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From Vulnerability Assessment to Climate Change Adaptation:

Lessons and Insights from the Philippine Component of the "Building Capacity to Adapt to Climate Change in Southeast Asia" Project

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Southeast Asian Regional Center for Graduate Study
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CHAPTER 1
INTRODUCTION

Responding to Climate Change and Its Impacts

Climate change and its expected adverse impacts on natural and human systems continue to receive much attention from various stakeholders across the global community. Vulnerability of human ecosystems in the light of changing climatic patterns, extreme weather events, and a variety of climate-related hazards, continue to be of primary research and development concern. In many developing countries, such vulnerability is characterized by fragile geographic and biophysical characteristics coupled with the multifarious socio-economic conditions of various sectors, many of which have very limited resources and have the least capacities to adapt to the impact of climate change.

Southeast Asia, in particular, has been noted as one of the world's most vulnerable regions to the climate change phenomenon. The region's vulnerability stems from the fact that many countries of the region are located along coastlines, have a high concentration of population and economic activities in coastal areas, and are heavily dependent on agriculture, natural resources and forestry for providing livelihoods (ADB 2009). In addition, the vulnerability of the region comes from high exposure to climate hazards as manifested in increasing frequency and intensity of storms, increased flooding, seawater intrusion, and coastal erosion.

The Philippines is among the top-3 countries in Southeast Asia that are most likely to be affected by climate hazards including floods, droughts, cyclones, and landslides (Yusuf and Francisco, 2009). Being an archipelago, the country is especially vulnerable to impacts of climate change such as sea level rise, droughts, flooding and storm surges that accompany typhoons occurring with increasing intensities. An average of 20 tropical cyclones enter the Philippine Area of Responsibility (PAR) per year (http://kidlat.pagasa.dost.gov.ph/cab/tc_frame.htm), with an increase of 4.2 in the frequency of cyclones during the period 1990 to 2003 (PAGASA, 2001 as cited by IPCC, 2007). With rainy seasons bringing in more rains, and drought episodes becoming more intense, all these variability are seen as having serious impacts on the country's human ecosystems, especially in the state of its natural ecosystems and their biodiversity, as well as its condition in the areas of food security, human nutrition and health, water resources, and human settlements. The country's vulnerability is compounded by the dependence of the Philippine economy on climate-sensitive sectors such as agriculture, fisheries, and forestry. Fatalities of typhoons reached more than

1,100 people and damages to crops and properties amounted to around USD 903 Million.

The Philippine government continues to attend and respond to the challenges and risks that are expected of climate change. The Philippine Climate Change Act of 2009 (Republic Act 9729), which was signed into law on October 23, 2009 had been instrumental in establishing the Philippine Climate Change Commission (CCC) which actively participates in global climate change fora and bodies; at the same time, the CCC continues to provide directions in policy and on-ground implementation of climate change adaptation and mitigation. By 2011, the country had set its general direction of response to climate change and its impact for the period 2011 – 2028 as embodied in the National Climate Change Action Plan (NCCAP). With the NCCAP as an anchor, the country recognizes the need to assess the vulnerabilities of its regions so as to provide scientific bases for the efforts to improve the adaptive capacities of local communities. In addition to this, the signing into law of the Philippine Disaster Risk Reduction and Management Act of 2010, otherwise known as Republic Act 10121, has created and mandated the National Disaster Risk Reduction and Management Council (NDRRMC) to coordinate efforts of various government agencies in preparing and responding to disasters including those that are brought about by climate change-related hazards.

Assessment of vulnerability given different context and conditions of communities and societal sectors is a necessary basis for informed decisions regarding climate change adaptations. Moreover, physical, financial and institutional constraints continue to hinder the effort to develop appropriate and effective location-specific adaptation strategies especially in areas that are most vulnerable to climate change. This is not to mention the weakness in mainstreaming relevant research results in the formulation of development strategies. Evidence-based or science-based policy support continues to be a need to guide and pin down the most appropriate and most effective climate change adaptation measures considering that financial resources are constantly a limiting factor. It is in this regard that the project entitled **"*Building the Capacity to Adapt to Climate Change in Southeast Asia*"** (Project) was undertaken.

The Project: From Vulnerability Assessment to Climate Change Adaptation

The Project was a three-year, three-country project that primarily aimed for the building of capabilities of the researchers and partner local government units (LGUs) in the area of climate change adaptation (CCA) through: 1) the conduct of research and the generation of subsequent publishable research outputs; 2) attendance in trainings, technical and consultative meetings; and, 3) participation in both local-level and international workshops.

It commenced in 2011 and implemented in one province each in Cambodia, Vietnam, and the Philippines. The Project adopted a single capacity building framework across countries which ensured a certain level of uniformity in the research framework and the conduct of subsequent research components. Key researchers were all based in the academe: from the Royal University of Phnom Penh (RUPP) in Cambodia, Hue University in Vietnam, and the University of the Philippines Los Baños (UPLB) in the Philippines. Main partners and stakeholders where from different local government units (LGUs) within each of the study sites in the countries involved.

The research consisted of two main components. The first was the conduct of vulnerability assessment (VA) with three interrelated sub-studies focusing on 1) community vulnerability with the commune / barangay as the basic unit of analysis; 2) household vulnerability; and, 3) a more cross-cutting focus on social vulnerability. The other major research component was the economic analysis of specific adaptation options that were meant as responses given the findings of the vulnerability assessment.

Research in this regard was both an end and a means towards the end of a comprehensive capacity-building for climate change adaptation. The Project therefore provided considerable attention to research activities. Trainings were also conducted prior to each major project activity as a preparation for the conduct of research and towards producing the expected outcomes of the Project. The project culminated by providing opportunity and assistance for the target LGUs / offices to develop climate change adaptation project proposals, given the research results.

Outline of the Manuscript

This volume reports the project as implemented in the Philippines. It is organized into eight (8) chapters. This chapter provides the tone for the rest of the manuscript by providing the background of the topic and the project on which the contents of the book are based on. It hopes to provide a clear path for the reader as she goes through the content of the book. Chapter 2 contains the research framework which served as guide to the implementation of the project. It provides the methodology in the conduct of both vulnerability assessment and the economic analysis of adaptation options, and a link between them that highlights a participatory approach. Chapter 3 reports extensively on Laguna as the Philippine project site. This is followed by three (3) chapters containing the report on the findings of the vulnerability assessment: community vulnerability assessment and mapping (Chapter 4), household vulnerability assessment (Chapter 5), and social vulnerability (Chapter 6). Chapter 7 contains the economic analysis of adaptation options selected on the basis of the results of the vulnerability assessment and a systematic operationalization of a participatory approach. The final chapter (Chapter 8) serves as a synthesis, bringing forth some policy implications from the lessons learned from the project, both from its process as well as its content.

CHAPTER 2

A Research Framework for a Comprehensive Vulnerability Assessment and Economic Analysis of Climate Change Adaptation Options

Response to reducing climate-induced events such as floods and typhoons is not only the responsibility of each community but also largely the responsibility of the government as an agency of development, in carrying out its mandate to be in the forefront of disaster risk and climate risk management. It is thus expected that government from national down to local units, must have adequate capability and appropriate capacities to carry out its tasks in climate change adaptation and mitigation. Successful implementations of adaptation strategies will be dependent on the government's performance in carrying out its mission, in addition to the efforts put forth by local people, the degree of transfer of knowledge generated in academia and research institutions, and the important support and contributions from the business sector as well as the rest of civil society.

Capacity for planning and action on climate change adaptation by local governments is found wanting in many countries across the region. This is true for the three countries covered by the project (Vietnam, Cambodia, and the Philippines). In more ways than one, this may be attributed to delayed progress and the need to systematize the initiatives of universities and research institutions to link their research and training activities to the needs of provinces and districts. At the local level, some of the more urgent capacity building needs identified are vulnerability assessment skills and the knowledge on economic analysis of adaptation measures. There is an urgent need to build capacities in research, planning, and action for LGU staff at various levels and research institutions in these countries to address the needs for climate change adaptation more effectively. This research project is designed to meet this capacity building need.

Capacity Building Approach

Available information indicates that LGUs and research institutions of the Philippines still lack knowledge and skills to undertake vulnerability analysis of their communities at risks, and to design effective adaptation measures/options. This is a factor hindering the development and implementation of good strategies for climate change adaptations. There is a huge need of funding for adaptation while availability of fund is limited. In this context, the prioritization and ranking of adaptations option for funding is of great importance. Cost-benefit analysis, cost-effective analysis and multi-criteria analysis of adaptive options are important decision-making tools that would help LGU make best use of their limited adaptation fund.

This knowledge and skill gap was fulfilled through training and action research. Relevant training on vulnerability analysis were identified through gap and need assessment (Cross-country project on climate change adaptation funded by EEPSEA, 2010). The training courses for LGUs covered a number of topics such as adaptive capacity measurement, climate risk measure and assessment, vulnerability analysis and mapping, adaptive planning, economic/multi-criteria analysis of adaptation options. However, training alone is insufficient to build the needed capacity. Trained LGU staffs were engaged in the two action researches. These were vulnerability assessment and adaptation option design for selected sites and economic analysis of adaptation options.

The project assisted in provincial- and municipal- level LGUs in planning for climate change adaptation actions and to assist them in looking for funding to support some development activities to help build adaptive capacities, based on existing capacities. The approach was a mix of training, research, workshops and dialogue between local agencies and university/research institute. The project adhered to the principle that adaptation to short-term climate variability and extreme events can serve as a basis for reducing vulnerability to longer-term climate change. The features of the implementation approach are:

- Training to equip researchers and LGU staff with knowledge on vulnerability measurement, socio-economic and gender analysis, and economic analysis of adaptation;
- Further strengthening capacity through action research: engaging LGU staff in undertaking research on vulnerability assessment, socio-economic and gender analysis, and economic analysis of adaptation options;
- Enhancing access to adaptation funds: providing training for and helping LGUs prepare adaptation proposal and send to potential adaptation funding agencies.

Conceptual Framework

The framework that guided the project focused on two key concepts – vulnerability and adaptation. Vulnerability is defined from the starting-point approach that focuses on prevailing, rather than consequential, set of conditions that adversely affect people’s ability to prepare for and respond to hazards. In this approach, vulnerability is determined by the social and environmental features of the community, showing the dynamics through which hazards lead to livelihood impacts. Social variables such as access to climate information, nutritional status, and quality of housing will have varying importance as determinants of the outcomes of hazards depending on the kind of hazard. Environmental variables such as slope, soil type and water sources influence and are influenced by human activities.

The project adopted the starting-point definition of vulnerability because this definition considers that the current livelihood activities, coping strategies or larger issues can effect alterations in the social and environmental variables that bolster vulnerability (Smit and Wandel 2006). Only the starting-point view of vulnerability can catch the dynamic dimension of vulnerability in terms of the possibility of social, politico-economic and environmental change. This consideration of change in a temporal context is basic in examining climate hazards. The alternative end-point approach to vulnerability "relies on social and economic models to translate *predicted* biophysical impacts into *predicted* livelihood impacts following some *anticipated* adaptation" (Ensor and Berger 2009:15). Thus, the weakness of the end-point approach is that analysis "of the choice of adaptation measures at some future time to an uncertain future climate in an unknown socio economic context is bound to be highly speculative" (Burton et al. 2002:8).

The starting-point view of vulnerability is adopted by the project in order to be able to study the biophysical, socio-cultural, and politico-economic variables that constitute vulnerability to hazards. The role of adaptation, in this approach, is to reduce the underlying causes of vulnerability. The adaptation activities should lessen the impacts of impending climate hazards and, at the same time, enhance the quality of life of communities in the short-term such as by improving housing conditions. These vulnerability-reduction strategies are called "no-regrets strategies – meeting climate change adaptation goals while fulfilling broader development ends even if climate change predictions do not play out" (Ensor and Berger 2009:16).

Figure 1 is the schematic presentation of the project conceptual framework. This project is designed with three studies (1) Vulnerability Measurement and Mapping (2) Gendered Ethnography of Vulnerability and (2) Economic Analysis of Adaptation. To facilitate the implementation of these studies relevant training courses and technical supports will be provided for research teams and local government staffs. Table 1 presents project activities.

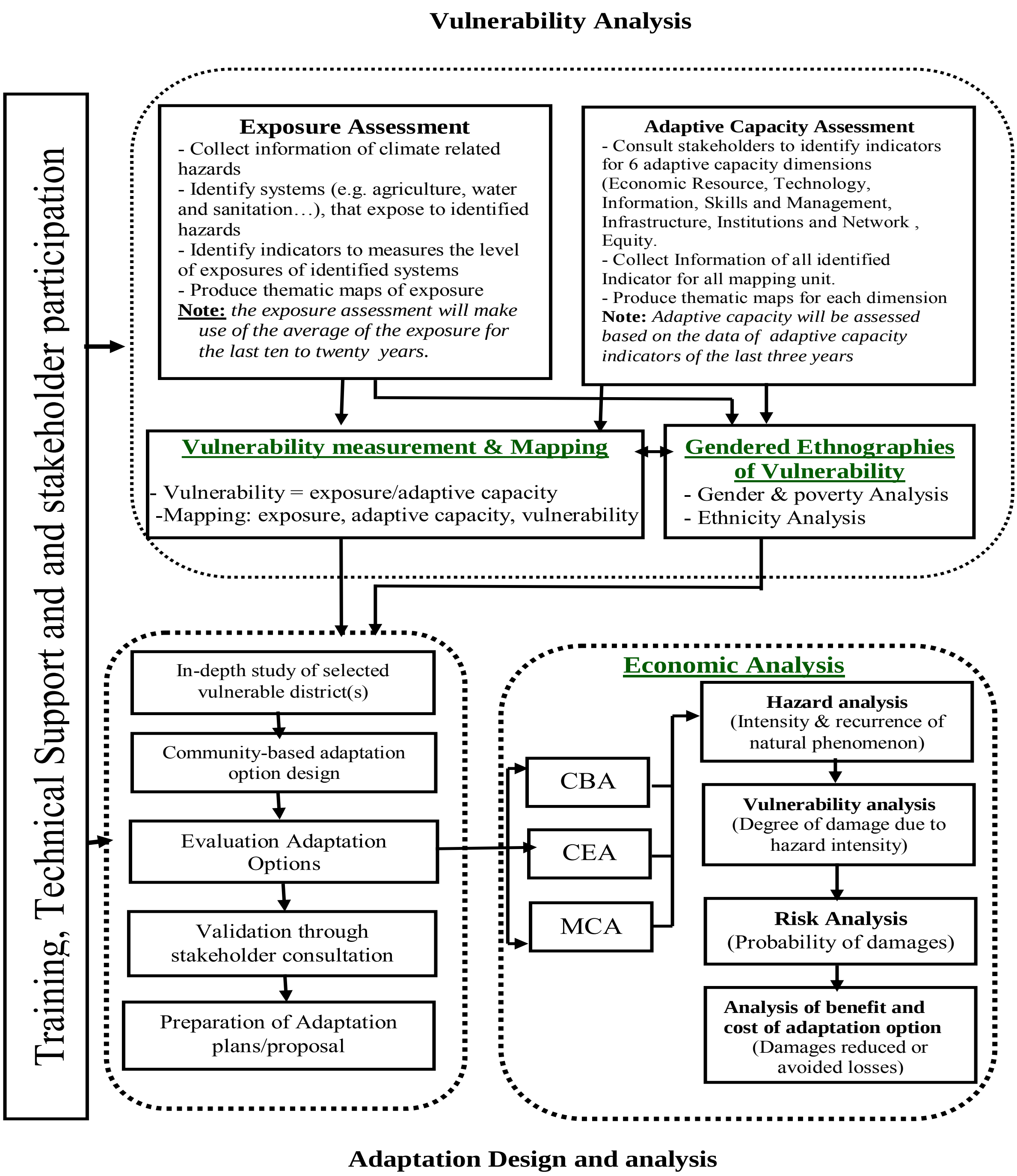


Figure 1. Conceptual Framework for the Vulnerability and Adaptation Analysis

Table 1. Project Activities

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
1. Kick-off meeting	- Discussing and clarifying of project design - Presenting the description of study sites and detailed action plans of each country. - Highlighting the difficulties and challenges to each teams in terms of technical issues - Launching project	- Research teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) - Representatives of local government (1 person/country) - Representatives of EEPSEA, IDRC (2) - Representatives of local host institutions (5) - Press (2) (total: about 40 pax)	SEARCA	2 days in January 2011 in the Philippine	Meeting Reports
2. International training courses for researchers on vulnerability measurement, GIS mapping, and socio-economic analysis	- Vulnerability measurement - GIS vulnerability mapping techniques - Socio-economic and gender analysis in vulnerability assessment	- Core teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) (total: about 20 pax)	SEARCA	6 days in the Philippines right after kick off meeting	Training reports
3. Design and deliver local training courses on vulnerability measurement, mapping, and socio-economic analysis by trained researchers in each country	- Introducing the project to local participants - Vulnerability analysis methods - GIS vulnerability mapping techniques - Socio-economic and gender analysis in vulnerability assessment	- Local partner researchers - Local government units, mass organizations and NGOs. (30 pax)	SEARCA, HCE RUPP	5 days in February, 2011	- Training reports

Table 1. Project Activities *(cont'd)*

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
4. Each country team conduct action research on overall and sectoral vulnerability measurement and mapping	- Buying GIS maps - Determining indicators and preparing research tools: questionnaire, guidelines, - Conducting field surveys (FGDs, KII, LGUs survey (Province, Districts and Commune, HH surveys) - Technical support visits by invited international/regional expert for research tool design and data analysis (02 visits per country) - Data analysis - Documenting	- Country research teams - Local stakeholders	- Research Teams of each country	8 months from March to September, 2011	- Set of research tools - Datasets - Research reports - Hazard maps , - Adaptive capacity maps, - Vulnerability maps: comprehensive vulnerability map, vulnerability maps of selected sectors, vulnerability maps to specific hazards. - Progress reports
5. Each country team conducts gendered ethnographies of vulnerability study (poverty, gender, ethnics)	- Developing research methods and tools - Conducting field surveys (FGDs, KII, community organizations, individual interviews, HH surveys) and case studies. - Technical support for research tool design and data analysis (01 visits per country) - Data analysis - Writing reports	- Country research teams - Local stakeholders - Philippines team (visit to provide technical support)	- Research Teams of each country - Philippines team takes the lead role in research tool development	8 months from March to September, 2011	- Set of research tools - Datasets (qualitative and quantitative data) - Research reports

Table 1. Project Activities *(cont'd)*

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
6. Local workshops on vulnerability assessment, mapping, and socio-economic analysis	- Sharing and validating the research findings	- Invited technical experts - Country teams, - Local stakeholders (30 pax)	HCE, SEARCA, RUPP	2 days in Last week of September, 2011	- Local workshop reports [1]
7. International workshops on vulnerability assessment, mapping, and gendered ethnographies of vulnerability	- Sharing findings of three country studies on vulnerability assessment, mapping, and socio-economic analysis - Presentation by invited speakers - Planning for next steps of project	- Research teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) - Representatives of local governments (1 person/country) - Representatives of EEPSEA, IDRC (4), - Representatives of host institutions (2), - Representatives from relevant, International/regional institutions (10), - Press (2) (total: about 40 pax)	HCE	2 days in first week of December, 2011, Vietnam	- Workshop reports

[1] Two weeks after the local workshops, all country teams are requested to submit the first draft of vulnerability, mapping and socio-economic research reports to CCW and EEPSEA for review

Table 1. Project Activities *(cont'd)*

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
8. International training course for researcher on adaptation analysis	- CBA, CEA, MCA - Valuation Techniques	- Core teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) (total: about 20 pax)	HCE	5 day in December, 2011 (right after the International Workshop), Vietnam	- Training reports
9. Local training course on adaptation analysis in each country by trained researchers	- CBA, CEA, MCA analysis - Valuation Techniques	- Local partner researchers - Local government units, mass organizations and NGOs. (Total: 30 pax)	SEARCA, HCE RUPP	5 days in February, 2012	- Training reports
10. Design and analysis of adaptation options for selected district(s)	- In-depth situation study of selected districts; - Designing adaptation options for a selected districts/localities by local experts; - Field surveys to collect data for adaptation option analysis; - Data analysis; - Technical support visit by international/regional expert for option analysis/evaluation to the study site (02 visits per country) - Writing report	- Country core teams - Local stakeholders	- Research Team - Local stakeholders	10 months from Feb to November, 2012	- Report of Situation Analysis and adaptation option description (June, 2012). - Datasets - Reports on adaptation option analysis (November, 2012) - Report of second year
11. Local workshops on adaptation option analysis at the study site	- Presenting and validating results of adaptation option analysis	- Invited technical experts - Country teams, - Local stakeholders (30 pax)	HCE, SEARCA, RUPP.	2 days in the second week of January 2013	Workshop reports

Table 1. Project Activities *(cont'd)*

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
12. International workshop on adaptation option analysis	- Sharing findings of adaptation option analysis - Presentations by invited speakers - Planning for next steps of project	- Research teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) - Representatives of local governments (1 person/country) - Representatives of EEPSEA, CCW (4) - Representatives of host institution (3) - Representatives from international/regional organizations dealing with climate changes (10), - Press (3), (total: about 40 pax)	HCE	2 days in the second week of Feb., 2013	- Workshop reports
13. International Training on adaptation proposal development and adaptation fund mobilization and research finding communication for research team	- Adaptation proposal development - Adaptation fund mobilization/access - Research finding communications	- Country teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) (total: about 20 pax)	SEARCA	5 day in February, 2013 (right after the International Workshop on Adaptation Option Analysis)	- Training reports

Table 1. Project Activities *(cont'd)*

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
14. Local training on adaptation proposal development and adaptation fund mobilization/access and research finding communication in each country	- Training on adaptation proposal development - Adaptation fund mobilization/access - Communicating research findings to policy makers and local communities	- Country research teams, - Local stakeholders (30 pax)	HCE, SEARCA, RUPP	5 days in March of 2013	Training reports
15. Supporting LGUs in preparing adaptation project proposal and apply for funding	- Assisting LGUs to packaging adaptation proposal, - Seeking potential adaptation funding agencies	- Core research team - Local government units	HCE, SEARCA, RUPP	3 months from April to July, 2013	- Adaptation project proposals of LGUs
16. Documentation and publications	- Documenting and publishing project results	- Research teams - Local partner researchers	HCE, SEARCA, RUPP	April to September, 2013	- Policy brief, - Journal papers, - Guidelines on vulnerability assessment, adaptation option analysis - Books, maps - Documentary films
17. International conference participation	- Supporting researchers to attend and present research at international conference	- From second year, financing two researchers/country attend international conferences	Researchers from recipient institutes	From 2012 to 2013	- Conference papers and journal articles

Table 1. Project Activities *(cont'd)*

Activities	Content	Participants	Leading institution(s)	Time and location	Deliverables
18.Project evaluation	- Developing evaluation tools for the capacity building project - Evaluating the impact of project on LGUs' capacity to adapt to climate change - Evaluating the impacts of project on the research and consultant capacity of recipient institutions	- Researchers - Local partner researchers - External evaluators	- Recipient institutions	September to October, 2013	- Evaluation report of each country - Overall evaluation report
19. Final Workshops of project	- Physical Display of project publications and documents - Evaluating achievements of project - Institutionalizing local capacity on climate change adaptation - Following up activities - Fieldtrips to selected districts	- Core teams of three countries (3 researchers/country) - Local partner researchers (3 researchers/country) - Representatives of central government and local governments (5 person/country) - Representatives of EEPSEA, CCW, IDRC (4) - Representatives of international agencies, Local Organizations - Representatives of host institutions (3) - Press (2) (total: about 45 pax)	RUPP	November, 2013	Workshop Report

Research Tools and Data Analysis

As mentioned this project included two research studies: vulnerability assessment and economic analysis of adaptation options. On the other hand, the vulnerability assessment consisted of three related sub-studies. First is the community vulnerability assessment and mapping. The second is the vulnerability assessment at the household level. The third is the study on social vulnerability which necessitated for more in-depth and qualitative approach to surface characteristics of vulnerability which may not be captured by the survey-based community and household assessments. This section discusses the research tools and methods that used in undertaking these studies.

Community Vulnerability Assessment and Mapping

The study on "Community Vulnerability Assessment and Mapping" of the project have two main objectives:

(i) to measure and develop maps of overall relative vulnerability to climate change of the communes/barangays in the selected municipalities in Laguna; and

(ii) to measure and develop maps of relative vulnerability to climate change of selected sectors to dominant climatic hazards of the communes/barangays in the selected provinces.

To attain these objectives, the study used Participatory Vulnerability Assessment (PVA) and Participatory-Mapping (P-Mapping) approaches. The participatory method aims to solicit detailed information from indigenous people and community about the complexity of vulnerability threats and their unique ways of adaptation which are not ordinarily captured in literatures and other previous studies in other affected areas. It works on the belief that local knowledge is unique to a culture or community and it denotes a type of knowledge that has evolved within the community and has been passed from one generation to another. As such, local people should be considered as experts of their environment, particularly where they have maintained their traditional livelihoods and subsistence economies.

However, because the climate and the environment are changing, the communities may find it hard to predict what will happen due to the new or changed conditions. The communities may also have deficiencies in the way that their local information have been stored and communicated through the years. And, the local knowledge may have very little quantification such that these may be difficult to analyze. The project, therefore, will try to bridge traditional knowledge with new technologies that will result in both community and civil society groups working in collaboration. The methodologies that will be adopted will result to the merger between participatory learning and action methods as in the case of P-Mapping where sketch maps from the local people will be combined with aerial photographs and satellite imagery in a Geographic Information Systems (GIS) environment.

If the available data and digital maps are not appropriately scaled to the study/research unit (generally the scale is greater than required), it is advisable to conduct more detailed mapping at the lowest administrative level in order to generate community vulnerability maps.

Measuring Vulnerability

There is not a univocal definition commonly accepted for vulnerability (Kelly & Adger, 2000). According to the Intergovernmental Panel on Climate Change (IPCC) vulnerability defines “the extent to which climate stimuli may damage or harm a system; it depends not only on a system’s sensitivity but also on its ability to adapt to new climatic phenomenon”. Blaikie et al. (1994) define vulnerability in terms of human dimension alone as “the capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard”. Furthermore, Smit & Pilisofa (2003) acknowledges exposure or damage potential and adaptive capacity or sensitivities as the two main components of vulnerability. The interaction of environmental and social forces determines sensitivities, and various social, cultural, political and economic forces shape adaptive capacity. Considering the data availability, usage of the maps and training purposes, in this study, we consider vulnerability is a function of exposure and adaptive capacity with the relationship described below:

$$V_{it}^{s} = f(\overline{E}_{it}^{s}; \overline{A}_{it}^{s})$$

Where

V_{it}^{s} = Vulnerability of system i to climate stimulus s in time t

$\overline{E}_{it}^{s}$ = Normalized Exposure Index of system i to stimulus s in time t

$\overline{A}_{it}^{s}$ = Normalized Adaptive capacity Index of system i to deal with stimulus s in time t

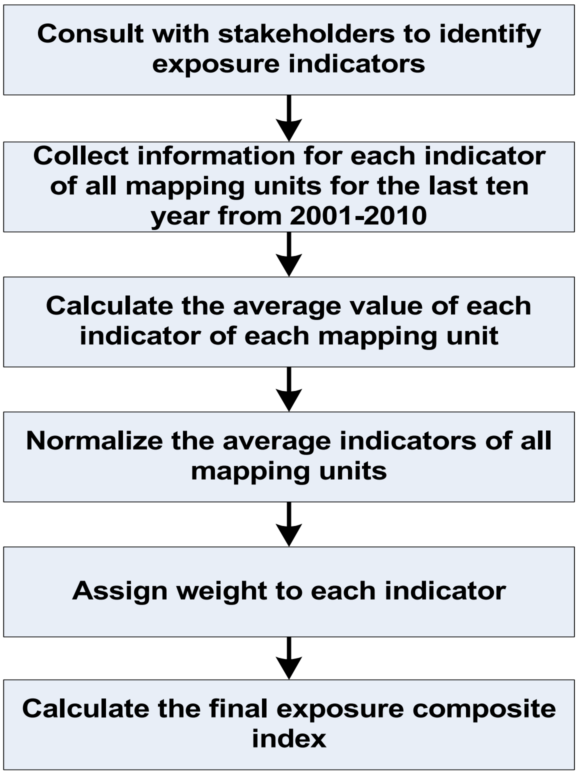
Exposure assessment. Exposure of system i to stimulus s in time t refer to the degree, duration and/or extension of the system’s contact with the stimulus. The system’s exposure to the stimulus is, however, an attribute of the relationship between the system and the stimulus. As such, it is not an attribute of the system. In the case of human systems, these are the households or the people that are likely to be affected by the climatic stimulus such as floods, typhoons, droughts within a certain land area or geographic boundary.

Exposure indicators. For each one of natural hazard the provincial experts will be consulted to find out the exposure indicators. List the exposure indicators proposed for each hazard and the source of data to fulfill them can be found in the Annex Table 1. The data collection will be generally implemented at district level, district's environmental section, and district committee for flood and storm control through Microsoft Excel form. The reason behind this choice is the presence at that level of data disaggregated for commune, while at provincial level the information is very often reported aggregated for district.

Exposure Index. The overall index of exposure, as a composite index, it is generated from the weighted average of the identified exposure indicators which can be identified through stakeholder consultation. Weights are composed of measures of importance associated with each indicator. But before data are to be combined, they first need to be normalized, and then weighting needs to be considered. Normalizing indicator means putting them on the same scale. In this study, scores for each indicator will be calculated by the formula:

$$(1) \qquad X_i - X_{min} / X_{max} - X_{min};$$

Where X_i is the original value for location i, X_{max} is the highest value of all communes, and X_{min} is the lowest value of all communes. The steps of combing the exposure indicators into a composite exposure index are shown in figure below:



Adaptive capacity assessment

Adaptive capacity is context-specific and varies from country to country, from community to community, among social groups and individuals, and over time. Furthermore, the cumulative effects of increased frequency of events near the limit of the coping range may decrease the threshold beyond which the system cannot cope/adapt/recover (Jones, 2001; Dessai et al., 2003).

Adaptive capacity is similar to or closely related to a host of other commonly used concepts, including adaptability, coping ability, management capacity, stability, robustness, flexibility, and resilience (Smithers and Smit, 1997; Adger and Kelly, 1999; Smit et al., 1999; Jones, 2001; Fraser et al., 2003; Tompkins and Adger, 2004; Brooks, 2003; Füssel and Klein, 2006). The forces that influence the ability of the system to adapt are the drivers or determinants of adaptive capacity (Adger, 2003; Turton, 1999; Walker et al., 2002; Wilbanks and Kates, 1999; Blaikie et al., 1994; Kasperson and Kasperson, 2001).

Adaptations are manifestations of adaptive capacity, and they represent ways of reducing vulnerability. Therefore, adaptation, whether analyzed for purposes of assessment or practice, is intimately associated with the concepts of vulnerability. It is in ecological systems that the resilience concepts have been most developed (Berkes et al., 2003; Holling, 2001; Gunderson and Holling, 2002). Although the definition of adaptation in the natural sciences is disputed, it broadly refers to the development of genetic or behavioral characteristics which enable organisms or systems to cope with environmental changes in order to survive and reproduce (Futuyama, 1979; Winterhalder, 1980; Kitano, 2002). Consideration of adaptation within natural sciences encompasses scales from the organism or individual to the population of a single species or an entire ecosystem (Krimbas, 2004). In the context of climate change, Pielke (1998) and later Smit et al. (2000), described adaptations as the adjustments in individual groups, institutional behaviour or generally in ecological-socio-economic system in order to reduce human group's vulnerability to actual climate or expected stimuli.

At the local level the ability to undertake adaptations can be influenced by such factors as managerial ability, access to financial, technological and information resources, infrastructure, the institutional environment within which adaptations occur, political influence, kinship networks, etc. (Watts and Bohle, 1993; Hamdy et al., 1998; Adger, 1999; Handmer et al., 1999; Kelly and Adger, 2000; Toth, 1999; Smit and Pilifosova, 2001; Wisner et al., 2004; Adger et al, 2001; Blaikie and Brookfield, 1987). Therefore, adaptive capacity explains why, with a given level of natural hazard, people are more or less at risk.

This project focuses on the relative vulnerability level of communities in a province, and involves comparative evaluation or rating based on criteria, indices and variables typically selected by the researchers (Van der Veen and Logtmeijer, 2005; O'Brien et al., 2004; Kelly and Adger, 2000; Adger et al., 2004; Brooks et al., 2005; Rayner and Malone, 2001) through a participatory mechanism. Hazard and adaptive capacity, are assumed to be measurable based on attributes or determinants selected a priori. The main purpose is to provide an evaluation of the relative vulnerability of the commune within a province. The expected application is that climate change adaptation efforts should be directed to those areas with the greatest hazard level or higher vulnerability. Thus, surrogate measures of hazard and elements of adaptive capacity for each system are estimated and then aggregated to generate an overall risk ''score'' (or level or rating) for each system (Adger, 2006).

In this study, we use the determinants of adaptive capacity proposed by Smit et al. (2001) as a framework for identifying indicators. Starting from this framework the indicators will be identified in collaboration with the local stakeholders to make the best use of data that already existed for all communes in the studied provinces. The five determinants used in this study are:

Determinant	**Rationale**
Institution	Well-developed social institutions help to reduce impacts of climate related risks, and therefore increase adaptive capacity.
	Policies and regulations can constrain or enhance adaptive capacity.
Infrastructure	Greater variety of infrastructure can enhance adaptive capacity, since it provides more options.
	Characteristics and location of infrastructure also affect adaptive capacity.
Natural resources	Equitable distribution of resources increases adaptive capacity.
	Both availability of, and entitlement to, resources is important.
Economic resources	Grater economic resources increase adaptive capacity.
	Lack of financial resources limits adaptation options.
Human resources	Lack of informed, skilled and trained personnel reduces adaptive capacity.
	Greater access to education, technology and information increases likelihood of timely and appropriate adaptation.

For each of the five determinants a list of factors/indicators will be developed through a process of consultation with relevant stakeholders in the study areas and according to their opinion the factors was transformed in indicators to fill after data collection. A tentative list of indicators for the determinants can be found in Annex Table 2.

The above-mentioned framework (Smit et al., 2001) will be explained to the local expertise. Within this framework, the discussion will be stimulated between the participants to develop a list of factors that influencing adaptive capacity to hazards of local communities. The meeting's participants will also define how assess and measure such factors transforming them into indicators of adaptive capacity. Finally, the participants will determine the source and the feasibility of the collection of data for each indicator. Adaptive capacity index for each commune will be calculated, using the same indexing approach as discussed above.

Weighting

The issue of weightings is highly controversial due largely to the subjectivity inherent in assigning weightings. While the application of weights facilitates an indication of importance of the different variables, it also leaves the results open to manipulation. However, the calculation of an index through the combination of any set of data implies in any case a system of weighting. Putting weights into the formula makes this explicit, and thus more transparent. To ensure that this is the case, the issue of weighting must be explained to users and stakeholders. This is particularly true since weightings modify the relative importance of specific components, and the determination of the importance of any part of an index is a political decision. For the provision of baseline values of Vulnerability index, an equally weighted index may be the most neutral choice. It is important to note that also if comparisons are to be made between scores for different locations or situations, the weightings used must be the same in all cases.

Weights are effectively multiplicative factors which are applied to each component. When totaled, weights must equal 100 (%). A weight of 30% means that the specific domain score for that particular component is multiplied by 0.3.

Five approaches to allocation of weights are discussed below:

- **Entirely arbitrary**: When weights are chosen without reference to theory or empirical evidence, or even when equal weights are selected, this is classed as ‘arbitrary’;
- **Determined by consensus**: In this case, policy makers and

stakeholders could simply be asked for their views and the choices obtained by consensus;

- **Determined by policy relevance**: Components can be weighted in accordance with public expenditure on particular areas of policy;
- **Empirically driven**: There are two approaches that might be applicable. First, analysis of an existing survey might generate weights. Here one might construct a proxy for the issue being examined, and multivariate predictive modeling can be used to derive weights. Second, factor analysis (Senior, 2002) to extract a latent ‘factor’ representing the issue can be used, assuming that the analysis permitted a single factor solution;
- **Driven by theoretical considerations**: In the theoretical approach, account is taken of the available research evidence, which informs the theoretical model of what is being examined, and weights are assigned according to this. (e.g., if deriving an index of susceptibility to Malaria, the theory suggests that the presence of specific mosquito types is essential to the transmission of Malaria. This would imply that this would have the greatest weight, while other issues, such as presence of standing water, would be less important, and so would have less weight).

Both the Human Development Index and the Water Poverty Index are examples of composite indices calculated using weighted averages of individual indicators. Weighting methods vary. Eakin and Bojorquez-Tapia (2008) note that equal weighting makes an implicit judgment about the degree of influence of each indicator and propose a complex fuzzy logic-based weighting method as a more objective approach. Vincent (2004, 2007) and Sullivan et al. (2002) suggest expert opinion and stakeholder discussion, respectively, to determine weighting schemes.

The research team intends to develop an assessment tool accessible to a diverse set of users; therefore, the formulas for vulnerability index and for each sub-components use the approach of applying weights that are to be determined by consensus among stakeholders.

Measuring relative vulnerability

Vulnerability refers to the different variables that make people less able to absorb the impact and recover from a hazard event. These may be economic (lack of reserves), social (weak social organization), technical (poorly constructed housing) or environmental (fragility of ecosystems). This operative definition of vulnerability implies the use of indicators across the range of five “themes”: institutions, infrastructure, environment, livelihoods and social factors. Based on exposure and adaptive capacity one can measure the relative vulnerability of the communes.

Vulnerability mapping

Following is the list of suggested GIS maps that will be used in the vulnerability analysis:

- Administrative map
- Hazard map
- Irrigation map
- Land use map and land cover
- Microclimate map
- Water resources and hydro-geologic maps
- Soil map
- Topographic map
- Transportation map

To collect vulnerability data, participatory appraisal techniques will be also used to incorporate local knowledge in the whole process of map making. In the process of vulnerability assessment and mapping, consultative meetings with local authorities will be conducted. At the consultative meetings the participants first share their ideas and opinions on the purpose of developing the vulnerability maps and what important factors they would like to put into the map.

Once the data are collected the teams will carry out the natural hazards and vulnerability analyses and will elaborate the indexes and GIS maps. This project will use the ArcView/Info Software Package to present the index and also to determine some vulnerability factors by using its spatial analysis tools.

METHODOLOGY AND DATA

Component Methodology and Data Collection

The vulnerability mapping component followed the procedure presented in Figure 2. The component started with the identification of the vulnerability determinants and their respective indicators. These vulnerability determinants are the exposure, sensitivity and adaptive capacity. This initial activity was critical in the creation of vulnerability index and maps. It was at this stage that all the necessary indicators were discussed among country teams to draw the final list of indicators that set the focus of the study (see Annex Table 3 for the different indicators agreed upon and used). Once the list was finalized, the data collection started. Primary and secondary data including those from Focus Group Discussions (FGD), Key Informant Interviews (KII) and commune/barangay surveys were gathered. Physical measurements on the study sites were done whenever necessary. After the data were collected, the team underwent data processing and analysis to come up with vulnerability index and maps.

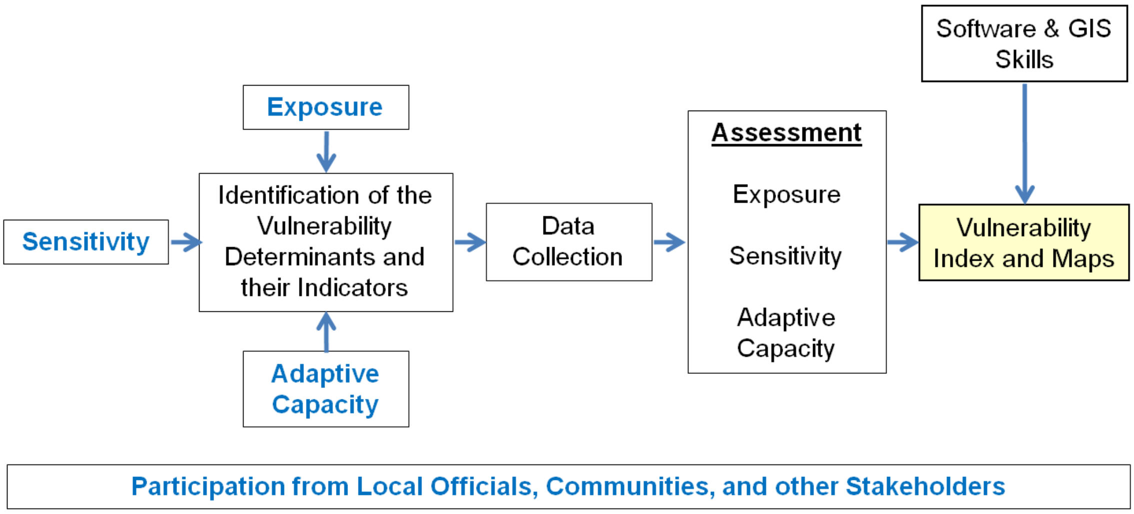


Figure 2. Vulnerability Measurement and Mapping Procedure

Analytical Procedure

Vulnerability Measurement and Mapping

According to the Intergovernmental Panel on Climate Change (IPCC) vulnerability defines "the extent to which climate stimuli may damage or harm a system; it depends not only on a system's sensitivity but also on its ability to adapt to new climatic phenomenon". Exposure or damage potential and adaptive capacity or sensitivities are the two main components of vulnerability (Smit & Pilisofa 2003). The interaction of environmental and social forces determines sensitivities, and various social, cultural, political and economic forces shape adaptive capacity. In this study, the component considered vulnerability as a function of exposure, sensitivity and adaptive capacity with the relationship described below:

$$V_{it}^{s} = f(\overline{E}_{it}^{s}; \overline{A}_{it}^{s})$$

Where

V_{it}^{s} = Vulnerability of system i to climate stimulus s in time t

$\overline{E}_{it}^{s}$ = Normalized Exposure Index of system i to stimulus s in time t

$\overline{A}_{it}^{s}$ = Normalized capacity/sensitivity Index of system i to deal with stimulus s in time t

As indicated by the function, to measure relative vulnerability of communes in the selected municipalities of Laguna, the team calculated normalized exposure index, normalized sensitivity index, and normalized adaptive capacity index.

Exposure measurement and mapping

IPCC defines exposure as the extent of climate change to which a system is exposed. The process of exposure assessment and the calculation of the exposure index made the following steps:

- Identification of exposure indicators: For each one of natural hazard the experts were consulted to find out the exposure indicators. Findings from Gender Ethnographies of Vulnerability were also used to determine exposure indicators. A tentative list of exposure indicators proposed for each hazard and the source of data to fulfill them can be found in the Annex Table 2.
- Collection of data of each indicator for the communes/barangays for the last 10 years: Historical data of hazards were collected from different municipal agencies (e.g. Municipal Planning and Development Office, Municipal Agricultural Office, Municipal Social and Welfare Development, Alliance of Barangay Captains, etc). Commune/barangay surveys were also implemented to collect additional data needed.
- Calculation of the average value of each exposure indicator for each commune/barangay.
- Normalization of the exposure indicator value to make the indicator values comparable across communes/barangays: The following formula was used to normalize the value of exposure indicators:

$$Z_{ij} = (X_{ij} – X_i^{min})/ (X_i^{max} – X_i^{min})$$

where Z_{ij} is the normalized value of indicator i of commune j;
X_{ij} is the original value of indicator i of commune j;
X_i^{max} is the highest value of all communes, and
X_i^{min} is the lowest value of all communes.

- Weight assignment that takes into account the relative importance of exposure indicator: Using a simple logic on the level of importance of each indicator as reflected from stakeholder consultation and expert meeting in the 12 conducted Municipal FGDs, weights were determined via the Analytic Hierarchy Process (AHP) approach.

- Calculation of composite exposure index: The composite exposure index is the weighted average of all normalized values of exposure indicators.
- Use of Software Package to produce overall climate hazard/exposure maps: ArcView/Info software was used to produce vulnerability maps in this study.

Sensitivity and Adaptive capacity measurement and mapping

IPCC defines sensitivity as the impact of climate change – the impact of long-term seasonal change, short-term/severe climate change events, and climate change related hazards/stresses. While adaptive capacity is defined as the degree to which adjustment in practices, processes, or structure can moderate or offset potential damage or take advantage of opportunities. Adaptive capacity can be influenced by factors such as managerial ability, access to financial, technological and information resources, state of infrastructure, the institutional environment, political influence, kinship networks, etc. (Watts and Bohle, 1993; Hamdy et al., 1998; Adger, 1999; Handmer et al., 1999; Kelly and Adger, 2000; Toth, 1999; Smit and Pilifosova, 2001; Wisner et al., 2004; Adger et al, 2001).

The process of measuring relative sensitivity and adaptive capacity of communes in the selected municipalities is similar to that of exposure measurement discussed above. Adaptive and sensitivity indicators were identified, followed by collection of data that were relevant to indicator estimation, calculation of normalized values of the indicators, assignment of weights to each indicator, and calculation of sensitivity and capacity indices as the weighted average of the normalized values of all indicators.

In this study, the determinants of adaptive capacity proposed by Smit et al. (2001) as a framework for identifying indicators was used. According to Smit et al. (2001), there are five important determinants of adaptive capacity: institution, infrastructure, natural resources, economic resources, and human resources. Starting from this framework the indicators were identified in collaboration with the local stakeholders. A tentative list of indicators for the determinants can also be found in the Annex Table 2. Data necessary for the measurement of relative sensitivity and adaptive capacity of commune/barangay were collected from different municipal and district agencies.

Commune/barangay surveys were also implemented to collect necessary data. Using the same normalization methods and weight assignment as discussed above, the sensitivity index and adaptive capacity index were calculated for each commune/barangay. Using the ArcView/Info

Software Package, maps of all communes/barangays in the selected municipalities of Laguna province were produced that indicate overall sensitivity and adaptive capacities.

Calculating vulnerability index and mapping

The overall index of climate change vulnerability of each commune/barangay was calculated as the simple average of the exposure and sensitivity indices and the inverse of adaptive capacity index. The communes were then ranked according to their respective indices to identify the vulnerable communes. Using the ArcView/Info Software Package, overall vulnerability maps of communes/barangays in selected municipalities of Laguna province were produced.

Agricultural vulnerability

The overall vulnerability with regards to agricultural sector was also computed as the average of the sector's exposure and sensitivity indices and the inverse of its adaptive capacity index with the same procedure and concept as discussed above. The agricultural vulnerability indicators can also be found in Annex Table 3.

METHODOLOGY AND DATA

Data Collection Method

A survey of 600 households were undertaken to collect information needed in the study. In-person interviews were conducted using a survey questionnaire. The questionnaire was written in the local dialect (Filipino-Tagalog). It includes 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 whether the household is located in a rural or urban barangay. A stratified random sample of 600 households was then obtained using proportionate sampling, i.e., the size of each stratum in the sample is 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 (BIDANI-UPLB). Whenever a household included in the sample cannot be located or refuses 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 Procedure

Various statistical procedures were applied in the study, such as the estimation of means, standard deviation, and frequency distribution. To determine whether significant differences in various indicators can be observed, the student t-test or Analysis of Variance (ANOVA) were employed, whenever applicable. Correlation analysis was also conducted to establish the strength of relationships between variables. In estimating vulnerability, two approaches were applied: Vulnerability Index (VI) as a function of hazard exposure, sensitivity and adaptive capacity, and the Vulnerability as Expected Poverty (VEP) Framework (VEP).

Vulnerability Index as a Function of Hazard, Sensitivity and Adaptive Capacity

The Intergovernmental Panel on Climate Change (IPCC), defined vulnerability as the susceptibility of a system to sustain impacts or damages from climate change. In this study, it is assumed that vulnerability is determined by three factors: hazard exposure, sensitivity, and adaptive capacity. Various indicators for these three factors have been used to calculate the index (Table 2).

Table 2. Variables Used in the Estimation and their Relationship with Vulnerability

Hazard	Typhoon	Number of typhoons and tropical depressions in the last 10 years	+
		Numbers of typhoons classified as Signal Number 3 and above in the last 10 years	+
	Flood	Number of flood events experienced in the last 10 years	+
		Highest flood height experienced in the 10 years (in feet)	+
		Longest flood duration experienced in the last 10 years (in days)	+
	Drought	Number of droughts experienced in the last 10 years	+
	Landslide	Number of landslide events experienced in the last 10 years	+
	Flash flood	Number of flash floods experienced in the last 10 years	+
Sensitivity	Human sensitivity	Dependence ratio: ratio of dependent person (below 15 years old and 65 and above) to family size	+
	Livelihood sensitivity	Percent of annual income generated from agriculture, fishery and forestry activities	+
	Infrastructure sensitivity	Ratio of family size to area of weak house	+
		Distance of dwelling unit to nearest body of water	-
	Financial sensitivity	Percent of debt to total income of households	+
Adaptive Capacity	Infrastructure	Average area of permanent dwelling per head	-
	Economic indicators	Income per capita	-
		Amount of remittance per year	-
	Technology indicators	Number of TVs, radios	-
		Number of line phones and cell phones/household	-
		Number of vehicles per household	-
	Social capital indicators	Number of contacts the household can ask for financial help	-
	Human indicators	Number of working household members	-
		Level of education: schooling years that the household head finished	-

The initial step undertaken in calculating the vulnerability index was the normalization or standardization of values. For variables that have a positive influence or impact on vulnerability, equation 1 was used:

$$y = \frac{X_i - Min\{X_i\}}{Max\{X_i\} - Min\{X_i\}} \qquad \text{Equation 1}$$

For variables that are hypothesized to negatively affect vulnerability, equation 2 was used:

$$y = \frac{Max\{X_i\} - X_i}{Max\{X_i\} - Min\{X_i\}} \qquad \text{Equation 2}$$

where,

y	:	normalized value
Xi	:	value of the observation
Min{Xi}	:	minimum value for all observations
Max{Xi}	:	maximum value for all observations

After data normalization, the vulnerability index was estimated by getting the weighted average of all the variables. Specifically, a composite index was calculated wherein each sub-indicator are assigned equal weights to compute for the indicator average, each indicator are assigned equal weights to compute for the factor average, and each factor are assigned equal weights to compute for the composite vulnerability index. This computed composite index is again normalized to get relative vulnerability estimates for each household.

Vulnerability as Expected Poverty: an Econometric Approach

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 & Suryahadi (2002) and Deressa, Hassan & Ringler (2009). First, it is assumed that the stochastic process that generates the consumption of a household is given by:

$$lnc_h = X_h\beta + e_h$$

The variable is per capita consumption expenditure, is a vector of observable household characteristics, is a vector of parameters, and is a mean-zero disturbance term which captures shocks. As proxy for consumption, the household monthly expenditure was used. The explanatory variables are gender, age, 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 landownership, 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 as well as those who experienced landslides.

The model assumes that the variance of $e_h$is given by:

$$\sigma_{e,h}^2 = X_h\theta$$

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

$$\hat{E}[lnc_h \ X_h] = X_h\hat{\beta}$$

As well as the variance of log consumption:

$$\hat{V}[lnc_h \ X_h] = \hat{\sigma}^2_{e,h} = X_h\hat{\theta}$$

By assuming that consumption is log-normally distributed, the above 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:

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

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. The World Bank minimum of US$ 1.25 per capita per day was used in the estimation. The analysis is based on 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 & Ringler, 2009).

Social Vulnerability

The general objective of the study on "Gendered Ethnographies of Social Vulnerability" is to empower/capacitate local communities and stakeholders to assess gendered community vulnerability and adaptation to climate change. The specific objectives are

i. to analyze social vulnerability of local communities in terms of gender, geographic location, ethnicity, and socio-cultural, demographic and political-economic features, and their potential community-based adaptation;
ii. to analyze the ethnographies across cases to derive a framework that contributes to understanding community vulnerability and adaptation in Southeast Asia;

Participatory and gendered approaches in vulnerability research

In examining vulnerability and adaptation of the project employs a gender lens to make “gender visible in social phenomena, asking if, how, and why social processes, standards, and opportunities differ systematically in women and men… and recognizing that gender inequality is inextricably intertwined with other systems of inequality” (Howard et al. 2005:x). It is the social systems that “generate unequal exposure to risk by making some people more prone to disaster than others and… these inequalities are largely a function of the power relations (class, age, gender and ethnicity among others) operative in every society” (Bankoff 2003:1). The connections of climate change to “gender justice” (Terry 2009) needs to be examined more closely in various cases.

It is recognized that many important research questions related to climate change remain unanswered, if articulated at all, primarily because research on climate change has been dominated by the positivist paradigm employing reductionist quantitative methods that are non-participatory and thus are insensitive to cultural meanings. The proposed cross-country project looks at climate change vulnerability and adaptation at the micro level, that is, at the level of a community or household with its particular circumstances and contexts pertinent to a given hazard. The project’s interest in community vulnerability and adaptation requires the application of the participatory approach that is a type of qualitative research underlined by an interpretive paradigm. In other words, vulnerability and adaptation are to be studied as socio-cultural constructs of specific groups of people. Thus, climate change is defined not as a single, objective reality but rather as multiple realities constructed by subjects differentiated by class, gender and ethnicity that compose a community. These groups pursue varied interests that pit the powerful against the powerless in discourses on dominance and marginality. The goal of any qualitative study is to make sense of phenomena in terms of the meanings people bring to them (Denzin and Lincoln 2005). An ethnography, or description of people/culture, is an in-depth qualitative study that requires the researcher’s immersion in the particular community. Culture is viewed as humans’ adaptive mechanism that allows a group of people to survive in a given environment or adjust to changes in its environment. Culture is a dynamic, integrated symbol-meaning system that includes techno-economy, ideology or worldview, and social relations.

Two major approaches to vulnerability can be gleaned from the literature on climate change namely, the “end-point” and “starting-point” views. The end-point approach emerged from the attempt to measure the potential costs of climate change (Burton et al. 2002). Vulnerability is viewed as the livelihood impact after an adaptation option has been adopted (Kelly and Adger 2000). End-point vulnerability aims to estimate the effectiveness of an adaptation option in reducing the damage due to a specific hazard. What are assessed are not contexts but rather adaptation intervention options based on the outcome of an anticipated hazard. In contrast, the starting-point approach to vulnerability, which the proposed project adopts, concentrates on the pre-existing processes within a system (O'Brien et al. 2004; Kelly and Adger 2000). This view of vulnerability aims to understand the dynamics of the community to identify the characteristics that render it vulnerable to climate change. Vulnerability in this view exists independently of the hazard. Thus, the starting-point approach to vulnerability is interested in the broad social and environmental context rather than in specific adaptation intervention options. The case studies in Ensor and Berger (2009) serve as illustrative examples. Clearly, the methodological challenges are greater in research on starting-point vulnerability because of the broadness of considerations, the diversity of contexts (from biographical to institutional, from spatial to temporal, from biophysical to cultural, and so on), and the need to develop context-sensitive research tools. The proposed project takes on these challenges by adopting an interdisciplinary, multi-stakeholder participatory approach grounded in local contexts.

Methods and tools

The primary participatory tools will be those that involve visual-verbal informal techniques to ensure appropriateness to local contexts. In particular, the project will use video as a major tool for several reasons: 1) the conduct of ethnographies requires "thick description" and videos can capture more than what words can portray. Data collected will be holistic and sensitive to cultural nuances. This will help researchers who are new to in-depth qualitative methods. In addition, video productions can be subjected to iterative analysis; 2) the communities will be trained to plan and produce video documentaries, thus the people will be provided the space to tell their own stories. The communities will "own' the video productions, keep them in their own community "knowledge resource centers", and utilize them for their own purposes; 3) a potentially large audience outside the communities ranging from neighboring communities to international policy and aid organizations can be reached; 4) the project covers three countries, which will not be visited by all researchers. The video productions can "bring the field" to those who cannot go to the field. This is crucial in the cross-case analysis.

Table 3 summarizes how each specific objective/question will be achieved through what methods/activities.

Table 3. Research Objectives/Questions and Methods/Activities

Specific objective/questions	Methods/activities
• To identify communities vulnerable to specified hazards • Who are vulnerable? Which community sub-groups (gender, class and ethnic categories) were the most seriously affected by climatic hazards, and what are the features of these sub-groups in terms of geographic location; and socio-cultural, demographic and politico-economic features? How do they access hazard information/warning: information sources and timeliness? How did they adapt? What role did the local social networks play in the people's adaptive capacity in terms of knowledge sharing, access to resources and influence on policy?	• Identification of individuals and organizations that will compose "stakeholders" in each study site through consultations and review of documents • Participatory vulnerability mapping and assessment to be done by multi-stakeholders to identify specific community sub-groups based on purposive sampling criteria
• To characterize the vulnerable communities • What is the local meaning of vulnerability and adaptive capacity? What are the community sub-groups' view of their vulnerability and adaptive capacity? What is the local knowledge equivalent to the English terms, vulnerability, adaptive capacity, hazard, and others? What would indicate vulnerability, adaptive capacity? Is vulnerability connected to adaptive capacity? How and why?	• Conduct of participatory ethnographies that will employ multiple methods primarily participant-observation, informal group and key informant interviews, review of secondary data, and video documentation. Tools that can be used are timelines, seasonal calendars, resource mapping.
• To assess particular social vulnerability in terms of underlying problems and their corresponding solutions • Why are people vulnerable and how can this problem be addressed? What is the community sub-groups' assessment/analysis of their vulnerability? Why are they vulnerable? How do they think their vulnerability can be reduced?	• Use of appropriate participatory tool such as Strengths, Weaknesses, Opportunities and Limitations analysis; Problem-Tree analysis; Community Environmental Analysis; Ranking, Sorting and Rating. The ethnographies (including the video) will be used to trigger reflections and analysis.
• To analyze the ethnographies across cases to derive a grounded theory or framework • What are cultural themes in the country cases of vulnerability and adaptive capacity? What are the similarities and differences in the cases of community vulnerability and adaptive capacity in the four selected countries? What grounded theory or framework is provided by the project based on cross-case analysis and interpretation?	• Conduct of project-wide workshops (face-to-face or computer-mediated) to analyze and interpret results of cases.

Research Methodology

Conceptual framework

The social and gender component of the project were guided by the research framework presented in Figure 3. The first step in the research was the identification of social and other non-climatic indicators to be incorporated in the vulnerability mapping. This was to ensure that more social and anthropogenic indicators aside from the climatic and geo-physical indicators be included in the assessment of climate change vulnerability. Conceptual clarification of the different dimensions of vulnerability (exposure, sensitivity, and adaptive capacity) served as guide in the identification of these indicators and thus ensured that all these dimensions have representative indicators. Given the identified indicators, more information were gathered and consequently analyzed. The objective was to be able to conduct vulnerability mapping and arrive at a vulnerability index that takes into consideration non-climatic social and economic factors.

Social vulnerability to climate change

Climate change vulnerability. The Intergovernmental Panel on Climate Change (IPCC) defines the concept of climate change as adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or exploits beneficial opportunities (Care 2010). The impacts of climate change can affect all sectors and levels of society so much so that reducing vulnerability to climate change has become an urgent issue for most of the world's developing countries (UNDP, 2004). ***Vulnerability*** refers to the propensity of human and ecological systems to suffer harm and their ability to respond to stresses imposed as a result of climate change effects (IPCC, 2007). In the context of the literature review done on the topic of social vulnerability, Cutter and her colleagues defines vulnerability as the "susceptibility of a given population, system, or place to harm from exposure to the hazard and directly affects the ability to prepare for, respond to, and recover from hazards and disasters" (2009:2).

Social vulnerability. Social vulnerability, on the other hand is more specifically defined as explicitly focusing on those demographic, socioeconomic and cultural factors that either increase or alleviate the impacts of hazard events on local populations (Tierney et al. 2001; Heinz Center 2002). Social vulnerability thus considers the variety that populations at risk may take on, and the differences in the degree to which these populations may be adversely affected. This study takes the perspective that vulnerability to climate change depends on the interrelationship of key elements of exposure, sensitivity, and adaptive capacity (Adger, 2006), and that these three elements have a socio-political and cultural character.

The IPCC (2007, as cited by Yusuf and Francisco, 2010) defines exposure as the nature and degree to which a system is exposed to significant climatic variations, while sensitivity is defined as the degree to which a system is affected, either adversely or beneficially. Adaptive Capacity, on the other hand, refers to the degree to which adjustments in practices, processes, or structures can restrain or offset potential damage or take advantage of opportunities arising from climate variability and extreme climatic conditions. It is the ability of a system to adjust to climatic changes and the increasing degree of variability in weather conditions, to respond to the potential damage from these, to cope with its consequences, or to take advantage of its opportunities.

According to Morrow (2008, as cited by Susan at al. 2009), social vulnerability helps explain the reasons for the different experiences of communities even if they encounter the same level of hazards. An assessment of social vulnerability is therefore necessary to ensure comprehensive and strategic mitigation plans as a response to the threats of natural hazards to the communities.

Participatory epistemology

Much of the social and gender research component was conducted using a participatory epistemology. Because the larger scheme of the project is capacity-building, the basic assumption upon which the social and gender research rests was that there are fundamental human needs which are materially, historically and contextually based. These needs drive the process of inquiry. The advent of climate change and the more frequent experiences of extreme weather conditions in the region necessitate a paradigm that accommodates local people's realities and capacities in responding to new challenges confronting socio- ecological systems. It is a paradigm that assumes that local people subject to the effects and impacts of climate change are active participants within the local scenario, and given the opportunities enhancing their capabilities, have the capacities to claim ownership over questions regarding their vulnerabilities, and over objectives and processes toward increased adaptability.

Research in this regard is aimed toward the creation of movement for personal and social transformation toward enhanced capabilities to assess local people's vulnerabilities and adaptive capacities to climate change-related disasters. The conduct of research is thus part of the learning process of identified stakeholders. Consequently, the research process particularly the methods of data and information gathering are those that hold opportunities for in-depth discussions, participative discussions and the surfacing of local knowledge in the assessment of vulnerabilities and adaptive capacities. Stakeholders at the local government units are especially given the opportunity to participate not only active discussions that tend to generate rich data, but also in providing support to facilitate this discursive generation of data at the community and sectoral venues.

Gender and climate change

Gender concerns cut across the whole project cycle, more so in the research component. A gender perspective in social vulnerability research premises that climate change has different effects on women and men due to gender relations and roles. In Asia, women, children and the elderly are considered high risk sectors (Ariyabandu and Wickramasinghe 2003; Wisner et al. 2004, as cited by Ahmed and Fajber, 2009). In the study conducted by Ahmed and Fajber (2009) for instance, poor women in flood-prone villages in eastern Uttar Pradesh in India expressed the difficulty in accessing food after floods indicating their vulnerability to food insecurity.

Basic considerations in the assessment of the gender aspect of vulnerability are the following: (1) access to resources; (2) diversity of income sources; and (3) differences in the relative social status of women and men in a community when confronted with climate change-related threats and hazards. Any intervention to mitigate the vulnerability of communities must make these considerations. The Hyogo Framework for Action that emerged from the United Nation's 2005 World Conference on Disaster Reduction states that "a gender perspective should be integrated into all disaster risk management policies, plans and decision-making processes, including those related to risk assessment, early warning, information management, and education and training" (ISDR, 2005: 4).

Participation and gender flashpoints have been identified and shall be addressed in both the research and training components of the project. For the research component, these included:

- Women participation in the research process
    - As source of data
    - As participant in data generation
- Local partners' participation
- Employment of gender analysis in the analysis of social vulnerability
    - Women's statuses and roles
    - Women's access to resources
    - Women's access to income opportunities

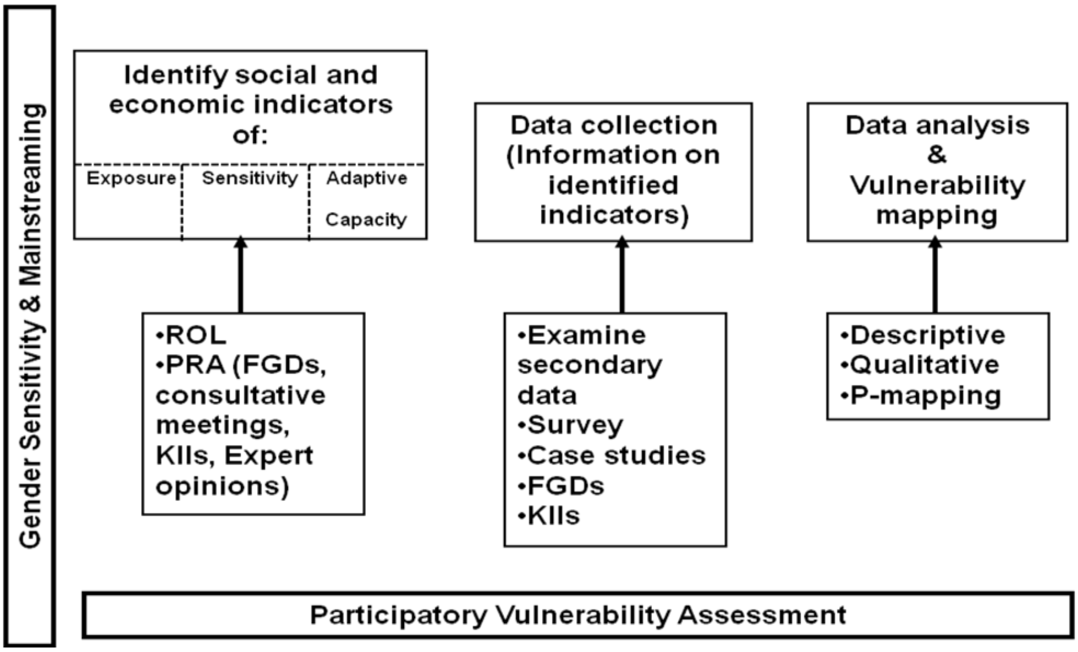


Figure 3. Schematic Diagram of Social and Gender Research Framework

Social Capital

The literature on studies done attest to the multi-dimensional character of social capital. Evidence to these is the various definitions and utilities of social capital. Many of the earlier researches which had conceptually or theoretically employed social capital are in the areas of social institutions and organizations, governance, issues of collective action, and economic development. It has also been utilized in studies on health, migration and public protection (Woolcock 2001, as cited by Franke, 2005).

More recently, social capital theory has also influence the understanding of vulnerability and adaptation to climate change. Moreover, there are very few climate change vulnerability or adaptation indexes that do not attempt to capture social capital one way or another (Birkmann, 2006).

<u>**Definitions of social capital**</u>. Social capital has been often associated with social participation and with networks characterized by cohesion and cooperation. Other concepts such as trust and institutional effectiveness had also been used to define it (Franke, 2005). Among the earliest reference to social capital was Hanifan's (1916) article about the importance of community involvement and local support for successful schools. To differentiate it from material and economic goods, he defined social capital as follows:

I do not refer to real estate, or to personal property or to cold cash, but rather to that in life which tends to make these tangible substances count for most in the daily lives of people, namely, *goodwill, fellowship, mutual sympathy and social intercourse among a group of individuals and families who make up a social unit… If he may come into contact with his neighbor, and they with other neighbors, there will be an accumulation of social capital, which may immediately satisfy his social needs and which may bear a social potentiality sufficient to the substantial improvement of living conditions in the whole community. The community as a whole will benefit by the cooperation of all its parts, while the individual will find in his associations the advantages of the help, the sympathy, and the fellowship of his neighbors* (Hanifan, 1916: 130-131).

It was Putnam, however, who introduced what has become the most frequently used definition of social capital: *"features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives"* (Putnam, 1995: 664-65). In his earlier work about the governmental reforms of Italy in the 1970s Putnam suggested that social capital will facilitate the cooperation and supportive relations in communities and nations and would therefore be valuable in overcoming many of the problems besetting modern societies (Putnam 1993). As Siisiäinen explains it, the main question of Putnam's Italian study is: what are the preconditions for the development of strong, responsive representative institutions and a prosperous economy? (Siisiäinen, 2000). On the other hand, Uzzi and Dunlap (2005) refer to social capital along the line of increasing personal access to information and skills useful to further their career prospects. This is more in line with Bourdieu's use of the concept to refer to social relations that increase the ability of an actor to advance her/his interests. To Bourdieu, *"the volume of social capital possessed by a given agent ... depends on the size of the network of connections that he can effectively mobilize"* (Bourdieu, 1986:249). It is a quality produced by the totality of the relationships between actors, rather than merely a common feature of the group. Membership in groups, and involvement in the social networks developing within these and in the social relations arising from the membership can then be utilized in efforts to improve the social position of the actors in his/her social context (Bourdieu, 1986).

Two significant dimensions of social capital relevant to the development of its indicators are apparent here. First is the reference to social capital for the good of organizations and social collectives versus the view of social capital as a personal/individual resource. For instance, the study of Pham Khanh Nam on the Mekong River Delta in Vietnam defined social capital as *"social networks and social skills owned by the individual and used to facilitate particular actions"* (Nam, 2011). This is clearly in line with the definition emanating from the Hanifan's and Bourdieu's definition of social capital, emphasizing the person or agent's social characteristic and context. In the same manner, Wellman (2001, as cited by Acevedo, 2007) describes social capital as network capital and defines it as the form of capital that makes resources available through interpersonal ties. He writes that it consists of "*knowing how to maintain a networked computer, search for information on the Internet and use the knowledge gained, create and sustain online relationships, and use these relationships to obtain needed resources, including indirect links to friends of friends*" (Wellman 2001 in Acevedo 2007). Woolcock and Narayan (2000) best capture this nature of social capital by referring to it *as "the norms and networks that enable people to act collectively"* (p.226), presenting the community (as opposed to individuals, households, or the state) as the primary unit of analysis, yet, allowing for the fact that *"individuals and households (as members of a given community) can nonetheless appropriate social capital"* (p. 227).

A second dimension that needs to be clarified in employing social capital in the assessment of hazard vulnerability and adaptive capacity is its dual definition as 1) a necessary feature or precondition possessed either by an individual actor or a collective; and 2) as a process within which social actors participate thereby decreasing their vulnerability and enhancing their adaptability. The first view is structural; the second is relational in perspective. Grootaert and Bastelaer (2002), while acknowledging the "the lack of an agreed-upon and established definition of social capital," (2002:2) best reflect this duality as they defined social capital as "the *institutions, relationships, attitudes, and values that govern interactions among people and contribute to economic and social development"* (Grootaert and Bastelaer, 2001:4).

To Bourdieu, social capital is produced by the "totality of the relationships between actors, rather than merely a common "quality" of the group (Bourdieu, 1980: 2 as cited by Siisiäinen, 2000). This perspective contends that social capital refers not only to mere membership to groups, but more importantly to the involvement in the social networks developing within these groups, and in the social relations arising from the membership. These relations can be eventually utilized in efforts to improve the social position of the actors in a variety of different fields (Siisiäinen, 2000). Given this perspective, the formation of voluntary associations as an indicator of social capital for instance, can be seen as collective and individual strategies of investment aimed at the creation of permanent networks of relations that will make possible the accumulation of social capital (Bourdieu, 1986). In Woolcock and Narayan's (2000) analysis, this perspective will allow research to focus on the sources, as opposed to the consequences, of social capital. At the same time, this provides the opportunity to recognize that important features of social capital, such as trust and reciprocity, are developed in an iterative process. It will thus afford room for social capital research to include individuals' subjective feeling (recognition, respect, and communality) and institutional support provided by the organizational membership, as factors leading to the development of social networks (Siisiäinen, 2000).

The relational view of social capital, evident early on in the writings of Bourdieu, also coincides with what Woolcock and Narayan (2000) summarizes as the network view of social capital. According to their discussion, this perspective *"stresses the importance of vertical as well as horizontal associations between people, and relations within and among other organizational entities such as community groups and firms"* (p.7). This guides and ensures that when outlining social capital indicators, social network be captured in terms of structural and relational measures of both "bonding" (referring to horizontal and intra-community relations) and "bridging" (referring to vertical and inter-community relations). In the same light, the model developed by the PRI of Canada defines social capital as *"social networks that may provide access to resources and social support,"* (Franke 2005: 9) and emphasizes that the unit of analysis they are interested in is not the isolated individual, nor the theoretical group (household, community) or real group (group, organization), but rather the *relationships* between them. The clear message about social capital is as collective social capital referring to an analysis of relationships between groups (Franke, 2005).

