respondents Employed (n=600)
	Female	Male	All		Female	Male	All			
Bay	44	44	44	84	10	8	9	48	96	74
Calauan	45	50	47	72	9	8	9	45	77	57
Liliw	52	45	49	73	8	8	8	55	77	64
Los Baños	49	48	49	78	10	10	10	38	75	52
Magdalena	45	55	49	86	7	7	7	58	89	71
Majayjay	50	49	49	81	8	11	9	47	94	71
Nagcarlan	50	49	49	74	9	10	10	53	74	64
Pagsanjan	47	47	47	78	9	9	9	29	95	65
Pila	43	48	45	81	8	9	9	58	75	64
Rizal	47	46	47	63	11	7	9	70	100	81
Sta. Cruz	50	48	49	78	10	9	9	52	81	61
Victoria	50	51	50	76	9	7	8	44	83	57
ALL	48	48	48	77	9	9	9	48	83	63

are Agriculture, Aquaculture/Fishery and Forestry (AFF) household which experienced drought, and 326 experienced a landslide.

The VEP index has a value that ranges from 0 to 1, with 1 having the highest vulnerability. In categorizing household according to vulnerability, the study assumed that households with a VEP of less than 0.50 are not vulnerable, while those with 0.50 to 0.79 are moderately vulnerable, lastly those with 0.8 to 1 VEPs are highly vulnerable. VEP can also be expressed in percentage form. For instance, if the calculated VEP is 0.78, it is interpreted as follows: the probability that the household will fall below the minimum consumption threshold level (or will be poor) is 78%, hence the household is considered moderately vulnerable. As mentioned earlier, three minimum consumption threshold levels were included in the study, US$ 1.25 per capita per day, US$ 1.50 per capita per day, and US$ 2.00 per capita per day. VEP estimates from these three thresholds are labelled as VEP1, VEP2, and VEP3, respectively.

The mean VEP index for all households are 0.37, 0.41, and 0.46, at US$ 1.25, US$ 1.5, and US$ 2.00 thresholds, respectively (**Table 4**). As expected, the mean VEP index and the incidence of vulnerability increases as the minimum consumption threshold increases.

Following the discussion in *Deressa, Hassan and Ringler* (2009), a scatter diagram of VEP vis-à-vis the log of per capita consumption is presented (**Figure 2**, **Figure 3** and **Figure 4**). The graphs are divided into six segments by a red line. Points on the left of the red vertical line are households that are currently poor, while those on the right side of the red vertical line are households that are not poor. Households are classified poor if their current (actual) consumption level is lower than the minimum consumption threshold. On the other hand, households situated below the lower horizontal line are not vulnerable, while those above

Table 3. Number of respondents per municipality.

Variable	Mean	Min	Max	SD	Frequency (Dummy=1)
Consumption (PhP/month)	8,875	-	120,000	9,867	
Consumption per capita (PhP/month)	2,061	-	48,000	2,953	
Livelihood dependence on the AFF- sector (Ratio of AFF Income to Total Income)	0.10	-	1	0.25	
Age of the household (HH) head	51	22	94	13.34	
Gender of the HH head (Dummy variable takes on the value of 1 if male)	0.81	-	1	0.39	
Number of years of schooling of HH head	8.95	-	23	3.53	
Household size	5.02	1	20	2.29	
With chronically ill or disabled members (Dummy variable takes on the value of 1 if there is a chronically ill or disabled HH member)	0.07	-	1	0.26	43
Number of strong typhoons (at least Signal Number 3 Category) experienced in the last 10 years	2.94	-	30	2.99	
Highest flood height experienced by the HH in the last 10 years), in inches	0.94	-	12	1.58	
Drought (Dummy variable takes on the value of 1 for AFF households that has experienced drought in the last 10 years)	0.11	-	1	0.32	67
Landslide (Dummy variable takes on the value of 1 if household has experienced landslide in the last 10 years)	0.54	-	1	0.50	326

Table 4. Descriptive statistics of the Vulnerability as Expected Poverty (VEP) Index.

