

**Flood Vulnerability Assessment:  
Structural, Social and Economic Aspects  
Case study: Naga City, Philippines**

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# **Flood Vulnerability Assessment: Structural, Social and Economic Aspects. Case study: Naga City, Philippines**

by

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## Abstract

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This research is carried out under the ITC SLARIM Project (Strengthening Local Authorities on Risk Management). One of the main objectives of this project is to develop a methodology for spatial information systems for municipalities that allows local authorities to assess risk of natural disasters in their municipality, in order to implement strategies for risk and vulnerability reduction.

In this research an exercise has been undertaken to analyse vulnerability in two of these most at risk barangays Triangulo and Mabolo from three perspectives: Physical, economical and Social by using the 'sustainable livelihoods (SL) approach' and combining participative and GIS methods to gather together Peoples' perceptions and knowledge with spatial issues. It is tried to contribute with the understanding of communities' vulnerability in Naga by describing and visualizing the 'pre-hazard' conditions of vulnerability to floods at household, zone level and barangay level.

Natural Hazards are physical events which have an impact on human beings and their environment (unless this conjunction occurs, there will be no hazard or disaster). The hazard involves the human population placing itself at risk from geophysical events. Disaster is defined as the result of natural events taking place within socio-economic system.

The extent of disruption, as well as the territorial and social distribution of these two 'societal risk' is determined by the differential levels of exposure, resistance and resilience of the societal, physical and economic systems. These three vulnerability components are all shaped by an actor's access to rights, resources and assets. Frequently opportunities for increasing resilience are often less when resistance is already low ('every day risk') and exposure is high, increasing the vulnerability to 'extreme' disaster events.

To achieve the objectives of this research, a data set that allows characterizing the study area from the structural, social and economical aspects was required. However most of the existing information is aggregated at barangay level, making difficult its use to achieve the objectives of this research.

A flooding scenario was developed with the maximum water depth experienced by the households in Mabolo and in Triangulo.

The analysis of the flood vulnerability assessment for the structural, social and economic aspects was performed by selecting the most relevant pre-hazard conditions in order to construct indicators to assess vulnerability to floods.

Several methodologies and models, most of them implemented under GIS environments, have tried to explain the impact of hazard events mostly in terms of expected damages and losses. However to be able to carried out this type of applications enormous amount of good quality data need to be available. On the other hand these types of approaches are generalized and do not address the differences in vulnerability, adaptation and coping mechanism that different groups of people have.



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# 1. Introduction

## 1.1. Background

This study is carried out under the ITC SLARIM Project (Strengthening Local Authorities on Risk Management). One of the main objectives of this project is to develop a methodology for spatial information systems for municipalities that allows local authorities to assess risk of natural disasters in their municipality, in order to implement strategies for risk and vulnerability reduction.

Natural hazards are threatening events, capable of producing damage to physical and social aspects of a society where they take place not only at the moment of their occurrence, but also on a long-term basis due to their associated consequences. When these consequences have a major impact on society and/or infrastructure, they become disasters.

A society becomes vulnerable when its human socio-economic and physiological systems do not have the capacity to avoid or minimize the impact of a disaster. A situation of disaster implies severe impact and dislocation on a community's economic performance and social well-being, reflected in the infrastructure, productive capacity, basic services, housing and environment, resulting in a reduction in the "Quality of Life".

Over the past few decades, there was an exponential increase in human and material losses from disaster events, though there was no clear evidence that the frequency of extreme hazard events had increased. This may indicate the rise in disasters and their consequences was related to a rise in people's vulnerability, induced by human-determined development patterns: environmentally unsound practices, global environmental changes, population growth, urbanization, social injustice, poverty, and short-term economic vision are producing vulnerable societies (UNISDR, 2002). While climate change may already be playing a role, the key origin of rising disaster losses is increasing vulnerability.

Developing countries, especially their most densely populated regions, are the most affected by the occurrence of hazardous events. Developing countries are particularly vulnerable, because they have limited capacity to prevent and absorb these effects. People in low-income countries are more than four times as likely to die as consequence of the impact of hazardous events than people in high-income countries (WDR, 2002).

According to The International Red Cross half of the 2557 disasters triggered by natural events between 1991 and 2000 took place in countries with medium HDI (Human Development Index), but two-thirds of the deaths occurred in countries with low HDI. Only the 2 per cent of deaths were recorded in countries with high HDI. (Table 1.1).

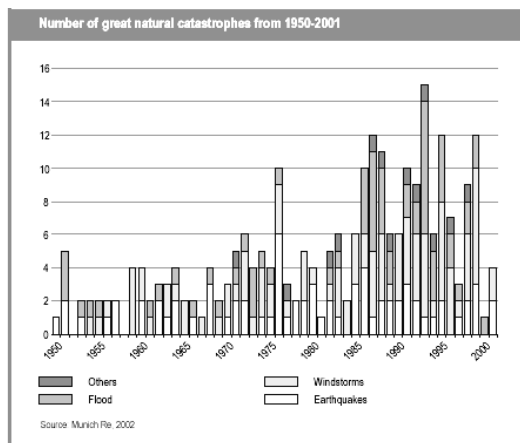
This is a trend that will continue unless concerted actions are taken to mitigate the impacts from natural hazards.

**Table 1.1 Level of human development and disasters impacts**

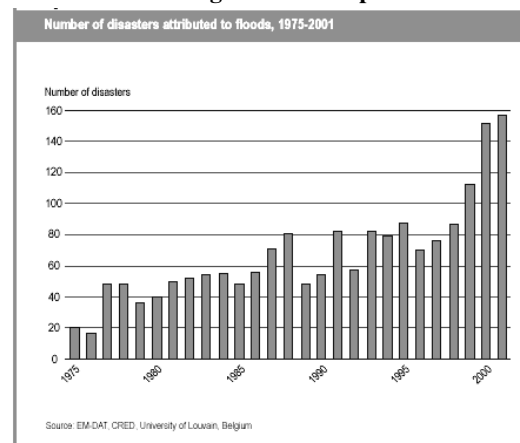
HDI	Deaths per disaster	Loss per disaster (\$millions)
Low	1052	79
Medium	145	209
High	23	636

IFRC (2001)

Flooding is the single most destructive type of natural disaster that strikes humans and their livelihoods around the world (Figure 1.2).



**Figure 1.1: Number of great catastrophes from 1950 -2001**



**Figure 1.2. Number of disaster attributed to floods from 1975 to 2001**

In the last decade, there has been catastrophic flooding experienced in China, India, Bangladesh, Germany, Poland, Mozambique, the USA, and elsewhere. Flooding is not restricted to the least developed nations, but also occurs in devastating fashion in the most developed and industrialized countries of the world. However, it is the citizens of the least developed nations that suffer the highest toll from the occurrence of flooding (UNISDR 2004)

Changes in attitudes to cope with damaging events have occurred over the past years with a shift in focus from 'disaster recovery and response' to 'risk management and mitigation' emphasizing community planning and public participation. The International Decade (1990-2000) for Natural Disaster Reduction (IDNDR) followed by the International Strategy for Disaster Reduction (ISDR) remarked the need to adopt a more pro-active approach to risk and disaster management.

Disaster management aims to reduce the impacts and losses before, during, and after events. Following the recognition that a mere focus on after-the-fact approaches is unsustainable in the long run, the paradigm has recently been shifting towards more emphasis on measures taken before events, referred to as an ex-ante approach. Today, efforts in this field generally aim at a more comprehensive approach involving a combination of measures taken before actual occurrence of hazardous events (ex-ante) and measures during and after disasters (ex-post) (Mechler 2003).

Regarding flooding there is seldom a single approach to reduce and manage risk, but rather an array of measures that run from development and enforcement of policies, construction of engineering works, development of forecasts, warnings, and response programme. UN recalls the emphasis should be placed on arriving at solutions that are practical, appropriate and sustainable for the community at risk (UNISDR 2004)

Flood risk management in a narrow sense is the process of managing an existing flood risk situation. In a wider sense, it includes the planning of a system, which will reduce the flood risk. Figure .



Figure 1.3 Stages of operational risk management

Risk management is the sum of actions for a rational approach to flood disaster mitigation. Its purpose is the process of controlling or avoiding disasters triggered by flood, in the sense of being prepared for a damaging flood event, and to minimize its impact. It includes the process of risk identification and analysis, which provides the basis for long term management decisions for the existing flood protection system. Continuous improvement of the system requires a reassessment of the existing risks and an evaluation of the hazards depending on the newest information available.

Disaster Risk reduction and management practices depends, in the first instance, on an adequate understanding of the processes by which risk is constructed in a society (UNDP, 2000). Comprehensive risk assessment requires improved data on the severity and frequency of natural phenomena in a particular place, and on the existing levels of vulnerability and resilience among others (Cardona et al, 2003).

According to the United Nations (2002) disaster reduction strategies should include, first and foremost, vulnerability and risk assessment, as well as a number of institutional capacities and operational abilities. The assessment of the vulnerability of critical facilities, social and economic infrastructure, the use of effective early warning systems, and the application of many different types of scientific, technical, and other skilled abilities are essential features of a disaster reduction strategy.

### ***Vulnerability as a key issue for risk and disaster reduction***

The term vulnerability has taken on a new and increased importance due to the greater scale of disasters. In general terms, it may be defined as the probability of a community, exposed to a natural threat, given the degree of fragility of its elements (infrastructure, housing, productive activities, degree of organization, warning systems, political and institutional development), suffering human and material damages. The magnitude of such damages is, in turn, related to the degree of vulnerability.

Vulnerabilities are generally defined as long-term factors that affect the ability of a community to respond to events or make it susceptible to calamities. They contribute to a disaster's severity, impede effective responses, are present before disaster strikes and remain long after the event is over.

In evaluating disaster risk the social production of vulnerability needs to be considered with at least the same degree of importance that is devoted to understanding and addressing natural hazards (Blaikie et al 2003). Vulnerability, need to be analysed from different perspectives (physical, social, political, technological, ideological, cultural and educational, environmental, institutional), although in one way or another all are actually related. Risk arises as a product of the a priori function linking threat and vulnerability, and is intrinsic and latent within society, although its level, degree of perception and means used to confront it, depend on the guidelines laid down by that society. All in all, vulnerability and risks are related to the political decisions a society has taken over time and, therefore, depend on a country's or region's development (IADB 2000).

The most desirable starting point for reducing the associated risks that disasters imply is by reducing vulnerability to existing hazards. In some countries such an approach is vital and urgent in order to address current developmental issues. In terms of identifying priorities for adaptation assistance, the management of adaptation in the near future may be based on assessments employing indicators of current risk and vulnerability, based on recent historical and current data.

### ***Information for Risk and vulnerability identification***

One of the latest researches carried out for the World Bank (Segnestam, 2002) show that for been able to work with indicators of environment and sustainable development many practical aspects should be tackled first such as regarding lack of data, low quality of available data, differences in scale and scope and even difficulties in presenting and disseminating the results in an effective manner. However, this same institution calls for new initiatives and creativity in order to gradually overcome the problem of non-existing or low quality data.

Some of these alternative methods are based on the use of existing literature, support from NGO's or institutions specialized in the topic, involvement of organizations representing the stakeholders' interests (using their vested interests as an incentive),



participation of schoolchildren as part of their education, or the local population – for example farmers, residents, and researchers – all of them encouraged to take an active role in the changes of their social, environmental, and economic surroundings by contributing to the data collection.

These alternatives for data sharing and collection become even more valuable when, as the UN (2004) states, communities should not be seen as passive recipients of information. There is an increasing need to uphold communities' to help themselves by providing the mechanism and tools accordingly. Some other advantages of working with local stakeholders include their active involvement in the information dissemination system, support and sustainability of the project that usually follow; and enhancement of issues that are relevant for the disaster risk management plans such as credibility, cost efficiency and incentives which may determine not only the quality of the monitoring system, but also its sustainability and the possibilities to integrate it into the decision-making process (Segnestam, 2002).

Participation has been recognized as the basis for appropriation of risk management by affected groups and such appropriation is a defining characteristic of the basis for future sustainability. External professional and technical actors are clearly highly relevant but must work alongside the subjects of risk in searching for adequate interventions that respond to their needs and requirements and which uses their capacities, resources and opportunities (LARED, 2002).

### ***Involving vulnerable communities in risk management***

Community participation has an important role to play in each stage of the disaster risk management framework as in many cases there is a missing link between what is needed and what is provided for instance in terms of policies, plans, measures and responses. Local risk management has now a good deal of attention as key component of the increasing primary risk reduction and risk management concerns (particularly over the last decade). Communities are the ones that suffer the most, but on the other hand local populations and authorities are the first and faster to respond to a disaster before the arrival of external help (UN 2004).

Community-based disaster organizations are crucial to instrument early warning measures and secure local support and ownership for risk management plans. Experience shows that engaging community stakeholders in a participatory process improves among others the quality and dissemination of information, fosters community cohesion, and produce ideas such as micro or local level mitigation solutions.

UN has as one of its main strategies for disaster reduction the involvement of local communities in processes of risk identification. Encouraging and training people to document disastrous events, damages and copying mechanism at their level, in any possible way, for future research on mitigation and preparedness is seen as a way to enhance their capacities for dealing among others with climate variability.

In fact, communities in hazard-prone and most especially in flood-prone areas develop what has been called local, place-based or indigenous knowledge - LTK which has spatial associations and components. This type of local knowledge, which have been also termed Local spatial knowledge – LSK - (McCall, 2003), 'describes home and action space, is innate and sustained knowledge about the land, identifies issues of immediate significance, and encodes the information about the environment in a language a region's inhabitants understand' (Duerden&Kuhn, 1996).

Regarding flood risk assessment, Whitehouse (2001) considers that local communities are indeed the primary sources of information (e.g., flood heights, severity measured in terms of damage, etc.). Systematic collection and collation of flood data, from significant

flood events, using public participation can often provide a very useful complement for the development of data-sets to be used at municipal level as input for flood studies

Aspects of flood risk management that can involve community cooperation and consultation (modified from Whitehouse, 2001) are:

- Identification of the flood problem (flood hazard assessment)
- Information gathering about damages from past events (elements at risk – vulnerability)
- Construction of flood risk scenarios
- Formulation and analysis of alternative mitigation strategies (vulnerability reduction scenarios)
- Implementation of the flood risk management strategies
- Flood awareness and response.

Local knowledge has been recognized as an important complement to scientific approaches (Sadler and Boothroyd, 1994; Pimber and Pretty 1997), providing additional advantages such as:

- Develop a more complete list of warnings,
- Examine risks that themselves are willing to take;
- Compare alternatives, using all available knowledge, and
- Recognize not only the risks they faced but also the benefits (Montague 2004)

However, the incorporation of such judgments in disaster risk identification is just at its embryonic stage. Even tough arguments in favour of enrolling communities in their own risk identification and management processes appear here and there few methods and tools exist for doing so.

One of the most direct applications of GIS in developing countries is participatory mapping, where, for example, specialists interact with farming communities to create spatial inventories of natural resources, property status, land-use rights, and perceived problems. Such inventories feed into a consultative process aimed at building consensus on more equitable and sustainable resource-management arrangements.

Participatory GIS (P-GIS), refers to the GIS technology used by members of the public, individually or grassroots group, for participation in public processes that affect their lives and so, encompasses data collection, mapping and analysis /or decision-making (Tulloch 2003). In other words, P-GIS is a spatial decision-making tool designed to utilize GIS technology in the context of the needs and capabilities of community that are involved with. For the collection of primary data, a number of different data acquisition techniques are used, such as Rapid Rural Assessment, the semi-structured interviews, workshops, fieldwork and observation, use of questions checklist (e.g. to collect historical data), analog maps, aerial photographs (e.g. multi-temporal).

Such integrated techniques can be efficient in obtaining reliable information from local people and are considered to have superior effects that merely application of conventional analysis within a GIS environment in terms of relevance, usefulness,

sustainability, empowerment and good governance objectives, due to its stress on participation and on utilizing local knowledge.