Woolcock and Narayan (2000) provide a useful categorization of social capital perspectives represented by studies they reviewed. When social capital is equated with local level organizations such as associations, clubs and civic groups, they call this the communitarian view of social capital. This view stresses the fundamental role of social ties in helping the poor manage risk and vulnerability, thus implying that its presence always has a positive effect on the welfare of the community. Because of this bias in favor of the goodness of social capital, the communitarian view does not have explanatory power where communities or networks are isolated, parochial and inconsistent with society's collective interests, thus serving as hindrances to economic development.

According to Woolcock and Narayan (2000), the weakness of the communitarian view is where the network perspective takes off, attempting to account for both advantages and disadvantages of social capital. This perspective also stresses the conceptual differentiation of horizontal and vertical relations. Accordingly, strong horizontal associations and intra-community ties give families and communities a sense of identity and common purpose. However, when these strong ties become the basis of narrow personal or sectarian interests and tend to be inconsistent with societal interests, they become inhibitors rather than facilitators of human, social and economic development. The view asserts that without strong intercommunity ties such as those that cut across boundaries of religion, class, ethnicity and gender, bonding relations can be detrimental to larger collective interests. To this effect Granovetter (1995, as cited by Woolcock and Narayan) contends that *“economic development takes place through a mechanism that allows individuals to draw initially on the benefits of close community membership but that also enables them to acquire the skills and resources to participate in networks that transcend their community, thereby progressively joining the economic mainstream”* (2000: 232). In the same manner, in an assessment of the social base of adaptive capacity Adger (2003) uses bonding and networking to distinguish between the public and private faces of social capital and acknowledges that these two realms are likely to deliver conflicts in interest. Adger contends that while it would be in the public interest and long-term individual advantage to build collective social organizations, it is not always advantageous for individuals to contribute toward this process.

In contrast to the communitarian and networks view which treats social capital as a source of social wellbeing and economic development, a third perspective gleaned by the review of Woolcock and Narayan (2000) is the institutional view which puts emphasis on social capital as a dependent variable. This view argues that the very capacity of social groups to act in their collective interest depends crucially on the quality of the formal institutions under which they reside (North 1990, as cited by Woolcock and Narayan). The strength of community networks and civil society is largely the product of the political, legal, and institutional environment. Social capital, represented by networks, norms and trusting tendencies, and which may eventually reduce or increase risks and vulnerability of communities, depends on institutional quality which may be indicated by either presence/absence/levels of corruption, bureaucratic red tapes, civil liberties, inequality, ethnic tensions, and failure to safeguard property rights. Pelling (2005), however, acknowledges that while capturing the informal ties that cross-cut and may direct the formal may be significant to capture, they may not be clearly visible and easy to capture.

The fourth perspective represented by literature reviewed by Woolcock and Narayan (2000) is the synergy view which attempts to bridge the networks and institutional views. Social capital here is measured by the synergy between government and citizen action, emphasizing the role of community networks and state-society relations. This is best embodied in legal frameworks that protect rights of associations (chambers of commerce, cooperatives etc.), and the nature and extent of the ties connecting citizens and public officials. Labonne and Chase (2008) examine the impacts of a large-scale community-driven development project, the KALAHI-CIDSS, on community-level social capital. Using the synergy perspective which acknowledges the importance of both community networks and the link of citizens with the state, the study examined an original sample of 2,400 households in 135 villages in 16 municipalities, in 4 provinces of the Philippines. It includes municipalities in which the project is being implemented as well as comparison municipalities. The study reported changes in the social dynamics and practices in our sample villages between surveys, and observed an increase in the proportion of household's membership to community groups. An increase in participation rates in collective action was also reported. The same increase was observed in the percentage of households which requested service from their local government. Overall, the study provided some evidence to the dependence of social capital on supportive systems and institutionalized opportunities for participation.

Components of social capital. According to Devine and Roberts (2003), social capital should be viewed as being composed of both structural and cognitive components. Structural components 'facilitates mutually beneficial collective action through established roles and social networks supplemented by rules, procedures and precedents' (Hitt et al. 2002), while cognitive components, which includes shared norms, values, attitudes, and beliefs, 'predisposes people towards mutually beneficial collective action' (Krishna and Uphoff 2002; Uphoff 1999). Trusting tendencies are indicative of cognitive social capital.

Structural relations are classified into three types: *bonding, bridging and linking*. Bonding social capital refers to the networks and relationships within an organization or group (Grafton, 2005). Bonding social capital includes relations among relatively homogenous groups such as family members and close friends and is similar to the notion of strong ties. Putnam (2000) lists examples of bonding social capital such as ethnic fraternal organizations and church-based women's reading groups.

Bridging social capital, on the other hand, focuses on networks among different organizations or 'the horizontal connections among similarly oriented but different groups' (Grafton, 2005) which tend to bring together people across diverse social divisions (Field, 2003). This type may include relations with distant friends, associates and colleagues. Putnam (2000) identifies civil rights movements and ecumenical religious organizations as among social capital under this category. Indicators which can be used to mark bridging capital include 1) the existence of venues where interaction with other organizations is possible; 2) affiliation with other organizations; and 3) participation in immediate/local organizations and as well as those outside the immediate community. These ties tend to be weaker and more diverse, but these "weak" ties are nevertheless important resource in enabling mobility opportunities (Granovetter, 1973).

Lastly, linking social capital refers to relations between individuals and groups in different social strata in a hierarchy where power, social status and wealth are accessed by different groups (Cote and Healy, 2001 as cited by Eddyson, 2009). These are vertical connections in formal hierarchy made between groups and institutions (Woolcock, 2001; Mayoux, 2001). Woolcock (2001) extends this definition to include the capacity to leverage resources, ideas and information from formal institutions beyond the community.

Research methods

Locale of the study

The study site in the Philippines included three watersheds located in the province of Laguna (Figure 4). The watershed boundary covers an area of 568 km^2 which is slightly less than a third of the Province's entire area. It included 12 municipalities and 274 barangays (Annex Table 4).

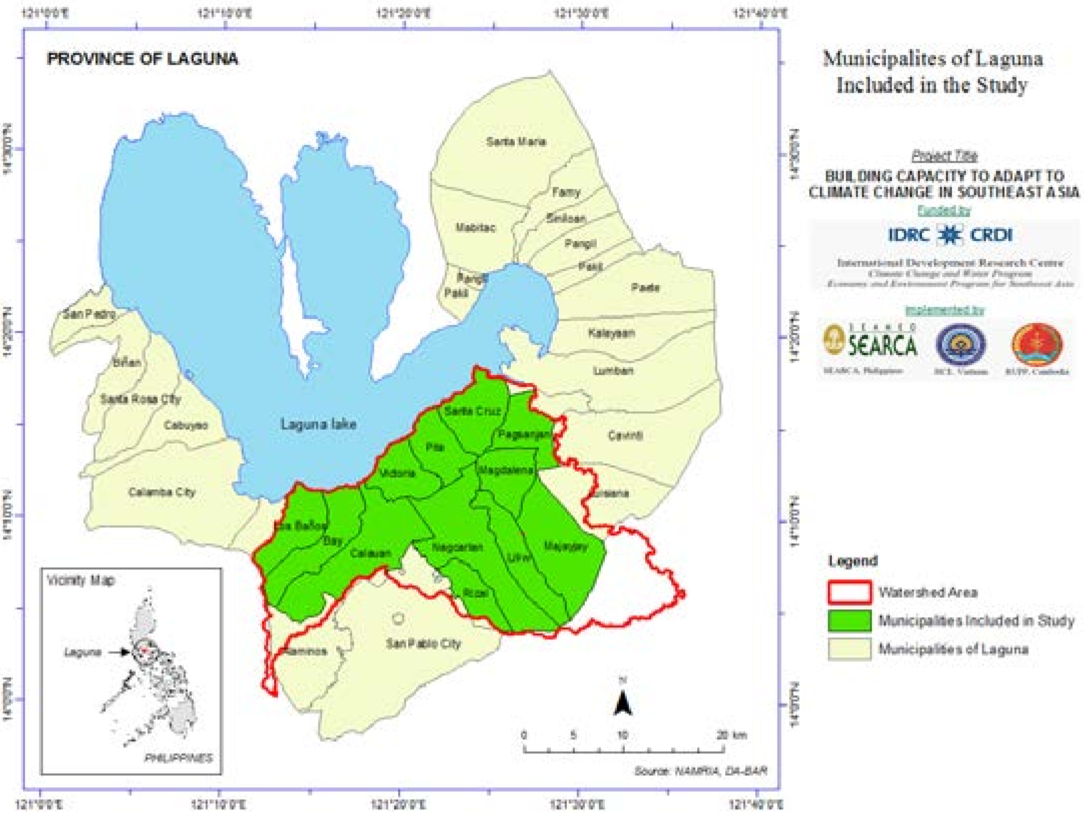


Figure 4. Philippines Study Site

The use of the watershed approach for the Philippine study is significant to the assessment of social vulnerability since it allows for the capture of the variety of vulnerabilities associated with the impact of flooding and typhoon on different human ecological systems. For purposes of the social vulnerability research, it allowed representation of highland, lowland and coastal communities and households.

A participatory approach was employed in the research process. This was done through the use of participatory research methods and through continuous, iterative and progressive engagement of local partners from identified government agencies and local government units all throughout the research. Building up of community partnerships in the process of research was also an utmost consideration. In consonance with the participatory and gender framework of the project, three main methods of gathering information for the social and gender research were employed: key informant interviews (KIIs), focused group discussions (FGDs), and in-depth interviews from which cases were built.

Key informant interviews (KIIs)

The objective in the use of key informant interviews was to gain a wider understanding of vulnerabilities and capacities of barangays/communes through those who have knowledge and influence on local communities. After a series of consultations and discussion meetings with initially identified local partners (for capacity-building/training), various categories were identified to facilitate a systematic selection of targeted informants. These categories were: 1) local chief executives and representatives from the legislative branch of local governance; 2) local government unit (LGU) planning offices; 3) key informants for agriculture; 4) key informants for the environment; 5) key informants for disaster risk reduction and management; 6) the Laguna Lake Development Authority (LLDA) as a quasi-government agency; 7) LGU social welfare and development offices; 8) municipal local government operations; and, 9) NGOs. Thirty-five (35) interviewees were purposely chosen from these categories (Table 4). An interview guide was prepared for this purpose (Annex 2). Among the 35 key informants, 20 were males and 15 were females.

Local government officials, some community leaders and NGO stakeholders were chosen as key informants since they usually have more contact with locals and thus are privy to community issues and concerns. Their knowledge of community life is thus crucial in arriving at a more holistic assessment of the climate change – related vulnerabilities of their communities. Their knowledge is also important to the eventual success of disaster risk reduction activities and the impact of these on different community sectors. This is partly because they have influence over development planning and subsequent activities in the area. By communicating with key informants, there will be an increased chance that activities to reduce vulnerability will eventually be supported, or at least not challenged, by those in power.

Table 4. Key Informants Interviewees

Category	Key informants	Office/ Department	Municipality / Organization / Agency	Sex	Total
Local Chief Executives; LGU Legislative Branch	Antonino, Aurelio	Mayor	Rizal	M	5
	Endozo, Josefina O.	Municipal Councilor; Gender Focal Person	Rizal	F	
	Molina, Dante R.	Brgy. Captain, Brgy. San Pablo Norte	Sta. Cruz	M	
	Ochoa, Ulysses	Executive Secretary	Pila	M	
	Ebron, Felix	Barangay Councilor – Brgy Malinta; Head – Committee on Environment / BDRRM Committee	Los Baños	M	
Planning Office	Arellano, Abet F.	MPDO Coordinator	Pagsanjan	M	9
	Bautista, Josephine	MPDO Staff	Calauan	F	
	Cejo, Aldwin M.	Staff, PPRRMO	PPDO, Laguna	M	
	Comendador, Lourdes A.	MPDO Staff	Nagcarlan	F	
	Gutierrez, Rosaly M.	MPDO Coordinator	Sta. Cruz	F	
	Guidote Valentin Jr. P.	PPDO Coordinator; Provincial Government Focal Person for PDRRM and Climate Change	PPDO – Laguna	M	
	Herradura, Renato S.	MPDO Coordinator	Victoria	M	
	Licong, Norman B.	MPDO Coordinator	Magdalena	M	
	Torres, Twila T.	MPDC	Los Baños	F	
Agriculture	Kampitan, Divina T.	MAO, Victoria	Victoria	F	6
	Bustamante, Antonio	Former Brgy Councilor - Brgy. San Francisco; BAFC – Brgy San Francisco	Victoria	M	
	Estrella, Casiano	Chairman, MAFC and BAFC – Brgy Banca-banca	Victoria	M	
	Crucillo, Romulo	Deputy Provincial Officer of FPA; CC Mitigation and Adaptation Focal Person; Designated Planning Officer, PAO	PAO – Laguna	M	
	Leal, Soledad	Agri. Tech. ; Coffee Project Coordinator; Rice Focal person	PAO – Laguna	F	
	Goma, Christy D.	Supervising Agriculturist; Corn focal person	PAO – Laguna	F	

Table 4. Key Informants Interviewees *(cont'd)*

Category	Key informants	Office/ Department	Municipality / Organization / Agency	Sex	Total
Environment	Itorralba, Jojo	Engr. Staff	Nagcarlan	M	6
	Ramos, Ronald H.	LGU	Sta. Cruz	M	
	Talavera, Perfecto Jr.	DENR-PENRO Staff	Laguna	M	
	Ocampo, Josefina M.	LMI, DENR-PENRO	Laguna	F	
	Malixi, Jerry	Municipal Engineer	Rizal	M	
	Malihan, Raul L.	Municipal Engineer	Calauan	M	
Disaster Risk Reduction Office	Javier, Jonas P.	Head, PDRRMO	Provincial Disaster Risk Reduction and Management Office (PDRRMO), Laguna	M	1
Quasi-Government Agency	Borja, Lennie S.	Chief, Research and Development Division	Laguna Lake Development Authority (LLDA)	F	1
Social welfare Office	Coronado, Magdalena	MSWDO - Rizal	Rizal	F	2
	Flores, Vinia T.	MSWDO - Victoria	Victoria	F	
Municipal Local Government Office	Tolentino, Rebecca	MLGO Officer - Liliw	Municipal Local Government Operations (MLGO) - Liliw	F	1
NGOs	Telleran, Rowena	Bagong Rizal Women's Club – President	Rizal	F	4
	James Antioquia	RCY Youth	Red Cross, Laguna Chapter	M	
	Paraiso, Ferd*i*nand	Red Cross Laguna Chapter; Disaster Response focal Staff Rizal	Red Cross, Laguna Chapter	M	
	Lecciones, Amy	Executive Office and Vice President	Society for the Conservation of Philippine Wetlands, Inc. (SCPW)	F	
TOTAL					**35**

In-depth interviews

There were 30 long/in-depth individual interviews from the Philippines. The intent was to analyze the results of the 30 in-depth interviews and built 8 to 10 cases representing various faces of social local vulnerability and adaptive capacities. Given the depth and breadth of vulnerabilities which the in-depth interviews would like to capture, a systematic multi-level stratification sampling method that started with the stratification of communes/barangays within the study site was employed.

The first-level stratification was be based on various ecological systems. The strata included the following human ecosystem categories:

1. Highland /Upland barangays
2. Lowland barangays
3. Coastal / lakeshore / riverside communes /barangays

After the different barangays within the study site were stratified, a second-level stratification was done based on identified vulnerable sectors. Respondents were chosen such that identified sectors were represented for all human ecosystem categories. The key informant interviews (KIIs) were used together with informal consultations with local authorities to identify / validate list of vulnerable sectors. The household survey was also taken into consideration in finalizing the list for the in-depth interviews. The strata / sectors included the following:

- Women-headed HHs
- Men-headed HHs
- Agriculture sector
- Elderly
- Youth

The 30 interviewees were purposively chosen from these sectors coming from all types of socio-ecological systems. The in-depth interview schedule developed by the social and gender component team was the data gathering instrument utilized for this purpose (Annex 3). The interview schedule was adapted according to the interviewee, and the situation/hazard in question. For example, if interviewing the non-agricultural households, the questions to probe gender-based farming activities were skipped, while for agriculture-based households, the respondents were asked to shed light on his/her household and his work. More probing questions relating to the effect upon his/her farm and his/her farming activities, or the role of their farmers' association before, during and after an identified disaster were considered. Table 5 shows the distribution of the respondents for the in-depth interviews.

From the 30 respondents, eight cases where chosen for full stories as a vehicle to analyze the vulnerabilities of the identified sectors.

Table 5. Distribution of Respondents for the In-Depth Interview

Classification	Highland	Lowland	Coastal	Total
Male – Headed HH	2	2	2	6
Female-Headed HH	1	2	3	6
Agri/ Aquaculture HH	2	2	2	6
Elderly	2	3	1	6
Youth	2	2	2	6
Total	**9**	**11**	**10**	**30**

Focus group discussions (FGDs)

Six (6) focus group discussions (FGDs) were conducted to probe and discuss vulnerability of various sectors (Table 6). To ensure a more focused discussion on the vulnerability of identified sectors, the researcher opted to conduct FGDs with homogenous participants based on sector. The FGDs conducted were on the following:

- Women sector/group
- The elderly / senior citizens
- Agricultural sector
- Coastal community
- Upland community
- Youth sector

Aimed towards a dynamic discussion of sectoral and gender-based vulnerability, around ten to twenty representatives participated in every individual FGD. As part of information generation, and to facilitate focus of participants on specific topics, participatory activities were employed during the conduct of each FGD. These activities were:

1) Timeline to identify type of exposure/ climate hazard trend and sensitivity for the past 10 – 20 years;
2) Community mapping exercise for climate hazard trend and sensitivity in the community;
3) Use of metacards to identify and enumerate available resources in the community and existing social capital; and
4) Identification and ranking of adaptation options

Typhoon and flooding incidences were identified using a timeline for 10 – 20 years. For the past twenty years, the participants identified the significant disasters they experienced and listed the effects of these events on themselves, their sector and their community. They were also asked to rate the hazards that they have experienced as high, medium, or low in terms of its intensity. Participants in each FGD were also asked to identify vulnerable sectors and groups and to assess their exposure, sensitivity and adaptive capacities as either low, medium or high.

Mapping of hazards and their trends was facilitated by the use of existing base or community maps. The participants used markers to draw the physical and natural features of the community for the past ten years and its changes over time due to land use, flooding, drought, etc.

Available resources and networks of participants were identified using metacards. This was done to surface the resources and indicators of social capital such as presence of organizations and microfinancing in the community which make their communities more prepared for typhoon and flooding events.

Table 6. FGDs Conducted

FGD No.	Sector	LGU represented	No. of Participants		
			Male	**Female**	**Total**
1	Elderly	Los Baños	6	1	7
2	Women	Los Baños	0	9	9
3	Agricultural community	Victoria	19	3	22
4	Coastal community	Brgy San Pablo Norte, Sta. Cruz	12	6	18
5	Upland community	Brgy. Ibabang Banga of Majayjay	11	2	13
6	Youth	Laguna	6	6	12
TOTAL			**54**	**27**	**81**

Table 7 presents a summary of the assessment tools utilized for the study.

Table 7. Summary of Assessment Tools Utilized

Tool	Purpose	Source of information
Key informant interviews (KIIs)	To gain a better understanding of vulnerabilities and capacities of communities and individuals through those who have knowledge and influence on local communities	Local government officials Community leaders Sector representatives NGOs
Focus Group Discussions (FGDs) • Community-mapping • Community historical timeline • Resource identification • Identification and ranking of adaptation options • Identification of social networks (social capital)	To gather information and generate local knowledge about barangay/commune vulnerability	Women's group Youth sector Elderly sector Agricultural sector Coastal community Upland community
In-depth Semi-structured interviews	To obtain a greater depth of information on the implications of climate and climate-related hazards/disasters on the lives of people in the study site and on their capacity to deal with these hazards/disasters	Selected household respondents From 3 human ecosystems (highland, lowland and coastal) and representing various types of HHs (male-headed, female-headed, agriculture/aquaculture-based, with youth, and with elderly)

Economic Analysis of Adaptation

Adaptation option

Adaptation policy or measure which can address climate change impacts can be reactive or proactive (Annex Table 5). In general, adaptation policies or measures identified should address one or more of the following strategies as defined by Carter, et al. (1994):

- Prevention of loss: involves anticipatory actions to reduce the susceptibility of exposure units to the impacts of climate change
- Tolerating loss: where adverse impacts are accepted in the short-term because they can be absorbed by the exposure units without long-term damage

- Spending or sharing a loss: where the actions distribute the burden of impacts over a larger population beyond those affected by the climate change impact
- Changing use or activity: switching of activity or resource use to adjust to the adverse as well as the positive consequences of climate change
- Changing location: migration to other areas not affected by climate change impact
- Restoration: restoring a system to its original condition following damage or modification due to climate

Benefit and cost of an adaptation option

Benefit of an adaptation option. The benefit of an adaptation project or policy can be determined by comparing the “with” and “without” adaptation case. Hence, the benefit is equal to the difference between the cost of impacts without adaptation and with adaptation, or simply the damages avoided because of the adaptation procedure (Figure 5). This will be estimated as a percentage of vulnerability.

Since climate change impacts involve risk and uncertainty, a risk-hazard approach will be applied in the evaluation of adaptation options. This approach consists of Hazard Analysis, Vulnerability Analysis and Risk Analysis.

In hazard analysis, the likelihood or probability of occurrence of the hazard events will be established and the hazard’s potential for bringing about destruction will be assessed. This involves the characterization of the hazard event (typhoon) (e.g. in terms of intensity, rainfall volume and flooding potential) and assigning a probability based on the hazard’s expected return/re-currency period. Historical data and General Circulation Models (GCM) projection for climate variables will be used in the analysis.

Vulnerability analysis, on the other hand, is concerned with identifying and estimating the hazard impacts, which may include damages or losses to population, material assets, and natural assets. For this purpose, socio-economic information of the population living in the community will be collected and an inventory of vulnerable assets (private, public and economic) will be undertaken. Moreover, a household survey will be conducted to determine the actual losses and damages from a recent hazard event. Information generated from the survey will be harmonized with past data on aggregate damages collected by the LGUs.

Climate disasters such as flooding and typhoon bring about a wide range of impacts on households, public sector, economic sector and the environment. Specifically, buildings and economic assets may be damaged, while standing crops, livestock, aquaculture stocks, and ecological goods may be lost. There are also immediate health impacts, as well as injuries and psychological stresses linked to the hazards. At the extreme, the hazards can cause the tragic loss of human life. Indirect impacts, on the other hand, include the loss of economic production, traffic disruptions, market disturbances (higher food prices or decreased prices for properties affected by the flood), and reduction of productivity (Messner & Meyer, 2005).

Both qualitative and quantitative assessment of these impacts needs to be undertaken. Qualitative assessment provides a deeper understanding of the context by which impacts are felt and perceived by the local community, which in turn will help in planning for a community-based adaptation. Quantification, on the other hand, is necessary so as to provide LGU stakeholders with relevant information which can be used in making decisions about how to allocate their limited resources. Simple valuation techniques, such as market-based approaches and the benefit transfer method will be utilized in the quantitative analysis while a toolkit will be developed for the community-based assessment. Relevant local government staff will be trained in conducting these two methodologies.

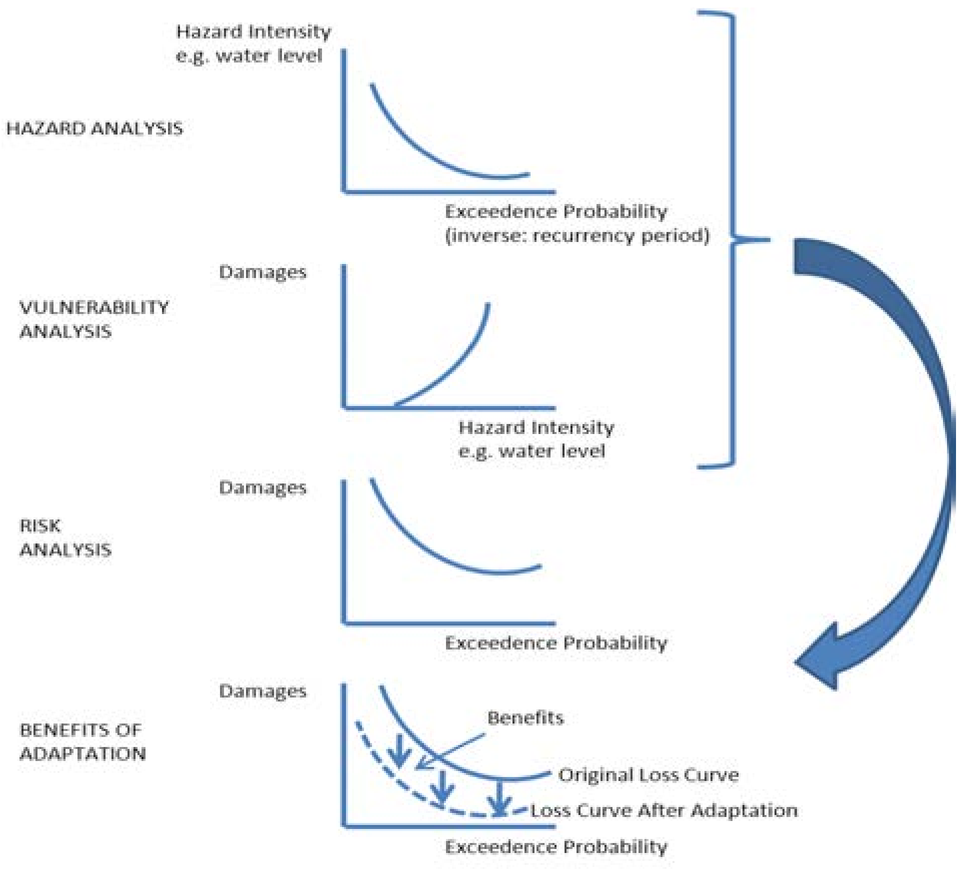


Figure 5. Hazard, Vulnerability and Risk Analysis as Inputs in Estimating the Benefits of Adaptation (adapted from Mechler, 2005).

The main output from this exercise is the establishment of a relationship between the hazard (characterized for example by rainfall volume) and the expected losses or damages associated with the hazard. A climate disaster could cause direct and indirect impacts (Annex Table 6a). To incorporate benefits without market values, (for example life or environmental services saved), several methods for valuation of non-market goods may be employed: Contingency Valuation Method (CVM), Hedonic Pricing, Travel Cost Method, Defensive Expenditures Method and Benefit Transfer. A review of techniques for quantifying and valuing climate disaster impacts can be found in Annex Table 6b.

Depending on the availability of time and resources, and the objective of the impact or damage assessment, a micro-, meso-, or a macro-level of analysis may be undertaken. Macro-scale analysis is useful for a national-level decision making, while meso-analysis is appropriate for a regional scale decision making (e.g. river basins, flood plains, coastal areas). Micro-scale, on the other hand, is for assessing the feasibility of a single protection measure on a local level (Messner & Meyer, 2005). The meso-scale level of analysis is deemed appropriate, and hence, will be used for this undertaking. Since the purpose of the project is to equip local government units with the capability to undertake the evaluation themselves, it is recommended that simple market based methods and Benefit Transfer be used in place of more “expert-reliant” techniques like Hedonic Pricing, Travel Cost, Contingent Valuation and Choice Modeling.

In risk analysis, a loss-frequency function will be constructed relating the losses or damages with its associated probability of occurrence. At least four data points will be established in the analysis. From the loss-frequency function annual damages or losses will be computed as the sum of the product of the damages and its associated probability.

Based on that, the benefits of adaptation can be determined. The benefits of adaptation options are the avoided or reduced losses; graphically, this is represented in shifting downwards the Loss Curve After Adaptation (see Figure 5).

Co-benefits of Adaptive Measures: The adaptive measures that will be identified will also be evaluated for their co-benefit potentials. These may include the multiple-use of evacuation centers also as school facilities, storage facilities for farm produce, and as community activity center. Control measures against flooding like dikes and dams can serve also as impounding structures where the collected water can be used by the community especially during dry periods. Materials from dredging or improvement of rivers can be used as fill materials for low-lying areas.

GHG Mitigation Benefits: GHG mitigation benefits can also be expected from the adaptation measures that may be generated since the project will be using a watershed approach to flood mitigation. The watershed approach would mean that it is not only the flooded areas that will be evaluated, but it will include the whole watershed from which runoff is generated. Therefore, some of the adaptation measures will definitely involve the improvement of the vegetation or tree cover of the watershed that can help reduce the amount of runoff water. With this expected improvement in vegetation, GHG mitigation can be expected and will therefore be part of the benefits that will be included in the analysis.

Cost of an adaptation option

The cost of adaptation, on the other hand, is the value of resources the society uses to adapt (Callaway, 2003). The cost of adaptation consists of the cost of planning, preparing for, facilitating, and implementing the adaptation measure (including transaction costs) (Carter, et. al, 1994). The cost may include a one-time expenditure for capital investments and a recurrent cost (e.g. maintenance and operational costs) (Boardman, Greenberg, Vining and Weimer, 2006). Although conceptually the cost of adaptation should include both financial as well as social costs (opportunity foregone by the society), in practice the financial cost is usually used in the estimation.

For example, the costs of a flood protection measure are the one-time investment costs and maintenance costs that arise over the lifetime of the measure. Benefits of such measure arise due to the savings in terms of direct and indirect damages avoided such as avoidance of loss of life and property in the downstream area.

Adaptation Option Evaluation and Comparison

In determining which adaptation option is the best option, various approaches may be used: Cost-Benefit Analysis (CBA), Cost-Effectiveness Analysis (CEA), and Multi-Criteria Analysis (MCA). Burton, et al (2005) presents the pros and cons of the various methodologies as well as decision criteria to help analysts determine which methodology to use in adaptation assessment (Table 8).

Table 8. Comparison of CBA, CEA and MCA

Method	Advantages	Disadvantages
Cost-Benefit Analysis	Can handle optimization and prioritization; Main Concern: Economic efficiency.	CBA has comparatively heavy data requirements. Only considers economic efficiency in judging whether a project is good or not.
Multi-Criteria Analysis	Suitable when more criteria are thought to be relevant and when quantification and valuation in monetary terms is not possible. MCA can be used for ranking of options.	Subjective judgment plays an important role in this method, making outcomes more arbitrary than that of CBA.
Cost-Effectiveness Analysis	A method that falls somewhere between CBA and MCA. Can be used if benefits are difficult to monetize.	CEA only produces a ranking.

Source: Burton, et al, 2005

CBA can be used if there is only one objective (i.e. economic efficiency) and that quantification of benefits and costs are possible, while CEA can be used if benefits cannot be quantified. CEA can also be applied for projects with two objectives so long as the objectives can be weighted. For projects with at least three objectives, the MCA may be chosen (See Appendix 8).

CBA may be the most desirable option. However, this depends on the purpose and stage of the analysis. In cases where important criteria cannot be accommodated in CBA (such as sociological or cultural barriers), or when benefits cannot be quantified and valued (such as the benefits of preserving biodiversity), MCA is preferred. If desired, the outcomes of CBA can be incorporated into MCA, making the overall analysis a hybrid one (Burton et al., 2005).

Cost-Benefit Analysis

Cost benefit analysis is a method by which the impacts (both benefits and costs) are systematically identified, quantified and monetized so as to determine the net benefit of the project vis-à-vis the status quo. Its main purpose is to determine whether a project is worthwhile doing on the basis of efficiency. The decision criteria used is: If the net present value of a project is positive, then it is a good project. The generic steps for conducting a CBA are as follows: 1) Specifying the alternative projects; 2) Identifying whose benefits and costs count; 3) Cataloguing the impacts (benefits and costs) and selecting measurement indicators; 4) Predicting the impacts over the life of the project; 5) Monetizing impacts; 6) Discounting net benefits to obtain present values; 7) Computing the net present value of each alternative; 8) Performing sensitivity analysis; and 9) Making a recommendation (Boardman, Greenberg, Vining, and Weimer, 2006).

Since the stream of costs and benefits of adaptation are experienced at different points in time, discounting should be undertaken to obtain present values. The discount rate may significantly affect the NPV computation, it is suggested that several discount rate be used as part of the sensitivity analysis (Margulis et. al, 2008). Apart from the discount rate, sensitivity analysis may also be done by varying the expected impacts of the hazard as well as that of the adaptation.

As climate change impacts involve risk and uncertainty, there is a need to adjust the deterministic NPV calculation above for the adaptation options under considerations. The deterministic cost-benefit analysis will be converted into stochastic model by applying risk analysis which involves identification and quantification of risks and uncertainty in the decision variables of the model. Risk analysis is a quantitative method that seeks to determine the outcomes of a decision situation as a probability distribution. One of the commonly used techniques to analyze risk is through Monte Carlo simulation[2] to derive probability distribution of outcome variable. In this particular exercise, probability distributions of NPV will be based on projected climatic variables from climate change scenario for the country such as rainfall and temperature. The popular approach suggested by Hardaker et al. (1997) to use triangular distribution using information derived from experts' judgment or Delphi technique will also be applied to calculate the cumulative distribution function of the net present value for each alternative adaptation options. To address the issue of uncertainty, sensitivity analysis of the stochastic results for each adaptation option will be conducted.

Cost-Effectiveness Analysis

If the benefit of an adaptation option is difficult to monetize, CEA may be employed in the analysis. The decision criterion of CEA is to choose the option that can achieve the objective at the least cost. In cases where the

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[2] Risk analysis uses Monte Carlo simulation on key inputs in the analysis. The analyst has to determine the probability distribution (normal, skewed, etc.) of the occurrence (say of an increase in cost, or number or intensity of extreme events) and the possible co-variance between these inputs. The computer model, using a random number generator, makes a large number of runs to determine the (average) outcome. If a probability (or combinations) is an input into the analysis, the output, naturally, is also a probability distribution (e.g., of the NPV or the rate of return), see Burton et al. (2005) for more detailed discussion.

objective of adaptation is multiple, CEA can be applied if one objective can be expressed in the other by assigning importance (weight) to the objectives (this is called “weighted CEA”). To compare climate change alternative adaptation options using this approach, cost effectiveness ratio can be computed in two ways:

Cost per unit of outcome effectiveness: $CE_i = \frac{C_i}{E_i}$

Ci is cost of option i; Ei is outcome (or physical measure of benefit) of that option. The CE ratio can be interpreted as the average cost per unit of effectiveness. In other words, the most cost-effectiveness adaptation option has the lowest average cost per unit of effectiveness.

Outcome per unit of cost effectiveness: $EC_i = \frac{E_i}{C_i}$

This EC ratio can be interpreted as the average effectiveness per unit of cost. Simply, it means that adaptation option with the highest average effectiveness per unit of cost is considered the most cost-effective option.

METHODOLOGY AND DATA

Identification of Adaptation Options for Economic Analysis

Figure 6 summarizes the process undertaken in order to come up with the adaptation option for economic analysis. Evident in the process is the participatory framework considered as a cross-cutting theme in the project.

The first round of consultations were undertaken during the training-workshop on the economic analysis of adaptation options which involved our stakeholders, the municipal planning officers of the 12 municipalities of Laguna, as well as representatives from the Department of Environment and Natural Resources (DENR). During this consultation, a long list of options was identified (Table 9). In order to narrow down the list, the participants were asked to identify sets of criteria by which to judge the various options. The evaluation of the options was done through a simple scoring system, and those that garnered the highest scores were considered for the second round of consultations. The criteria used are indicated in Table 10.

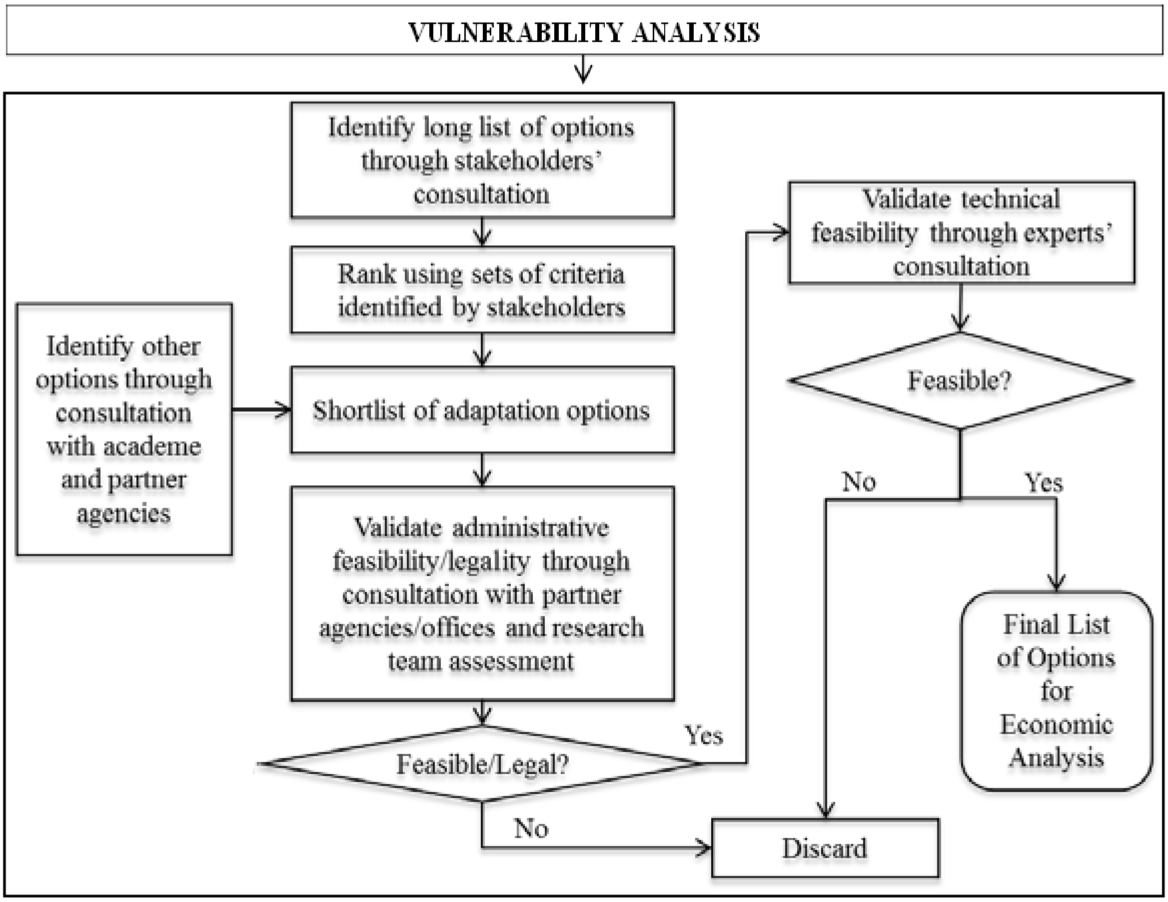


Figure 6. Process Used in Identifying the List of Adaptation Options for Economic Analysis

Table 9. Initial List of Adaptation Options Identified During the Stakeholders' Workshop

CATEGORY	OPTION
Technology	Planting of submersible rice variety Sloping agricultural land technologies Organic farming
Infrastructure	Coordination with the Manila Metropolitan Development Authority (MMDA) and LLDA regarding the Napindan Channel Operation Construction of road dike sea wall along the perimeter of the Laguna de Bay Dredging of drainage canal, esteros and waterways
Regulation	Strict implementation of 12.5 meters lakeshore waters (no development zone) Relocation of informal settlers
Information and Aid	Massive Information and Education Campaign (IEC) Installation of early warning system
Environmental Management	Waste management Floating toilets and elevated artesian well Planting of putat tree and bamboo along the lakeshore Tree planting/reforestation Green architecture
Livelihood Assistance	Charcoal briquetting

Table 10. Criteria Used in Screening the Adaptation Options for Economic Analysis

CRITERIA	DESCRIPTION
Effectiveness	Will the option meet the objectives? Will it increase/ensure climate change resiliency? Potential for increased climate resilience and environmental conservation/ protection/preservation Will it address targets of intervention?
Multiple Goals/Benefits	Will it generate other benefits? Able to achieve multiple goals Potential for conservation/preservation of the environment Decrease carbon emission / decrease energy consumption Socio- economic efficiency Minimize illegal logging activity Promote solid waste management Sustainable organic food production May reduce health hazards Increase land productivity Reduce soil erosion/siltation of rivers and lakes
Social Acceptability/ Legitimacy	Is the option politically, culturally and socially acceptable?
Practicality/Low Barriers	Is it feasible? Can the option be implemented on relevant timescales? Sustainability / Sustainable
Scalability/ Replicability	Can it be replicated in other areas? Can it be implemented on a larger scale? Potential for up-scaling to larger areas or replication Potential for a “ripple effect” to neighboring towns and provinces Potential for up-scaling or mainstreaming to larger market
Equity	Will the option benefit vulnerable groups and communities? Participation of other entities Promote participation of household
Urgency	How soon does the option need to be implemented? Will the intervention target a high-priority area? Has a huge urgent impact to CCA

In the second round of consultations, the shortlisted options were presented to our partner agencies which include the Laguna Provincial Planning Development Office (PPDO), Laguna Lake Development Authority (LLDA) and the Provincial Environment and Natural Resources Office (PENRO). They assessed the legal and administrative feasibility of the shortlisted options and at the same time contributed in identifying other options that did not come up during the first consultation.

In order to validate the technical feasibility of options, a last round of consultation was undertaken involving experts from the academe. Through this venue, the experts provided insights as to the availability of technologies that could be used to implement the proposed adaptation projects as well as suggested other options that could be applicable to the study site. Field/on-site visits were undertaken to aid in the validation.

Through this rigorous process and considering the output of the vulnerability assessment done in the first year, the following options were considered for analysis: Technology Based-Early Warning System for the whole of Sta. Cruz River watershed, and Relocation, Evacuation and Building Modification for a case study in selected lakeshore barangays.

The Study Site Selection

Since the project, as implemented in the Philippines, utilizes a watershed approach in designing the adaptation strategies, one of the critical set of activities that was conducted is the analysis of GIS topographical maps and a review of the results of the vulnerability assessment done in Year 1. Computational modelling was done to guide in the selection of the study site for the economic analysis.

A '**Rational Method'** was applied in the computational modelling in order to estimate peak runoffs that contribute to flooding. This method is a function of the study site's watershed characteristics together with rainfall intensity for various return periods. The result yielded the highest runoff estimates in the Sta. Cruz River watershed (middle). This coincides with the results of the vulnerability index study conducted in Year 1, wherein the two most vulnerable barangays in terms of overall vulnerability and the three most vulnerable in terms of agricultural vulnerability were found to be located within this particular watershed. Thus, while the Year 1 vulnerability assessment was originally conducted with three sub-watersheds comprising the study site: Mabacan, Sta. Cruz and Balanac, the Philippine team decided to narrow down the Year 2 study site on the Sta. Cruz (middle) watershed. Contiguous municipalities belonging to the Sta. Cruz watershed and with the highest vulnerability index were selected. These are the municipalities of Sta. Cruz, Victoria and Pila.

Data Collection Method

A household survey was conducted to collect data on household profile and characteristics, impacts and damages from flooding, and willingness to pay for early warning system. Respondents were chosen using a two- stage stratified random sampling procedure. First, the population of households was stratified by municipality (i.e. Sta. Cruz, Pila and Victoria) and second, by the households location, whether it is in a rural-high vulnerability index, rural-low vulnerability index, urban-high vulnerability index or urban-low vulnerability index barangay. A stratified random sample of 500 households was then obtained using proportionate sampling i.e. the size of each stratum in the sample is proportionate to the size of the stratum in the population. The households making up the sample were selected from a list of households provided by the LGUs and the Barangay Integrated Development Approach for Nutrition Improvement of the University of the Philippines (BIDANI-UPLB). Whenever a household included in the sample cannot be located or refuses to participate, a replacement household was selected randomly from the same stratum.

Focus Group Discussions (FGD), Key Informant Interviews (KII) and secondary data collection were also undertaken for the study. Through the

FGD, the Contingent Valuation Scenario was identified. From KIIs, we were able to gather information about the experiences of selected barangays on long-term floods as well as their responses during the calamity. Secondary information collected includes the municipal comprehensive land use plans, municipal profiles, Laguna lake profile, typhoon damage data, evacuation data, and building construction cost standards. Our informants include:

- Laguna Provincial Planning and Development Office
- Sta. Cruz Municipal Mayor
- Sta. Cruz Municipal Planning and Development Coordinator
- Sta. Cruz Municipal Social Work and Development Office
- Sta. Cruz Municipal Health Office
- Sta. Cruz Municipal Engineering Office
- Laguna Lake Development Office
- Victoria Municipal Planning and Development Coordinator
- Pila Municipal Planning and Development Coordinator
- Barangay Officials of San Pablo Norte, Santissima and Poblacion 4, Sta. Cruz.
-

Flood Inundation Model and Damage Estimation

Market-based valuation was applied to monetize the property and asset losses from flooding. There are five categories of land use in our study site based on collected maps: (1) built-up/residential; (2) rice lands; (3) sugar and cereals; (4) coconut; and (5) industrial. Since our site-validation shows that there is no sugar production in the area, the sugar and cereal category was also considered as rice land areas. Also, due to the absence of data, we were not able to establish the typical damage cost for industrial lands. It is assumed that the damage cost for coconut lands is zero since the crop is relatively resilient to floods.

In collecting the property damage data, we adopted a synthesis of approaches: the real damage approach; the absolute damage approach; and the relative damage approach. In the real damage approach a social survey is undertaken to get real damage data. In the absolute damage approach, the damage per square meter of floor space is estimated, usually using information from insurance claims. The relative damage function approach on the other hand, estimates damage as a percentage of the market value of the property (Messner & Meyer, 2005).

In this study, we collected data on damage costs per household through a household survey and utilized this information to estimate the typical damage cost per hectare based on varying flood depths. Specifically, we looked at the typical household appliances, furniture, and vehicles that are damaged during a typhoon event, and used the average repair costs for these assets (RC). There are three ways to value damages: a) repair cost; b) replacement cost; and c) depreciated values. In this study, the repair cost was used. The replacement cost was deemed to be inappropriate because replacement also entails improvements, that is, old goods damaged by the flood are replaced by new goods which are more productive and efficient (Penning-Roswell et al., 2003). On the other hand, depreciated costs are difficult to estimate as it needs information on the average age of assets.

To get the typical damage cost per household of flood depth i, the repair cost for asset j multiplied by the probability of incurring the damages are summed.

$$D_i = \sum (P_{ij} * RC_j)$$

Where:

D_i is the typical damage cost per household exposed to flood depth i
P_{ij} is the probability of damage on asset j, for flood depth i
RC_j is the repair cost for asset j
i:4 feet and above, 2.5-3.9 feet, 2-2.4 feet, less than 2 feet

P_{ij} is computed using the formula:

$$P_{ij} = \frac{n_{ij}}{N_i}$$

Where:

P_{ij} is the probability of damage on asset j, for flood depth i
n_{ij} is the number of households exposed to flood depth i, that reported damage on asset j
N_i is the total number of households exposed to flood depth i

To get the per hectare flood damage cost, D is multiplied to the household density per hectare. The household density per hectare for built-up areas in the study site is 50. It must be noted, that the per hectare damage cost estimates are lower bound as the study did not undertake a survey of business firms. Hence, flood impacts to businesses and commercial establishments were not included.

For rice lands, the lost producer's surplus, approximated by the lost net income per hectare of a typical rice farm, was used to value the flood damages. The threshold level of flood which can destroy standing crops is 2.5 feet. In the estimation, rice production cost data was sourced from existing literature (Philippine Department of Agriculture, 2012), while rice yield and market price was based from the household survey.

Contingent Valuation Method

To capture the benefit of the technology-based early warning system project, the Contingent Valuation Method (CVM) was used. CVM is a survey based valuation technique which directly asks individuals or households about their willingness to pay for a good or service. It is a direct method that measures the values of non-marketed goods or services. It is survey-based, wherein a hypothetical market is presented in a realistic and structured way to the respondents before eliciting the value of their willingness to pay (WTP), rather than inferring from an observed behavior (Carson, 2009). Leary (1999) defined WTP as the amount paid by a person which would have an equivalent effect on the person's welfare as would the policy. It is referred to as "contingent" as valuation is dependent on the information provided to the respondent during the survey.

Review of Literature

The concept of using the public opinion as an applicable instrument to value public good was first proposed by Bowen (1943) and Ciriacy-Wantrup (1947). However, it was Davis (1963) who was able to implement the first contingent valuation survey in his attempt to value recreation in the Maine woods. Early empirical developments of CVM in the 1950s and the 1960s were due to the interest of the U.S. National Parks and Forests Services to obtain the preferences and WTP of the people as well as the interest of the US agencies building water projects on benefit cost analysis framework to make these projects more attractive.

The technique's ability to estimate values of non-marketed goods made it a useful tool in estimating environmental benefits and costs. In 1986, the U.S. Department of Interior recognized CVM as a preferred method for measuring benefits and damages under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. After the Exxon Valdez spill the National Oceanic and Atmospheric Administration (NOAA) established a panel of experts to assess the reliability of CVM estimates on natural resource damage. The Nobel Prize awarded Kenneth Arrow and Robert Solow co-chaired the National Oceanic and Atmospheric Administration (NOAA) Blue Ribbon Panel. Numerous guidelines necessary to gain reliable estimates on CVM application were established and then the panel declared that "CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages including lost passive-use value".

Since then this technique has become one of the most widely used methods for valuation of non- market goods. This is the only methodology that can estimate both the use and non-use value in the estimation of welfare changes (Hanneman, 1994), (Mitchell and Carson, 1989), (Bateman et.al.2002). This technique is flexible; it allows valuation of a wider variety of non-market goods and services. Nevertheless, CVM is also subject to biases such as information, design and compliance which can overestimate or underestimate the real value of a good in question. However, the effect of such biases can be minimized upon careful application of the technique and design of survey (Akhter, 2010). Furthermore Lipton et al. (1998) confirmed that the CV can be regarded as the best method to estimate the economic value of anything.

Also, according to Hanemann (1994) CVM is extensively used by governments and the World Bank in appraising a variety of investments, such as transportation, sanitation, health, literature, education, and the environment. It also became a prominent method on policy analysis and academic researches (Awad and Hollander, 2010). In the United Kingdom, the Department of Environment recommended the use of CVM for project and policy appraisal (U.K. Department of Environment, 1991).

CVM also became a useful methodology for climate change mitigation and adaptation studies. Layton and Brown (2000) and Brouwer et al., (2008) used WTP on tree plantation for carbon sequestration, and Akhter (2010) to estimate economic value of campus carbon offsets. In addition, Akhter and Bennet (2009) did a WTP survey to support the proposed carbon pollution reduction scheme by the Australian government. This study did a web-based survey of 600 respondents using single bounded dichotomous choice elicitation format. Results show positive demand for climate change mitigation action.

Markantonis and Bithas (2009) did a CVM survey on climate change experts to estimate climate change adaptation and mitigation policies in Greece. On the other hand, Cardoso and Benhin (2011) used CVM to estimate the market and non-market benefits of protecting the Columbian Caribbean Coast from sea level rise. The estimates from CVM were incorporated in the Cost Benefit Analysis (CBA) of the adaptation options. Results of the CVM is positive and it indicates that majority of the respondents are willing to pay USD 2.41 to USD 7.22 per month. CBA analysis shows that long term benefits of protecting the coast outweighs the implementation cost.

Various studies confirm that the dominant share of the potential impact of climate change is non-market impacts. In addition, IPCC's Second Assessment Report, states that between 30 -80% of the total existing estimates of climate change cost are non-market costs (Rothman et. al. 2003). Thus, excluding non-use impacts of climate change is an underestimation.

Theoretical Framework

The theoretical framework of the Contingent Valuation Method described below was borrowed from Bateman, Carson, et al 2002.

Basic utility theory suggests that individuals (or households) maximize their utility subject to their budget constraint. Following standard economic theory, an indirect utility function, *V*, can be defined which shows the maximum amount of utility that a household can derive from their income *Y*, given prices of goods *P* and the level of provision of a non-marketed good *Z* (which in this case is the early warning system). It is also assumed that the household's utility depends upon their socio-demographic characteristics *S*. Hence, $V(Y, P, S, Q)$

It is expected that the higher the income or the lower the prices, the higher the utility level. Also, an increase in provision of the non-marketed good, let's say from Q^0 toQ^1, will increase the household's utility, such that:

$$V(Y, P, S, Q^0) < V(Y, P, S, Q^1).$$

When households are answering a CV question, they are essentially comparing their utility at Q^0 vis-à-vis Q^1. At Q^1, they are experiencing higher levels of utility hence it is reasonable to assume that they would be willing to pay an amount to get Q^1. However, as they increase their payment to get higher provision of Q, their utility diminishes. Hence, the maximum amount that they would be willing to pay is defined where:

$$V(Y,P,S,Q^0) = V(Y-C,P,S,Q^1)$$

That is, when the household is indifferent between its original position, when the provision of the non-marketed good is Q^0, and the position wherein Q^1 is provided but it has to pay for the provision of the non-market good. If payment exceeds C, then the household is better off at Q^0. In the equation, *C* is the compensating variation measure of a change in welfare or the household's maximum WTP to achieve the increase in provision of the non-market good.

From the previous equation, a bid function $C(\ )$ can be defined as a function of the other parameters in the model. It is also assumed that maximum WTP is equal to C and should be less than income Y.

$$C = C(Q^0, Q^1, Y, P, S) = WTP \leq Y$$

Parametric Estimation of WTP

In the binary choice format, households just state whether they are willing to pay a certain amount (B), or not. In response to the CV question, they can either answer:

No if $C_i < B$ or

Yes if $C_i \geq B$

The probability that the household is willing to pay can be estimated using Hanemann's binary logit model wherein the dichotomous choice WTP responses are regressed on bid values and a vector of socio-economic and awareness/attitudinal variables (X_i).

$$\Pr(Yes) = E\left(Y = \frac{1}{X_i}\right) = 1/(1 + e - [\beta_0 + \beta_1 X_i])$$

The mean willingness to pay is then estimated using the formula:

$$WTP = -\alpha/\beta_1$$

Where:

α: the sum of the constant term and the coefficients of all explanatory variables multiplied with the mean values of explanatory variables (except the variable bid price).
β_1: coefficient of the bid price.

Empirical model

The dependent variable takes on the value of 1 if the household is willing to pay the bid amount, and takes on the value of 0 if not. The explanatory variables used in the analysis are summarized in Table 11.

Table 11. Explanatory Variables Used in Logit Regression

Explanatory Variable	**Notation**	**Description**	**Expected Sign**	**Rationale**
Bid	BID	Takes on the values of Php25, Php50, Php100, Php200, Php300	-	As the price of the good increases, the less will be the likelihood of paying.
Household income per capita	INC	Monthly household income divided by the household size	+	As the income increases, the greater the likelihood of paying.
Exposure	EXP	Number of floods inundating house in the last 10 years	+	As exposure to flooding becomes greater, the greater the likelihood of paying.
Knowledge about early warning system	KNOW	Dummy, if self-rating on knowledge is above 2, the variable takes on the value of 1; 0 if below 3.	+	The more aware and knowledgeable a household is about the early warning system, the greater the likelihood of paying.
Autonomous adaptation	RISK	Dummy, if household has undertaken any form of autonomous adaptation, the variable takes on the value of 1; 0 if otherwise.	+	Autonomous adaptation may be indicative of risk aversion. Risk-averse households will be more likely to be willing to pay.

Table 11. Explanatory Variables Used in Logit Regression *(cont'd)*

Control Variables Reflecting Respondent Characteristics		
Respondent's Sex	RSEX	Dummy, if male the variable takes on the value of 1; 0 if female.
Respondent's Education	REDUC	Number of years of schooling.
Respondent's Age	RAGE	Age as of last birthday.
Control Variables Reflecting Geographical Location		
Pila	PILA	Dummy, if household is located in Pila, the variable takes on the value of 1; 0 if otherwise
Sta. Cruz	SCRUZ	Dummy, if household is located in Pila, the variable takes on the value of 1; 0 if otherwise

Non-parametric Estimation

To get a non-parametric estimate, the lower bound Turnbull mean willingness to pay equation was used (Haab and McConnell, 2003). The Turnbull estimator is a distribution-free estimator relying on asymptotic properties. The proportion of "no" responses is higher as the bid price increases, while the survival function is decreasing in bid.

The mean is given by:

$$E_{LB}(B) = \sum_{j=0}^{M} B_j\left(F_{j+1} - F_j\right)$$

With variance:

$$V\left(E_{LB}(B)\right) = \sum_{j=1}^{M} F_j(1 - F_j)(B_j - B_{j-1})^2/T_j$$

where:

M: is the number of bids

B: bid level

T_j: number of respondents offered the bid price β_j

F_j: proportion of No responses to the bid price β_j

The CV Survey Design

To get reliable estimates of maximum willingness to pay, the CVM survey was carefully designed, from the drafting of questionnaire, to the sampling process, and survey implementation. The following are the key features of the CV survey and questionnaire:

- The mode of the survey was face to face interview as recommended by Arrow et al (1993).
- A probabilistic sampling technique was applied. The population from which the sample was drawn includes all households within Pila, Victoria and Sta. Cruz, which are the lakeshore municipalities belonging to the Sta. Cruz River Watershed. Specifically, the researchers conducted multi-stage stratified random sampling.
- A total of 497 completed household questionnaires were used in the analysis, 147 of which were replacement households. Of the total non-response, 67 households were not located, 37 already moved, 32 refused/cannot be interviewed, while 7 did not have electricity connection. The total population of households in the study site is 41,869.
- Most of the contents of the questionnaire used in the survey were written in Tagalog, the local dialect, except for some terminologies that do not have a direct translation in the vernacular. The questionnaire is 22-pages long which cover: an Introduction/Screener Page and 6 Modules (Attachment 1):

    Module 1: Experience and Perceptions about Flooding Risk
    Module 2: Knowledge and Perceptions about Early Warning Systems
    Module 3: CV Scenario and Willingness to Pay
    Module 4: Household Profile and Characteristics
    Module 5: Livelihood Characteristics
    Module 6: Flood Damage Experience and Adaptation Activities

- As an input to the drafting of the CV Scenario, focus group discussions were undertaken to obtain information on the possible range of WTP bids, payment vehicle, and local experiences on floods and early warning systems. Also, a technical expert was consulted to provide the description of the Early Warning System (EWS) technology.
- Before finalizing the questionnaire, a pre-test was conducted in Los Baños, a lakeshore municipality in Laguna near our study site. The pre-test site was selected because of its similar socio-economic characteristics and also because of its similar exposure to floods.
- Training was given to the enumerators prior their field work.
- The Tailored Design Method (Dillman, 2000) was adopted in the survey. The aim is to encourage respondents to participate in the survey by establishing trust and lowering perceived costs, while increasing perceived rewards of joining the survey. First, the purpose of the study as well as the institutions involved was relayed to the respondent. Strict confidentiality of the responses was assured. Respondents were

informed that they will be given a short report if they wish to receive an update of the study. Also, a token (a fabric reusable shopping bag) was given to all the respondents. The token was carefully thought out, so as not to encourage biased responses. The token was simple and inexpensive, yet useful. It also bears the name of the project and the name of the institutions undertaking the project so as to re-enforce the legitimacy of the survey. Visual aids were also used to help respondents in the cognitive task of understanding the good that they are being asked to value.

- A good CV questionnaire has a clear and easily understood scenario. The scenario provides a description of the proposed project which is a Technology-based Flood Early Warning System (EWS) which will be installed along the Sta. Cruz River Watershed. To aid in explaining the project, a pre-tested brochure was used (Annex Figure 1). The proposed EWS technology utilizes an Automated Weather System (AWS) and a Water Level Monitoring System (WLMS). These equipments can collect weather and water data on regular intervals and send it automatically to a remote server that can be accessed through the internet. This information can then be used as basis for issuing warnings. The warning will be sent through a text message to households subscribed in the service. The lead time is between 2-4 hours and the information included are: areas that will be flooded and areas that need to evacuate immediately. The institution responsible for the project is the local government of the three municipalities. The duration of the project is 10 years which covers the life span of the equipment (2014-2023).
- The payment vehicle used is mandatory through an additional charge in the electricity bill. This will be collected on a monthly basis for a period of 10 years (the duration of the project). Since EWS has a public good nature, mandatory payment is deemed incentive compatible. During the FGD, we found that people were less inclined to pay additional taxes. Also, water bill surcharge was not suitable because a significant proportion of households are not connected to the water district. Instead, they source their water from private wells. An additional surcharge to the electric bill was deemed acceptable.
- The choice of benefit measure is 'willingness to pay' noting that we are eliciting the household's valuation of the good. Hence, the target respondents are the head of the family. In the event that the head of the family is unavailable, the spouse, or working son/daughter of at least 21 years of age was asked to answer the question.
- The elicitation technique is single-bounded dichotomous choice. Although there are other elicitation techniques such as open-ended, bidding game, payment card and double-bounded dichotomous choice. The single-bounded dichotomous choice was chosen for its simplicity and incentive compatibility. The bid levels used are 25, 50, 100, 200, 300 pesos per month which will be paid for 10 years.
- To minimize strategic bias, a provision point was stated, wherein it was explained that the project will push through only if more than 50% of the respondents vote 'yes' in the barangay referendum. To discourage yea' saying and minimize warm glow effect, cheap talk script was

included. Specifically, the respondents are reminded of their income constraint as well as the existence of alternative projects.

- A scope test was not included in the survey due to the limited size of the sample. However, the scope and limits of the project were explained in the scenario.
- Debriefing questions were also included to identify invalid and protest votes. Table 12 categorizes responses according to whether they are valid or invalid answers. If 'yes' answers are invalid, they should be converted to 'no' votes. On the other hand, if 'no' votes are protest votes; these could be dropped from the observation or retained. In this study, the protest 'no' votes were retained.

Table 12. Classification of Answers to the WTP Debriefing Question

	Valid Answers	Invalid (Bias or Protest)
Reasons why respondents are willing to pay	• My household will benefit from the project • I have confidence in the effectiveness of the technology that will be used • I have confidence in the government's ability to execute this project	• We will not really be made to pay • We are happy that we are able to help.
Reasons why respondents are not willing to pay	• We cannot afford to pay any amount • Our electricity bill is already too high • There are other more important problems that should be given priority • Early warning systems are not beneficial • The lead time is not sufficient • The local government gives ample warning • No one in my household owns a cellular phone	• The government should be made to pay • Only the rich should be made to pay • I don't have confidence on the ability of the government to implement this project • I don't have confidence on the technology

- A certainty question was included to further verify validity of yea-answers. In the survey, the respondents were asked about how certain they are that they will have the same vote if they were asked in a real barangay referendum. With 1 being the lowest score (not sure) and 5 the highest (very sure), those that answered 3 or better were considered as legitimate 'yes' votes. Those that answered 2 or below were further classified based on their reasons for being uncertain. If the reason for their high uncertainty is because they want to know first the responses of the majority, then these are still considered as valid 'yes' votes as this just reflects aversion to free-riding. However, if their reason is because they want to consult first with their spouses or because they are unsure about their income in the future, these are converted into 'no' votes. The total number of 'yes' responses converted into 'no' votes is 31.

Benefit Cost Analysis

As mentioned, Benefit Cost Analysis (BCA) was applied to evaluate the Early Warning System Project. Benefit-Cost analysis is a method by which impacts of a project are systematically identified, quantified and monetized so as to determine the net benefit of the project vis-à-vis the status quo. Its main purpose is to determine whether a project is worthwhile doing on the basis of economic efficiency. A project is considered good if the net present value (NPV) is positive. The generic steps for conducting a BCA are as follows: (1) Specifying the alternative projects; (2) Identifying whose benefits and costs count; (3) Cataloguing the impacts (benefits and costs) and selecting measurement indicators; (4) Predicting the impacts over the life of the project; (5) Monetizing impacts; (6) Discounting net benefits to obtain present values; (7) Computing the net present value of each alternative; (8) Performing sensitivity analysis; (9) Making a recommendation (Boardman, Greenberg, Vining, and Weimer, 2006).

Since the stream of costs and benefits of adaptation are realized at different points in time, discounting should be undertaken to obtain present values. The present value of a benefit (B) or cost (C) at year t can be computed by dividing it by $(1 + s)^t$; where s is the social discount rate and t is the year. The discount rate used in the study is 15%, which is the discount rate used by the National Economic and Development Authority (NEDA) in evaluating local projects. To get the net present value, one simply gets the difference between the present value of benefits and the present value of costs:

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+s)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+s)^t}$$

Since only one option was subjected to BCA, the Benefit Cost Ratio (BCR) was also calculated. A project is considered good, if it has a BCR of greater than 1. The BCR is estimated by dividing the present value of benefits by the present value of the costs:

$$BCR = \frac{PV(B)}{PV(C)}$$

To address uncertainties, sensitivity analysis must also be undertaken. It is good practice to look at the sensitivity of NPV estimates to varying levels of discount rates (Margulis et. al, 2008). However, since the estimated BCR for the project is large, the Internal Rate of Return (IRR) was estimated instead. The IRR shows the discount rate where the NPV of the project equals zero.

Cost-Effectiveness Analysis

For the case study of adaptation options to long-term flooding, Cost-Effectiveness Analysis (CEA) was employed. The method was chosen because it is difficult to monetize or even directly attribute the benefits of the relocation option and the evacuation option. The decision criterion of CEA is to choose the option that can achieve the objective at the least cost. It uses the equation below to get the Cost Effectiveness (CE) ratio:

$$CE_i = \frac{\sum_{t=0}^{T} C_{it} / (1+r)^t}{E_i}$$

Where C_{it} is the adaptation cost component at time t and r is the discount rate. The discount rate used is 15%.

The CE ratio can be interpreted as the average cost per unit of effectiveness. In other words, the most cost-effective adaptation option has the lowest average cost per unit of effectiveness.

To account for uncertainty and risk, risk analysis using Monte Carlo simulation was undertaken. Risk analysis is a quantitative method that seeks to determine the outcomes of a decision situation as a probability distribution. In the simulation, about 10,000 pairs of values of cost and beneficiary households were drawn from their respective normal distributions. For each cost and effectiveness pair, the cost-effectiveness ratio was then computed.

User Participation

The main users of this project's results are LGUs (at provincial, municipal and barangay levels) and local communities at the study sites. The project will employ participatory action research. Participants involved in this project are government units and concerned agencies at all three administration levels including provincial, district and barangay/commune levels. The provincial government officials and its concerned agencies staffs (e.g., representatives from Department of Agricultural and Rural Development, Dept. of Natural Resource and Environment, Committee for Flood and Storm Control, Center for Hydrology and Meteorology) will form part of the Project Management Team and is expected to facilitate participation of municipal LGU and Barangays/communes in the participatory vulnerability assessment and economic analysis of adaptation options. The local communities shall identify their adaptation needs and options as well as develop their respective adaptation proposals/plans.

DATA COLLECTION

The research will gather both secondary and primary data through household survey, focus group discussions and key informant interviews. Number of FGDS, key informant interviews and stakeholder consultation meetings of each studies are presented Available data and digital maps shall be obtained from the provincial and/or municipal government units and/or concerned national agencies to update or prepare the provincial/municipal vulnerability maps. If necessary, detailed mapping will be conducted at the lowest administrative level to produce community vulnerability maps. Socio-economic data shall likewise be obtained. Key informant interviews will be conducted at the provincial, municipal and barangay/commune levels on vulnerability and adaptation options. Due to nature of the project, at the moment it is difficult to assess whether this is an appropriate size. Final sample size cannot easily be predetermined until the precise form of the information to be gathered has been specified. Here we proposed a minimum sample size. The number of FGDs, KIIs and household interviews for each of the three studies are as follows:

VULNERABILITY MEASURMENT AND MAPPING

10 FGDs (04 provincial FGDs and 06 municipal FGDs)
30 KIIs
Commune survey: 274 barangays
600 households

GENDERED ETHNOGRAPHIES STUDY

6 FGDs
30 key informant interviews
30 Individual in-depth Interviews

ADAPTATION OPTION DESIGN AND OPTION EVALUATION

3 FGDs
16 KIIs
500 households

Gender Considerations

Gender is considered as a cross-cutting issue in this proposed project. Issues of gender and social inclusion are strongly emphasized in all aspects of the project. The representation of women in research team, meeting, training, and survey sample should be at least 30%. Gender analysis has been identified as an important topic and an in-depth study on this has been designed as an activity of the project (see Figure 3 and Table 1). All meetings and consultations with local communities will be incorporating and mainstreaming sensitivity to gender and inclusion issues in aspects of team awareness, sensitive assessment, and project implementation. It is assure that voices of women and vulnerable groups will adequately considered. The country coordinator and each team members will be required as resource and advocate on gender and social inclusion issues.

Social Capital

Training

The Training of Trainer (TOT) approach was adopted in this project. First, the project provided short term regional training courses on vulnerability assessment and mapping and economic analysis of adaptation options for the research teams. Then trained researchers of each country did echo trainings at the local level to LGU staff and community organizations on those topics. The project organized the following training courses:

International training courses for researchers:

- One international training course on vulnerability assessment and mapping for research teams;
- One international training course on adaptation analysis (risk assessment and Cost Benefit/Multi-criteria Analysis of Adaptation Options) for research teams;
- One international training course on adaptation proposal development, adaptation fund mobilization and research finding communication for research team.

Local/in-country training courses for LGU staff and local community organization:

- Three in-country/local training courses on Vulnerability Assessment and Mapping with the provincial and selected municipal/communes LGU personnel (one course per country)
- Three in-country training courses on Risk Assessment and Cost Benefit/Multi-criteria Analysis of Adaptation Options for LGUs and Community Organizations (one course per country)
- Three in-country/local training courses on adaptation proposal development and adaptation fund mobilization and research finding communication for staff of LGU and Community Organizations (one course per country).

CHAPTER 3

The Study Site: Laguna, Philippines

This report on the general information on the project site aims to give an **initial** picture of the features of the study site that will be relevant for climate change adaptation. More data will be collected through the succeeding activities of the project.

NATURAL FEATURES

GEOGRAPHICAL LOCATION

The Province of Laguna is about 30 km south of Metro Manila and is bounded on the east by the Sierra Madre Range, on the south by Quezon Province and on the northwestern part by the provinces of Batangas and Cavite (Annex Figure 2). Laguna has a total land area of 175,973 hectares.

The proposed vulnerability mapping for the Philippines will be slightly modified from that of Vietnam and Cambodia. The Philippine group will be using the watershed boundary in addition to the political boundaries from the province to its municipalities and down to the barangays. The significance of using the watershed boundary for the Philippine study is that it will allow the research team to capture more effectively the full dimension of the impact of flooding and typhoon. Flooding that usually occurs at low lying downstream areas is caused by the cumulative effect of rainfall and runoff that also come from the upper reaches of the watershed. The watershed approach will therefore ensure that all the major contributors to flooding, from the mountain to the lake, will be included in the study.

Although using the watershed boundary will reduce the size of the project site, from 1,760 km^2 total area of Laguna to 568 km^2, the proposed watershed will still include 16 municipalities and about 260 barangays from the original 30 municipalities and 676 barangays (Annex Figure 2 and Table 13). This will ensure that the generated vulnerability maps will have wider variation. The proposed watershed also includes the municipalities that have experienced flooding and heavy typhoon damages in recent years. The chosen watershed will include the agricultural area of Laguna thus enabling a level of analysis for the agricultural sector (Annex Figure 3).