Threshold	VEP (All Households)		
	US$ 1.25	US$ 1.5	US$ 2.00
Mean	0.37	0.41	0.46
Standard Deviation	0.37	0.37	0.38
Minimum	-	-	-
Maximum	1.00	1.00	1.00
Incidence of Non-Vulnerable HH (%)	64	60	54
Incidence of Moderately Vulnerable HH (%)	14	14	15
Incidence of Highly Vulnerable HH (%)	23	27	31

are vulnerable. Households above the higher horizontal line are considered highly vulnerable. Hence, in segment I, we have poor but non-vulnerable households; in segment II, poor and moderately vulnerable households; in segment III, poor and highly vulnerable households; in segment IV are not poor and not vulnerable; in segment V, not poor but moderately vulnerable; and in segment VI, not poor but highly vulnerable households (**Table 5**).

The distribution (proportion) of households across the six segments is summarized (**Table 6**). At US$ 1.25 consumption threshold, about 11% of households are considered non-poor but vulnerable. This proportion becomes smaller as the threshold level increases. On the other hand, 32% of households are considered poor but not vulnerable, and the proportion of this segment becomes larger as the threshold level increases.

Table 5. Segments of the VEP index vis-à-vis ln (per capita consumption) diagram.

	Poor	Not Poor
Not Vulnerable	Segment I	Segment IV
Moderately Vulnerable	Segment II	Segment V
Highly Vulnerable	Segment III	Segment VI

The main purpose for doing a vulnerability assessment is to come up with relevant information that can serve as a guide in formulating adaptation strategies. The results can be used by the local government, non-government organizations, and the residents of the community in identifying possible interventions or measures that are strategic and responsive to the needs of the locality. Focusing on the vulnerable groups is a rational approach as this can potentially provide the maximum benefit from investments, especially since financial resources for adaptation are usually limited. As such, it is a useful exercise to describe and characterize the households that are considered vulnerable. Specifically, the incidence of vulnerability based on livelihood dependence, as well as based on geographical location were analyzed.

A surprising result of the analysis is that non-AFF households seem to have higher mean VEP than AFF households. At US$1.25 threshold, mean VEP for AFF is 0.29 while that for Non-AFF is 0.39. The disparity between the two gradually increases as the consumption threshold level increases. As for the distinction between moderate and high vulnerability, the incidence of highly vulnerable households is higher at about 17% compared to 13% for moderate vulnerability (at the lowest poverty threshold level) for AFF households. For non-AFF households the incidence of highly vulnerable households is 24%, while for the moderately vulnerable, the incidence is 14% (at the lowest poverty threshold level) (**Table 7**). A test of differences between means show that the p-value is 0, signifying that the mean VEP between AFF and non-AFF are statistically different.

Table 6. Distribution of households across the six segments of the VEP diagram.

At US$ 1.25 minimum consumption threshold level		
	Poor	**Not Poor**
Not Vulnerable	32	32
Moderately Vulnerable	9	5
Highly Vulnerable	17	6
At US$ 1.5 minimum consumption threshold level		
	Poor	**Not Poor**
Not Vulnerable	34	25
Moderately Vulnerable	11	3
Highly Vulnerable	21	6
At US$ 2.00 minimum consumption threshold level		
	Poor	**Not Poor**
Not Vulnerable	39	16
Moderately Vulnerable	13	2
Highly Vulnerable	27	3

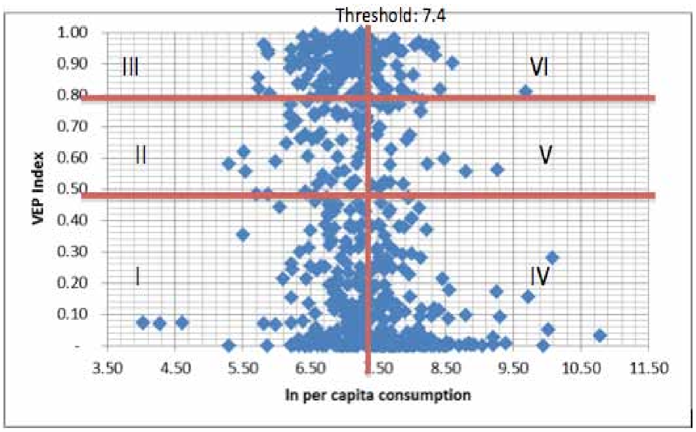

Figure 2. Vulnerability vis-a-vis ln (per capita consumption) at US$ 1.25 threshold.