## **1.2. Problem statement**

A disaster is the intersection of two opposite forces: those processes generating vulnerability on one side and the natural event on the other. However not all groups in hazard-prone areas are necessarily victims. The impact on different social and economic groups may be more or less severe. Flood hazards have a variable impact on people according to vulnerability patterns generated by the socio-economic system in which they live.

To be able to understand the impact flooding can cause to a community the 'pre-hazard' conditions of people must be determined. Location of homes (and their proneness to inundation) as well as the structure and type of housing and workplaces are most of the times function of household income, legal or social limitations on land use, availability or cost of building materials and the location of livelihood activities.

Naga city in Camarines sur province has been chosen for this case study because of its vulnerability to climatic hazards such as typhoons and floods. Naga city is composed of 27 Barangays from which 17 are located in the floodplains of the Bicol and Naga rivers. According to the NCDMP (ADPC 2001a) regardless the magnitude of flooding the population of 9 of these barangays is prominently at risk.

Despite many efforts from the municipality and citizens disaster still continuing being part of Naga's recent history. Three typhoons (Yoyong , Violeta and Unding) and a tropical depression "Winnie" hit Naga City between November 19 and December 2, 2004, bringing dislocation and destruction to the Luzon Region.

Reports from these events encompass 2 persons reported dead due to hypothermia (extreme cold) another one from drowning when they refused to evacuate, some 60 Million pesos worth of crops, livestock, infrastructure, 1,974 residential houses destroyed (mostly those built of light materials), 1026 heavily damaged, agricultural fields, crops, fisheries and forest were destroyed (TS Unding and Yoyong disaster Rapid assessment, Naga 2004, Mr E. Elcamel personal communication).

Several projects to identify the population and other elements at risk have been carried out in Naga. The Naga City Disaster Mitigation Plan (2001) prepared as part of the Philippines city disaster mitigation plan is a comprehensive exercise at this respect that addresses many of the factors related with the high vulnerability and consequent risk associated with flooding in Naga.

However lack of detail or micro-level information, poor cartographic representation of these problems as well as the generalization of interpretations at municipal or barangay level hampers the visualization of the problem, overlook specific conditions regarding flood behaviour and vulnerabilities at micro-scale, makes difficult the specific location and distribution of those communities and households most at risk, tend to simplify specific conditions that enhances vulnerability and overlook capacities they develop as part of their continuous process of adaptation to a difficult environment.

Knowing who is vulnerable and why is as important as where and when are they located where a hazardous situation threatens the security of a community. At the moment of impact of a given event such as flooding people were to be found in coordinates of time and space as might be expected from their pursuit of 'normal life' (Blaikie et al 2003).

In this research an exercise has been undertaken to analyse vulnerability in two of these most at risk barangays Triangulo and Mabolo from three perspectives: Physical, economical and Social by using the 'sustainable livelihoods (SL) approach' and combining participative and GIS methods to gather together Peoples' perceptions and knowledge with spatial issues.

This study tries to contribute with the understanding of communities' vulnerability in Naga by describing and visualizing the 'pre-hazard' conditions of vulnerability to floods at household, zone level and barangay level.

Floods in Bicol and Naga Rivers will continue occurring as part of their natural processes. However vulnerability and risk of Naga society can be reduced just if aspects such as social, economic and structural conditions of flood-prone communities are taking into consideration for addressing adequate risk and disaster management strategies integrated in short, medium and long-term development plans.

### **1.3. Research Objectives**

#### **1.3.1. Main Objective**

To identify the structural (buildings), social and economic 'pre-hazard' conditions of two communities in Naga in order to determine their vulnerability to floods by applying participatory methodologies combined with GIS.

#### **1.3.2. Sub Objectives**

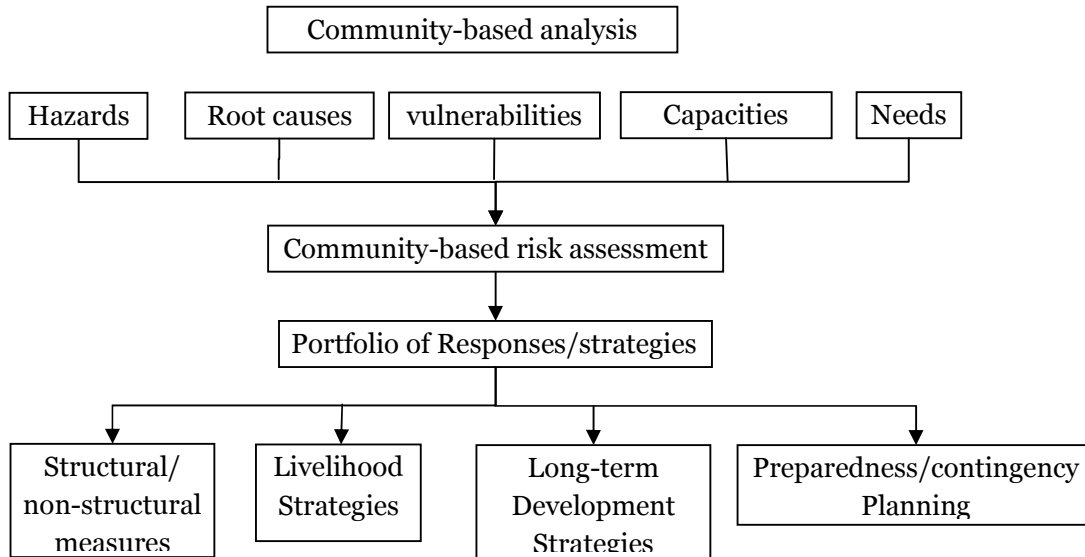
- To identify and make a profile of the most affected barangays (wards) by flooding.
- To determine communities' perception of flood hazard.
- To identify the structural, social and economic characteristics of the barangays.
- To assess the structural, social and economic vulnerability in flood-prone areas.

#### **1.3.3. Research Questions**

- Which are the flood events that communities perceived as a hazard?
- Which is the communities' risk perception regarding a given flood event?
- What are the 'pre-hazard' characteristics (indicators) found in a community that can help to address and monitor structural, social and economic vulnerability?
- Which is the spatial distribution of this characteristics (indicators)?
- What is the relationship between the different indicators?

### **1.4. Methodology**

The basic premise of the methodology applied in this research is that communities located in flood- (or hazard) prone environments do have developed knowledge and perception of risk that may be used as the starting point for every risk identification project. People that bear the risk that hazards such as floods pose to their life may help themselves to identify risk reduction measures that will reduce their vulnerabilities and enhance their capacities (Figure 1.4)



**Figure 1.4: Flood risk identification from communities perspective**

In order to get this perception participative methods were applied to recognize different people's perception of risk. Communities may have different understanding and experience in coping with risk and therefore may have different views and how to reduce the risk. At the same time was important to address different vulnerabilities and capacities from various communities' members and groups.

A community-based risk identification process was set in order to warranty that the communities' real needs were considered. By developing a participatory risk assessment (PDRA) a diagnostics process to identify the risk that the communities' faces and how people overcome these difficulties was carried out.

One of the first steps in this research was to interact with communities in the selected barangays in order to understand the perception of risk and which events they consider as hazardous for their livelihood. Information about hazards, damages, losses and coping mechanism was collated for most affected zones within every barangay.

The second step consisted of a mini-survey carried out at micro level (household), in order to identify the characteristics of those most affected by floods. By applying pre-designed and further adapted questionnaires local people (households) were interviewed in order to collect flood related information such as structural characteristic of the dwellings, means of livelihood and social characteristics for the evaluation of vulnerability.

The sample consisted of 129 respondents at a household level, using a simple purposive random sampling (CARE 2000). Triangulation for this information was done though several other participative tools such as workshops and transects. Triangulation refers to the comparison of data among different sources of information to improve its validity and reliability (CARE 2000).

Three workshops were carried out (2 in Triangulo and 1 in Mabolo) with the zone leaders and participants in each barangay.

In the third step the conceptual model of Environmental Risk of Pelling was adapted in order to address the communities' actual levels of exposure, resistance and resilience. In order to model the vulnerability to floods, a quantitative methodology widely applied by

LARED in Central America was adapted in this research (Villagrán de León 2005). This method intends to quantify people's vulnerability by selecting indicators that address a community's characteristics (elements/components) and assigning weights to each of them, using standard mathematical models and employing specific house-to-house surveys.

Vulnerability assessment processes are complex issues that should be carried out in different levels: single household, neighbourhood, community, sector, and/or country. The vulnerabilities to be assessed are at a household level in the following aspects:

- Structural vulnerability of buildings is related to the status of the building itself (material and construction systems) according to the capacity of the house has against a flood hazard.
- Social vulnerability related to different aspects within a family, including number of members within a family, household composition.
- While for the economic vulnerability, is referred at the level of access to resources and therefore to income opportunities.

When assessing flood vulnerability using the quantitatively methodology is important to select carefully the indicators of the structural, social and economic characteristics taking care that firstly they reflect the situation at hand and second suit the purpose of study. The general idea about some indicators came from literature review especially for those aspects that are part of the environmental risk, (Pelling 2003, Suarez 2003, IDEA 2003, Villagrán de León 2005). However the current indicators used in this research were carefully selected from both the community through the workshops and during fieldwork taking care that they depict the characteristics of the community and the built environment.

## **1.5. Scope**

The scope of this study is about engaging communities in flood-prone areas in processes of risk identification and converting this local knowledge into information that can provide municipalities with input for risk assessment and further risk and disaster management and vulnerability reduction measures.

## 2. Flood vulnerability assessment, literature review

### 2.1. Introduction

Natural Hazards are physical events which have an impact on human beings and their environment (unless this conjunction occurs, there will be no hazard or disaster). The hazard involves the human population placing itself at risk from geophysical events (Alexander 1993). Disaster can be defined as the result of natural events taking place within socio-economic system.

According to Uitto (1998), a natural hazard only becomes a disaster when it affects a human population that is exposed and vulnerable. The occurrence and extent of disasters thus depends on three basic variables: (1) hazard (natural phenomena such as earthquakes, typhoons or volcanic eruptions); (2) exposure (structures, buildings, humans and other entities at risk); and (3) vulnerability (propensity to suffer loss).

The past decade has been a very significant period in relation to floods (Wisner, 2004). Floods seem to shock not only the victims, but also governments, planners and insurers. The media and popular conceptions of floods shifted significantly to suggestions that the disaster were happening because people and buildings were in the wrong places on flood-prone land (Wisner, 2004).

An integrated assessment of flood risk involves a broad definition of the flood system. Flooding system is viewed as an encompassing all of those physical and organisational systems that influence or are influenced by flooding (Hall et al., 2003b), as follows:

- The physical attributes of the earth's surface involved in the water cycle, i.e., the processes of rainfall, snow melt, and marine storms that lead to fluvial coastal flooding, runoff from the land, and flood inundation in fluvial floodplains and coastal lowlands.
- The artificially created systems of drainage, storage, and flood defence that are intended to convey flood discharges and resist or control inundation of flood plains.
- The economic, social and environmental assets that are located in floodplains and are impacted upon by flooding and/or have an impact on the flooding process.
- The organisations with a statutory responsibility for managing flood risk. These may be government organisations with duties or powers to manage flood risk.
- Insurers, who provide cover for flood risk.
- Broader stakeholder groups who have an interest or role in the impacts (both positive and negative) of flooding and the actions that they may take to manage flooding.

The Pressure-State-Impact-Response (PSIR) model based on Rapport and Friend's (1979) Pressure-State-Response model.

- Socio-economic drivers lead to environmental pressures.
- Environmental pressures lead to changes in environmental state.
- Changes in environmental state are reflected in environmental and socio-economic impacts.
- Stakeholder gains/losses from impacts lead to policy responses.

This framework deals with the changes in system state. Any phenomenon that may change the time-averaged state of the flooding system is referred to as a driver (Hall, 2003). These drivers will be under control of flood managers (construction, defence system, flood warning system, etc.) and others are outside the control of flood managers (rainfall) (Hall, 2003).

Blaikie et al (2003) argued that disaster occur as the result of the impact of hazards on vulnerable people. In order to explain the relationships between natural events and the social processes that generate unsafe conditions they develop the Pressure and Release (PAR) model which shows in diagrammatic terms how the causes of vulnerability can be traced back from unsafe conditions, through economic and social ('dynamic') pressures, to underlying root causes. The *access model* is designed to understand complex and varied sets of social and environmental events and longer-term processes that may be associated with a specific event that is called a disaster. It sets out to explain at a *micro-level* the establishment and trajectory of vulnerability and its variations between individuals and households. It deals with the impact of a disaster as it unfolds, the role and agency of people involved, what the impacts are on them, how they cope, develop recovery strategies and interact with other actors.

## 2.2. Floods

Due to their particular behaviour pattern, most types of floods are *known as risk* (Blaikie 2003). Riverine floods are normally restricted to flood plains, where events over thousands of years have deposited silt and levelled the land becoming good for agriculture and cheap for modern construction. Flash floods also occur in the hilly upper reaches of river basins, when heavy rain over a limit area drains rapidly into a main channel (Blaikie 2003). It is generally agreed that flash floods have the following characteristics:

- They occur suddenly, with little lead time for warning;
- They are fast-moving and generally violent, resulting in a high threat to life and severe damage to property and infrastructure;
- They are generally small in scale with regard to area of impact;
- They are frequently associated with other events, such as riverine floods on larger streams and mudslides; and
- They are rare.

Also, floods affect some low-lying inland areas as a result of rainfall, and some coastlines are liable both to rain flooding and sea invasion. Coastal areas are also at risk of tsunami, the waves triggered by earthquakes, volcanoes or undersea landslides that can cross oceans at 800 km/h and rise to enormous heights when striking the shore (Wisner, 2004).



### 2.3. Flood risk and disaster management

Risk management has been established as a well defined procedure for handling risks due to natural, environmental or man made hazards, of which floods are representative. Risk management actually takes place on three different levels of actions: the *operational level*, which is associated with operating an existing system; the *project planning level*, which is used when a new, or a revision of an existing project is planned; and the *project design level*, which is embedded into the second level and describes the process of reaching an optimal solution for the project (Plate, 2002).

A change to proactive management of natural disasters requires an identification of the risk, the development of strategies to reduce that risk, and the creation of policies and programmes to put these strategies into effect. Risk management is a fundamental activity geared to the evaluation of schemes for reducing but not necessarily eliminating the overall risk, as in many cases risk cannot be entirely eliminated. Figure 2.1 provides a schematic of the steps associated with risk assessment and management. Flood risk management should include assessing the potential for a hazard to occur and a vulnerability analysis to provide an understanding of the consequences should an event of a certain magnitude and frequency occur. Based on this initial work, various mitigation measures can be evaluated to assess their ability for reducing risk exposure. Based on a thorough risk assessment, disaster management plans and specific mitigation measures can be identified. Efforts would then be undertaken to implement the selected mitigation measures. For flooding events, there is a need to calculate the probability or likelihood that an extreme event will occur and to establish and estimate the social, economic and environmental implications should the event occur under existing conditions (UNISDR 2002).