Table 13. Municipalities of Laguna

Municipality	Area (km^2)	No. of Brgys	Municipality	Area (km^2)	No. of Brgys
Alaminos	54.7	15	Majayjay	56.4	40
Bay	48.5	15	Nagcarlan	69.0	52
Biñan City	43.2	24	Paete	33.1	9
Cabuyao	59.9	18	Pagsanjan	37.7	16
Calamba City	141.8	54	Pakil	16.0	13
Calauan	69.9	17	Pangil	29.8	8
Cavinti	71.9	19	Pila	31.1	17
Famy	37.0	20	Rizal	25.3	11
Kalayaan	61.6	3	San Pablo City	191.1	80
Liliw	32.4	33	San Pedro	19.2	20
Los Baños	53.7	16	San Cruz	37.0	26
Luisiana	67.9	23	Santa Maria	120.2	25
Lumban	82.8	16	Santa Rosa City	44.5	18
Mabitac	70.9	15	Siniloan	35.4	20
Magdalena	35.8	24	Victoria	29.3	9

Although Laguna is relatively small (1,707 km^2), it nevertheless have a large number of barangays (676). In terms of the logistics and time frame of the project, it will not be practical to cover all the barangays. The watershed approach will therefore provide an area which will be manageable within the project resources and an approach which can enable the research team satisfy its objective.

TOPOGRAPHICAL FEATURES

Annex Figure 4 shows the elevation map of the Province. It has a terrain that consists mainly of narrow plains extending along the eastern, southern and western shores of Laguna de Bay. There are elevated areas that include Mt Makiling on the western side of the project site and Mt Banahaw on the southeastern portion.

Laguna has a slope classification (Annex Figure 5) categorized into level to nearly level, gently sloping to undulating, undulating to rolling, rolling to moderately steep, steep and very steep. A large portion of the project site has level to nearly level slope particularly those along the coast, making these areas high threatened by flooding.

CLIMATE AND HYDROLOGY

The project site has three distinct climates (Annex Figure 6). The western portion has two pronounced seasons, dry from November to April and wet during the rest of the year. Most of the middle part has a season which is not very pronounced, dry from November to April and wet the rest of the year. The eastern side has rainfall that is more or less evenly distributed throughout the whole year.

Laguna Lake is the largest living lake in Southeast Asia with a size of about 90,000 ha. It serves as a catchment basin for 21 major tributaries (Annex Figure 7) with a total catchment area of 45,000 km^2. Interestingly, this huge lake has only a single outlet into Manila Bay through the Napindan Channel. Seventeen of the tributaries draining to the lake are within Laguna.

NATURAL RESOURCES

The project site is predominantly coconut plantations and arable land with crops mainly cereals (Annex Figure 8). A large portion is also planted to a mixture of crops and coconut.

About 134,720 (77%) of Laguna has been classified and certified as Alienable and Disposable while 41,253 ha (23%) are considered as forest lands (Table 14). Within the Alienable and Disposable lands, 60,624 ha are classified as agricultural, 20,208 ha are industrial, 13,472 ha are commercial, and 40,416 ha are residential.

Rice production (Table 15) in the province has gone down from 170,849 MT in 2001 to 137,998 which has been attribute to conversion of rice areas into other uses and to reduction in available irrigation water.

Table 14. Land Classification by Hectare and Percentage Share of Total Land Area of Laguna, 2007

TYPE	Area (h.a.)	% Share
FOREST LANDS	41,253	23.44
TIMBERLAND	5,727	13.88
FOREST RESERVE	11,999	29.09
NATIONAL PARK	5,581	13.53
CIVIL RESERVATION	4,244	10.29
MT. MAKILING FOREST RESERVE	4,600	11.15
ISF PROJECTS (EXISTING)	5,246	12.72
REFORESTATION PROJECT (EXISTING)	3,356	8.13
ALIENABLE, DISPOSABLE LAND	134,720	76.56
TOTAL LAND AREA	**175,973**	**100**

Source: PENRO, PPDC

Table 15. Rice Production in Laguna

CROPPING YEAR	SEASON	RICE PRODUCTION AREA PLANTED (HAS.	PRODUCTIO N (MT.)	AVE. YIELD (MT/HA.)	TOTAL PRODUCTION (MT)
2001-2002	Dry Season	20,356.43	103,428.37	5.08	
	Wet Season	15,790.83	67,420.56	4.27	170,848.93
2002-2003	Dry Season	17,337.04	84,731.40	4.89	
	Wet Season	16,778.91	78,860.67	4.70	163,592.07
2003-2004	Dry Season	19,731.32	102,602.87	5.20	
	Wet Season	16,200.56	76,252.14	4.70	178,855.01
2004-2005	Dry Season	16,797.84	85,401.86	5.10	
	Wet Season	15,727.48	74,431.24	4.70	159,833.10
2005-2006	Dry Season	16,580.66	75,503.87	5.30	
	Wet Season	13,019.53	62,493.74	4.80	137,997.61
2006-2007	Dry Season	13,776.00	74,390.40	5.40	
	Wet Season				

ADMINISTRATION SYSTEMS AND DEMOGRAPHY

ADMINISTRATION SYSTEMS AND MASS/COMMUNITY ORGANIZATION

Like any other provinces in the country, Laguna is governed by three levels of political subdivisions: provincial, municipal, and barangay, each of which has an executive (governor, mayor and barangay captain), a legislative council and local special bodies (Figure 7) elected by the people.

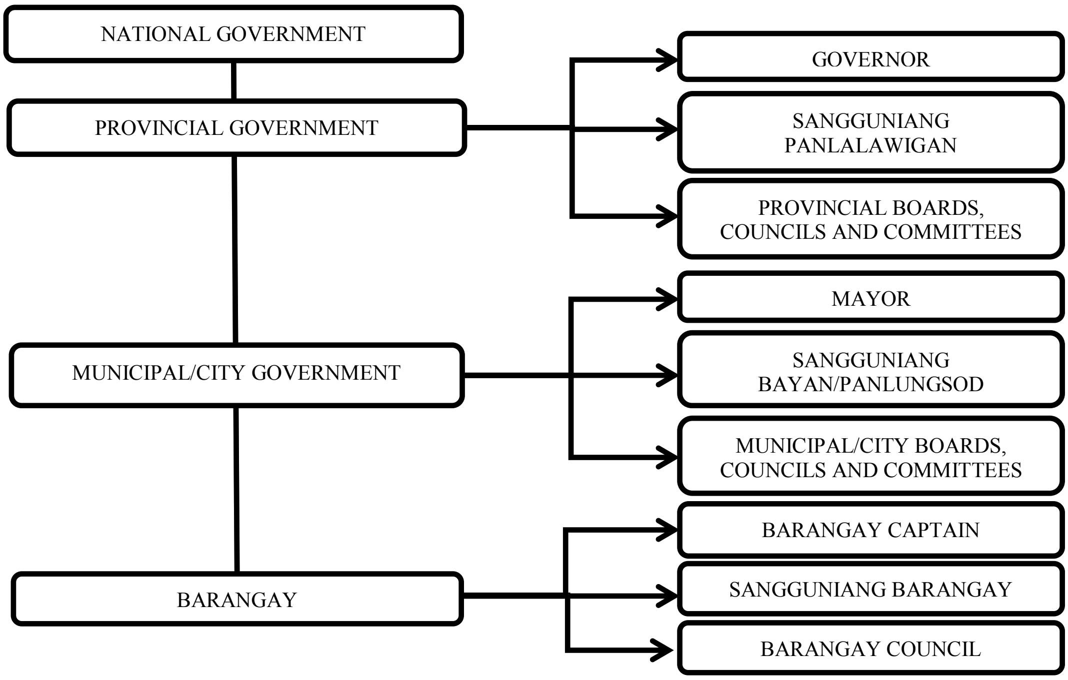


Figure 7. Structure of Local Government Administrative System

Since the implementation of the Local Government Code in 1991, the provision of basic services (Table 16) has been devolved to the local government; hence they now enjoy greater autonomy and are given more powers, responsibilities, and resources.

Table 16. Basic Services of the Local Government

BARANGAY

- Agricultural support services
- Health and social welfare services which include maintenance of barangay health center and day-care center
- Services and facilities related to general hygiene and sanitation, beautification, and solid waste collection
- Maintenance of "katarungang pambarangay"
- Maintenance of barangay roads and bridges and water supply systems
- Infrastructure facilities such as multi- purpose hall, multipurpose pavement, plaza, sports center, and other similar facilities
- Information and reading center
- Satellite or public market

MUNICIPALITY

- Extension and on-site research services and facilities related to agriculture and fishery activities; water and soil resource utilization and conservation projects; and enforcement of fishery laws in municipal waters including the conservation of mangroves;
- Implementation of community-based forestry projects
- Health services
- Social welfare services
- Information services
- Solid waste disposal system or environmental management system and services or facilities related to general hygiene and sanitation
- Municipal buildings, cultural centers, public parks including freedom parks, playgrounds, and sports facilities and equipment, and other similar facilities
- Infrastructure facilities
- Public markets, slaughterhouses and other municipal enterprises
- Public cemetery
- Tourism facilities and other tourist attractions
- Sites for police and fire stations and substations and the municipal jail;

PROVINCE

- Agricultural extension and on-site research services and facilities
- Industrial research and development services
- Enforcement of forestry laws limited to community-based forestry projects, pollution control law, small-scale mining law, and other laws on the protection of the environment; and mini-hydroelectric projects for local purposes
- Health services which include hospitals and other tertiary health services;
- Social welfare services
- Provincial buildings, provincial jails, freedom parks and other public assembly areas, and other similar facilities
- Infrastructure facilities including provincial roads and bridges; inter-municipal waterworks, drainage and sewerage, flood control, and irrigation systems; reclamation projects; and similar facilities
- Programs and projects for low-cost housing and other mass dwellings
- Investment support services, including access to credit financing
- Upgrading and modernization of tax information and collection services
- Inter-municipal telecommunications services
- Tourism development and promotion programs

CITY

All the services and facilities of the municipality and province, plus

- Adequate communication and transportation facilities;
- Support for education, police and fire services and facilities.

Source: Local Government Code of the Philippines

POPULATION

The population of Laguna based on the 2007 census is 2,473,530 (Table 17). It has a growth rate of 3.55 from 1995 to 2007. Due to the increasing activities in the commercial and industrial sectors, the population of the Province is expected to further increase. The average population density is 1,406 persons per square kilometer. The Municipality of San Pedro has the highest population density with 12,470 persons per square kilometer, while Mabitac has the lowest with 240.

The increasing population of the Province can be attributed more due to the increasing urban population which comprises about 66% of the total (Table 18). Urban population has an average annual growth rate of 4.2% during the past ten years compared to the rural growth rate of only 2.3%.

Areas with high population densities and growth rates are the Municipality of Cabuyao, and the cities of Sta. Rosa and Calamba. The higher values are due to the immigration from other provinces that who are attracted by the availability of employment opportunities.

The municipalities of Los Baños, Pakil, Pila and San Pedro have low growth rates. Los Baños plays host to two large institutions, the University of the Philippines Los Baños (UPLB) and the International Rice Research Institute (IRRI) thus having only transient population of students, researchers and scientists. Also, Mt. Makiling which is a large portion of the municipality has been classified as a protected forest reserve. Pakil and Pila are major agricultural areas of the Province and are far from the industrial and commercial areas. Although San Pedro has the highest population density, its low growth rate is due to its already congested area that can now accommodate only few incoming residents.

Table 17. Total Population, Annual Population Growth Rate, Density and Area by Municipality/City

Municipality City	Population			% Share	Annual Population Growth Rate			Density (pop/sq.km.)		Area (sq.km.)	Area %
	1995	2000	2007	2007	1995-2000	2000-2007	1995-2007	2000	2007		
Alaminos	31,442	36,120	40,380	1.6	3.02	1.55	2.12	660.33	738.2	54.7	3.11
Bay	37,563	43,762	50,756	2.1	3.33	2.06	2.56	933.09	1,082.2	46.9	2.67
Binan	160,206	201,186	262,735	10.6	5.00	3.75	4.24	4,624.97	6,039.9	43.5	2.47
Cabuyao	77,302	106,630	205,376	8.3	7.13	9.46	8.54	1,260.40	2,427.6	84.6	4.81
Calauan	36,677	43,284	54,248	2.2	3.61	3.16	3.34	651.87	817.0	66.4	3.77
Cavinti	16,157	19,494	20,469	0.8	4.10	0.67	2.00	276.90	290.8	70.4	4.00
Famy	9,661	10,419	13,577	0.5	1.63	3.72	2.90	537.06	699.8	19.4	1.10
Kalayaan	16,955	19,580	21,203	0.9	3.13	1.10	1.98	420.17	455.0	46.6	2.65
Liliw	24,434	27,537	32,727	1.3	2.59	2.41	2.48	704.27	837.0	39.1	2.22
Los Banos	71,683	82,027	98,631	4.0	2.93	2.57	2.71	1,451.81	1,745.7	56.5	3.21
Luisiana	16,269	17,109	19,255	0.8	1.08	1.64	1.42	268.17	301.8	63.8	3.63
Lumban	21,996	25,936	28,443	1.1	3.59	1.28	2.18	267.93	293.8	96.8	5.50
Mabitac	13,309	15,097	17,608	0.7	2.74	2.14	2.38	205.96	240.2	73.3	4.17
Magdalena	15,927	18,976	20,204	0.8	3.82	0.87	2.01	551.63	587.3	34.4	1.96
Majayjay	18,989	22,159	23,681	1.0	3.36	0.92	1.87	319.29	341.2	69.4	3.94
Nagcarlan	43,679	48,727	57,070	2.3	2.37	2.20	2.27	623.91	730.7	78.1	4.44
Paete	21,809	23,011	24,696	1.0	1.16	0.98	1.05	710.22	762.2	32.4	1.84
Pagsanjan	28,999	32,622	35,944	1.5	2.55	1.35	1.82	1,235.68	1,361.5	26.4	1.50
Pakil	15,663	18,021	20,242	0.8	3.05	1.61	2.17	1,386.23	1,557.1	13.0	0.74
Pangil	17,664	20,698	23,421	0.9	3.45	1.72	2.39	899.91	1,018.3	23.0	1.31
Pila	31,251	37,427	44,227	1.8	3.94	2.33	2.96	1,199.58	1,417.5	31.2	1.77
Rizal	11,537	13,006	15,459	0.6	2.60	2.41	2.48	466.16	554.1	27.9	1.59
San Pedro	189,333	231,403	281,808	11.4	4.39	2.75	3.39	10,239.07	12,469.4	22.6	1.28
Santa Cruz	86,978	92,694	101,914	4.1	1.37	1.32	1.34	2,401.40	2,640.3	38.6	2.19
Santa Maria	22,296	24,574	26,267	1.1	2.11	0.92	1.38	191.39	204.6	128.4	7.30
Santa Rosa City	138,257	185,633	266,943	10.8	6.52	5.13	5.67	4,747.65	6,827.2	39.1	2.22
Siniloan	26,914	29,902	34,877	1.4	2.28	2.14	2.20	727.54	848.6	41.1	2.34
Victoria	25,424	29,765	33,829	1.4	3.43	1.78	2.42	899.24	1,022.0	33.1	1.88
Calamba City	218,951	281,146	360,281	14.6	5.50	3.48	4.27	1,941.62	2,488.1	144.8	8.23
San Pablo City	183,757	207,927	237,259	9.6	2.68	1.84	2.17	971.62	1,108.7	214.0	12.16
Total	1,631,082	1,965,872	2,473,530	100	4.08	3.22	3.55	1,117.3	1,405.8	1,759.5	100

Source: NSO, PPDCO,2007

Table 18. Urban and Rural Population Growth (2007-2017)

Municipality City	Urban Population			Rural Population		
	2007	% Share Growth	2017	2007	% Share Growth	2017
Alaminos	12,276	0.75	14,317	28,104	3.37	32,777
Bay	6,410	0.39	7,860	44,346	5.31	54,376
Binan	262,735	16.03	379,664			
Cabuyao	39,514	2.41	97,568	165,862	19.88	409,544
Calauan	10,437	0.64	14,246	43,811	5.25	59,799
Cavinti	9,651	0.59	10,318	10,818	1.30	11,565
Famy	8,418	0.51	12,129	5,159	0.62	7,434
Kalayaan	9,249	0.56	10,318	11,954	1.43	13,336
Liliw	15,182	0.93	19,264	17,545	2.10	22,263
Los Banos	78,826	4.81	101,595	19,805	2.37	25,526
Luisiana	8,160	0.50	9,602	11,095	1.33	13,054
Lumban	20,240	1.23	22,985	8,203	0.98	9,316
Mabitac	6,967	0.43	8,610	10,641	1.28	13,150
Magdalena	5,471	0.33	5,966	14,733	1.77	16,066
Majayjay	13,418	0.82	14,704	10,263	1.23	11,248
Nagcarlan	27,553	1.68	34,252	29,517	3.54	36,692
Paete	24,696	1.51	27,226			
Pagsanjan	13,159	0.80	15,047	22,785	2.73	26,055
Pakil	12,793	0.78	15,008	7,449	0.89	8,739
Pangil	9,432	0.58	11,185	13,989	1.68	16,591
Pila	15,882	0.97	19,995	28,345	3.40	35,687
Rizal	4,155	0.25	5,273	11,304	1.35	14,343
San Pedro	281,808	17.19	369,634			
Santa Cruz	101,914	6.22	116,194			
Santa Maria	5,989	0.37	6,563	20,278	2.43	22,223
Santa Rosa	266,943	16.29	440,234			
Siniloan	3,484	0.21	4,306	31,393	3.76	38,796
Victoria	19,063	1.16	22,741	14,766	1.77	17,616
Calamba City	212,998	12.99	299,875	147,283	17.65	207,356
San Pablo City	132,296	8.07	158,755	104,963	12.58	125,957
Total	**1,639,120**	**100.00**	**2,275,437**	**834,410**	**100.00**	**1,249,506**

Source: NSO, PPDCO,2007

LABOR FORCE

Sixty three percent (63%) of Laguna's 2.5 million working age population were in the labor force in 2006 (Table 19). There is an expected increase of labor force from 1.3 M in 2006 to 1.8 M in 2010 due to the continuing development in the Province. With this employment projection, about 0.5 M new entrants in the labor force is expected.

Table 19. Labor and Employment in Laguna in 2006

Indicators	Date	Data
Total Population 15 yrs. Old & Over (in '000)	Apr. 2006	1,314
Labor Force Participation Rate	Apr. 2006	63.1
Employment Rate	Apr. 2006	84.4
Unemployment Rate	Apr. 2006	15.6
Visible Underemployment Rate	Apr. 2006	9.9

CHAPTER 4

Climate Change Vulnerability Mapping of Selected Municipalities in Laguna, Philippines

Research Objectives

The overall objective of the study is to build local capacity to adapt to climate change, especially in vulnerability assessment and adaptation analysis

The specific research objectives of this study are:

1. To measure community's vulnerability to climate change through research in selected communities;
2. To produce maps of each community's relative vulnerability to climate change (commune and agriculture).

Research Questions

The study aims to answer the following research questions:

(1) What communes/barangays in the study sites are most vulnerable to climate change and where are they?
(2) For agricultural sector, what communes/barangays in the study sites are most vulnerable to dominant climatic hazards?

RESULTS AND DISCUSSION

Study Site and Its Topography

Figure 8 shows the three delineated red polygons which are the watershed boundaries. Inside these boundaries are the selected 12 municipalities. Delineated parcels of lands within these municipalities are 274 total barangays, 194 of which were chosen as study areas.

The topography of the study site is shown in Figure 9. The mountainous part (>500 m elevation) is situated SE of the site that includes some parts of Rizal, Nagcarlan, Liliw and Majayjay. Also, there are mountainous portions on the western part such as in some parts of Los Baños and another one situated in the central part of the site such as in one barangay of Calauan. Coastal areas can be found along the Laguna lake coastline which includes portions of Los Baños, Bay, Calauan, Victoria, Pila, and Santa Cruz. The midlands (250m – 500m) to lowland areas (0 – 250m) seem to manifest generally from SE portion of the site after the mountains towards NW, the Laguna Lake. Majority of the 194 chosen barangays in the study site are in lowlands (127 of them) followed by 41 barangays in midlands while 21 barangays are in coastal areas. Only 5 barangays are situated in the highlands.

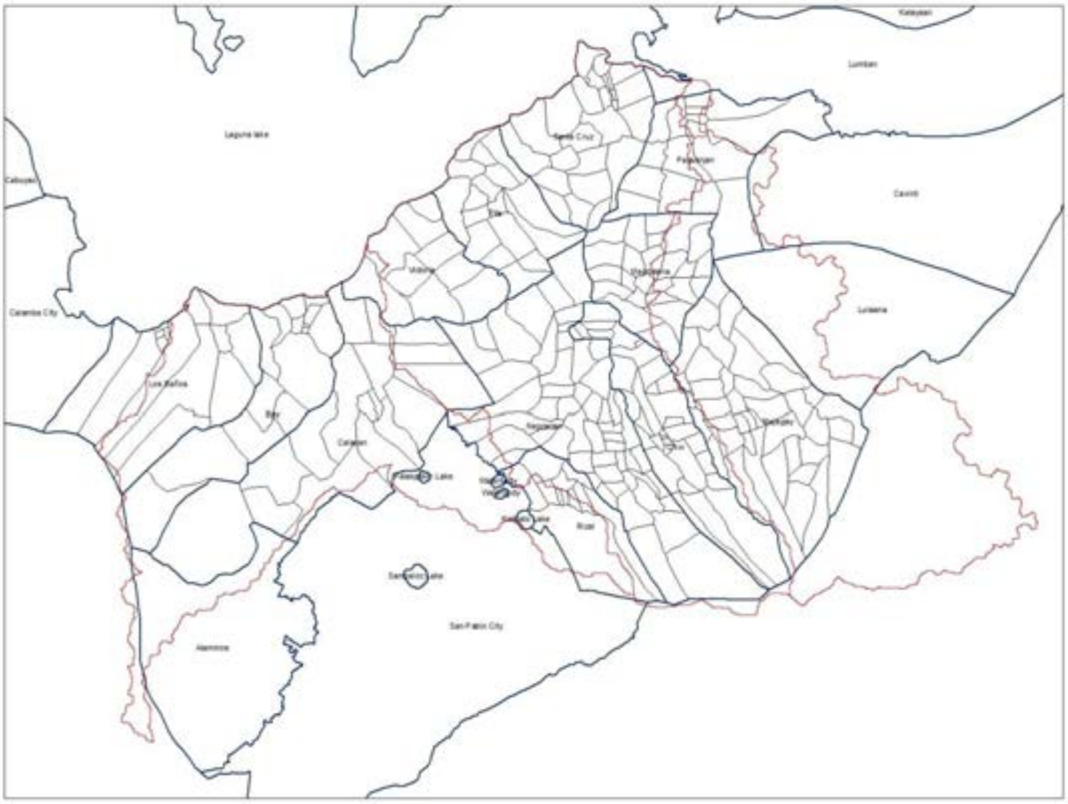


Figure 8. Watershed Boundaries Encompassing the Study Site

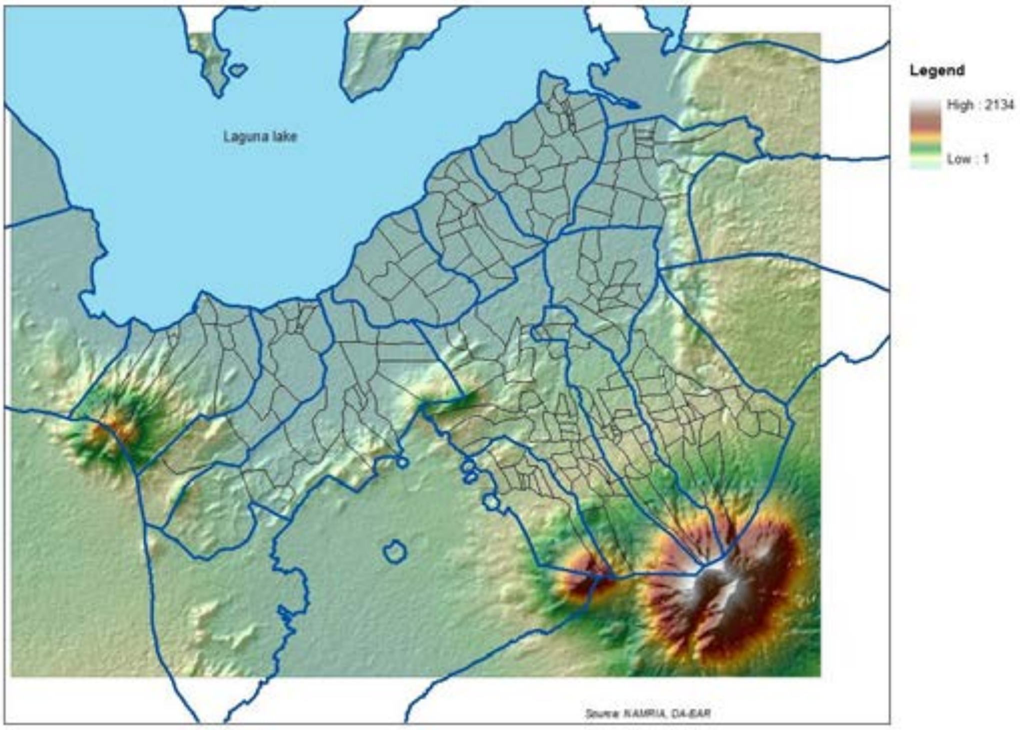


Figure 9. Study Site's Topography

Commune Exposure Index

The exposure index is shown in Figure 10. This is the weighted average of all normalized values of exposure indicators namely, Typhoon and Flood. It can be seen from the figure that most of the area is less vulnerable to climatic hazards especially those situated at midland to highland regions. All of the indicators for typhoon and flood indices were also individually mapped (see Annex Figures 9 and 10).

If the vulnerability threshold index is considered to be >0.5, this is the portion in the map where yellow colour starts to change to red as seen in map's Legend, then there will only be 5 municipalities that will be vulnerable. This is shown in Table 20 together with its topographic classification and actual relative vulnerability index. It can be noticed that only the coastal and lowland regions are vulnerable with five and four barangays respectively.

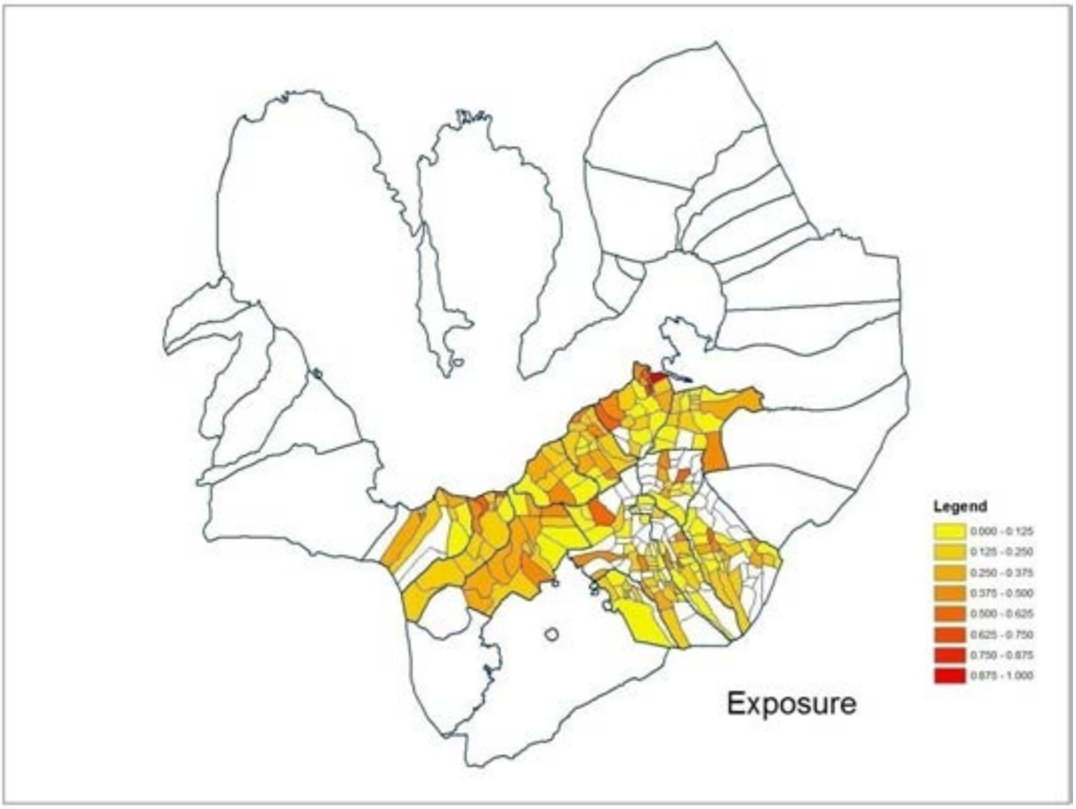


Figure 10. Exposure Index

Table 20. Vulnerable Areas in terms of Exposure to Climatic Hazards

Municipality	Barangay	Topographic Classification	Relative Exposure Vulnerability Index
Bay	Maritime	Coastal	0.618
	Tagumpay	Coastal	0.544
Magdalena	Bucal	Lowland	0.504
Majayjay	Munting Kawayan	Lowland	0.621
Nagcarlan	Maravilla	Lowland	0.516
Sta. Cruz	Duhat	Coastal	0.513
	Poblacion V	Lowland	0.591
	San Pablo Norte	Coastal	1.000
	Santisima Cruz	Coastal	0.609
	Santo Angel Sur	Lowland	0.634

Commune Sensitivity Index

The sensitivity index is shown in Figure 11. This particular index is the weighted average of all normalized values of sensitivity indicators namely, Natural, Human, Infrastructure, and Livelihood. Unlike the exposure determinant where only 9 barangays of 5 municipalities were vulnerable, the map here shows more vulnerable areas. It involves all the 12 municipalities with a total of 59 barangays being affected (see Table 21). It can also be seen in the Table that no highland barangay is highly sensitive, while coastal areas, although not all of them, consisted of very high vulnerability in terms of sensitivity ranging from as low as 0.776 to as high as 0.981.

All of the indicators for natural, human, infrastructure, and livelihood indices were also individually mapped (see Annex Figures 11 to 14).

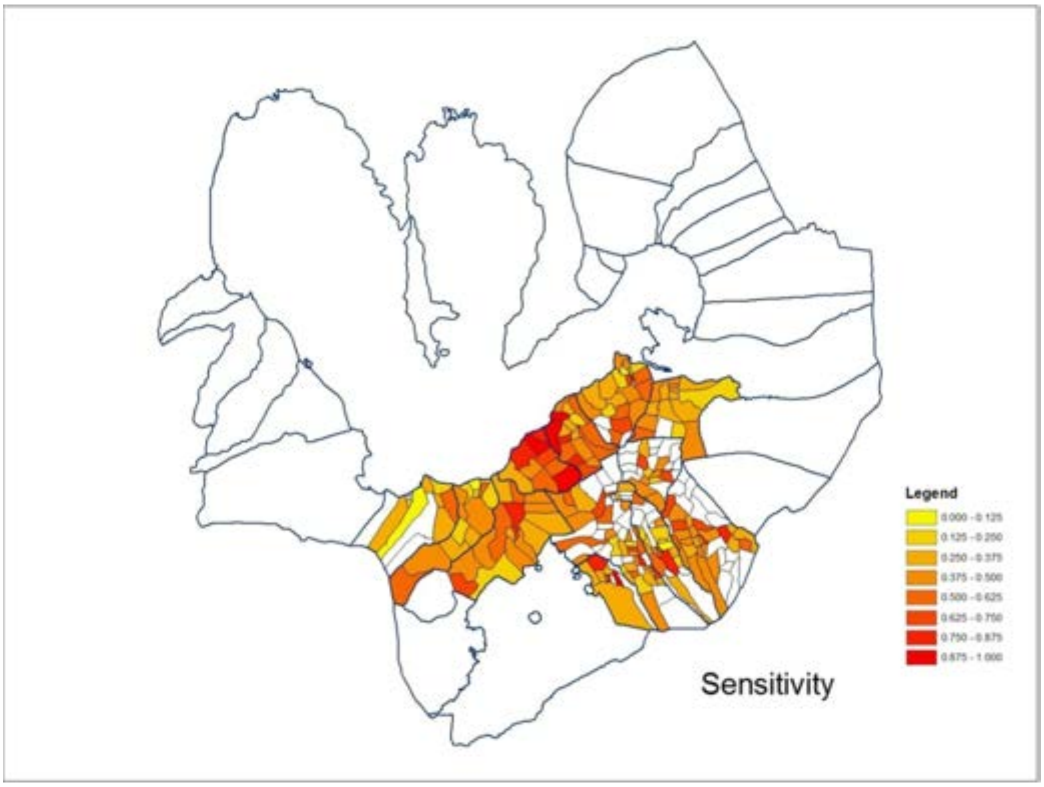


Figure 11. Sensitivity Index

Commune Adaptive Capacity Index

The adaptive capacity index shown in Figure 12 is the weighted average of all normalized values of adaptive capacity indicators such as Infrastructure, Economic, Technology, Social, and Human. As seen in the figure, reddish areas are very prominent; this is because 135 out of 194 barangays are very vulnerable to climate change because of its very low capacity to adapt. All of the 12 municipalities are vulnerable with Magdalena having the most vulnerable number of barangays with 90%, followed by Calauan (88%), Majayjay (83%), Pila (82%), Nagcarlan (77%), Rizal (75%), Liliw (70%), Bay (57%), and Sta. Cruz (52%). The last three municipalities have less than 50% affected areas, they are Victoria (44%), Pagsanjan (33%), and Los Baños (25%). Refer to these values in Table 21.

All of the indicators for infrastructure, economic, technology, social, and human indices were also individually mapped (see Annex Figures 15 to 19).

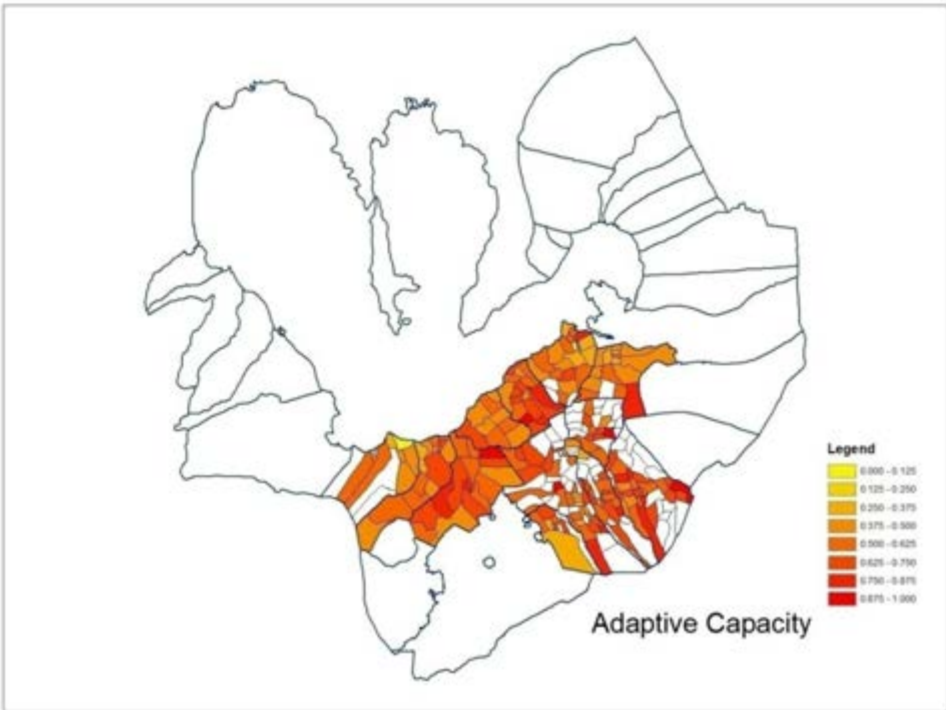


Figure 12. Adaptive Capacity Index

Table 21. Percentage of Vulnerable Barangays having a Low Adaptive Capacity

Municipality	Number of Vulnerable Barangays	Percentage
Bay	8 out of 14	57%
Calauan	14 out of 16	88%
Liliw	14 out of 20	70%
Los Baños	2 out of 8	25%
Magdalena	9 out of 10	90%
Majayjay	20 out of 24	83%
Nagcarlan	23 out of 30	77%
Pagsanjan	5 out of 15	33%
Pila	14 out of 17	82%
Rizal	6 out of 8	75%
Sta. Cruz	12 out of 23	52%
Victoria	4 out of 9	44%

Commune Overall Vulnerability

The overall index of climate change vulnerability (Figure 13) is the simple average of the exposure and sensitivity indices and the inverse of adaptive capacity index. By looking at the figure, a compromise of a very few areas exposed to climatic hazards, a moderate amount of sensitive areas, and a large number of areas with very low capacity to adapt resulted to a map with 11 of 12 vulnerable municipalities and 37 of 194 vulnerable barangays. Details are tabulated in Table 22.

Only the Los Baños municipality is not vulnerable while Pagsanjan has only one vulnerable barangay involved. This result is consistent based on their low vulnerabilities in the three determinants. The 9 barangays included in the exposure index are all included in the overall list with 28 more included mainly due to the high vulnerability in sensitivity and/or adaptive capacity.

Ten out of 21 coastal barangays (48%) are included in the overall vulnerable list followed by 23 out of 127 lowland barangays (18%) and 4 out of 41 midland barangays (10%). No highland barangays are included in the overall vulnerability list.

Exposure Index for Agriculture

Based on Figure 14, the number of vulnerable barangays in terms of exposure to climatic hazards is increased when agricultural sector is involved. From 5 municipalities with 9 barangays in the commune exposure index to 11 municipalities (Rizal excluded) with 27 barangays. The same 9 barangays are involved with additional of 18 more mainly due to flooding especially in rice areas where they are usually planted at lower elevations. Coastal and lowland areas are greatly affected by these climatic hazards.

Sensitivity Index for Agriculture

The agricultural sensitivity index is shown in Figure 15. Compared to commune sensitivity index where 12 municipalities with 59 barangays were affected, the agricultural sector involved 11 municipalities (Los Baños excluded) with 66 vulnerable barangays. Still, majority are the lowlands and coastal areas with very few midlands and just 2 highland barangays.

Adaptive Capacity Index for Agriculture

The agricultural adaptive capacity index in Figure 16 shows that it has the most vulnerable areas (98 barangays) among the three determinants. This is consistent with the observation in the commune adaptive capacity index (135 barangays) although with 37 less vulnerable barangays. All of the 12 municipalities are involved here.

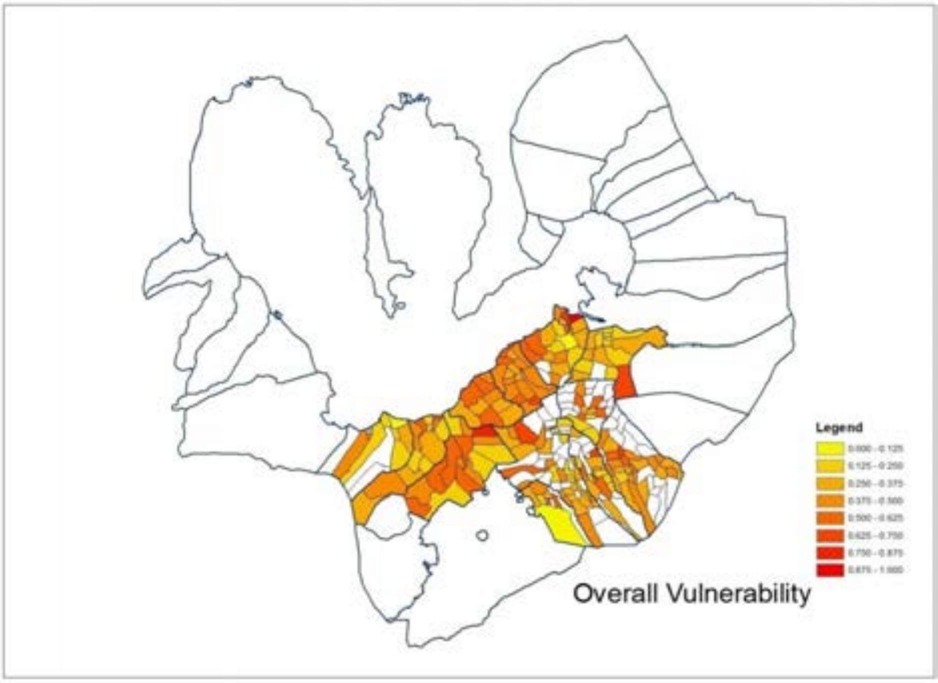


Figure 13. Overall Vulnerability to Climate Change

Table 22. Overall Vulnerable Areas

Municipality	Barangay	Topographic Classification	Overall Vulnerability
Bay	Maitim	Coastal	0.530
	Tagumpay	Coastal	0.582
Calauan	Balayhangin	Lowland	0.598
	Dayap	Lowland	0.770
	Mabacan	Lowland	0.554
	Masiit	Lowland	0.566
	Perez	Lowland	0.535
	San Isidro	Lowland	0.599
	Silangan	Lowland	0.538
Liliw	Ilayang Palina	Lowland	0.502
	Kanlurang Bukal	Midland	0.546
	Tuy-Baanan	Lowland	0.656
Magdalena	Bucal	Lowland	0.563
	Ibabang Butnog	Lowland	0.581
	Ilayang Atingay	Lowland	0.545
	Tipunan	Lowland	0.531
Majayjay	Munting Kawayan	Lowland	0.718
	Olla	Lowland	0.502
	Santa Catalina	Lowland	0.549
Nagcarlan	Maravilla	Lowland	0.628
	Sabang	Midland	0.615
Pagsanjan	Anibong	Lowland	0.634
Pila	Aplaya	Coastal	0.551
	Bukal	Lowland	0.596
	Masico	Lowland	0.659
	Pinagbayanan	Coastal	0.581
Rizal	East Poblacion	Midland	0.503
	Tuy	Midland	0.561

Table 22. Overall Vulnerable Areas *(cont'd)*

Municipality	Barangay	Topographic Classification	Overall Vulnerability
Sta. Cruz	Duhat	Coastal	0.537
	Gatid	Coastal	0.505
	Poblacion V	Lowland	0.612
	San Pablo Norte	Coastal	1.000
	Santisima Cruz	Coastal	0.652
	Santo Angel Sur	Lowland	0.577
Victoria	Masapang	Lowland	0.615
	Nanhaya	Coastal	0.593
	San Roque	Coastal	0.525

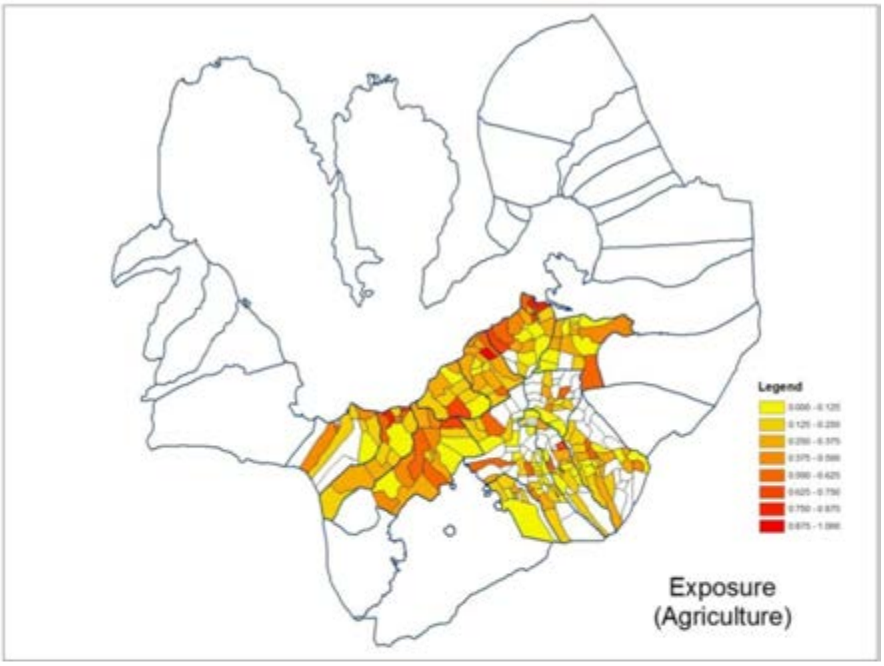


Figure 14. Agricultural Exposure Index

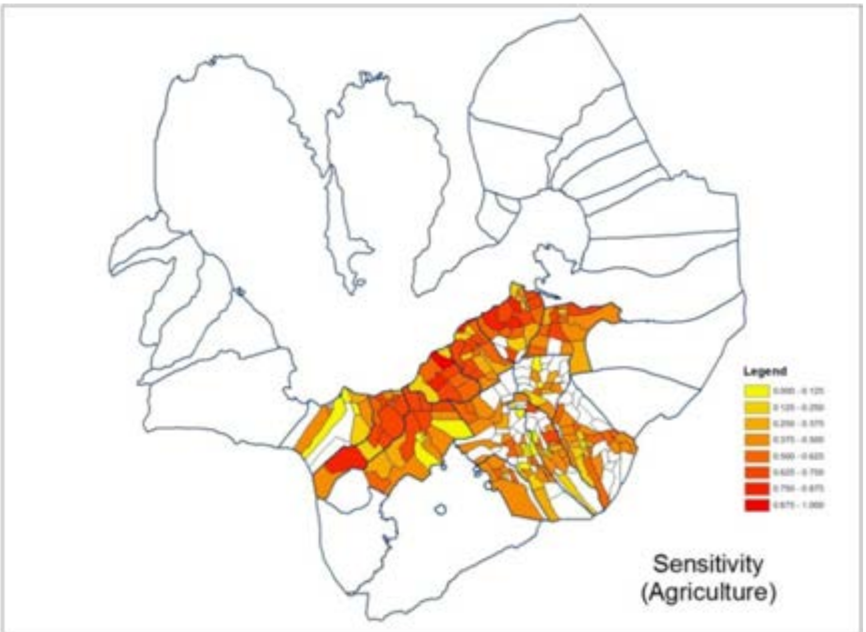


Figure 15. Agricultural Sensitivity Index

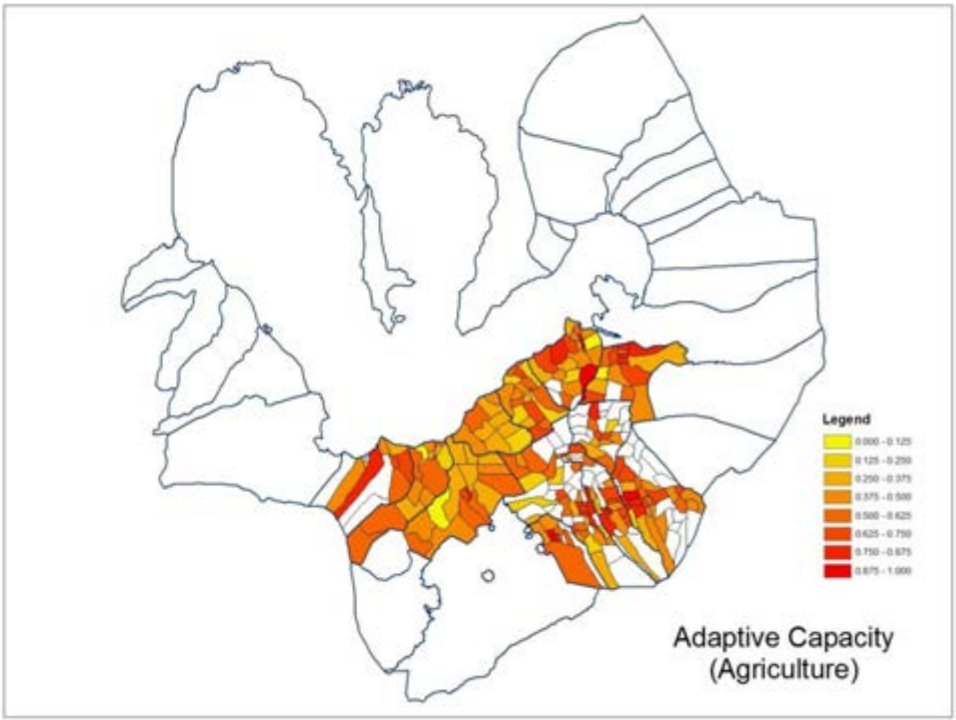


Figure 16. Agricultural Adaptive Capacity Index

Overall Vulnerability Index for Agriculture

The overall index of climate change vulnerability for agricultural sector shown in Figure 17 resulted to 48 vulnerable barangays as a compromise from the three determinants: 27 vulnerable barangays in terms of exposure, 66 vulnerable barangays in terms of sensitivity, and 98 low adaptive capacity barangays. Details are tabulated in Table 23.

12 out of 21 coastal barangays (57%) are included in the overall vulnerable list followed by 33 out of 127 lowland barangays (26%) and 3 out of 41 midland barangays (7%). No highland barangays are included in the overall vulnerability list for agricultural sector.

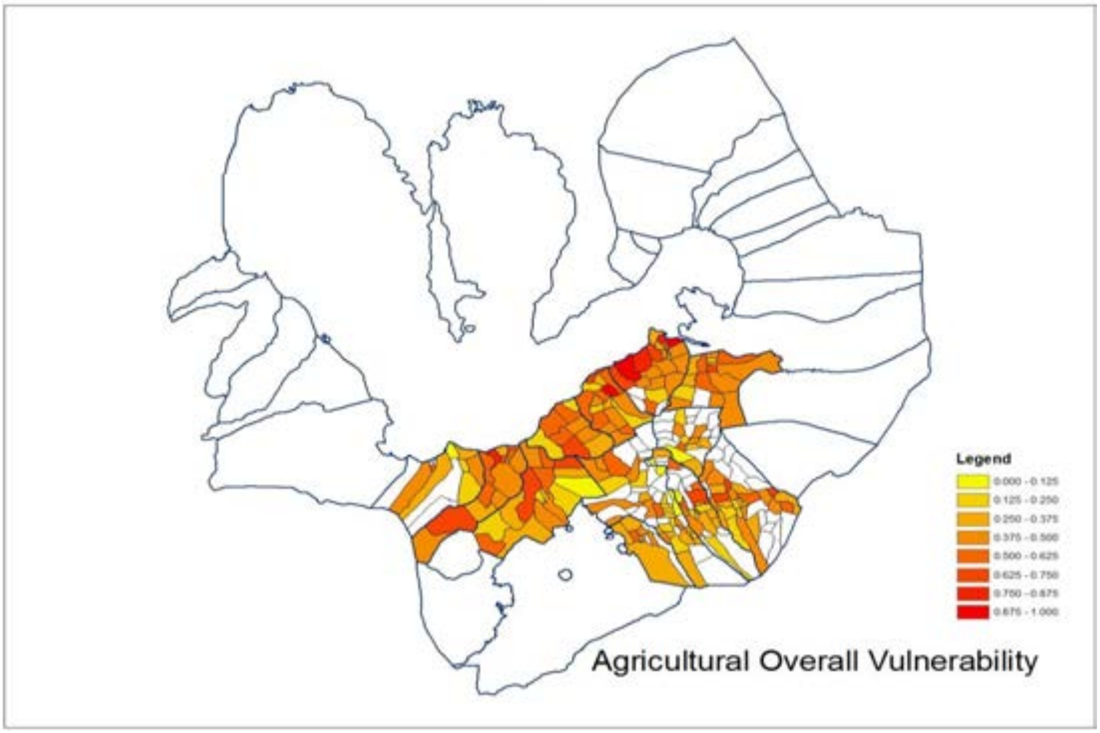


Figure 17. Overall Vulnerability to Climate Change for Agricultural Sector

Table 23. Overall Vulnerable Areas in Agriculture

Municipality	Barangay	Topographic Classification	Overall Vulnerability
Bay	Calo	Lowland	0.632
	Maitim	Coastal	0.788
	Paciano Rizal	Lowland	0.513
	San Isidro	Lowland	0.623
	Sta. Cruz	Lowland	0.724
	Sto. Domingo	Coastal	0.619
	Tagumpay	Coastal	0.531
Calauan	Bangyas	Lowland	0.599
	Dayap	Lowland	0.735
	Masiit	Lowland	0.629
	Perez	Lowland	0.577
	San Isidro	Lowland	0.585
Liliw	Bongkol	Lowland	0.688
	Calumpang	Lowland	0.615
	Ilayang Palina	Lowland	0.568
	Tuy-Baanan	Lowland	0.615
Los Baños	Timugan	Lowland	0.540
Magdalena	Tipunan	Lowland	0.519
Majayjay	Bitaoy	Midland	0.512
	Botocan	Midland	0.637
	Ilayang Banga	Midland	0.523
	Munting Kawayan	Lowland	0.687
	Talortor	Lowland	0.628

Table 23. Overall Vulnerable Areas in Agriculture *(cont'd)*

Municipality	Barangay	Topographic Classification	Overall Vulnerability
Nagcarlan	Maravilla	Lowland	0.617
	Yukos	Lowland	0.555
Pagsanjan	Calusiche	Lowland	0.580
	Magdapio	Lowland	0.544
	Maulawin	Lowland	0.674
	Sampaloc	Lowland	0.553
Pila	Aplaya	Coastal	0.747
	Bagong Pook	Lowland	0.537
	Bulilan Norte	Lowland	0.591
	Labuin	Lowland	1.000
	Masico	Lowland	0.617
	San Antonio	Lowland	0.568
	Tubuan	Coastal	0.578
Rizal	Talaga	Lowland	0.509
Sta. Cruz	Bagumbayan	Lowland	0.773
	Calios	Coastal	0.705
	Duhat	Coastal	0.659
	Gatid	Coastal	0.885
	Oogong	Lowland	0.539
	San Pablo Norte	Coastal	0.876
	Santisima Cruz	Coastal	0.807
Victoria	Masapang	Lowland	0.686
	Nanhaya	Coastal	0.620
	San Felix	Lowland	0.541
	San Roque	Coastal	0.573

Summary and Conclusion

12 municipalities in Laguna province were selected based on watershed approach. These comprise 274 barangays where 194 were selected as study areas. Three vulnerability determinants (exposure, sensitivity, and adaptive capacity) and their respective indicators were determined both for the commune and agricultural sector. The following table (Table 24) summarizes the results.

Mostly lowland and coastal areas are greatly affected in all the vulnerability determinants. This implies that areas located from 0 to 250 m are more vulnerable compared to midlands and highlands (250 m and above). Agricultural areas are also more vulnerable, hence livelihood of agricultural dependent areas will be greatly affected by climate change.

Exposure to Climatic Hazards (Typhoon and Flood) obtained the least number of vulnerable areas among the three determinants. This is based on the fact that Laguna province is not always hit by typhoon as compared to other parts of the Philippines such as Northern Luzon and Bicol regions. But what are alarming here are the other two determinants where vulnerable areas are increased especially in adaptive capacity where more than half of the study areas (51% and 70% for agriculture and commune respectively) are vulnerable. This implies that if ever Laguna province will be frequently hit by typhoons due to changes in climate, the area will be highly susceptible to damages since the capacity to adapt is too low.

Table 24. Summary of Results

	COMMUNE			AGRICULTURE		
Determinants	**No. of Vulnerable Municipalities**	**No. of Vulnerable Barangays**	**Most Vulnerable Barangay**	**No. of Vulnerable Municipalities**	**No. of Vulnerable Barangays**	**Most Vulnerable Barangay**
EXPOSURE	5	10	San Pablo Norte of Sta. Cruz	11	27	Labuin of Pila
SENSITIVITY	12	60	Pinagbayanan of Pila	11	66	Nanhaya of Victoria
ADAPTIVE CAPACITY	12	131	Ilayang Atingay of Magdalena	12	98	Talaga of Rizal
OVERALL	11	37	San Pablo Norte of Sta. Cruz	12	48	Labuin of Pila

CHAPTER 5

Household Vulnerability to Climate Change in Selected Municipalities in Laguna, Philippines

Research Objectives

The general objective of this study is to assess the vulnerability of households situated in twelve selected municipalities of Laguna, Philippines. Specifically, it aims to:

(1) assess the overall vulnerability of households using the Vulnerability as Expected Poverty (VEP) framework, and the Vulnerability Index as a function of hazard exposure, sensitivity and adaptive capacity approach.
(2) describe the profile and characteristics of vulnerable households;
(3) determine the level of awareness and perception of households of different levels of vulnerability regarding climate change impacts and adaptation;
(4) assess the exposure of households to various climate-related hazards as well as their impacts; and to
(5) identify the coping and adaptation measures being undertaken by households to address climate-related hazards.

Research Questions

The study aims to answer the following research questions:

(3) What is the level of vulnerability of households to climate change? What are the characteristics of vulnerable households?
(4) How exposed are households in Laguna to climate-related hazards and what are the impacts of these hazards?
(5) What adaptation and coping mechanisms are households adopting to become more resilient to typhoon and flooding?

Results and Discussion

Profile of the Household Survey Respondents

The household survey covered 12 municipalities and 178 barangays, where 600 households were randomly selected (see Annex Table 7). These municipalities include Bay (where 8% of the total household sample was selected), Calauan (10%), Liliw (6%), Los Baños (15%), Magdalena (4%), Majayjay (5%), Nagcarlan (10%), Pagsanjan (6%), Pila (9%), Rizal (3%), Sta. Cruz (18%), and Victoria (6%) (Figure 18). Of the 600 respondents, 118

(20%) belong to households whose livelihood depend on the agriculture, fishery and forestry sector, and 248 (41%) are male (see Annex Table 8). The mean age of the respondents is 48. 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 9 years (see Annex Table 9).

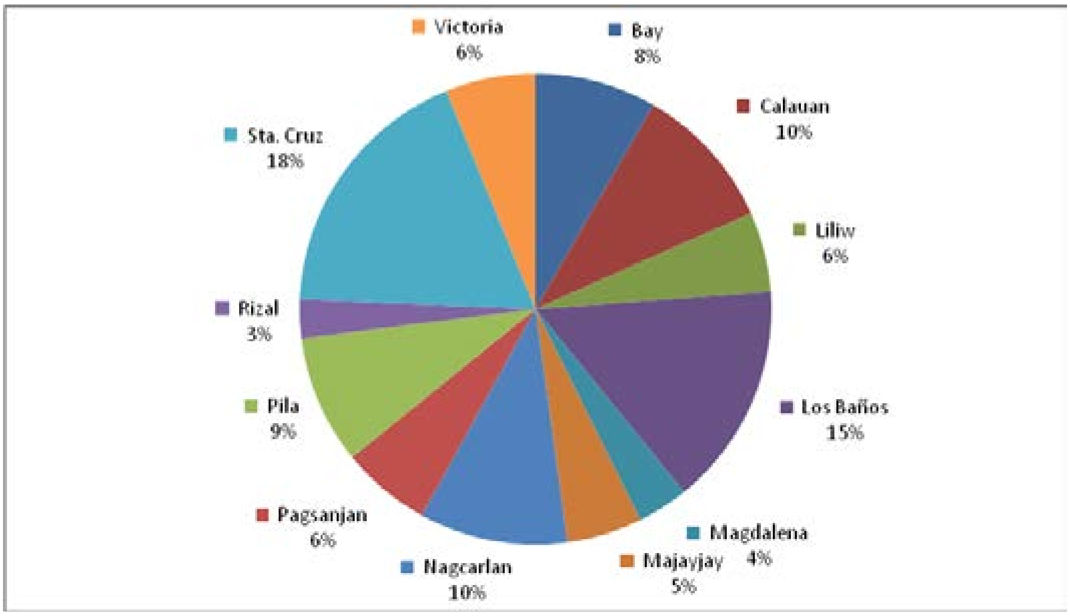


Figure 18. Municipalities Included in the Survey

Vulnerability Estimates

Two methodologies were applied to aid in the quantitative assessment of vulnerability at the household level. The two methodologies differ in approach and have their own strengths and weaknesses. The index approach (Vulnerability Index) provides a broader view of vulnerability through its multidimensional approach covering biophysical, economic and social aspects. However, estimates are highly sensitive to the assumptions about the weight or relative importance of the variables, as well as the choice of indicator variables used in the computation. On the other hand, the econometric approach (Vulnerability as Expected Poverty) is not sensitive to weighting issues and hence not prone to subjectivity and possible manipulation. Its weakness, however, is that its view of vulnerability may be a little bit more narrow compared to the indicator method. It is therefore interesting to explore the outcomes of the assessments and see whether they would be consistent with each other or whether they would significantly deviate from one another.

Values that will be estimated from both approaches are expected to have a range of 0.00 to 1.00, with 0.00 having the lowest vulnerability level and 1.00 the highest vulnerability. In this study, households with a vulnerability of less than 0.50 are categorized under the non-vulnerable group, those with 0.50 to 0.79 are in the moderately vulnerable group, and those with 0.80 to 1.00 are in the highly vulnerable group.

Vulnerability Index (VI) as a Function of Hazard, Sensitivity and Adaptive Capacity

In estimating the Vulnerability Index (VI), three factors were considered: hazard, sensitivity, and adaptive capacity of households (See Annex Tables 10 and 11). Hazards are events or occurrences which are climate-related, such as typhoons, floods, flash floods, drought, and landslides. The more exposed households are to these natural calamities, the higher their vulnerability. Sensitivity, on the other hand, refers to the inherent characteristics of the household which makes them more susceptible to the impacts of the hazards. It is looked at through four dimensions, human, infrastructure, livelihood and financial. Human sensitivity is reflected through the dependency ratio. The greater the number of dependent members in a household, relative to the non-dependent members, the more susceptible the household is from climate change impacts. Dependents include children and the elderly (those whose age is below 15 or greater than 64). They are more sensitive because they are relatively frail and prone to illnesses and injuries. Livelihood sensitivity, on the other hand, is based on the degree of dependence in agriculture, fishery and forestry. It is assumed that the higher the percentage of income coming from this sector the more sensitive the household is. The primary reason is because agriculture, fishery and forestry activities are highly dependent on natural resources which in turn are highly sensitive to natural hazards. Infrastructure sensitivity is represented by two variables - the ratio of household size to area of weak house and the distance of dwelling unit to the nearest body of water. The weaker the structure of the house, the higher the probability that it will be damaged due to calamities. Also, the nearer their house to a body of water, such as rivers, creeks, and lake, the more sensitive the household is to climate change impacts. Lastly, financial sensitivity is represented by the percentage of debt to the total income of household. The higher this value, the higher the sensitivity of the household.

Adaptive capacity is the ability of households to reduce the impacts of climate-related hazards through adjustments and modifications in their behavior. Five aspects are included: infrastructure, economic, technology, social capital and human. With infrastructure, it is assumed that the greater the size of a household's permanent dwelling, the more resistant they will be from climatic hazards. Economic indicators include income and remittances. With greater financial resources, the household will be better able to invest in activities that can increase their resilience. Technology indicators include communication and transportation assets. With technologies such as televisions, radios, and phones, households will be able to receive and communicate information as needed. Ownership of vehicles, on the other hand, increases mobility which can allow households to transfer to safer areas or to transport resources during calamities. The proxy variable used to represent social capital is the number of contacts that the household can ask for financial help. This is assumed to increase adaptive capacity of households. Finally, human indicators include the number of working or employed household members, and the level of education of household head. The greater the number of household members who are working, the greater the access of the family to resources and assets that can increase their ability to invest in adaptation activities. Also, the higher the level of education of the household head, the greater the capacity of the household in finding ways to reduce their vulnerability from climate change hazards.

Table 25 shows that on average households have a mean hazard index of 0.08, mean sensitivity index of 0.26, and mean adaptive capacity index of 0.17. This translates to a mean overall vulnerability of 0.43. Across different levels of vulnerability, the mean vulnerability index for the non-vulnerable household is 0.36, 0.58 for the moderately vulnerable, and 0.87 for the highly vulnerable group. It can be seen that the mean hazard and sensitivity index is highest for the highly vulnerable group with 0.24 and 0.49, respectively, and lowest for the non-vulnerable group with 0.07 and 0.23, respectively. The opposite is true for adaptive capacity with the non-vulnerable group having a mean index of 0.19 and the highly vulnerable group having a mean index of 0.13.

Table 25. Descriptive Statistics of Hazard, Sensitivity, Adaptive Capacity and Vulnerability Index

Group	Indicator	Mean VI	Standard Deviation
All Households	Hazard	0.08	0.07
	Sensitivity	0.26	0.09
	Adaptive Capacity	0.17	0.07
	Vulnerability	0.43	0.15
Not Vulnerable (0.0 to 0.49)	Hazard	0.07	0.05
	Sensitivity	0.23	0.07
	Adaptive Capacity	0.19	0.07
	Vulnerability	0.36	0.10
Moderately Vulnerable (0.50 to 0.79)	Hazard	0.12	0.07
	Sensitivity	0.32	0.08
	Adaptive Capacity	0.12	0.04
	Vulnerability	0.58	0.07
Highly Vulnerable (0.80 to 1.00)	Hazard	0.24	0.15
	Sensitivity	0.49	0.09
	Adaptive Capacity	0.13	0.03
	Vulnerability	0.87	0.07

Vulnerability as Expected Poverty (VEP)

The VEP estimate shows the probability that a household will fall below the minimum consumption level at which they will be considered poor. In the regression analysis, the variables that were hypothesized to affect consumption are gender, age, and education of household head, household size, dependence of livelihood on natural resources, landownership, presence of chronically ill or differently-abled members, frequency of strong typhoons and maximum flood height experienced over the last 10 years, drought, and landslide (See Annex Tables 12 & 13).

The influence of gender on vulnerability is highly debated. Some argue that female-headed households are more vulnerable because majority of the world's poor are female and they are the ones whose livelihoods are highly dependent on natural resources. Some, on the other hand, contend that females play a crucial role in adaptation which effectively reduces their vulnerability. In the same manner, gender is assumed to influence consumption level of households. A priori, it is expected that male-headed households positively affects consumption levels. Also, the higher the level of education as represented by the variable years of schooling, the higher the consumption level of the household. Dependence on natural resources (specifically, the higher the proportion of income coming from agriculture, fishery and forestry) is assumed to negatively influence consumption levels and thus increases vulnerability, while ownership of land increases consumption and reduces vulnerability. The presence of chronically ill or differently-abled household members may increase or decrease consumption. It may increase consumption because households are expected to have higher expenditures to cater to the needs of their ill members, while it may also decrease consumption because it may mean a lower earning potential for the household since members who are well, may have to spend more time in providing care for their ill family member. For the climate-related indicators, it is expected that the frequency of strong typhoons, flood level and experience of drought and landslides will also have an impact on consumption.

Table 26 shows the mean and standard deviation of VEP estimates across different vulnerability levels. For all households, the mean VEP is 0.37, with a standard deviation of 0.37. This can be interpreted as follows, *on average, the probability that households will fall into poverty or have their consumption fall below US$1.25 is 37%.* The table also shows that for the non-vulnerable group, mean VEP is 0.12, 0.66 for the moderately vulnerable and 0.91 for the highly vulnerable households.

Table 26. Descriptive Statistics of Vulnerability as Expected Poverty (VEP) Estimates

Group	Mean VEP	Standard Deviation
All Households	0.37	0.37
Not Vulnerable (0.00 to 0.49)	0.12	0.14
Moderately Vulnerable (0.50 to 0.79)	0.66	0.09
Highly Vulnerable (0.80 to 1.00)	0.91	0.06

It is interesting to see how VEP estimates compare to the log of per capita consumption. This relationship is presented in a scatter diagram in Figure 19. The diagram can be divided into six segments. Those to 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 considered 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 non-vulnerable; those above are at least moderately vulnerable; while households above the higher horizontal line are considered to be highly vulnerable.

Therefore, in segment I, we have poor but not vulnerable households; in segment II, poor and moderately vulnerable households; in segment III, poor and highly vulnerable households; in segment IV are non-poor and non-vulnerable households; in segment V, not poor but moderately vulnerable; and in segment VI, not poor but highly vulnerable households (Table 27).

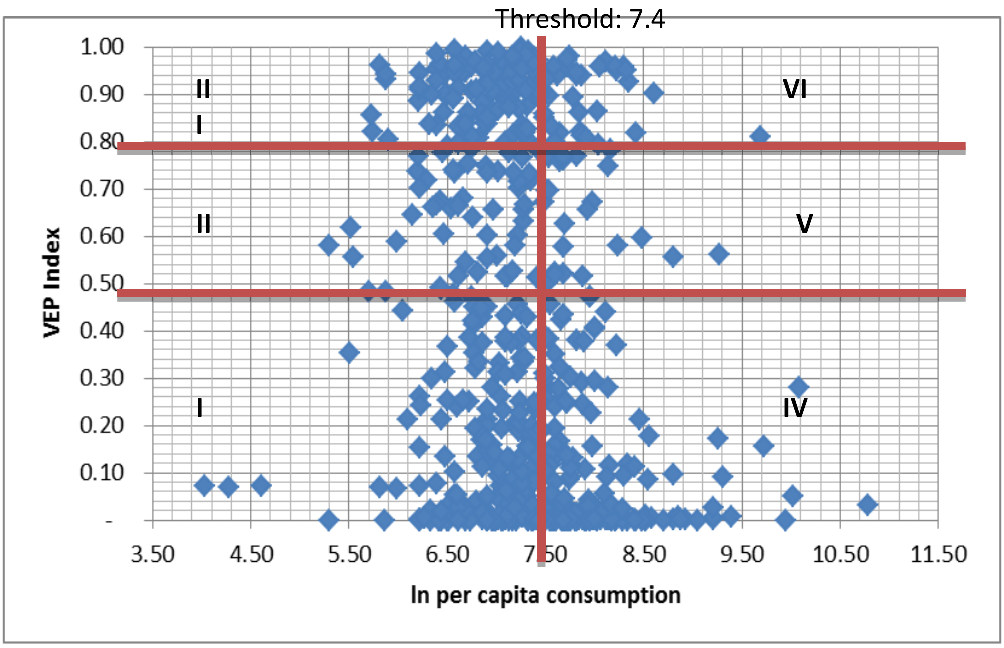


Figure 19. Vulnerability vis-a-vis ln (per capita consumption) at US$1.25 Threshold

Table 27. 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

In Table 28, the distribution (proportion) of households across the six segments is summarized. What can be gleaned from this data is that not all poor households are vulnerable, and similarly not all non-poor households are not vulnerable. In fact, about 11% of households are considered non-poor but vulnerable, while 32% of the household respondents were poor but were found to be not vulnerable.

Table 28. Distribution of Households Across the Six Segments of the VEP diagram (in %)

Group	Percentage Share (%)	
	Poor	Not Poor
Not Vulnerable	32	32
Moderately Vulnerable	9	5
Highly Vulnerable	17	6

Comparison between VI and VEP estimates

In Table 29, the results of VI and VEP analysis are summarized. It is shown that the mean vulnerability estimate is higher for VI at 0.43 than VEP at 0.37, while the variability of the estimates is greater for VEP (0.37) than for VI (0.14). A higher proportion of households were found to be vulnerable using the VEP approach with 36% incidence, as compared to 29% under the VI approach. The incidence of high vulnerability is also higher for VEP at 23% compared to VI with only 1%. A correlation analysis reveals that there is a weak but positive relationship between VI and VEP estimates at 0.23. However, a paired t-test reveals that their means are statistically different.

Table 29. Summary of VI and VEP Estimates

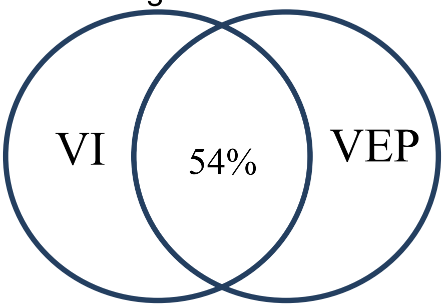
	VI				VEP			
	Not Vulnerable	**Moderately Vulnerable**	**Highly Vulnerable**	**All Households**	**Not Vulnerable**	**Moderately Vulnerable**	**Highly Vulnerable**	**All Households**
Mean	0.36	0.59	0.87	0.43	0.12	0.66	0.91	0.37
S.D.	0.09	0.08	0.06	0.14	0.14	0.09	0.06	0.37
Number	416	164	7	171	375	77	138	215
Percentage Share	71	28	1		64	13	23	
Incidence of vulnerability				29				36
p-value of t-test	0.00							
Correlation coefficient	0.23							

Looking more closely at the data, we can verify whether the results of the two approaches are consistent or whether they deviate significantly. In Table 30, the encircled values show the number of observations wherein the results, in terms of classifying whether a household is vulnerable or not, are consistent or the same between the two approaches. Representing it through a Venn diagram (Figure 20), it was found that the results were consistent in only about 53% of the observation.