Households whose head are employed in aquaculture/ fisheries had the highest incidence, followed by those employed in manufacturing. Households whose head are engaged in agriculture had a relatively low incidence, even lower than those employed in the commercial/services sector. The least incidence is for those in government and the academe (**Table 8**).

In terms of topography, households situated in coastal barangays had higher mean VEP than those situated in the

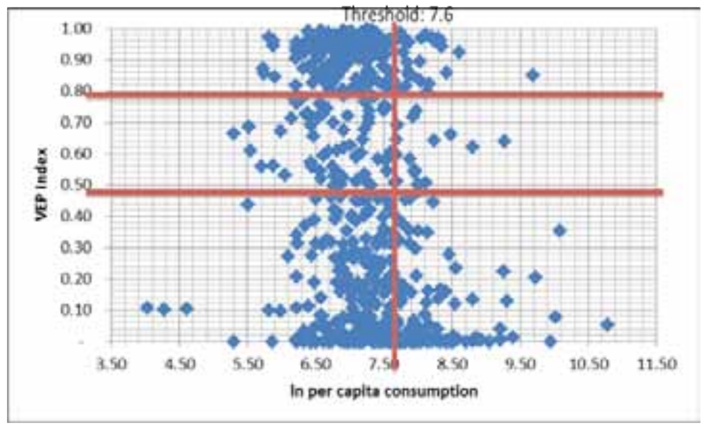

Figure 3. Vulnerability vis-a-vis ln (per capita consumption) at US$ 1.50 threshold.

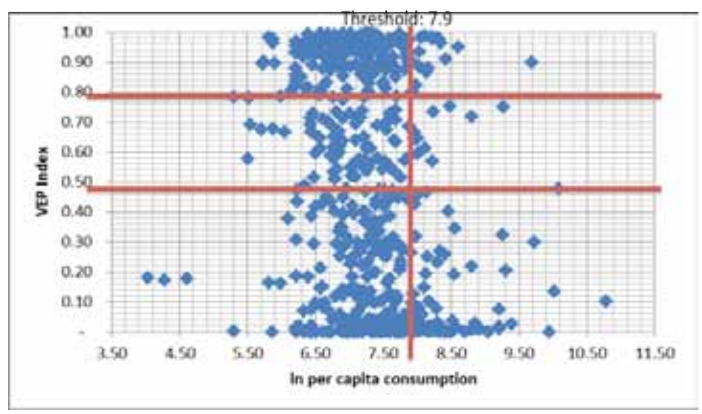

Figure 4. Vulnerability vis-a-vis ln (per capita consumption) at US$ 2.00 threshold.

Table 7. Summary of the VEP index of Agriculture, Fishery, and Forestry (AFF) households vis-à-vis Non-AFF households.

Threshold	AFF Households			Non-AFF Households		
	US$1.25	US$1.5	US$2.00	US$1.25	US$1.5	US$2.00
Mean	0.29	0.31	0.35	0.39	0.43	0.48
Standard Deviation	0.35	0.37	0.38	0.37	0.37	0.38
Incidence of Non-Vulnerable HH (%)	70	68	65	62	58	51
Incidence of Moderately Vulnerable HH (%)	13	12	13	14	14	16
Incidence of Highly Vulnerable HH (%)	17	20	23	24	28	33

Table 8. Incidence of vulnerability in different occupations using US$1.25 per capita income per day threshold level (%).

Sectoral Occupation of Household Head	Incidence of Moderately Vulnerable Households	Incidence of Highly Vulnerable Households
Agriculture	10	13
Aquaculture/Fisheries	-	57
Government	3	15
Manufacturing	-	42
Commercial/Services	17	24
Academic	-	17

Table 9. Summary of the VEP index of households situated in coastal, lowland and midland to highland barangays.