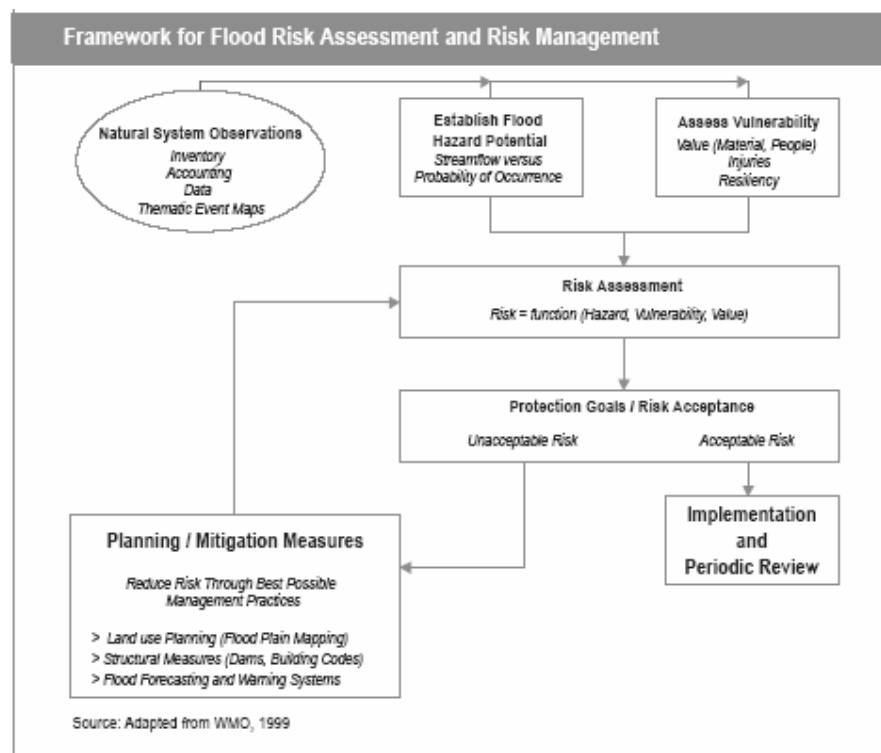


Figure 2.1 Framework for flood risk assessment and risk management (UNISDR 2002)

## 2.4. Vulnerability

'Vulnerability' is here defined as the characteristics of a person or group that affect their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. The degree of vulnerability is defined by factors such as socioeconomic status, wealth, ethnicity, gender, disability and age. People and groups that are socio-economically disadvantaged, such as the poor and immigrants, are often consigned to more vulnerable locations (Uitto, 1998).

## 2.5. Vulnerability assessment

"Vulnerability and capacity assessment is a basic process; it is used to identify the strengths and weaknesses of households, communities, institutions and nations" (IFRC, 1999). Hence, vulnerability can be defined as "the characteristics of a person or group of elements exposed to the risk in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard". For vulnerability assessment, the suggestion is to define clearly "where is the element that is vulnerable to?".

A vulnerability assessment is a profile with a specific focus on the relationship between a natural hazard and recipient subject. The vulnerability assessment identifies the strengths and weaknesses of the recipient subject in relation to the identified hazard, based upon readily attainable information. At the same time, it identifies the stakeholders relevant to the recipient subject and the decision making process of the stakeholders. This is done in an effort to allow stakeholders to more effectively mobilise and allocate the finite resources available in an effort to strengthen the ability of the subject to prevent and mitigate the effects of the hazard so as to further development.

A vulnerability assessment is carried out so as to allow stakeholders to better make decisions on how to protect the recipient subject from a certain hazard.

The goal of the stakeholders is always to ensure the greatest protection of the subject from the hazard, be it a house, factory or bridge, or specific ecosystems, in order to limit any loss. This is important because any loss among the stakeholders has the potential to either temporary or permanently retard the development of the stakeholders and the larger community, and the management and utilisation of the environment and natural resources.

Therefore vulnerability is related to the following three types of potential intervention as the results of identification and assessment of vulnerability:

- Reducing the challenge;
- Mediating the challenge; or
- Enhancing coping capacity.

Different levels of decision-making require assessments of vulnerability across different geographical scales. In addition, administrative boundaries rarely coincide with the boundaries of catchments or sub-catchments. However, the larger the geographical scale on which the vulnerability assessment is based, the greater the detail that is lost is.

vulnerability is not a readily measured or monitored parameter, rather than a combination of various parameters that are related to socio-economic, political and environmental settings of specific locality. Further, it is again to be noted that the concept of vulnerability is for relative comparison for the decision-makers to decide on how and where their interventions should take place. Therefore, the threshold or critical

level of vulnerability should be agreed upon by decision-makers, particularly through economic and political processes.

The aim of vulnerability assessment is to provide decision-makers with information as to where and when interventions should be made in what form. Such assessment should also provide indication as to what development restriction exists in specific location within a basin. In other words, vulnerability assessment should be designed so as to produce such information for specific target areas. In this way, presentation of vulnerability constitutes part of the early warning system to flood damages.

The ever-changing environment and patterns of vulnerability of communities in disaster-prone areas will require mapping local vulnerabilities in order to plan community-based risk reduction measures. "Vulnerability itself is a property or a circumstance of persons, activities and sites" (Hewitt, 1997). Gender, wealth, age group may influence on how the people are affected by economic trends or urban congestion. These factors can also play an important role in the communities' vulnerability. It is also seen how the vulnerability is embedded in the social geography of settlements and land uses, and the space or distribution of influence in communities and political organisations.

The assessment of the vulnerability of a community needs to be carried out within different groups of stakeholders due to the importance of their local knowledge and experience.

Some ways in which the people or communities become more vulnerable could be:

- Exposure to hazard: through occupation, life-style, location
- Weaknesses and susceptibility: genetic predisposition, disability, poor design of buildings, insecure practices
- Disadvantage or structural weakness: poverty, dependency, lack of capabilities and rights
- Defencelessness: lack of protection or aids to counter or avoid danger
- Powerlessness: inability to influence sources of danger or protection

Other aspects that should be considered in the vulnerability assessment are:

- Identification of the hazard itself
- Identification of the areas more affected (location) by the hazard

The adaptation to a natural disaster is another issue to be considered in the vulnerability assessment:

- warning and evacuation
- learning to live in hazards
- Adjustment: use of floodplain by land-use regulation to reduce flood risk instead of building a substantial river-bank levee, which is unlikely a complete protection against extreme flood

Within a flood hazard, in urban areas different aspects of danger and human vulnerability have been identified according to Hewitt (1997):

- Drowning and injury of persons, their domestic animals and crops, possible to use wildlife resources upon which they depend.
- Barrier hazards: the disruption of pedestrians, road, rail and air traffic, although access by water may be increased temporarily and used for relief purposes.
- Denial of life-supporting supplies, services, access to means of livelihood or work places. Inundated or destroyed homes result in a housing crisis.
- Secondary and tertiary damage includes outbreaks of waterborne disease and spread of unwanted pests. Wildlife (snake bites) or insect plagues are secondary hazards in some tropical areas.

The nature of the damage and the role of various flood parameters depend equally upon human exposure and vulnerability. In areas with rural population and important agrarian sector, losses of human life, domestic animals or ruined croplands may be the greatest danger. In urban-industrial areas, damaged materials, severed communications and lifelines, or lost amenities, are compared with rural population. Land uses and land use changes in flood plain areas are often, and increasingly, seen to be directly responsible for the scale of flood risks or changing risks than hydrological conditions (Hewitt 1997).

The assessment of vulnerability should be seen as a necessary complement, rather than an alternative, from the hazard's perspective, to show how the communities are exposed to dangers or become unsafe, rather than the character of natural agents.

Vulnerability can be assessed at various levels: individual, household unit, village, ecosystem, sub-basin, basin and national. For different levels, different sets of information will be required. Ultimately the whole purpose of the vulnerability assessment exists as an inexpensive process to allow stakeholders to have clear and concise information to make decisions that will most effectively reduce their vulnerability to floods and consequently further to their development. Partially in order to do this, there must be a clear understanding of who the stakeholders are and the processes by which decisions are made (UNCHS 2001).

## **2.6. Urban vulnerability**

Vulnerability and risk in urban areas are usually determined by factors such as:

*Lack of or inadequate social security systems*, migration from rural to urban areas generates the loss of traditional social security system which generally is not replaced by other private or public system. This weakens the capacity to mitigate the probabilities and magnitudes of damage associated with global risk, such as natural disasters.

*Slum formation* is generally the response to unsolved problems particularly those in rural areas of developing countries reflected in the formation of unplanned settlements without adequate public infrastructure.

*Deficiencies in urban planning and infrastructure*, in developing countries, urban planning administration and infrastructure are mostly not able to provide basic services to all urban inhabitants. The supply of electricity, drinking water and wastewater disposal services is generally concentrated upon a few districts of the city. A substantial part of the urban inhabitants who gain their living in the informal sector is forced to be self-reliant. Due to these infrastructural and organizational deficits, urban inhabitants are more vulnerable to risk in developing countries than in industrialized countries.

*Resource access* in urban areas results from cash exchanges. For the urban poor, as with other city dwellers, the building of financial assets is almost always a key activity for

greater livelihood security. Financial assets are often fragile; many urban poor live by arranging complex systems of loans and debt-servicing, borrowing small amounts and calling in debts from others to pay bills as they arise. A large proportion of the urban poor are forced to work in the informal sector, earning low incomes for long hours of work. Competition for work is intense, usually making incomes very low. For such workers, insurance, health care or sick pay do not exist. Working in poor conditions serves to increase long-term vulnerability to disease and ill-health (Sanderson 2000).

*Tenure* is a key physical asset to acquire. Squatters and slum dwellers will endure dangerous conditions to be close to sources of income, whilst in the rental sector, many families may share crowded, poor quality, illegally divided tenements. Having a degree of ownership of land, therefore, is often the starting point for households to consolidate shelters. A better building reduces vulnerability to sudden impact disasters, for example, an earthquake or fire.

*Opportunities for earning income*, benefits from different household members entering into a range of activities based on skills, knowledge and ability increases the chances of sustaining a household. However, some strategies serve to increase vulnerability and threaten household sustainability; for example, young children working in factories may miss out on an adequate education and childhood.

### **2.6.1. Exposure**

Exposure can be defined as the location of the element at risk in relation with the hazard occurrence. Exposure is also a matter of activities and responsibilities. Exposure and reasons for being exposed reflect people's participation in the activities and concerns of their society.

### **2.6.2. Structural vulnerability of buildings**

A natural disaster such as flood may cause physical damage which may be either widespread across the community or isolated to specific geographic locations. Direct impact and damage, as well, may be only one sector of the urban economy affected.

#### **2.6.2.1. Building location**

Location could be one of causes of urban vulnerability to a particular natural hazard, however, that does not imply that the problem could be solved by replacing the city, which is not the correct action. There is a need to understand why the city is placed there or which are the wishes of the city's inhabitants or could be the geographical location is one of the factors responsible for urban growth (Farazmand 2001).

### **2.6.3. Social vulnerability**

Social vulnerability is analyzed considering special areas where individual resources for loss prevention and disaster recovery tend to be minimal.

According to Dwyer (2004), the social vulnerability to natural hazards impacts has been simplified into four different levels:

- Individual within household (relating to personal attributes)
- Community (relating to how we interact with those around us)
- Regional/geographical (relating to how far we are from services)
- Administrative/Institutional (relating to disaster funding and mitigation)

This simplification aims to illustrate that there are diverse factors contributing to social risk from natural hazards, including those that relate to how hazards are managed by the region or nation we live in, while others relate directly to individual attributes (Dwyer, 2004).

For purpose of this study, the level of social vulnerability is at household level. The concept of social vulnerability was taken from Dwyer (2004) It is defined as “the ability of an individual within a household to recover from a flood hazard impact”

#### **2.6.4. Economic vulnerability**

Most of natural hazards such as floods occur within urban areas impacting not only the physical infrastructure but also, the employment and income (social and economic factors).

As a result of the special structure of regional production and transactions, the urban economy is vulnerable to tremendous upheaval and displacement arising from a major disaster event. Vulnerability arises from 3 primary sources. The first source is direct impact damage and losses, arising as a consequence the loss of infrastructure, capital loss, and displaced population and labor. Second, temporary disruptions of economic activity may also result in changes in the pattern of intraregional and interregional trade. Third, a large scale disaster event may also cause in the regional structure of production, and regional economic linkages, further changes in intraregional and interregional trading patterns.

Along with natural disaster, the vulnerability of the urban area arises from 2 sources: the social, political and institutional setting; and the natural disaster agent itself (hurricane, flood, drought, earthquake, etc.) outside of human control.

#### **2.7. Community vulnerability assessment**

The concept of Community-based Disaster Risk Management (CBDRM) has emerged during the past two decades in South East Asian countries. It is a process of disaster risk management in which communities at risk are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks in order to reduce their vulnerability and enhance their capacities. The aim of CBDRM is to reduce vulnerabilities and to strengthen people’s capacity to cope with the disaster risks they face (Abarquez, 2004).

In the context of disaster risk management, a community can be defined as people living in one geographical area, who are exposed to common hazards due to their location. They may have the common experience in responding to hazards and disasters. However, they may have different perceptions of and exposure to risk (Abarquez, 2004).

Participatory Rural Appraisal (PRA) is defined as the set of approaches, behaviours and methods for enabling people to do their own appraisal, analysis and planning, take their own actions, and do their own visuals, such as diagrams and maps. This method is also known as Participatory Learning and Action (PLA), (Abarquez, 2004).

Participatory Disaster Risk Assessment (PDRA) is the process whereby all concerned parties collect and analyze disaster risk information, in order to make appropriate plans and implement concrete actions to reduce and/or eliminate disaster risks that will adversely affect their lives. It is a kind of dialogue and a negotiated process involving those at risk, authorities and other stakeholders.

A Risk Vulnerability Assessment (RVA) performed by and/or with the community should provide knowledge, insight, and feedback throughout the RVA process. The communities

can use RVA results to reduce the impacts from hazards through the development or revision of emergency response, disaster recovery, and hazard mitigation *strategies*, and *comprehensive land use plans* that incorporate sustainable development practices (Flax, 2002).

Community-based assessment instruments (or approaches), such as Capacity and Vulnerability Assessment – CVA, Hazards, Vulnerability and Capacity Assessment – HVCA, and Damage, Needs and Capacity Assessment – DNCA, have been developed for analysing disaster situations at the grassroots levels and for improving the community's expertise in identifying and articulating its necessities and reducing its vulnerabilities. They have been used more widely in preparedness and mitigation phases of disaster management with developmental approaches to disaster together with community participation in planning and implementation (Heijmans and Victoria, 2001; IFRC, 2002; Christian Aid, 2003; Cannon et al, 2003). The use of Participatory mapping and participative GIS (P-GIS) capabilities has been considered also an essential tool for supporting and strengthening spatial planning and landuse management. This process assist communities to look at their environment and freely explore around with alternative scenarios based on understanding of their own goals, constraints, preferences, as in the co-learning process of GIS joint development (Gonzales, 2000; Weiner&Harris, 2002, McCall, 2003).

## **2.8. Vulnerability models**

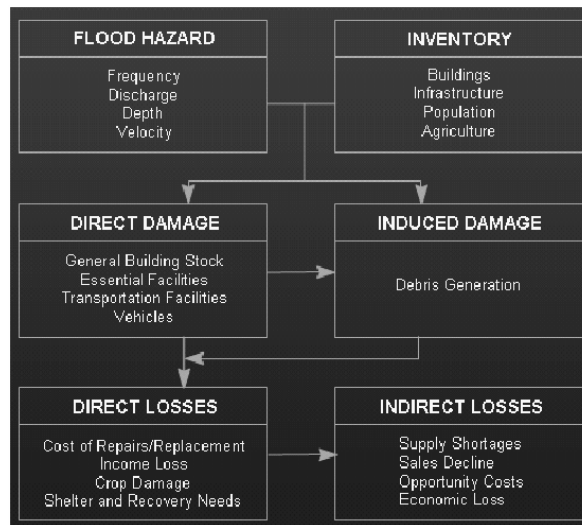
### **2.8.1. HAZUS model**

The HAZUS Flood model was developed for use by floodplain managers and other users who have the responsibility of protecting citizens and property from the damaging affects of flooding. It is an integrated system for identifying and quantifying flood risks based on advanced science and engineering technology. It is meant to provide an analytic, decision support tool to help communities make informed decisions regarding land use within flood prone areas (FEMA, 2004).

The HAZUS model, designed by FEMA, is restricted for flood, earthquake and hurricanes hazards in the USA. This model is perhaps one of the very few integrated risk assessment models.