Table 30. Distribution of Households according to Level of Vulnerability, VI vs. VEP (number)

		VEP			TOTAL
		Not Vulnerable	**Moderately Vulnerable**	**Highly Vulnerable**	
VI	Not Vulnerable	**284**	51	76	411
	Moderately Vulnerable	75	**23**	60	158
	Highly Vulnerable	6	1	**1**	8
	TOTAL	365	75	137	577

Figure 20. Venn Diagram of VEP and VI Estimates



Also, results were more consistent in the non-vulnerable (49%) category than it is for the vulnerable category (15%) (Table 31). It is observed that 22% of households were classified as vulnerable under VEP but not vulnerable under VI, while 14% were identified as vulnerable under VI but not vulnerable under VEP. This result is quite alarming and may raise questions about the reliability of vulnerability estimation. However, one must not undermine the quantitative approach, so long as the conceptual and theoretical foundations are clear and strong, and the users know how to interpret the vulnerability estimates, the results can still provide useful insights that can guide in policy formulation. It must be kept in mind that VEP can identify households that may fall into poverty in the future due to external shocks including those that are climate related, while VI can identify households that are at high risk of sustaining substantial damages from future climate related hazards.

Table 31. Distribution of Households based on Vulnerability, VI vs. VEP (%)

		VEP		Total
		Not Vulnerable	**Vulnerable**	
VI	Not Vulnerable	49	22	71
	Vulnerable	14	15	29
Total		63	37	100

1.1 Profile and characteristics of vulnerable households

The main reason 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 interventions 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 profile of vulnerable households will be described based on gender and primary occupation of the household head, and perception and knowledge about climate change. Both the results of the VEP and VI analysis will be discussed, and some discrepancies are to be expected. The users are thus, reminded of the underlying assumptions and interpretation of VEP and VI estimates (see previous section).

1.1.1 Gender and vulnerability

It is often advocated that development interventions, as well as policies for climate change adaptation should be gender sensitive. This makes it imperative to look at the composition of vulnerable households in terms of the gender. About 81% of the household respondents are headed by men which means that only 19% are female-headed.

Based on VEP and VI estimates (Figure 21), 1/5 of the moderately vulnerable households are headed by females. On the other hand, VEP estimates show that 1/3 of the highly vulnerable households are headed by females, while VI estimates show that no female-headed households belong in the highly vulnerable group. Nonetheless, the proportion of female-headed households belonging in the vulnerable group is still deemed substantial.

Therefore, the local government should keep in mind that they have to design adaptation options that would also be relevant and compatible with the needs and capacities of women.

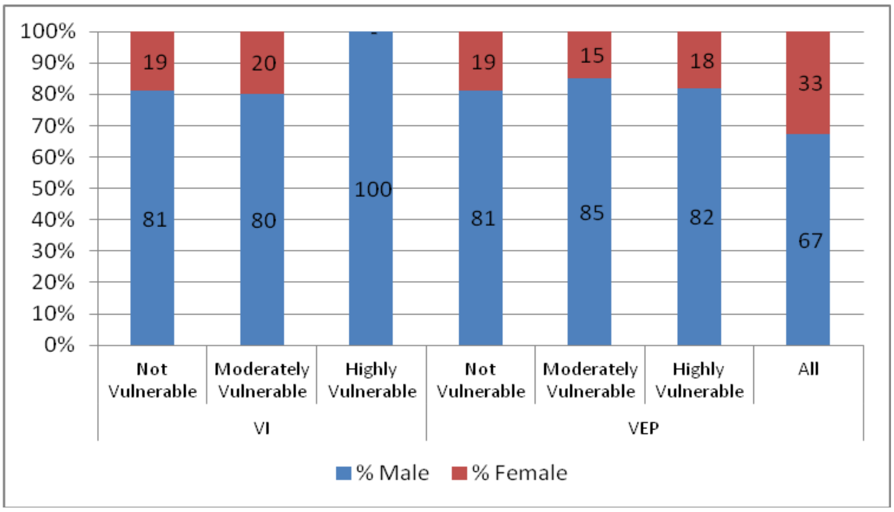


Figure 21. Composition of Groups based on Gender

Although majority of the vulnerable households are male-headed, it does not imply that males are more vulnerable than females. As a rough assessment, one has to look at the incidence of vulnerability for both sexes. In Table 32, it shows that the incidence of vulnerability in male-headed and female-headed households is about the same at 29% using the VI classification. An incidence of vulnerability in males can be interpreted as follows: *29% of all male-headed household respondents can be classified as at least moderately vulnerable.* Using the VEP results, the incidence of vulnerability was found higher for female-headed households than for males at 51% and 33%, respectively.

Table 32. Incidence of Vulnerability in Male- and Female-Headed Households (%)

Approach	Vulnerability Level	Incidence in Male-headed Households	Incidence in Female-headed Households
VI	Moderately Vulnerable	27	29
	Highly Vulnerable	2	0
	All Vulnerable	29	29
VEP	Moderately Vulnerable	13	12
	Highly Vulnerable	20	39
	All Vulnerable	33	51

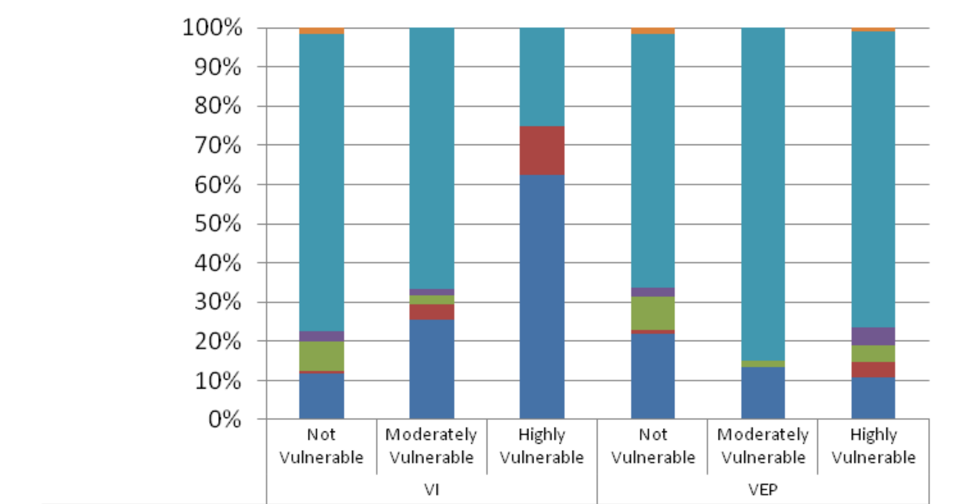
A test of difference of means show that VEP estimates significantly differ between male- and female-headed households. However, the test was not statistically significant for VI estimates. Using VEP, mean vulnerability for female-headed households is 0.52, while mean vulnerability is 0.34 for male-headed households. Mean VI estimates between male- and female-headed households are about the same at 0.42 and 0.43, respectively (Table 33).

Table 33. VI and VEP Estimates for Male- and Female-Headed Households

	Mean		Standard Deviation	
	VI	**VEP**	**VI**	**VEP**
Male-headed	0.42	0.34	0.15	0.35
Female-headed	0.43	0.52	0.13	0.39
p-value of t-test	0.73	-		

1.1.2 Livelihood and vulnerability

Figure 22 shows the distribution of households based on the primary occupation of the household head. Majority (59%) of the head of household have jobs in the commercial and services sector. Second in line is the agriculture sector with 16% share, the government with 6%, aquaculture and manufacturing both with 2% share and lastly by the academic sector with 1% share. Looking at the composition of the vulnerable group can provide guidance as to which sector to prioritize in terms of providing assistance for climate change adaptation. For the moderately vulnerable group, majority of the households are headed by those working in the commercial and services sector (53% and 74%, for VI and VEP, respectively), and then by those in the agriculture sector (20% and 12%, for VI and VEP, respectively). For the highly vulnerable group, however, results of the VI suggest that majority of households belonging to this group are headed by those working in agriculture (56%), while VEP shows that majority are still in the commercial and services group (60%), followed only by agriculture (9%).



	VI Not Vulnerable	VI Moderately Vulnerable	VI Highly Vulnerable	VEP Not Vulnerable	VEP Moderately Vulnerable	VEP Highly Vulnerable
% in Academic	1	-	-	1	-	1
% in Commercial/Services	63	53	22	54	74	60
% in Manufacturing	2	1	-	2	-	4
% in Government	6	2	-	7	1	4
% in Aquaculture	0	3	11	1	-	3
% in Agriculture	10	20	56	18	12	9

Figure 22. Primary Occupation of the Household Head (percentage share)

To provide a more complete picture, the incidence of vulnerability for each of the sector is presented in Table 34. Both VI and VEP show that the sector with the highest incidence of vulnerability is aquaculture, with 76% and 57%, respectively. However, VEP shows that agriculture has a relatively low incidence of only 23% compared to VI with 48%, while manufacturing and commercial, and services have higher incidence of vulnerable households with 42% and 41%, respectively. The above results suggest targeting interventions toward households in the agriculture and aquaculture sector as well as in the commercial and services sector.

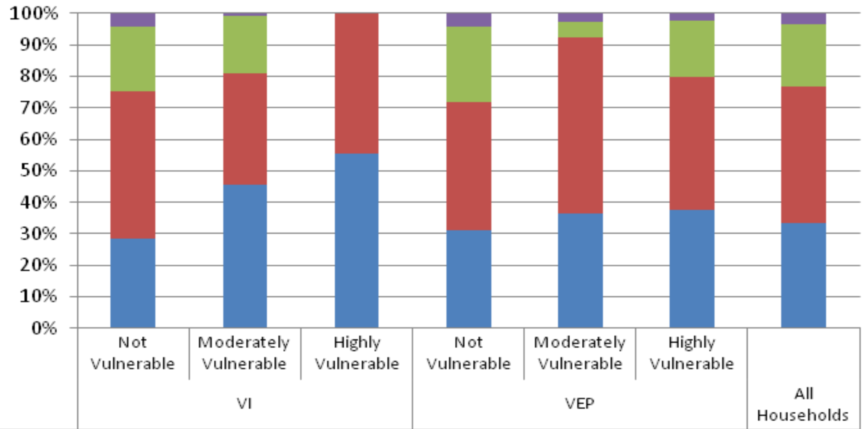
Table 34. Incidence of Vulnerability in Different Occupations (%)

Sector	VI			VEP		
	Moderately Vulnerable	**Highly Vulnerable**	**Total**	**Moderately Vulnerable**	**Highly Vulnerable**	**Total**
Agriculture	42	6	48	10	13	23
Aquaculture	63	13	76	-	57	57
Government	10	-	10	3	15	18
Manufacturing	18	-	18	-	42	42
Commercial/Services	25	1	26	17	24	41
Academic	-	-	0	-	17	17

Information and Knowledge about Climate Change Issues

Information and knowledge plays an important role in climate change adaptation. Equipped with the right information, households will be able to make wise and timely actions that can reduce their vulnerability to climate hazards. For instance, if farmers are knowledgeable about weather patterns, they will be able to make adjustments in their farming practices or they can adopt technology that can make their farms more resilient.

It is quite worrying that a large proportion of households (34%) revealed that they had no information or knowledge about climate change. Focusing on the vulnerable group, it can be seen that 38% and 36% of the highly vulnerable and the moderately vulnerable, respectively, had no information based on the VEP. This proportion is higher if we consider the VI estimates, with 56% of the highly vulnerable and 46% of the moderately vulnerable claiming that they had no information about climate change issues. It is prudent, therefore, to also engage in information dissemination and education activities (Figure 23).



	VI: Not Vulnerable	VI: Moderately Vulnerable	VI: Highly Vulnerable	VEP: Not Vulnerable	VEP: Moderately Vulnerable	VEP: Highly Vulnerable	All Households
Fully knowledgeable	4	1	-	4	3	2	4
Adequate knowledge	20	19	-	24	5	18	20
A little bit of knowledge	47	35	44	41	56	42	44
No information/knowledge	28	46	56	31	36	38	34

Figure 23. Distribution of Households based on the Level of Knowledge about Climate Change (% share)

Household Exposure to Hazards

The climate related hazards considered in the study are typhoon, flood, drought and landslides. These are the usual natural calamities that hit the province of Laguna. To aid in prioritization, it is important to identify which of these hazards is the most widely felt, especially by the vulnerable group. In Table 35, it shows that all of the households have experienced typhoon, 86% experienced strong typhoons which are categorized as at least signal number 3, 57% experienced floods, 49% experienced drought, while only 8% and 4% experienced flash floods and landslides, respectively. Looking at the vulnerable group, it seems that typhoon, flooding and drought, are the most important hazards as it affected the largest proportion of households.

Over the last 10 years, the average number of typhoon episodes experienced was 34 (about 3 typhoons per year). Three of which were categorized as at least signal number 3 typhoons. Moreover, an average of 6 floods and 1 flash flood were experienced. The average flood height reported was 1 foot, and the average flood duration was 6 days. The maximum flood height reported was about 12 feet and the maximum flood duration experienced was 300 days (Table 36).

Table 35. Percentage of Households that Experienced Climate Related Hazards in the Last 10 Years (%)

Hazard	All Households	VI			VEP		
		Not Vulnerable	Moderately Vulnerable	Highly Vulnerable	Not Vulnerable	Moderately Vulnerable	Highly Vulnerable
Experienced Typhoons	100	99	100	100	99	97	99
Experienced Signal #3 Typhoons[1]	86	83	93	100	83	88	93
Experienced Floods	57	51	72	78	41	69	93
Experienced Drought	49	45	57	67	47	52	49
Experienced Landslides	4	3	6	22	3	8	3
Experienced Flashfloods	8	6	14	22	4	6	20

[1] A typhoon is classified as signal number 3 if it has a wind speed of about 100 km/hour to 185 km/hour. This typhoon causes moderate to heavy damage.

Table 36. Hazard Indicators

Hazard Indicator	All HH	VI			VEP		
		Not Vulnerable	Moderately Vulnerable	Highly Vulnerable	Not Vulnerable	Moderately Vulnerable	Highly Vulnerable
Number of typhoons	34	28	48	76	32	38	35
Number of Signal #3 typhoons	3	3	4	4	3	3	3
Number of Floods	6	3	14	36	4	8	10
Maximum Flood Height (feet)	1	1	2	3	0	1	3
Longest Flood Duration (days)	6	4	8	40	3	6	12
Number of Droughts	2	2	3	3	2	2	2
Number of Landslides	0	0	0	1	0	0	0
Number of Flashfloods	0	0	0	2	0	0	1

Households in the vulnerable group reported experiencing higher occurrence of the hazard as can be seen in the data. For typhoons, the average number is as high as 76 for the highly vulnerable group in VI, and about 35 in VEP, while the moderately vulnerable household had a mean incidence of 48 and 38, in VI and VEP, respectively. Flooding frequency is also higher, with as much as 36 in VI and 10 in VEP for the highly vulnerable, while the mean frequency for the moderately vulnerable group is 14 (VI) and 8(VEP). The mean maximum flood height is about 3 feet for the highly vulnerable group while the longest flood duration is 12 days for VEP and 40 days for VI. For the moderately vulnerable group, these mean values are lower at about 1ft. (VEP) and 2 ft. (VI) for the flood height, and 6 days (VEP) and 8 days (VI) for the flood duration.

Hazard Impacts

Understanding how households have been affected by the hazards can also provide insights as to what particular interventions can be carried out. The study focused on typhoons and floods since this is the most common hazard experienced by the household. In Table 37, the extent of the impact of typhoons and floods are summarized.

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 reported being forced to borrow money. It also has impacts on health, spreading illnesses, causing injury and worse, death. Many also experienced emotional distress.

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; 73% (VEP) and 76% (VI) of vulnerable households), emotional impacts run in second, and loss of income comes in third. Seldom investigated, it seems that emotional and psychological distress is quite an important impact. 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 damages to their household appliances (26%) and 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 and 15% (VI) to 17% (VEP) of the vulnerable households. Illnesses are rampant during typhoons and floods as water borne diseases are spread rapidly. Worst case scenario is experiencing deaths in the family. Unfortunately, about 2% of the households were placed in this unfortunate circumstance.

Table 37. Typhoon and Flood Impacts

Impact	% of all HH affected	% of Vulnerable Households Affected		Rank
		VI	VEP	
Damage to house	66	76	73	1
Stress/Emotional impact	62	63	66	2
Loss of income	43	54	49	3
Damage to properties/appliances	26	35	43	4
Financial impact (forced to borrow money)	24	31	33	5
Illnesses in the family	12	15	17	6
Death in the family	2	2	1	7
Damage to vehicles	2	1	2	7
Injury in the family	2	2	2	7

Looking at the agriculture and fishery sector, 79 farms sustained damages to their crops, 24 experienced loss of livestock and 6 lost their fish stock (Table 38). The average cost incurred by those who sustained damages in their agricultural production is about P24,600, while the median cost is P10,000 and the usual cost is P5,000. Livestock losses amounted to about P127,100 on average, the median is P15,500 and the mode is P1,000. Cost of fish stock losses averaged about P14,400, while the median value was P12,000 (Table 39).

Table 38. Impact of Typhoon and Flooding in Agriculture and Fishery Households

Impacts	Number of households affected	% of agricultural households affected n=118
Damage to farm/pond equipment	13	13
Loss of standing crops	79	67
Loss of livestock	24	20
Loss of fish stock	6	5

Damage Cost

Table 39 shows that the mean damage cost to house and properties for those who reported sustaining this impact is about P11,360, while the median is P3,000 and the mode is P5,000. Business income losses averaged about P5,920, while the median and mode are P1,500 and P500, respectively.

Table 39. Cost of Damages Resulting from Typhoon and Flood

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	
Business income	116	5,918	11,533	1,500	500
Medical expenses	60	2,561	4,357	1,000	1,000

It is interesting to look at the relationship between damages and the vulnerability level. Table 40 shows that the mean and median values of damages are higher for the vulnerable group as compared to the non-vulnerable group. In particular, under the VI classification, the mean damage cost is about P12,800 for the non-vulnerable group while the mean damage cost for the vulnerable group is about Php 25,600. The median damage cost was about P2,200 and P5,000 for the non-vulnerable group and vulnerable group, respectively. Under the VEP classification, the average damage cost in the non-vulnerable group is about P11,400 while the cost is about P25,200 for the vulnerable group. The median damage cost is P2,000 for the non-vulnerable and P 5,000 for the vulnerable households.

Table 40. Descriptive Statistics for Damage Cost

		Not Vulnerable	Moderately Vulnerable	Highly Vulnerable	All Vulnerable
VI	Mean	12,789	26,119	16,383	25,607
	Median	2,225	4,900	13,150	5,000
	S.D.	40,331	137,167	14,520	133,542
VEP	Mean	11,360	17,816	29,351	25,220
	Median	2,000	5,000	5,050	5,000
	S.D.	37,917	40,231	149,211	121,896

Migration

Another consequence of climate change is displacement of people. In the study, it was found that about 91 or 16% of the household respondents were forced to evacuate during a typhoon. About 51 or 9% of the households were forced to permanently relocate (Table 41). The study however failed to examine whether the relocation was a private initiative from the part of the household or whether this was facilitated by the government. Also, it would have been interesting to know whether the relocation was voluntary or mandated by the government. Although relocation is desirable because it can ensure the safety of the household, it entails substantial costs. Apart from the expenses of having to buy or rent a new house and transporting belongings, most are adamant from moving because they will be uprooted from a place where they have already built social networks and where they are in close proximity to their farms, workplace, schools and the market. Nonetheless, it was found that in the study that 10% of the households have intentions to relocate in the future. Migration impacts of climate change should be further explored in future studies.

Table 41. Households Forced to Evacuate or Permanently Relocate

Impact	Number	% of all households
Forced to evacuate	91	16
Forced to permanently relocate	51	9

Adaptation and Coping Responses

A large number of respondent households stated that they undertook activities to minimize the potential damages from typhoon and flooding events. Since these are independently undertaken without support from the government, these are considered as autonomous adaptation. In the study, both proactive (before the hazard) and reactive (after the hazard) activities of the households were documented.

Actions before the hazard

About 20% of the households have undertaken modifications and improvements in their homes to strengthen and protect the structure against wind and flood waters. The same proportion revealed that they moved their belongings to a safe place in anticipation that the flood will inundate their house. Quite a few evacuated their families to a safe place (4%) while some dug canals and planted trees or vegetation to prevent floodwaters from reaching their homes and farms (Table 42).

Table 42. Actions Undertaken by Households before a Typhoon

Actions taken before a typhoon	% of Households (N=600)
House improvement to increase resiliency against typhoons and flooding	21
Moved personal properties to a safe place	20
Evacuated to a safe place	4
Dug canals	4
Planted trees along the perimeter of property	1

For the agri/aqua based households, only a limited few undertook preparations before the onset of the typhoon. Only 3% harvested their crops/fish stocks early, 2% applied flood resilient farming methods, 1% availed crop insurance, 1% reinforced their ponds/fish cages/animal pens, and 1% joined savings/credit groups (Table 43).

Table 43. Actions Undertaken by Agriculture, Fishery, Forestry Households before a Typhoon

Actions taken before a typhoon	% of Agriculture/Fishery/ Forestry Households (N=118)
Harvested early	3
Applied flood resilient farming methods	2
Availed crop insurance	1
Reinforced ponds/fish cages/animal pens	1
Joined savings/credit groups or coops	1

Actions after the hazard

After the typhoon, majority (58%) of the households undertook structural improvements to make their houses more resilient against typhoons and floods. About a quarter revealed that they had to borrow money to cope with income losses and damages while 9% had to withdraw money from their savings. A small percentage of households (2%) had to evacuate their house during the typhoon (Table 44). For the agriculture/aquaculture households, 25% immediately replanted their crops, 3% availed of crop insurance, 3% replaced their livestock and 3% reinforced their fish pens and animal cages. A few replaced their fish stock and joined a savings group or a cooperative (Table 45).

Table 44. Actions Undertaken by Households Immediately After a Typhoon

Actions taken immediately after a typhoon	% of Households (N=600)
House improvement to increase resiliency against typhoons and flooding	58
Borrowed money to cope with income losses and damages	19
Evacuated to a safe place	2
Withdrew from savings to undertake repairs and deal with additional expenses	9

Table 45. Actions Undertaken by Agriculture, Fishery, Forestry Households after a Typhoon

Actions taken immediately after a typhoon	% of Agriculture/Fishery/ Forestry Households (N=118)
Replanted farm	25
Availed crop insurance	3
Reinforced ponds/fish cages/animal pens	3
Replaced livestock	3
Replaced fish stock	1
Joined savings/credit groups or coops	1

Expenditures on adaptation

Expenditures on adaptation activities are summarized in Table 46. Before the onset of the typhoon, the mean expenditure for adaptation activities is about P1,450. This increases to P12,539 after the typhoon. The median and mode expenditures before the typhoon were nil while the median expenditure after the typhoon is P2,000.

Table 46. Expenditures on Adaptation Activities

	Adaptation expenditures before the hazard	Adaptation expenditures after the hazard
Mean	1,447	12,539
Median	0	2,000
Mode	0	0
Standard Deviation	20,615	53,715

A correlation analysis (Table 47) reveals that there is a moderate positive relationship between damage cost and adaptation expenditures before the typhoon/flood. This suggests that those who had higher propensity to incur damages may have made greater effort and preparations to defend themselves against the impacts of the hazard. It is rational to expect that people more prone to damages have higher incentives to invest in activities that can reduce their risk.

Damage cost and expenditures on adaptation /coping activities after the hazard, on the other hand, exhibits a strong positive relationship. This might imply that the attitude of the households may be more reactive rather than proactive.

Table 47. Correlation Analysis between Damage Cost and Adaptation Expenditures

Correlation Coefficient	Adaptation expenditures before the hazard	Adaptation expenditures after the hazard
Damage Cost	0.26	0.88

Assistance Needed by Households

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. For all households, the top 5 interventions are (1) financial assistance; (2) distribution of food/relief goods after disasters; (3) information; (4) medical assistance/provision of free medicines; and (5) construction of protective infrastructures against flooding. Focusing only on the needs of the vulnerable households, the top 5 needed interventions are financial assistance, infrastructures, medical assistance, livelihood assistance, and distribution of relief goods (Table 48).

Table 48. Assistance and Interventions Needed by Households

Assistance / Interventions Needed	% of all households	Rank	% of vulnerable households (VI)	Rank	% of vulnerable households (VEP)	Rank
Financial assistance	47	**1**	42	**1**	47	**1**
Relief goods	31	**2**	8	**5**	10	**5**
Information	17	**3**	5	6	6	7
Medical assistance	15	**4**	11	**3**	12	**4**
Infrastructures	11	**5**	30	**2**	30	**2**
Insurance	6	6	4	7	5	8
Shelter/Relocation	5	7	1	9	2	9
Emergency evacuation and shelter	4	8	4	7	6	7
Construction materials	4	9	-	10	-	10
Provide livelihood assistance	2	10	9	**4**	16	**3**
Proper waste management	2	11	1	9	0	10
Inputs for production	1	12	2	8	2	9
Trainings	0	13	4	7	7	6

Summary and Conclusion

Laguna is a province that is dualistic in nature where one can find rural and urban communities, and where livelihoods vary from agriculture, forestry, fishery to industry, manufacturing and services. Its topography is also complex with coastal, lowland and highland systems. Hence, it is an interesting case study for vulnerability analysis at the household level. Quantitative vulnerability assessment was done using the indicator approach- Vulnerability Index (VI) and the econometric approach- Vulnerability as Expected Poverty (VEP). Each has its own strength and weaknesses. The VI, although prone to biases due to weighting, is multidimensional and is able to capture a holistic view of vulnerability encompassing biophysical, social and economic aspects. VEP on the other hand, although narrower in focus, is less prone to biases and manipulation. The study found that VEP and VI estimates had consistent results in terms of categorizing households as vulnerable or non-vulnerable at about 51% of the time. This may raise questions about the validity of quantitative approaches. However, it is argued that so long as the underlying assumptions and interpretation of the results are clear to the users/readers, the approach warrants its own place in vulnerability assessment. For VI, vulnerability is essentially the susceptibility of a household in sustaining damages from climate related hazards, while VEP shows the probability that households will fall into poverty (or fall below minimum consumption threshold set by the World Bank) if exposed to shocks including those that are climate related.

The main purpose of vulnerability assessments is to come up with information that can help identify strategies for adaptation interventions. Knowing who the vulnerable households are as well as their characteristics and exposures to the hazards can aid in policy/project formulation. The assessment reveals that about 29% of the respondent households under the VI classification and 36% under the VEP classification can be categorized as vulnerable. Mean VI estimate is 0.43, while mean VEP estimate is 0.37. Majority of these vulnerable households are employed in the commercial and services sector as well as the agriculture sector. Hence, one recommendation that can be made is to focus strategies toward assisting these sectors. It was also found that a significant proportion of the vulnerable households are female-headed which entails devising options that are gender sensitive, catering to the needs and abilities of women. The study also shows that a high percentage of the vulnerable households do not have knowledge about climate change which suggests that engaging in information and education activities is a rational strategy to pursue.

In this study, it was found that the most significant hazard for Laguna, in terms of frequency and proportion of households affected, are typhoon and floods. The most widespread impacts are damages to house, psychological and emotional distress, and loss of income. It is not surprising that a large proportion of households prefer to receive financial assistance during typhoons and floods. For the agriculture/fishery sector, a significant number reported having their crops destroyed and livestock and fish stock killed. The average cost of damages to houses is about P11,400, while the income losses from agricultural production is about P24,600, P127,100 for livestock production, P14,400 for aquaculture production, and about P5,900 for business. The hazard also brought about health impacts, the average cost of which is about P2,560.

Majority of those interviewed believe that their household was adequately prepared to handle the adverse impacts of the hazards. Some of the preparations they made include strengthening their houses, as well as moving personal properties to higher ground away from flood waters. A small proportion evacuated their homes to keep their family safe. For agriculture/fishery/forestry households, only a small percentage (less than 5%) undertook precautionary measures such as the application of flood resilient farming methods, availing crop insurance, early harvesting, and reinforcement of fish/animal pens, to protect their livelihood before a typhoon and flooding event. This may explain the substantial number of farming households who had to replant their farm or replace their fish/livestock after the typhoon and flood. The average expenditures on adaptation before the hazard was about P1,450 which substantially increased to about P12,540 after the hazard.

There seems to be a positive relationship between damage cost and adaptation expenditures. It is believed that households, who had higher propensity to incur damages, had higher incentives to invest in adaptation activities. The top 5 interventions preferred by the households are financial assistance, relief goods, information dissemination, medical assistance, flood mitigation infrastructures and livelihood assistance. These options will be considered for economic analysis in the second phase of the project.

CHAPTER 6

Social Vulnerability in the Province of Laguna, Philippines

Background

The UN/ISDR (2004) defines vulnerability as “the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.” The definition clearly includes the social nature of vulnerability. The social and gender component is thus integral to the vulnerability research and is meant to complement the physical and economic components of the project in achieving the overall project objective stated as follows: *to build capacity for research, planning, and action with respect to climate change and the economics of adaptation.* While there is no doubt that vulnerability assessment is important in achieving the overall project objective, it is crucial that addressing vulnerability be done in a comprehensive manner. This necessitates a focus on the social character of vulnerability vis-à-vis climate change related stress sources.

An earlier reference to social vulnerability to climate change done by Adger (1999) clarifies that vulnerability as a social phenomenon encompasses a collective nature involving a complex set of factors which may include institutional arrangements for preparedness for hazards. It also has a more individual and group-based nature which may focus on the impact of climate change on the wellbeing of individuals and groups. A better understanding of social vulnerability therefore calls for a methodology that will provide opportunities to look deeper into the vulnerabilities of households in different circumstances defined by their social and ecological systems, as well as the vulnerabilities of certain sectors. It is in this regard that a deeper understanding of social vulnerability both at the household and individual level, as well as the sectoral and community level, is being addressed by the social and gender component of this particular research.

Research objectives

The general objective of the study on social vulnerability is to arrive at an in-depth understanding of vulnerability to climate change of selected communities in the province of Laguna, Philippines.

Specifically, the study aims to:

1) identify and describe typical social sub-groups vulnerable to specified hazards in the province of Laguna;

2) assess the social vulnerabilities of the social-subgroups in terms of underlying problems and their corresponding solutions;
3) provide recommendations to reduce the vulnerability of the communities and social groups to climate change-related hazards and threats.

Research questions

Given the aforementioned objectives, some of the research questions addressed by the research on social vulnerability are as follows:

- Who are vulnerable?
- Why are they vulnerable and how can this problem be addressed?
- Which community sub-groups are the most seriously affected by climatic hazards?
- What are the features of these sub-groups in terms of geographic location?
- What are their socio-cultural, demographic and politico-economic features?
- How do they access hazard information/warning: information sources and timeliness?
- How do these vulnerable sectors adapt to climatic hazards?
- What role do the local social networks play in the people's adaptive capacity in terms of knowledge sharing, access to resources, and influence on policy?
- What is the community sub-groups' assessment/analysis of their vulnerability?
- How do they think their vulnerability can be reduced?

The gender perspective in the research process was underscored by the use of a gender analysis framework in looking at vulnerability. In this regard, the following questions were addressed:

- Do climate change-induced hazards affect everyone in the same ways?
- Do women and men face climate change-induced hazards in similar conditions?
- Do they have the same abilities and resources to deal with these hazards?
- In what adaptation measures do women play crucial roles? What are these roles?

To answer these questions, the analysis necessitates the examination of gender roles, gender differentials in access to, and control of resources and benefits, and the socio-economic and cultural contexts of women.

Social Indicators of Climate Change Vulnerability

The social dimension of climate change vulnerability

Hazard exposure of vulnerable sectors

Based on the secondary data gathered, the discussions that ensued during the FGDs, and the results of the in-depth interviews and KIIs, the population in the Philippines study site are generally exposed to the following climatic hazards: typhoon, flooding, landslides/erosion, and droughts. Other hazards mentioned are earthquakes and extreme weather conditions that are observed to follow major tropical storms. Some allied hazards were also mentioned such as pest infestations which become more pronounced during droughts. Information from the Laguna Provincial Agriculture Office (Laguna – PAO) indicated the threat posed by extreme weather conditions like La Niña and El Niño. According to the climate change mitigation and adaptation focal person of the Laguna – PAO, a period of drought and water shortage usually occurs after the advent of strong typhoons. This was evident after TS Milenyo in 2006 and TS Ondoy and Santi in 2009. This was corroborated by both the KIIS and the FGD conducted among the agricultural sector in Victoria. Accordingly, in the 1980s drought was experienced every two to three years, but it became yearly starting year 2000.

Right after the typhoons in 2009, some portions in the province experienced extreme drought and water shortage after a dam was damaged thus affecting the water supply of dependent municipalities. It was reported that the province's 1,604.9 ha of land suffered from drought at that time.

> *"may tag-init kaming naranasan pagkatapos ng Ondoy, Pepeng at Santi, 2009 yata. Nasira pati yung Dam, yung Liliw-Sta. Cruz Dam"* (we experienced a dry spell after Ondoy, Pepeng, and Santi in 2009. The Liliw-Sta Cruz Dam was damaged).

However, typhoon and flooding are identified as having the most serious damages. The most notable typhoons that have struck the province in the past 10 years are in Table 49.

Table 49. Notable Typhoons, 2000 - 2010

Name of Tropical Storm	International Name	Date of Entry in the Philippine Area of Responsibility (PAR)
Milenyo	Xangsane	Sept. 26, 2006
Reming	Durian	Nov. 26, 2006
Ondoy	Ketsana	Sept. 24, 2009
Pepeng	Parma	Sept. 30, 2009
Santi	Mirinae	Oct. 31, 2009

While some upland barangay are not exempted from flooding and swelling of rivers due to heavy rains that accompany most typhoon incidents, communities residing along the shores of Laguna de Bay are the most vulnerable. The coastal barangays under the municipalities of Pila, Bay, Victoria, Sta. Cruz, and Los Baños are the most exposed to floods. In many instances, the poor in these areas are more exposed compared to the rest of the population with many of them establishing residents in public/government lands along waterways and irrigation canals. Based on the FGDs conducted at the municipal level, these municipalities have some of the highest percentage of flood prone areas while also registering the highest incidences of poverty (Table 50). Incidentally, the same municipalities reported the highest number of strong typhoons and flooding incidents among the 12 municipalities.

When brought down to the barangay level, this picture of exposure shows that barangays near the shorelines and along major river banks are most vulnerable. Interestingly, there are those barangays not necessarily high on exposure to flooding but which still registered high overall vulnerability. In terms of exposure, this highlights the role played by typhoons in the overall vulnerability of the study site. Table 51 shows the contribution of typhoons over flooding and inundation in analyzing exposure. Of the top 20 vulnerable barangays (based on overall vulnerability) within the study area, 12 barangays also topped in overall exposure. However, only six of these barangays registered high indices for flood-related indicators, while 16 registered high indices for typhoons. It is also noteworthy that of these 20 most vulnerable barangays, only five barangays registered high exposure indices, indicating the significant contribution of sensitivity and adaptive capacity indices on overall community vulnerability.

Of those cited, the tropical storms that struck in the years 1995, 2006 and 2009 remains vivid in the memories and collective experience of the communities. They were also indicated as having the most adverse effects on living conditions and livelihood (Table 52). Prominent in the narratives during the interviews and group discussions conducted among women, the elderly, youth, and members of an upland community and a coastal barangay, were the adverse effects on agriculture and the fishery sector, damage to houses and the flash floods in the upland communities. The reference on damages in agriculture regardless of the sector classification indicates that the agriculture sector is one of the most vulnerable sectors vis a vis climate change related hazards, cutting across different types of human ecosystems.

Following the reports captured by the interviews and groups discussions, typhoons and flood incidents are not only increasing in intensity; there is also an indication that major typhoons are in fact becoming more frequent. In most cases, the information from the local population show that the time gap between major typhoons and flood incidents is becoming shorter. Mostly, people remember the devastation brought by TS Rosing in 1995. The next major typhoon that remains in their consciousness is TS Milenyo which happened around 11 years after. The time gap between TS Milenyo in 2006 and TS Ondoy (and subsequently TS Santi) in 2009 is noticeably shorter. With population growth not experiencing any stall both at the national and in the province of Laguna, more and more human populations stand to be affected by climate change-related hazards and disasters.

Table 50. Percent Flood Prone Areas, Typhoon and Flooding Experience and Percent Poverty Incidence

Municipality	Flood Prone Area (%)	Above signal no.2 typhoons	No. of flooding events	Population	No. of households	Poor HH (%)
Pila	15	6	6	54,812	≈ 10,000	60
Magdalena	< 5	5	1	21,761	4,588	25
Liliw	5	5	3	35,054	7,012	5
Bay	60	> 10	> 10	53,967	10,793	40
Pagsanjan	10	4	4	42,000	3,991	30
Nagcarlan	< 5	2	1	60,600	15,000	15
Calauan	25	5	4	61,437	11,911	60
Victoria	10	4	4	37,656	7,917	60
Sta.Cruz	25	5	5	105,992	23,244	60
Los Baños	40	6	6	103,956	nd	30
Majayjay	nd	2	0	29,115	6,566	20
Rizal	48.3	6	0	16,008	3,456	nd

Source: Municipal level FGDs

Table 51. Normalized Values for Exposure and Overall Vulnerability of 20 Most Vulnerable Barangays, Laguna, Philippines

RANK	BARANGAY	MUNICIPALITY	HAZARD EXPOSURE						OVERALL VULNERABILITY
			Typhoon		Flood				
			No of Typhoons	Above Signal 2	Flooding Events	Average Flood Level	No of Days Flooded	Overall	
1	San Pablo Norte	Sta. Cruz	0.222	0.200	0.016	0.123	0.875	1.000	1.000
2	Dayap	Calauan	0.889	1.000	0.240	0.031	0.008	0.494	0.770
3	Munting Kawayan	Majayjay	1.000	0.800	0.008	0.766	0.003	0.621	0.718
4	Masico	Pila	1.000	1.000	0.012	0.027	0.005	0.477	0.659
5	Tuy-Baanan	Liliw	1.000	1.000	0.040	0.023	0.017	0.483	0.656
6	Santissima Cruz	Sta. Cruz	1.000	1.000	0.012	0.123	0.379	0.609	0.652
7	Anibong	Pagsanjan	1.000	0.800	0.000	0.000	0.000	0.404	0.634
8	Maravilla	Nagcarlan	1.000	1.000	0.008	0.092	0.079	0.516	0.628
9	Sabang	Nagcarlan	1.000	1.000	0.000	0.000	0.000	0.467	0.615
10	Masapang	Victoria	0.556	1.000	0.200	0.107	0.013	0.460	0.615
11	Poblacion 5	Sta. Cruz	1.000	1.000	0.040	0.050	0.376	0.591	0.612
12	San Isidro	Calauan	0.778	0.400	0.320	0.061	0.006	0.309	0.599
13	Balayhangin	Calauan	1.000	1.000	0.000	0.000	0.000	0.467	0.598
14	Bukal	Pila	0.167	0.160	0.004	0.153	0.008	0.121	0.596
15	Nanhaya	Victoria	0.000	0.100	0.088	0.518	0.129	0.225	0.593
16	Tagumpay	Bay	0.778	0.400	0.040	0.050	1.000	0.544	0.582
17	Ibabang Butnong	Magdalena	1.000	0.400	0.024	0.050	0.015	0.300	0.581
18	Pinagbayanan	Pila	0.222	0.060	0.008	0.153	0.375	0.202	0.581
19	Santo Angel Sur	Sta. Cruz	1.000	1.000	1.000	0.092	0.006	0.634	0.577
20	Masiit	Calauan	0.333	0.800	0.160	0.092	0.006	0.351	0.566

Table 52. FGD Results of Timeline

Sector	Event	Year	Impact	Level of impact
Agriculture	TS Rosing	1995	Fisheries, Rice field, Livestock, crops, houses were damaged by the typhoon	High
	TS Milenyo	2006	Fisheries, Rice field, Livestock (duck and piggeries), crops, houses were damaged by the typhoon	High
	TS Ondoy, Pepeng, Santi	2009	• Fisheries, Rice field, Livestock (duck and piggeries), crops (vegetables, 2 hectares banana plantation), houses, farm to market roads were damaged by the typhoon • 2 people died (swept away by the flood) • Flooding • Coastal areas were highly affected • Hurricane was experienced by several barangays • Trauma • Dengue	Very high
	El Niño (drought)	2009	Affected 1 cropping season	Medium
Coastal Community	TS Rosing	1995	• Fish cages were destroyed, roofing, furniture and appliances were destroyed, people used the window to pass through • Pigs were swept away • Water lilies were on roads • Chapel was destroyed • Fruit trees were destroyed	High
	Typhoon Ondoy	2009	Houses and livelihoods were affected and destroyed	High
	TS Santi	2009	• Oct 31- house and source of income have been washed out • Sewing machine worth • Php 10,000 was swept away and only cloths were saved (livelihood)	High
	TS Basyang	2010	Roofing was swept away	Medium

Table 52. FGD Results of Timeline *(cont'd)*

Sector	Event	Year	Impact	Level of impact
Youth	Drought	2004-2005	Dam in Calumpang, Laguna was broken and became the reason for the drought on nearby towns	High
	TS Milenyo	2006	Landslide (Los Baños)	Light
			Drought and flood (Pila)	High
			Light posts and trees blocked off the roads, electricity were down in some houses (Magdalena)	High
	Typhoon Ondoy and Santi	2009	Flood (Sta. Cruz)	Medium
			Brgy. Biñan was affected by flood, Food shortage was present in Pinagsanjan and Bagumbayan, loss of electricity for almost a month (Pagsanjan)	Medium
			Canals and drainages overflowed (Nagcarlan)	Medium
Upland Community	TS Rosing	1995	• 13 pigs were flooded away • Crops were affected	Medium
	Earthquake	1999	Pigs died	Low
	TS Milenyo	2006	Crops were affected	Medium
	TS Ondoy and Santi	2009	• 2 bridges were broken (Coralao and San Isidro Bridge) • Houses near river were swept away • There were houses which were affected by flood • Crops were affected • Drought soon affected the agricultural sector	High

Table 52. FGD Results of Timeline *(cont'd)*

Sector	Event	Year	Impact	Level of impact
Elderly	TS Rosing	1993-1994	• Flooding • Damaged Houses	High
	Taal Volcano Eruption	1993-1994	• Roofs accumulate ashes • Caused respiratory disease to children • Temperature in LB rose	Low
	TS Frank	2004	• Flood • Agricultural products were affected • Gish cages were destroyed, fish ponds overflowed • Landslide occurred • Houses were destroyed	Medium
	Flooding	2005	Rapid Growth of Water Lily	Low
	TS Milenyo	2006	• Landslide • Uprooted trees • Destroyed Infrastructure • Deaths / Casualties • Destroyed agricultural products • Outbreak of diseases caused by flood water and typhoon	High
	Typhoon Ondoy	2009	• Flooded residential areas and destroyed houses • Agriculture suffered • Backyard gardening (livelihood) affected • Destroyed/ damaged infrastructures • Deaths • Landslide	High
	Unidentified disaster/calamity	2009-2010	• Flash flood • Deaths • Destroyed infrastructures	High

Table 52. FGD Results of Timeline *(cont'd)*

Sector	Event	Year	Impact	Level of impact
Women	TS Rosing	1995	• Caused the Cherry hills landslide in Antipolo • Flood in Brgy Tadlac • Damaged Houses • Some residents were evacuated • Experienced 2 weeks without electricity	High
	Jamaica Erosion	1998	• Trees were uprooted	Medium
	El Niño Phenomenon (drought)	2000-2001	• Rice fields caught fire • Those engaged in horticulture were greatly affected	High
	Landslide/ Erosion Quarrying	2002-2005	• Landslide in Dampalit Site (Jamaica) • The dumpsite located in Timugan was damaged and washed-out. • Contaminated water supply • Residents suffered diarrhea • A tourist spot was damaged	High
	TS Milenyo	2006	• Flooding and Landslide • Damaged Houses • Agriculture and livelihood affected • Suspension of Classes	High
	TS Ondoy	2009	• Hurricane • Damaged houses • Some houses in Umali were affected, including CDLB • Agriculture and livelihood affected • Suspension of Classes	High

Most affected sectors

Vulnerability in the province of Laguna is obviously a function of exposure of varying human ecosystems to typhoons and floods, with coastal barangays having a higher exposure to flooding and prolonged inundation. However, it is also significant to note that human, social and economic sensitivity to these hazards also has major contributions to overall vulnerability. For instance, eight barangays within the study site were not found to be highly exposed yet they are among the 20 most vulnerable barangays. These barangays are Anibong in the municipality of Pagsanjan, Masapang and Nanhaya in Victoria, San Isidro and Masiit in the municipality of Calauan, Bukal and Pinagbayanan in Pila, and Ibabang Butnong in the municipality of Magdalena. A closer examination of their vulnerability indicates that their high vulnerability can be attributed more either to human, social and economic indicators of sensitivity and/or low adaptive capacity of the communities (Table 53). Barangay Nanhaya in the municipality of Victoria ranked highest in terms of sensitivity although it is not even part of the upper 50% in terms of exposure. Its vulnerability is clearly a function of its sensitivity as indicated by its levels of poverty and malnutrition, and its significant number of women and elderly-headed households. It is also a predominantly agriculture-based community.

Another case in point is Barangay Dayap in the municipality of Calauan which is equally exposed to typhoons, although relatively low in flooding, but which registered high in overall vulnerability. A closer look of other indicators of vulnerability showed that, Barangay Dayap is one of the highest in malnutrition rates which is indicative of high sensitivity to the impact of climate change – led threats; it also has low adaptive capacity as a result of low scores on technological, social and human indicators. Another is the case of Barangay San Isidro also in Calauan, the vulnerability of which is due to high sensitivity as a result of having many women-headed households in a predominantly agricultural community.

The FGDs also resulted to the list of the participants' perception of the most vulnerable sectors given climate-change-related hazards (Table 54). Among these are the elderly, women in various circumstances, farmers and fisher folks, lakeshore residents and those living near bodies of water, and the poor. Within the frame of vulnerability indicators for exposure, sensitivity and adaptive capacity used for the household survey (Annex Table 14), the various sectoral discussion groups generated consensus on the level of vulnerability of each vulnerable sector / social group they mentioned. After they identified sectors they perceive as vulnerable to the effects of climate change, the participants were asked to assess the vulnerability of the sectors. A summary of this is shown in Table 55. As gleaned from the group discussions, poor households are perceived as most vulnerable because of their high sensitivity and low adaptive capacity, followed by the agriculture sector and the informal settlers. These sectors are considered vulnerable because their sources of income are sensitive to occurrences of hazards and their financial capacities to adapt to the impact of climatic hazards are low.

Table 56 summarizes the perspectives arrived at during the FGD sessions regarding the state of livelihood during and after the onslaught of typhoons and flooding. Evident in all FGD sessions was the reference to damage to agricultural crops during typhoons and flooding; the little produce that agriculture-based households were able to salvage were sold but at very low prices. Moreover, there is the immediate impact of decrease in yield both for animal and plant production right after the disaster. In terms of hazards, typhoons were discussed as more damaging since even high value crops in areas which do not suffer from inundation are affected.

The predominance of agriculture and forestry-based source of income increases the sensitivity of a community since climate change-related hazards do not only affect their living conditions but also directly impact on their level of productivity and consequently their income level. Comments during the FGDs attest to this:

> *The effect of TS Milenyo and typhoons that become stronger and stronger is terrible. The flashfloods washed out the pigs. Vegetable crops were also damaged. Also rice.* – From Highland barangay FGD
>
> *Banana plants were uprooted*. – From Agriculture sector FGD
> *Rice yield decreased and sold at very low price.* – From Youth, Elderly and Agriculture sectors FGDs
>
> *Some duck raisers stopped their business due to the effects of typhoons and flooding. This is because they have to use commercial feeds which is costly, since there was a shortage in snail shells after the typhoon…Prices of eggs also drop after calamities.* – From Agriculture sector FGD

Table 53. Normalized Values for Human, Infrastructure and Livelihood Sensitivity, and Overall Vulnerability of 20 Most Vulnerable Barangays, Laguna, Philippines

RANK	BARANGAY	MUNICIPALITY	SENSITIVITY									OVERALL VULNERABILITY
			Human					Infra		Livelihood		
			Population Density	Poverty Rate	Women Headed HH (%)	Solely Elder Headed HH (%)	Malnutrition Rate	Water from Lakes (%)	Water from Wells (%)	HH involved in Agri (%)	Overall	
1	San Pablo Norte	Sta. Cruz	0.000	0.050	0.100	0.338	0.000	0.200	0.300	0.000	0.244	1.000
2	Dayap	Calauan	0.015	0.000	0.286	0.125	0.750	0.010	0.990	0.970	0.494	0.770
3	Munting Kawayan	Majayjay	0.015	0.500	0.214	0.125	0.200	0.000	0.000	0.800	0.315	0.718
4	Masico	Pila	0.051	0.080	0.071	0.500	0.200	0.000	1.000	0.400	0.431	0.659
5	Tuy-Baanan	Liliw	0.004	0.700	0.085	0.334	0.326	0.000	0.000	0.750	0.451	0.656
6	Santissima Cruz	Sta. Cruz	0.162	0.400	0.286	0.125	0.059	0.000	0.864	0.003	0.389	0.652
7	Anibong	Pagsanjan	0.006	0.700	0.143	0.250	0.250	0.000	0.000	0.900	0.450	0.634
8	Maravilla	Nagcarlan	0.010	0.850	0.159	0.063	0.025	0.010	0.090	0.700	0.361	0.628
9	Sabang	Nagcarlan	0.011	0.600	0.143	0.375	0.025	0.500	0.000	0.700	0.518	0.615
10	Masapang	Victoria	0.017	0.000	0.143	0.625	0.063	0.000	0.900	0.800	0.522	0.615
11	Poblacion 5	Sta. Cruz	0.048	0.340	0.429	0.125	0.025	0.000	0.200	0.000	0.306	0.612
12	San Isidro	Calauan	0.023	0.450	0.714	0.313	0.341	0.000	1.000	0.750	0.766	0.599
13	Balayhangin	Calauan	0.088	0.500	0.071	0.063	0.250	0.000	1.000	0.300	0.383	0.598
14	Bukal	Pila	0.015	1.000	0.286	0.125	0.750	0.010	0.990	0.970	0.791	0.596
15	Nanhaya	Victoria	0.098	0.500	1.000	0.625	1.000	0.000	0.300	0.025	0.916	0.593
16	Tagumpay	Bay	0.067	0.300	0.071	0.250	0.025	0.000	0.100	0.850	0.290	0.582
17	Ibabang Butnong	Magdalena	0.003	0.700	0.714	0.381	0.125	0.000	0.500	0.700	0.711	0.581
18	Pinagbayanan	Pila	0.123	1.000	0.571	0.375	0.750	0.000	1.000	0.500	1.000	0.581
19	Santo Angel Sur	Sta. Cruz	0.428	0.000	0.571	0.750	0.300	0.000	0.100	0.050	0.626	0.577
20	Masiit	Calauan	0.011	0.500	0.014	0.274	0.250	0.000	1.000	0.900	0.507	0.566

Table 54. Sectors Vulnerable to Climate Change-Related Hazards

FGD1: **Elderly** Los Baños Federation of Senior Citizens Incorporated (LBFSCI)	FGD2: **Women** Kababaihan Lingkod Bayan ng Laguna (KLBL)	FGD3: **Agriculture** Municipal Agriculture and Fisheries Council (MAFC-Victoria)	FGD4: **Coastal** Brgy San Pablo Norte, Sta. Cruz	FGD5: **Upland** Brgy Ibabang Banga, Majayjay	FGD6: **Youth** c/o Laguna Youth Affairs Office
1. Children 2. Elderly 3. Widow / widower 4. Farmers and fisher folks 5. Poor families 6. Lakeshore residents 7. Residents in landslide / erosion prone areas	1. Differently-abled 2. Children 3. Elderly 4. Women 5. Poor families 6. Poor, large households 7. Lakeshore residents 8. Farmers 9. Unemployed	1. Children 2. Elderly 3. Women 4. Poor, large households 5. Farmers 6. Fisher folks 7. Duck raisers 8. Lakeshore residents 9. Residents near bodies of water	1. Children 2. Elderly 3. Poor families with many children 4. Women 5. Farmers; those who get income from planting and livestock	1. Children 2. Elderly 3. Poor family with more than five children 4. Farmers 5. Households near bodies of water 6. Women 7. The sick	1. Children 2. Elderly 3. Women 4. Poor family with large number of children 5. Less educated 6. The underemployed and unemployed

Source: Sectoral FGDs

Table 55. Average Level of Exposure, Sensitivity and Adaptive Capacity and Overall Vulnerability

Sector / Group	**Exposure**	**Sensitivity**	**Adaptive Capacity ***	**Overall Vulnerability**
Elderly and elderly-headed HHs	1.71	1.75	2.38	1.95
Children	1.71	1.50	2.50	1.90
Women-headed HHs	1.71	2.00	2.38	2.03
Residents on/ near lakeshore and rivers	2.36	2.50	2.13	2.33
Poor households	2.00	3.00	2.75	2.58
Large families/ HHs	1.71	2.50	2.00	2.07
Agriculture-based HHs (including fishing, livestock and duck raising)	2.29	2.50	2.25	2.35
Informal settlers	2.00	2.75	2.25	2.33

Legend: 1 = low 2 = medium 3 = high
Source: FGD results

Table 56. Livelihood Situation During and After Flooding

Women FGD KLBL, Los Baños	Elderly FGD LBSCFI, Los Baños	Agriculture FGD MAFC, BAFC, MAO Victoria	Coastal Barangay FGD Brgy. San Pablo Norte, Sta. Cruz	Youth FGD Youth representatives from Los Baños, Lumban, Magdalena, Nagcarlan, Pagsanjan, Pila, Sta Cruz, and Victoria	Highland Barangay FGD Brgy Ibabang Banga, Majayjay
• Grass and rice fields caught fire • Plants were damaged, dried up and died. • Fish pens located in Laguna lake were completely damaged • Absence from work due to flooding or sickness	• Fish pens located in Laguna lake were completely damaged • Absence from work due to flooding or sickness • Fruit-bearing trees were uprooted • Palays were sold at a very low price	• Ducks suffered molting • Prices of eggs dropped • Duck raisers used commercial feeds, which is costly, for there was a shortage in snails after the typhoon • Some duck raisers stopped their business due to damages caused by typhoon and flooding • Palays were sold at a very low price • Banana trees were uprooted	• Residents were not able to fish for months due to rough waters and their houses, flooded • Absence from work due to flooding or sickness	• Absence from work due to flooding or sickness • Prices of eggs dropped • Palays were sold at a very low price	• Pigs were washed out • Vegetable crops were damaged • Palay yield decreased • Absence from work due to sickness

Those whose source of income are from daily wage labor which are not agriculture-based are also affected by typhoons and occurrences of flooding. Mostly, this was due to the interruptions in everyday life of major flooding incidences, preventing workers from reporting to their workplaces. The damage in residences and the transfer to evacuation centers that need to be attended to by the members of the households also hinders daily wage earners from going to work. Illnesses reportedly also prevent workers from making it to their workplaces.

During the FGD with participants from Brgy. San Pablo Norte, in the municipality of Sta. Cruz, it was highlighted that their community experienced four months of flooding after TS Rosing in 1995, aside from the damages incurred during the typhoon itself. This effect intensified in the case of TS Ondoy and Santi both in 2009, with the community suffering five months of flooding and seven months of staying in evacuation centers. With such a situation, many of the residents stopped going to work and many of the school children stopped going to school. They thus became dependent on food sourced from relief goods operations (from FGD with coastal community). Aside from flooding incidents brought by tropical storms, the community also indicated that the rice field area in their barangay have significantly decreased with some portions perennially inundated.

Residents of upland areas are however not totally exempted from similar exposure to the threats of flooding. One of the cases developed out of the in-depth interviews proves that even if the barangay where they are residing is geographically classified as a highland barangay, the more specific location of their residence makes their household relatively more exposed to flooding than other upland dwellers. In this particular case of an agriculture-based household in Barangay Tranca of the municipality of Bay, there is report of the hazards of floods in addition to typhoons, droughts, and landslides and severe soil erosion (Case Stories, Case 9). With their original house washed away by flood waters brought by TS Milenyo in 2006, their current abode is still beside a river prone to flooding during heavy rains.

The agricultural sector is also one of the most vulnerable to climate change-related hazards and disaster. In the aftermath of TS Ondoy, Laguna reported PhP200M worth of damage to agricultural crops. Rice land and areas planted to vegetables and high value crops were submerged in flood waters. Accordingly, rice farmers in the municipality of Pila experienced using boats to harvest their palay (from interview with Laguna-PAO climate change focal person). In many coastal barangays of the municipalities of Pila, Sta. Cruz and Los Baños, flooding was observed even three to four months after the typhoon (from municipal level FGDs).

Equally affected by strong typhoons and flooding incidents were hogs and livestock raisers. In the municipality of Victoria, known for its duck raising and duck egg production industry, flooding incident flushed away ducks and destroyed poultry houses (from FGD with Victoria agricultural sector). Prolonged inundation also leads to decrease in rice planting and duck raising. Many duck raisers were also reportedly traumatized by the losses they incurred due to TS Ondoy that is why they have decided not to pursue duck raising anymore (FGD with members of Victoria MAFC). This experience was also expresses by one of the in-depth interviewees who suffered severe losses in their rice farming and duck raising ventures, causing her husband to fall into depression that eventually contributed to his untimely demise. This has transformed her household from a male-headed to a female-headed household, opening up new challenges and roles for the respondent not only as a farmer, but also as a woman.

As surfaced during the FGD, the small-scale fisheries sector were also affected in the short term due to damage or loss of fishnets, but not in the long term. More long term effects and heavier damages were usually experienced by those with large fish pens in Laguna Lake.

The other vulnerable sector in the community is the elderly. Because they are physically vulnerable, they can be doubly burdened by severe flooding and the effects of climate-related hazards. The elderly interviewees for the in-depth study reported the exposure to the effect of floods and typhoons with their houses damaged most especially by the typhoons that hit the area in 2009. Most senior citizens during the FGD focused on facilities that will make things easier for them like vehicles and communication equipments.

Women are also adversely affected by typhoons and flooding due greater demands on their traditional roles in the home, and the disruption in the gender division of labor both in the household, in the farm, as well as the community level. Biological factors such as childbearing and nursing also aggravate the effect of hazards on women.

Human and social sensitivity to hazards

The 12 municipalities comprising the study area in the province of Laguna are generally of three major human ecosystems: highland, lowland and coastal. Table 57 reflects the process of urbanization characterizing the generally coastal municipalities of Sta. Cruz, Los Baños, Pila, Victoria and Pagsanjan, with Sta. Cruz registering the highest population density at around 25 persons per hectare. With the exception of barangays in Victoria where majority of the residential areas are in barangays further from the shores, the population density is expected to be bigger in coastal barangays where houses tend to cluster together along or near the shores of Laguna de Bay. In many cases informal settlers cluster within public lands which may include those near irrigation canals. Poverty incidence are also found to be high in this municipalities.

The impacts of climate change-related hazards are the following: damage to agriculture and livestock; damage to houses, property, facilities, roads, bridges and other infrastructures; delay in the delivery of social services; isolation of barangays and other part of the province; siltation; reported cases of flood water borne diseases and other flood related diseases; loss of lives; infestation; and even brought issues and conflicts between and among municipalities.

Table 57. Population and Population Density per Municipality

Municipality	Total Area (ha)	Population	Population Density (P/ha)
Pila	3,120.00	54,812	17.57
Magdalena	3,708.90	21,761	5.87
Liliw	5,680.50	35,054	6.17
Bay	4,116.18	53,967	13.11
Pagsanjan	2,650.00	42,000	15.85
Nagcarlan	7,810.00	60,600	7.76
Calauan	7,458.00	61,437	8.24
Victoria	2,283.15	37,656	16.49
Sta.Cruz	3,860.00	105,992	27.46
Los Baños	5,650.00	103,956	18.40
Majayjay	nd	29,115	nd
Rizal	2,790.00	16,008	5.74

Source: Municipal level FGDs

Impact on Agriculture

As mentioned in the previous section, the agricultural sector is found to be highly sensitive to floods and typhoons, with climatic events and extreme weather conditions impinging on crop, livestock and poultry production, aside from the general welfare and wellbeing of the households. Aside from the mention of damage directly due to the floods and typhoons, the FGDs of both the agricultural sector and that of an upland community mentioned the destructive effect of periods of droughts occurring soon after. Strong typhoons brought flooding to coastal and low-lying areas in the province. Typhoon Ondoy left Php 200 Million worth of damage in agriculture as rice fields and vegetable crops were submerged in flood water. In 2009, TS Ondoy was followed by the three typhoons in the same year, affecting one whole cropping season of Palay. Some farmers tried to save their palay by harvesting them before the typhoon came, but their harvest was washed out by flood water. Livestock was also affected; there are incidences of pigs and ducks being washed out. If not washed out, those that survived the flood suffered from diseases, ducks suffered molting. Some duck raisers in the Municipality of Victoria closed their businesses.

Drought soon affected the agricultural sector in our barangay – (FGD, community constituents of Brgy. Ibabang Banga, Majayjay, Laguna)

Drought in 2009 after the typhoon affected one cropping season. Pests were terrible during the drought. Big worms affected our rice fields. – (FGD, MAFC of Victoria)

The same sensitivity is reflected in the statements of the respondents of the in-depth interviews.

We were into piggery business and planting vegetables, but we stopped after Typhoon Ondoy. All of our crops were and pigs were washed out. We haven't recovered yet from our lost. – Estelita Lancauon, 48, San Pablo Norte, Sta Cruz

Of course when a typhoon strikes, our fruit trees are greatly affected and so is our livelihood. – Marilyn Brosola, 34, Tranca, Bay

Extreme climatic condition affects the quality of our crops. - Catalina Plantilla, 52, Balimbing, Nagcarlan

During heavy rains, my crops are damaged; During droughts, my crops dies. – Romel Comendador,32, Tuy, Rizal

Some of our sow and piglets drowned and it was very hard for us to maintain the business especially when the flood water took 3 months before it ceased. – Filipina Chua, 40, Sto Angel Norte, Sta. Cruz

The variability in climatic conditions adds to the sensitivity of the farming sector. Decision-making is now reportedly more complicated since the traditional planting calendars for various crops are not applicable anymore. In stating some of the environmental constraints in the exercise of their technical assistance to farmers, a key informant interviewee has this to say:

> *We are sometimes blamed if the weather forecasting is wrong and the interventions are inapplicable. No planting calendar anymore for corn because there is no defined wet and dry season. For rain fed crops wala ng kasiguraduhan kung kelan uulan.* – (KII, Supervising Agriculturist; Corn focal person, Laguna – PAO)

Constant rains and subsequent floodings have resulted to siltation of rivers and streams in the province, including Laguna Lake. Some coastal barangays are flooded until now because the water from the lake already occupies some of their original residential and agricultural areas. One barangay in Sta Cruz can now only plant for two months (March to May) before the land will be occupied by water again.

Figure 24. This area used to be hectares of agricultural land; now it caters only to water lilies and *kang-kong* (Morning Glory).

Figure 25. Seen through the window of the barangay hall, the multipurpose hall on the left is now already submerged in water

During the FGD with the MAFC of Victoria, it was also mentioned that the agriculture is all the more made vulnerable by the character of the farmers. Mentioned specifically is the graying of the farming sector.

> *Most of the residents of Victoria go to abroad instead of continuing farming practices. Most farmers in the sector are old-aged residents. The youth are not into farming because they are too lazy to do it*. – (Mr. Jaime Sumilang, a 75-year old farmer-participant, FGD with MAFC, Victoria)

Some farmers who joined the FGD also expressed some apprehension about the national government's thrust in agriculture to reduce seeds and seedlings dispersal/subsidy programs in favor of hard infrastructure. While they still currently enjoy subsidies for agricultural production, they are concerned that these subsidies will not continue.

> *Farming is a difficult enterprise. Especially now that the focus of the government is hard infrastructure. They say we will not have free planting materials anymore from DA (Department of Agriculture). Maybe the LGU and the mayor's office will still continue with the duck dispersal* (FGD, MAFC, Victoria)

This is also corroborated by the KII with Laguna-PAO personnel who said that indeed, there is no more seed subsidy for the province from the national government as the Department of Agriculture is now focused on infrastructure development. The seed subsidy and free planting materials the farmers in the province are now enjoying is a provincial-level initiative.

The sensitivity of the agricultural sector is aggravated by the lack of a good database of farmers as well as the political dynamics in the province. As the Laguna-PAO interviewees expressed,

> *Many times we receive farmer complaints that they do not receive the assistance we provide for rehabilitation efforts after disasters. This is because many of them are not identified as affected. Many times together with those who are waiting for help are farmers who become farmers only during times when help is coming. Politics also play a role here because LGUs include in their master list names of those who should not receive any assistance*. – (KIIs, Laguna – PAO)

Climate change and local governance

This reference to the issues and concerns regarding local government politics is also somehow reflected in the statements of the NGO informants and a barangay official in Sta. Cruz.

> *Some barangays offered to redistribute the relief goods, asked RC to leave the relief goods and let them distribute it. Whatever happens to the goods is beyond our control when this occurs*. – (KII with Red Cross –Laguna Chapter)

> *Corrupt officials, I ask for 10Million to build the elementary school near the barangay hall because I know that the 5 million will automatically be corrupted. I know 5 million is enough but I thought of doubling the price so that our barangay can receive the whole of 5 million.* – (KII, Brgy Captain, Brgy San Pablo Norte, Sta. Cruz)

This sentiment is also from the local social welfare and development offices which are usually mandated to coordinate relief operations in their jurisdiction during disasters.

> *(We) ask Brgy Captains for the master list of affected residents, and some were included*

> *because they are related to the barangay officials, while deserving residents complain for not being included in the list…(While) there were citizens who kept on asking for relief goods, wants to be prioritized doing the proper procedures*. – (KII, MSWD, Rizal)

Human welfare and wellbeing

Generally, many of the limitations of and challenges faced by the population within the study site are reflected in the constraints mentioned by the key interviewees. A summary of these constraints is in Table 58.

Houses located at the Coast of Laguna Lake and other bodies of water were affected by typhoons, and were partially or completely damaged. Some areas suffered from four to six feet flood which lasted from four hours to three months. There had been cases of houses made out of temporary materials being washed away by floods. Damaged/ blocked bridges and roads contributed to the delay in the delivery of services to affected areas during disasters. Red Cross –Laguna Chapter shared that they needed to find another route to be able to give their relief goods to an isolated barangay in Calamba; the route took them longer to reach their destination. Also, the flood's current is too strong for rescuers and volunteers that they have to wait until it is passable. Barangay Ibabang Atingay suffers from isolation when hit by strong typhoons because the only foot bridge that connects them to the Poblacion is always washed away by strong water current.

Families living in flooded communities even until now have poor living conditions. Most of the houses in Brgy San Pablo Sur in the municipality of Sta. Cruz depend on public toilets which are now insufficient for the barangay's growing population. In addition, the community people have problems with regards to awareness on proper hygiene. The people in this area use the artesian well located at the same flood waters as a source of drinking water and other domestic uses.

Figure 26. Perennial flooding in Brgy San Pablo Sur, Sta. Cruz, Laguna

Due to prolonged flooding, residents of coastal barangays suffered from cough, flu, fever, athlete’s foot and leptospirosis. These diseases were common to evacuees and those who stayed in their unsecured houses. Many times, residents no other choice but to stay in their flooded homes to protect whatever material things they have.

There have been reported cases of drowning and victims of landslides during the typhoon in the province. In Victoria, two six year old children drowned, one was on his way to the evacuation center while the other one was mentally impaired. Typhoon Milenyo left fourteen casualties in Barangays Bagong Silang in Los Baños and five in Brgy Limao in Calauan due to landslide.

Students coming from flooded barangays experienced using boats for weeks just to attend their classes. While there are schools used as evacuation centers to shelter families greatly affected by flooding, thus suspending their classes on all levels. Evacuees sometimes steal school properties after evacuating in schools, books, notebooks, and school supplies are being stolen. Though there is a law (RA 10121) which prohibits the use of schools as evacuation centers, greatly affected municipalities have no other choice especially if there is no other appropriate and available area conducive for evacuation in their area.

The immediate concern of community constituents during floods and typhoons is the lives and safety of the household members. The statements of in-depth interview respondents reflect this concern.

> *We prioritized the safety of our family, making our business suffer from bankruptcy due to the flood.* – Elvira Sanggalang, 64, San Roque, Victoria

> *We experienced a 4 feet deep flood here in our house during the typhoon. I want my family to transfer to a safer place*. – Irene Roceo, 18, Ilayang Banga, Majayjay

> *We bought a rope worth 300.00 pesos to tie our house to the trees to prevent it from being washed out, but it wasn't effective.* – Marilyn Brosola, 34, Tranca, Bay

Those who are not engaged in agriculture are also affected by hazards. The effect of climate change-related weather disturbances on those who get their income from employment is also apparent. Either their job routine is disturbed in the short term by the events, or there is additional toll in terms of expenditures after the disasters.

> *I can't go to work especially if it's raining and only few visits the cockpit arena, my income is affected*. – Judelyn Evidente- Avarquez, 27, Burlungan, Magdalena

> *The problem here in our barangay is livelihood and employment. Money is a necessary in providing food for your family and rehabilitation during and after the disaster*. – Conrado Paynaganan, 51, Hanggang, Calauan

They are forced to be absent from work to help their family in rehabilitation or they get sick while doing repairs during the typhoon. Three to four feet deep flood water is a hindrance for families to transfer to another place. Their source of income is greatly affected leaving families without the means to acquire their needs (food, clean water, medicines, etc…)

Gender and climate change vulnerability

Gendered division of labor during and after disasters show overrepresentation of women. This is usually most apparent in agriculture and among informal settlers. In agriculture-based households, the in-depth interviews indicated that although husbands and sons also tend to contribute more work in production, harvesting and marketing activities as a result of climate-related hazards and disasters, the same was reflected for women. Marketing of whatever salvaged products in many cases become more of the burden of women members in the household in the aftermath of disasters since the males are expected to contribute to the rebuilding of damaged infrastructures both at the community and the household level. On top of this additional workload within the production sphere, non-productive work such as household chores and many care-giving tasks, such as caring for the children, sick, elderly, the home and assets increases for women, but not so much for men.

There is also a predominance of women in some agriculture sub-sectors adversely affected by typhoons and flooding. The FGD with the agriculture sector, for instance, surfaced that most of the beneficiaries of the local government's program on small-scale duck-raising in the municipality of Victoria are women. The duck-raising industry was identified as one of the subsectors most sensitive to typhoons and flooding. In many cases, duck-raising becomes less viable during as well as immediately after typhoons and floods. Factors contributory to this include: 1) decrease in number of ducks raised due to mortality caused by hazards; 2) cost of production increases due to difficulty to access snail shells from the lake, traditionally a major source of food for ducks; duck raisers often has to resort to commercial feeds which are costly; 3) egg laying of ducks, and thus egg production decreases during and right after occurrences of flooding and typhoons; and, 4) price of eggs tend to go down after typhoons and floods.

It was observed in the FGD that women focused on the effects of disasters at the household level: how they were not able to wash their clothes, and iron them because of power outages. At the community level, they are also very particular to services and resources that should be present in a barangay health center, because these health centers often provide services to pregnant women and children.

Migration and climate change

Local and international out-migration is very evident in vulnerable areas. Majority of the respondents for the in-depth interview have out migrants in their community. This is due to the lack of livelihood opportunities in their area, such that family members tend to look for jobs outside their community. Aside from the lack of livelihood opportunities, high-paying jobs are most of the time located outside their municipality. Some families depend on remittances provided by relatives working abroad. Daughters and sons of farmers tend to migrate abroad rather than stay in their homeland and help their parents.