Threshold	Coastal			Lowland			Midland to Highland		
	US$1.25	US$1.5	US$2.00	US$1.25	US$1.5	US$2.00	US$1.25	US$1.5	US$2.00
Mean	0.42	0.46	0.52	0.40	0.43	0.49	0.17	0.20	0.24
Standard Deviation	0.37	0.37	0.37	0.37	0.38	0.38	0.27	0.29	0.31
Incidence of Non-Vulnerable HH (%)	58	53	49	60	56	49	87	85	79
Incidence of Moderately Vulnerable HH (%)	15	17	18	15	14	17	7	7	7
Incidence of Highly Vulnerable HH (%)	27	30	33	25	30	34	6	7	13

lowlands. While coastal and lowland households had higher mean VEP than those situated in midlands to highlands (**Table 9**). Mean VEP for coastal dwellers, lowland dwellers and midland to highland dwellers are 0.42, 0.40, and 0.17, respectively, at the lowest threshold level. At the highest threshold level, these values increase to 0.52, 0.49, and 0.24, respectively. An ANOVA test reveals that the difference in mean VEP estimates among the different topographies is statistically significant at 1% level (**Table 10**).

Table 10. One-way ANOVA of VEP of coastal, lowland and midland to highland households.

VEP1 (Threshold: US$1.25)					
Source	SS	Df	MS	F	P>F
Between	3.16	2	1.58	12.12	0
Within	73.36	563	0.13		
Total	76.52	565	0.14		
Bartlett's test for equal variances: chi2(2)	8.33		Prob>chi2	0.016	
VEP2 (Threshold: US$1.50)					
Topography	Mean	SD	Freq		
Source	SS	Df	MS	F	P>F
Between	3.38	2	1.69	12.63	0
Within	75.60	564	0.13		
Total	78.99	566	0.14		
Bartlett's test for equal variances: chi2(2)	6.4341		Prob>chi2=	0.04	
VEP3 (Threshold: US$2.00)					
Source	SS	Df	MS	F	P>F
Between	3.64	2	1.82	13.21	0
Within	77.81	565	0.14		
Total	81.45	567	0.14		
Bartlett's test for equal variances: chi2(2)	3.644		Prob>chi2=	0.162	

Climate Hazard Exposure and Impacts

The study identified the types of households that have high vulnerability. This will enable us to identify target sectors that can be prioritized. However, it is also important to determine what types of vulnerabilities do households in the study site face. This information can be derived from the climate-related hazard exposure and impact indicators. From the responses of the survey respondents, it was found that typhoons and floods are the most pervasive. About 98% of households reported that they experienced typhoons, 86% experienced typhoons that were at least Signal No. 3, 57% experienced floods, 49% experienced droughts, 4% experienced landslides, and 8% experienced flash floods (**Table 11**). A typhoon is classified as signal number 3 if it has a wind speed of about 100 km h^{-1} to 185 km h^{-1}. This typhoon causes moderate to heavy damage.

The average number of typhoon episodes experienced was 38 (about 3.8 typhoons per year). Three of these were categorized as at least signal number 3 typhoons, which implies that the occurrence of strong typhoons is approximately once every three years. Moreover, an average of six floods and one flash flood were experienced. The average flood height reported was one foot, and the average flood duration was seven days. The maximum flood height

Table 11. Household exposure to various climate related hazards, in percent.

Hazard Indicators	Percent of Household Respondents Exposed to the Hazard (n=600)
% of HH who experienced typhoons in the last 10 years	98
% of HH who experienced typhoons with Signal No. 3 or higher in the last 10 years	86
% of HH who experienced floods in the last 10 years	57
% of HH who experienced droughts in the last 10 years	49
% of HH who experienced landslides in the last 10 years	4
% of HH who experienced flashfloods in the last 10 years	8

Table 12. Summary of selected hazard exposure indicators.