The HAZUS model is a technical model that also employs limited quantitative measurements of social vulnerability factors, such as ethnicity and gender. However, other social factors, such as age, disability, insurance levels and links that social vulnerability has to grater economic losses are not included.

In the Figure 2.1 explains the methodology of the model as well as the data required.



**Figure 2.2: HAZUS Flood Methodology – FEMA**

## 2.9. GIS for risk identification

GIS have proved useful for identifying areas that are exposed to natural hazards, distributions and quality of physical structures at risk, and the socioeconomic characteristics of endangered populations. GIS can assist the planning of effective response strategies, including evacuation routes and reception areas. Finally, they can also facilitate the long-term recovery process. Such analyses may be carried out on different scales, from the neighbourhood level down to a block or single residence (Uitoo, 1998).

According to Zhang (2002) the integrated use of geographic information systems (GIS) and remote sensing (RS) has been playing a very important role in monitoring, controlling, relieving, and assessing natural disasters, especially flood disasters.

GIS have considerable potential for improving urban disaster management since they offer more efficiency and speed in the input, management, manipulation, analysis and output of data/information, but also because of the value of better decisions (Montoya, 2003).

GIS plays very important role in the setup of the database-driven web-enable integrated hazard, vulnerability and risk information system. Considering GIS is the one of the most significant components for the interactive communication between user and the system.

Regarding flooding Geographic Information Systems (GIS) can provide a computer-based information and manipulation system useful in support of flow forecasting and emergency response. Information from a variety of sources and scales can be combined as a series of layers, provided that the information can be identified in terms of the common denominator of location. For example, information on vegetative cover can be combined with soils and land slope information to estimate infiltration rates for forecasting purposes. Similarly layers of utility, land use, flood plain delineation, and structures information can help in the development and updating of emergency response plans.

However, GIS approaches have been criticized for been merely technocratic and exclusive due to the skilled knowledge required and the data requirements in quality and quantity that are not always present within a community. A GIS application able to represent the risk imagery of a vulnerable community would be a supportive tool to assist them in



visualizing the risk scenarios from a broad context, rising awareness and promoting proactive rather than reactive strategies for vulnerability reduction. New paradigms in information management are looking produce and manage GIS/EO products that can be combined with adequate communication strategies in order to enhance processes of consensus and negotiation regarding flood risk management, taking advantage of the multiple risk and risk reduction scenarios that can be depicted (using a GIS). In this sense, GIS ought to be used also for forecasting and modelling the results of several vulnerability reduction strategies. From this perspective, GIS will help in the democratisation of risk-concerning information and development of tailor-made applications for vulnerable communities (Maskrey, 1998).



## 3. Methodology for vulnerability assessment

### 3.1. Introduction

The existence of different levels of disaster risk or extent of disruption is determined by the way in which hazard and vulnerability interact. Specific 'disaster risk' ('exceptional' losses) can be seen as one component of global societal risk. The other major component relates to what may be called 'life style' or 'every day risk' (Lavell 2004). The relatively permanent living conditions of the poorest sectors of society represent a constant threat to their physical and social wellbeing. The sum of conditions such as economic poverty, social and political marginalization, lack of options as well as lack of resources indicates that poor communities live under permanent conditions of 'disaster' and that disaster related to environmental extremes is just one component that strike from time to time (see Maskrey 1989; Blaikie et al 1994; Anderson 1995; Wilchex-Chaux 1998; Lavell op cit).

Exceptional losses derive from the occurrence of environmental extreme events (hazards) reach the category of disaster precisely because the population is in a previous state of near destitution and not necessarily due to the absolute size of the losses experienced. The extent of disruption, as well as the territorial and social distribution of these two 'societal risk' is determined by the differential levels of exposure, resistance and resilience of the societal, physical and economic systems (modified after Pelling 2003) These three vulnerability components are all shaped by an actor's access to rights, resources and assets. Frequently opportunities for increasing resilience are often less when resistance is already low ('every day risk') and exposure is high, increasing the vulnerability to 'extreme' disaster events.

### 3.2. Pelling conceptual model

According to Pelling (2003), natural disaster should be seen as a part of an on-going relationship between society and nature, no as one-off. Figure 3.1 represents this integrated perspective. Environmental risk or humanitarian disaster with a natural trigger is the result of physical pressures in the form of environmental hazard, and human pressures experienced as vulnerability.

Environmental hazard and human vulnerability are presented as the local outcome of progressions from root causes (global political economy, global climate change), via intervening dynamic pressures that link global or historical forces with the immediate conditions (a lack of institutions, rapid urbanization, local topography) that superficially indicate danger. Vulnerability is broken down into three components: *exposure, resistance and resilience* (Pelling, 2003).

*Exposure* is largely a product of physical location and the character of the surroundings built and natural environment. For example, a family living in ground-level, poorly maintained rental accommodation on a river bank and adjacent to a sewerage outfall will be highly exposed to flooding. The exposure component can be reduced by hazard mitigation investments in individual or household level as well as collectively through public-private social investment policy.

*Resistance* reflects economic, psychological and physical health (*social*, in this study) and their system of maintenance, and represents the capacity of an individual or group of people to withstand the impact of a hazard. If resistance is low then even a small hazard stress can lead to systems failure.

*Resilience* to natural hazard is the ability of an actor to cope with or adapt to hazard stress. It is a product of the degree of planned preparation undertaken in the light of potential hazard, and of spontaneous or premeditated adjustments made in response to felt hazard, including relief and rescue. The most important policy options available to enhance resilience are those that shape formal or informal insurance mechanisms. Insurance is the key tool to use in spreading the economic cost of disasters across society and over time.

This model has been developed to analyze vulnerability in urban environments taking into account not only the physical but also the socio-economic aspect.

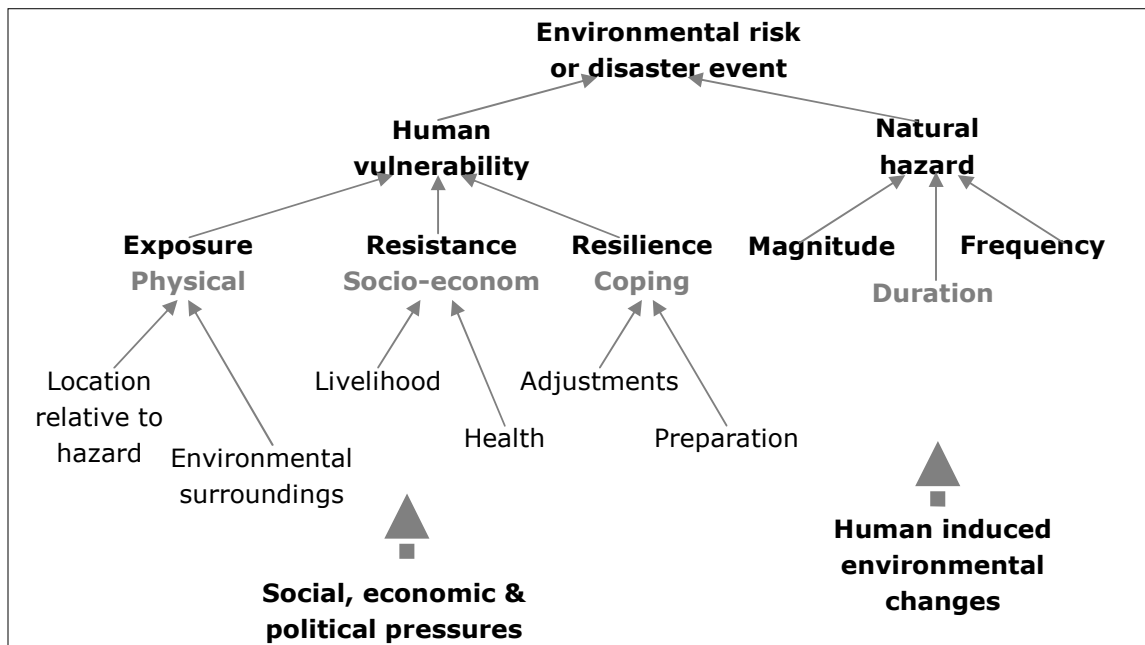


Figure 3.1: Components of environmental risk – Pelling 2003

### 3.3. Household livelihood security assessment (HLSA)

Sustainable and security livelihoods methodologies provide a valuable opportunity for combining disaster reduction and development interventions in one unifying approach (Sanderson 2000). Several agencies and donors are currently developing livelihoods-based approaches as bases for policy and practice formulation. These include DFID, the United Nations Development Programme (UNDP), non-governmental organizations (NGOs) including Oxfam and CARE, and research institutes including the Institute of Development Studies (IDS) (Ashley, C and D Carney 1999).

A common understanding of livelihoods is given by Chambers and Conway: "A livelihood comprises the capabilities, assets (both natural and social) and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stresses

and shocks, maintain or enhance its capabilities and assets, both now and in the future, while not undermining the natural resource base". The key element of livelihoods approaches is that people are the starting point. A livelihoods approach describes how people obtain "assets", what they do with them, what gets in their way whilst obtaining them, and who controls the resources on which assets (Chambers, R and G. Conway, 1992).

HLSA employ a set of data collection techniques and analytic tools adapted from social science interviews and survey methods. HLSA provides comprehensive sociocultural, economic and ecological assessment of a given area for planning and project implementation. It bridges the gap between formal surveys and non-structured interviewing.

Household livelihood security according to CARE is defined as the adequate and sustainable access to income and resources to meet basic needs (food, potable water, health facilities, educational opportunities, housing and time for community participation and social integration). Each household can have several possible sources of entitlement which constitute its livelihood. Entitlements include the rights, privileges and assets that a household has, and its position in the legal, political and social fabric of society (Abarquez, 2004).

The risk of livelihood failure determines the level of vulnerability of a household to income, food, health, nutritional insecurity. The greater the share of resources devoted to food and health service acquisition, the higher the vulnerability of the household to food and nutritional insecurity (Abarquez, 2004). Thus, livelihoods are secure when they have secure ownership of, or access to, resources and income earning activities as well when they are able to acquire, protect, develop, utilize, exchange, and benefit from assets and resources (Abarquez, 2004).

HLSA is holistic and multidisciplinary analysis which recognizes that poor families commonly suffer more than one problem at a time and often have to make significant sacrifices to meet their basic needs.

### **3.4. Quantification of vulnerability**

In carrying out the vulnerability assessment, it is ideal that vulnerability is quantified for comparison purposes. Such quantification would facilitate comparison of necessity of intervention among various hot spots, sectors and areas. For this purpose, it is advisable that vulnerability index be developed to be used as policy-support instrument.

An *index* can be defined as a composite or more than one indicator. For example, the In carrying out the vulnerability assessment, it is ideal that vulnerability is quantified for comparison purposes. Such quantification would facilitate comparison of necessity of intervention among various hot spots, sectors and areas. For this purpose, it is advisable that vulnerability index be developed to be used as policy-support instrument.

An "index" can be defined as a composite of more than one indicator. For example, the Human Development Index aggregates life expectancy at birth, adult literacy rate, school enrolment and GDP per capita. An indicator is a single measure of a characteristic, for example, per capita income. In the process of combining indicators into an index (or composite index), techniques like summing/averaging, weighting, and normalisation may be used (Downing et al, 2000).

In assessing and valuating vulnerability, some authors suggest a sectoral approach, i.e., Assessment of vulnerability is carried out for each of identified sectors (such as water, ecology, human settlements, infrastructure, etc.), and then these assessments are weighed and integrated into a single assessment (UNCHS, 2001).

It is worth discussing whether or not a single index can represent vulnerability of the target area. One may consider dividing the whole vulnerability scope into several components. One possible direction is dividing the vulnerability into:

- present state of environment and socio-economic situation;
- flood hazards and underlying causes; and response/preparedness capability of the society,
- Resistance and adaptability of the ecosystem.

### **3.4.1. Indicators of vulnerability**

Risk as decision has to be approached from some material basis. This is particularly clear if the idea of constructing risk and vulnerability indicators is to help promote risk reduction decisions at the government and societal levels and to allow a preliminary understanding of the factors that increase the potential for loss and damage. This material dimension says nothing about the real significance of loss to individuals and society but merely represents what could be lost. This is a necessary starting point and does not in any way imply a rationalization of whether society is willing to loose or gamble on loss, and certainly says nothing about decision. In fact, in constructing indicators it is important to separate objective possible loss levels from capabilities and decisions to do something about it. The three types of problem--objective loss, capabilities and decision-- are linked but clearly separate in analytical terms and in terms of the types of indicators and data that is necessary (Lavell 2003).

Indicators are relative rather than absolute and are anticipated to be more reliable in comparing vulnerability within a particular country than for making comparisons between countries (INHABITAT). It is not necessarily true that the risk to life in tropical countries is greater than existed in European countries; the unexpectedness of the rainfall intensity may be more important than the absolute level.

Because of different parts of a country are likely to be shown as being vulnerable in different way, a series of different indicators is proposed to assess flood vulnerability. The indicators are not intended to be additive but rather overlaid on each other so as to identify the particular forms of vulnerability in different geographical areas. Also, because of the indicators reflect different forms of vulnerability, they are appropriately applied at different geographical scales.

Regarding floods there are a number of criteria with which the indicators should be consistent. They should:

- require only existing and readily available data;
- be easy and cheap to apply;
- be appropriate to the particular rainfall and stream flow conditions in the country or province under consideration;
- discriminate to a reasonable degree between different levels of vulnerability; and
- be valid, the results being reasonable predictors of the results of more detailed studies.

In carrying out the assessment, the following issues should be answered:

- Scale of study (all counties, sample counties or percentage of counties etc)
- Scale of flooding (depth, velocity or occurrence (time) etc)

- Rural vs. urban
- Type of structure
- Type of environment
- Jurisdiction of government

For example the scale of study could be by taking a representative number of counties from each part of a basin that represent the different geographical areas, both rural and urban environments. The various industries and levels of infrastructure would be represented as well. While with each specific type of structure it could be broken down into different categories of house and the effect of different severity of floods upon the structure

#### **3.4.2. Presentation of Vulnerability Index/Indicators**

In order to clearly address vulnerability factors each indicator should be depict on a separate layer. Further, it is recommended that each category of vulnerability indicators will be composed into an index (land use, economy, risk to life, building, etc.) to be also shown on a cartographical representation. Finally, an overall vulnerability index (a composite of all the indicators, most probably weighted based on the significance of each indicator) will be presented, if such index is deemed meaningful.





## 4. Description of the Study area

### 4.1. Background

South east of Asia, because of its geographical location, ranks as one of the most vulnerable areas on the earth to natural hazards. Hence, according to United Nations' report, nearly 70% of all lives lost due to natural disasters occur within the Asia-Pacific region (United Nations, 2002).

The Philippines occupies one of the top positions in the world's most disaster prone countries. The National Disaster Coordinating Council recorded 523 disasters for the period 1987 to 2000 with total cost of damage of Php 150.071 Billion, or some 37 disasters on the average annually (OCD, March & August 2001).

The Philippines' exposure to disasters is to a significant extent due to the country's geographical and physical characteristics. The Philippine archipelago lies along the Western Pacific Basin, the world's busiest typhoon belt, with the average of 20 typhoons hitting the country each year. Within 1988–2000, 198 typhoons entered the Philippine area of responsibility and caused Php 22.105 Billion damages. Coastal and extended swamp areas are prone to floods and storm surges during typhoons. In recent years, even heavy rains associated with other climactic conditions such as monsoons, thunderstorms, inter-tropical convergence zone also cause floods in low-lying areas (ADPC 2001b)

The poverty situation of many Filipinos severely restricts capacity to cope with the many natural hazards and more so, to recover from the damages caused by disasters. Adverse socio-economic situations lead people to inhabit high-risk areas and engage in unsustainable and dangerous livelihoods. The population of this country is 86,241,697 (July 2004 est.). Figure 4.1 illustrate the geographic location of the Philippines and Naga City (study area).