“Do you know what our barangay needs? (It’s) Livelihood opportunities for the unemployed, how can we prepare for coming typhoons if we don’t have the means to buy food?” - Conrado Paynaganan, 51, Brgy. Hanggan,Calauan, Laguna

Table 58. KII, Summary of Constraints

Municipality / Office	Constraints			
	Personal Choices	**Structural Constraints**	**Environmental / Ecological factors**	**Economic Consideration**
PAO (3)	• *Some legitimate farmers complain that they do not Inirereklamo ng mga magsasakang hindi nakakatanggap ng tulong dahil hindi na-identify na affected*. *Naghihintay din ng tulong ang mga "farmers na nagiging magsasaka lang kapag may dadating na biyaya"* • *Napopolitika pati ang tulong dahil may mga isinasama sa master list na hindi naman dapat nakakatanggap.*		• Blamed if the weather forecasting and the interventions are wrong / inapplicable. • No planting calendar anymore for corn because there is no defined wet and dry season. • *For rainfed crops, wala ng kasiguraduhan kung kelan uulan.*	• There's no seed subsidy for the province, DA focused on hard Infra.
Laguna- Red Cross (2)	• Some barangays offered to redistribute the relief goods, asked RC to leave the relief goods and let them distribute it. Whatever happens to the goods is beyond our control when this occurs.	• Bridge in Calamba was damaged causing them to find an alternative route to distribute relief goods and provide other services • Some roads are blocked by uprooted trees		

Table 58. KII, Summary of Constraints *(cont'd)*

Municipality / Office	Constraints			
	Personal Choices	**Structural Constraints**	**Environmental / Ecological factors**	**Economic Consideration**
Sta Cruz (3)	• *Hindi nadating ang mga residente kapag alam na walang matatanggap na biyaya sa mga meetings.* • Informal Settlers • *Corrupt officials, humingi ako ng 10Million para sa aming elementary school na malapit sa barangay hall dahil alam ko na yung 5 million ay automatic na sa bulsa nila. Alam kong tama na ang 5 million kaso naisip ko doblehin para naman matanggap ng barangay naming ang buong 5 million*	• No flood mitigating facilities/ infrastructure in the barangay. • No efficient early warning device for the barangay. • *Hindi malagyan ng bubong ang coast na maari sanang maging evacuation center kapag mababa lang ang baha.*	• Laguna lake is polluted	• Budget to implement programs/ projects for the barangay from medical equipments to rescue/ flood mitigation to livelihood and education.
Magdalena (2)		• A need to reconstruct and add farm to market roads. • *Gusto niyang malaman kung may epekto ba sa kanila yung pag lalabas ng tubig ng Botocan Powerplant kasi malaking portion yung nakakin ng tubig pag lumalakas yung current. May mga barangays na n-iisolate dahil sa pagtaas ng tubig, yung temporary foot bridges nila nasisira.*		• Needs a lot of money to reconstruct the damaged bridges and to construct new ones to prevent the isolation barangay during disasters. • *Dahil sa revenue cut may mga projects silang hindi magawa kasi kailangan ng malaking pondo.*

Table 58. KII, Summary of Constraints *(cont'd)*

Municipality / Office	Constraints			
	Personal Choices	Structural Constraints	Environmental / Ecological factors	Economic Consideration
Victoria (4)	• People don't like to evacuate even if houses are inundated. • Politics- problems with regards to identifying beneficiaries so they resort to stub sys. • "bulong brigade"- *hindi naitutuloy yung mga magagandang activities/ opportunities na dumadating sa barangay dahil nabubulungan yung mga nanunungkulan at pinapalitan yung mga heads ng committee/ organization hanggang sa nadidisolve na yung project dahil sa mismanagement.* • *Uma-attend lang yung ibang farmers kapag alam na may matatanggap na fertilizer o binhi sa meeting. Kapag wala, kaaunti lang ang na-attend. Minsan hindi maka chorum.* • Staffs that are politically appointed should have a background on the field (Social services, welfare, etc...) and not because they are relatives of politicians. • Political influences • Poverty • Some residents are illiterate, making them hard to implement their projects (*mahirap paliwangan, minsan mas magaling pa sa kanila)*	• Logistics- financial and materials are short for demand	• Nangingitim ang palay dahil nabasa	• Mababang presyo ng palay dahil nabasa, Php 10 /kg is too low • Php 13.00/kg is average, while Php 15.00/kg is a good price for the farmers. • Mababa ang presyo ng live weight na baboy dahil mataas ang supply pero mababa ang demand. • Mababang presyo para sa itlog ng itik, Php 6.40-6.50 – good. • Php 5.50 for medium sized eggs and Php 4.00 for rejects. • Presence of "asoreros" who provides financial assistance/ loans (ex. A farmer loans Php 10,000, he needs to pay the amount + the interest + certain amount of cavans of palay. • *Hindi lahat ng nalo-loan ng mga farmers ay nagagamit sa agriculture, minsan yung iba nagagamit sa pang gastos sa bahay.* • Masyadong mababa ang IRA ng barangays para masuportahan ang mga kagamitan para sa peace and order.

Table 58. KII, Summary of Constraints *(cont'd)*

Municipality / Office	**Constraints**			
	Personal Choices	**Structural Constraints**	**Environmental / Ecological factors**	**Economic Consideration**
Rizal (4)	• Asks Brgy Captains for the master list of affected residents, some were included because they are related to the barangay officials, while deserving residents complain for not being included in the list. • There were citizens who kept on asking for relief goods, wants to be prioritized doing the proper procedures. • A significant portion (20%) of women's pop. Suffers from breast cancer- needs medical assistance and equipment.	• Repair and extend Farm to market roads. • Develop spring water tanks • Implementation of Waste segregation at the barangay level • No beneficiary for 4Ps because indigents have concrete houses, can afford cheap community water service (Php 20-30.00 /month), and having a small population.		• Financial support from DSWD, provincial and national. • Municipalities near the coast were prioritized before providing assistance to municipalities located in the highlands. This causes a delay in the distribution of relief goods, aids, and materials.

Social capital and climate change

Upon discussion of their networks and interaction in relation to their coping with the challenges of climate change and disasters, the participants mentioned help and assistance ranging from immediate families to the municipal government as well as NGOs and the academe (Table 59).

The structural social capital of the participants in the FGDs show that their bonding social capital, referring to the networks and relationships within an organization or group is high. The participants have strong family ties enabling them to source funds and other necessary material things to help them recover from the devastation of storms and the ensuring floods. Friends and neighbors, aside from relatives, tend to form the close-knit social network that facilitates immediate coping.

Their bridging social capital, on the other hand, provides for some of them the opportunities for them to interact with other organizations. This is relatively strong for women and the elderly who form sectoral organizations to facilitate their access to various material and technical assistance during and after disasters. This is also true for the farmers who actively participate and join the local farmers association and the barangay agriculture and fisheries committee (BAFC). Being members of the local BAFCs enable them to easily access information, resources and assistance emanating from the national and municipal governments. Women in more difficult economic and social circumstances tend to have lower bridges since they are limited from pursuing these relationships by their need to work or stay at home to tend to the household.

The links of the participants is lowest among the three components.

Table 59. Social Capital: Bonds, Bridges and Linkages

Women FGD **KLBL** **Los Baños**	**Elderly FGD** **LBSCFI** **Los Baños**	**Agriculture FGD** **MAFC, BAFC, MAO** **Victoria**	**Coastal Barangay FGD** Brgy. San Pablo Norte	**Youth FGD** **Laguna –wide representation**	**Highland Barangay FGD** Brgy Ibabang Banga, Majayjay
1. Working members of the family (locally or in abroad) 2. Friends and neighbors 3. Credit Cooperatives 4. Local Government 5. Municipal Government 6. Others organizations in the Barangay (Senior Citizens and Youth) 7. NGOs / POs 8. Universities/ Academe	1. Children working locally or in abroad) 2. Friends, relatives, and neighbors 3. IRA 4. Credit Cooperatives 5. Local Government 6. Others organizations in the Barangay (Youth, Women, and Men) 7. Municipal Government 8. NGOs / POs 9. Universities/ Academe	1. Working members of the family (locally or in abroad) 2. Relatives 3. Friends and neighbors 4. Credit Cooperatives 5. Municipal Government 6. NGOs / POs 7. Universities/ Academe	1. Working members of the family (in homeland or in abroad) 2. Relatives 3. Friends and neighbors 4. Credit from 5/6 sources 5. Credit cooperatives 6. Local Government 7. Municipal Government 8. NGOs / POs	1. Parents/ Siblings working abroad 2. Friends and neighbors 3. Universities/ Academe 4. Youth Organizations 5. Church-based Organizations 6. Local Government 7. Municipal Government 8. NGOs / POs	1. Working members of the family (in homeland or in abroad) 2. Friends and neighbors 3. Credit cooperatives 4. Local Government 5. Municipal Government 6. NGOs /POs

*Note: 1 being highly accessible and prioritized and 9 being the least.

Adaptive capacity towards climate change

Since the agricultural sector is the most vulnerable among the sectors affected, the Provincial Agriculture Office provides pre and post disaster programs. These projects are the following (1) Farmer's Field School on Palay Check, Techno Cinics, and Techno Updates where they introduce new technology for rice production, conducts lectures and seminars. Municipalities of Famy, Mabitac, Siniloan, and Sta. Maria were some of their participants in their seminar on flood tolerant crops and rice varieties. They also provide foundation seeds during these seminars; (2) Binhi Loan Assistance to reduce the effects of removing the seed subsidy of the national government; (3) Special livelihood office that teaches farmers alternative livelihood activities like bag making (using water lilies), dress making, manicure, etc… (4) Requests barangays for vulnerability maps with identified rescue equipments, early warning devices, and possible evacuation areas for DRR; (5) Action Rehabilitation Plan for those affected by Milenyo, distributed alternate crops like mango, corn and veg. seeds; (6) Loan Assistance for vegetable farmers for two years with two percent interest; and (7) Provided flat bed driers, irrigation pumps, rice mills, and shallow tube well with the help of the provincial and national government. The Municipal Agriculture Officer of Victoria regularly meets with MAFC and BAFC, to talk about the farmers' problems and other concerns. The provincial government also made use of its calamity fund to support and help affected sectors to cope with post disaster damages.

The municipality of Rizal implemented an ordinance that requires the participation of youth in their flood and landslide mitigation projects. For every graduating student, he or she should plant at least one tree. The municipality has been very active in their greening program in Tayak Hill. In connection of the Takay Hill rehabilitation, a cash for work project was conducted to repair the road to Tayak Hill. They also started on bamboo propagation in their municipality. The municipality of Magdalena plans on repairing and constructing new bridges to prevent the isolation of some of their barangays and to utilize their agricultural areas through farm market roads.

Red Cross-Laguna Chapter provides pre disaster training courses/ seminars and education on proper hand washing. They visit schools and seminars to teach and act as resource speakers; they also create vulnerability maps of barangays. For the Red Cross Youth, they continuously recruit youth volunteers throughout the province and conduct leadership development. During disasters, together with their youth volunteers, they respond to the needs of disaster victims by providing relief goods, counseling (for those who were traumatized), and medical assistance. They also have housing projects for families whose house were completely damaged and livelihood assistance for post disaster rehabilitation.

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 undated areas. In Victoria, they have placed 20 units in Brgy Masapang and 42 in Brgy. San Benito and another 30 units will be added. In Rizal, Barangay Nutrition Scholar (BNS) and Barangay Health Workers (BHWs) were also part of a training on Disaster preparedness. Supplementary feeding

At the barangay level, flood prone barangays conducts regular clean-ups to prevent clogging of canals and strict implementation of the waste segregation. In Victoria, a youth shared that their municipality have an annual contest on the cleanest barangay to encourage residents to clean their surroundings. During disasters, the use the barangay patrol to warn the resident of the rising water level. To solve the problem on the lack of medicine in their barangay, the barangay captain of San Pablo Norte suggested to plant medicinal plants beside the health center.

To be able to adapt to climate change, respondents of the in-depth interview have reinforced while other are planning to reinforce their houses; one even plans in adding another floor to his house. Since some of them have experienced evacuating, they are now preparing means for evacuation. Declogging and the implementation of proper solid waste management at the household level were considered by some to prevent clogged canals which contribute to flooding in their area. A minority of them planted wind break/ fence trees, diversified their agricultural activities, and took part in training courses regarding disaster risk reduction and emergency response.

The common assistance given during and after hazards were financial support, food aid, and distribution of building materials for families whose house was completely damaged. Also, there have been distributions of rescue materials, clothes and conduct of training courses in disaster preparedness. This support came from both the national and municipal government.

Other organizations help by volunteering in rescue and relief operations like Red Cross. Others focus on providing financial assistance and housing materials like Kilusan sa Laguna provides financial assistance to farmers and Self-Employment Assistance-Kaunlaran (SEA-K) which focuses on the national program for housing. Oxfam provides technical assistance especially to vulnerable barangays; they provide hazard maps and livelihood assistance for affected families.

Faces of Vulnerability: Selected Cases

Eleven cases were chosen from the 30 in-depth interviews conducted. The cases highlight the vulnerabilities of various types of households with members belonging to at least one identified vulnerable sector: women-headed HHs, upland agriculture, lowland agriculture, informal settlers and the elderly (Annex 1).

CHAPTER 7

Economic Analysis of Adaptation Options for Flooding

Why is there a need for the economic analysis of adaptation projects? Economics provides a framework by which one can assess the feasibility of a project considering the whole society's point of view. It is different from financial analysis where the only concern is whether the project is profitable from the perspective of an investor or even from fiscal analysis where the consideration is the impact of the project only on the budget of the government. Economics lends a broader picture, for which one can have a transparent decision making. It is deemed that a project is worthwhile doing only if it promotes the welfare of the society as a whole. If the project is found to be welfare improving, the implementation of the project ensures the efficient allocation of resources. With limited financial and human resources to implement climate change adaptation measures, there is a need to increase capacities of local government units (LGU) in incorporating the most appropriate, cost-effective and socially acceptable climate change adaptation measures in development planning and implementation.

In this research, benefit-cost and cost-effectiveness analyses of selected adaptation projects were undertaken. The selection of adaptation options was done in a participatory manner, through consultations with various levels of the local government as well as experts in the academe.

It is intended that the output of this research will be used in assisting the local government in crafting an adaptation project proposal for submission to various funding agencies. This ensures that the findings of this scientific research will actually be utilized for policy making. Hence research is made relevant, not just in contributing to the body of knowledge but also by having a direct impact on the community.

For this study, we narrowed down our focus on flooding hazards. Flooding imposes the highest risk in terms of the severity and extent of impacts in our study site. Our study site covers Sta. Cruz River Watershed, the watershed that was found to have the highest vulnerability as well as the highest estimated peak run-off based on our GIS model. Specifically, three sets of analysis were undertaken which were taken as independent of each other. The first is concerned with direct flood damage cost estimation for the whole Sta. Cruz River Watershed covering the municipalities of Victoria, Pila, Sta. Cruz, Calauan and Pagsanjan. The second looks into a project that can be implemented in the lakeshore municipalities of the Sta. Cruz River watershed, namely Victoria, Pila and Sta. Cruz. Under this, a Technology-Based Early Warning System Project was considered for benefit-cost analysis. The third is a case study focusing on selected lakeshore barangays of the municipality of Sta. Cruz which experiences long-term inundation. For the case study, cost-effectiveness analysis was undertaken to assess the following options: Relocation, Evacuation and Building Modification.

Project Objectives

For the second year, the research activities undertaken were meant to contribute toward achieving the following project objectives:

1. Document and assess economic viability of selected adaptation options adopted by households in the study sites;
2. Design collective adaptation options for selected localities in the study sites and undertake economic analysis of these options using Benefit Cost Analysis (BCA), Cost Effectiveness Analysis (CEA) or Multi-Criteria Analysis (MCA); and
3. Formulate policy recommendations to enhance local capacity to adapt to climate change for the province of Laguna.

It was noted at the onset that local responses to climate hazards may already exist in the areas. Questions loom, however, as to whether these responses are the most appropriate and effective to reduce (or eliminate) the negative impact of climate change on the communities—their lives, livelihood, and properties. The analyses done were meant to provide basis for identifying and recommending policies that would facilitate the development, dissemination and adoption of appropriate and effective climate change adaptation strategies that will enhance resiliency against flooding in the study site.

Research Objectives

The general objective of the study was to identify suitable adaptation projects for flooding along the lakeshore municipalities of the Sta. Cruz River watershed that meet the criterion of economic efficiency. The specific objectives are:

1. To generate flood inundation maps for the Sta. Cruz River watershed.
2. To estimate typical direct flood damage cost for the Sta. Cruz River watershed.
3. To identify feasible adaptation options that can address the problem of flooding in the lakeshore municipalities of the Sta. Cruz River watershed.
4. To identify, quantify and monetize, wherever possible, the benefits and costs of the identified flood adaptation projects.

5. To make recommendations as to which projects are suitable for the study site.

Research Questions

1. Which areas along the Sta. Cruz River watershed are expected to be flooded in the future?
2. What is the value of flood damages along the lakeshore municipalities of the Sta. Cruz River watershed?
3. Using the Contingent Valuation Method (CVM), what is the estimated maximum willingness to pay of households along the lakeshore municipalities of the Sta. Cruz River watershed for a technology-based early warning system?
4. What are the costs associated with the implementation of a technology-based early warning system?
5. Is the technology-based early warning system a good project?
6. Which among the following options are the most cost-effective: Relocation, Evacuation, or Building Modification?

RESULTS AND DISCUSSIONS

Study Site Description

Sta. Cruz is the capital of the province of Laguna and has a land area of 3,860 hectares comprising of 29 barangays. The topography is level or nearly level with slope ranging from 0 to 2.5%. In 2010, the estimated population is about 127,320 or about 26,150 households. Although, Sta. Cruz serves as the commercial and service hub of eastern Laguna, the municipality is still dependent on agriculture, with rice, coconut and vegetables as the main crops. All of Sta. Cruz is considered urban.

Pila is similar in size and topography to Sta. Cruz. The total land area covers 3,120 hectares with 17 barangays. Majority (67%) of the population are considered rural. The estimated population in 2010 is 51,300 with about 10,260 households. The municipality is considered agriculture based. Major crops include rice, coconut and fruit trees.

The municipality of Victoria has a total land area of 2,235 hectares covering 9 barangays. Population as of 2010 is estimated to be 34,600 or about 6,900 households. Out of the 9 barangays, only 2 are considered urban. The major contributor to the economy is the agricultural sector. The municipality is well known for duck-raising.

Three types of flood occur in these lakeshore municipalities: (1) rapid-onset which is characterized by a quick rise in water levels but flood also quickly dissipates; (2) slow-onset which involves gradual increase in the water level but inundation lasts over a long period; and (3) flash floods which occur within minutes or hours after a typhoon or heavy rainfall. These floods bring about huge economic losses in terms of damages to property, income losses, morbidity and mortality.

Flood water in the area comes from upland run-offs as well as rising water levels in Laguna de Bay (Laguna Lake). However, the major flood contributor in the area is the Laguna de Bay. Laguna de Bay is the largest lake in the Philippines with a surface area of 900 km^2. More than 100 streams feed into the lake but it has only one outlet, the Pasig River, which drains out to Manila de Bay. It serves as the catch basin for the provinces of Laguna, Rizal, Batangas, Cavite, Quezon, and some parts of the National Capital Region. However, its water holding capacity has been declining over the years due to siltation. Its depth now only averages about 2.5 meters, a substantial decline from its maximum observed depth of 10 meters (LLDA). Figure 27 shows the study site in reference to the Laguna de Bay.

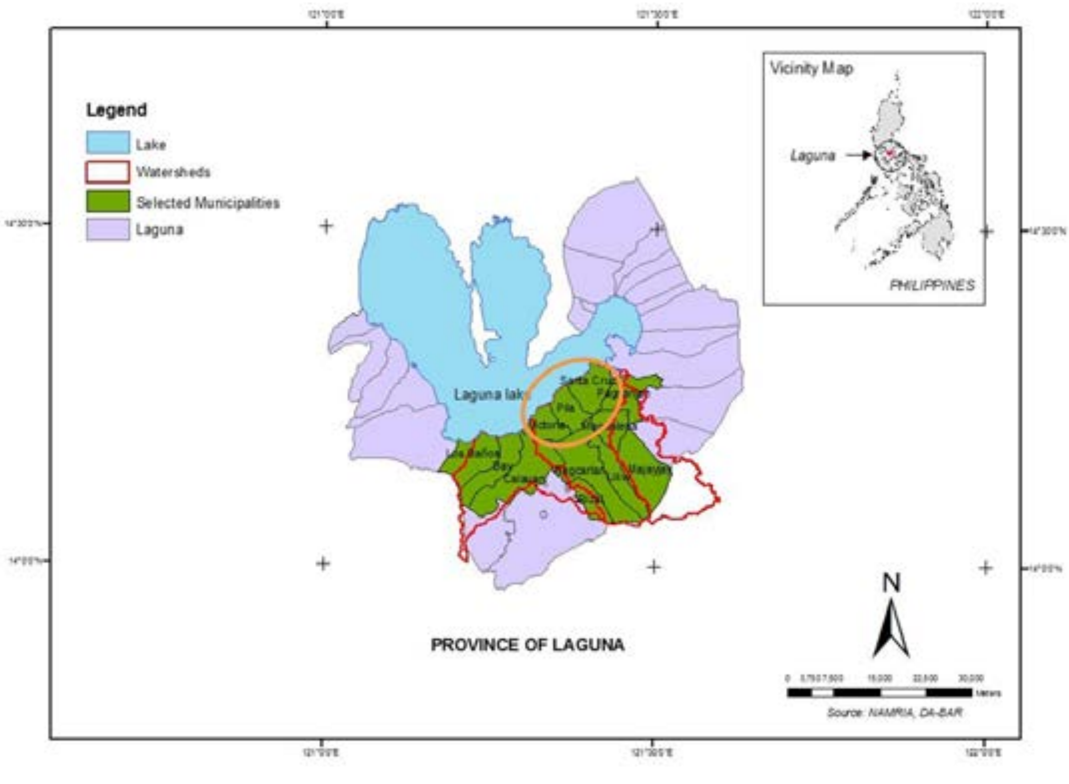


Figure 27. Locale of the Study

Household Survey Respondents' Profile

The composition of respondents according to sex, position in the family, marital status and primary occupation are summarized in Table 60. About 64% are female and majority (76%) is married. In terms of occupation, about 28% are housewives, 21% are small business owners, and 17% are laborers or unskilled workers. Eighty seven percent are the heads of the family or their spouses.

Table 60. Composition of Respondents based on Sex, Civil Status, Position in the Family, and Primary Occupation

Indicator	Frequency	%
Sex		
Male	180	36
Female	320	64
Civil Status		
Single	27	5
Married	379	76
Widowed	61	12
Divorced/Separated	13	3
Common law	14	3
Unknown	6	1
Position in Family		
Head	236	47
Wife/Spouse	198	40
Son/Daughter	27	5
Son-in-law/Daughter-in-law	11	2
Grandson/Granddaughter	1	0
Father/Mother	8	2
Other	19	4
Primary Occupation		
Farmer	13	3
Farm worker/laborer	12	2
Fisherman/Fish pen owner	6	1
Animal/livestock raiser	13	3
Small business owner	105	21
Unskilled labor, vendor, pedicab driver	85	17
Skilled laborer	34	7
Government employee, LGU	14	3
OFW	3	1
Student	3	1
Housewife	141	28
Office Staff	2	0
Professional	4	1
Pensioner	14	3
Unknown/Others	51	10

Majority (60%) of the households source their livelihood mainly from employment in the services sector. Twenty-seven percent are engaged in small non-agriculture related business, while 12% are agriculture based (Table 61).

Table 61. Composition of Respondents based on Main Source of Livelihood

Household's Main Source of Livelihood	Frequency	%
Farming	36	7
Livestock/Poultry	26	5
Small Business	135	27
Services Sector	301	60

The mean age of the respondents is 48, while the mean years of schooling is 9. The average individual income is Php 5,125 per month, while the mean monthly income of the whole household is Php 17,000. The average household size is 5 (Table 62). Female respondents have a significantly lower mean individual income compared to male respondents. The difference is as much as Php 5,000 per month. For the whole household, the mean income is also lower for female respondents by as much as Php 2,000.

Table 62. Summary of Respondents Characteristics

Indicator	All	Male	Female
Mean Age	48	50	46
Mean Years of Schooling	9	8.99	9.37
Mean Income	5,125	8,356	3,308
Mean HH Income	17,000	18,321	16,263
Mean HH Size	5	5	5

Thirty six percent of the respondents have lived in the same house since birth with average residency of about 28 years while the rest (64%) are transferees/migrants (Table 63).

Table 63. Composition of Households based on Previous Residence

Previous Residence	Frequency	%
Same house	180	36
Same barangay	145	29
Another barangay	64	12.8
Another municipality	38	7.6
Another province	58	11.6
Others	15	3
Total	**500**	**100**

About 3% of respondents claimed that the reason why they transferred to their current house is due to flooding in their previous residence. About 3%

expressed intent to transfer to another house in the future because of flooding in their current home (Table 64).

Table 64. Incidence of Flood-Related Migration

Indicator	Frequency	%
Moved because of flood	14	2.8
Plans to move because of flood	15	3

The average size of the ground floor of the houses is 80 square meters (Table 65) and most houses are built as single-level detached structures. As such high floods pose a threat to the safety of its occupants. Structural-wise, majority of the houses are well-built comprising of permanent roofing and walls. Majority (77%) own their houses, 5% are renting, while 13% are occupying the house with the owner's consent (Table 66).

Table 65. Selected Housing Indicators

	Mean	Standard Deviation
Years in Residence	28	20
Size of Ground Floor	80	9

Table 66. Composition of Households based on Selected Housing Indicators

Indicator	Frequency	%
Ownership		
Owned	385	77
Rented	26	5
Occupied with consent	65	13
Occupied without consent	4	1
Others	18	4
House Type		
Single-detached	453	91
Duplex	43	9
Others	3	1
Number of Floors		
1 floor	374	75
2 floors	122	24
3 floors	2	0
4 floors	1	0
Type of roofing		
Permanent materials	369	74
Light materials	34	7
Mixed but predominantly permanent	73	15
Mixed but predominantly light	24	5
Type of wall		
Permanent materials	324	65
Light materials	54	11
Mixed but predominantly permanent	92	18
Mixed but predominantly light	28	6

In terms of flood exposure, the mean number of flood events that respondents have experienced over the last 10 years is 5. An average of three flood events inundated their homes over the same period. The mean highest flood height is 1 foot, while the mean longest duration of the flood is 16 days (Table 67). Fifteen percent experienced knee-deep flood (about 1-2 feet), 9% waist-deep (3 feet), 5% about neck-deep (4 feet) and 6% above the head (5 feet and above) (Table 68). In terms of duration, 21% reported experiencing long term flooding which corresponds to at least a month of inundation (Table 69).

Table 67. Flood Exposure Indicators

Flood Exposure	Mean	S.D.
Frequency of floods in the last 10 years	5	13
Frequency of floods inside house in the last 10 years	3	9
Highest flood height in ft	1	2
Longest duration of flood in days	16	34

Table 68. Composition of Households based on Reported Maximum Flood Height Inside their House

Flood Height	Frequency	%
0	250	50
1 ft	42	8
2 ft	34	7
3 ft	43	9
4 ft	27	5
5 ft	15	3
6 ft	8	2
>6 ft	6	1
Total	**250**	**50**

Table 69. Composition of Households based on Reported Longest Duration of Flood Inside their House

Duration	Frequency	%
<1 day	246	49
1 day	108	22
1 week	39	8
1 month	24	5
2 months	29	6
3 months	41	8
4 months	7	1
5 months	3	1

In order to gauge the respondents' perception towards flooding risk and impacts, several attitudinal questions were asked. To determine their perceived risk of flooding, they are asked how frequent they think they would experience flood inundation in the future. Majority (47%) believes that they face a risk of flooding that occurs once every 5 years, while 36% believes that they face no risk at all. About 4% thinks that they face a very small risk which corresponds to a flood that occurs once in 50-100 years while 6% feels that they are exposed to floods that occur every 10-25 years (Table 70).

Table 70. Composition of Households based on Perceived Risk of Flooding

Perceived risk of flooding	Male	%	Female	%	Total	%
once in 5 years	92	51	144	45	236	47
once in 10 years	8	4	16	5	24	5
once in 20 years	2	1	3	1	5	1
once in 25 years	2	1	2	1	4	1
once in 50 years	1	1	0	-	1	0
once in 100 years	7	4	14	4	21	4
Never	56	31	122	38	178	36
Don’t know	12	7	19	6	31	6
Total	**180**		**320**		**500**	

In terms of risk acceptability, majority (77%) believes that some degree of flood risk is acceptable because floods cannot be avoided, while 23% believes that no amount of flooding is acceptable (Table 71). The distribution is the same regardless of whether the respondent is male or female.

Attitudes toward risk acceptability can provide insights as to the type of interventions that would be acceptable to the respondents. For those who do not want to accept any flood risk, it might be appropriate to recommend options that totally mitigate the flood, or even propose relocation. But since majority thinks that some degree of flood risk is acceptable, then the early warning system and the fixed evacuation center options may be deemed as sufficient.

Table 71. Composition of Households based on Perceived Risk Acceptability

Risk Acceptability	Frequency	%	Male	%	Female	%
Any type of flooding is unacceptable	115	23	41	23	74	23
Floods are unavoidable, hence we just have to learn to live with it	378	77	134	77	244	77

The consequences of flooding on the emotional and mental wellbeing of affected households are seldom included in the valuation of flood impacts. The main reason is because it is difficult to monetize. However, these impacts should not be disregarded as these may prove to be very significant. Hence, to get a small glimpse of the psychological impacts of the hazard, respondents who have experienced flood inundation in the past were asked to rate the severity of their worry about future floods and how they think they would be affected emotionally by the hazard. It is apparent that the psychological stress is quite significant as majority (76%) of the respondents rated their worry as 5, which is the highest rate in the scale. It was also observed that a slightly higher percentage of male respondents rated their worry as 5, more than females. As for the perceived impact on emotional well-being, about 70% of those who were asked gave a rating of 4 to 5. This proportion is about the same for male and female respondents (Table 72).

Table 72. Composition of Households based on Perceived Severity of Impacts and Worry about Floods

Indicator/Rate	Frequency	%	Male	%	Female	%
Worry about flooding						
Rate 1 (lowest)	5	2	0	-	5	3
2	9	3	2	2	7	4
3	29	9	10	8	19	10
4	32	10	12	10	20	10
5 (highest)	238	76	94	80	144	74
	313		118		195	
Perceived impact of future floods on emotional wellbeing						
Rate 1 (lowest)	21	7	9	8	12	6
2	30	10	8	7	22	11
3	48	15	22	19	26	13
4	60	19	21	18	39	20
5 (highest)	154	49	58	49	96	49
	313		118		195	

Flood Inundation Simulation and Direct Flood Damage Cost Estimates

Flood Inundation

This section discusses the results of our simulation of flood inundation in the study site for various return periods, which include 1 in 2 years, 1 in 15 years, 1 in 25 years and 1 in 50 years. Specifically, we predicted the total area that will be inundated by at least 4 feet (neck-level), 2.5-3.9 feet (waist to neck), and 2-2.4 feet (knee-level). In the Sta. Cruz River watershed, which covers the municipalities of Victoria, Pila, Sta. Cruz, Calauan and Pagsanjan, the total area of land classified as built-up is about 1,170 hectares (excluding Pagsanjan because of the absence of data), while rice lands cover about 7,769 hectares.

In Table 73, it is shown that a flood return period of 1 in 2 years will inundate about 146.8 hectares (13% of total built-up lands) of built-up lands in the study site. A return period of 1 in 15 years on the other hand, will result in the inundation of about 309.5 hectares (26%). Flooding increases further to 375.1 hectares (32%) for a return period of 1 in 25 years, and 506.4 hectares (43%) for a 1 in 50 years flood. Majority of these flooded areas are situated in municipality of Sta. Cruz and Victoria.

Table 73. Area of Built-up Lands Predicted to be Inundated by Floods (ha)

		Area of Built-up Lands Predicted to be Inundated by Floods (ha)				
Return Period	**Flood Depth (ft)**	**Victoria**	**Pila**	**Sta. Cruz**	**Calauan**	**Total**
1 in 2 years	4 and above	-	-	-	-	-
	2.5-3.9	-	-	9.2	-	9.2
	2-2.4	65.9	0.0	71.1	0.5	137.5
	All	65.9	0.0	80.3	0.5	146.8
1 in 15 years	4 and above	-	-	9.2	-	9.2
	2.5-3.9	-	0.0	60.9	0.5	61.5
	2-2.4	69.1	3.6	162.7	3.4	238.8
	All	69.1	3.6	232.9	3.9	309.5
1 in 25 years	4 and above	-	0.0	29.9	0.2	30.0
	2.5-3.9	1.1	1.2	94.9	1.5	98.6
	2-2.4	71.4	4.4	166.0	4.8	246.5
	All	72.4	5.6	290.7	6.4	375.1
1 in 50 years	4 and above	-	0.0	71.1	0.5	71.6
	2.5-3.9	3.2	3.6	162.7	3.4	172.9
	2-2.4	75.8	6.1	172.5	7.5	261.9
	All	79.1	9.7	406.2	11.4	506.4
Total Built-up Area (ha)		125.0	59.3	836.8	149.6	1,170.7

* No data for Pagsanjan

It can be seen in Figure 28 that the coverage or the percentage of total built-up lands flooded is highest for Victoria (53%-63%), followed by Sta. Cruz (10%-49%), Pila (0 -16%) and Calauan (0-8%).

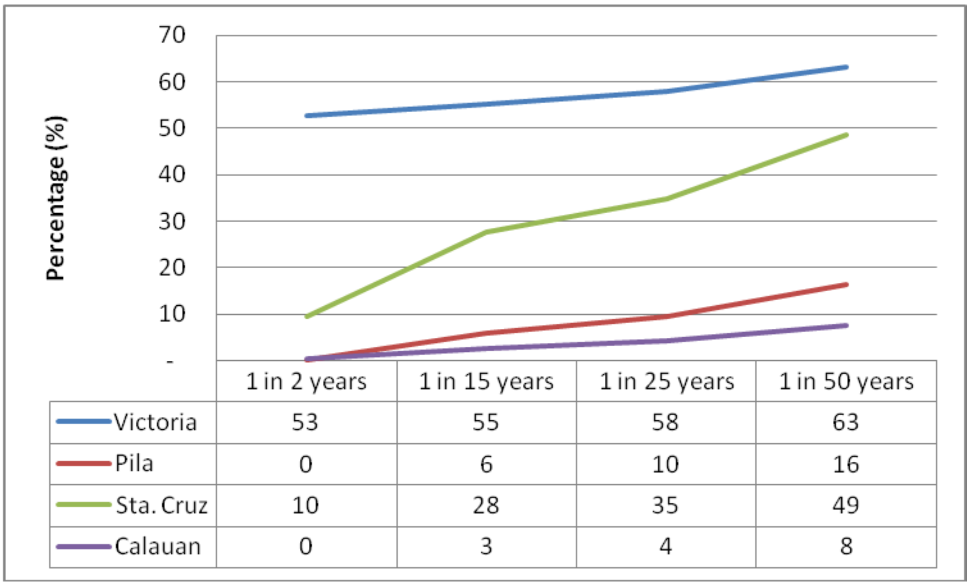


Figure 28. Percentage of Built-up Lands Predicted to be Inundated by Floods

For rice lands, the predicted area that will be inundated is about 674 hectares for a 1 in 2 years flood, 1,952 hectares for a 1 in 15 years flood, 2,157 hectares for a 1 in 25 years flood, and 2,566 hectares for a 1 in 50 years flood (Table 74). Maps showing these scenarios are found in Annex Figures 20 to 23. In terms of coverage, the highest percentage of rice lands predicted to be inundated is in Sta. Cruz (11%-47%), followed by Victoria (15%-45%), and last by Pila (4%-26%) (Figure 29).

Table 74. Area of Rice Lands Predicted to be Submerged by at least 2.5 feet of Water (ha)

	Area of Rice Lands Submerged by at least 2.5 feet (ha)			
Return Period	**Victoria**	**Pila**	**Sta. Cruz**	**Total**
1 in 2 years	338.4	89.3	246.3	673.9
1 in 15 years	689.7	391.6	870.9	1,952.2
1 in 25 years	791.6	448.5	916.5	2,156.6
1 in 50 years	995.4	562.4	1,007.7	2,565.5
Total Area of Rice Lands	2,207.4	2,193.3	2,146.3	6,547.0

* No rice lands are predicted to be inundated in Pagsanjan and Calauan

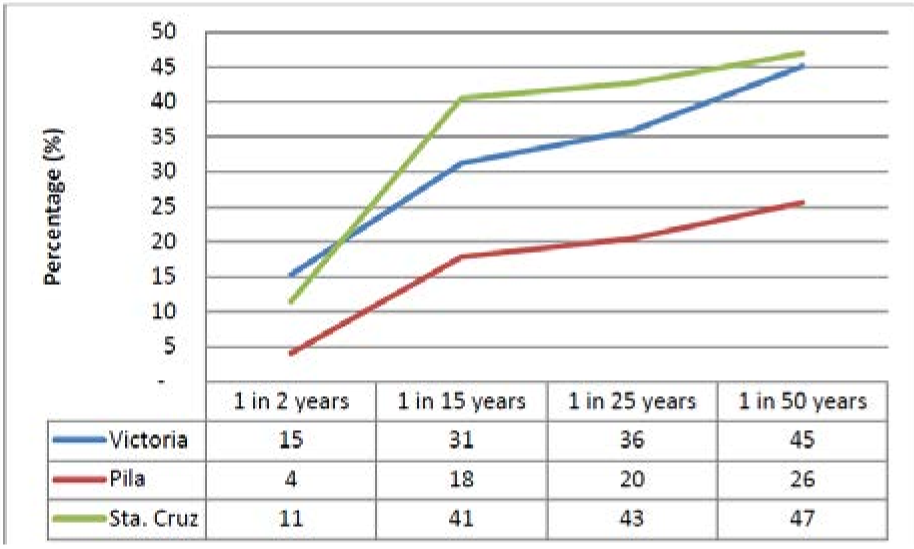


Figure 29. Percentage of Rice Lands Predicted to be Submerged by at least 2.5 feet

Direct Damage Cost Estimates

The significance of monetizing property damage impacts is that the values can be used as an estimate for the benefits of flood mitigation projects. In the Laguna Lake Basin, there are several flood mitigation projects being considered. These include lake dredging, and the construction of a road-dike system that will run along the whole perimeter of the lake. Results of this research can be utilized in studies that will look into the feasibility of these projects.

Table 75 summarizes the damage cost of major flood events using the data set we collected from the survey. There were three major flood events commonly recalled by the respondents: *Habagat* (Monsoon, 2012), *Ondoy* (Ketsana, 2009), and *Santi* (Mirinae, 2009). In the study site, the damage cost was highest for *Santi*, followed by *Ondoy*, and last by *Habagat*. Specifically, the mean damage cost per household was Php 16,969 for *Santi*, Php 9,374 for *Ondoy*, and Php 6,511 for *Habagat*.

Table 75. Actual Damage Cost per Household

	Damage Cost per HH (Php)				Damage Cost per HH (US$)			
	Habagat 2012	**Ondoy 2009**	**Santi 2009**	**All**	**Habagat 2012**	**Ondoy 2009**	**Santi 2009**	**All**
Mean	6,511	9,374	16,969	10,450	163	234	424	261
Median	2,750	3,000	7,750	4,350	69	75	194	109
Mode	5,000	8,000		1,000	125	200	-	25
n	18	55	23	106	18	55	23	106

From this dataset, we also estimated the typical damage cost incurred by households from floods of varying depths (Table 76). A flood reaching 2 to 2.4 feet (about knee-deep) results in a typical damage cost of Php 1,700 per household. This amount dramatically increases to Php 4,300 if flood reaches 2.5 to 3.9 feet (waist to neck-deep) while a flood depth of at least 4 feet (above the neck) results to a damage cost of Php 8,200 per household. Converting these into per hectare units, for built-up residential lands, the typical damage cost is estimated to be Php 410,000 per hectare for a flood height of 4 feet and above, Php 215,000 for waist-deep to neck-deep floods (2.5-3.9 feet), and Php 85,000 for knee-deep (2-2.4 feet) floods. Rice lands, on the other hand, incur a damage cost of Php 29,600 per hectare for a flood height of at least 2.5 feet (Table 77 & 78).

Table 76. Typical Damage Cost per Household per Flood Depth

	Damage Cost per Household per Flood Event	
Flood Depth	**in Php**	**in US$**
4 ft and above	8,200	205
2.5 to 3.9 ft	4,300	107.5
2 to 2.4 ft	1,700	42.5
0 to 1.9 ft	0	0

Table 77. Damage Cost per Hectare by Flood Depth (Pesos)

Land Type	Damage Cost per Hectare by Flood Depth (Pesos)				
	4 ft and above	2.5 to 3.9 ft	2 to 2.4 ft	1 to 1.9 ft	0 to .9 ft
Built-up/ Residential	410,000	215,000	85,000	0	0
Rice Lands	29,600	29,600	29,600	0	0

Table 78. Damage Cost per Hectare by Flood Depth (US Dollars)

Land Type	Damage Cost per Hectare by Flood Depth (US Dollars)				
	4 ft and above	2.5 to 3.9 ft	2 to 2.4 ft	1 to 1.9 ft	0 to .9 ft
Built-up/Residential	10,250	5,375	2,125	0	0
Rice Lands	740	740	740	0	0

Exchange Rate: US$ 1=Php 40

Using the per hectare cost estimates above, we predicted that the damage cost of floods in the study site's built-up areas that occur every 1 in 2 years is about Php 13.68 million. This increases to Php 37.3 million for floods that occur every 1 in 15 years, Php 54.47 million for 1 in 25 years, and Php 88.8 million for 1 in 50 years (Figure 30).

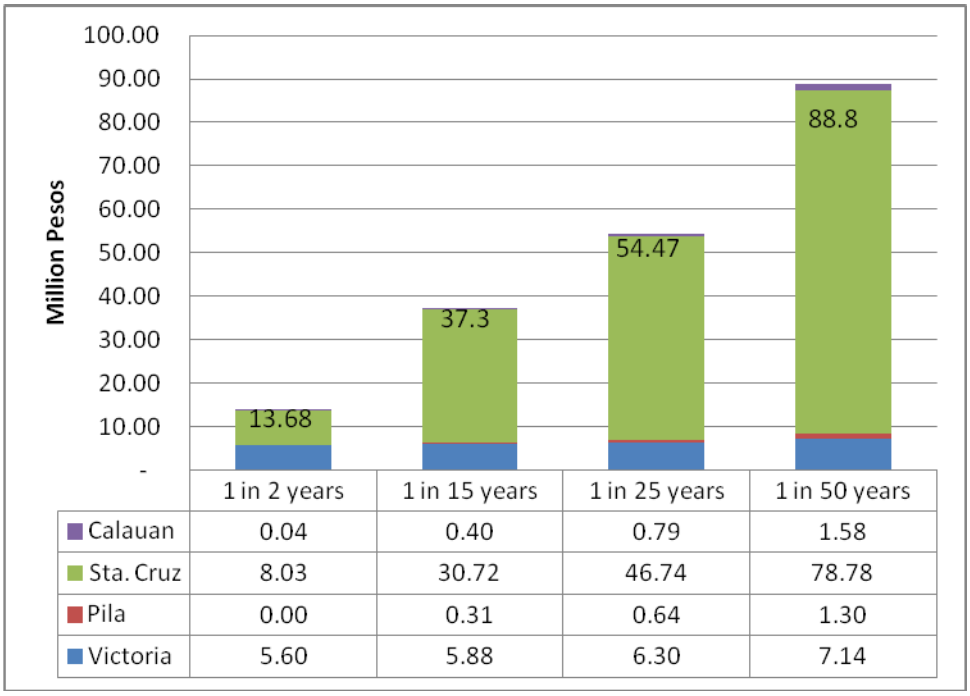
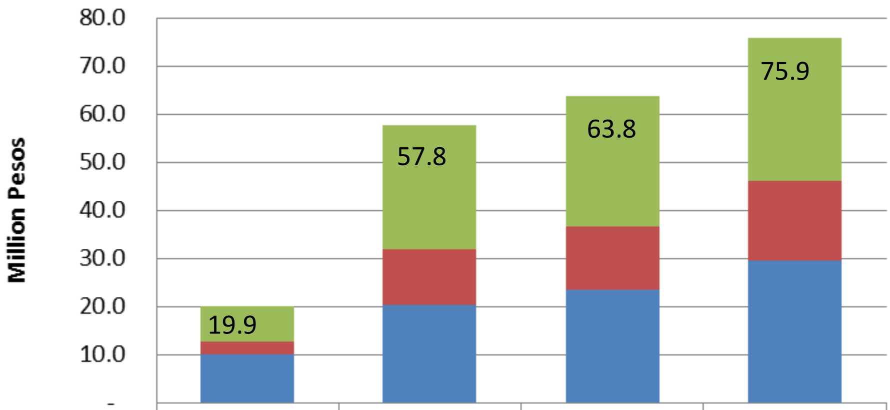


Figure 30. Predicted Direct Flood Damage Cost Estimates for Built-up Lands

For rice lands, direct damage cost amounts to Php 19.9 million for a 1 in 2 years flood, Php 57.8 million for a 1 in 15 years flood, Php 63.8 million for a 1 in 25 years flood, and Php 75.9 million for a 1 in 50 years flood (Figure 31).



	1 in 2 years	1 in 15 years	1 in 25 years	1 in 50 years
Pagsanjan	-	-	-	-
Calauan	-	-	-	-
Sta. Cruz	7.3	25.8	27.1	29.8
Pila	2.6	11.6	13.3	16.6
Victoria	10.0	20.4	23.4	29.5

Figure 31. Predicted Direct Flood Damage Cost Estimates for Rice Lands

Benefit Cost Analysis of a Technology-Based Early Warning System

The term early warning system (EWS) is defined by the United Nations International Strategy for Disaster Reduction (UNISDR) as *"the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by hazards to take necessary preparedness measures and act appropriately in sufficient time to reduce the possibility of harms or losses".* All over the world, there have been evidences that EWS is an effective strategy to minimize loss of lives as well as damage to properties (Basha and Russ, 2007 and Mercy Corps Practical Action, 2010). In the Philippines, it was able to prove its effectiveness in the case of Bulacan, wherein the establishment of a community based early warning system saved the aquaculture industry from experiencing losses during the typhoon Marce in 2006. In Dumangas, Iloilo the presence of EWS reduced casualties of typhoon Frank (2008) to zero (Pagulayan, 2012).

The agency at the forefront of promoting and establishing the use of early warning systems in the country is the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) of the Department of Science and Technology (DOST). Recognizing that flood is becoming more prevalent [with 134 incidences covering the period 2000-2006 (Esperanza and Paat, No Date)], PAGASA installed a network of fully automatic and telemeter flood early warning systems in at least 4 major river basins and reservoirs in Luzon as well as in other parts of the country.

In addition to the technical approach, modern equipment, and infrastructure, PAGASA also promotes the community-based flood early warning system (CBFEWS). The CBFEWS, which is also referred to as the local flood early warning system (LFEWS), has an advantage of being significantly inexpensive and timely when it comes to issuing localized warnings. It is also designed according to the needs and capabilities of the LGUs, as well as the local physical make-up of the watershed where it will be installed. The community-based approach is perceived by PAGASA to be more sustainable since it empowers the community and it also has an additional benefit of expanding the agency's operational hydrological services to the countryside.

Two locations served as the pilot sites for CBFEWS: Bulacan and Dumangas, Iloilo. The CBFEWS in Bulacan is located in the Lower Pampanga River Basin and was completed in 2005 through the initiative and funding of the Provincial Government of Bulacan. The project which uses Short Messaging Service (SMS) for the transmission of data, costs about Php 1 million. The CBFEWS in Dumangas, Iloilo commenced in 2003 and was completed in 2006. This CBFEWS was established through the initiative of the Municipal Government of Dumangas, Iloilo but was funded by the National Disaster Coordinating Council. The cost of this project was also Php 1 million. (Perez et.al, 2007; and Esperanza and Paat, No Date).

With the success of the pilot projects, the establishment of CBFEWS in other sites soon followed with funds coming from different international agencies. The Japan International Cooperation Agency (JICA) donated Php 1.9 million for the establishment of CBFEWS in Agno-allied River Basin in Pangasinan (Perez et.al, 2007 and Esperanza and Paat. No Date). JICA also funded CBFEWS in Cagayan, Pampanga and Bicol while Korea International Cooperation Agency (KOICA) donated a Php 10 million for the establishments of CBFEWS in Iloilo, Lanao and Aurora. UNDP-AUSAID, on the other hand, funded CBFEWS in Ilocos Sur, Zambales, Cavite, Laguna, Northern Samar, Surigao del Norte and Surigao del Sur (Pagulayan, 2012).

The establishment of a CBFEWS follows a rigorous process: (1) consultation and assessment of site and the capability of the proponent LGU; (2) identification of appropriate monitoring and communication technology to be used, (3) site survey and ocular inspection, (4) installation of equipment, and (5) training.

During the consultation, the feasibility of implementing an early warning system in the locality is assessed. The capacity of LGU is also evaluated in terms of the existing facilities and resources of the LGU proponent. Once, the feasibility of setting up the EWS is established, the equipment to be used for monitoring will be identified, and the communication channels will be selected. The mode of communication can be through: (1) SMS; (2) radio; or (3) walkie-talkie. In the remote areas of the country where the above mentioned systems are absent or impractical, the bell and bottle method is also recommended.

During the site survey and ocular inspection, the site for the proposed monitoring stations will be verified and assessed for the presence of an observer, accessibility of the site, and the availability of communication facilities. After which, the appropriate monitoring facilities will then be installed by PAGASA personnel together with the proponent LGUs. Hydraulic survey will also be conducted to determine the capacity of the river for holding water. After installation, capability building will also be undertaken. Specifically, LGU personnel with members of the community are trained on: (1) the protocols for observing, recording and transmitting data to a disaster coordinating office; (2) data interpretation; and (3) issuance of flood warning/advisory. Before the CBFEWS is turned over to the LGUs, a dry run is conducted to test the system and the observers (Pagulayan, 2012).

Description of the Technology-Based Early Warning System for the Study Site

The proposed early warning system project for the study site will utilize meteorological monitoring equipment developed by the Philippine Department of Science and Technology-Advanced Science and Technology Institute (DOST-ASTI) and will follow the Community-Based Flood Early Warning System scheme. The technology to be used includes an Automated Weather System (AWS) and a Water Level Monitoring System (WLMS). Both equipment collects data real-time and sends these to a central server maintained by the DOST through the cellular network. The AWS collects information on wind speed and direction, air temperature, air humidity, air pressure, and rain amount, duration and intensity while the WLMS collects information on water levels. These information can be can be accessed over the internet and can be used for predicting flood occurrence along the Sta. Cruz river watershed which will serve as the basis for issuing warnings. The lead time for the issuance of a warning is estimated to be between 2 to 4 hours. The warnings are proposed to be sent through SMS or text message to registered households providing information on areas that are expected to be flooded and evacuation warnings for critical areas.

The installation of the system requires several steps which include: (1) the acquisition and setting-up of the AWS and WLMS stations, (2) training and capacity building of personnel, (3) research and field validation to establish thresholds for meteorological parameters, (4) establishment of a database containing contact information of households, and (5) setting up of the monitoring and communications office.

The AWS station needs to be installed in the upland area of the watershed. This upland area is under the jurisdiction of the municipality of Nagcarlan and Liliw hence, the EWS project should also involve these two municipalities. Ideally, the equipment should be installed in a secured location, preferably in a public school compound while the WLMS can be installed under a bridge for easy access and monitoring. The instruments will be regularly maintained and cleaned to ensure the accurate collection of data. Site validation needs to be conducted to identify the specific locations for these stations.

It is proposed that each municipality maintains its own monitoring and communications office linked to the Disaster and Risk Reduction Management (DRRM). Each office will be manned by two full-time personnel with technical capabilities. Training and capacity building will also be conducted for DRRM personnel. Computer software that maintains contact numbers and locations of households, and manages bulk text messaging, will be acquired for the project. Households will be required to do a one-time registration to establish the database; hence information dissemination will also be conducted. This will be channeled through the primary, secondary and tertiary school systems situated in the project site. To establish the thresholds as basis for the warning, experts will be commissioned to do research and field validation.

Willingness to Pay for a Technology-Based Early Warning System

A substantial proportion of the respondents have revealed that they have little knowledge about early warning systems prior the survey. When asked to rate their knowledge, with 1 being the lowest and 5 the highest, 45% rated their knowledge as below 3. This proportion is about the same regardless of whether the respondent is male or female (Table 79). The brochure explaining the details of the early warning system proved to be useful in the conduct of the willingness to pay survey.

Table 79. Knowledge about Early Warning Systems

Rate	All	%	Male	%	Female	%
Rate 1 (lowest)	152	30	53	29	99	31
2	77	15	28	16	49	15
3	132	26	47	26	85	27
4	64	13	20	11	44	14
5 (highest)	75	15	32	18	43	13

The responses to the “willingness to pay” question which have been corrected for uncertainty are summarized in Table 80. It can be seen that the proportion of “yes” votes are declining as the bid level increases. For all bid levels, the total “yes” votes is 252 out of the total 500 responses.

Table 80. Distribution of Responses to Willingness to Pay Question by Bid Level

Bid Level	**Frequency**					**%**				
	25	***50***	***100***	***200***	***300***	***25***	***50***	***100***	***200***	***300***
Yes	64	67	54	37	31	65	66	53	36	31
No	34	34	46	64	69	34	33	46	63	68
Total	99	102	101	102	101	100	100	100	100	100

Majority of those who answered ‘yes’, stated that their primary reason is to ensure the readiness of their community during floods (73%). Ten percent stated that the fee was affordable, 4% claimed that they have confidence in the technology that will be used, while 3% stated that they are confident about the capacity of the local government to carry out the project. Ten percent claimed that they feel happy knowing that they could help others through the project (Table 81). This latter reason however, signals the presence of ‘warm-glow’ effect. Hence, if this was the sole reason for voting ‘yes’, then the votes were converted into ‘no’.

Table 81. Distribution of Reasons for ‘Yes’ Response

Reason for Yes Response	**Frequency**	**%**
To ensure the readiness of my community during floods	173	73
I have faith in the technology that will be used	9	4
I have faith in the ability of the local government to implement this project	8	3
I feel happy knowing that I could help others	23	10
The fee is affordable and our area is always at risk	23	10

The reasons for ‘no’ responses were varied. Majority thinks that the fee is unaffordable (39%) and that their electricity bill is already too high (22%). Eight percent thinks that there are more important problems that need to be prioritized, while 6% do not think that the early warning system is useful. Five percent claimed that they have no confidence on the local government (3%) or the technology that will be used in the project (2%) (Table 82).

Nineteen percent stated that they are not willing to pay because it should be the government or the rich households who should shoulder the cost of the project. This reason signals the tendency for free-riding. However, we chose to retain these observations in order to arrive at a conservative estimate of mean willingness to pay. It is important to note that our mean WTP may be an underestimation of the true willingness to pay.

Table 82. Distribution of Reasons for 'No' Response

Reason for No Response	Frequency	%
The fee is unaffordable	105	39
Our electricity bill is already too high	58	22
There are other more important problems that must be prioritized	22	8
The government should pay for the project	48	18
Only the rich should pay for the project	4	1
I do not have confidence on the capability of the local government	7	3
The early warning system is not useful	17	6
I do not have confidence on the technology that will be used	5	2
We are already being warned by our local officials	3	1

Table 83 shows the result of the logit regression analysis. Of the 10 explanatory variables, 6 were found to be statistically significant which include the bid level, income, respondent's sex and age, flood exposure and attitude toward risk. The results conform to economic theory in that the bid level was found to have a negative coefficient while income has a positive coefficient.

It was also found that the male respondents are more likely to be willing to pay, while age reduces the likelihood of paying. The higher propensity of male respondents to pay may be explained by the patriarchal nature of households in the Philippines wherein the males usually take on the lead role of ensuring the safety and wellbeing of their families. The attitude toward risk wherein the indicator used is the conduct of autonomous adaptation showed positive impact on willingness to pay. That is, those who have undertaken some form of autonomous adaptation were found to be more likely to be willing to pay.

Table 83. Results of the Logit Regression Analysis

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
BID***	-0.0057	0.00	-5.85	0.00	-0.01	0.00
INC*	0.0001	0.00	1.91	0.06	0.00	0.00
RSEX**	0.4865	0.21	2.36	0.02	0.08	0.89
REDUC	-0.0124	0.04	-0.35	0.72	-0.08	0.06
RAGE**	-0.0163	0.01	-2.16	0.03	-0.03	0.00
EXP**	0.0973	0.03	2.81	0.01	0.03	0.17
KNOW	0.3752	0.22	1.67	0.10	-0.07	0.82
RISK***	0.6333	0.21	3.09	0.00	0.23	1.04
PILA	0.1756	0.29	0.60	0.55	-0.40	0.75
SCRUZ	-0.2039	0.27	-0.77	0.44	-0.72	0.32
CONSTANT	0.8698	0.60	1.46	0.15	-0.30	2.04

* Significant at 1%
** Significant at 5%
*** Significant at 10%

No. of observation	497
Likelihood Ratio	75.09
Prob>chi2	0.00
Pseudo R2	0.11

Based from the logistic regression, mean willingness to pay was estimated to be Php 140 per household per month. The confidence interval is between Php 127 to Php 152 at 99% confidence level. The non-parametric lower-bound mean willingness to pay estimate falls within this limits, averaging Php 128 per household per month. The mean willingness to pay is about 0.8% of the average household income of the respondents (Table 84).

Table 84. Parametric and Non-Parametric Mean Willingness to Pay

	Parametric	**Non-Parametric**
Mean WTP per HH per month	Php 140	Php 128
(in US Dollars)	US$ 3.5	US$ 3.2
Confidence Interval for Mean WTP	[Php 127, Php 152]	
(at 99% confidence level)		
(in US Dollars)	[US$ 3.175, US$ 3.8]	

Exchange Rate: US$ 1=Php 40

Benefit-Cost Analysis

The estimated initial investment needed to establish the EWS is about Php 2 million or US$ 50,000. This covers the acquisition and installation of the equipment, capacity building and training, and setting up of the monitoring and warning dissemination office. The annual operations cost, on the other hand, is about Php 1.7 million per year or US$ 42,500 (Table 85).

Table 85. Technology Based Early Warning System Cost Items

COST ITEM	AMOUNT IN PHP
INITIAL INVESTMENT	
a. Technology Installation Cost	
Machine and Equipment Purchase	
Automated Weather Station	120,000
Automated Water Level Monitoring System	260,000
Computers	360,000
Installation (20,000 @ 3 units)	60,000
Shipping (2000 @ 3 units)	6,000
Fencing, Polemask, and Other Civil Works (30,000 per monitoring site)	90,000
b. Research to establish thresholds	200,000
c. Capacity building/Training	150,000
d. Software Acquisition	150,000
e. One-time Registration	42,288
f. Communication Expense	72,000
g. Internet	72,000
h. Overhead Cost	360,000
OPERATIONS AND MAINTENANCE	
a. Personnel	1,152,000
b. One-time Registration	423
c. Communication Expense	72,000
d. Internet	72,000
e. Overhead Cost	360,000

Using the lower bound estimate of mean willingness to pay equal to Php 128 per household per month, the estimated benefit for the first year is about Php 65.6 million or Php 1.64 million. Projections are done to estimate the benefit for the succeeding years considering the growth of the population. It was assumed that the population growth rate is 1% per year and the number of households is calculated by dividing the total population by the average household size of 5. Table 86 shows the baseline number of households corresponding to the year 2012.

Table 86. Baseline Household Population (2012)

Municipality	Number of Households
Pila	9,331
Sta. Cruz	23,550
Victoria	8,988

Using a discount rate of 15%, the net present value is estimated to be Php 330 million or US$82.5 million. The benefit-cost ratio (BCR) is 33, while the estimated internal rate of return is more than 3,000%.

To further check the validity of estimates, it is useful to compare our results to similar studies on the Benefits and Costs of Early Warning Systems (EWS). Table 87 shows case studies which used direct damage cost avoided in estimating the benefit of EWS. Our BCR estimate seems to be conservative as compared to the two case studies particularly in Bangladesh (BCR of 558) and Thailand (BCR of 176). Our estimate exceeds that of Sri Lanka's with a low BCR of 0.93. The reason for this low estimate, however, as the authors cited, is the infrequent occurrence of floods in Sri Lanka.

Table 87. Summary of Benefit Cost Ratio Estimates from Various Case Studies

Case Study	BCR
Sri Lanka, May 2003 floods case study	0.93
Bangladesh, 2007 Flood case study	558
Thailand, 2007 Flood case study	176

Reference: Subbiah, A.R., L. Bildan, and R. Narasimhan (2008)

Cost-Effectiveness of Relocation, Evacuation and Building Modification

Lakeshore barangays of the municipality of Sta. Cruz are at risk to long-term floods which lasts for several months (See Figure 32). In the last 5 years, two long-term flooding events have been reported in the area. In 2009, flooding occurred as a result of typhoon *Ondoy,* wherein some houses was submerged under water for as long as 6 months. The second event happened in 2012, induced by a strong monsoon and later extended by typhoon *Gener*

(Saola) and *Ofel* (Son-Tinh). Inundation lasted for as long as 4 to 6 months. The photos (Figures 33 and 34) below show the extent of devastation brought about by typhoon Ondoy on the municipality.

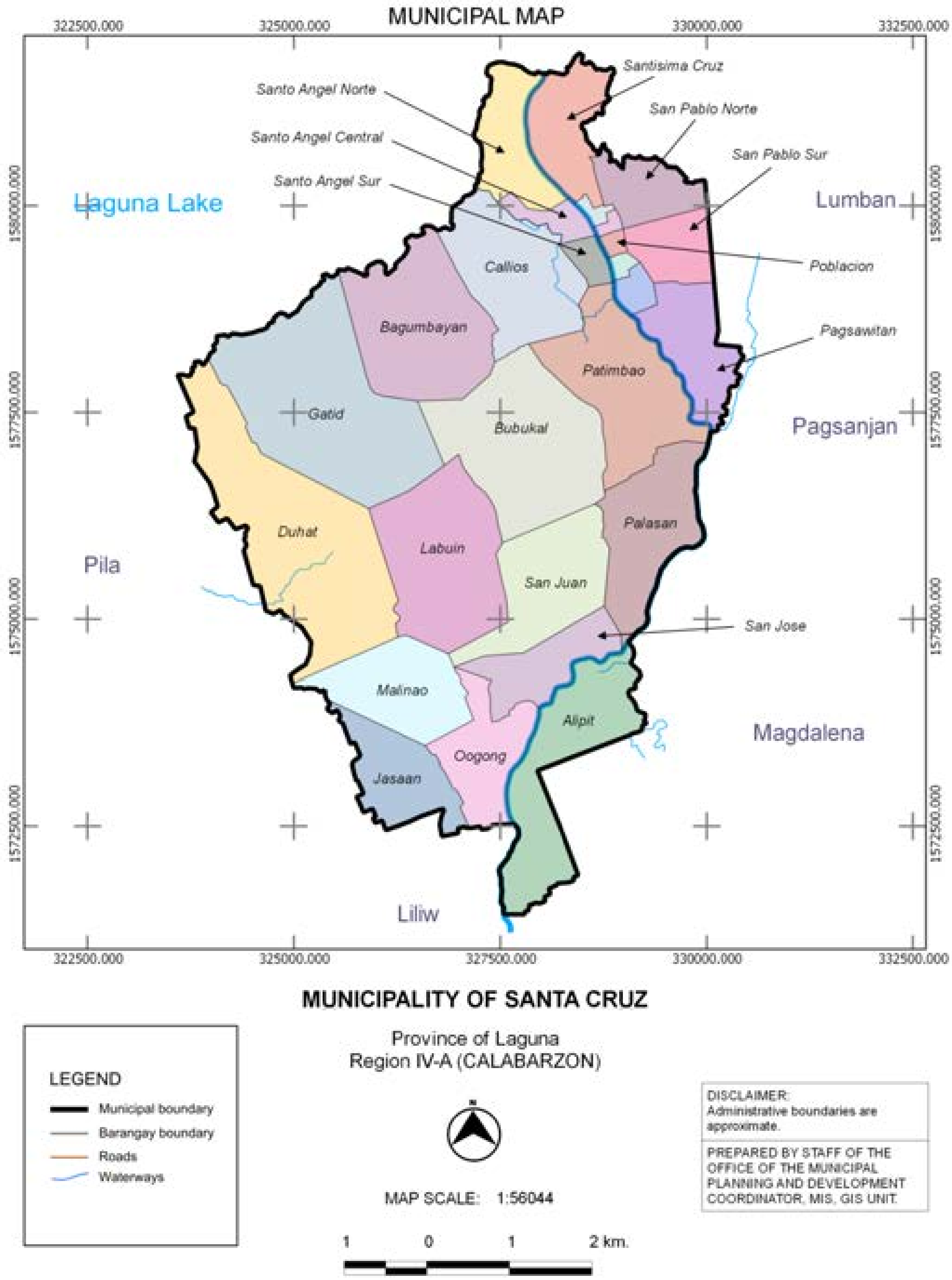


Figure 32. Municipal Map of Sta. Cruz

Figure 33. Flood Impacts of Typhoon *Ondoy* in Sta. Cruz, Laguna
Photo courtesy of the Sta. Cruz Municipal Planning and Development Coordinator

Figure 34. Aerial Photos of Flooding in Sta. Cruz, Laguna during Typhoon *Ondoy*
Photo courtesy of the Sta. Cruz Municipal Planning and Development Coordinator

These long-term floods brought about severe economic losses and inconveniences to affected households. During the 2012 flood, important public buildings submerged under water which includes the Sta. Cruz Public Market, Two Public Elementary Schools and several barangay halls. The Public Market had to be closed down for more than a month and sellers conducted their trade in the Plaza while some barangay offices transferred to the Municipal Hall. In addition, several businesses had to close shop for a couple of months resulting to loss of income.

It was also reported that 8,917 houses were inundated. As a result, 2,075 (23% of total) families moved to make-shift evacuation sites which are primarily public schools (Table 88). Those who opted not to stay in the evacuation sites, stayed in their homes, moved with relatives, or rented houses in unaffected areas. Those who stayed in their houses lived in the second floor during the flood. Their means of transportation are boats ferried by fishermen living in their barangay while bamboo bridges were also installed to aid people in crossing the roads.

Table 88. Number of Houses Inundated and Families in Temporary Evacuation Centers during Typhoon Gener

Barangay	No. of Houses Under Water	No. of Families in Evacuation Center	% in Evacuation Center
Santisima Cruz	3095	359	12
San Pablo Norte	2900	242	8
Santo Angel Central	550	141	26
Santo Angel Norte	600	25	4
Calios	625	148	24
Gatid	300	170	57
Poblacion V	115	98	85
Bagumbayan	250	141	56
San Pablo Sur	120	32	27
Poblacion IV	320	0	-
Pagsawitan	42	0	-
Santo Angel Central, San Pablo Norte, and Santisima Cruz	-	719	
Total	8917	2075	23

Source: Sta. Cruz Municipal Social Welfare and Development Office

To aid the victims, the Sta. Cruz local government provided evacuation and relief operations to households, and livelihood assistance to farmers and fishermen. These however, are reactive strategies which have short-term impacts.

Since Sta. Cruz has no permanent evacuation center, affected families were housed in public schools, churches, and a Sports Complex. Housing evacuees in temporary evacuation sites such as schools posed several problems:

- Barangay Officials needed to get the permission of the school principal before they can utilize the building for evacuation hence coordination problems sometimes caused delays in the evacuation.
- Students got displaced and schools needed to reduce the school hours to accommodate students and the evacuees. As a consequence, the quality of education might have been compromised.
- There were concerns about the safety of the students since there were isolated reports of harassment.
- The existing facilities of the school are not sufficient to meet health and sanitation standards given the large number of evacuees.
- There have been reports of school building and facilities deterioration/vandalism.
- There were instances where in the schools which served as primary evacuation sites also got inundated, requiring emergency evacuation in the middle of the night. This compromises the safety of the evacuees.

Objective of the Intervention

Given the problems outlined above, the municipal local government recognized the need to implement a more long-term solution for the problem. As of 2012, it has already initiated a housing project which is benefitting about 80 households. This was made possible through the funding assistance coming from the International Organization for Migration (IOM) and the Department of Social Welfare and Development (DSWD). In addition, the construction of a multipurpose evacuation center with a capacity to house 400 families is also underway. However, there are still about 1,700 households that are facing high risk of flooding that needs to be assisted. Hence, the focus of this sub-study is to identify the best intervention that can attain the objective of providing these remaining at-risk households in Sta. Cruz, Laguna with a dignified temporary or permanent shelter so that they will be able to avoid the hazards brought about by floods. Three options are subjected to Cost Effectiveness Analysis: (1) Evacuation Center; (2) Relocation; and (3) Building Modification.

Due to the nature of flooding in Sta. Cruz, which is recurrent and long-term, it is reasonable to consider relocation, building modification and the construction of a permanent/fixed evacuation site as possible interventions. For this analysis, the target beneficiaries are limited to the poor households. This limitation was set because of the administrative and legal difficulties of implementing relocation for rich households and because rich households also have the financial means to undertake autonomous adaptation.

It is important to specify from the outset that the designs of the options considered are generic and costs are merely rough estimates based from building and construction cost standards (Annex Table 15). Another limitation of the analysis is that the indirect impacts associated with the options such as social, psychological, health and environmental costs are not included because of difficulty of attribution and monetization. As an example of these impacts, uprooting a family from their homes may cause emotional distress and may lead to alienation and loss of social capital. It might also result to higher expenditures as households will need to travel longer going to and from their place of work/business. Evacuation, on the other hand, will have potential health impacts since diseases are easily spread in crowded areas. Also, construction will have consequences on the environment due to emissions into the air, water spills, waste generation, soil pollution, and resource consumption. Hence, a more detailed assessment is recommended for further study.

Household Relocation

Relocation is a form of adaptation that involves movement of population from areas at risk. It is defined by the World Bank as "a process whereby a community's housing, assets, and public infrastructure are rebuilt in another location." Several development and humanitarian agencies have already exerted viable effort to relocate a number of communities that are deemed at risk or uninhabitable. However, most of these planned relocation projects did not work out as expected. As Scudder-Corlson (1982) argues, relocation is a stressful experience. Many families are reluctant to leave their damaged home even if a better housing is provided (Oliver-Smith, 1991).

Davis (1977) stated that after the 1963 Skopje earthquake, Macedonians who were transferred to Yugoslavia returned to their native town due to the difficulty to speak the local language. This is also the case with the Muslims and Catholic victims of the devastating 1992 earthquake and tsunami in the Island of Flores (Boen et. al., 2001). Cultural and religious differences triggered return of the victims to their native villages. Gaillard (2008) states that culture and ethnicity should be incorporated in resettlement program planning while Artur (2012) includes sensitivity of the Institutions.

In the Philippines, 13 relocation sites were developed for those that were affected by the eruption of Mt. Pinatubo in 1991. According to de Guzman (n.d.) the cost of resettlement spent on Aetas alone was Php 349 million and Php 1.689 billion for lowlanders. The relocation site has ample space and each family was given a 94 sq m land with a 27 sq m concrete house. However, due to cultural differences, poor location, and inadequate facilities, massive abandonment of these resettlement sites took place (Gaillard, 2008). In contrast, the transfer of around 3,120 families from Marikina and Pasig in Metro Manila to a relocation site in Calauan, Laguna in the aftermath of Typhoon Ondoy (TS Ketsana) had proven successful due to the provision of support services for community-building and livelihood opportunities in the relocation site (Mendoza, et al, 2013).

Livelihood and financial capacity of the families should indeed be taken into account to avoid failure of a resettlement program. In La Union, Philippines the government invested 7.2 million pesos for a relocation facility intended for fishermen residing in areas threatened by coastal erosion. A relocation facility consisting of 81 unfinished housing units was constructed further inland. In addition, for the units to be inhabitable, the resettlement program requires a Php 140,000 initial outlay for the construction of sanitary facilities and kitchen. As a result, after 2 years of construction only 20 units were reportedly occupied (Arias, 2011).