Hazard Indicator	Values
No. of typhoon experienced in the last 10 years (mean)	38
No. of signal 3 typhoon experienced in the last 10 years (mean)	3
No. of flooding experienced in the last 10 years (mean)	6
No. of drought experienced in the last 10 years (mean)	2
No. of landslides experienced in the last 10 years (mean)	0
No. of flashfloods experienced in the last 10 years (mean)	1
Flood height experienced in the last 10 years, in foot (mean)	1
Flood height experienced in the last 10 years, in foot (max)	12
Flood height experienced in the last 10 years, in foot (min)	0
Flood duration experienced in the last 10 years, in days (mean)	7
Flood duration experienced in the last 10 years, in days (max)	300
Flood duration experienced in the last 10 years, in days (min)	0

reported was about 12 feet and the maximum flood duration experienced was 300 days. This implies that some areas in the study site are susceptible to prolonged flooding (**Table 12**).

Understanding how households have been affected by the hazards can also provide insights as to what particular interventions can be carried out. The impacts of past typhoons and floods is presented since this are the most common hazards experienced by households (**Table 13**).

During strong typhoons and floods, damages to properties and infrastructures are common place. If areas are inundated, households need to evacuate to avoid fatalities and injuries while some are forced to permanently relocate. Supply of basic utilities are usually halted because facilities are damaged by the strong wind and flowing water. There is also work stoppage, which translates to lost wages for the employed while businesses close down resulting to income losses. Standing crops are destroyed, and livestock and fish stocks are killed. Because the hazard causes financial strain, some households are reported being forced to borrow money. It also has impacts on health, spreading illnesses, causing injury and worse, death. Many also experienced emotional distress.

The percentage of vulnerable households which experienced the negative impacts of typhoon and flood was found to be consistently higher than the overall. Based on scope or coverage, it was found that the impact which affected the most number of households is damage to house (66% of all households and 73% of vulnerable households). Emotional impacts run in second, and loss of income comes in third. Seldom investigated, it seems that emotional and psychological distress are quite important impacts. In fact, this is usually not included in the valuation of damages from climate hazards which makes it an interesting topic that can be explored in future studies.

A large proportion of households also reported that they sustained losses in terms of lost/damaged household appliances (26%), while some experienced financial distress forcing them to acquire loans (24%). In terms of health impacts, a substantial proportion reported experiencing illnesses in the family covering about 12% of all households.
Illnesses are rampant during typhoons and floods as water borne diseases are spread rapidly. These percentages are higher for households classified as vulnerable. Worst case scenario is experiencing deaths in the family. Unfortunately, about 2% of the households were placed in this hapless circumstance.

The mean damage cost to house and properties for those who reported sustaining this impact is about PhP 11,363.00 (**Table 14**). Reported damages to agriculture production was estimated to average PhP 24,559.00, while for livestock, the mean value is about PhP 127,105.00. Damages sustained from aquaculture is about PhP

Table 13. Summary of reported flood and typhoon impacts and percentage of affected households.

Impact	Percentage of all Households Affected	% of Vulnerable Households Affected	Rank
Damage to house	66	73	1
Stress/Emotional impact	62	66	2
Loss of income	43	49	3
Damage to properties/appliances	26	43	4
Financial impact (forced to borrow money)	24	33	5
Illnesses in the family	12	17	6
Death in the family	2	1	7
Damage to vehicles	2	2	7
Injury in the family	2	2	7

Table 14. Damage cost estimate incurred by households in a typhoon/flood event.

Cost of damages	No of observations	Mean	Standard Deviation	Median	Mode
House and properties	373	11,363	35,641	3,000	5,000
Agriculture production	87	24,559	58,713	10,000	5,000
Livestock production	16	127,105	253,532	15,513	1,000
Aquaculture production	7	14,395	17,414	12,000	No value?
Business income	116	5,918	11,533	1,500	500
Medical expenses	60	2,561	4,357	1,000	1,000

Table 15. Descriptive statistics for estimated damage cost from a typhoon/flood event.

	VEP based on US$1.25 threshold level			
	Not Vulnerable	Moderately Vulnerable	Highly Vulnerable	All Vulnerable
Mean	11,360	17,816	29,351	25,220
Median	2,000	5,000	5,050	5,000
Standard Deviation	37,917	40,231	149,211	121,896

14,395.00, and business income losses averaged about PhP 5,920.00. Lastly, the average medical expense per household was PhP 2,561.00.