However, despite the fact that Philippines is one of the most disaster-prone countries, the number of people killed by hazards has been considerably reduced during the past decade, 1991- 2000 as compared to the period covering 1981-1990. Below is the table showing the number of people killed and affected by disasters in the Philippines during the past two decades:

**Table 4.1 number of people killed and affected by disasters in the Philippines during the past two decades**

YEAR	Total No./Annual Average of People Killed	Total No./Annual Average of People Affected
1981-1990	18,418 / 1,842	28,270,879 / 2,827,088
1991-2000	13,947 / 1,395	65,017,679 / 6,501,768

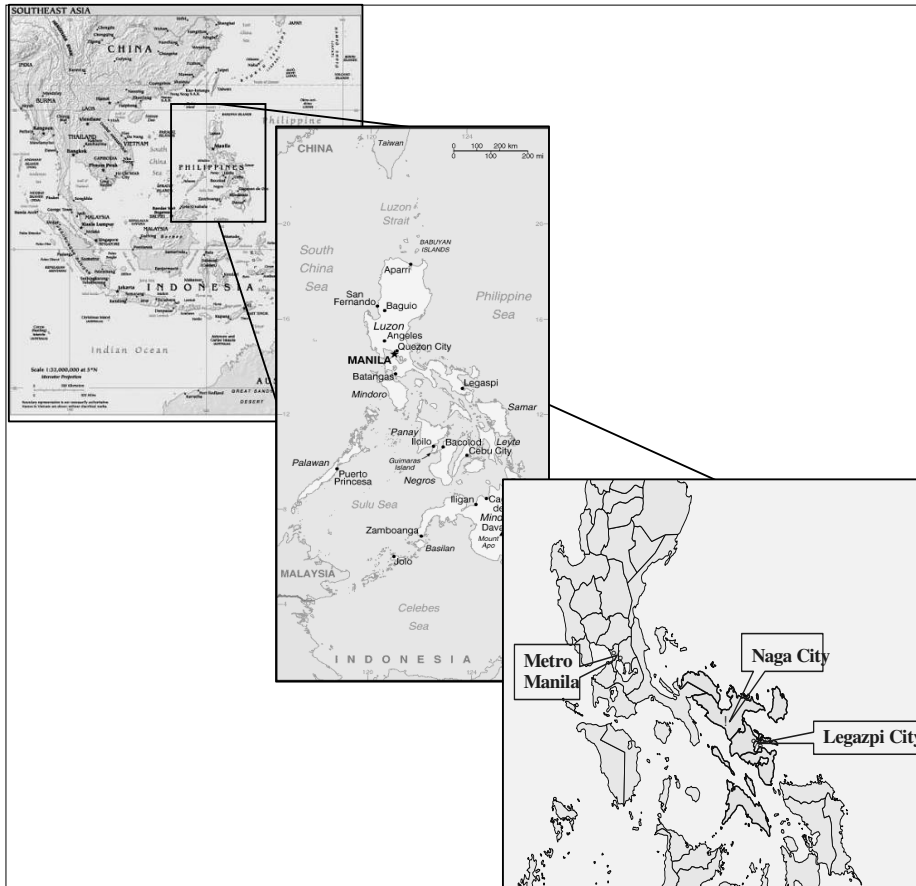


Figure 4.1: Location map of the Philippines and Naga City

## 4.2. Naga city

Naga City is centrally located in the province of Camarines Sur and nestles at the foot of Mt. Isarog. It is about 377 kilometres south of Manila and about 100 kilometres north Legazpi City. Naga has a total land area of 8,448 hectares but the highest percentage (67.59%) corresponds to agricultural land. According to the National Statistics Office classification, Naga City is 100 percent urban. Thus, Naga City has a population density at present of 1,503 people per square kilometers.

Table 4.2 Naga Historical Growth of Population from 1903-1995 (CLUP 2000)

YEAR	POPULATION	GROWTH RATE
1903	17,943	-
1918	9,396	(4.22%)
1939	22,505	4.25%
1948	56,238	10.71%
1960	55,506	(0.11%)
1970	79,846	3.70%
1975	83,337	0.86%
1980	90,712	1.71%
1990	115,329	2.43%
1995	126,972	1.94%

Naga City and its urban area was said to be part of San Miguel Bay itself thousands of years ago. The city’s topography shows that its urban core is in the lowest lying end of the city. All of the built up areas in the city are between 0 to less than 5-meter elevation, making the present urbanized area prone to flooding (CDP, 2002); therefore, Naga becomes a prone area to flood hazards as a consequence to annual rainfalls and typhoons, mainly in the months from November to January. Figure 4.2 shows the flood hazard map for the urban area of Naga, appearing that most of the urban area is flooded (Naga, 2000).

Naga is the central business district in the sense of being the trading area. The city has expanded northeast beyond its original area near the Naga River. Thin strips of light commercial activities also appear from the bank of the Bicol River (Naga, 2001). Table 4.1 shows the percentage of land use area, with respect to the total area of Naga (Naga, 2000).

**Table 4.3: Distribution of the land in area and percentage**

Existing Land Area and Uses		
Land Use	Area (hectares)	Percentage
Residential	1,208.42	14.30%
Commercial	161.13	1.91%
Industrial	32.20	0.36%
Agricultural	5,709.05	67.59%
Institutional	150.29	1.78%
Idle Land/Grassland*	504.43	5.97%
Parks	2.49	0.03%
Forest Parks and Reserves	611.14	7.23%
Dumpsite	3.55	0.04%
Cemeteries	17.11	0.20%
Water Bodies	43.72	0.52%
Transportation Utilities	4.47	0.05%
<b>T O T A L</b>	<b>8,448.00</b>	<b>100.00%</b>

Land use change is a crucial factor to be mentioned in this study due to the important role that plays in a flood hazard. Figure 4.3 illustrates the land use changes between 1994 and 2000. There was a considerable increase of the commercial sector in relation with the use of the land. Also it is needed to consider the rapid city growth as a consequence of the migration from rural areas to the city.

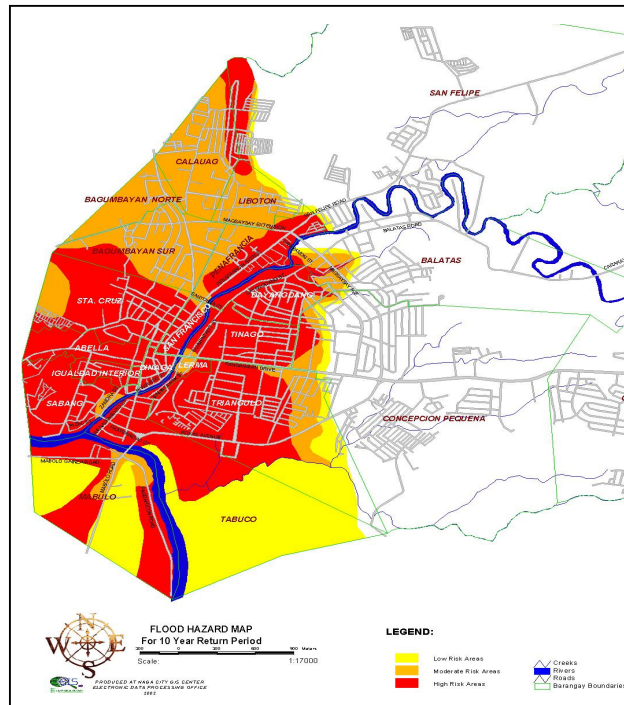


Figure 4.2: Naga City, flood hazard map for a 10 years return period

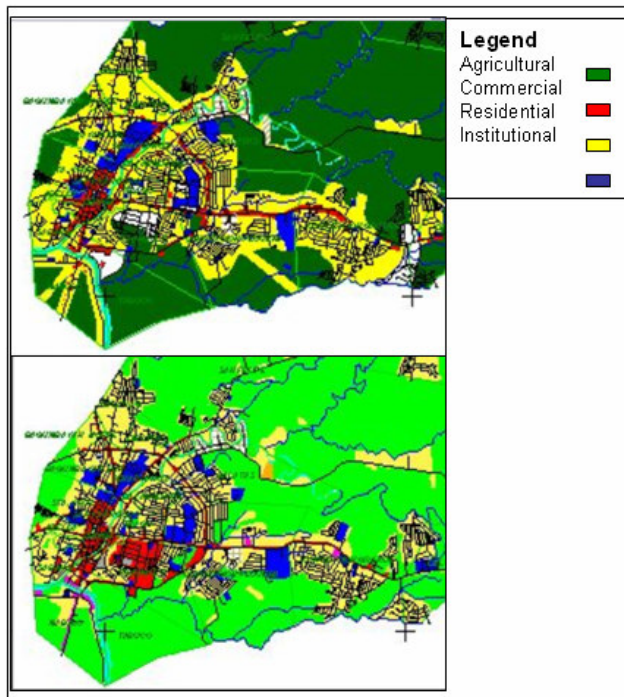


Figure 4.3: Land use change from 1994 to 2000

### 4.3. Flood related facts

Based on the flood hazard maps developed for the NCDMP (2001) (see Figure 4.2) is evident that the flood-prone area of Naga City covers about 800 ha and spreads out over the 17 out of the 27 barangays of the city. Areas that suffer perennial flooding during the rainy season includes Barangays Abella, Bagumbayan Norte, Bagumbayan Sur, Calauag, Dayangdang, Dinaga, Liboton, Igualdad, Lerma, Mabulo, Peñafrancia, San Francisco, Sabang, Sta. Cruz, Tinago, Tabuco, and Triangulo.

The area affected is just the 10% of the total municipality; however this area holds 85% of the city's aggregate population and most of the main economic activities. Most of the flooded areas are located in the vicinity of the Bicol and Naga Rivers on the western side of Naga City (Table 4.4)

**Table 4.4 population at risk in residential zones by flood-return period in Naga**

Flood Return Period	High Risk Residential Area (Ha.)	% To Total Residential Area	Estimated Population At High Risk (1999)	Estimated Population At Medium/High Risk (1999)
1.8-year return period	30.29	23 %	10,248	25,339
3-5 year return period	87.88	25 %	12,425	26,403
5-year return period	121.48	35 %	16,891	29,619
10-year return period	191.51	55 %	25,581	42,235
20-year return period	259.42	75 %	32,238	43,023

Source: Naga City Disaster Mitigation Plan, 1998

Records at the Urban Poor Affairs Office (UPAO) indicate that about 55 percent of the urban poor families are located in the flood-prone barangays and these include the following barangays with their estimated number of urban poor families. The Strategic Watershed Management Plan of Naga City has identified about 500 households are living in the settlements or houses of which are located in the river easements. Majority of the families residing along the riverbanks lives in shanties or dwelling units made of light materials which are oftentimes poorly constructed.

**Table 4.5 Number of families in high flood risk areas**

BARANGAY	FAMILIES
Triangulo	734
Sabang	568
Abella	557
Calauag	549
Tabuco	389
Igualdad	332
Total	3129

Source: NCDMP, 1998

Unhealthy practices and recent development trends are contributing to exacerbate flooding in Naga. Landfilling and raised structures (sometimes until three meters from ground level) are worsening the flooding in areas where flooding before was marginal. In other areas duration and water depths are increasing (NCDMP 2001)

The existing drainage system is another obstacle the city has to confront. Most of the natural waterways and drainage creeks in the city have been built-over with structures blocking the natural flow of flood water (Naga, 2001). The absence of any natural drainage ways subject the low-lying areas to prolong flooding even during moderate rainfall (Naga, 2001). A drainage master plan was prepared in 1981 but has been destroyed

during one of the major floods arising difficult improvements, especially considering the rapid changes in the land use of the city (Naga, 2001).

The tidal gate structure built along the Naga River is other of causes of flooding. This gate also serves as bridge. The purpose of this gate was to control the flow of the Naga River during the annual Penafrancia fluvial parade. Due to the design of the gate, during flood flows, this gate (bridge) usually accumulate debris which provide damming effects, causing the increase of flood levels upstream which aggravate the inundation of the low lying areas near the river banks (Naga, 2001). Garbage disposal practices along the riverbanks are a major contributory factor in the pollution of the Naga River.

At a broader level unsafe agricultural practices and laxity in full protection of the headwaters against any form of natural resource exploitation are further compounding the problem of Naga River's degradation, particularly *kaingin* which had been encroaching on the timberland portion of the watershed.

#### **4.4. Vulnerability and risk assessment in Naga – Naga City Disaster Mitigation Plan (NCDMP)**

Seventeen of the 27 barangays, are located in the flood plains, occupying only the 10% of the total land area of the city (Naga, 2001). According to Naga City Disaster Mitigation Plan (NCDMP) (2001), the population directly exposed to flood risk are those that inhabit the 17 flood-prone barangays and the level of risk to the population is associated with their spatial distribution in the barangays affected. In the NCDMP, to identify the magnitude of the risk across the population centers, density factors were matched against identified high-risk residential areas by flood return period.

NCDMP, in the social vulnerability analysis, identify the population at risk based on spatial location associated with flooding and wind hazard. In the context of Naga, the marginal groups comprising the urban poor communities of the city are considered as the most highly vulnerable sector to flooding and wind risk.

In the economic vulnerability NCDMP identify direct and indirect damages and income losses affecting vulnerable groups as:

- Daily wage earners such as those of the transport industry,
- Business sector
- Agricultural sector

The vulnerability and risk analysis presented in the NCDMP refers to the assessment based on the spatial location and in the groups affected, without considering the community participation.

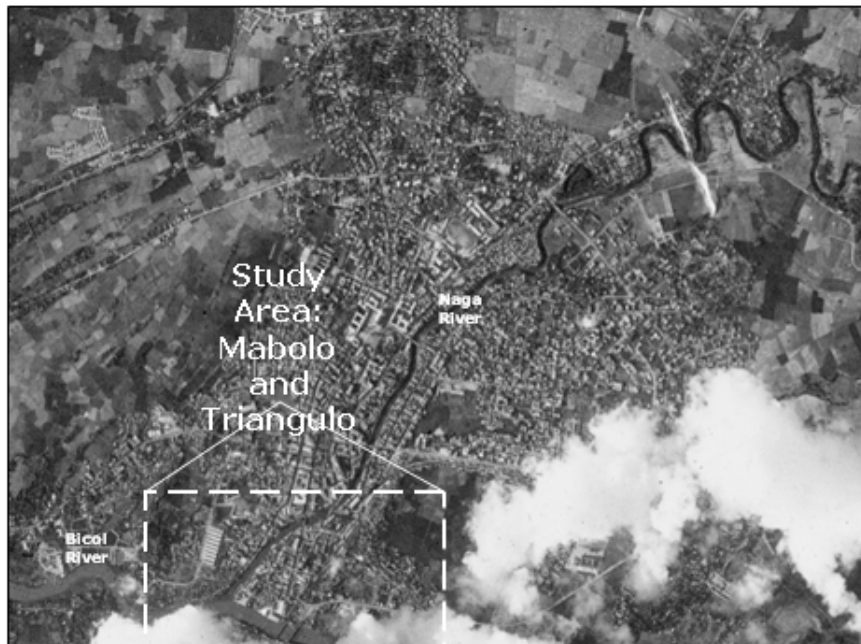
#### **4.5. Study area: Mabolo and Triangulo**

The study area was selected for two Master of Science researches and for a PhD research that are under the framework of the SLARIM project. The criteria took into consideration for selection of the study area was:

- Severity of exposure to risk
- Different environment (urban Vs rural)
- Willingness for participation of the communities

- Marginalized and poor communities
- Accessibility to the communities

After settling the selection criteria, the barangays (wards) Mabolo and Triangulo were chosen for this study considering that these are two of the most impacted by flood hazard regardless the magnitude of the flooding. Figure 4.4 shows the location of barangays Mabolo and Triangulo within Naga City context.