In Alaska, 31 villages are in imminent danger from coastal erosion and flooding and are forced to relocate. The estimated cost according to the US Army Corps of Engineers (USACE, 2006a) of relocating Kivalina is at USD 9 million to USD 125 million, Newtok at USD 80 million to USD 130 million and Shishmaref at USD 100 million to USD 200 million. The villages of Kivalina, Newtok and Shishmaref are estimated to be completely eroded in ten to fifteen years. However, the high cost of relocation and complications on getting funding due to cultural, political and economic factors complicates the relocation process.

However, one notable successful resettlement project is the Xiaolangdi Resettlement Project in China. This project intended to assist the 172,487 residents of the 227 villages that will be affected by the construction of Xiaolangdi Dam. The project cost USD 480 million wherein USD 295 million was spent for land, infrastructure and commercialization. Ferris (2011) stated that the success of this project is due to political commitment, careful planning and participation of the community in the decision-making process and significant resources.

In the relocation option considered in this study, core shelters made from concrete and plywood materials will be provided to the households. The size of the core shelter is 30 square meters and each has its own toilet and sewerage facility. There is an existing land owned by the municipal government situated in barangay Oogong which has a total area of 4.6 hectares. Half of this land is already being used for their on-going housing project and about 2 hectares is still available for a relocation project. Oogong is situated about 20 minutes away from the Poblacion - the center of business activities in the municipality. The site is accessible via a concrete road and is situated far from the Laguna Lake which makes the site flood-free and ideal for the relocation project. However, since the total land area needed for the project is 17 hectares, an additional 15 hectares need to be acquired.

The costs associated with the relocation project include an initial capital outlay (CO), and an annual maintenance and operations cost (MOC). Under capital outlay are land acquisition cost, construction cost, transportation and hauling/moving cost, civil works for utilities, and livelihood support. The MOC consists of the land rent.

The construction cost is about Php 240,000 per shelter while the hauling/moving cost is Php 1,800 per household. The civil works for electrification and sewerage is estimated to be Php 60,000 per household. As mentioned, one of the reasons why a relocation project is not successful is due to the absence of economic activity or the lack of livelihood support for relocated families. Hence, this project will also have a livelihood component so that beneficiaries will be able to start a business or a livelihood near their new residence. The assistance will be given as a onetime payment amounting to Php 10,000 per household following the model of IOM.

Rent for existing owned land is included because using the resource for the relocation project entails an opportunity cost. This is associated with the income that could have been earned if the land was put into other productive uses, for example for agricultural production. Hence, land rent is accounted for and is estimated to be equal to the net income per year from rice production or Php 120,000 per year.

Compared with the other options analyzed, the relocation option is deemed to be the most effective in ensuring zero casualties during disasters. However, its main disadvantage is its difficulty of implementation because people might be reluctant to leave their homes apart from the fact that it entails a very huge capital outlay.

Evacuation Center Option

The evacuation center option can also be constructed in the 2 hectare open lot owned by the municipal government in Oogong. Following the international standards of 3.5 sq. m. per person, the center will have a total area of about 29,750 sq. m. which can be built as a three-storey structure. The CO associated with the evacuation option include the building construction cost, while the MOC include transportation of households to and from the evacuation site during calamities, communication, maintenance, and the damage cost to properties during floods.

Since the building is intended to be multi-purpose which also includes recreation and storage during times when there are no evacuees, only about 85% of the construction cost will be attributed to the evacuation center option. The construction cost is about Php 379.3 million.

Households are still expected to incur some flood damage cost because they will still keep their house that is at risk to the hazard. The flood damage cost used in the estimation is the modal value of the reported damage cost during *'Habagat'* equal to Php 5,000 per household. To get the annualized flood damage cost, this value is multiplied to the probability of occurrence which is one in five years. The maintenance cost, on the other hand, covers utility bills and cleaning which is approximately Php 600,000 per year, while the transportation cost and communication cost is assumed to be Php 10 and Php 1 per person, respectively. The transportation and communication cost will be incurred during the evacuation operation.

The cost of providing food in the evacuation site is not included. It is expected that people will still incur costs for food even if they are not sheltered in the evacuation site. This cost item is therefore just a transfer from private individuals to the government.

The main advantage of evacuation over other options is that, it is flexible, meaning, that even if the hazard does not occur, the building can still be used for other purposes. However, compared with relocation, evacuation may be less effective in attaining the objective of the intervention and in ensuring zero casualties during disasters. This is especially true if the early warning system that can facilitate timely evacuation is not yet in place. Compared to building modification, on the other hand, evacuation has the disadvantage of being less convenient and less comfortable for the evacuees.

Building Modification

The last option analyzed is building modification to enhance the resiliency of existing house structures to flooding. This can be a government-led intervention via regulation coupled with financing. The idea is, instead of putting funds for a relocation project or an evacuation center; the money can be used directly to assist households living in at-risk areas in modifying or improving their existing houses. Although this option is usually deemed as an autonomous type of adaptation, there might be a rationale for government intervention if households underinvested in adaptation activities because they are faced with liquidity constraints. Hence, the government can address such market failure and provide financing to households.

Since most houses in the area are concrete, the modification will entail building of a second floor rather than raising houses on stilts. The proposed size of the second floor is 20 square meters. Since first level bathrooms are not usable during floods, floating toilets will also be provided. The toilet is made from plastic drums and wood, while the waste treatment material will be charcoal and garden soil.

The CO associated with this option includes the building modification cost and the cost of floating toilets. The MOC includes residual property damages due to floods, the cost of maintaining the floating toilets, and emergency evacuation. The cost of building modification is about Php 160,000 per household while the cost of the floating toilets is about Php 50,000 per unit, with each unit serving 10 families. If this option is implemented, there are still residual property damages that are expected to occur. The construction of the second level does not guarantee a 100% protection for households and their properties. It is assumed that some the damage cost will be incurred by the household estimated to be Php 340 per year, which is the damage cost associated with a knee-deep inundation multiplied by the probability of occurrence (one in five years).

In addition, some emergency evacuation is still expected to occur even with the implementation of building modification. Hence, this will entail an additional cost covering communications and the transportation of affected households estimated to be about Php 93,500 per year.

The main advantage of this option is that the households need not leave the comfort of their own homes during disasters. However, this has the lowest effectiveness among the three options. Building modification may not be as effective in attaining our objectives as compared to relocation or evacuation, especially if flood height exceeds the height of the house's second floor. This means that their houses will remain to be uninhabitable during the occurrence of the flood and households will still sustain full damages from the flood. Hence, they would still need to be evacuated from their homes. Also, it does not shield households from other hazards such as earthquake-induced liquefaction which is one of the major hazards identified for the area by the Municipal Planning and Development Coordination Office. In addition, if the project is implemented with government funding, it may encourage households to engage in risky behavior (moral hazard) that is, situate in flood-prone areas since they are assured of financial support.

Comparison of the Adaptation Options

Table 89 summarizes the advantages and disadvantages of the adaptation options.

Table 89. Advantages and Disadvantages of Relocation, Evacuation Center, and Building Modification Options

	Advantages	Disadvantages
Relocation	Ensures the highest probability of zero casualties during disasters.	Difficult to convince people to relocate. Highest capital outlay. Requires major and permanent adjustments for affected households.
Evacuation Center	Flexible, even if flood does not occur, the building can be used for other purposes.	Inconvenience and discomfort associated with living with other people in a public environment. May not ensure zero casualties during floods if evacuation is untimely.
Building Modification	No need to uproot people from their existing communities.	Households not shielded from other hazards like earthquake-induced liquefaction. May not ensure zero casualties during floods. May still need to evacuate people if floods are more intense than expected. May promote risky behavior associated with moral hazard. That is, there is an incentive for households to locate in risky areas if government shoulders the cost of building modification.

Table 90 summarizes the flow of costs associated with the three options. The highest capital outlay is required for relocation amounting to about Php 552 million, followed by evacuation at about Php 377.5 million, while the cheapest in terms of capital outlay is building modification at about Php 279.8 million. The annual operations and maintenance cost is about Php 0.12 million for relocation, Php 3.1 million for the evacuation center, and Php 0.68 million for building modification.

Table 90. Comparison of Capital Outlay and Annual Operations and Maintenance Cost of the Three Options (Php)

Item	Relocation	Evacuation Center	Building Modification
Capital Outlay	551,940,000	377,519,000	279,814,900
Annual Operations and Maintenance Cost	120,000	3,101,500	685,100

Risk-based Cost-Effectiveness Analysis

Although the costs of the options are designed in such a way that they meet the target of 1,700 household beneficiaries, it is recognized that the options may not yield the same level of effectiveness. Among the three options, relocation is deemed to have the highest effectiveness in attaining the primary objective of the intervention, followed by evacuation and last by building modification.

However, to determine which option is best, it is necessary to compare the Incremental Cost Effectiveness Ratio (ICER). The results show that Building Modification is the most cost effective option among the three with an ICER of 279,342. This is followed by Evacuation with an ICER of 340,413, while the least cost-effective is Relocation with an ICER of 447,902 (Table 91).

Table 91. Cost Effectiveness Analysis of Relocation, Evacuation, and Building Modification

Options	PV of Cost*	Effectiveness	CER	ICER
Relocation	552,955,698	1,700	325,268	447,902
Evacuation	400,669,058	1,360	294,610	340,413
Building Modification	284,928,589	1,020	279,342	279,342

* Used a discount rate of 15% and time frame of 25 years.

To test the robustness of the above findings, risk analysis should also be performed. Monte Carlo simulation was undertaken using the estimated mean and standard deviation of cost and effectiveness summarized in Tables 92 and 93. The standard deviation of cost is predicted to be 20% of the estimated cost while the standard deviation of effectiveness is based on the ratings given by the research team.

Table 92. Present Value and Standard Deviation of the Estimated Costs of the Adaptation Options

Options	Present Value of Cost (Pesos) (15% discount rate, 25 years)	Standard Deviation (Pesos)
Relocation	552,955,698	110,591,140
Evacuation	400,669,058	80,133,812
Building Modification	284,928,589	56,985,718

Table 93. Effectiveness Measure of Relocation vis-a-vis Evacuation and Building Modification

	Effectiveness*	
Options	Percent	# of Households
Relocation	100%	1,700
Evacuation	70% - 90%	1,190-1,530
Building Modification	50% - 70%	850-1,190

* Based from ratings provided by the researchers. The researchers represent a diverse background (Engineering, Sociology/Human Ecology, and Economics).

Table 94 shows the summary statistics of the simulation. Based from the analysis, we found that Building Modification has the lowest expected CER (Php 286,502), followed by Evacuation (298,829) and Relocation (324,973), which means that Building Modification seem to be the best option.

Table 94. Descriptive Statistics of the Results of the Monte Carlo Simulation

Descriptive Statistics	Relocation	Evacuation	Building Modification
Mean CER	324,973	298,829	286,502
Median CER	324,825	293,120	277,680
S.D. of CER	65,032	72,159	78,739
Min CER	64,899	22,303	57,643
Max CER	550,301	739,964	953,896

In order to have a more systematic comparison, the cumulative distributions of each alternative were generated and compared. Figure 35 shows that the distribution of the evacuation option is consistently situated to the left of relocation, while Figure 36 shows that building modification is consistently to the left of the evacuation option. This means that among the alternatives, the building modification option consistently offers the higher probability of achieving more desirable outcomes, i.e., lower cost-effectiveness ratio.

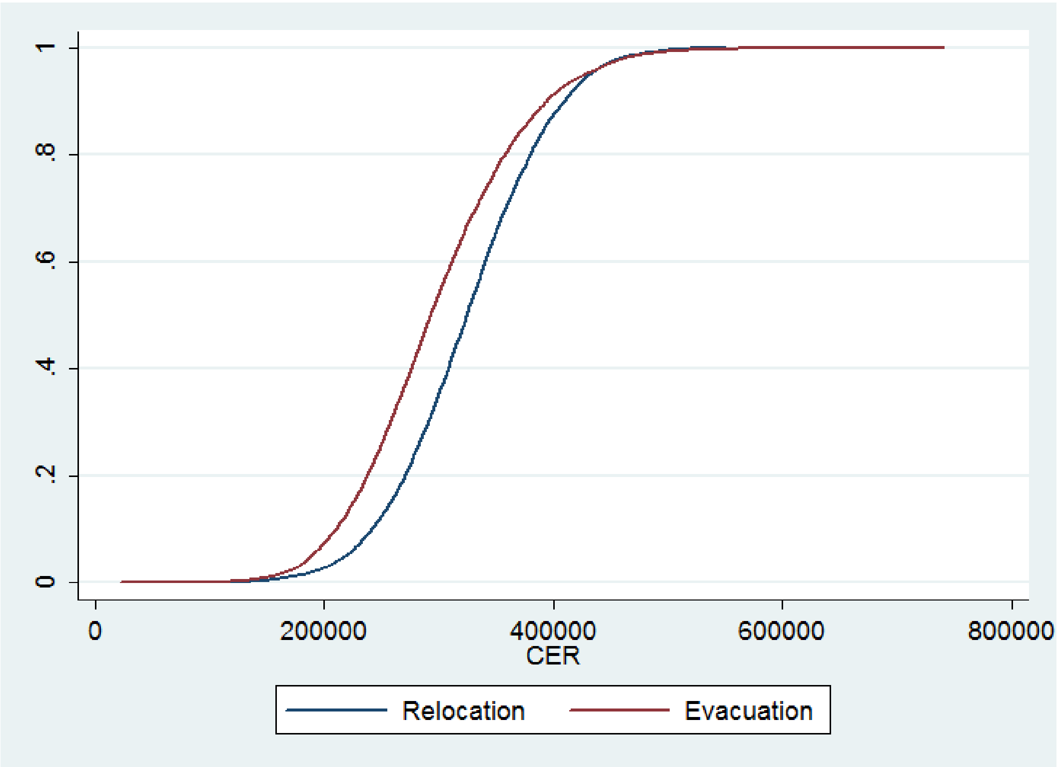


Figure 35. Cumulative Distribution of the Cost Effectiveness Ratios of the Evacuation and Relocation Options

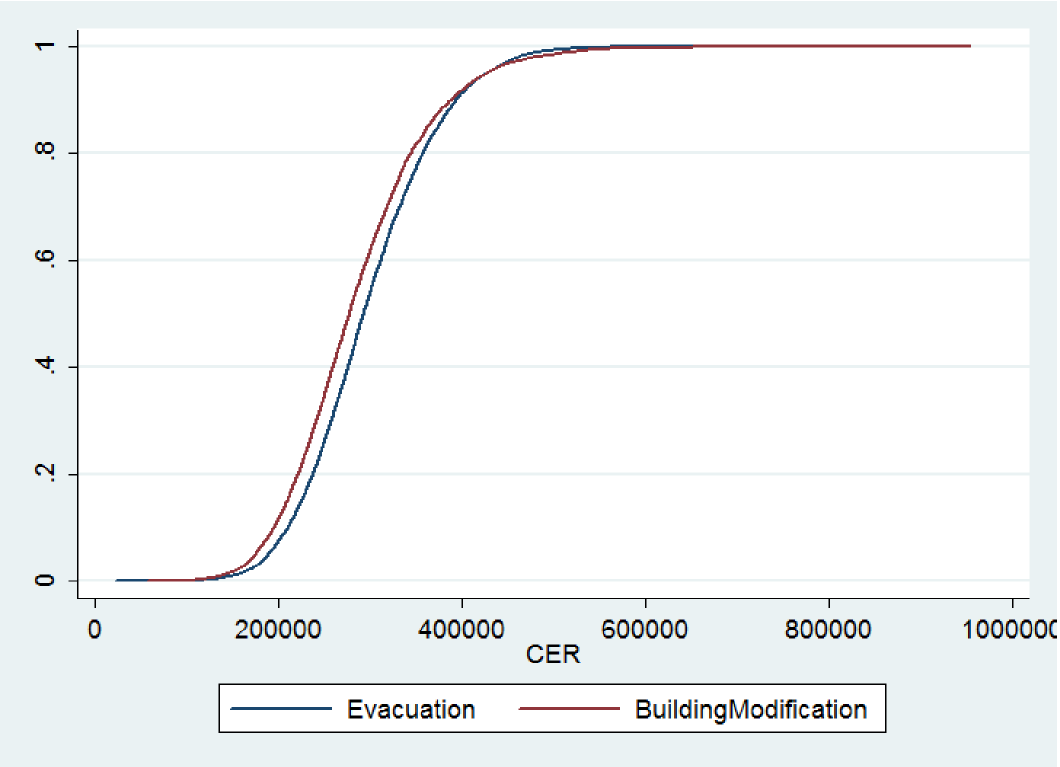


Figure 36. Cumulative Distribution of the Cost Effectiveness Ratios of the Evacuation and Building Modification Options

SUMMARY AND CONCLUSION

Considering the results of the Vulnerability Assessment Study in Year 1 combined with run-off estimates using the *Rational Equation*, this year's study site was narrowed down to the municipalities belonging to the Sta. Cruz River Watershed.

For this year, the project focused on the identification and economic analysis of adaptation options. Applying the participatory framework and the watershed approach, we identified the Technology-Based Early Warning System project for the lakeshore municipalities of the study site, and Relocation, Evacuation and Building Modification for the lakeshore barangays exposed to long-term floods in the municipality of Sta. Cruz, Laguna. The technology-based Early Warning System was subjected to Benefit Cost Analysis, while the three adaptation options for long-term floods were subjected to Cost Effectiveness Analysis.

We found out that the respondents in the study site have a positive willingness to pay for a technology based early warning system. The estimated mean willingness to pay is between Php 127 to Php 152 per household per month. The analysis also shows that the proposed project produces large social net benefits, with a Benefit Cost Ratio (BCR) reaching as much as 33. Hence, we highly recommend the implementation of this project in the study site.

Among the three adaptation options for long-term floods, the Building Modification Project was found to be the most cost-effective and this result is robust when risk analysis is applied. Hence, instead of the evacuation center already in the pipeline of projects for implementation, the local government should consider the financing of building modification as an alternative. However, a more in-depth study is recommended so as to include the indirect costs associated with the projects.

In addition, we also estimated the direct flood damage costs corresponding to various flood depths and land use. This estimate can be used as an input for studies that will look into the benefits of flood mitigation projects such as lake dredging or a road dike system, which are currently being considered as the long-term strategy for addressing flood in the Laguna Lake basin. Our flood damage cost estimate per hectare for built-up lands is about Php 410,000, Php 215,000 and Php 85,000 for more than neck-high, waist-deep and knee-deep flood levels, respectively. On the other hand, rice lands incur a damage cost of Php 29,600 per hectare for flood level corresponding to 2.5 feet and above.

We also conducted simulation of flood inundation in the whole Sta. Cruz River watershed. It is predicted that about 146.8 to 506.4 hectares of built-up lands and about 673.9 to 2,565 hectares of rice lands are at risk to flooding. The corresponding damage cost resulting from this ranges from Php 13.7 million to Php 88.8 million for built-up lands and Php 19.9 million to 75.9 million for rice lands.

CHAPTER 8

From VA to CCA Development: Some Policy Implications

Growing scientific evidence for the last three decades has shown that climate change is one of the major serious, if not the main, problems besetting the global community. As a matter of principle and urgency, the Philippines had adopted a policy of climate change response where adaptation is central. The lessons and insights from the Project reported extensively in this volume point, among others, to an integrated vulnerability assessment as the primary basis for this response.

With R.A. 9729 and the consequent establishment of the Philippine Climate Change Commission (CCC), the National Framework Strategy on Climate Change (NFSCC) covering the 12 – year period of 2010 – 2022 was formulated. Accordingly, it is anchored on the climate change vulnerabilities and adaptation needs of key sectors while taking into consideration the country's potentials for global climate change mitigation (NFSCC, 2010-2022). By identifying key result areas in addressing the impacts of climate change the NFSCC provides a basis for the national program on climate change. Section 3.8 of the Framework specifies that it "shall guide the national and sub-national development planning processes," from the formulation of the Medium-term Philippine Development Plan (MTPDP) to the crafting of the local-level Comprehensive Land Use Plans (CLUPs) and Comprehensive Development Plans (CDPs). The details of the strategies outlined in the Framework are further developed in the National Climate Change Action Plan (NCCAP) which prioritizes climate change response and strategic directions for the period 2011 - 2028 in the seven (7) major areas of: food security, water sufficiency, ecological and environmental stability, human security, climate-smart industries and services, sustainable energy, and knowledge and capacity development.

The NCCAP is meant to guide local government units (LGUs) in preparing their respective Local Climate Change Action Plans (LCCAP). The operational framework it adopts in this regard is based on the concept of ecologically stable and economically resilient towns or Ecotowns. An ecotown, as defined in the NCCAP, is a "planning unit composed of municipalities or a group of municipalities located within and in the boundaries of critical key biodiversity areas (forest, coastal/ marine and fishery, or watersheds), highly vulnerable to climate change risks due to its geography, geographic location, and poverty situation" (NCCAP, 2011-2028).

The Need for a Comprehensive and Integrated Vulnerability Assessment for Climate Change Adaptation

The implementation of the ecotown as the framework of local climate change initiatives is necessitated by a comprehensive and integrated assessment of the vulnerability and adaptive capacity of an ecotown unit. Such an assessment must be comprehensive in capturing natural, social and economic vulnerabilities of the ecotown. In many instances, impact areas such as food security and water resources have clear coupled natural-social/organizational dimensions that need to be addressed to improve resiliency. It must also be integrative such that the possible adaptation and/or mitigation options to improve the resiliency of the ecotown to the impacts of climate change may be focused on specific vulnerabilities but at the same time are able to respond to multiple goals and needs of the ecotown.

Because vulnerability to climate change is multi-faceted, it is not enough for one discipline to amply address the assessment of all its components and concerns. At the most basic, a multidisciplinal approach can be employed wherein researchers coming from different disciplinal fields remain within the bounds of each of their disciplines and apply disciplinal concepts and methods without necessarily sharing a common goal with each other. The results may end up individually sound but fragmented with each discipline advancing a climate change vulnerability research agenda. Thus, we may have natural scientists conducting a natural resource assessment without consideration of how such assessment will necessarily input into the economic valuation of the resources for eventual analysis of the opportunities of an ecotown unit for climate change adaptation. We may also have social scientists conducting social vulnerability assessments that for all their richness in information, remain in the quiet margins of climate change adaptation due to an emphasis on the vulnerability of the natural ecosystem to climatic variability.

A vulnerability assessment comprehensive enough to guide adaptation options will need for disciplines to collaborate to be able to provide better and more thorough information needed by policy and decision makers as well as government officials in formulating laws and action plans. Moreover, there will be a need for close discussion and dialogues between the scientific community where disciplinal trainings flourish, and the agencies mandated to mainstream climate change action plans at all levels of governance and public service. Such interaction will essentially bring climate change adaptation discourse beyond a disciplinal, and into interdisicplinal and transdisciplinal planes. Needless to say, this need for close collaboration and cooperation among scientists and academicians, and between the scientific and academic community and other members of civil society, will have to extend from assessing vulnerabilities, and towards the identification and prioritization of climate change adaptation initiatives and options.

Interdiciplinal and Transdisciplinal Approaches to Climate Change Adaptation

Lawrence (2010) explains that an interdisciplinary approach takes place with the acceptance of the integration of points by researchers coming from different disciplines in the light of achieving a shared goal that is usually a common subject of study. In assessing the vulnerabilities and capacities of an ecotown unit and the various sectors therein, interdisciplinarity generally involves scientists from at least two disciplines, who make use of their disciplinal competence so as to work on achieving a shared set of results. Following the explanation of Lawrence, an interdisciplinary approach to climate change vulnerability assessment has the goal to integrate concepts, methods, and principles from various disciplines to arrive at a more coherent and integrative assessment of an ecotown's vulnerabilities and capacities. To a large extent, this interdisciplinarity is demonstrated in the project described and presented in this book.

Some of the significant findings of the assessment conducted point to the multiple features of vulnerability that require this interdisciplinarity and transdisciplinarity:

1) Vulnerability in the study area is generally due to exposure to tropical cyclones and flood events.
2) Even if exposure is generally low for some barangays within the study area, overall vulnerability can still be significantly high due to the significant contributions of sensitivity and adaptive capacity as determinants of relative vulnerability.
3) Sensitivity and adaptive capacity are significantly defined by social, economic, infrastructure and other anthropogenic variables.
4) Relative vulnerability of barangays is higher when indicators for agriculture were employed. This corroborates literature indicating the significant part of agriculture in the vulnerability of an area.
5) There is substantial proportion of female-headed households considered as vulnerable.
6) Some agriculture subsectors adversely sensitive to typhoons and flooding warrant attention as there may be a predominance of women in these subsectors affected by typhoons and flooding.

Assessing vulnerability to climate change is diagnostic work that thus requires an integrative mixing of disciplinal perspectives, methods and tools. Once initial diagnosis has been done towards the more value-laden decision of pinning down adaptation options, however, there may be advantages in fusing disciplinary and other kinds of knowledge, especially those emanating from major stakeholders. In contrast to the interdisciplinary nature of academic research, a transdisciplinary approach described by Lawrence (2010) considers not only knowledge generated within the bounds of academic disciplines through either basic or applied researches, but also includes contributions and knowledge generated within civil society, private and public sectors, in the realm of governance, the political arena, as well as the those produced by local people and communities in their everyday lives.

The project also demonstrated this transdisciplinarity to some extent. With the identification of flooding as a main exposure, the need to come up with adaptation options for the problem of long-term flooding in the municipalities of Sta. Cruz, Pila and Victoria became a major motivation in the project. By using participatory approaches such as training-seminars and workshops, continuous consultations and discussions, engagement of key local government offices in project activities, the conduct of focused group discussions (FGD) and key informant interviews (KIIs) with Local Government Units (LGU) as well as other community stakeholders, the project was able to include non-academics in the assessment of the climate-related vulnerability of the study area, and in consideration of consequent appropriate adaptation options for probable implementation in the communities within the study site in Sta. Cruz, Laguna.

As a result, the core research team together with the partner LGUs arrived at two sets of adaptation options for economic analysis: 1) the establishment of a technology-based, community-implemented flood early warning system (FEW); and, 2) relocation, evacuation and building modification. These possible options zeroed were in consideration of the vulnerability profile of the municipality. This profile included exposure to flooding and prolonged inundation, especially among coastal barangays. Human, social and economic sensitivity to these hazards also made major contributions to overall vulnerability both at the community and the household level.

Using the Contingent Valuation Method (CVM) whereby respondents were directly asked about their maximum willingness-to-pay for receiving service that can be provided through the installation of a technology-based FEW, it was estimated that the expected benefit from such a project for the municipalities of Sta. Cruz, Victoria, and Pila is about Php 65.6 million per year. With an initial investment of Php 2 million for installation costs, and an annual operations cost of Php 1.7 million, this translates into an estimated benefit of about Php 43.00 for every Php 1.00 worth of investment. On the other hand, the cost-effectiveness analysis of relocation, evacuation and building modification as possible adaptation responses to long term inundation suggests that building modification is the most cost-effective option among the three, followed by the establishment an evacuation center, and last by relocation.

With identified adaptation options subjected to analytical procedures within the bounds of economics as a discipline, having objective bases for decision-making in choosing viable adaptations was demonstrated by the project. This is an example of disciplinal contribution. Over and beyond this, the continuous engagement of partner LGU offices and the use of participatory methods in assessing vulnerabilities of the communities and in the identification of possible adaptation options provided the opportunity for the marriage of ideas not only among like-minded disciplinal practitioners, but the local people as well. Consequently, a new level of appreciation for scientific and disciplinal contributions in local governance in the area of climate change adaptation resulted. At the same time, the interaction surfaced locale-based intricacies, limitations, and particulars that will eventually affect the local climate change action plans. Most of these pertain to technical as well as organizational and institutional capacities for sustained efforts in vulnerability analysis and sustained knowledge-based planning for necessary adaptations.

Thus, while a more in-depth study is eventually recommended by the research team towards the inclusion of indirect cost in the analysis of viable adaptation options, a parallel recommendation is made towards the strengthening of academe-local community partnerships. This means taking operational steps towards the transdisciplinal response to the issue of climate change, especially in the area of participatory vulnerability assessment and the identification, analysis and eventual implementation of socially acceptable and viable adaptations to mitigate existing vulnerabilities.

Some Policy Recommendations

The continuous engagement of partner LGU offices and the use of participatory methods in assessing vulnerabilities of the communities and in the identification of possible adaptation options, opened opportunities for more in-depth understanding of vulnerability and the assessment of adaptation options for eventual incorporation into local climate change action plans. Advancing from multidisciplinal towards interdisciplinary and transdisciplinary approaches in dealing with complex subjects like climate change vulnerability and adaptation is thus seen as contributory to enlarging shared visions and enriched understanding of the subject. Specifically, it incorporates more perspective coming from a diverse group of people which opens for new explanatory theories to address issues accompanying the subject matter. The alliance of different methods of understanding and answering these complex issues results into an integrative and more effective assessment of vulnerability and adaptive capacities. Using a transdisciplinary approach in addressing the complexity of climate change adaptation researches and project development gives wider and diverse sides to the story of climate change adaptation options.

The ecotown strategy to localize the thrusts stipulated in the Philippine's NCCAP is seen as an important field where interdisciplinary and trandisciplinary approaches are imperative. While researchers and practitioners may no longer question the need for interdisciplinary contributions and a more transdisciplinary approach, the following recommendations are being made towards the operationalization of such approaches in the implementation of the ecotown framework:

1) The adoption of an integrated framework of vulnerability assessment whereby vulnerability is necessarily a confluence of climatic, bio-physical, geographical, demographic, socio-economic, political and institutional factors. A strong natural resource assessment to provide quality baseline information for an ecotown unit must therefore have an equally strong socio-demographic and economic profiling counterpart, with clear considerations of ensuring the capture of data necessary for analysis of local situation in the area of food security and water sufficiency, human security, climate-smart industries and services, power and energy, and climate change knowledge and capacities both at the community (barangay) as well as household levels.

   In this regard, analytical tools such as GIS-base mapping should also lend its utility not only in mapping bio-physical and topo-geographical vulnerabilities, but also social vulnerabilities. Vulnerability maps can thus be produced not only to show geographically, biologically or topographically vulnerable areas of the ecotown unit, but also the spatial location of vulnerabilities in terms of health, income and livelihood, and in terms of organizational capacities, among others. This necessitates a healthy mix of, and close collaborative work culture among, disciplinal experts from the natural and social science disciplines involved in the conduct of baseline profiling and vulnerability assessment.

2) The use of a participatory epistemology, as well as a gender perspective, as cross-cutting themes in the conduct of base lining, resource accounting, vulnerability assessment, and in the identification of adaptation measures to address specific vulnerabilities or capitalize on existing capacities of the ecotown unit. Specific methods toward this end may include:

a) Ensure avenues for regular and continuing discussions and consultations among researchers, and between researchers and local government unit key personnel.
b) Plan to conduct vulnerability and capacities assessment with strong involvement of local stakeholders (i.e., local government key personnel, BNSs and BHWs, local POs, etc.). This might entail initial trainings to capacitate these stakeholders to participate in the assessment activities.
c) Ensure data that can be disaggregated by gender, and the sensitivity to capture statuses and roles of women in local everyday life, especially in terms of livelihood activities and access to important resources and basic services.
d) Utilize participatory techniques of data generation and analysis whenever possible.
e) Identify participatory flashpoints in the process of implementing the ecotown framework to maximize participation from various sectors. The process flow in Figure 37 based on the experience of the IDRC-funded project can serve as an initial guide. [3]

Nowhere in history has such significant and voluminous knowledge on climate change and adaptive (as well as mitigative) response to it been produced than the past two decades. By all indications, the saga will continue as change and variability continue to confront humankind, and pose challenges especially to the sustainable development in highly vulnerable countries such as the Philippines. Indeed, the knowledge production is imperative. It is, however, equally important that such knowledge is produced collaboratively between and among the scientific community, regulatory and implementing agencies, other members of civil society, and local communities that stand at the forefront of climate change impacts. Above all, there is the urgency of making such knowledge useful, practical and available. In this way will socio-ecological systems move from vulnerability to resiliency.

[3] Highlighted parts of the process flow were conducted in the Philippine component of the project *"Building Capacity to Adapt to Climate Change in Southeast Asia."*

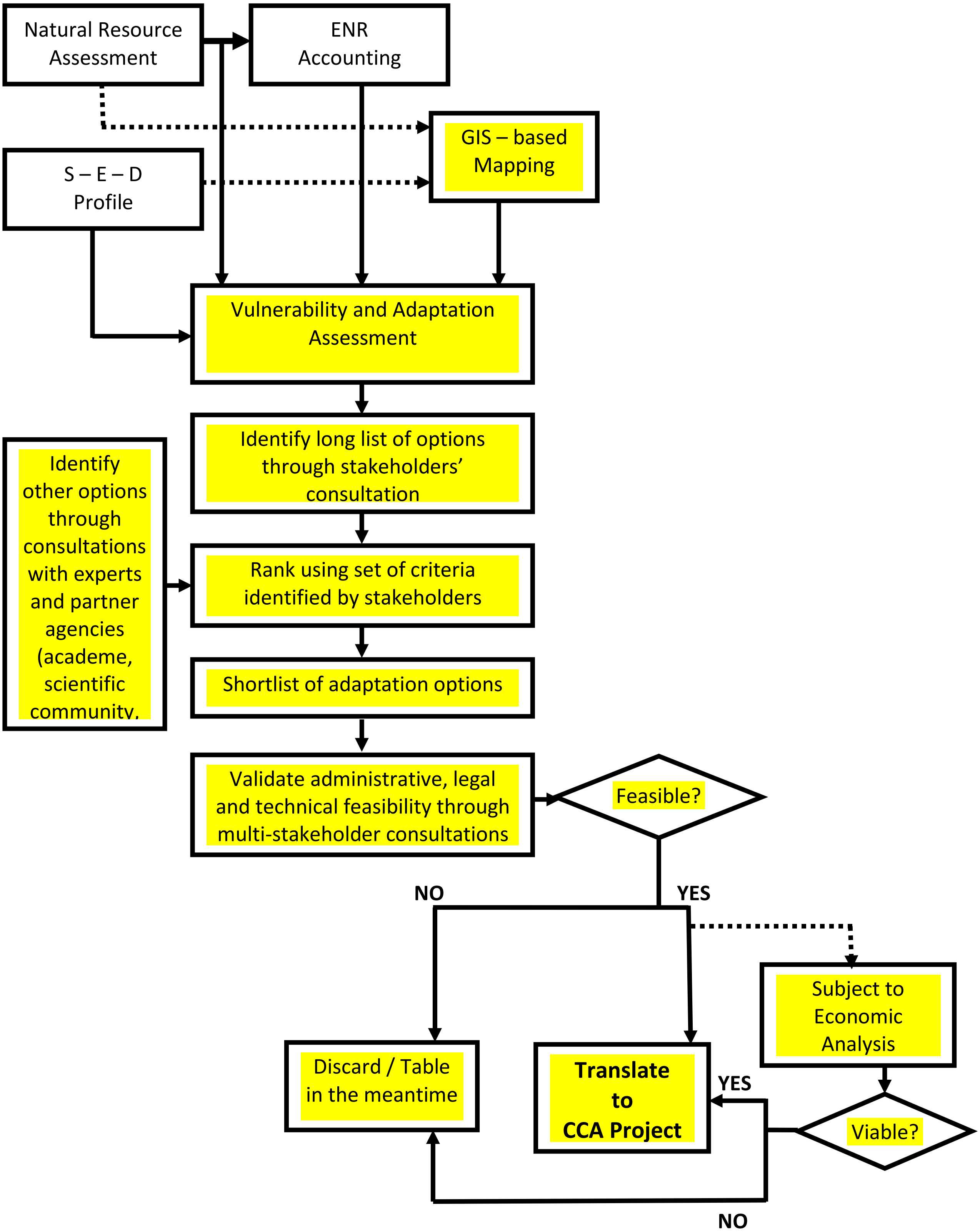


Figure 37. Recommended Decision-making Process Flow for Climate Change Adaptation within the Ecotown Framework

Annex 1. Faces of Vulnerability: Selected Cases

Case Number 1

Classification: Agri – Male Headed Household (Lowland)
Brgy San Isidro, Calauan, Laguna

Name: Serafin Lanip
Sex: Male
Age: 49
Civil Status: Married
Educational Attainment: Elementary level
Occupation: Fish pond laborer
Monthly Income: Php 3,000.00 (also the family's HH income)
Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 6

Relation to Respondent	Sex	Age	Civil Status	Educational Status
wife	Female	45	Married	Elem graduate

Number of Children: 4
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status
Son	Male	17	Single	HS level
Son	Male	14	Single	HS Level
Daughter	Female	12	Single	Hs Level
Daughter	Female	10	Single	Elementary level


Their house is located beside the irrigation for the fishponds

- One needs to cross this foot bridge in order to reach their house.
- The footbridge is washed out and needs to be replaced every time after a typhoon. No reports of any accident related to the footbridge.

Family's Monthly Expenditures:

Food	6000
Clothing	1000
Education	3000
Health	200
Electric Bill	600
Total	**10800**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: Flood, Typhoon and Drought
- Their house ensures their family's security during typhoons, but must be further reinforced
- There is no evacuation center near their house
- Can only seldom prepare for upcoming typhoons due to lack of financial resources
- No available financial resources that will help the family during recovery/rehabilitation.
- Only 1 member of the family has an insurance (life insurance)
- Damage on assets due to disasters: house and furniture
- Didn't received any support to adapt to climate change

- Brings injured / sick family members to the barangay health center (tricycle)
- Haven't heard of the term climate change but said they can cope with disaster, thanks to mass media. Their yield is affected by extreme weather.
- Both husband and wife help each other in working at a 4000 sq meters fish pond
- Only the wife attends to household chores, attends barangay meetings, and takes care of the sick /infirmed member of the family.
- Likes to stay in homeland to be with his family.
- Both husband and wife discuss HH decisions but the HH head makes the final decision in the family.
- Flood control and typhoon mitigation committee at the barangay should consist of both males and females to avoid conflict.
- It is the male members of the family who takes the role in assessing post disaster needs of the HH.
- Their family needs the following after disaster: repair house/working tools, rice, school kits, and clean water.
- Was resettled due to economic reasons; *pinaalis sila ng may-ari ng lupa sa dating tinitirhan.*
- Ethnic group have experienced typhoon, landslide, and drought.
- Said their church is a safe place for evacuation, but haven't experienced flood yet.
- Said that it is nature that causes disasters and by illegal logging.
- Received early warning messages more than 5 days before disaster from their TV.
- The LG did not check the local's emergency preparedness and did not received news update about the occurring disaster.
- Have access to telephone/mobile phone and works during disaster.
- The barangays doesn't have any flood control near their area because of their location.
- Does not take part in any emergency preparedness planning in the community.

XI. Solutions

- Reinforced/ rebuild their house
- Their community needs to enhance awareness on DRR and CC
- Plans to rebuild/ add additional floor in their house.
- Recommendations to increase adaptability: plant trees.

Case Number 2

Classification: Female Headed Household (Upland)
Brgy Burlungan, Magdalena, Laguna
Previous residence: Brgy. Baanan, Magdalena, Laguna

Name: Judelyn Evidente- Avarquez
Sex: Female
Age: 27
Civil Status: Widow (husband died 2 years ago due to road accident)
Educational Attainment: College Graduate (Secretarial Associate)
Occupation: *nagtitinda ng BBQ* and cashier in the cockpit arena in Magdalena.
Monthly Income: Php 4,240.00 (also the family's HH income)
Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 5

Relation to respondent	Sex	Age	Civil Status	Educational Status
HH help	Female	18	Single	Elem Grad

Number of Children: 3
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status
Daughter	Female	5	Single	kinder
Daughter	Female	3	Single	-
son	Male	11 months	Single	-

During our first visit, *nakatira pa po siya sa bahay nilang mag-asawa. Noong pangalawa na po, doon na po siya tumira sa bahay ng parents niya sa kabilang bahay. Siya, yung 3 niyang anak at yun pong kasama niya sa bahay yung kasama niya. Maliit lang po yugn bahay nila nung asawa niya dati e. Hindi din po xa gawa sa concrete materials.*

The house in the picture was for sale (4 floors), she told me that if it is sold she will transfer to her parent's second house.

Family's Monthly Expenditures:

Food	Covered by her parents and relatives
Clothing	Covered by her parents and relatives
Education	Covered by her parents and relatives
Health	Covered by her parents and relatives
Electric Bill	375
HH help's salary	Covered by her parents and relatives
Baby's needs	2400
communication	200
transportation	100
Total	**3075**

IV. Exposure, Sensitivity and Adaptation to Disasters:
Types of Regular Disasters: Typhoon and Drought

- Helps neighbors affected by disasters by letting them stay in their house.
- Prepares whenever there's a coming typhoon by saving 5 kg of rice and 1 gallon of mineral water (both good for 7 days).
- Some expenses were covered by her family and other relatives.
- Only 1 member of the family has an insurance (medical insurance)
- Damage on assets due to disasters: house, furniture, and absence from work.
- Didn't receive any support to adapt to climate change/ disaster because the barangays thinks they don't need it.
- Brings injured / sick family members to the barangay health center (tricycle)and to the government hospital (tricycle and jeep)
- Unaffected by typhoons because of their location (upland).
- Heard the term climate change from the TV and explains that it causes flooding and droughts.
- Unaware of existing projects/activities regarding DRR and CC in their barangay, also she haven't participated in any yet.

- Admits her work is affected by CC because they don't earn that much during rainy season.
- Her HH help and her male relatives are in-charge of the household chores.
- No one in their family attends barangay meetings; she takes care of the sick /infirmed member of the family.
- Likes to stay in homeland because she's afraid to travel (to ride a plane/ ship) and to be able to see her children grow.
- She decides for the family because her husband died.
- There have been incidences of women incurring illness after the typhoon because of old age (weak).
- Flood control and typhoon mitigation committee at the barangay should consist males because they are stronger than the women.
- It is her male relatives/ father who takes the role in assessing post disaster needs of the HH because they are skilled/ knowledgeable in that aspect.
- Their family needs the following after disaster: rice, nutritional food, electricity, and clean water.
- Was resettled due to economic reasons and because her husband died.
- Didn't use past experience in dealing with calamities since they are not affected that much.
- Her Ethnic group have only experienced typhoon.
- If she would be given a chance, she would sill choose to live in the upland.
- Said their church is a safe place for evacuation because it is made of good quality materials, but haven't experienced flood yet. The church was never used for evacuation since evacuating is not a need.
- Said that disasters are caused by supernatural reasons, but should still prepare to keep themselves safe.
- Received early warning messages 1 to 2 before disaster from their TV, but didn't do anything about it.
- The LG did not check the local's emergency preparedness, but received news update about the occurring disaster.
- Have access to telephone/mobile phone and works during disaster.
- The barangays doesn't have any flood control because they are not affected by flood.
- Does not take part in any emergency preparedness planning in the community.

XI. Solutions

- Their community needs support in strengthening infrastructure (Brgy Burlungan).

- They should also have declogging and clean-up activities. Their community is having a hard time dealing with their clogged canals especially when it rains. Some houses are flooded by the water coming from their canals (Brgy Baanan).
- Recommendations to increase adaptability: declogging and clean-up activities.

<u>Case Number 3</u>

<u>Classification: Youth (Coastal); informal settlers</u>
Pinagsanjan, Pagsanjan, Laguna

Name: Nico Neil Abas
Sex: Male
Age: 14
Civil Status: single
Educational Attainment: 1^{st} year HS
Occupation: NA
Total HH's Monthly Income: Php 2,800.00

- His mother is the one supporting their family with 9 members
- His father left them when he was 8 years old (2005).

Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 9
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status
Mother	Female	44	Separated	College level
Sibling	Female	25	Single (Parent)	HS level
Sibling	Female	20	Single (Parent)	HS Level
Nephew	Male	6	Single	Primary Level
Nephew	Male	4	Single	-
Niece	Female	1	Single	-
Aunt	Female	40	Single	HS Graduate
Uncle	Male	39	Single	HS Graduate

Family's Monthly Expenditures:

Food	2700
Clothing	600
Education	1600
communication	120
transportation	50
Total	**5070**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: Typhoon and Flood
- Their house is totally unsecure during disasters; they proceed to the nearest road and wait until the water subsides (elevated). All family members are responsible during evacuation and rehabilitation.
- Damage due to disasters: furniture and absence from work.

- Prepares whenever there's a coming typhoon by saving 2 kg of rice (for 2 days), 1 gallon of water (for a day), 3 bags of clothes (for 1 week), and 5 pcs. of candles (good for 3days).
- Can ask for financial support/ assistance from their relatives.
- Receive Food aid from the barangays after the disaster.
- Brings injured / sick family members to the barangay health center (barangay patrol).
- Thinks they can no longer withstand stronger typhoons and deeper flooding because their area is very vulnerable.
- Heard the term climate change in their school and explains that it is the drastic change in the climate.
- Unaware of existing projects/activities regarding DRR and CC in their barangay, also she haven't participated in any yet. Shared that only the friends and relatives of barangay officials and barangay volunteers are invited to attend and receives more (relief/support) compared to those who are not.
- Admits they are affected by CC because his mother gets sick if the weather becomes unpredictable.
- It is her sisters who is in-charge of the household chores.
- His mother seldom attends barangay meetings
- Likes to stay in homeland because he thinks that the cost of living in other areas are higher and they don't have any place to go.
- *Tumigil siya pag-aaral dahil nabundol ng tricycle. 2years na hindi pumasok dahil sa nerbyos.*
- His mother decides for the family.
- Flood control and typhoon mitigation committee at the barangay should consist of both males and females, but men should occupy important decision-making positions because they are stronger than the women.
- All of them takes the role in assessing post disaster needs of the HH.
- Their family needs the following after disaster: repair house/working tools, rice, clothes/ blankets, cash, nutritional food, gen. medicine, and clean water.
- His Ethnic group have experienced earthquake and flash flood.
- If he would be given a chance, he would sill choose to live in the lowland because uplands are prone to landslide.
- Said their church is not conducive for evacuation because it is small and it was never used for evacuation.
- Said that disasters are caused by supernatural reasons, but should still prepare to keep themselves safe.
- Received early warning messages 1 to 2 before disaster from neighbor's TV and radio and prepared for emergency cases

- The LG did not check the local's emergency preparedness, but heard the alarm that the water from the river will soon reach the community. 1st alarm: water level is rising; 2nd alarm: flood water has already reached the community.
- Have access to telephone/mobile phone and works during disaster.
- The barangays doesn't have any flood control because they are surrounded by trees that will act as wind brakers / water barriers.

XI. Solutions

- Have reinforced their house.
- Their community needs support in strengthening infrastructure, resettlement for people living in vulnerable areas, unity in the community, and enhance awareness on DRR and CC.
- Recommendations to increase sensitivity: be informed by the LG regarding DRR and CC.
- Recommendations to Increase adaptability: reinforce/rebuild house, save money, and keep food.

- They get their drinking water in a faucet in the slaughter house
- They don't pay any electric bill because it was cut off.; charges his phone in his relative's house near the area.
- Her sister shared that they will be relocated together with the other residents in the area because it will be used as a commercial area by the land owner. Their resettlement area is located beside the river.
- *Nakaranas ng hanggang tuhod (Ondoy) at hanggang leeg na baha (Santi). Dahil masyadong malaki ang tubig, nabanggit nilang hindi na nagagawang magtulungan ng mga magkakapitbahay."Nagkakanya-kanya nalang kami".*


Case Number 4

Classification: Female –Headed HH (Coastal)
Brgy. Sto Angel Norte, Sta. Cruz Laguna

Name: Wenda Onglengco
Sex: Female
Age: 35
Civil Status: Separated (husband is in jail)
Educational Attainment: Elementary Graduate
Occupation: part time vendor and laundry woman; Small time lottery collector
Monthly Income: Php 6,000.00 (also the family's HH income)
House is made of Semi-permanent materials.
Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 4
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status
children	Male	16	Single	HS level
Children	Male	12	Single	Elem level
children	Female	10	Single	Elem Level

Family's Monthly Expenditures:

Food	3000
Education	1000
transportation	6000
Total	**10000**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: Typhoon, drought and floods
- Their house is only secure from minor flood/ typhoon; they evacuate to their neighbor's house. Since she is a single parent, she is the one responsible for the evacuation of the family and the rehabilitation.
- Damage due to disasters: house, furniture and absence from work.
- Her son stopped schooling due to financial problems and during recovery phase he is also the one suggested to be pulled out of school.
- Prepares whenever there's a coming typhoon by saving 2 kg of rice (for 1 day)

- No available financial resources since she stopped joining cooperatives because she can no longer pay for her loans and other additional costs incurred by being a member.
- Received Food aid from the barangays after the disaster.
- Brings injured / sick family members to a government hospital (barangay patrol).
- Thinks they can adapt to CC
- Heard the term climate change in their TV and explains that it is the drastic change in the climate.
- Attends community meetings and trainings.
- Admits they are affected by CC because part time job offers are affected by heavy rains and typhoons.
- All of the members of the family are in-charge/responsible of the household chores.
- Likes to stay in homeland because she wants to be with her children.
- Her children got sick for 2 days after the typhoon.
- She is the one who decides for the family.
- Flood control and typhoon mitigation committee at the barangay should consist of both males and females because women can understand the situation of families while men are needed for their physical strength.
- All of them takes the role in assessing post disaster needs of the HH.
- Their family needs the following after disaster: repair house/working tools, rice, cash, nutritious food and, gen. medicine, and clean water.
- If she would be given a chance, he would sill choose to live in the lowland.
- Said their church is safe for evacuation, but it was never used for evacuation.
- Said that disasters are caused by nature, but that this is also due to illegal logging in the uplands.
- Received early warning messages 3 to 4days before disaster from neighbor's TV and radio and prepared for emergency cases
- The LG checked for emergency preparedness and for repairs. Updated with the occurring disaster through their television.
- Have access to telephone/mobile phone and works during disaster.
- The barangays have flood control and typhoon response committee.
- Takes part in emergency preparedness and planning through cleaning her surroundings.

XI. Solutions

- Have reinforced their house.
- Their community needs support in providing rescue equipment, enhance awareness on DRR and CC, and build. Upgrade early warning sys.
- Plans to continue repairing their house.
- Recommendations to reduce sensitivity: financial and material assistance for the HHs
- Recommendations to Increase adaptability: additional information regarding CC; improve warning device/ alarm system.

Case Number 5

Classification: Male – Agri/ Aqua HH (Coastal)
Brgy. San Pablo Norte, Sta. Cruz Laguna

- **2 months during summer lang can plant rice**
- **No private comfort room, only public**

Name: Joel Ramos
Sex: Male
Age: 41
Civil Status: Married
Educational Attainment: Elementary Level
Occupation: Part time **vendor** / Fisherman
Monthly Income: Php 3,600.00
Total HH's Monthly income: Php 15,600.00
House is made of temporary materials.
Informal settler at the lakeshore of Laguna Lake
Religion: Aglipay
Ethnicity: Tagalog

Total HH Size: 11
Details: other child got married already (18 yrs old)

Relation to Respondent	Sex	Age	Civil Status	Educational Status	Occupation
Mother-in-law	Female	65	Married	HS level	-
Father-in-law	Male	65	Married	Elementary Level	Fisherman
Sister-in-law	Female	29	Single	HS Level	Saleslady
Niece	Female	1	Single	NA	NA
Wife	Female	36	Married	HS Level	Vendor
Son	Male	15	Single	Elementary Graduate	NA
Daughter	Female	17	Single	HS Level	NA
Son	Male	4	Single	NA	NA
Son	Male	14	Single	Elem level	NA
Son	Male	2	Single	Elem Level	NA

- To be able to reach the Ramos' residence, we need to use this (15-30 meters long) foot bridge made out bamboo and scrap wood.
- Only one person at a time can pass through this makeshift footbridge; somebody from the opposite direction needs to wait for his/her turn to pass through.

Family's Monthly Expenditures:

Item	Amount
Food	3000
Education	800
Health	675
Electricity / water bills	300
Transportation	300
Total	**8,165**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: typhoon, drought, and flood
- Their house is totally unsecure, they evacuate to the nearest evacuation center whenever the water level rises.
- Male members of the family are responsible for the evacuation of the family, while female members are responsible for the rehabilitation.
- Damage due to disasters: house, furniture, damage on production (aquaculture), and illness.
- His son Jomar got sick (asthma and cols) for 3 days after the typhoon.
- His son and 2 daughters stopped schooling due to financial problems and disability (eye defect). During recovery phase he suggested to pull his daughters out of school.
- Does not make any preparation before the disaster.
- The family seeks the financial assistance of 5/6 sources.

- Received financial assistance from NGO; building materials from DSWD, Oxfam, and national government. and other NGOs; food aid from the barangays and municipal government. after the disaster.
- Brings injured / sick family members to a government hospital (tricycle).
- Thinks they can adapt to CC because they are used to flooding.
- Haven't heard the term climate change.
- Have already attended a training course held at the barangays regarding safety measures and evacuation during typhoon.
- Does not consider CC as a factor affecting their income.
- Females do the household chores and taking care of the sick/ infirmed member of the HH.
- Likes to stay in homeland because the cost of living in other area is higher.
- His father-in-law attends community meetings and trainings in the barangay.
- His wife decides for the family because she earns more than he does even if he does not agree.
- Flood control and typhoon mitigation committee at the barangay should consist of only men are strong.
- In their family, it is the men who take the role in assessing post disaster needs of the HH.
- Their family needs the following after disaster: repair house/working tools, clothes/ blankets, nutritional food, and gen. medicine.
- Resettled because the land will be utilized by the owner. Was not able to use his past experience to prepare or cope because both previous and present residence is flooded.
- His Ethnic group have experienced typhoon and drought.
- If he would be given a chance, he would sill choose to live in lowland.
- Said their church was never used for evacuation.
- Said that disasters are caused nature.
- Received early warning messages 3 to 4 days before disaster from their TV and prepared for emergency cases.
- The LG checked for emergency preparedness and ordered early evacuation. Updated with the occurring disaster through their TV and barangay's radio.
- Have access to telephone/mobile phone and works during disaster.
- Unaware if the barangays have flood control and typhoon response committee.
- Takes part in emergency preparedness and planning by participating in early evacuation and attending barangay meetings.

XI. Solutions

- Have reinforced their house.
- Their community needs resettlement for people living in vulnerable areas and availability of a barangay patrol during evacuation
- Does not have any plans to adapt since they are already used to it (flooding). Recommendations to reduce sensitivity: resettlement, but with livelihood opportunities within the area.
- Recommendations to increase adaptive capacity: preparation of both the municipality and the barangays in terms of early evacuation.




Case Number 6

Classification: Elderly (Lowland)
Brgy. San Nicolas, Bay, Laguna

Name: Fidela " Peding" Miranda
Sex: Female
Age: 81
Civil Status: Widow
Educational Attainment: Elementary Level
Occupation: Magtutuhog ng Sampaguita

- Total HH's Monthly income: Php 1,350.00
- House is made of semi- permanent materials.
- Living with her son who suffered from stroke (half paralyzed)

Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 2
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status	Occupation
Son	M	53	Separated	HS Level	none

Family's Monthly Expenditures:

Food	1350
Electric bill	Covered by her daughter
Total	**1350**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: typhoon, drought and flood
- Their house is totally unsecure; they stay at the second floor of their house during flooding. She and her daughter, who is living nearby is the one responsible for the evacuation of the family. Her son-in-law is responsible for the rehabilitation.
- Damage due to disasters: house, furniture and absence from work.
- Prepares whenever there's a coming typhoon by saving food, water and clothing good for 4-7 days.
- Receives financial assistance from relatives and neighbors.
- When accidents happen, they opt to stay at home instead of bringing the injured. Sick member of the family to the health center/hospital.
- Thinks they can cope during disaster because they can easily evacuate.
- Haven't heard of the term climate change, but admits they are affected because their yield (Sampaguita) decreases.

- She is responsible in every household chores, while her son supports her.
- Likes to stay in homeland to be with her children.
- Both her and her son caught fever and cough after the typhoon.
- Her son and 3 daughters stopped schooling due to financial problems.
- She decides for the family, because she is the only one capable of almost everything in their HH.
- Flood control and typhoon mitigation committee at the barangay should consist of women because men are always away.
- Their family needs the following after disaster: repair house/working tools, rice, clothes/ blankets, cash, gen. medicine, and clean water.
- Used her past experience in dealing/ coping with disaster, keeps /stocks food before the typhoon comes.
- Her ethnic group have experienced typhoon and drought.
- If she would be given a chance, he would sill choose to live in the lowland.
- Said their church is safe for evacuation, but it was never used for evacuation.
- Said that disasters are caused by supernatural reasons, but they should still prepare to reduce damage and prevent accidents.
- Received early warning messages more than 5 days before disaster from their TV and radio and did nothing
- The LG checked for emergency preparedness and for repairs.
- Doesn't have any access to telephone/mobile phone and works during disaster.
- The barangays doesn't have any flood control and typhoon response committee due to lack of funds.
- Too old to participate in barangay activities.

XI. Solutions

- Have reinforced their house.
- Their community needs support in finance, loan for DRR activities, strengthening infra. resettlement for people living in vulnerable areas, and enhance awareness on DRR and CC.
- Doesn't have any plans, will just stay at home and pray.
- Recommendations to increase sensitivity: additional information regarding CC.
- Recommendations to Increase adaptability: build a safe place for evacuation.

Case Number 7

Classification: Male Headed HH (Lowland)
Brgy. Hanggan, Calauan, Laguna

Name: Conrado Paynaganan
Sex: Male
Age: 51
Civil Status: Married (with live-in partner)

- His children from his first wife is still with him

Educational Attainment: HS Graduate
Occupation: none

- Former barangay councilor (served for 3 terms)
- Used to work as a guard in a construction site.
- Total HH's Monthly income: Php 3,000.00
- House is made of semi-permanent materials.

Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 7
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status	Occupation
Live–in partner	F				Laundrywoman
Son	M	14	Single	HS Level	NA
Son	M	12	Single	Elementary Level	NA
Daughter	F	16	Single	HS Level	NA
Son	F	1.2 mos	Single	NA	NA
Daughter	F	11	Single	Elementary Level	NA

Family's Monthly Expenditures:

Food	3000
Education	1000 (given by his son working in masiit)
Electric Bill	200 (illegally connected to neighbor)
communication	40
Total	**4240**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: Typhoon, earthquake and Flood
- Their house is only secure with small flood/ typhoon, they evacuate to the covered court neat the barangay hall. He is responsible for the evacuation of the family and the rehabilitation.

- Damage due to disasters: house, furniture and absence from work.
- Prepares whenever there's a coming typhoon.
- No available financial resources for the family.
- Received Food aid from the barangay after the disaster.
- Brings injured / sick family members to a government hospital (barangay patrol).
- Not sure if they can adapt to CC / cope with disaster because not all of his neighbors are prepared. In addition, livelihood and job opportunities lack in the barangay.
- Haven't heard of the term climate change, but knows that it affects their yield.
- His eldest son works in another place which provides for his children's education.
- He makes the final decision for the family.
- Flood control and typhoon mitigation committee at the barangay should consist of men only because they are strong.
- All of them take the role in assessing post disaster needs of the HH.
- Their family needs the following after disaster: repair house/working tools, firing wood/fuel for cooking, nutritional food, and clean water.
- His ethnic group have experienced typhoon.
- If he would be given a chance, he would sill choose to live in the highland.
- Said their church is safe for evacuation, and they use it because the evacuation centers are already full.
- Said that disasters are caused nature.
- Received early warning messages 3 to 4days before disaster from their TV and radio and prepared for emergency cases.
- The LG/DSWD checked for emergency preparedness and for repairs.
- Have access to telephone/mobile phone and works during disaster.
- Their barangay have flood control and typhoon response committee; he helps in cleaning canals.

XI. Solutions

- Their community needs resettlement for people living in vulnerable areas, diversification of income resource, and enhance awareness on DRR and CC, and build.
- Plans to repair their house, if only they have the means.
- Recommendations to Increase adaptability: construction mat's, proper SW management.
- Their house is just 5-10 meters away from the bridge. Lupa po yung flooring ng bahay nila. Medyo madilim din po sa loob ng bahay at mainit kasi parang kulong, hindi gasinong maaliwalas. *Kinuhanan po*

itong picture na ito ng maaraw, ganan na talaga kataas yung tubig sa kanila kahit normal lang yung weather. Bukod pa po dun puno pa ng basura.

Case Number 8:

Classification: Male-Headed HH (Upland)
Brgy. Tranca, Bay, Laguna

Name: Marilyn Brosola
Sex: Female
Age: 34
Civil Status: Married
Educational Attainment: Elementary Level
Occupation: laundry woman

- Total HH's Monthly income: Php 9,000.00
- House is made of semi-permanent materials.
- Engaged in Agri.
- Was a HH helper in Cavite, went home and looked for other sources of income because she had a hard time being away from her children.

Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 5
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status	Occupation
Husband	M	39	Married	Elementary Level	Nag uuling
Daughter	F	12	Single	Elementary Level	NA
Daughter	F	8	Single	Elementary Level	NA
Daughter	F	7	Single	Elementary Level	NA

Family's Monthly Expenditures:

Food	6000
clothing	100
Education	800
Repairing Houses	2000
Electricity and water bill	400
Total	**9,300**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: typhoon, drought and flood, landslide / erosion.
- Their house which is 5 meters away from their present residence was washed away by flood water. They tied their house with a rope which they bought for Php 300.00, but the house was still washed out.

- Their house is beside a body of water, and is totally unsecure. They evacuate to their relative's house.
- The HH head is responsible for the evacuation and rehabilitation of their family.
- Had a son who was epileptic, he died after the typhoon.
- Damage due to disasters: house, furniture, crops, and absence from work.
- The respondent (wife) has a medical insurance (Phil Health).
- Prepares whenever there's a coming typhoon.
- Depends on the financial assistance of TSPI (cooperative).
- Received food aid from the municipal govt. after the disaster.
- Thinks they can adapt to disasters because they are prepared.
- Haven't heard the term climate change.
- Likes to stay in homeland because she wants to be with her children.
- Male HH head makes the final decision for the family.
- Flood control and typhoon mitigation committee at the barangay should consist of men because they are strong.
- Their family needs the following after disaster: school kits and clean water.
- Uses settled cultivation and applies new cropping season due to changing climate, nobody provided the instruction they just decided when to plant.
- If she would be given a chance, she would sill choose to live in the lowland.
- Said their church is safe for evacuation, was already used as one during the prev. typhoons.
- Said that disasters are caused supernatural reasons.
- Received early warning messages 3 to 4days before disaster from their TV and prepared for emergency cases
- The LG checked for emergency preparedness. Updated with the occurring disaster through their television.
- Doesn't have any access to telephone/mobile phone.
- The barangay does not have any flood control and typhoon response committee.

XI. Solutions

- Have reinforced their house, changed cropping pattern, and diversified agri activities.
- Their community needs support in finance, loan for DRR activities and food.
- Recommendations to increase adaptability: repair their house






<u>Case Number 9</u>

<u>Classification: Elderly (Upland)</u>
Brgy. Antipolo, Rizal Laguna

Name: Francesca Uriquia
Sex: Female
Age: 74
Civil Status: Widow

- Her husband drowned during a typhoon last 2009
- The body of her husband was never found
- They own fish cages before, but was not maintained after her husband's death.

Educational Attainment: Elementary undergraduate
Occupation: none, but plants root crops for subsistence.

- Depends on her children for financial support

Total HH's Monthly income: Php 2,000.00 (from her son)
House is made of permanent materials.
Religion: Catholic
Ethnicity: Tagalog
Total HH Size: 1

Family's Monthly Expenditures:

Food	Given by children
transportation	200
electricity	25
Total	**225**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Her house is totally secure, but transfers to her son's house during disasters *dahil ninenerbyos daw siya pag may bagyo.*
- Damage due to disasters: furniture and damage to crops.
- It is her son and grandchild (male) who is responsible for the rehabilitation and the decision making for her.
- One of the reported houses damaged by the typhoon, experienced employees from municipal/provincial government went to investigate and took pictures, but did not received any support/assistance.
- Her daughter-in-law accompanies her during the day, she is also responsible in the HH chores and the person who takes care of the respondent whenever she's sick.
- Her daughters lives and works in manila where they already have their own families.

- No plans to move to other place, *kuntento na daw siya at hinihintay nlang din daw niyang mamatay na din siya.*
- Damage due to disasters: house, and damage on production (agriculture and aquaculture).
- *Hindi nakakuha ng insurance dahil hindi pa naman daw uso yun noong nagtatrabahao pa siya.*
- Aside from her children, she doesn’t have other financial resources.
- Thinks they can adapt to CC because her neighbors are capable of preparing and repairing their house.
- Flood control and typhoon mitigation committee at the barangay should consist of both women, because they should responsible in everything especially if their husbands are working.
- Their family needs the following after disaster: seedling/breeding, cash, and nutritional food.
- Her ethnic group have experienced typhoon.
- If she would be given a chance, she would still choose to live in lowland.
- Said she’s not sure if the church was used for evacuation because it is far from their house and they haven’t experienced flooding in the area.
- Said that disasters are caused by supernatural reasons, but they should still prepare to reduce effects/impacts.
- Received early warning messages 1 to 2 days before disaster from their TV and did nothing.
- The LG did not check for emergency preparedness.
- Have access to telephone/mobile phone and works during disaster.
- Said she doesn’t attend barangay meetings and other activities because she’s too old and weak.

XI. Solutions

- Have reinforced their house.

Case Number 10

Classification: Female Headed HH (Coastal)
Brgy. San Roque, Victoria, Laguna

Name: Elvira Sanggalang
Sex: Female
Age: 64
Civil Status: Widow

- Her husband died due to depression after being bankrupt in their itikan business caused by typhoons.

Educational Attainment: HS Graduate
Occupation: pensioner

- Total HH's Monthly income: Php 41,000.00
- All of her children graduated college and are already working, she depends on them for financial assistance.
- Owns 1 ha of rice cultivate land, after being bankrupt she gave it to her brother.
- Lost more than 1 million pesos due to disaster.
- House is made of permanent materials.

Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 6
Details:

Relation to Respondent	Sex	Age	Civil Status	Educational Status	Occupation
Daughter	F	30	S	College Graduate	Customer service ass.
Son	M	28	M	College Graduate	Quality control
Son	M	26	S	College Graduate	Seaman (OFW)
Daughter-in-law	F	26	M	College Graduate	Operator
Grand daughter	F	1.4 years	S	NA	Na

Family's Monthly Expenditures:

Food	10000
Health	500
Repairs	1000
Electricity	2500
Communication	1000
Transportation	1000
Baby's needs	3000
Total	**19000**

IV. Exposure, Sensitivity and Adaptation to Disasters:

- Types of Regular Disasters: typhoon, drought, and flood
- Their house is totally secure, they help their affected neighbors by providing food and financial assistance after the disaster.
- Male members of the family are responsible for the rehabilitation.
- Damage due to disasters: house, furniture, means of transportation, damage on production (agriculture and poultry), and death.
- Prepares before the disaster comes by storing rice, water and sources of light, enough to be used by her family for a week.
- Can ask for financial assistance from family members
- Received food aid from the barangay after the disaster.
- Brings injured / sick family members to the barangay health center (tricycle).
- Thinks they can adapt to CC because they are used to flooding.
- Have heard of the term climate change though their TV and radio.
- *Admits that their business is highly vulnerable to typhoons and flooding*. *Malayo daw po kasi yung itikan nila at rice field kaya pag nag baha sa Victoria masinuuna nilang isalba yung mga sarili at mga gamit nila bago i-check yung kabuhayan nila.*
- All of the family members assists in their poultry business, while the females are responsible for the household chores and taking care of the sick/ infirmed member of the family. The respondent is also responsible in attending barangay meetings and training courses in agri/aquaculture.
- Her youngest is an OFW.
- Likes to stay in homeland to be with her family.
- Flood control and typhoon mitigation committee at the barangay should consist of both men and women.
- Their family needs the following after disaster: repair house/working tools, rice, nutritional food, clean water, and gen. medicine.
- He ethnic group have experienced typhoon and drought.
- If she would be given a chance, she would sill choose to live in lowland.
- Said their church was never used for evacuation, but is safe place because it is located in an elevated area.
- Said that disasters are caused nature.
- Received early warning messages 1 to 2 days before disaster from their TV and radio and prepared for emergency cases.
- The LG checked for emergency preparedness and announced about the coming typhoon.
- Have access to telephone/mobile phone and works during disaster.
- Their barangays lacks the budget to afford flood control and typhoon response committee.

- Takes part in emergency preparedness and planning by attending barangay meetings and following the their orders when it comes to emergency preparedness.

XI. Solutions

- Have reinforced their house.
- Their community needs support in finance, loan for DRR activities, support in strengthening infra. Diversification of income resource, enhance awareness on DRR and CC, and regular barangay clean-up.
- Plans to repair their house.
- Recommendations to decrease sensitivity: IEC on CC.
- Recommendations to increase adaptability: use the barangay service for clean-ups.





CASE NUMBER 11

Classification: Non-agricultural (Lowland)

Brgy. San Nicolas, Bay, Laguna

Name: Julie Moral
Sex: Female
Age: 47
Civil Status: Married
Educational Attainment: Elementary Level
Occupation: occasional wreath making

- House is makeshift and made of temporary materials.
- Living with husband and 5 children

Religion: Catholic
Ethnicity: Tagalog

Total HH Size: 7

Julie Moral, a housewife of a contractual laborer in Brgy San Nicolas in Bay, Laguna, lives with her five children in their six (2x3) square meter house with an attic serving a sleeping area. All of her younger children are studying in Bay Central Elementary School, a public school in their municipality. Their family is a beneficiary of the 4Ps program of the national government, but the financial assistance tends to be delayed at times. She makes sampaguita leis and is paid Php 15.00 for every 100 pcs. of leis. She used to sell viands before engaging in sampaguita lei making, she needed home-based source of income since she takes care of her children.

They have experienced typhoon and flooding in their barangay. They were forced to evacuate during Typhoon Milenyo (2006) while they just stayed at the second floor of their house during Typhoon Ondoy (2009). They were drenched during the latter since their roof has small holes in it, making her children ill and suffer from fever. During Typhoon Milenyo, she was afraid that they might encounter a snake on their way to the evacuation center (Chapel) since the flood water is murky and deep. The lack of financial resources during emergencies made their situation in the evacuation center harder; they weren't able to contact her husband's employer since electricity and communication were down then. After the mentioned typhoons, they received food aid and building materials from their barangay and from the municipal government. Their house was seriously damaged after the typhoon, a portion of their roof was ripped off and their door and wall peeled off.
Their family needs the following after the typhoon: building materials for house repair, clothes/ blankets, rice/food, medicine, clean water, and money. Aside from the fact that they are informal settlers, they also plan to move to another

place since they are greatly affected during typhoons and flooding in the area. She shred that their community needs to build permanent housing or resettlement, rescue equipments, training and awareness on disaster preparedness and emergency response, and building or upgrading the barangay's early warning device/equipment.

Annex 2. Key Informant Interview (KII) Guide (Social and Gender Vulnerability Assessment)

Objective: To gain a wider understanding of vulnerabilities and capacities of barangays/communes through those who have knowledge and influence on local communities.

Suggested informants / interviewees:

Key Informant	Number
• provincial leaders including PG/ENRO	3
• district/municipal leaders/decision-makers o Mayor/leader o Planning officer o Environment/Agriculture/Disaster management o PO rep / Mass organization rep (can be flexible)	6
• commune/ barangay leaders/ village leaders	6
• farmer association reps at commune	3
• youth reps (from 3 communes)	3
• women leaders / mother and child association	3
• reps from religious sector	3
• NGO reps (e.g., Red Cross)	3
TOTAL	**30**

Justification for the choice of key informants:

Local government officials and other community leaders usually have more contact with locals and thus are privy to their issues and concerns. Their knowledge of community life is thus crucial in arriving at a more holistic assessment of the climate change – related vulnerabilities of their communities. Their knowledge is also important to the eventual success of disaster risk reduction activities and the impact of these on different community sectors. This is partly because they control many resources and have influence over development activities in the area. By communicating with key informants, there will be an increased chance that activities to reduce vulnerability will eventually be supported, or at least not challenged, by those in power.