The mean and median estimates consistently becomes higher, as the degree of vulnerability increases but while a higher standard deviation is also observed (**Table 15**). For the non-vulnerable group, the median damage cost was about PhP 2,000.00, while for the moderately vulnerable, the median is PhP 5,000.00. Lastly, the median for the highly vulnerable group is about PhP 5,050.00.

Respondents were also asked about the type of assistance that they prefer so that their household will be better able to cope with disasters in the future. Based on the frequency of affirmative responses, the following ranking could be derived: financial assistance; distribution of food after disasters; information dissemination; medical assistance/provision of free medicines; construction of protective infrastructures against flooding; temporary shelter/evacuation assistance and provision of insurance; distribution of materials for house repair; proper waste collection and management; reforestation/regulation of logging activities and provision of resettlement/ relocation area; and (10) livelihood assistance (**Figure 5**).

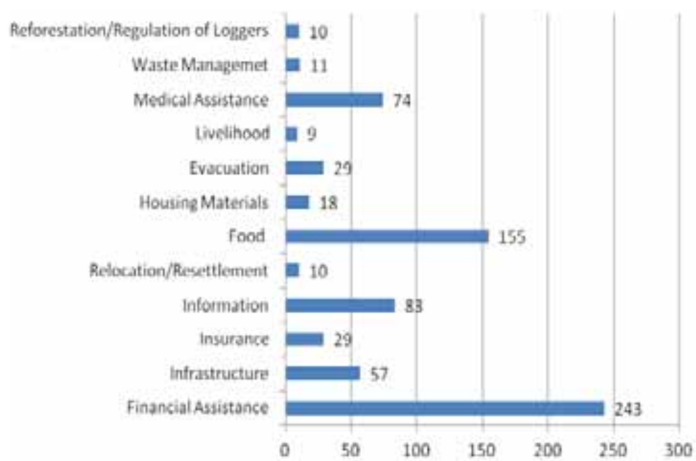

Figure 5. Assistance needed by households to better able cope with future disasters.

SUMMARY AND CONCLUSION

The study was able to establish the vulnerability index of households situated in three major watersheds in the province of Laguna, Philippines. The main reason for doing a vulnerability assessment is to come up with relevant information that can serve as a guide in formulatingdaptation strategies. It can also be used as a means to identify priority groups or sectors as well as for monitoring purposes. In this study, a vulnerability index using the Vulnerability as Expected Poverty (VEP) approach was estimated. Three minimum consumption thresholds were applied, US$ 1.25 per capita per day (VEP1), US$ 1.50 per capita per day (VEP2) and US$ 2.00 per capita per day (VEP3). Correspondingly, the percentage of households considered moderately to highly vulnerable are 37%, 41% and 46% for VEP 1, VEP 2, VEP 3, respectively.

The study found out that the latter had a higher incidence of vulnerability. However, further disaggregating the households based on the occupation of the household head, the study revealed that those dependent on aquaculture/fisheries were actually the most vulnerable, followed by the manufacturing sector. In terms of geographical location or topography, those in the coastal areas were observed to have a higher proportion of vulnerable households compared to those living in the lowland and highland areas. Hence, one recommendation that can be made is to target these most vulnerable household groups in terms of providing DRRM services.

Moreover, it was identified that the most pervasive types of hazard in the study site are typhoons and floods, while the most widespread impacts are damage to house, emotional impacts, and loss of income. This suggests the need to introduce interventions that encourage climate-proofing of dwelling units, or even relocation to a safer and less-exposed areas. Emotional impacts of weather-related disasters must also be addressed. Filipinos are known to be resilient in the midst of calamities, which can be attributed to their strong relationship with their family and their community. Communities, therefore should be encouraged to form stronger ties to help alleviate emotional distress after disasters. Moreover, mental health care services can also be offered by the local government. Lastly, savings in households should also be encouraged so that consumption will not be disrupted during calamities especially since many households experience loss of income during disasters.

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