**Figure 4.4: Location of Mabolo and Triangulo within Naga City**

#### **4.5.1. Barangay Mabolo**

Barangay Mabolo is located in the left side of the Bicol River, with a total land area of 105.26 ha. Divided in six zones from which five are frequently flooded. The terrain is mostly plain (85%) and 15% rolling to undulating. the north border is the Bicol River.

The total population is 6,633 inhabitants conforming 1,266 households for an average of 5 members per household. The main economic activity is farming while the means of livelihood is labor, selling goods and drivers. The predominant house material is wood (Naga, 2004).

In this barangay, the predominant characteristic related to land tenure is squatters in the urban area and tenants in the rural area.

The barangay is provided with electricity service in 94%, telephone service in 35%, drinking water is provided by MNWD. The water service is not supplied to the houses. The most common water facility is water sealed which is distributed throughout the barangay by pumps that are spread in the barangay. Mabolo has a health service facility (Naga, 2004).

The road network of Mabolo is in moderate conditions, having access of private and public transport like jeepneys, tricycles and buses. Figure 4.5 shows the urban characteristics of the barangay.



**Figure 4.5: Structural, social and economic characteristics found in Mabolo**

#### **4.5.2. Barangay Triangulo**

Barangay Triangulo is located close to the confluence of the Naga and Bicol Rivers. Topographically, Triangulo is located in the lowest terrain of Naga City, in what used to be swampy areas and paddy fields long time ago. Flooding in this zone can reach over two meters and last up to one month on any flood return period (Naga, 2004).

Triangulo has as total area 132.06 ha. It is subdivided in 7 zones; four of them are housing areas combined with minor and mayor commerce. The other zones are mainly mayor commerce. This barangay is mainly urban, but in the 4 housing zones the land tenure characteristic is squatter (Naga, 2004).

The total population of Triangulo is 6,996 inhabitants; 1,362 households whit an average of 5 members per household. The livelihood means in this barangay is mainly of porters and vendors (minor commerce). The houses are characterized by its light material and semi-concrete (Naga, 2004). Figure 4.6 shows the urban and social characteristics of this barangay.

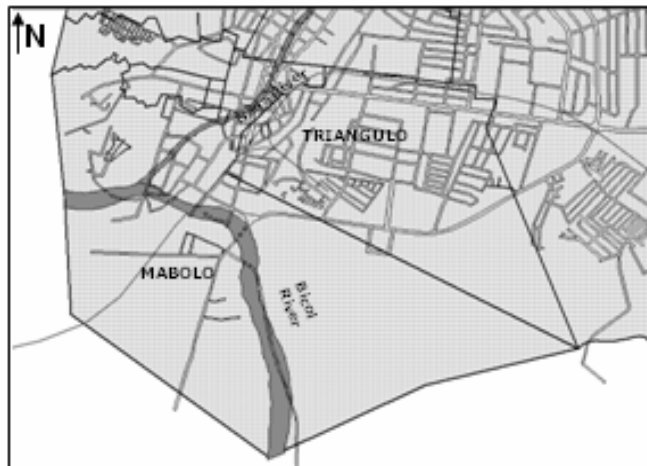
The barangay has facilities of telephone 50%, electricity 90%. The drinking water supply is provided by NAWASA and the most common water provided throughout the barangay by pumps is water sealed (Naga City, 2004). The barangay is crossed by the railroad track of the Philippine National Railroad (PNR).





**Figure 4.6** some of the social and structural characteristics found in barangay Triangulo.

Figure 4.7 shows location of Mabolo and Triangulo in relation with the rivers: Naga and Bicol. One of the origins of flood in this area is due to that the rains cause the rivers overflow.



**Figure 4.7** Location of barangays Mabolo and Triangulo in relation to Naga and Bicol rivers



## 5. Data collection, processing and analysis

### 5.1. General

To achieve the objectives of this study, a data set that allows characterizing the study area from the structural, social and economical aspects was required. However most of the existing information is aggregated at barangay level, making difficult its use to achieve the objectives of this research.

In order to overcome the data availability and quality shortcomings a primary data collection campaign was carried out in the area. In this chapter, the actual or 'pre-hazard' situation and/or characteristics (structural, social and economic) of the barangays are described at household level. Further and to allow comparison aggregation at zones and barangays level was prepared.

The set of primary data collected is related to hazards as well as structural, social and economic characteristics of the households through the barangays. Some of this information was produced and analyzed in a participative environment together with community leaders and participants. The rest was acquired through transects and walks across the study area.

### 5.2. Field data collection and methodology

In order to identify the current situation (September 2004) in the study area and characterized the barangays from the structural, social and economic aspects point of view a fieldwork campaign of four weeks was carried out.

The data collection was performed at household and zone level for the primary data as well as at barangay and municipal level for the secondary data. Primary data were gathered through the application of questionnaires that provided first hand information about the current situation under research. Other participative tools were used as complement and verification for the data collection: workshops, transects and semi structured interviews.. The methodology included participation from government officers too. At the household level, the fieldwork was carried out through contact with Barangay officers and Leaders. The secondary data were complementary information for this research. It is conformed Secondary data came from documentation review extracted from books, records, articles journals, newspapers and internet as well as documents obtained in fieldwork as historical data of floods, the Comprehensive Land Use Plan and the Naga City Disaster Mitigation Plan.

The methodology applied for sampling was adapted from the one proposed by CARE (2002) for Household Livelihood Security Assessment, in order to suit the needs and possibilities of this study. The method used is the simple purposive random sampling. Purposive sampling is used to ensure the certain characteristics included in the sample and random sampling is used to select one site among several sites that present particular characteristics that one wants to capture in the survey (CARE, 2002). The combination of both samplings is the best accomplishment. The purposive sampling ensures that the diversity conditions presents in the zone are captured in the sample. The

random selection reduces the likelihood that someone will introduce a bias in order to favor a specific agenda.

The total sample was composed by 129 households, 65 samples in Mabolo and 64 samples in Triangulo (see Figure 5.1). This number of samples was settled taking into account the available time of staying in the field as well as the time consumed applying the questionnaires. With the sample set surveyed, a picture of the range of situations that may influence vulnerability outcomes. In this study, interviews, questionnaires and workshops were designed and applied.

The spatial data were collected with the help of a Palm Compaq iPaq computer and ArcPad software for GIS. For each sample (household), a location was taken as well as the water depth that the household experienced in order to have scenario of the water depth. Not all the households could be referred to the same flood event.

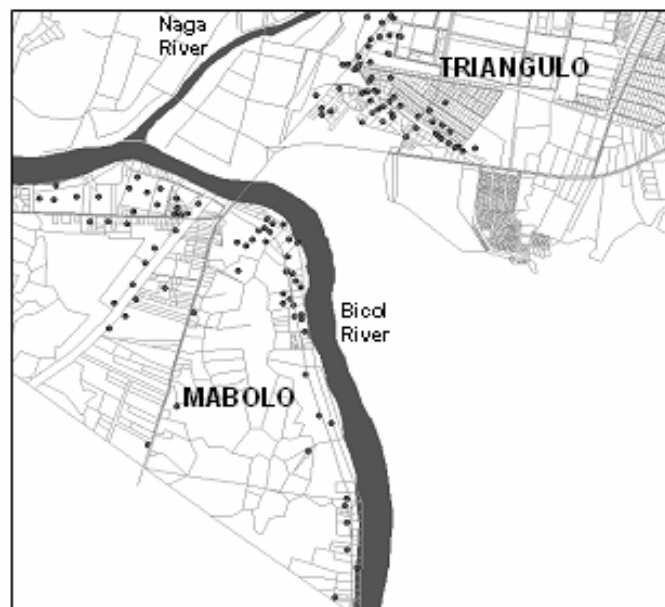


Figure 5.1 Spatial location of the 120 samples in Mabolo and Triangulo

### 5.2.1. Interviews

Interviews were applied to members of the municipality, barangay officers, zone leaders and workshops' participants and some of the households during the survey. The main idea of what is called semi-structured interviews is to obtain general information about the actual situation and the features of the community related with flood hazard, as well as to clarify and understand which is the role of the municipality in case of flooding (before, during and after the disaster) as well as communities. These interviews were recorded with the consent of the interviewer.

### 5.2.2. Workshops

Three workshops were conducted as a tool of the Household Livelihood Security Assessment (HLSA) as learning process of the actual situation of the community related with the flood hazard itself. They were projected to get understanding about community perception of flood events, people's behaviour (before, during and after) and expectative.

The workshops were carried out with the community of both barangays. The objectives of the workshop were:

- To determine the degree of spatial location and reference by identification of some of the main land marks in the barangay (schools, churches, bridges, etc.). Sketches were made by the community identifying and locating some of the the main physical aspects they recognize within (and outside) their community.
- Identification of most affected zones within the barangay.
- Identification of the different flood scenarios. Discussions arose among the participants explaining the different type of floods experienced in the community.
- Perception of the impact in their daily life. As in the previous case, the participants explained the most common situations presented.

The data obtained from the workshops consisted of the identification of the types of flood that constitute a hazard for the community, affected zones per flood scenario, water depth in each zone, duration of the flood and the time of occurrences as well as the damages caused by the different types of flood mainly (but not just) on the physical aspect and vulnerability profiles. The results of the workshops in Mabolo and Triangulo are shown in Appendix A.



**Figure 5.2: Workshop carried out in Mabolo**



**Figure 5.3: Workshop carried out in Triangulo**

### 5.2.3. Questionnaires

The questionnaire was designed in order to collect some of the characteristics required to carry out the Vulnerability Assessment and Coping Mechanisms as part of two MSc and a one PhD research regarding Flood Risk identification (Appendix B). The design of the questionnaires was adapted from literature review and previous researches related to risk assessment (Peters-Guarin, 2003). In order to gather detailed data (structural, social and economic aspects) with high quality instead of quantity, 129 samples were collected.



**Figure 5.4: Data collection in the field - Questionnaires**

The purpose of the questionnaire was to identify the characteristics of the structural, social and economic aspects in the communities. For instance data about structural characteristics of the dwelling were related to material of the walls, construction system, number of floors, presence of pillars and mezzanines to avoid flooding etc. For the social and economic aspects, the data obtained from the questionnaires were mostly related to number of members per household, income per household, means of livelihood and experiences about difficulties in their daily lives due to flooding.

During every interview a geo-reference point was assigned to the household by means of a PDA. This point was given a unique identifier that correlates also the questionnaire in which the characteristics of the household were writing down.

#### 5.2.4. Database

In order to facilitate modelling and processing of information for vulnerability assessment a database that holds all the information collected at household level and mostly during the fieldwork was created. As mentioned before a *unique code* was assigned to every particular household interviewed (at place). This code was registered at the head of the questionnaires, identifying among others the barangay, zone and plot. To fill in the database a point map was created with those *unique identifiers* and then several tables were created and linked through them. A complete explanation of the basic attributes contained in the database. This database contains the basic information from which indicators and vulnerability assessment were developed later on (see Table 5.1).

**Table 5.1: Description of the attribute table and records for the vulnerability**

Attribute Name	Description	Records
<b>Final Survey Points</b>	In this table information about the characteristics (structural, social and economic) of the households was stored	
Build_ID	Unique identifier for each point (household). The first character corresponds to the barangays, the second character corresponds to the Zone and the last two ones identify the household inside the plot.	i.e. M305 for Mabolo and T412 for Triangulo
Heigh_Pillar_above_ground	Identify for each house the elevation of the house from the land	See Table 7.5 – Appendix B
Mat_pillar	Identify the material of the pillars on which the house is built	See Table 7.5 – Appendix B
Mat_walls	Indicate the material of the walls	See Table 7.5 – Appendix B
Nr_Floors	Indicates the number of floors the house has	See Table 7.5 – Appendix B

Mat_Roof	Identify the material of the roof	See Table 7.5 – Appendix B
Nr_residents	Indicates the number of persons that conform the household	See Table 7.9 – Appendix B
Depend_ratio	Indicates the dependency of the members of the household in emergency times	See Table 7.9 – Appendix B
Hh_Comp	Indicates the composition of the household and type of kinship	See Table 7.9 – Appendix B
Age_source_income	Indicates the age of the main source of income into the household	See Table 7.9 – Appendix B
Place_Origin	Indicates where from the household come or if they were born in the barangay.	See Table 7.9 – Appendix B
Main_source_income	Indicates the means of livelihood (work type)	See Table 7.13 – Appendix B
Location_Income	Indicates located of place of work	See Table 7.13 – Appendix B
Nr_source_income	Indicates the number of members of a household who are currently working	See Table 7.13 – Appendix B
Daily_income	Indicates the amount of money earned per person per day	See Table 7.13 – Appendix B
Land_tenure	Indicates if the status of land property of the household (owner, rented, tenants or squatters)	See Table 7.13 – Appendix B

### 5.3. Drawbacks and constraints

- One of the main constrains for this research is the lack of imagery (satellite or aerial photo) at an adequate scale. Usually the presence of this type of products supports the data collection stage allowing a rapid reference and spatial location of each building and/or household. At the same time, through interpretation is possible to differentiate different types of building environments within a giving area, which make easier to interpolate results at a broader scale.
- Time constraint was another problem to overcome as the original idea was to achieve a sampling of 10%.
- As can be noticed from the questionnaire format in appendix B more information than the one found in the database was collected during fieldwork. Sheet formats are a rapid mean for gathering as much information as possible during fieldwork. It also allows more open questions and rapid modifications and adaptations to the characteristics in place.

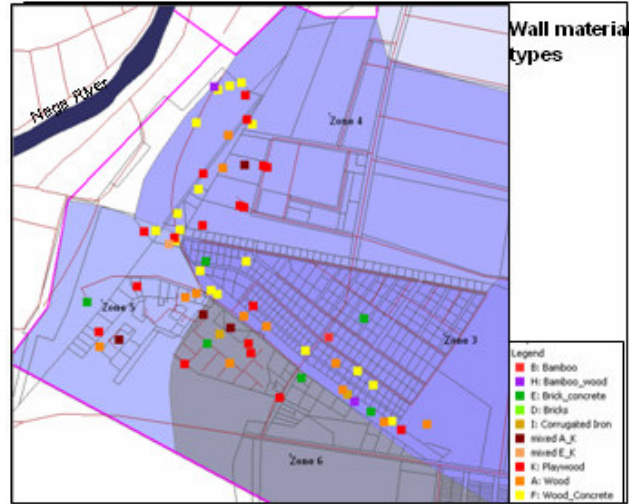
#### 5.3.1. Products

Some of the results that could be displayed directly from the database are shown in Figures 5.5. to 5.7

This maps display at some point the characteristics found at household level and can provide a rapid examination into the pre-hazard conditions and heterogeneity of the

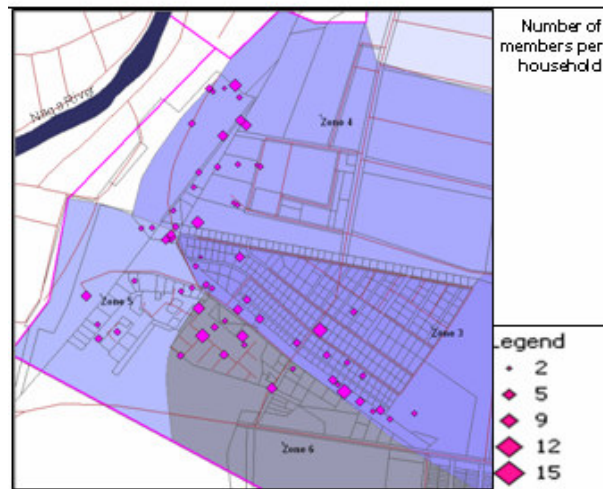


environment under research. Some of this information was later correlated and classified in order to construct the indicators used for vulnerability analysis. From Figure 5.5 can be seen how most of the houses researched are built on light materials. Houses in zone four are mostly built on plywood and bamboo.