Activities

- Identify key informants.
- Develop questions for semi-structured interviews.
- Interview the key informants.
- Consolidate information and present it to appropriate audience (in some cases this

may possibly or even necessarily include the key informants themselves, particularly
government officials) for communication, validation, and discussions about vulnerabilities and possible actions).

KII Guide Questions:

- How long have you lived or worked in the area? Have you changed residence within the area?
- What is your role?
- What hazards affect local communities?
- In the last 10 years, are there major flooding incidences that occurred in your community? When did these occur?
- How did these flooding incidences affect you? the other people in the community?
- What are your roles (differentiate prescribed, perceived and performed roles) specifically before (in preparation), during, and after the occurrence of flooding in your area?
- Are there any constraints in the performance of your roles? What are these constraints?
- Who do you consider to be the most vulnerable to flooding in the local area?
- What do you consider to be the priority vulnerabilities of local people?
- Why do these vulnerabilities exist?
- Are there actions being done to solve/ abate/ reduce these vulnerabilities?
- What else can be done at the community level and the household level to solve/ abate/ reduce these vulnerabilities?

Note: *You may use suggested KII Form1 to organize the interviews.*

KII Form 1.

Interviewer:		Call Number:
Name of key informant:	Position:	Date of interview:

How long have you lived or worked in the area? Have you changed residence within the area? Length of residence in the area (in years): (indicate changes in location of residence within the community)
What is/are your role(s)? What tasks does your position/ work entail? Type and length of work or occupancy of office in the area (in years): (capture changes in work e.g., farmer before, now LGU official, etc.)

What hazards affect local communities? In the last 10 years, are there major flooding incidences that occurred in your community? Climate change hazards:	***When did these occur?*** When	Length of occurrence
1. Typhoon		
2. Flooding		
3. Drought		
4. Landslide		
5. Extreme climatic conditions		
6. Others (specify)		

How did these flooding incidences affect you? the other people in the community? Effect of hazards:	On self	To community
1. Typhoon		
2. Flooding		
3. Drought		
4. Landslide		
5. Extreme climatic conditions		
6. Others (specify)		

What are your roles (differentiate prescribed, perceived and performed roles) specifically before (in preparation), during, and after the occurrence of flooding in your area?
Roles/tasks relative to hazards:

Hazard	Before (Preparedness)	During Response)	After (Recovery/Rehabilitation)
1. Typhoon			
2. Flooding			
3. Drought			
4. Landslide			
5. Extreme climatic conditions			
6. Others (specify)			

Are there any constraints in the performance of your roles? What are these constraints?
Contraints:

Personal choices
Structural constraints
Environmental / ecological factors
Economic considerations

Who do you consider to be the most vulnerable to flooding in the local area? Vulnerable groups/sectors in the community:	• ***What do you consider to be the priority vulnerabilities of local people?*** • ***Why do these vulnerabilities exist?*** Explanation for these vulnerabilities

Are there actions being done to solve/ abate/ reduce these vulnerabilities? Current Adaptations:	***What else can be done at the community level and the household level to solve/ abate/ reduce these vulnerabilities?*** Possible Adaptations:

Annex 3. In-Depth Interview Schedule (Social and Gender Vulnerability Assessment)

Questionnaire No.________

Household Code : _________

Sitio/Village:	
Barangay/Commune:	
Town / City:	
Province:	

Interviewer:	
Date of Interview:	
Time started:	Time finished:
Checked by:	Date:
Encoder:	Date:

I. RESPONDENT'S PROFILE

1.1 NAME:	1.2 SEX: 10. Male 11. Female	1.3 AGE:	1.4 CIVIL STATUS: • Single • Married • Widow(er) • Separated	1.5 EDUC. ATTAINMENT	1.6 OCCUPATION	1.7 MONTHLY INCOME	1.8 RELIGION	1.9 ETHNICITY

1.10 Is the respondent the household (HH) head?

- ☐ YES (go to 1.12)
- ☐ NO

1.11 If NO, what is the respondent's relationship with the HH head?

- Household head (HH)
- Wife/husband of HH
- Grandfather/ grandmother
- Children
- Other, please specify: __________________________________

II. HOUSEHOLD PROFILE

2.1 Name:	2.3 Relation To Respondent	2.4 Sex:	2.5 Age:	2.6 Civil Status:	2.7 Educ. Attainment	2.8 Occupation	2.9 Monthly Income	2.11 Religion	2.12 Ethnicity
2.2 * Total HH Size :						2.10 ** Total HH income:			

Codes:				
Relation to respondent:	*Sex*	*Civil status*	*Educational attainment*	
1 – husband *2 – wife* *3 – child* *4 – parent* *5 – sibling* *6 – grandparent* *7 – others, pls specify*	*1 – male* *2 - female*	*1 – single* *2 – married* *3 – widow(er)* *4 - separated*	*1 – no formal education* *2 – primary level* *3 – elementary level* *4 – elementary graduate* *5 – HS level* *6 – HS graduate* *7 – college level* *8 – college graduate* *9 – vocational* *10 – others, pls specify*	** Include respondent* ***include respondent's income*

2.13 Type of housing (based on ocular observation; take photos if possible)

Type of house	Description	Mark	Remarks
Permenant	Brick walls, cement pillars with steel rod	☐	
Semi-Permenant	Brick walls, bamboo/wood of low quality pillars	☐	
Temporary	Bamboo walls, bamboo/wood of low quality pillars	☐	
Others		☐	

III. LIVELIHOOD

3.1 Land resource of household

No.	Land type	Area (m2)	Yield *	Origin **	Erosion/ (m2)
1	Rice cultivated land				
2	Crop cultivated land				
3	Vegetable cultivated land				
4	Garden				
5	Forest land				
6	Residential land				
7	Aquaculture area				
8	Other (please clarify):				

Codes for origin:

1 – if landholding was awarded by gov't.
2 – if landholding has title
3 – if landholding was inherited
4 – if landholding was acquired through sale
5 – others, pls specify

3. 2 HH's sources of income

No.	***Resources***	Quantity *	Yield **	*GO of 2010 (in country's currency)*	*Estimated percentage of production on GO (%)*
1	*Rice (ha)*				
2	*Crop (ha)*				
3	Vegetable (ha)				
4	*Forest (ha)*				
5	Pig (head)				
6	*Cattle (head)*				
7	*Poultry (head)*				
8	*Aquaculture*				
9	*Handicraft (labor)*				
10	*Day laborer (labor)*				
11	*Services*				
12	*Lending/renting*				
13	*Small scale enterprise*				
14	*Remittance*				
15	*Pension*				
16	*Other (pls clarify) …………………….*				

*Notes: * record based on given unit*
*** record kg for resources*

3.3 What kind of jobs have you worked on for the last 10 years?

Name of jobs	**Number of years**

3.4 For what reasons do you change or take on another job?

____

____

3.5 Monthly expenditures of HH

No.	***Items***	**Monthly expenditures in 2010 (in country's currency)**
1	*Food*	
2	*Clothing*	
3	*Education*	
4	*Health*	
5	*Repairing houses/breeding facilities/working tools*	
6	*Funeral/wedding*	
7	*Electricity and water bills*	
8	*Communication*	
9	*Transportation*	
10	*Others, pls. specify* ________________________________	
	TOTAL	

IV. EXPOSURE, SENSITIVITY AND ADAPTATION TO DISASTERS

4.1 Types of regular disasters experienced by the HH

Type of disaster	**Mark**	**Remarks**
Flood	☐	
Typhoon	☐	
Drought	☐	
Landslide/erosion	☐	
Saline intrusion	☐	
Cold spell	☐	
Others, pls specify ______________________	☐	

4.2 In case of serious disasters (ex: flood in 2007, typhoon 2009), does you house ensures security for the members of your HH?

 1. Totally unsecure 2. Only secure with small flood/typhoon
 3. Secure but must be further reinforced 4. Totally secure (skip 4.3 and 4.4; go to 4.5)

4.3 If your house is unsecured, where can you evacuate?

 1. Neighbors' houses 2. Communal house / kindergarten / LGU covered court
 3. CPC's house / barangay hall 4. Second floors schools
 5. Church / pagoda 6. Others, pls specify ________________________________

4.4 Who is responsibile for the evacuation of the family when disaster occurs?
 1. Husband/son 4. All family members
 2. Wife/daughter 5. Others, pls. specify________________________________
 3. Husband and wife

4.5 If your house ensures security for your HH members, do you help neighbors in times of disasters?

 1. Yes 2. No

4.6. If Yes, how do you help them? Please describe ____
____
____

4.7 Have your family ever suffered any damages due to disasters past 10 years?

 1. YES 2. NO

4.8 If YES, please tick / mark type of damages you suffered?

No.	*Description*	Mark √ (if have)
1	*Damage on assets*	
	House	
	Furniture	
	Means of transporation / vehicles (bikes, motorcycle, cars and boats)	
	Others, pls specify ____	
2	*Damage on production(farm-based)*	
	Crop/agriculture/forestry	
	Animal husbandry	
	Aquaculture	
	Services	
	Others, pls specify ____	
3	*Loss of income (off-farm)*	
	Jobless/stop working due to disasters	
	Enterprise	
	Handicraft	
	Others, pls specify ____	
4	*Loss of lives / health*	
	Death (list down number of death)	
	Injuries (list down number of injured people	
	Illness (Number of people who incurred illnesses / diseases	
	Others, pls specify ____	
5	*Damage on cultivated land*	
	Land slide/erosion	
	Siltation	
	Saline intrusion	
	Broken dyke of Fishponds	
6	Others, pls specify ____	

4.9 Who is responsible for rehabilitation after disaster in family?

 1. Husband/son 4. All family members
 2. Wife/daughter 5. Others, pls. specify________________________________
 3. Husband and wife

4.10 Do you or your family members have insurance?

 1. Yes (pls supply information in the following table) 2. No (skip the table and proceed to 4.11

Name of HH member with insurance	Sex	Relation to HH head	Type of insurance
Respondent:			
Codes	*1 – Male* *2 - Female*	*1 – husband* *2 – wife* *3 – child* *4 – parent* *5 – sibling* *6 – grandparent* *7 – others, pls specify*	*1 – Social insurance* *2 – Health insurance* *3 – Accident insurance* *4 – Agricultural insurance* *5 – Others, pls specify*

4.11 If NO, why?____
____
____

4.12 Under impacts of climate change, agricultural production will most likely face more disaster risks. Do you think that farmers/fishermen should take out agricultural insurance?

 1. YES 2. NO

4.13 Why?
____
____

4.14 Do you make preparations before a disaster?

☐ 1. YES ☐ 2. NO ☐ 3. SOMETIMES ☐ 4. Others, pls specify _____________

4.15 If yes, what do you prepare? For how long will the items be used, or will last (in days)?

Item	Amount (specify unit – e.g., kg, L, no., etc)	Number of days item will last
Rice		
Drinking water		
Clothing		
Others, pls. specify ________________________________		

4.16 What type of financial resources are available to help in recovery/rehabilitation of the household after disaster?

☐ 1. Savings of family
☐ 2. Loan
☐ 3. Others, pls specify ________________________________

4. 17 Where can you get a loan? (pls check)

Formal Financial Insitutions	Mark	Informal Credit Sources	Mark
1. Banks	☐	6. Family member / relatives	☐
2. Micro-finance institutions	☐	7. Neighbors	☐
3. Savings and loans association	☐	8. Informal communal funds	☐
4. Credit cooperatives	☐	9. 5/6 sources	☐
5. Others, pls specify _______________	☐	10. Others, pls specify _____________	☐

4.18 Have you ever received support to adapt to climate change?

☐ 1. YES ☐ 2. NO

4.19 If Yes, what type of support have you received, and from whom/where?

Type of support *(check if applicable)*	Source of support *(choose codes below)*	Remarks
☐ 1) Labour	☐	
☐ 2) Finance	☐	
☐ 3) Building materials	☐	
☐ 4) Rescue material (lifevest, life bouy, first aid, medicine)	☐	
☐ 5) Food aid (drinking water, instant noodle, cloths...)	☐	
☐ 6) Production (seedling, fertilizer, ...)	☐	
☐ 7) Change livelihood (new activity of income generation)	☐	
☐ 8) Consultancy in changing calendar of crop/breeding	☐	
☐ 9) technical training courses	☐	
☐ 10) Others, pls specify ______________________________	☐	
Codes for source of support	*1 – national government* *2 – provincial government* *3 – municipal government* *4 – barangay* *5 – NGOs* *6 – family / relatives* *7 – friends / neighbors* *8 – others, pls specify*	

4.20 When accidents happen during disasters, where do you transfer injured members of your HH, and through what means of transport?

Where injured person is brought	Means of transport	Remarks
☐ 1. Stay at home		
☐ 2. Relative's house		
☐ 3. Naighbour's house		
☐ 4. Local / barangay health center		
☐ 5. Local private clinics		
☐ 6. Government hospital		
☐ 7. Private hospital		
☐ 8. Others, pls specify ________________		

4.21 Do you know any case of childbirth during disaster?

 1. YES 2. NO

4.22 If Yes, pls clarify (*who, where, when, how*):

____

____

4.23 Do you think people are able to adapt to climate change or cope with disaster?

 1. YES 2. NO

4.24. Why?

____

____

V. KNOWLEDGE ABOUT CLIMATE CHANGE

5.1 Have you ever heard of the term " climate change"?

 1. YES 2. NO

5.2 If Yes, what is the souce of your information?

Type of media	Mark (if applicable)	Remarks
1) Television		
2) Radio		
3) Posters		
4) Notice board		
5) Newspaper, magazine		
6) Training course		
7) Village meeting		
8) Others, pls specify ____________________________		

5.3 **What do you know about climate change?**

____

____

5.4 **Have you ever taken part in a training on climate change?**

□ 1. YES □ 2. NO

5.5 **If Yes, who conducted the training course?**

Source	Mark (if applicable)	Remarks
1. Local government		
2. NGO		
3. State project		
4. Mass organizations		
5. Academe / University		
6. others, pls specify ______________________________		

5.6 **Do you think climate change (extreme climate) affects to your work/income?**

□ 1. YES □ 2. NO

5.7 **If Yes, how does it affects your work/income?**

____

____

VI. GENDER & CLIMATE CHANGE

6.1 Compare the work of men and women under CC impacts

Type of work	**Wife** 1. work more 2. work less 3. Unchange 4. Not applicable	**Husband** 1. work more 2. work less 3. Unchange 4. Not applicable	**Daughter** 1. work more 2. work less 3. Unchange 4. Not applicable	**Son** 1. work more 2. work less 3. Unchange 4. Not applicable	**Other** 1. work more 2. work less 3. Unchange 4. Not applicable
a)Agriculture					
- Ploughing					
- Sowing					
- Fertilizing					
- Weeding					
- Spraying					
-Watering					
- Harverting					
- Selling products					
b) Husbandary					
- Pig, Poultry					
- Cattle					
- Water for animal					
c) Aquaculture					

Type of work	**Wife** 1. work more 2. work less 3. Unchange 4. Not applicable	**Husband** 1. work more 2. work less 3. Unchange 4. Not applicable	**Daughter** 1. work more 2. work less 3. Unchange 4. Not applicable	**Son** 1. work more 2. work less 3. Unchange 4. Not applicable	**Other** 1. work more 2. work less 3. Unchange 4. Not applicable
d) Services, handicraft					
- Services for cultivation					
- Small business					
- Handicraft					
e) Forestry					
- Ploughing					
- Planting					
- Protecting					
- Harverting added forestry products					
- Timbering					
-Selling products					
g)Housework					
Collecting wood for cooking					
Carrying water for daily activity of family (showering, cooking...)					
Taking care sick people					

6.2 Does migration occur in your barangay /commune?

 1. YES 2. NO

6.3 Does your family have any out migrants?

 1. YES 2. NO

6.4 If Yes, who migrates and for what reason(s)?

Check if applicable	Reason for out migration	Remarks
1. Husband		
2. Wife		
3. Eldest son		
4. Eldest daughter		
5. Others, pls specify ___________________		

6.5 **When husband/eldest son migrate to earn money, who is responsible for emergency preparedness or repairing house/working tools when disaster occurs?**

 1. Wife 3. All family members
 2. Eldest daughter 4. Others, pls specify _________________________

6.6 Are there any traditional customs and beliefs which make local people stay in their homelots even when disasters constantly affect their work?

 1. YES 2. NO

6.7 If Yes, pls explain / clarify:

____

____

6.8 Would you prefer to work in your homeland or migrate permanently to other places?

 1. Stay in homeland 2. Migrate permanently to another place

6.9 Why?

____

____

6.10 Are there incidences of women incurring injuries before, during and after disasters? (Flood 2007, typhoon 2009)

 1. YES 2. NONE (skip 6.11)

6.11 If Yes, what kind of injuries? Kindly explain why and how these injuries are incurred.

When injuries were incurred	Why?	How?
Before disaster		
During disaster		
After disaster		

6.12 After the disaster, did family members get sick? (Floodv2007, typhoon 2009)

 1. YES 2. NO (skip 6.13 and 6.14; go directly to 6.15)

6.13 If Yes, who got sick and what kind of diseases were contracted?

Family members who got sick (childrens, women, men, elderly, etc.)	Type of disease(s) contracted	Remarks
1.		
2.		
3.		

6.14 Who took care of the sick / infirmed members of the family?

 1. Husband
 2. Wife
 3. Children
 4. Self-care
 5. Others, pls specify ___________________________________

6.15 Who in the family takes part / attend in community meeting?

 1. Husband
 2. Wife
 3. Son
 4. Daughter
 5. No one
 6. Others, pls specify ___________________________________

6.16 Who takes part / attend in training course on aqua/agrictulture?

- 1. Husband
- 2. Wife
- 3. Elder son
- 4. Elder daughter
- 5. No one
- 6. Others, pls specify ________________________________

6.17 Does your household have children who dropped out of school before reaching high school? How many children?

- 1. YES
- 2. NO (skip 6.18)

Children	In school	Dropped out of school	Reasons for dropping out of school
Son(s)			
Daughter(s)			
Codes for Reasons			*1 – Financial problems* *2 – Children don't want to study* *3 – Difficulty in scholastic performance* *4 – Erratic school attendace due to disaster-related disruptions* *5 – Belief that child doesn't need to to have high level of education* *6 – Others, pls specify* ________________________________ ____

6.18 What are the reasons for the child's / children's dropping out of school? (you can use last column of table above)

____

____

6.19 During recovery phase from disaster or when needed, who among the children in your HH do you suggest to to be pulled out of school to help parents?

- 1. Daughters
- 2. Sons
- 3. None of them

6.20 Have anybody in your HH ever made major decision in changing jobs/livelihood/business?

- 1. YES
- 2. NO (skip 6.21)

6.21 Who was / were decisionmaker/s for those big change? (Mark only one)

Decision maker	Mark (✓)	Remarks
• Wife decided all, because her husband was absent	☐	
• Husband decided all, because his wife was absent	☐	
• Wife decided all without discussion with her husband	☐	
• Wife decided all even if husband did not agree	☐	
• Husband decided all without discussion with his wife	☐	
• Husband decided all even if wife did not agree	☐	
• Both of them discussed but husband made final decision	☐	
• Both of them discussed and agreed	☐	
• Other person (male) in family decided	☐	
• Other person (female) in family decided	☐	
• Others, pls specify ________________________________	☐	

6.22 Inyour opinion, flood control and typhoon mitigation commitee at the commune / barangay should consist of :

☐ 1. Only men
☐ 2. Men and women, but men should occupy important / decision-making position/s
☐ 3. Men and women , with both having equal opportunities to occupy important / decision-making positions
☐ 4. Only women

6.23 Please explain your opinion:

____

____

6.24 In your family who takes the role of assessing post-disaster (after disaster) needs of the HH?

☐ 1. Only men
☐ 2. More men than women
☐ 3. Men and women both play active role
☐ 4. More women than men
☐ 5. Only women

6. 25 Please explain your answer to 6.24:

____

____

6.26 Please list down your needs after disaster
(*<u>Note to interviewer</u>: do not lead respondent's answers by suggesting the options; only mark in separate columns according to answers and gender of interviewee*)

Needs	Male interviewee (✓)	Female interviewee (✓)
Repair house/working tools	☐	☐
Rice	☐	☐
Clothes, blankets	☐	☐
Firing wood/fuel for cooking	☐	☐
School kits	☐	☐
Seedling/breeding	☐	☐
Fertilizer	☐	☐
Food for animal/poultry	☐	☐
Cooking tools	☐	☐
Cash	☐	☐
Clean water	☐	☐
Nutritional food	☐	☐
General medicine	☐	☐
Medicine for gynaecological disease	☐	☐
Sanitary napkin	☐	☐
Others, pls specify ____________________	☐	☐
	☐	☐

VII. ETHNICITY

7.1 What is your ethnicity/ ethno-linguistic group? (Note: make choices according to ethnic groups applicable to each country

Vietnam: ☐ 1. Kinh ☐ 2. Ta Oi ☐ 3. Pa C ☐ 4. Van Kieu

Philippines:

☐ 1. Ilocano
☐ 2. Pangasinense
☐ 3. Kapampangan
☐ 4. Tagalog
☐ 5. Bicolano
☐ 6. Ilonggo
☐ 7. Samaron-Leytean
☐ 8. Cebuano
☐ 9. Others, pls. Specify ______________________________

7.2 Are you living in a mix ethnic group or separated ethnic group community?

☐ 1. Separated groups ☐2. Mix group

7.3 What is the classification of your residence?

☐. 1 Indigenous / original (skip 7.4 and 7.5) ☐2. Resettlement

7.4 Why you were resettled:

☐ 1. Due to economic reasons
☐ 2. Due to planning of local government
☐ 3. Due to living in inundated area/landslide/erosion
☐ 4. Others, pls specify ____

7.5 If due to 3RD reason, did you receive any support from the government for resettlement?

☐ 1. YES ☐ 2. NO (skip 4.6)

7.6 If Yes, pls explain (what kind of support, how support was extended, if there are requirements to be able to qualify for support, etc.)

____

____

7.7 In new resettled area, did you experience new disaster?

□ 1. YES □ 2. NO (skip 7.8 and 7.9)

7.8 If Yes, did you use your old experience to prepare/cope with these new experiences?

□ 1. YES □ 2. NO

7.9 Please explain why and how?

____

____

7.10 Does your ethnic group have experience in emergency preparedness/ coping with disaster?

□ 1. YES □ 2. NO

7.11 If Yes, please mark in what kind of disaster does your ethnic group have experience in coping / preparedness?

Type of disasters	Mark (✓)
Land slide/erosion	□
Typhoon	□
Drought	□
Cold spell	□
Flash flood	□
Others, pls specify ___________________	□
	□

7.12 Did you receive any support / assistance from the local government for your family during and after the disaster?

□ 1. YES □ 2. NO

7.13 What is your farming practice?

□ 1. Settled cultivation □ 2. Shifting cultivation

7.14 **If settled cultivation, do you apply a new crop season calendar due to climate-related changes?**

 1. YES 2. NO

7.15 **If Yes, who provided you with instructions?**

 1. Agricultural extension personnel 2. Neighbour 3.Self

7.16 **If you have chance to select living area, where do you want to live?**

 1.Lowland 2. Upland

VIII. CULTURAL BELIEF SYSTEM

8.1 **What is your religious practice?**

 1. Catholic 2. Protestant 3. Islam 4. None 5. Others, ______________

8.2 **Do you often go to Church/Pagoda/Temple?**

 1. YES 2. NO

8.3 **When disaster occurs, is the Church/Pagoda/Temple a safe place for evacuation?**

 1. YES 2. NO

8.4 **Pls explain why?**

____

____

8.5 **Did members of your religious group evacuate to Church/Pagoda/Temple during disaster?**

 1. YES 2. NO

8.6 Pls. explain why?

____

____

8.7 In your opinion, what causes disasters?

☐ 1. Nature ☐ 2. Supernatural

8.8 If caused by Supernatural reasons, should people still prepare or cope with disasters?

☐ 1. YES ☐ 2. NO

8.9 Please explain your opinion:

____

IX. COMMUNICATION

9.1 Did you receive early warning messages before disaster?

☐ 1. YES ☐ 2. NO (skip 9.2 – 9.4)

9.2 If yes, through what means did you receive messages?

Means	**Mark √ (if applicable)**
1) Television	☐
2) Radio	☐
3) Loudspeaker	☐
5) Portable speaker	☐
6) others, pls specify ____________________	☐

9.3 How long before the disaster did you receive the early warning message?

☐ 1-2 daysbefore ☐ 3-4 daysbefore ☐ 4-5 days before ☐ more than 5 days before

9.4 What did you do when you received messages?

 1. Prepared for emergency cases 2. Did nothing

9.5 Did local government check emergency preparedness of your family after providing early warning messages?

 1. YES 2. NO

9.6 If Yes, how they did theycheck?

____

____

9.7 During disaster, did you receive news update about the occurring disaster?

 1. YES 2. NO (skip 9.8)

9.8 If yes, pls explain how the news was updated or sustained (media, message, regularity of updates. etc.)

____

____

9.9 Does your family have access to telephone / mobile phone?

 1. YES 2. NO

9.10 Did your telephone / mobile phone work during disaster?

 1. YES 2. NO

9.11 If No, explain why: ____

____

X. EMERGENCY PREPAREDNESS PLANNING

10.1 Does your village has flood controland typhoon response committee?

☐ 1. YES ☐ 2. NO

10.2 If No, why?

____

____

10.3 Do you take part in emergency preparedness planning in your village / community?

☐ 1. YES ☐ 2. NO

10.4 If yes, what is the nature of your participation? ________________________________

____

____

10.5 If No, why? ____

____

XI. SOLUTIONS

11.1 What have you done so far so that you are able to adapt to climate change/disasters?

Adaptive activities	Mark √ (if applicable)
▪ Reinforce/rebuild house with permanent material which is able to cope with flood and typhoon	
▪ Prepare means for evacuation when disaster attacks community	
▪ Plant wind-break/fence trees	
▪ Change cropping patterns, crop season calendar	
▪ Diversify agricultural activities	
▪ Migrate to city / other places to find jobs, carry out off-farm activities,…	
▪ Take part in training courses on climate change adaptation	
▪ Others, pls specify ________________________________	
____	

11.2 What do you/does your community need to adapt to climate change/ extreme weather? (Can select more than 1 answer)

- ☐ 1. Consultancy and support in changing crop season calendar
- ☐ 2. Consultancy and support in changing cropping pattern.
- ☐ 3. Support seedling, breeding which are resistant to extreme weather
- ☐ 4. Support in finance, loan for disaster risk reduction activities
- ☐ 5. Support in building permanent houses
- ☐ 6. Support in providing rescue equipment
- ☐ 7. Support in strengthening infrastructure (dyke, road, irrigation system, school, clinic) to cope with disaster
- ☐ 8. Resettlement for people living in vulnerable areas.
- ☐ 9. Diversification of income resource
- ☐ 10. Enhance awareness on disaster risk reduction and climate change.
- ☐ 11. Build/Upgrade early warning system.
- ☐ 12. Others, pls specify ______________________________

11.3 Do you have your own plan for your current work to adapt to coming extreme weather/climate change?

____
____
____

11.4 Do you have any recommendations to be able to decrease the sensitivity and increase adaptability of your household and your community to climate change-related disasters?

Decrease sensitivity: ______________________________
____
____

Increase adaptability: ______________________________
____
____

Thank you for sharing!

<u>Additional Notes/ Remarks/ Observations:</u>

Annex Tables

Annex Table 1. Natural Hazard and Exposure Indicators

1) <u>Flash flood:</u>

i. **Number of events per year** (data source: district's committee for flood and storm control).
ii. **Economic loss per year** (data source: district's committee for flood and storm control)
iii. **Percentage of commune area covered by floodplain**. This will be prepared by GIS expert starting from topographic map.
iv. **Standard deviation of rainfall**. This information permit to evaluate the distribution of the rainfall during the year and evaluate if there are a higher concentration of rainfall in a short period.
v. **Average bed slope of river into the commune area**. We can calculate the average bed slope of a river simply as the difference of altitude between the point where the river enter in the commune area and the point where leave the commune area, divided for the length of the river in the commune. High river's bed slope values increases the likelihood to have flash flood (Streeter and Benjamin, 1988).
vi. **Upstream catchment area**. (data source: topographic map). We will assess such value using the tools "basin" and "watershed" available in ESRI Arc Map, to determining the contribute area above the commune (Streeter and Benjamin, 1988).

2) <u>Landslide.</u>

i. **Number of events per year**
ii. **Economic loss per year**
iii. **Percentage of area with high slope** (data source DTM): The DTM will be prepared by GIS expert starting from topographic map
iv. **Percentage of slope uncovered by vegetation** (data source: land use map): The slope area not covered by vegetation is prone to slip (Chen et al., 2008). We overlay the topographic map with land use map and assess the percentage of slope without vegetation.
v. **Standard deviation of rainfall**

3) <u>Drought:</u>

i. **Economic loss per year** (data source: agriculture section at district level): We will send a Microsoft excel form to the agriculture section of each district to collect such data.
ii. **Water resource availability** (data source: topographic map, irrigation map if available): using "line density" tool in ESRI Arc Map to calculate the density of water system in each commune that it possible consider as a proxy for water resources availability in each commune.
iii. **Standardized Precipitation index (SPI)*** (data source: provincial hydro-meteorological service): The SPI is calculated as follows: build a frequency distribution from the historical precipitation data (at least 30 years of data) at a location for a specified period (1, 3, 6, 9, 12, 24, or 48 months). Then, a theoretical probability density function (e.g., gamma distribution) is fitted to the empirical distribution of precipitation frequency for the selected time scale. An equiprobability transformation is then applied from the fitted distribution to the standard normal distribution (e.g., Edwards and McKee, 1997). (McKee et al., 1993).

4) <u>Flooding.</u>

i. **Number of events per year** (data source: district's committee for flood and storm control). The data will be collected sending a form in Microsoft Excel format to each district.
ii. **Economic loss per year** (data source: district's committee for flood and storm control).
iii. **Percentage of commune area covered by floodplain*** (data source: DTM): From topographic map (scale 1 : 10,000). We will produce DTM and then we highlight the floodplain area. Such data will be validate at provincial level in agreement with district staff of committee of flood and storm control and compared with hazards map if available.
iv. **Standard deviation of rainfall*** (data source: provincial hydro-meteorological service): This information permit to evaluate the distribution of the rainfall during the year and evaluate if there are a higher concentration of rainfall in a short period. The concentration of rainfall in few days increases the probability to have flooding (Chowdhury, 2003).
v. **Number of day of water permanence in the floodplain*** (data source: district's committee for flood and storm control): this data will be collected through a form in softcopy (Microsoft Excel) at each district office.

5) <u>Typhoons.</u>

i. **Number of events per year** (data source: district's committee for flood and storm control). The data will be collected sending a form in Microsoft Excel format to each district.

ii. **Economic loss per year** (data source: district's committee for flood and storm control).

iii. **Standard deviation of rainfall*** (data source: provincial hydro-meteorological service): This information permit to evaluate the distribution of the rainfall during the year and evaluate if there are a higher concentration of rainfall in a short period. The concentration of rainfall in few days increases the probability to have flooding during the typhoon (Chowdhury, 2003).

Annex Table 2. List of Tentative Indicators and Methods to Collect Information

1) Institution determinant indicators. Those indicators will be collected presenting a simple questionnaire to the district office of Committee for flood and storm control. Such indicators should be able to evaluate the quality of the office assigned to face disasters and emergency at communal level and evaluate the quantity of emergency structures (emergency team, equipments and map/plans).

   i. **Education of the commune leader (as number of years attending school)**: higher education level enhances the capacity of local authorities to face and mitigate natural disaster.
   ii. **Ability of commune leaders**: such parameter will be based on the judgment of district staff of the committee for flood and storm control. High ability of commune leaders rank leads to higher the adaptive capacity.
   iii. **Ability of commune committee for flood and storm control**: the value will be base on the judgment of district staff of committee for flood and storm control. High ability of commune leaders' rank leads to higher the adaptive capacity.
   iv. **Number of staff in emergency team in each commune**: high number of emergency team's staff makes higher the adaptive capacity of the commune.
   v. **Number of emergency equipment kit in each commune**: highest number of emergency kit available in a commune, higher is the adaptive capacity of the commune.
   vi. **Emergency plan evaluation**: we will ask to district staff if an emergency plan is establish in each commune, and how many time is updated. An establish and update emergency plan enhance the adaptive capacity of the commune.
   vii. **Warning system**: we will assess the presence of the warning system ranking the commune base on the number of speaker available in the commune. Higher the number of speaker higher is the adaptive capacity of the commune.
   viii. **Percentage of population involved in emergency drills**: a large part of population involved in emergency exercise increase the awareness and the risk perception of the population, therefore, enhance the adaptive capacity of the commune.

2) Infrastructure determinant's indicators: The indicators will be measured collecting data at district's statistical office.

   i. **Percentage of non permanent house**: permanent houses are vulnerable to climate stimuli; therefore increase the vulnerability of the local community.
   ii. **Percentage of non pavements road**: not pavement roads are vulnerable to natural hazard and decrease the efficiency of emergency operations, therefore, increase the vulnerability of the commune.
   iii. **Percentage of household without access to electricity**: the household that cannot access to electricity are generally more vulnerable to natural hazards (Cutter et al., 2003).
   iv. **Percentage of household without toilette**: house without toilette are more vulnerable to natural hazard (Cutter et al., 2003) and furthermore, the households are prone to disease outbreak after a natural disaster. A higher percentage of household without toilette enhance the vulnerability of the community.
   v. **Number of public building** (we will use the reverse number): the public buildings are generally used as shelter during the emergency phase to evacuate population and store food and medicine. Consequently a commune with few public building is more vulnerable than another with many public building.
   vi. **Length of irrigation system** (we will use the reverse number): the irrigation system has a pivot role in the hills and mountains agriculture economy. Consequently a commune with shorter irrigation system is more vulnerable to natural disasters. [However the loss of this infrastructure may place an insurmountable financial burden on smaller communities that lack the financial resources to rebuild it (Platt, 1995)].
   vii. **Distance from power station**: longer are the power cable higher is the probability of a break and consequently interruption of power service. Therefore, commune very far from power station are more vulnerable.
   viii. **Distance from railway station**: generally after a natural disaster the train is one of the main vectors to bring food, medicine and helps to local population. The distance from the railway station will be assessed overlaying topographic map with transport map available at provincial department of transportation. Commune far from railway are more vulnerable, because the helps take longer time to arrive.
   ix. **Number of bridge**: this information will be supplied from provincial department of transportation. Communes with many bridge are more vulnerable because have a higher probability to remain isolated due to collapse of a bridge.

3) Natural resources determinant's indicators:

   i. **Percentage of land without forest cover**: the data will be extract from land use map. Commune with low percentage of forest cover land has higher vulnerability because its natural resources are already over exploited and the community loss the buffer, and generally very exposed to natural disaster as soil erosion, landslide, etc... (Hamilton, 1992).
   ii. **Average slope**: we will calculate this indicator from topographic map through DTM modeling. Steep slope increase the vulnerability because increase the probability of landslide and soil erosion, furthermore steep land cannot be farmed comfortably and decrease the buffer of natural resources unexploited from the community (Heltberg et al., 2008).
   iii. **Microclimate**: data from microclimate map will analyze to identify a group of parameter to find out a "climate" indicator.
   iv. **Productivity per hectare.** Data will be collected for the last ten years to assess temporal trend. Low productivity per hectare increases commune vulnerability, as proxy of low sustainability of land use and agriculture practise.
   v. **Percentage of soil type not suitable for agriculture activity**: data from soil map will be elaborate to identify the most suitable agriculture land in agreement with local expert. Commune with high percentage of soil not available for agriculture purpose is more vulnerable as already overexploited or anyway with a small capacity to cope with natural disaster (Heltberg et al., 2008).
   vi. **Percentage of land with soil erosion**: data for soil erosion for commune will be collected at provincial DARD soil section. High soil erosion means low land use sustainability (Heltberg et al., 2008). Agriculture land with soil erosion increase the vulnerability of the community because prone to natural disaster and less able to give a response after a disaster. Moreover, soil erosion decreases the agriculture productivity and therefore, the chance to set up stocks for the community.
   vii. **Average of soil thickness*** (we will use the reverse number): we will collect data on soil thickness at provincial if available in the soil map. Commune with thin soil are more vulnerable because prone to soil erosion and landslide. Furthermore such indicator is a proxy for not sustainable agriculture practise (Heltberg et al., 2008).
   viii. **Standard deviation of productivity***: from the data of productivity we evaluate the standard deviation of the three main cultures during the observed period (five or ten years, up to data availability). The high standard deviation of productivity is a proxy for very strong fluctuations of agriculture production. Therefore a culture system not stable is more vulnerable to natural hazard, moreover because the households have not finance reserve.

4) Economic resource determinant's indicators: all the data useful to determine this determinant's indicators will collect at district statistic office. Generally all this indicators describe the economic development of a commune. The economic dimensions of vulnerability are deeply rooted within the hazards and development literature (Adger, 1999; Cutter et al., 2003). A weak economic situation is related directly to access to resources and the process of marginalization. It is common sense consider that increasing inequality within a population can heighten collective vulnerability, all other things being equal (Kelly and Adger, 2000). Greater inequality may be associated with a reduction in communal resource allocation and in the pooling of risk (Scott, 1976). In addition, there are strong links between inequality and a lack of diversification of income sources as well as with poverty, placing further constraints on response options (Reardon and Taylor, 1996). Finally, the potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster (Mileti, 1999).

   i. **Income per capita.** A small income per capita lead to increase the vulnerability of the population.
   ii. **Percentage of poor households**: Poverty is a crucial element of vulnerability.. A large number of poor households increase the number of dependant people and therefore, increase the vulnerability of a commune. After a disaster, the rich get richer, the poor, poorer and the access to opportunities within the social entity are unequal and indirectly proportional to the occurrence of natural disasters (the less opportunities, the more vulnerability, the more affected by natural disasters) (Alcantara-Ayala, 2002).
   iii. **Percentage of income sources from agriculture sector**: High percentage of income from agriculture, therefore, low diversification of income, increase the vulnerability of the population (Few and Tran, 2010).

iv. **Average household per hectare of agriculture land**: Households with small amount of land pro capita are more vulnerable to natural hazards. For example, prior to the Irish Potato Famine, many peasants were unable to afford draught animals or ploughs and did not have access to enough land to diversify their crops (Fraser, 2007).

v. **Percentage of unemployed**: commune with large part of unemployed population are more vulnerable as the unemployed people rely completely on the aids suppliers after a natural disaster. (Cross, 2001).

vi. **Total economic growth rate** (we will use the reverse number): we will collect data for the last five or ten years (up to the availability) and we will assess the stability of economic growth. A small economic growth is a proxy of weak and instable economy, more vulnerable to natural disasters (Rose ,2007).

vii. **Debt per capita**: After a disaster to restart any economic activity, the entrepreneur need loan money from the bank. Furthermore the bank system rarely lends money to household already indebted. Therefore, the presence of large amount of debt in the population increases their vulnerability (Cardona, 2005).

viii. **Saving per capita** (we will use the reverse number): unlike the debt vulnerability relationship, the presence of save money in the bank reduces the request of loans at the bank system after a natural disaster. Consequently low accumulation of bank saving increase the vulnerability of the commune.

ix. **Foreigner direct investments** (we will use the reverse number): generally foreigner investments reward the area more stable and promising of a reason. Therefore, the communes with few foreigner investments are more vulnerable to natural hazards.

5) Social resources determinant's indicators:

i. **Percentage of people without diploma**: High education level enhance the ability to cope with climate change and natural disasters, as generally reported in large part of literature (Cardona, 2005). Education is linked to socioeconomic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information. Therefore, the population with lower diploma is more vulnerable to natural disasters.

ii. **Percentage of minority**: Vulnerability is enhanced by imposes language and cultural barriers that affect the access to post-disaster funding. Moreover, minority are marginalized leading to leave them the less suitable area for agriculture and for residential location (Pulido, 2000; Peacock et al., 2000). Therefore commune with large part of minority population have a higher vulnerability.

iii. **Percentage of population dependant**: According to Morrow (1999) special needs populations (young people, infirm, old people, homeless), while difficult to identify and measure, are disproportionately affected during disasters and, because of their invisibility in communities, mostly ignored during recovery. Hewitt (2000) include also those people who are totally dependent on social services for survival are already economically and socially marginalized and require additional support in the post-disaster period.

iv. **Population density**: population density is the first indicator of vulnerability used in natural hazards assessment (UNEP, 2000). A very high density populated area has a high vulnerability.

v. **Population growth rate**: Communes experiencing rapid growth lack available quality housing, and furthermore the social services network may not have had time to adjust to increased populations (Morrow, 1999). Therefore where the population experiment a high growth rate, are more vulnerable to climate stimuli.

vi. **Percentage of malnutrition in children**: Malnutrition is linked with poverty and illiteracy; therefore we can assess through such indicator the level of vulnerability. Moreover malnutrition in children are often present in families with large numbers of dependents or single-parent households often this families have limited finances to outsource care for dependents, and thus must juggle work responsibilities and care for family members. All affect the resilience to and recovery from hazards (Morrow, 1999; Puente, 1999).

vii. **Number of medicals staff per 1,000 inhabitants***: Health care providers, including physicians, nursing homes, and hospitals, are important post-event sources of relief. The lack of proximate medical services will lengthen immediate relief and longer-term recovery from disasters (Morrow, 1999).

Annex Table 3. List of Vulnerability Indicators

COMMUNE LEVEL

	Types	Indicators and definition	Measurement
Hazard	Typhoon	1. Number of typhoons and tropical depressions in last 10 years	No. of typhoons and tropical depressions
		2. Numbers of typhoon above 9 magnitude scale in last 10 years	No. of above 9 magnitude typhoons
	Flood	1. Number of flooding events above 2nd flood alert in last 10 years	No. of floods
		2. Average inundation level of the commune	Meters
		3. Number of inundation days in commune	No. of days inundated
Sensitivity	Natural sensitivity	1. % of Commune area with forest cover	% = (total forest area/total commune area) * 100%
		2. % of protection forest area to total commune area	%=(protection forest area/ total commune area)*100
		3. Percentage of Commune with steep slope (>30%)	% = (total area >30%/total area) * 100%
		4. % of low-lying (inundated) area to total commune area	%=(low-lying area/total commune area)*100
	Human sensitivity	1. Commune population density	person/km2
		2. Poverty rate of commune	% = poor household/total commune households) * 100%
		3. % of women-headed households	% = (women-headed households/ total commune households)*100
		4. % of solely elder headed households	% = (solely elder headed households/ total commune households)*100%
		5. Commune malnutrition rate of under 5-year children	% = (under 5-year malnutrition children/total children in commune)*100
	Infrastructure sensitivity	1. % households accessing unhygienic water for daily use (water from river, lake, pond)	% = (No. of households using unhygienic water/ total commune households)*100%
		2. % of households using water from wells for daily use	% = (No. of households using water from well/total commune households)*100%
	Livelihood sensitivity	1. % of commune laborers/households involving in agricultural sector (cultivation, husbandry, forestry, aquaculture)	% (total laborers or households in agricultural/ total commune laborers or households)*100

Adaptive capacity	Infrastructure indicators	1. % of irrigated land	% = (area of irrigated land/total agricultural land)*100%
		2. % of paved roads and concrete roads	% = (length of paved road/total length of roads)*100%
		3. % of households accesses to tap water	% = (No. of households with access to tap water/total commune households)*100%
		4. % of permanent houses	% = (No. of permanent houses/total houses in commune)*100
		5. % of two-storied houses	% = (No. of two-storied houses/total houses)*100
		6. No. of general doctors in commune heath stations	No. of doctors
	Economic indicators	1. Average income per capita	$
		2. % of income from off-farm earnings	% = (off-farm earning/total income)*100%
		3. Economic growth rate in last five years	%
	Technology indicators	1. % of villages has loudspeaker	% = (villages with loudspeakers/total villages)*100
		2. % of households has Radios	% =(hhs having Radios/total households in commune)*100
		3. % of households has TVs	%=(hhs having TVs/total households in commune)*100
		4. % of household has line phone &cell phone	%=(hhs. with line/cell phones/total hhs. in commune)*100
		5. Number of Internet shops in a commune	No. of Internet shops/commune
	Social capital indicators	1. % of Bachelor holders in commune staff	% (No. of staff with BA/total commune staff)*100%
		2. Budget of development projects in the commune during last five years	$
		3. Number of projects undertaken by mass organization in the commune during last three years	No. of projects
	Human indicators	1. Number of training courses on climate change adaptation/year	No. of training courses
		2. No. of doctors/1000 residents	No. of doctors
		3. No. of hospital beds/ 1000 residents	No. of hospital beds

AGRICULTURE

	Types	Indicators and definitions	Measurement
Hazard	Typhoon	1. Number of typhoons and tropical depressions in last 10 years	No. of typhoons/ tropical depressions
		2. Numbers of typhoons above 9 magnitude scale in last 10 years	No. of above 9 magnitude typhoons
	Flood	1. Number of flooding events in last 10 years	No. of floods
		2. Average inundation level of agricultural areas	Meters
		3. Average number of inundation days in agricultural areas/flood	No. of days inundated
Sensitivity	Agriculture sensitivity	1. % of one crop rice land to total commune agricultural land (for drought, flood)	% = (area of one crop rice land/total agricultural land)*100
		2. % of rain-fed agricultural land to total commune agricultural land area (for drought, flood)	% = (area of rain-fed agricultural land/total commune agricultural land)*100
		3. % of aquacultural area to total commune agricultural land (for flood)	%=(aquacultural area/total commune agricultural land area)*100
		4. % of perennial plant area (rubber and production forest) to total commune agricultural land (for typhoon)	%=(perennial plant area/total commune agricultural land area)*100
Adaptive capacity	Infrastructure indicators	1. % of agricultural area with active irrigation (flood, typhoon, inundation)	% = (agricultural land with active irrigation/total agricultural land area)*100
		2. Rural transportation network	% = Km of rural transportation network/Km^2 of rural land
		3. Mechanized proportion in agricultural production: land preparation, harvesting, etc.	% = (area of agricultural land prepared by machine/total commune agricultural land area)*100
	Economic indicators	1. . Growth rate of agricultural sector during last five years	%
		2 . Budget of agricultural development projects in the commune during last five years	$ (amount of money)
	Technology indicators	1. % of grafting aquacultural area	%=(% grafting aquacultural area/total aquacultural area)*100
		2. % of rice area using certified seedling	% =(certified seedling/total rice area)*100
	Social capital indicators	1. Number of vets in village/commune / 1000 household	No. of vets
		2. No. of extension staff/1000 households	No. of extension staff
		3. % of households participates in saving groups	% = (total hhs. of saving groups/ total hhs. in commune)*100
	Human indicators	1. No. of training courses on agricultural production in last 3 years	No. of training courses
		2. % of agricultural household's heads finished high school or higher education	% = (No. of heads of agri. Hhs completed high school or higher education/total hhs in commune)*100

Annex Table 4. Municipalities and Number of Barangays included in the Study

No.	Municipality	Total Number of Barangays
1	Bay	15
2	Calauan	17
3	Liliw	33
4	Los Banos	14
5	Magdalena	24
6	Majayjay	40
7	Nagcarlan	52
8	Pagsanjan	16
9	Pila	17
10	Rizal	11
11	Sta. Cruz	26
12	Victoria	9
	TOTAL	274

Annex Table 5. Reactive and Proactive Adaptation Options

Sector	Reactive/Responsive	Proactive/Anticipatory
Water Resources	• Protection of groundwater resources • Improved management and maintenance of existing water supply systems • Protection of water catchment areas • Improved water supply • Groundwater and rainwater harvesting and desalination	• Better use of recycled water • Conservation of water catchments areas • Improved system of water management • Water policy reform including pricing and irrigation policies • Development of flood controls and drought monitoring
Agriculture	• Erosion control • Dam construction for irrigation • Changes in fertilizer use and application • Introduction of new crops • Soil fertility maintenance • Changes in planting and harvesting times • Switching to different cultivars • Educational and outreach programs on conservation and management of soil and water	• Development of tolerant/resistant crops (to drought, salt, insect/pests) • Research and development • Soil and water management • Diversification and intensification of food and plantation crops • Policy measures, tax incentives/ subsidies, free market • Development of early warning systems
Forestry	• Improvement of management systems including control of deforestation, reforestation, and afforestation • Promoting agroforestry to improve forest goods and services • Development/improvement of national forest fire management plans • Improvement of carbon storage in forests	• Creation of parks/reserves, protected areas and biodiversity corridors • Identification/development of species resistant to climate change • Better assessment of the vulnerability of ecosystems • Monitoring of species • Development and maintenance of seed banks • Forest fire early warning systems
Coastal/ Marine	• Protection of economic infrastructure • Public awareness to enhance protection of coastal and marine ecosystems • Building sea walls and beach reinforcement • Protection and conservation of coral reefs, mangroves, sea grass, and littoral vegetation	• Integrated coastal zone management • Better coastal planning and zoning • Development of legislation for coastal protection • Research and monitoring of coasts and coastal ecosystems
Health	• Public health management reform • Improved housing and living conditions • Improved emergency response	• Development of early warning systems • Better and/or improved disease/ vector surveillance and monitoring • Improvement of environmental quality • Changes in urban and housing design

Source: Adaptation to Climate Change: World Bank Policy Brief for Indonesia (www.worldbank.org)

Annex Table 6a. Direct and Indirect Impacts of Climate-Related Disasters

	With Market Values		Non-Market Values	
	Direct	Indirect	Direct	Indirect
Social Households			Number of casualties Number of injured Number affected	Increase of diseases Stress symptoms
Economic				
Private Sector Households	Housing damaged or destroyed	Loss of wages, reduced purchasing power		Increase in poverty
Public Sector Education Health Water and sewage Electricity Transport Emergency spending	Assets destroyed or damaged: buildings, roads, machinery, etc.	Loss of infrastructure services		
Economic Sector Agriculture Industry Commerce Services	Assets destroyed or damaged: buildings, roads, machinery, etc.	Losses due to reduced production		
Environmental			Loss of natural habitats	Effects on biodiversity

Source: Mechler, 2005

Annex Table 6b. Techniques for Valuing Climate Disaster Impacts

Impacts of flooding and typhoon and the valuation procedures monetize the impacts		
Sector	**Impacts**	**Valuation Method**
Urban Households	Loss and damage to houses and HH properties	Repair/replacement method
	Emergency spending (e.g. buying of water because of water supply disruption)	Defensive expenditures
	Illness/Injuries	Cost of illness
	Loss of human life	This will not be monetized
	Psychological stress	This intangible impact will not be included in the analysis due to valuation complexity
	Loss of time due to increased traffic congestion	This impact will not be included in the analysis due to difficulty of obtaining relevant data.
Rural Household	Same as above plus	
	Productive assets destroyed or damaged	Repair/replacement method
	Stocks destroyed or damaged (standing crops, aquaculture stock, livestock)	Shadow price
Economic Sector (Industry, Services)	Assets destroyed or damaged	Repair/replacement method
	Stocks destroyed or damaged	Shadow price
Public Sector (Education, Health, Water and Sewage, Electricity, Transport, Emergency Spending)	Assets destroyed or damaged	Repair/replacement method
	Public sector emergency spending	Defensive expenditures
Environment	Loss of ecological goods and services	Benefit transfer

Valuing property and asset losses

Market-based valuation will be applied to monetize property and asset losses in the household, economic, and the public sector (e.g. houses, buildings, cars, durable goods, machineries and equipment). The value of the damages can be calculated using three options: a) repair cost; b) replacement cost; and c) depreciated values. For partially damaged assets the repair cost will be used, while for fully destroyed assets the replacement cost will be used. It must be noted, however, that the use of replacement cost overestimates damages because replacement involves improvements (i.e., old goods damaged during the hazard event are replaced by new goods which are more productive and efficient) (Penning-Roswell et al., 2003).

There are several approaches to collecting property damage data: a) Real Damage Approach; b) Absolute Damage Approach; c) Relative Damage Functions; and d) Synthetic Approach. In the real damage approach, a social survey is undertaken, usually after a hazard event, to get real damage data. In the absolute damage approach, the damage per square meter of floor space is estimated while in the relative damage functions approach the damages are expressed as a percentage of the market value of the property. Lastly, the synthetic approach combines or “synthesizes” the above mentioned approaches (Messner & Meyer, 2005).

In this assessment, the synthetic approach will be utilized. A social survey will be undertaken to establish real or actual damages on properties and assets. This will serve as basis for estimating the damage per square meter of floor space for a typical household or establishment associated with a specific typhoon/flooding event. At least damage data for 3 hazard events of varying exceedence probability should be established.

In valuing damages to public infrastructures, the cost of repair will be used. A key informant interview will be undertaken with the Engineering Office to determine construction activities undertaken by the LGU to repair or replace damaged infrastructures. LGU expenditures report will be looked at to determine the cost of these activities.

Valuing losses in agriculture/aquaculture stocks, livestock, and firm inventory The damages due to destruction of agriculture and aquaculture stocks, livestock and firm inventory losses will be monetized through shadow pricing. In this assessment, world market prices will be used to approximate the shadow price of the goods. For standing crops, aquaculture fish stocks and livestock, the variable costs saved will be deducted from the shadow price. This includes harvesting and transportation costs saved. Both primary and secondary data will be used in the quantification of impacts.
Valuing health impacts and injuries The Cost of Illness (COI) Method will be used to monetize the health impacts and injuries resulting from typhoon and flooding. The COI consists of the following: cost of work loss days (WLD); cost of restricted activity days (RAD); and the cost of medicines and hospitalization. The following illnesses/diseases linked to flooding and typhoons will be included: 1) Water Borne Diseases: amoebiasis, cholera, dysentery, leptospirosis, typhoid fever, ecoli infection. 2) Vector Borne Diseases: dengue, malaria. To monetize WLD and RAD, the prevailing wage rate will be used. The typical WLD and RAD associated with the illness and the cost of medicine and hospitalization will be inquired from a medical practitioner. Although ideally, the attribution rate (proportion of morbidity cases linked to typhoon and flooding) estimated through an epidemiological study, is required to predict the number of morbidity cases linked to the hazards, the lack of data necessitates reliance on estimates coming from a social survey. Specifically, the number of morbidity cases (per illness) and injuries within a relevant time period after a hazard event will be asked from a random sample of households. The percentage of the population affected can then be calculated from this information. The same as with the previous impact and for all other impacts, at least 3 data points in the loss-frequency curve will be established.
Valuing household and public emergency spending Defensive expenditures will be used to monetize losses due to household and public emergency spending. The defensive expenditure is an amount spent to mitigate or eliminate the negative effects of typhoon and flooding (Boardman, Greenberg, Vining, & Weimer, 2006). For the households, this may include expenditures on the purchase of emergency lights and candles to prepare for power interruptions, purchase and treatment of water if there is water supply disruption and contamination, and for reinforcing or strengthening houses and buildings. Data required for the estimation will be collected through a social survey. The public sector, particularly the LGU may also undertake emergency spending which includes relief and rescue operations, and evacuation. Interviews with relevant LGU officials will be undertaken to collect data for this purpose.
Valuing the loss of ecological goods and services The Benefit Transfer Method will be applied to value the ecological goods and services that are lost due to the hazards. It works by transferring available information from already existing studies undertaken in another area (i.e. the study site) to the policy site that is of interest by the researcher. There are two general approaches: the unit value transfer and the function transfer method. After identifying the relevant environmental goods and services vulnerable to typhoon and flooding through community FGDs, an extensive literature search will be conducted to identify relevant primary studies to be used in the analysis. The studies to be included in the valuation will be chosen based on several criteria: scientific soundness; relevance; and richness in detail (Desvouges, Johnson & Banzhaf, 1998).

Annex Table 7. List of Barangays Included in the Survey

Bay	Calauan	Liliw	Los Baños	Magdalena	Majayjay
Bitin	Balayhangin	Bagong Anyo	Anos	Baanan	Balayong
Calo	Bangyas	Bungkol	Bambang	Balanac	Botocan
Dayap	Dayap	Calumpang	Batong Malake	Bucal	Burol
Dila	Hanggan	Ibabang San Roque	Bayog	Buenavista	Ibabang Banga
Maitim	Imok	Ibabang Taykin	Maahas	Halayhayin	Malinao
Masaya	Lamot 1	Ilayang Palina	Mayondon	Ilayang butnong	Munting Kawayan
Paciano	Lamot 2	Kanluran Bukal	Putho	Malinao	Olla
Puypuy	Limao	Laguan	Putho-Tungtungin	Maravilla	Oobi
San Agustine	Mabacan	Masikap	San Antonio	Munting Ambling	Origuel
San Antonio	Masiit	Masikap	Timugan	Poblacion	Panalaban
San Isidro	Perez	Maslun		Sabang	Piit
San Nicholas	Prinza	Mohon		Salasad	San Francisco
Sta. Cruz	San Isidro	Oples			San Isidro
Sto. Domingo	Silangan	Pag-asa			San Miguel
Tagumpay	Sto. Tomas	Tui-Baanan			Sta. Catalina
Tranca					Suba
					Talortor
					Tanawan
Nagcarlan	**Pagsanjan**	**Pila**	**Rizal**	**Sta. Cruz**	**Victoria**
Abo	Anibong	Aplaya	Antipolo	Alipit	Banca-Banca
Balimbing	Biñan	Bukal	East Poblacion	Bagumbayan	Daniw
Banago	Cabanbanan	Bulilan Norte	Pauli II	Bubukal	Masapang
Bucal	Calasiche	Bulilan Sur	Pook	Calios	Nanhaya
Cabuyew	Dingin	Labuin	Tala	Duhat	San Benito
Labangan	Magdapio	Linga	Talaga	Gatid	San Francisco
Malaya	Maulawin	Masico	Tuy	Labuin	San Roque
Malinao	Pinagsanjan	Mojon		Oogong	
Manaol	Poblacion 1	Pansol		Pagsawitan	
Maravilla	Poblacion 2	Pinagbayanan		Palasan	
Palayan	Sabang	Pook		Patimbao	
Palina	Sampaloc	San Antonio		Poblacion 1	
Poblacion 2	San Isidro	Santa Clara Norte		Poblacion 2	
Poblacion 3		Sta. Clara Sur		San Jose	
Poblasyon 1		San Antonio		San Juan	
San Francisco				San Pablo Norte	
Sibulan				San Pablo Sur	
Silangan Kabubuhayan				Santisima Cruz	
Silangan Lazaan				Santo Angel Central	
Silangang Napapatid				Santo Angel Norte	
Silangang Ilaya				Santo Angel Sur	
Sinipian					
Sta. Lucia					
Sulsuguin					
Talangan					
Taytay					
Wakat					
Yukos					
Balinacon					

Annex Table 8. Number of Respondents per Municipality

Municipality	No. of Sampled Brgy	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

Annex Table 9. Respondents' Characteristics

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

Annex Table 10. Summary Statistics of Sensitivity Indicators

Indicator	Sub-indicator	Mean	Standard Deviation
Human sensitivity	Dependence ratio: ratio of dependent person (unemployed family member) to family size	0.63	0.22
Livelihood sensitivity	Percent of annual income generated from agriculture, fishery and forestry activities	0.09	0.25
Infrastructure sensitivity	Ratio of family size to area of weak house	0.04	0.15
Financial sensitivity	Percent of debt to total income of households	0.06	0.22

Annex Table 11. Summary Statistics of Adaptive Capacity Indicators

Indicator	Sub-indicator	Mean	Standard Deviation
Infrastructure	Average area of permanent dwelling per head	22.85	34.21
Economic indicators	Income per capita	45,638	70,599
	Amount of remittance per year	40,812	141,621
Technology indicators	Number of TVs, radios	2.07	1.80
	Number of line phones and cell phones/household	1.81	1.17
	Number of vehicles per household	0.29	0.54
Social capital indicators	Number of contacts the household can ask for financial help	2.86	3.13
Human indicators	Number of working household members	1.72	1.02
	Level of education: schooling years that the household head finished	8.94	3.53

Annex Table 12. Descriptive Statistics of the Key Variables of the Model

Variable	Mean	Min	Max	SD	Frequency (Dummy=1)
Consumption	8,875	-	120,000	9,867	
Consumption per capita	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

Annex Table 13. Results of the Three-Step Feasible Generalized Least Squares Regression Analysis

	Variance		Expected Value of Consumption	
	Coefficient	P>|t|	Coefficient	P>|t|
Livelihood dependence on the AFF-sector (Ratio of AFF Income to Total Income)	0.179	0.656	1.933	0
Age of the household (HH) head	0.012	0.318	0.029	0
Gender of the HH head (Dummy variable takes on the value of 1 if male)	-0.127	0.227	0.891	0
Number of years of schooling of HH head	0.0124	0.53	0.147	0
Household size	-0.0228	0.627	-0.152	0
With chronically ill or disabled members (Dummy variable takes on the value of 1 if there is a chronically ill or disabled HH member)	-0.083	0.532	-0.137	0.432
Number of strong typhoons (at least Signal Number 3 Category) experienced in the last 10 years	0.037	0.313	-0.017	0.308
Highest flood height experienced by the HH in the last 10 years), in inches	0.116	0	-0.65	0
Drought (Dummy variable takes on the value of 1 for AFF households that has experienced drought in the last 10 years)	-0.342	0.35	0.001	0.996
Landslide (Dummy variable takes on the value of 1 if household has experienced landslide in the last 10 years)	0.147	0.342	0.443	0
Constant	-0.685	0.62	4.97	0
Adjusted R-squared	0.27			0.76
Prob>F	0			0

Annex Table 14. Indicators used in FGDs for sectoral vulnerability assessment

Factor	Indicator	Sub-indicator	Scoring* 1 = low 2 = medium 3 = high
Hazard	Typhoon	1. Typhoons and tropical depressions experienced in the last 10 years	
		2. Numbers of typhoons classified as Signal Number 3 and aboveexperienced in the last 10 years	
	Flood	3. Number of flooding events experienced in the last 10 years	
		4. Highest flood height experienced in the 10 years (in feet)	
		5. Longest flood duration experienced in the last 10 years (in days)	
	Drought	6. Number of droughts experienced in the last 10 years	
	Flash flood	7. Number of flash floods experienced in the last 10 years	
Sensitivity	Human sensitivity	1. Ratio of dependent person (unemployed / children/ elderly family member) to family size	
	Livelihood sensitivity	2. Percent of annual income from agriculture, fishery and forestry activities	
	Infrastructure sensitivity	3. Material and strength/weakness of dwelling/ house	
	Financial sensitivity	4. Amount of debt compared to total income of households	
Adaptive Capacity	Infrastructure	1. Average area of permanent dwelling per head	
	Economic indicators	2. Income per capita (including remittances)	
	Technology indicators	3. Number of TVs, radios	
		4. Number of line phones and cell phones/household	
		5. Number of vehicles per household	
	Social capital indicators	6. Number of contacts the household can ask for financial help	
	Human indicators	7. Number of working household members	
		8. Level of education: schooling years that the household head finished	

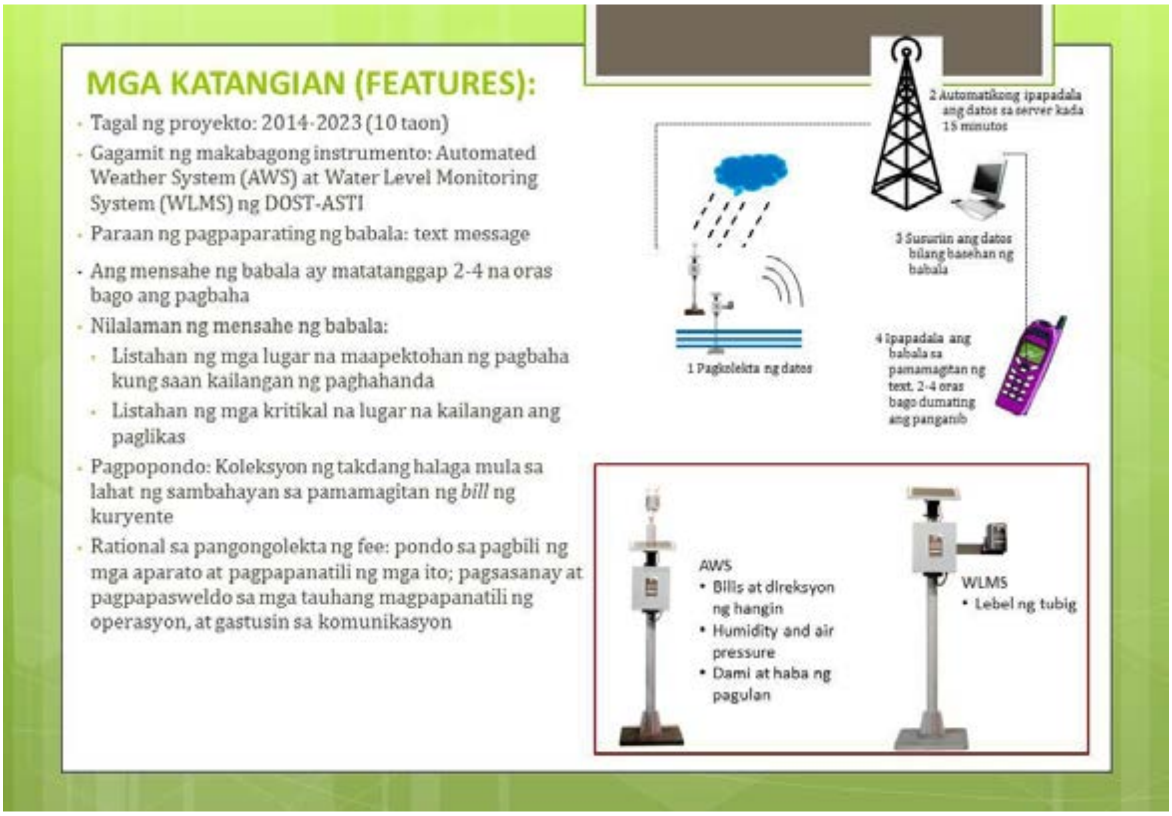
*for Adaptive capacity: 1 = high 2 = medium 3 = low

Annex Table 15. Per Unit Cost Assumptions of the Relocation, Evacuation Center, and Building Modification Projects (Pesos)

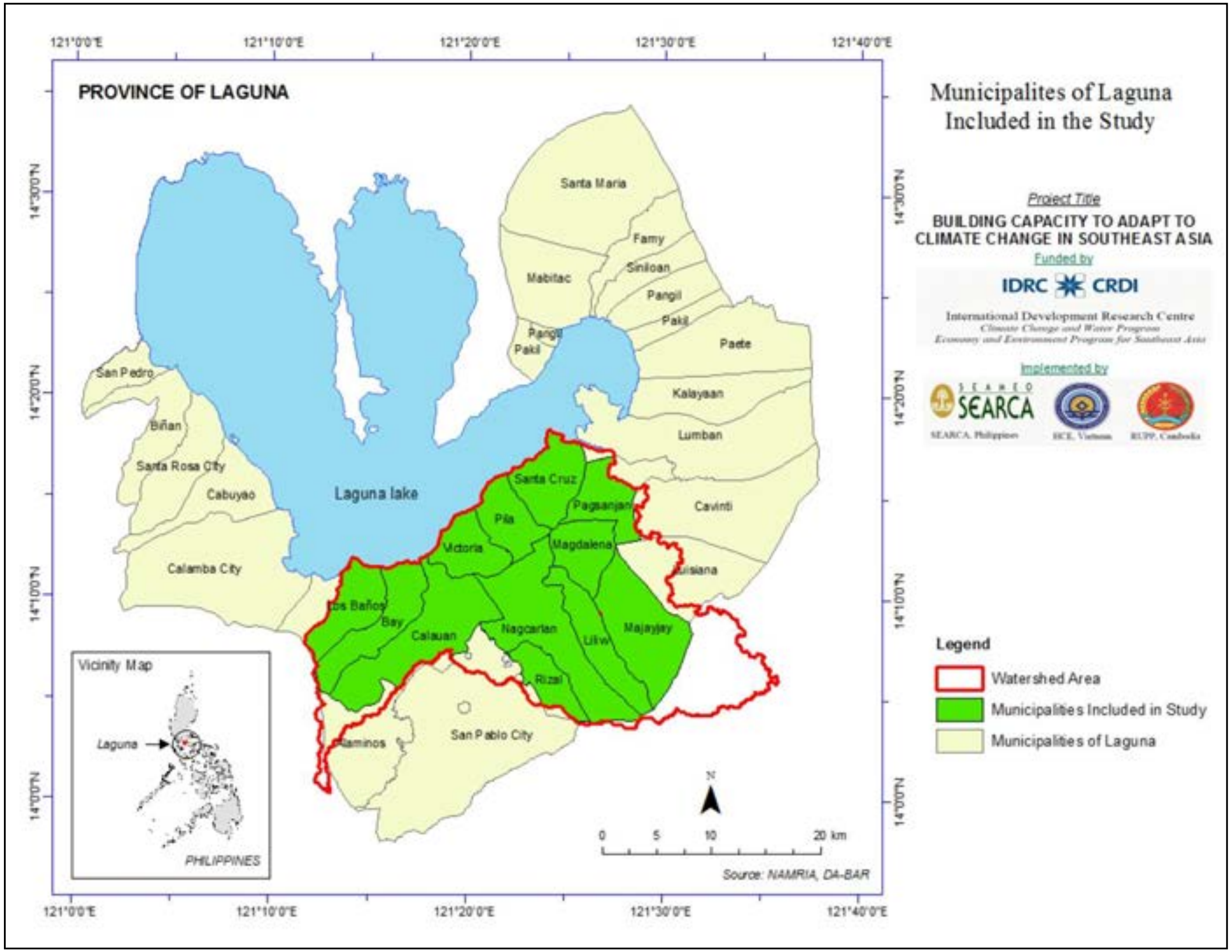
	Relocation Option	Evacuation	Building Modification
BUILDING CONSTRUCTION COST			
Building Size per Unit (sq m)	30	29,750	20
Building Construction Cost per sq meter	8,000	15,000	8,000
Building Construction Cost per House/Building	240,000	446,250,000	160,000
LAND COST			
Land cost per sq meter per year	260	260	-
Land rent per sq meter per year	6	6	-
Total Land Acquisition Cost	39,000,000	-	-
Total Land Rent per year	120,000	120,000	-
MAINTENANCE COST			
Utility Personel (250/day x 4 pax x 12 months)	-	360,000	-
Administration Personel (12000/month x 2 pax x 12 mo)	-	288,000	
Light and Water (35000/mo)	-	420,000	-
Supplies	-	120,000	-
Total	1,000	1,188,000	-
INFRASTRUCTURE			
Electrification	30,000	-	-
Water and Sewerage Connection	30,000	-	-
Road			
EVACUATION COST			
Transportation cost per person	-	10	10
Communication cost per person	-	1	1
MOVING COST			
Hauling Cost per household	1,800	-	-
ANNUALIZED DAMAGE COST			
Annualized Damage Cost Per HH	-	1,000	340
FLOATING TOILET			
Toilet Construction and Installation per Unit	-	-	50,000
Total Number of Units	-	-	170
Toilet Maintenance Cost per Unit per Year	-	-	80

Annex Figures

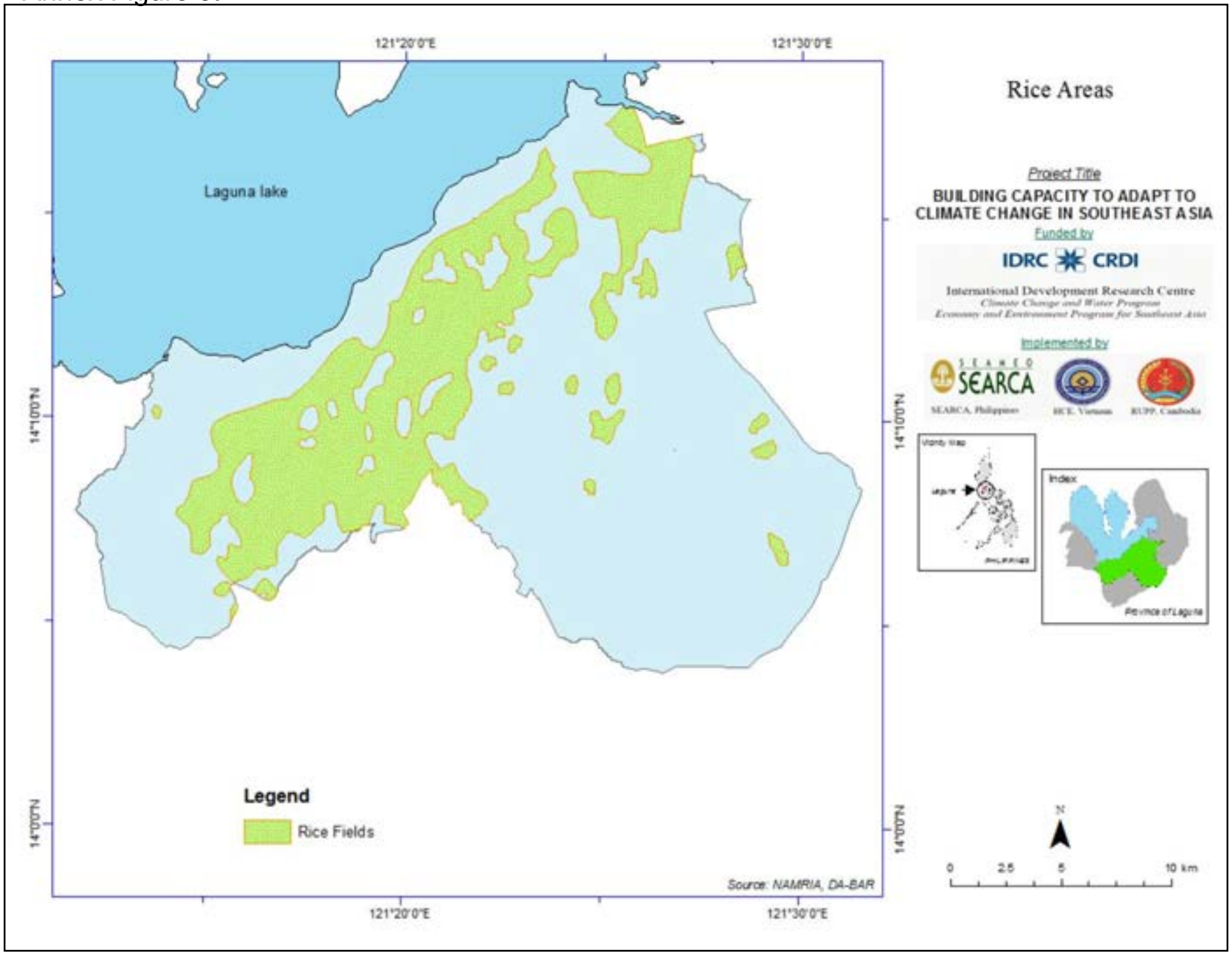
Annex Figure 1. CVM Brochure



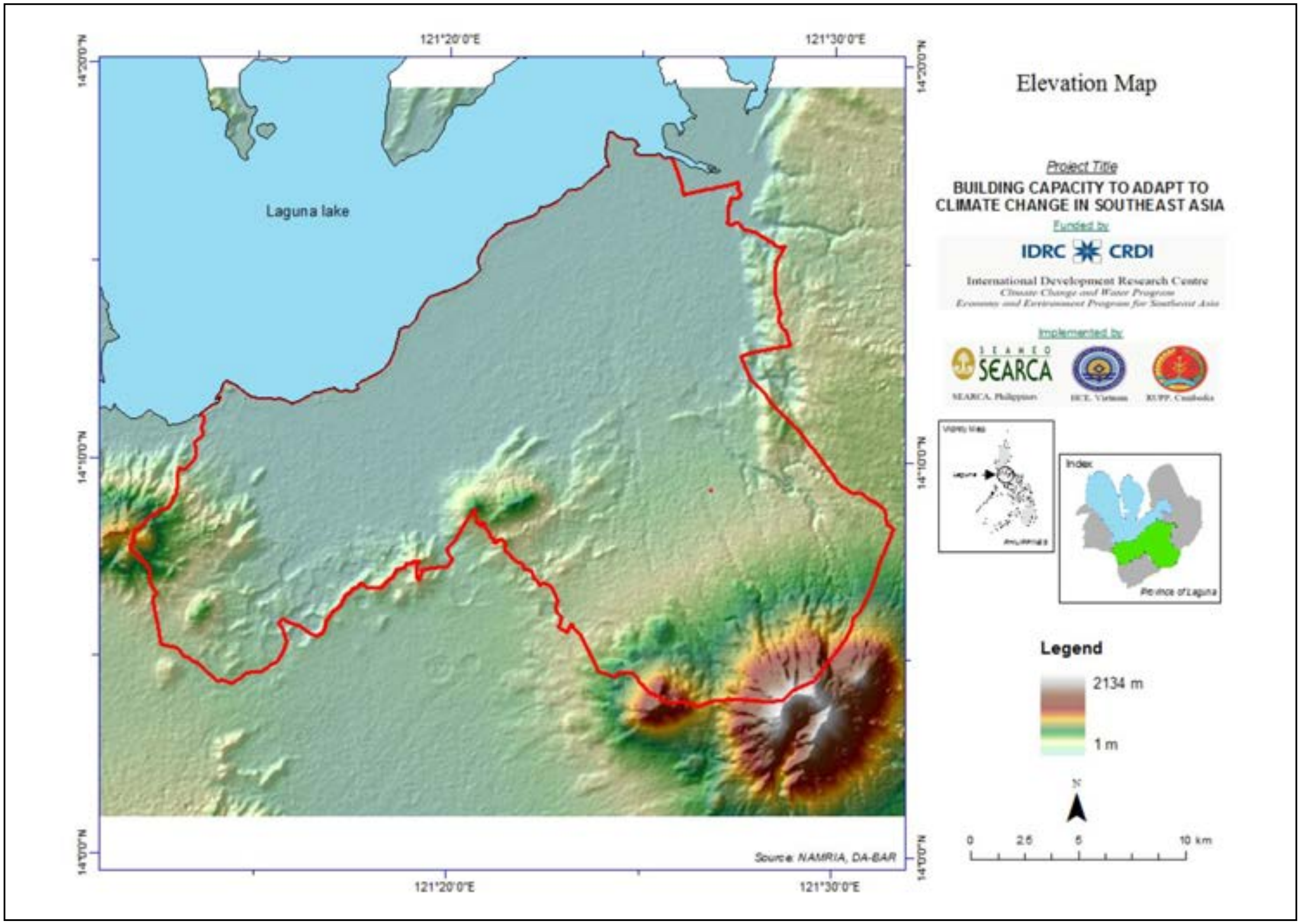
Annex Figure 2.