**Figure 5.5 Heterogeneous distribution of wall materials in Triangulo**

Figure 5.6 illustrates the findings regarding household composition. In Barangay Triangulo the number of members that compose a family ranges from 2 to 15 members.



**Figure 5.6 Household composition in Triangulo**

In figure 5.7 the type of land tenure found in barangay Triangulo is displayed. It is evident how most of the houses are located in land that is private or officially owned by the government or are part of the PNR (Philippines National Railway) right of way.



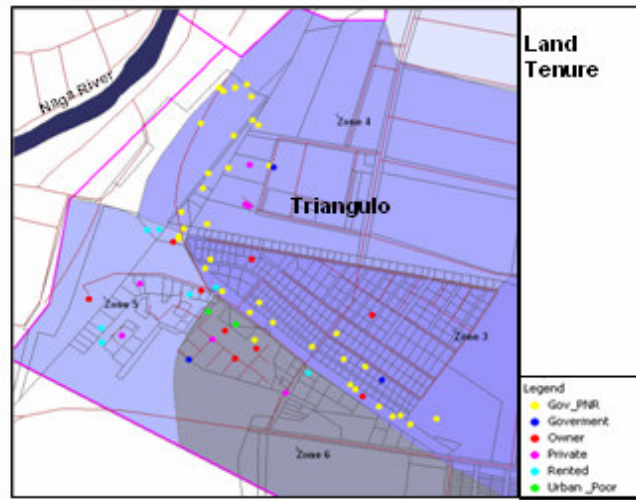


Figure 5.7 land tenure types found in barangay Triangulo



## 6. Flood Scenarios: Mabolo and Triangulo

### 6.1. Introduction

Flooding, a destructive large quantity of water (be it freshwater or sea water), has been a major concern in people populating, the locality of rivers and water bodies since pre-historic times. Despite developments in many areas of science and technology during the last decades, the hazard of flood has not been eradicated (Kundzewicz, 2002). In fact, the last flood events seem to be more destructive.

In this chapter flooding scenario with the maximum water depth experienced by the households in Mabolo and in Triangulo is reconstructed.

### 6.2. Flood scenarios

Flooding in Naga is mostly associated with the occurrence of typhoons. When there is a typhoon, a flood is expected in this area. The flood problem of Naga may appear to be relative small, only 10% of the total area is flooded (Naga, 2001). However the flooded area is the one, where the main economic and human resources are located. Then the impact of flood becomes significant (Naga, 2001).

The data of water depth used for reconstructed the flood scenario was collected during fieldwork; data for various levels of inundation (from less than 50 cm to over 2 meters) were collected. Water depth points were taken and geo-referenced in every household mention in each questionnaire. Not all the responders were able to refer always to the same flooding or typhoon event. To overcome this inconvenient the maximum water depth they have experienced was asked and recorded together with the potential event (typhoon by names, flash floods by year and period of occurrence). Information at household level was verified by means of coherence with responses nearby, watermarks and was correlated with scenarios obtained during the workshops and literature review.

During the mini-survey as well as the workshops most of the responders were able to indicate the water height of the flood by memory. The measures were referred to in British units (feet) and also using anatomic reference with parts of the body (ankle, knee etc) as reference to show the level of the water depth. For this study, those two types of measurements were additionally converted to *meters*. Table 6.1 displays the different heights corresponding to each water depth level.

**Table 6.1: Equivalence of Water depths from body parts to meters**

Body Part	Height in Feet	Height in meters
Ankle	.3	0.10m
Knee	1 to 2	0.50m
Waist	3	0.90m
Breast/chest	3 to 4	1.30m
Neck/shoulder	4 to 5	1.50m
Head	5 to 6	1.60m

### 6.3. Flood scenario in Triangulo

In barangay Triangulo, the housing areas are located in the zones 3, 4, 5 and 6, where the survey was done. The distribution of number of households per zone is indicated in the Table 6.2.

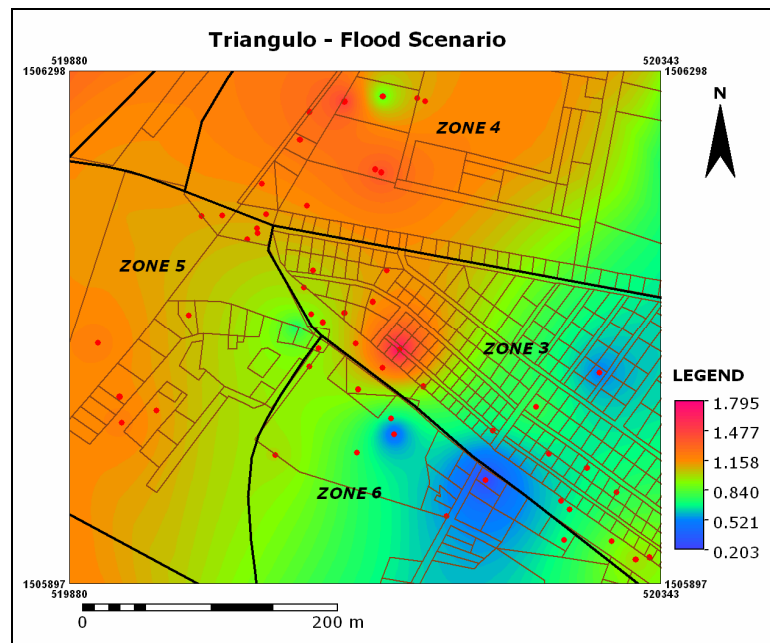
For this research the total number of samples in this barangay is 64 representing between 5% and the 10% of the total number of households (Table 6.2). Due to time constraints the sample could not reach 10% as a representative number, however it was found that the houses sampled represent the characteristics of the area.

**Table 6.2: Household sample**

Triangulo				
Zone	No. Households	5%	10%	Sample
3	296	14.8	29.6	23
4	265	13.25	26.5	20
5	137	6.85	13.7	10
6	321	16.05	32.1	11
<b>Total</b>	<b>1019</b>	<b>50.95</b>	<b>101.9</b>	<b>64</b>

The data used to calculate the maximum water depth scenario were the maximum height of the water that the people have experienced measuring from the ground level. Due to the topography of the area, the level of the water is not the same in all the zones of the barangay. Figure 6.1 shows the highest-level of water and the zones with the highest level of water (zones 4 and 5, and part of zone 3).

To represent the water depth in a raster map (Figure 6.1) an interpolation between the sample points was made using Ilwis software. In this raster map, there are some points showing high influence in the interpolation, it is due to the small sample set used. For accuracy, a large sample set is needed at this scale (barangay).



**Figure 6.1: Raster Map -Maximum Water Depth in Triangulo**

#### 6.4. Flood Impact in Triangulo

The flood impact in the socio-economic aspect is illustrated with an example of a family of Triangulo. Figure 6.2 explained a particular case of a family in zone 4.

*This is the experience of a family that is composed with four members: mother (54), father (62) and two daughters (19 and 20); and which their mean of livelihood is a Sari-Sari store (small grocery shop usually located into the house) in their house. The house is made of wood, has not pillars to separate it from the ground, it has one floor and the roof is made of wood and corrugated iron. They do not own the land. They were occupying the land per 24 years. After a flooding which water depth was more than one meter, the family lost their main source of income (Sari-Sari store), both the store and the house were destroyed and all the products in the sari store were lost. It means that all the investment that the mother had in the store which was around Pp 50,000 (pesos Philippines) was gone with the water. To rebuild the house the family had to loan money from their relatives. After the flood the mother started selling fish in front of her house. They considered that the damage of the house was disastrous, the livelihood was disrupted, they haven't had anything to eat and besides now they have a debt. They were not able to recover from such flood till one year after. They chose to settle there because it is close to the her husband's job (Database Identifier: T407)*

Figure 6.2: Socio-economic impact in Triangulo

#### 6.5. Flood scenario in Barangay Mabolo

As explained in the point 6.3, the same procedure was done in the barangay Mabolo. The housing areas are in zones 2, 3, 4, 5 and 6 which were considered for this study. The distribution of households are showed in Table 6.3

Table 6.3: Household sample

<b>Mabolo</b>				
<i>Zone</i>	<i>No. Households</i>	<i>5%</i>	<i>10%</i>	<i>Sample</i>
2	196	9.8	19.6	5
3	315	15.75	31.5	23
4	210	10.5	21	16
5	204	10.2	20.4	14
6	161	8.05	16.1	7
<b>Total</b>	<b>1086</b>	<b>54.3</b>	<b>108.6</b>	<b>65</b>

As mentioned already in the flood scenario in barangay Triangulo, the same criteria of sampling were applied in barangay Mabolo. The total number of samples in this barangay was 65 (Table 6.3).

In the raster map of the flood scenario of Mabolo, there is a high influence of two points in the result of the interpolation process (zone 5 and zone 6). This maps are used just for visualization purposes as was already said, the small sample set did not allow a more accurate interpolation.

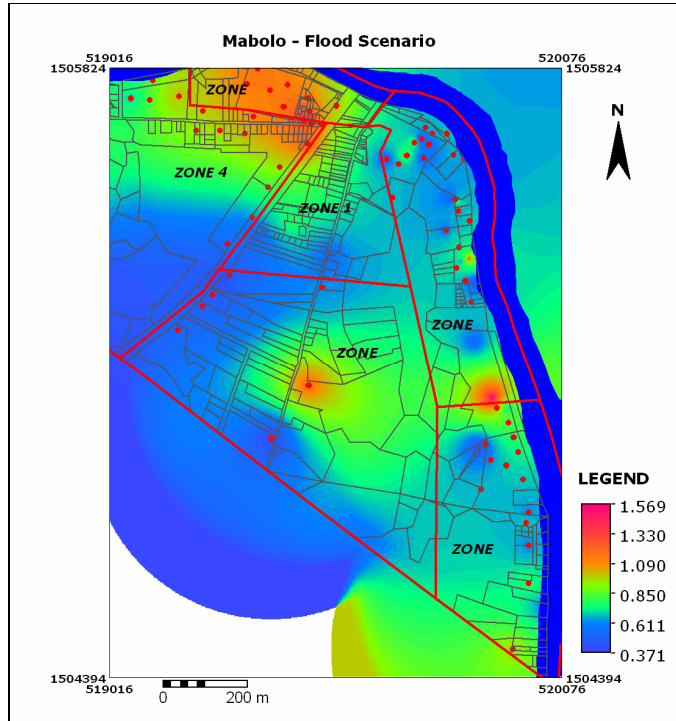


Figure 6.3: Raster Map - Maximum Water Depth in Mabolo

## 6.6. Flood Impact in Mabolo

As in the case of Triangulo, the flood impact in the socio-economic aspect was illustrated with an example of a family. Figure 6.4 is explained a particular case of a family in zone 5 in Barangay Mabolo.

*This family is composed by 9 persons: mother (33), father (48), grandmother (65) and 6 children (15, 12, 10, 4, 2 and a recent born child). The father is a tricycle driver (tricycle is rented) outside the barangay and the mother is a washerwoman in the barangay. The materials of their house are plywood for walls and palm leaves for the roof. The house is built on wooden stilts 60 cm. from the ground. Even though squatting in an agricultural land, they have managed to live there per 10 years; they migrated from a rural area. When a flood occurs, they lose their income because they cannot work. Their children got ill with fever, cough, and skin diseases. During last typhoon (1998) their house was destroyed and part of their belongings lost. At that time they stay in an evacuation center. They need more than one year to recover from a flood. (Database Identifier: T407)*

Figure 6.4: Socio-economic impact in Mabolo

## 6.7. Community perception

For been able to fully identify the hazard factor it is necessary to address which are the flood events that communities in the areas under study consider as having the potential to produce harmful consequences in other words that are perceived as hazardous for

them. The main objective for including community perception as starting point in this research was to avoid that 'expert' judgement does not match the judgements of communities and may fail to notice or understand facts that are considered important at local level for risk identification (Peters Guarin 2005)

During the workshops carried out communities at both study areas were able to identified several hazardous events and even more combination of events that when happening together can cause flooding at levels that constitute a 'threat' for them. During this identification process they made clear also that these 'harmful' scenarios can happen 'more than once in a year'. This knowledge stems mainly from their personal experience. By living in these places for several years they have developed what can be called as 'place-based knowledge' which regarding flooding relates the nature or origin of flooding, the interaction between several events, floodwater behaviour and likelihood of damage (see appendix A). This knowledge acquisition is reinforced by institutional information usually disseminated across media (mainly PAGASA weather forecast through local radio and TV stations).

The workshops for understanding community perception allowed also to validate and reinforced the findings at household level.

Characterization of Flood Hazard based on community perception is displayed on Table 6.4.

**Table 6.4: community-based flood hazard and risk assessment**

Water depth	Category/ 1 day	Category/ 2 days	> 1 week
> 20 cm	Low hazard	Moderate	High
20 - 60	moderate	High	Extremely high
60 -90	High	Extremely high	disastrous
90 - 130	Extremely high	Disastrous	
> 130	disastrous		





# 7. Flood Vulnerability Assessment for Mabolo and Triangulo

## 7.1. Introduction

This chapter presents the analysis of the flood vulnerability assessment for the structural, social and economic aspects, based on data collected in the field. The assessment for each aspect was performed by selecting the most relevant pre-hazard conditions in order to construct indicators to assess vulnerability to floods.

## 7.2. Structural vulnerability of buildings

The structural vulnerability of buildings is equivalent to unsafe conditions and exposure. Therefore it reflects other socio-economical conditions. In general terms, as household incomes increase practices of self-build recedes and compliance with official requirements or built codes increases (Peattie, 1987). Furthermore under conditions of medium term increases in income, households will tend to improve their houses by replacing inferior with superior materials, adding rooms and workshops, and sometimes personalising their outside space in other words building or acquiring self-safety.

In this research structural component reflects the status of a building and its structural weaknesses in relation to flooding. It takes into consideration types of construction materials and techniques employed number of floors and roof material. Hence, the structural vulnerability is assessed by the type of material employed in the construction of the various elements of the dwelling (wall, roofs and pillars). These components were defined as indicators for this study. In the case of Mabolo and Triangulo, the indicators for the structural vulnerability assessment were considered as follows:

- The *pillar* is the structural element upon which the house is built. This structural element becomes the most important one; the reason of importance is the fact that the area often is flooded, therefore this indicator reflects the way in which a household take decisions about coping or avoiding flood impact with the resources at hand. The *height of the pillar* was measured as the distance between the ground and the floor of the house
- *Material of the pillar*, material of this structural element becomes important when considering its resistance or susceptibility to be damage by flood or stagnated waters.
- *Wall material*, likewise in the case of the pillar, the material of the wall is considered due to its resistance or susceptibility to be damaged by floodwaters.
- *Number of floors*, when dealing with raising waters the presence of second floors or mezzanines provides additional safety to belongings and people as most of the times people tend to move their assets to elevated positions within the dwelling.
- *Roof material*, this element was included as indicator due to its potential to be damaged by strong winds and heavy rains.

After defining the indicators to assess structural vulnerability, a weight was assigned to each one, depending on the degree of its importance. It is essential to highlight that the selection of the indicators was considered not only for the case of a simple flood which is related with the water depth, but also for the case of heavy rainfalls.

In order to assign the weights to each indicator, the *Pairwise Comparison* procedure was applied. Pairwise comparison is a kind of divide-and-conquer problem-solving method (Salustri, 2003). It allows one to determine the relative order (ranking) of a group of items. This is often used as part of a process of assigning weights to criteria in design concept development. Therefore a scale for assigning the comparative importance between pairs of indicators was established. Table 7.1 shows the verbal judgment for relative importance, considered to evaluate the vulnerability of structural elements in case of a flood. The flood factor which was only considered was the height of the water. Other flood factors such as flow velocity, wind and/or flow direction should be considered in further researches.

The process of assigning weights should be done within a multidisciplinary group of experts based on their different criteria. In this study the process was done within a small multidisciplinary group of professionals to reach the most suitable criteria. A verbal judgment of relative importance was ranked as shown in Table 7.1.