Annex Figure 3.



Annex Figure 4.



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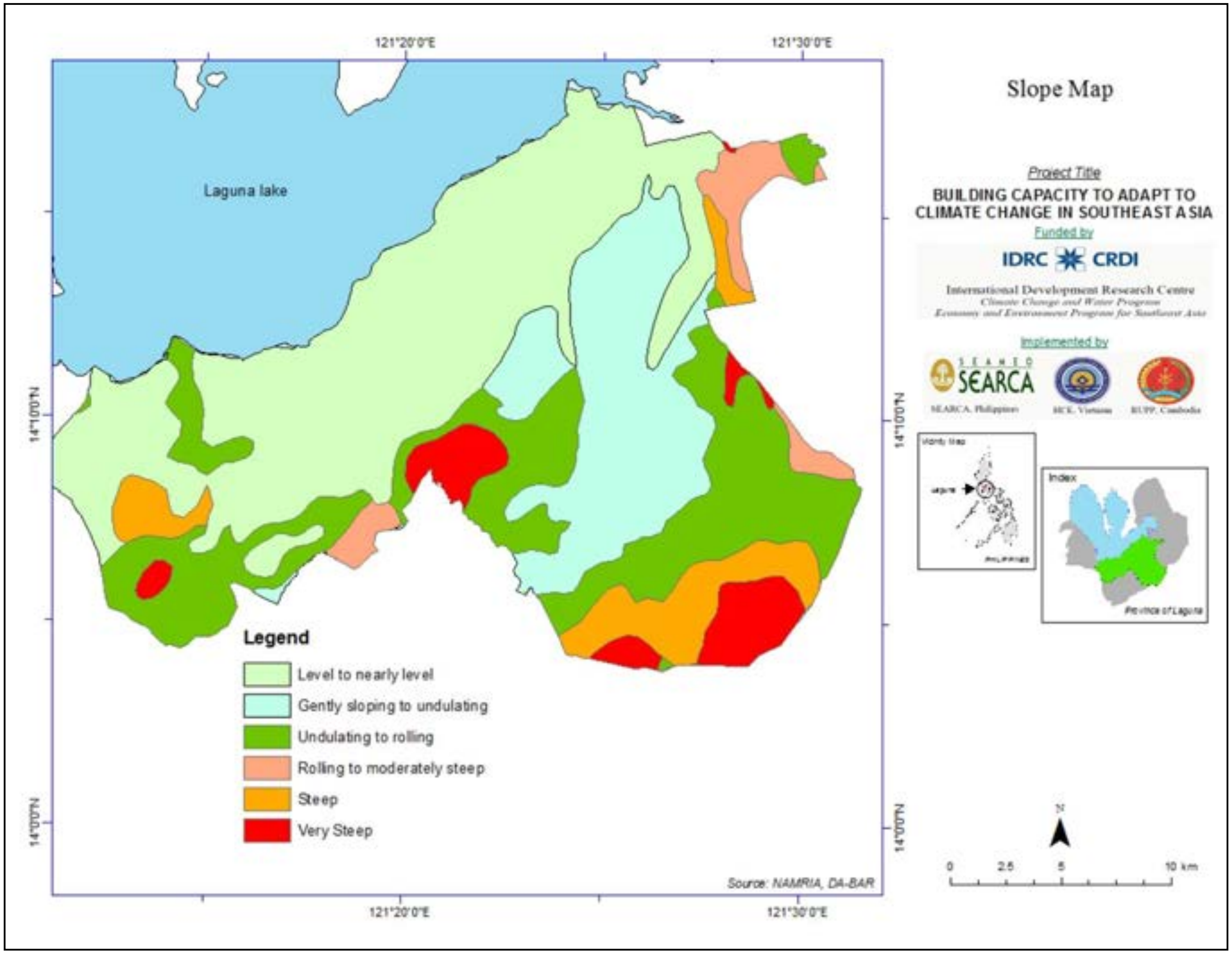

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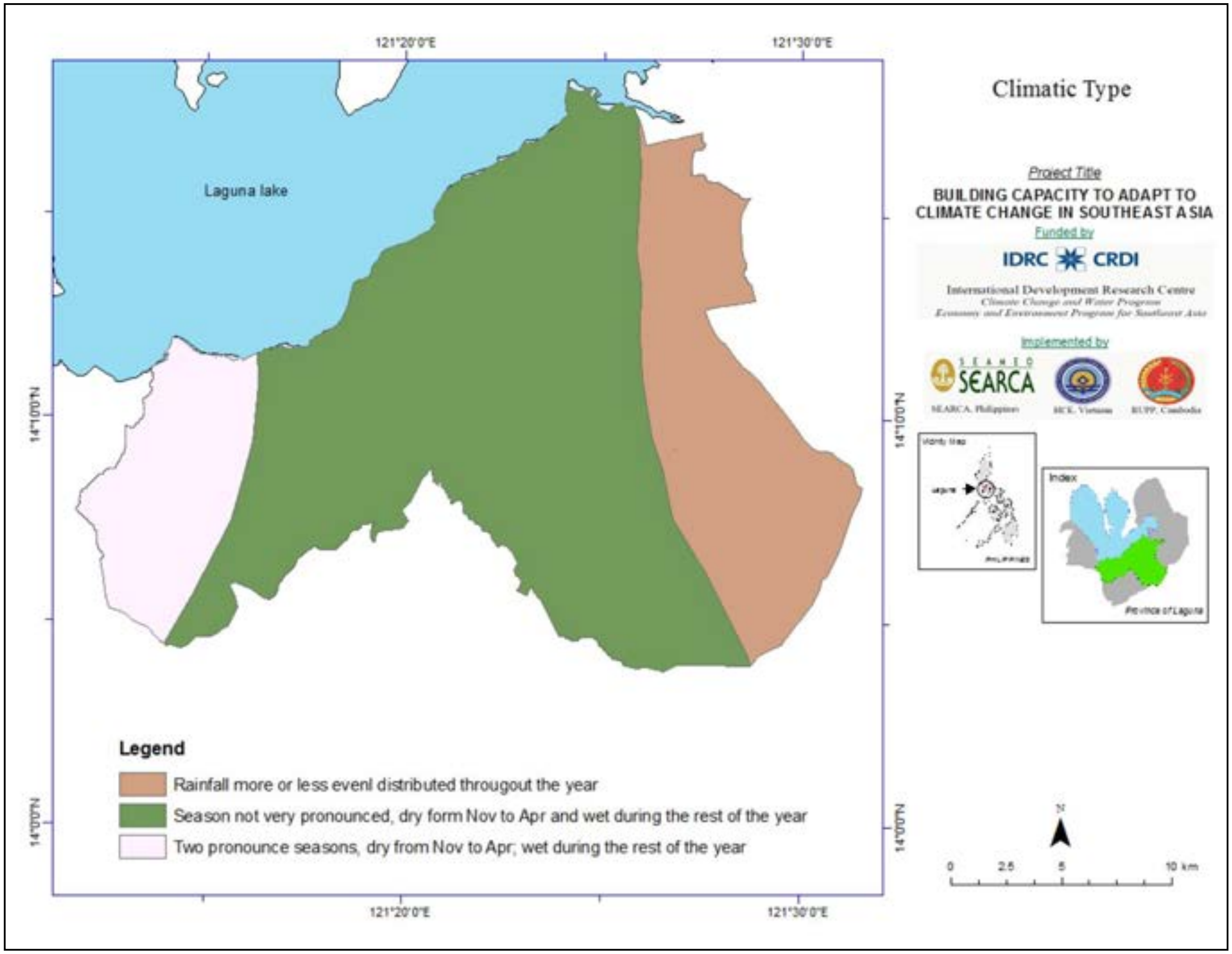
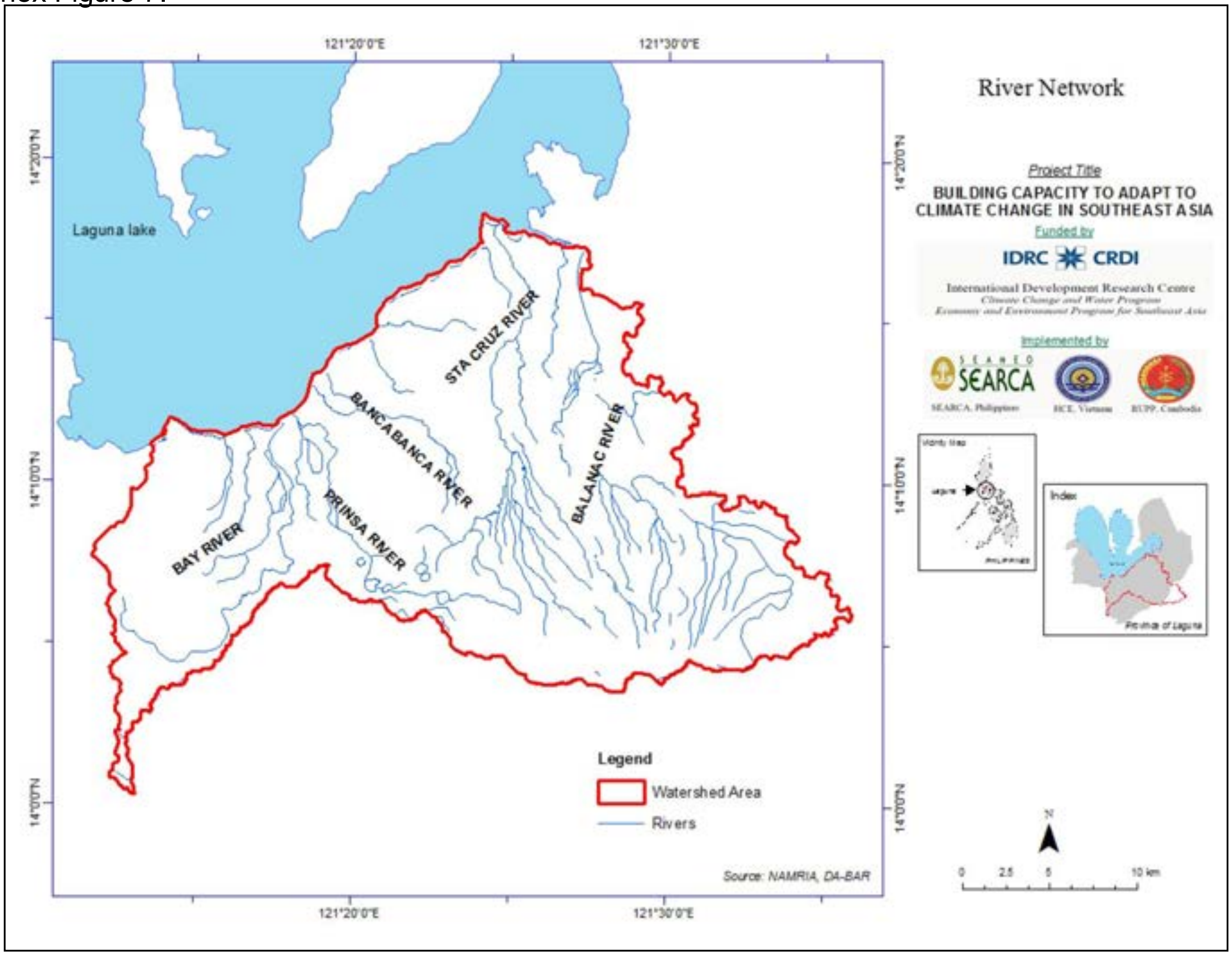
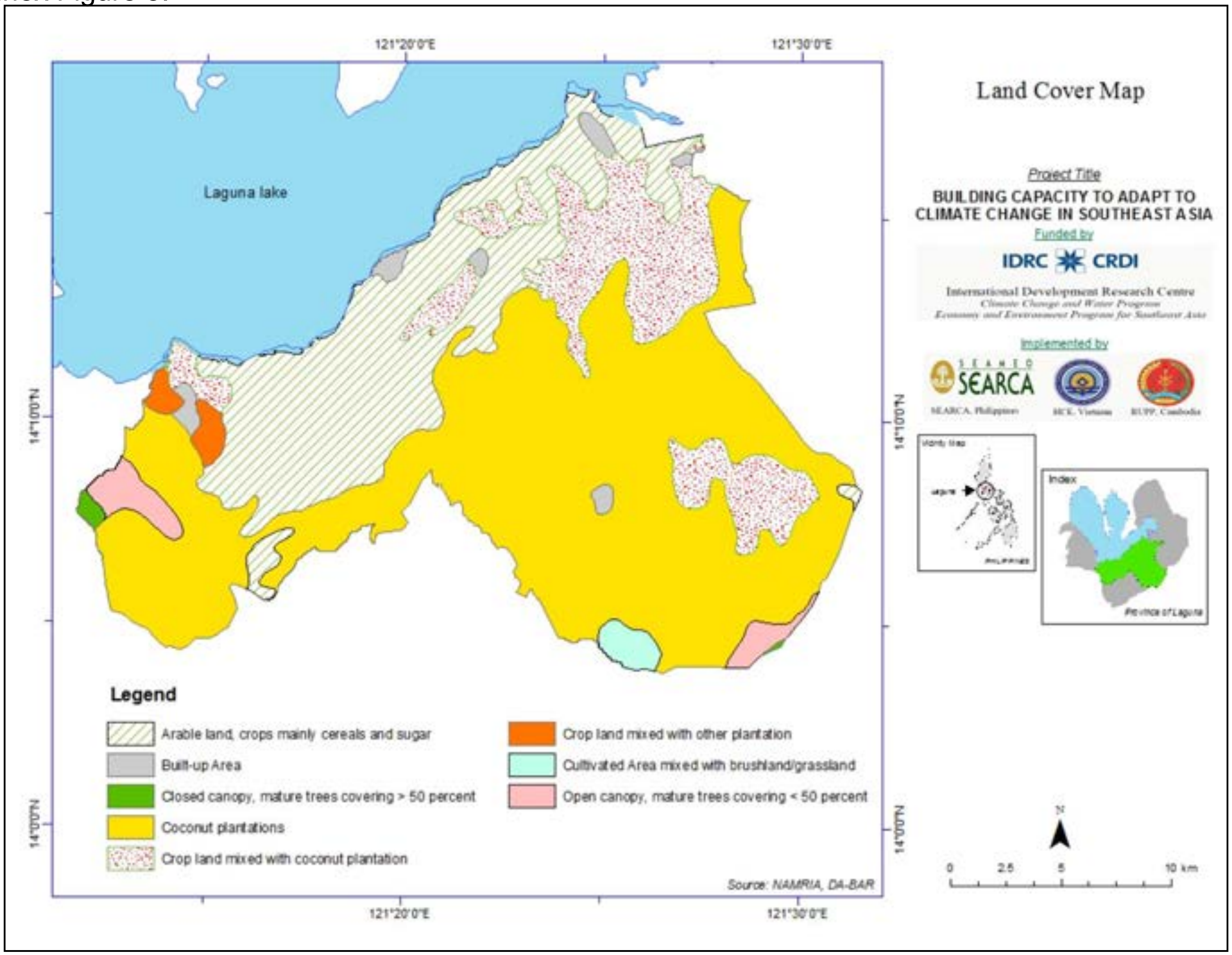


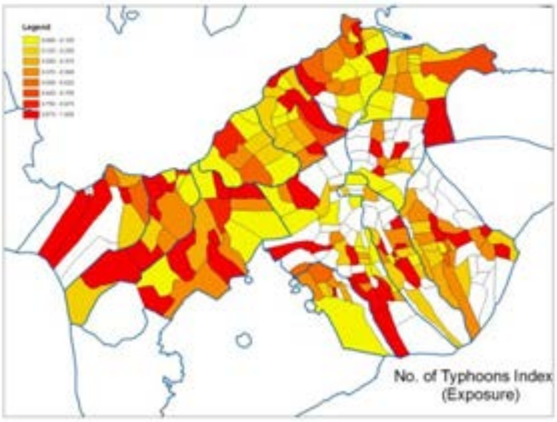
Annex Figure 7.

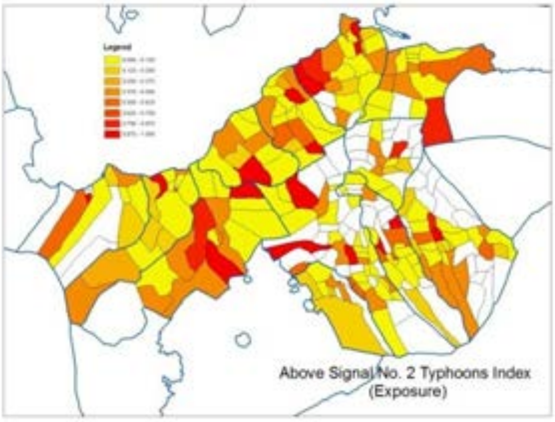


Annex Figure 8.

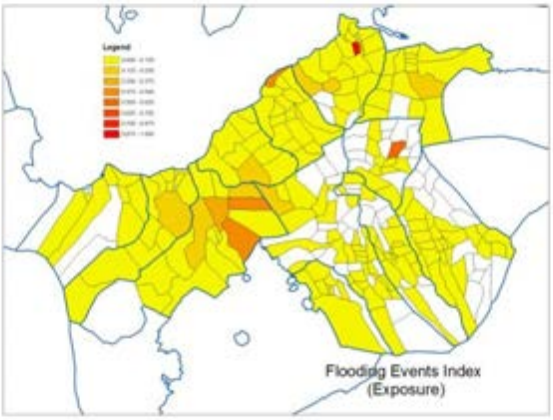


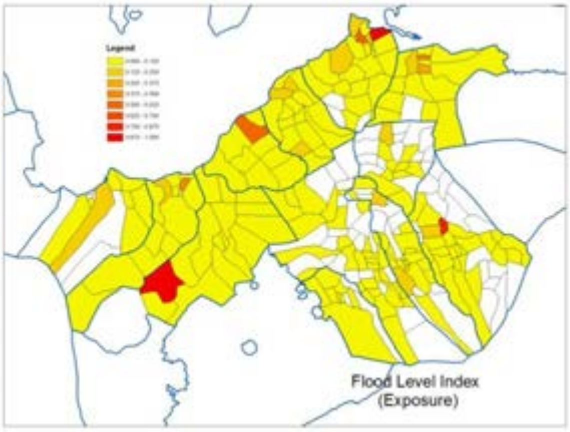
Annex Figure 9. Indicators for Typhoon

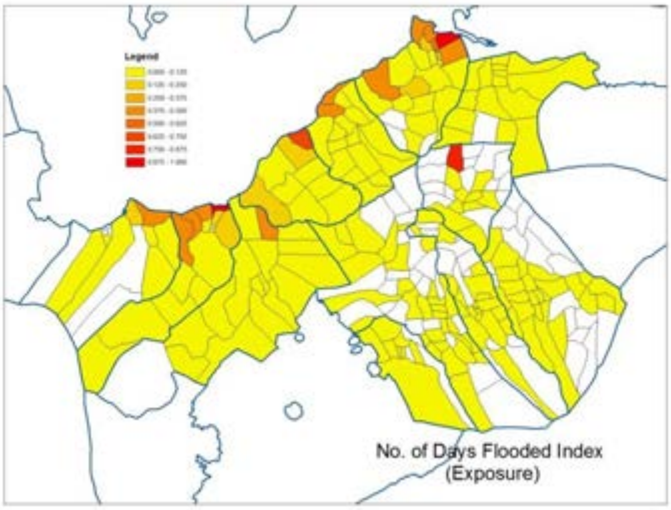




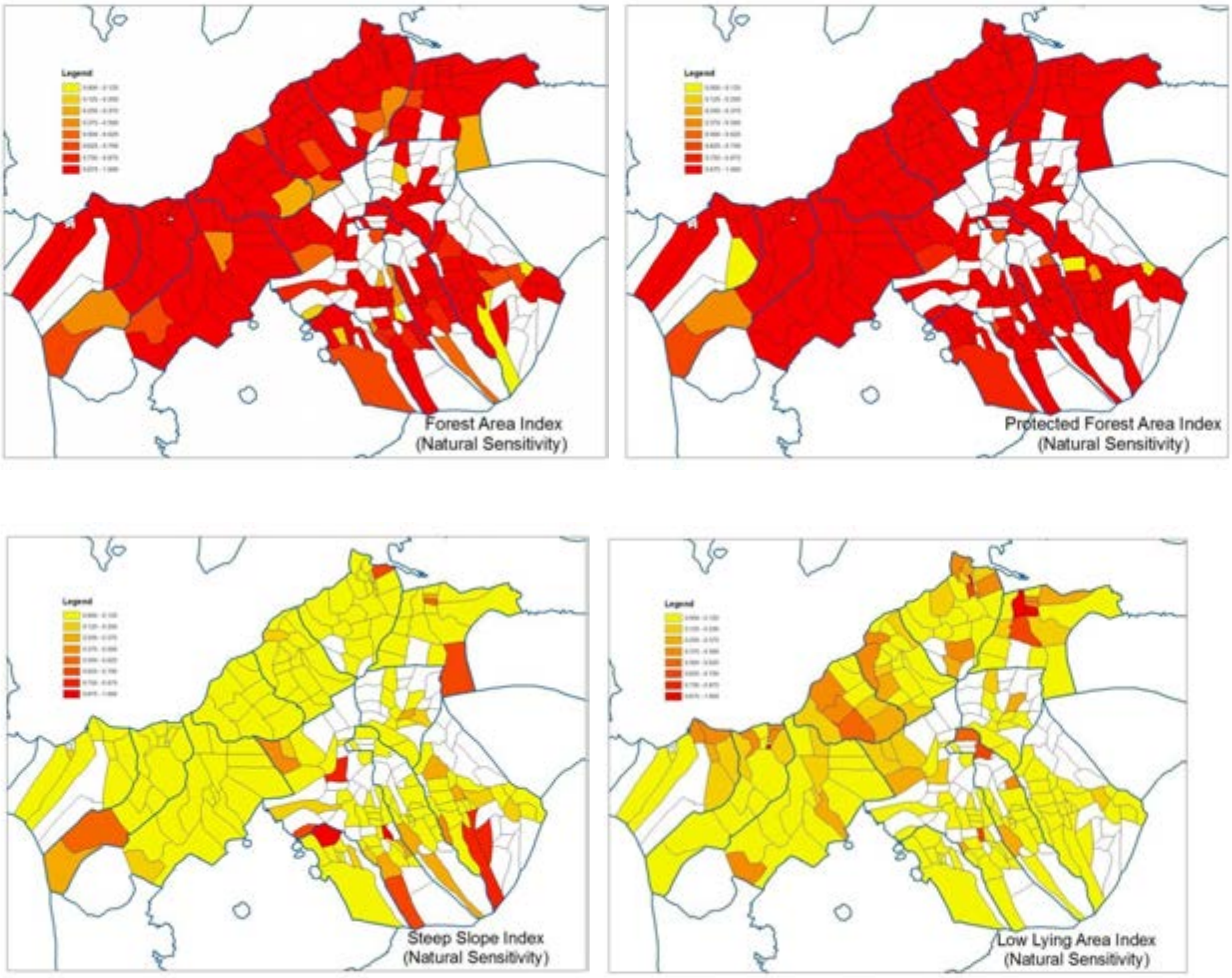
Annex Figure 10. Indicators for Flood



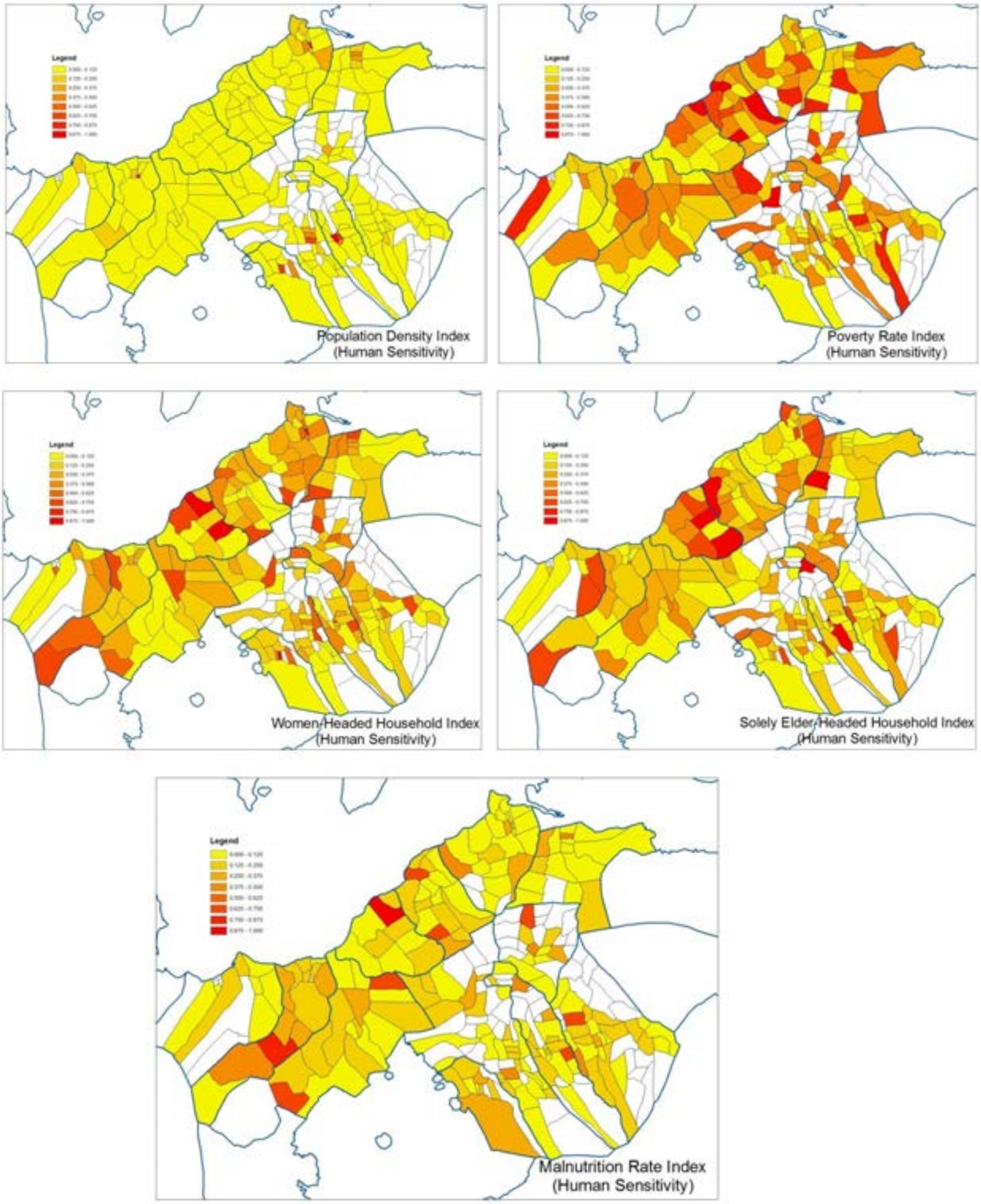




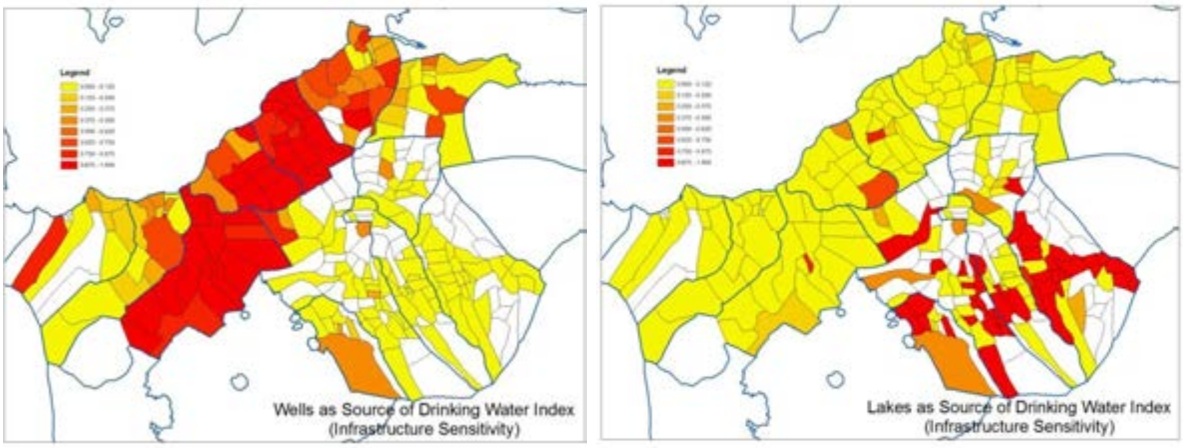
Annex Figure 11. Indicators for Natural Sensitivity



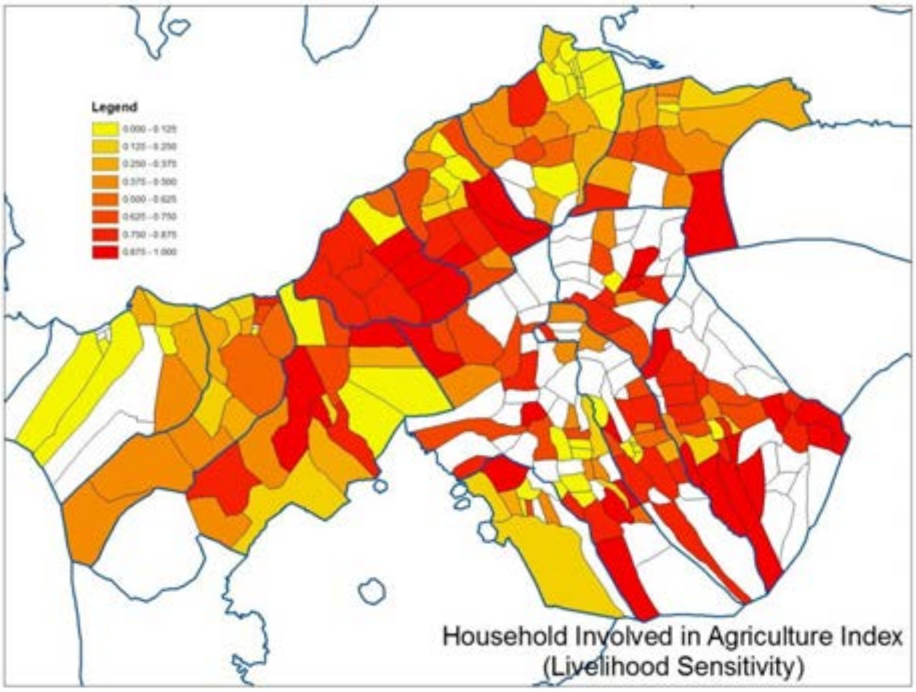
Annex Figure 12. Indicators for Human Sensitivity



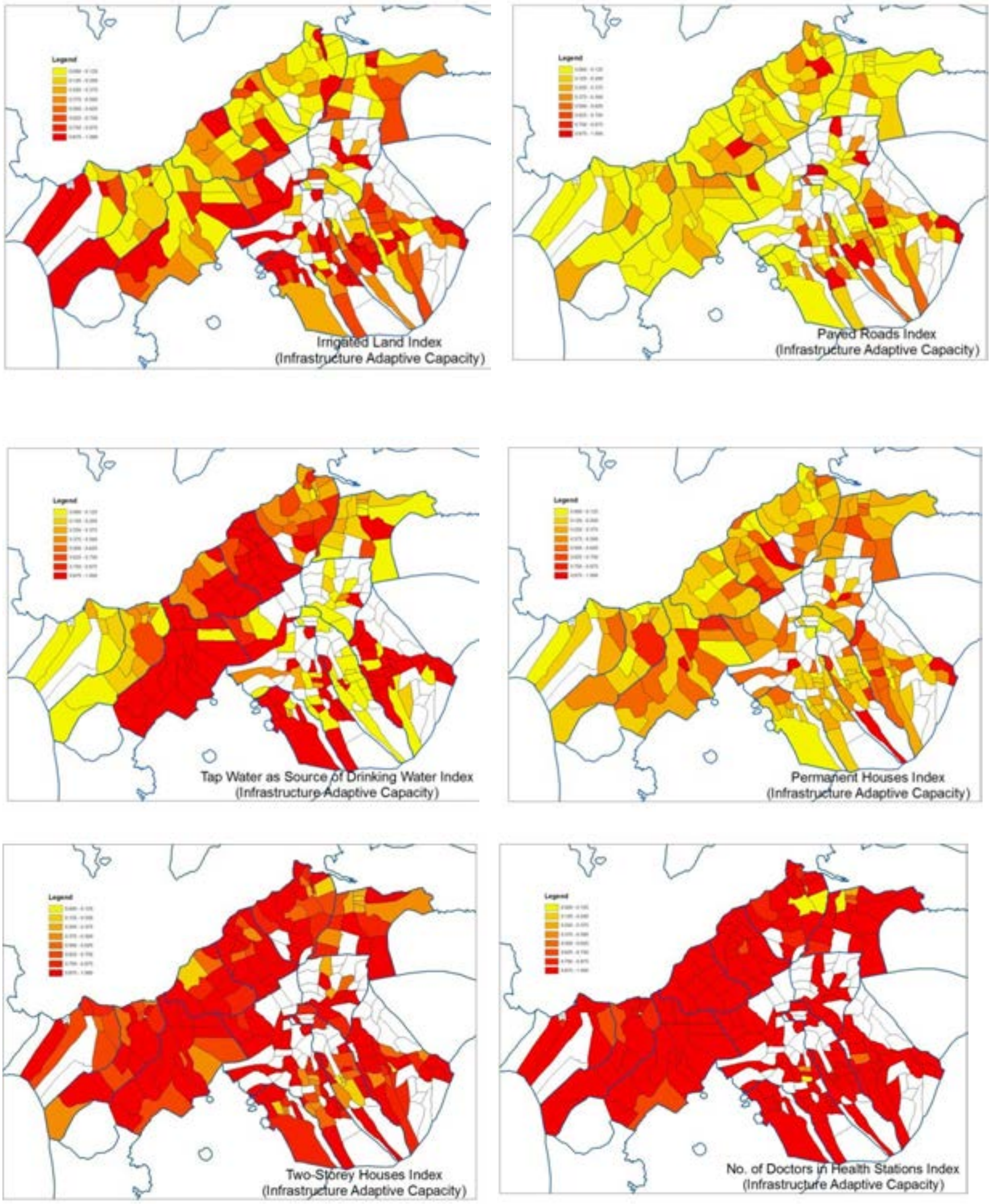
Annex Figure 13. Indicators for Infrastructure Sensitivity



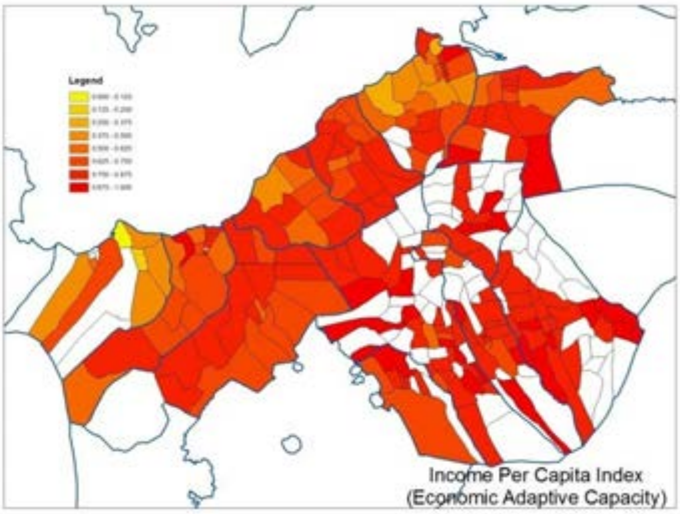
Annex Figure 14. Indicators for Livelihood Sensitivity

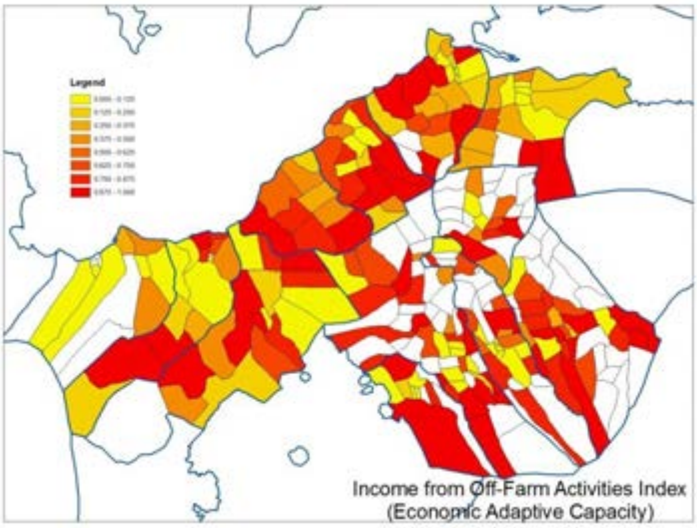


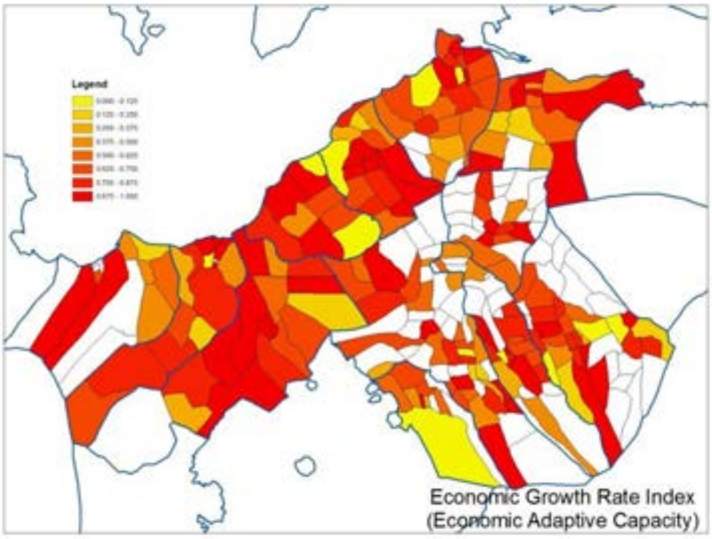
Annex Figure 15. Indicators for Infrastructure Adaptive Capacity



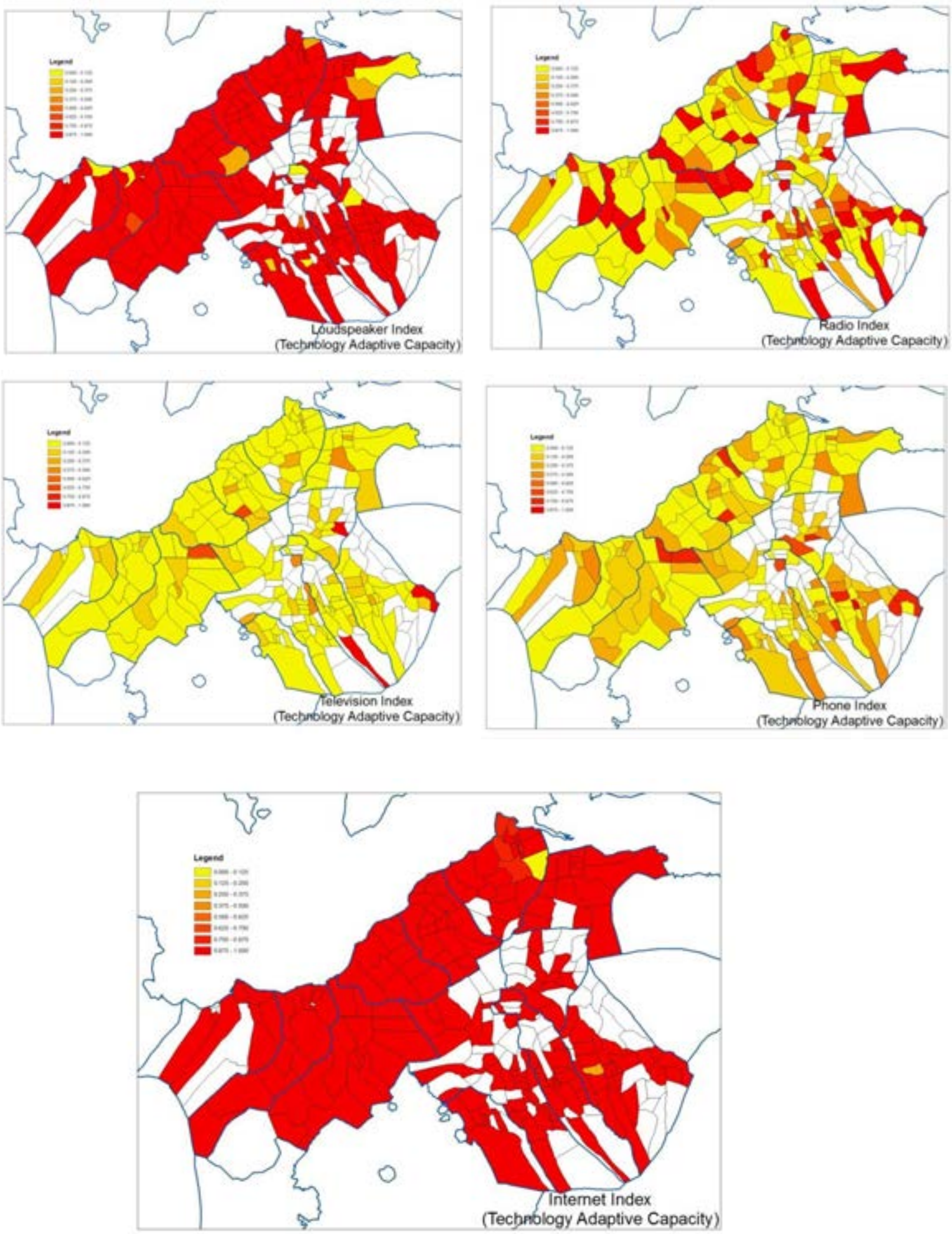
Annex Figure 16. Indicators for Economic Adaptive Capacity



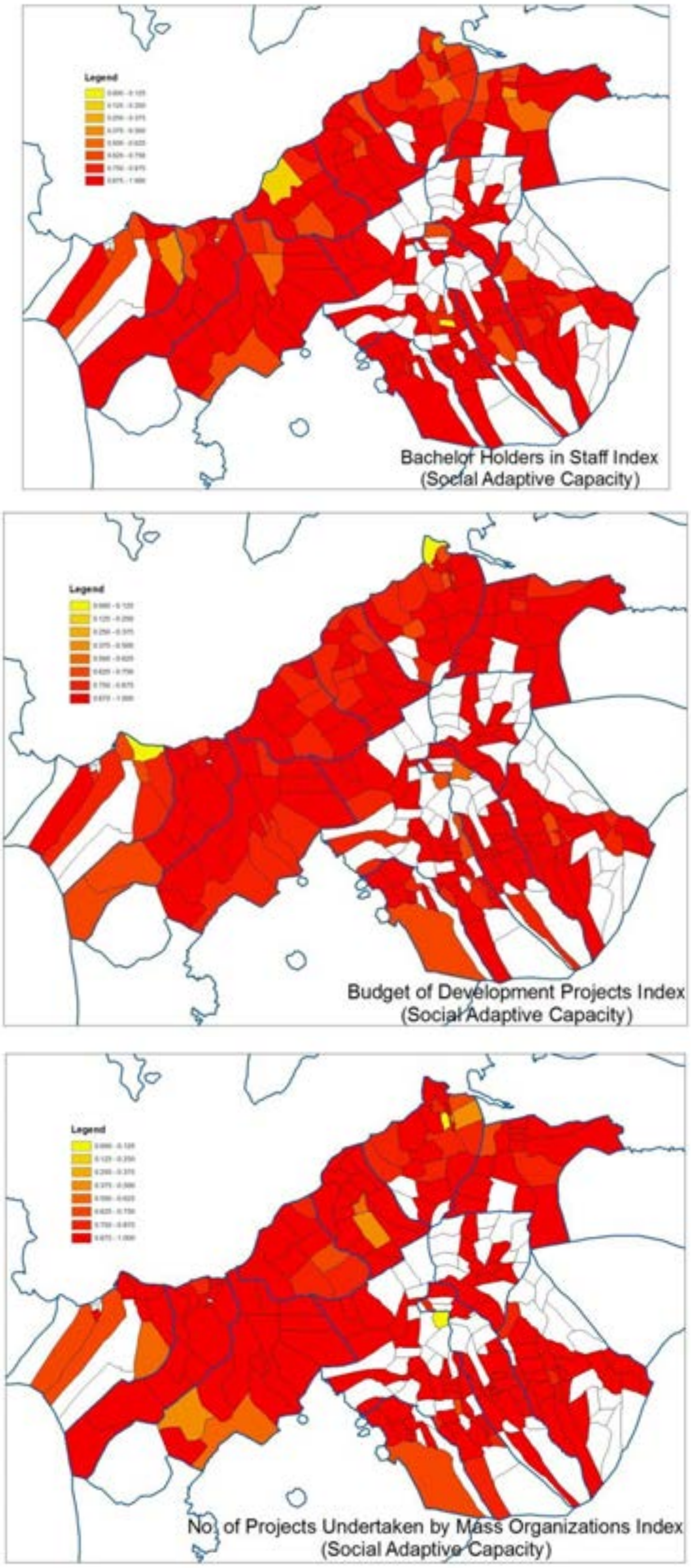




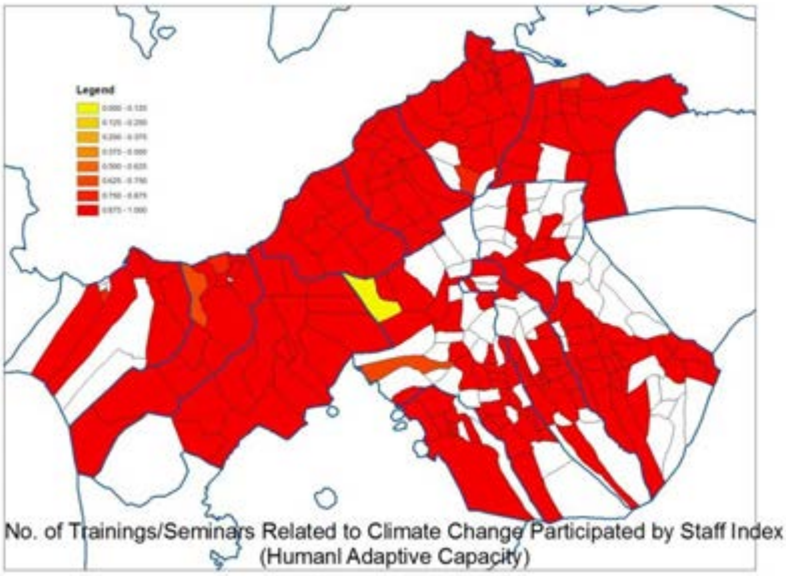
Annex Figure 17. Indicators for Technology Adaptive Capacity

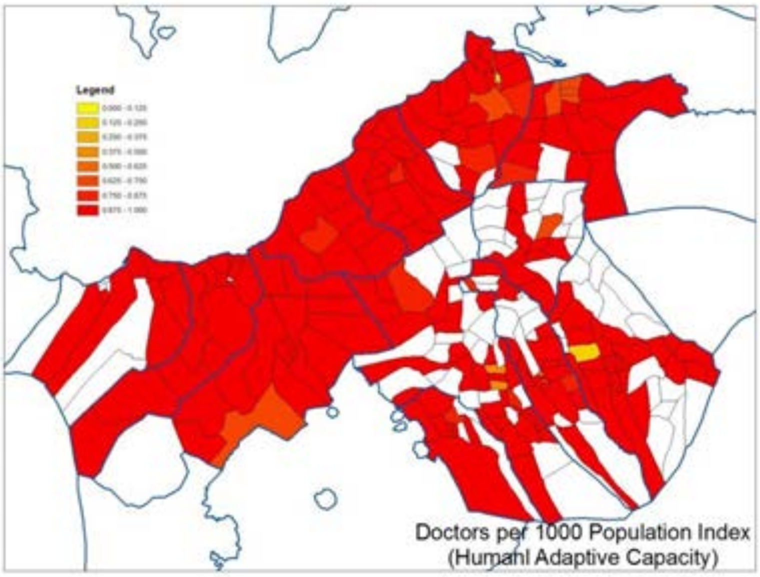


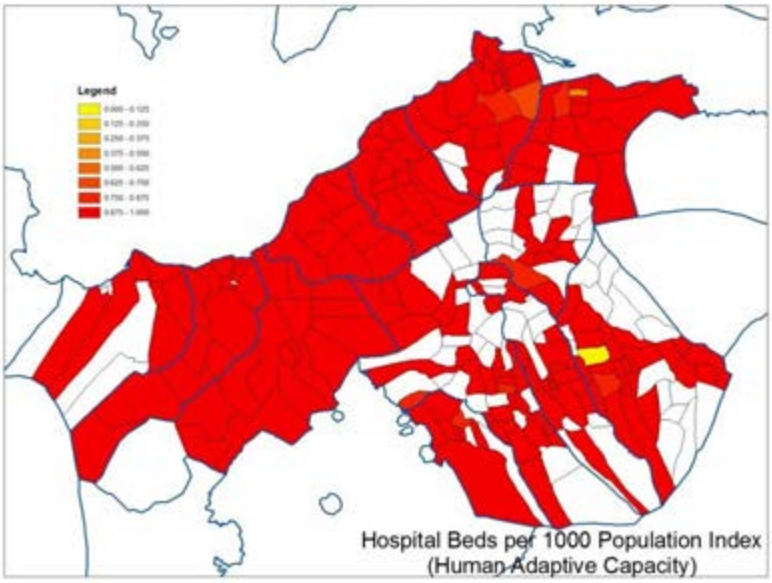
Annex Figure 18. Indicators for Social Adaptive Capacity

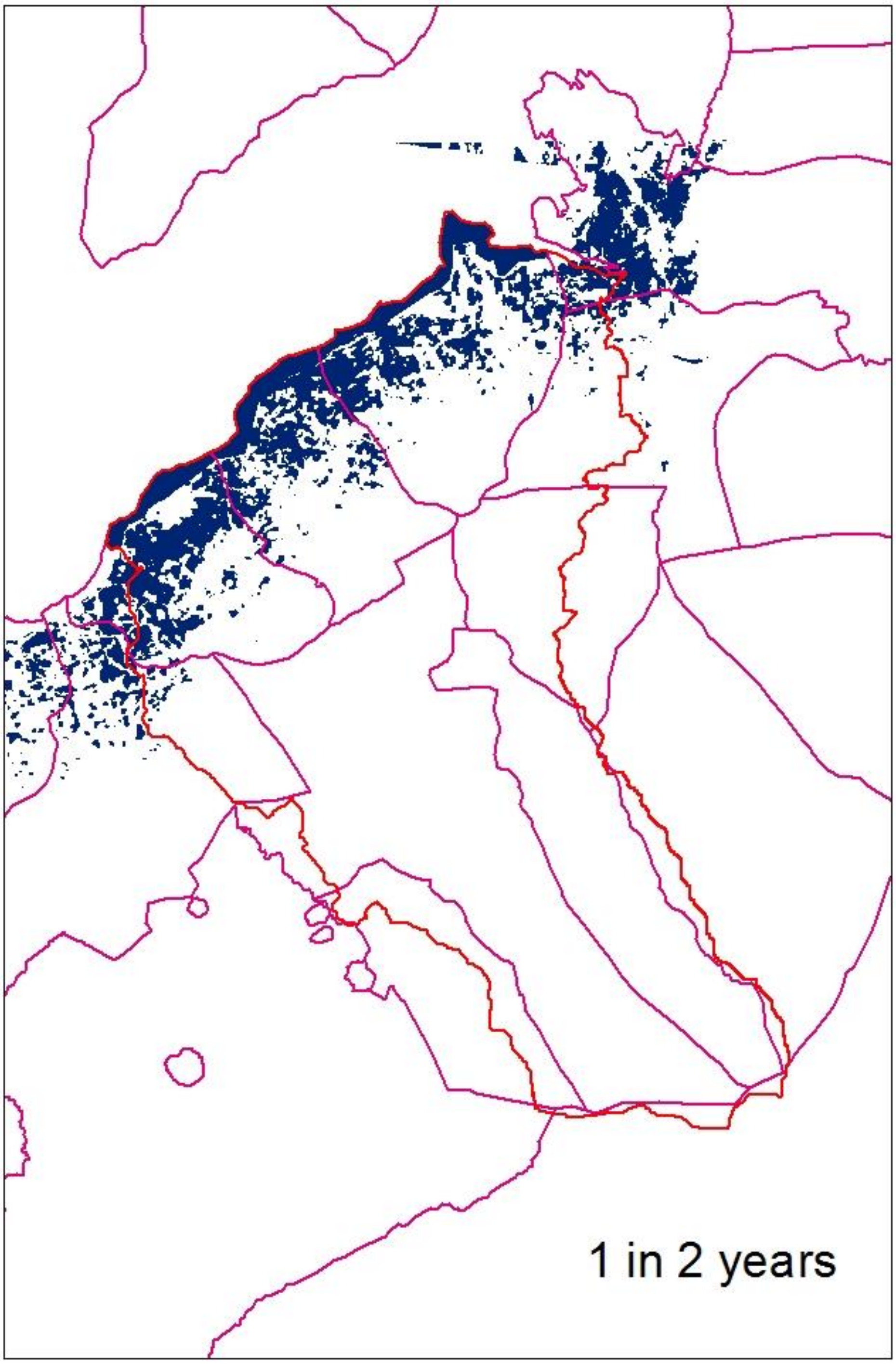


Annex Figure 19. Indicators for Human Adaptive Capacity

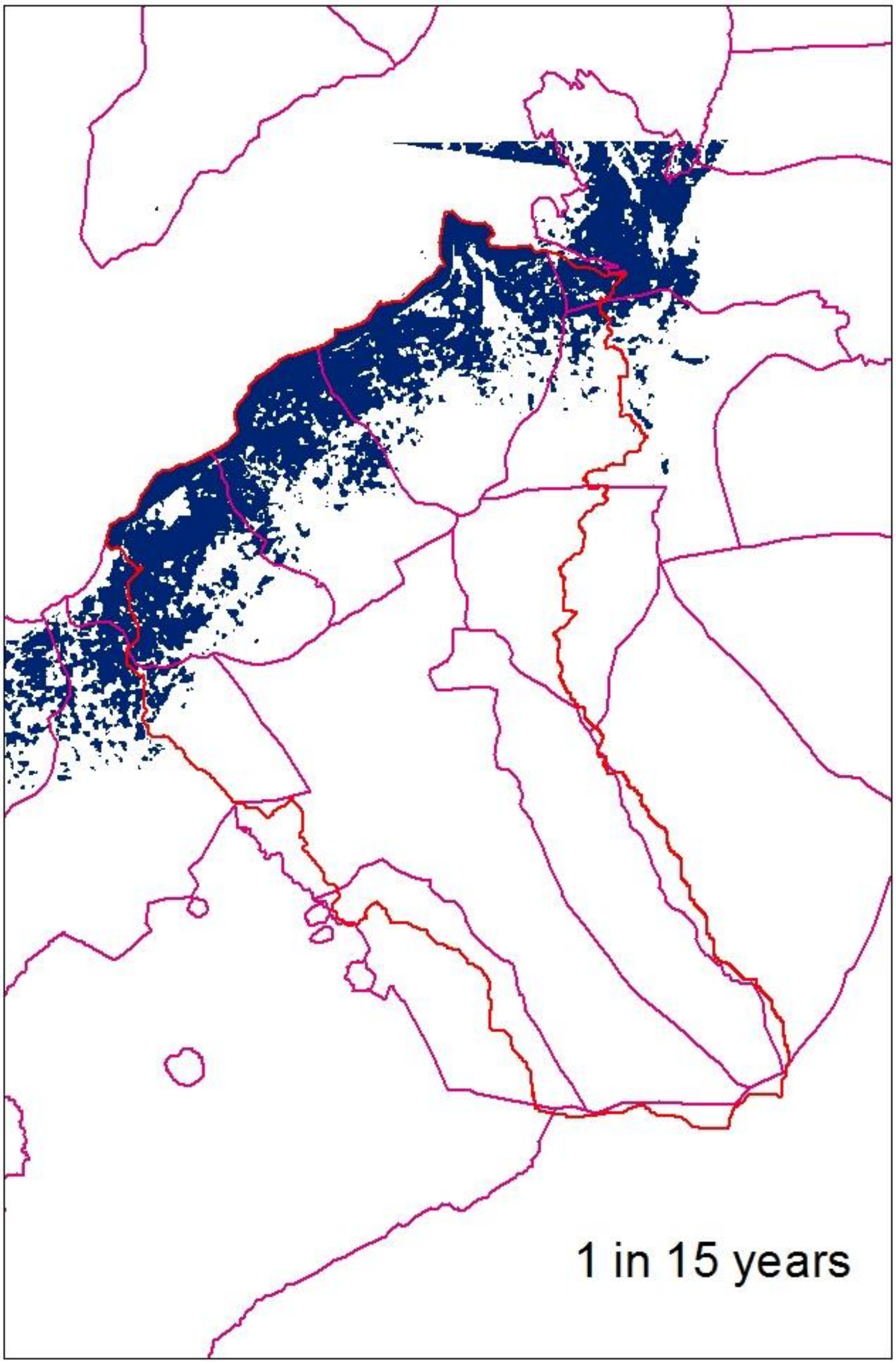




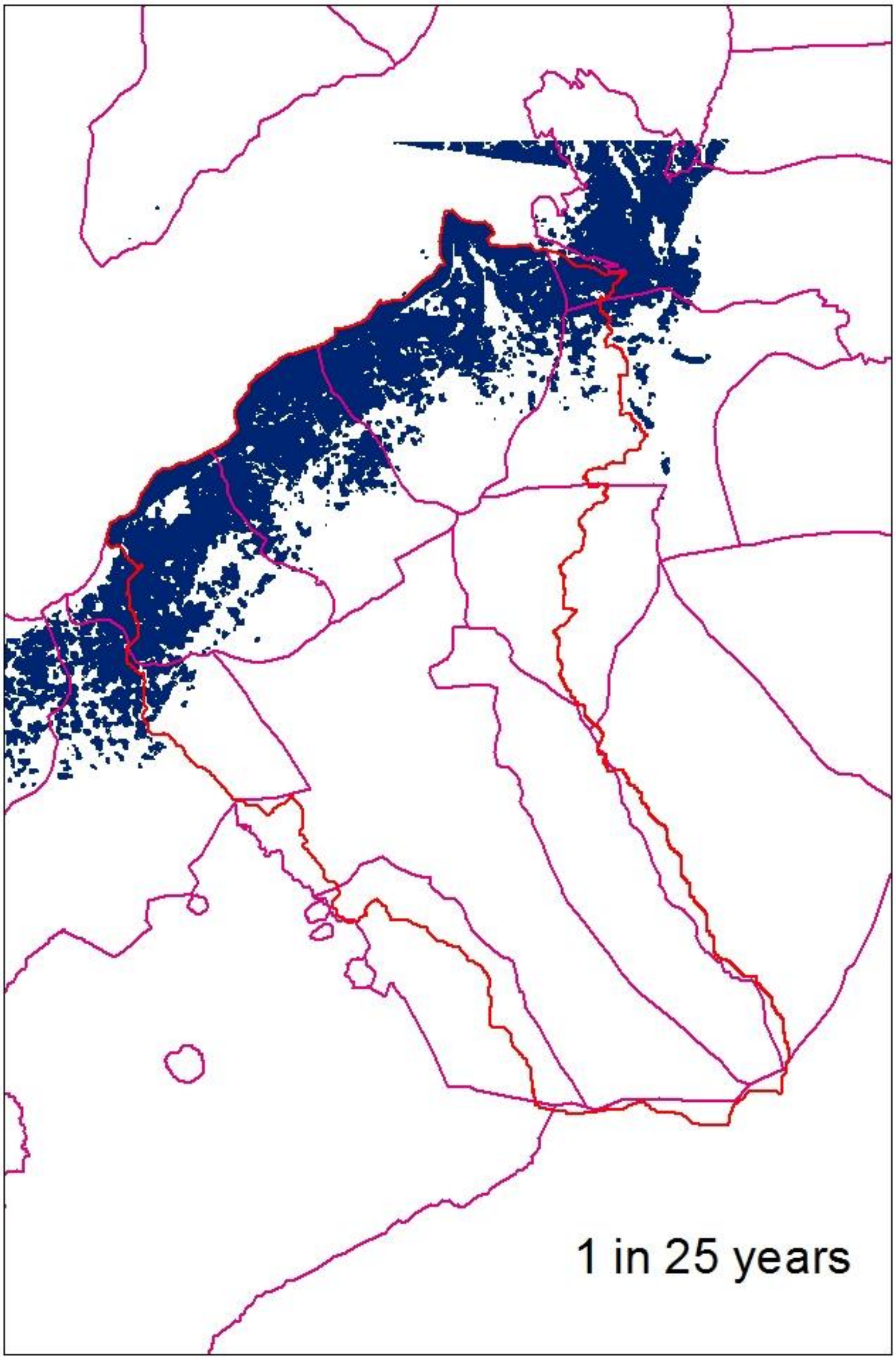




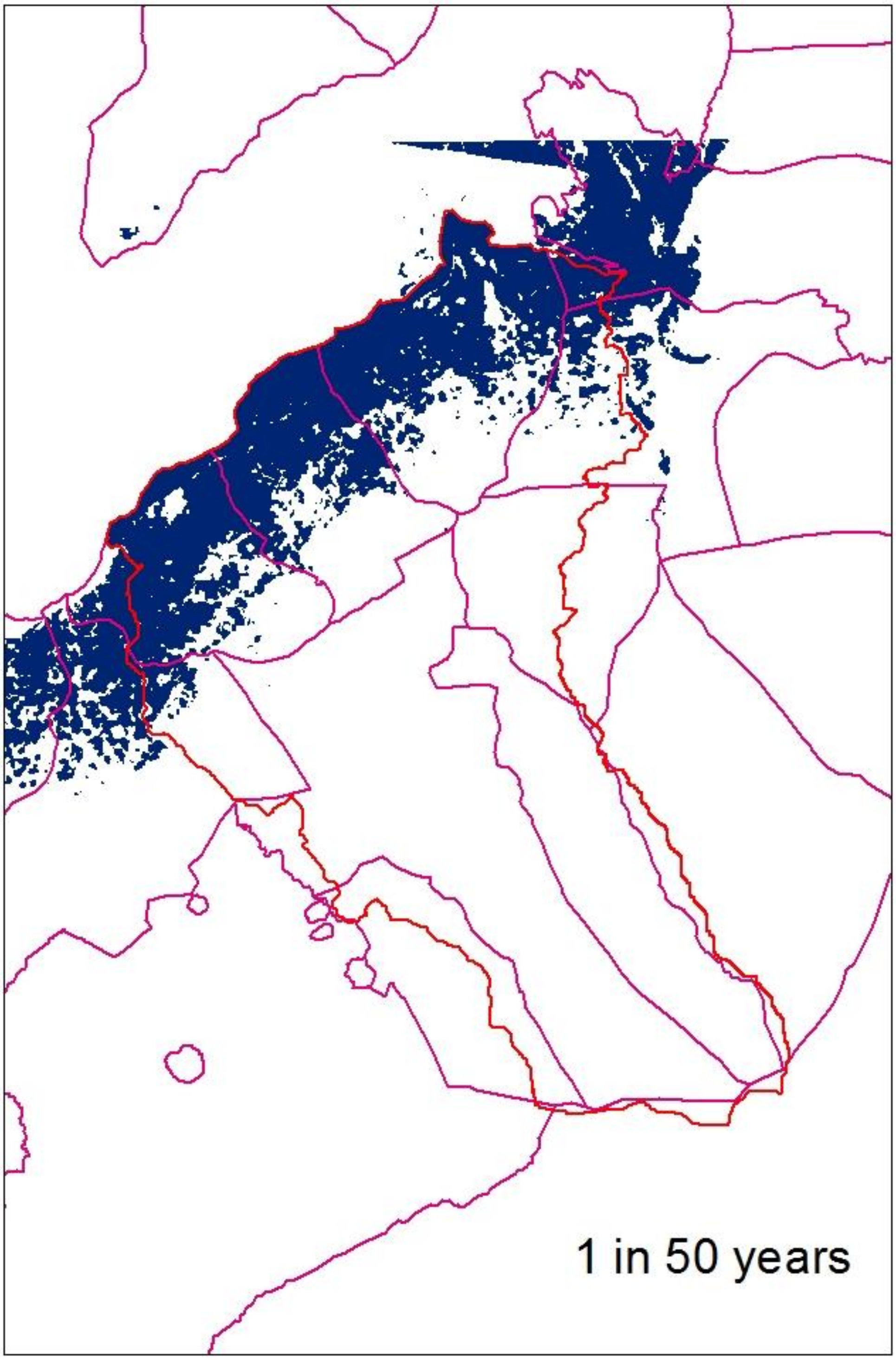
Annex Figure 20. Flood Inundation Map for a Flood with a Recurrent Period of 1 in 2 Years, Sta. Cruz River Watershed



Annex Figure 21. Flood Inundation Map for a Flood with a Recurrent Period of 1 in 15 Years, Sta. Cruz River Watershed



Annex Figure 22. Flood Inundation Map for a Flood with a Recurrent Period of 1 in 25 Years, Sta. Cruz River Watershed



Annex Figure 23. Flood Inundation Map for a Flood with a Recurrent Period of 1 in 50 Years, Sta. Cruz River Watershed