**Table 7.1: Scale for assigning the comparative importance only when comparing pairs of indicators**

<b>Verbal Judgment of Relative Importance</b>	<b>Numerical Rating</b>
Extremely important	9
Very strongly to extremely	8
Very strongly important	7
Strongly to very strongly	6
Strongly important	5
Moderately to strongly	4
Moderately important	3
Equally to moderately	2
Equally important	1

In the pairwise comparison matrix (see Table 7.2), the judgment of relative importance was assigned to each indicator. The relationship between each indicator for the case of flood was analyzed in order to find out the relative importance between a pair of indicators. If the relation is direct, an integer number was assigned while on the other hand if the relation between two indicators is indirect, a fraction number is assigned. After assigning an importance relation between a pair of indicators, the normalization was calculated by dividing the number of relative importance of each indicator by the total number of each column (see Table 7.3). In order to get better understanding, each normalization number was multiplied by 100 to obtain integer numbers which at the same time are divided by 5 in order to get as highest or total number 100, which is the case of highest vulnerability. The weight was obtained through adding the numbers of each row and dividing it by the number of indicators, which is 5 for this case (number of indicators).

**Table 7.2: Pairwise Comparison Matrix for Structural Indicators**

<b>Pairwise Comparison</b>						
<b>Structural Indicators</b>		StV1	StV2	StV3	StV4	StV5
Height of pillars	StV1	1	1	2	3	5
Material of pillars	StV2	1	1	1	1	7
Material of Walls	StV3	0.50	1.00	1	5	3
Number of Floors	StV4	0.33	1	0.2	1	5
Material of Roof	StV5	0.2	0.14	0.33	0.2	1
<b>Total</b>		<b>3.03</b>	<b>4.14</b>	<b>4.53</b>	<b>10.20</b>	<b>21.00</b>

**Table 7.3: Normalization and Weights of Structural Indicators**

<b>Normalization</b>							
	StV1	StV2	StV3	StV4	StV5	Total	<b>Weight</b>
StV1	7	5	9	6	5	31	<b>6</b>
StV2	7	5	4	2	7	24	<b>5</b>
StV3	3	5	4	10	3	25	<b>5</b>
StV4	2	5	1	2	5	15	<b>3</b>
StV5	1	1	1	0	1	5	<b>1</b>
<b>Total</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>		<b>20</b>

In the case of floods, the related structural vulnerability is reflected on the weakness of the house in relation to avoid the effect of raising, flowing and falling waters (in case of heavy rains) . Therefore, in this case study, five indicators were used to characterize the structural vulnerability: height of the pillars, material of the pillars, material of the walls, number of floors and the material of the roof. The height of the pillar indicator was assigned a higher importance because of the support of the house, while the material of the roof was assigned lower importance.

In this study, the vulnerability was classified in *low*, *medium* and *high*. Each of these classes was assigned a quantitative class 1, 3 and 5 correspondingly as shown in Table 7.4.

**Table 7.4: Vulnerability Classes**

<b>Vulnerability Classes</b>		
<b>Classes</b>	<b>Qualitative Vulnerability</b>	<b>Quantitative Vulnerability</b>
<b>Class 1</b>	Low	1
<b>Class 2</b>	Medium	3
<b>Class 3</b>	High	5

Table 7.5 shows the five indicators used in this analysis, the weight assigned and the classes of vulnerability.

**Table 7.5: Indicators and classes of the structural vulnerability**

Structural Indicators	Weight	Structural Vulnerability Classes		
		Low <i>Class 1</i>	Medium <i>Class 2</i>	High <i>Class 3</i>
		1	3	5
Height of pillars	6	> 100 cm	60 -100 cm	< 60 cm
Material of pillars	5	Concrete	Wood	Bamboo/others
Walls	5	Concrete	Mixed (concrete/light)	Light (bamboo, wood, plywood, etc)
Nr. Floors	3	2	1 ½ (mezzanine)	1
Roof material	1	Concrete	Corrugate Iron	Palm - nippa

The indicators were weighted by assigning coefficients depending on the importance of the components relative to each other; and also, depending on the material of the structural element. For example, the height of the pillar was weighted with the highest coefficient due to its importance structural function with the house against the water depth (second column). Also this was classified in three classes depending on the height of the pillars, which indicates the capacity of the house to avoid the water flow. It means, the higher the pillars, the less vulnerability to floods it has. In the case of material, these were classified taking into consideration the resistance by type of material to water. Hence, if the water-resistance of a material increases, its vulnerability will decrease.

The material of the roof was considered as other indicator for this analysis due the presence of heavy rains which can cause damage to the roofing and therefore allow elements inside the dwelling get wet and rotten. This indicator is also a part of the capacity and coping mechanism the people have against flood. It is used as a protector of peoples' belongings and also for escaping purposes.

In order to assess the structural vulnerability class, upper boundaries were assigned for each vulnerability class. The upper boundaries for low and medium class were obtained by making flexible the criteria considered. For instance a concrete house was considered low class even if the pillars were less than 60 cms and the roof was made of corrugated iron. This renders as real limit for the lower class 46 in stead of 20. The real limit for medium class was set at 72. (see Table 7.6).

**Table 7.6: Structural Vulnerability Limits**

Structural Vulnerability Limits			
	Low	Medium	High
<b>Weights</b>	<b>1</b>	<b>3</b>	<b>5</b>
<b>6</b>	6	18	30
<b>5</b>	5	15	25
<b>5</b>	5	15	25
<b>3</b>	3	9	15
<b>1</b>	1	3	5
<b>Limits</b>	<b>20</b>	<b>60</b>	<b>100</b>

Once the class of structural vulnerability was obtained for each household, it was represented in an attribute map. The map (see Figure 7.1) shows the structural

vulnerability at a household level and the zone of each barangay. Due to the heterogeneity of buildings, materials, etc. in these barangay, the structural vulnerability class at zone level is not shown in the map.

### 7.3. Social Vulnerability

Although a very complex issue, social vulnerability relates to the many social aspects within a family, including cultural and educational aspects, as well as issues related to the number of members within a household. Evaluation of social aspects must also include age of the people living within a household as has been demonstrated that the very young and the elderly can be more vulnerable because of their needs and their lack of mobility.

In this study, social vulnerability was represented by the number of residents per household, the age of the residents, the composition of the household (kinship), the age of the main income earner and the place of origin of the household members.

The number of residents per household is the total number of persons living in a household. The classification for vulnerability assessment of this indicator was done taking into consideration the average household size of 5.37 in 1995 (NCDMP, 2001). Hence, the first class (low vulnerability) is conformed by the resident number of 5 members. In the second class (medium vulnerability) the number of residents is between 6 and 9. The third class (high vulnerability) was assigned when the number of members in a household is more than 9.

Regarding the social vulnerability, *the age of the members* of the household was grouped in three classes. The presence of infants and elderly adults increase the social vulnerability in homes, whereas the presence of teenagers and adults reduces such vulnerability due to their greater mobility to evacuate the impacted zone. According to the purposes of this study, the age of the household members was shown as the *dependency ratio* quantified as the ratio of the number of children and elderly adults in relation to the number of adults within the household, multiplied by a suitable constant to increase the resulting magnitude to the level of other vulnerabilities. However, special measures need to be taken into account if there are no children or elderly adults in the house. The formula proposed for this method is as follows (Villagrán, 2004):

$$\text{Vulnerability} = 10 * ((0.5 + \text{number of children and elderly}) / \text{number of adults})$$

The *dependency ratio* of the household members represents the capacity of each member to be responsible of other household member according to their age, i.e. class 1 will be represented by a dependency ratio lower than 0.5, which means that there is no dependency with another person, while within class 2, the dependency of a person will be with another person, which means there is a relation of 1 to 2: one person has responsibility to himself and to one other more. And class 3 is assigned when the dependency ratio is higher than 1.5, which means that when one person has responsibility to himself and to more than one person becoming the class with high vulnerability.

The *Household composition* was classified according to the types of kinships found in the field. Because of the complex household composition, in this study, a reclassification was done. The new classes are: class 1, assigned to those families composed by only one family (parents and children). Class 2 is assigned if the household is conformed by two types of kinship or relationship (parents, children and grandparents/brothers/sisters, etc.). And class 3 is assigned if the household composition has more than 2 types of kinships.

In the indicator *age of main income earner*, the cluster of age was done according to international agreements, taking into account the capacity of the person to cope with a disaster. These clusters are groups of persons between 15 to 30 years old, 30 to 45 years old and the third cluster includes the persons older than 45. With these clusters, the vulnerable classes were classified as class 1, comprising the group of people between 30-45 years old, being this class the less vulnerable. The most vulnerable class (3) is formed by people older than 45 and the class with medium vulnerability (class 2) by people between 15 to 30 years old.

The *Place of origin* is the last indicator considered in the evaluation of vulnerability of Mabolo and Triangulo barangays. This indicator was used to identify the vulnerability of the household in terms of capacity and knowledge (i.e. what to do in case of a flood). This indicator was classified as follows: if the household was born in the barangay, it means that most probably the household members have dealt with floods before and therefore know what to do and how to react in case of floods. if the household origin is from other barangay, but within Naga city, their knowledge and capacity to face a flood is less or different than those mentioned above. And finally, the third class assigned high vulnerability because within this class the households that have come from other towns or cities and perhaps have not developed knowledge and coping mechanism for dealing with flooding.

For quantifying the social vulnerability, the same methodology (Pairwise Comparison) described above was applied by finding the relation between a pair of indicators as shown in the Table 7.7 and Table 7.8

**Table 7.7: Pairwise Comparison Matrix for Social Indicators**

<b>Pairwise Comparison</b>						
<b>Social Indicators</b>		ScV1	ScV2	ScV3	ScV4	ScV5
Number of Residents	ScV1	1	0.11	7	1	3
Dependency ratio	ScV2	9	1	3	0.33	7
Household composition	ScV3	0.14	0.33	1	0.2	0.33
Age of Main Income source	ScV4	1	3	5	1	3
Place of Origin	ScV5	0.33	0.14	3	0.33	1
<b>Total</b>		<b>11.47</b>	<b>4.58</b>	<b>19</b>	<b>2.86</b>	<b>14.33</b>

**Table 7.8: Normalization and Weights for Social Indicators**

<b>Normalization</b>							<b>Weights</b>
	ScV1	ScV2	ScV3	ScV4	ScV5	Total	
ScV1	1.7	0.5	7.4	7.0	4.2	20.8	<b>4</b>
ScV2	15.7	4.4	3.2	2.3	9.8	35.3	<b>7</b>
ScV3	0.2	1.4	1.1	1.4	0.5	4.6	<b>1</b>
ScV4	1.7	13.1	5.3	7.0	4.2	31.3	<b>6</b>
ScV5	0.6	0.6	3.2	2.3	1.4	8.0	<b>2</b>
<b>Total</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>		<b>20</b>

Table 7.9 shows the five indicators used in this analysis, the weight assigned to the different indicators and the classes of vulnerability.

**Table 7.9: Indicators and classes of the social vulnerability**

Social Indicators	Weight	Social Vulnerability Classes		
		Low <i>Class 1</i>	Medium <i>Class 2</i>	High <i>Class 3</i>
		1	3	5
Nr. residents	4	1 to 5	5 to 9	>9
Dependency ratio	7	<0.5	0.5 to 1.5	>1.5
Household composition	1	Single family	Two kinship types	More than two kinship types
Age of main income earner	6	30 – 45	15 – 30	> 45
Place of origin	2	Barangay	Naga	Outside Naga

Regarding social vulnerability, the highest weights were assigned to the dependency ratio and to the age of the main income earner due to the importance of the social support for the household. This is a result of the importance of the relationship between pairs of indicators as mentioned above.

**Table 7.10: Social Vulnerability Limits**

Social Vulnerability Limits			
	Low	Medium	High
<b>Weights</b>	<b>1</b>	<b>3</b>	<b>5</b>
<b>7</b>	7	21	35
<b>4</b>	4	12	20
<b>1</b>	1	3	5
<b>6</b>	6	18	30
<b>2</b>	2	6	10
<b>Limits</b>	<b>20</b>	<b>60</b>	<b>100</b>

The upper boundaries considered for the social vulnerability were extended by making flexible the place of origin as follows:

- 26 for Low social vulnerability (Low to medium social vulnerability)
- 64 for Medium social vulnerability (Medium to high social vulnerability)
- 100 for High social vulnerability ( High to very high social vulnerability)

After obtained the social class vulnerability for each household, these classes of vulnerability were represented in an attribute map as in the case of the structural vulnerability (see Figure 7.2) .The map (Figure 7.2) shows the social vulnerability at a household level and the zones of each barangay. In order to maintain the social heterogeneity existing in these barangays the social vulnerability map was not aggregated at zone level.

## 7.4. Economic Vulnerability

One of the main factors affecting families during a disaster is the possibility of losing income as a result of vulnerable types of employment or income. For example, a family that depends on agriculture as a single source of income can be very vulnerable in the case of floods or droughts, as this activity can be drastically affected by such natural event.

Similarly, as in the previous cases, five indicators were selected in order to obtain a quantified vulnerability (see Tables 7.11 and Table 7.12). Based on the information gathered in the field, the following indicators are included in this specific type of vulnerability: main source of income, the locality of such income sources, the number of sources of income, amount of daily income and land tenure.

Regarding the *main source of income*, experience shows that at rural level agriculture and cattle farming are the most vulnerable sources of income (Villagrán, 2004) with respect to floods. At urban level the most vulnerable class are those represented by informal livelihoods, marginal activities and small businesses taking place in the house. Formal workers and/or those whose source of income is located outside of the flooded area are considered as the less vulnerable. Medium class are the incomes of informal workers and/or services providers that take place inside the barangay affected. This classification was done taking in consideration not only the type of income, but also the location of the source of income. This classification is shown in Table 7.13.

The *number of sources of income* refers to the number of members that have income for the same household. The classification of this indicator was done having the following criteria as a basis: as more earners the household has, less vulnerable the household is. Therefore, the more vulnerable household are those with only one source of income and the less vulnerable those with more than two wages.

The *daily income* refers to the amount of money needed per day per person. It was calculated according to the annual per capita food threshold for the Philippines in 2000 stood at P7,829 for every Filipino, which is a 15.1% increase over the 1997 threshold of P6,801. The 2003 figure is equivalent to P21.46 per day (approximately P21.00) for the Philippines. Further, for an average Filipino family of size 5 (national average: exactly 5.0) in order to be able to meet its minimum food needs, the family should have a minimum income of P39, 145 for the whole year or P 107.31 per day.

The last indicator for the assessment of economic vulnerability is the *Land Tenure*. It is considered as one of the main household economic support. It also determines the type of investment in security households are willing to take. Land tenure indicator was classified in terms of ownership. A household has low vulnerability if it owns the land and a high vulnerability if the family is settled as squatter. The second class was assigned when the household rents or occupies as tenant the land where is settled. The table 7.13 shows the classes and the levels of economic vulnerability.

**Table 7.11: Pairwise Comparison Matrix for Economic Indicators**

Pairwise Comparison						
Economic Indicators		EcV1	EcV2	EcV3	EcV4	EcV5
Main source of Income	EcV1	1	1	0.2	1	0.33
Location of source of income	EcV2	1	1	5	1	3
Number of Income sources	EcV3	5	0.2	1	1	5
Daily Income	EcV4	1	1	1	1	5
Land Tenure	EcV5	3	0.33	0.2	0.2	1
<b>Total</b>		<b>11</b>	<b>3.53</b>	<b>7.4</b>	<b>4.2</b>	<b>14.33</b>



The economic vulnerability class was obtained following the same procedure described for structural and social vulnerability. the attribute map was prepared illustrating the economic vulnerability classes at a household level (see Figure 7.3).

**Table 7.12: Normalization and Weights for Economic Indicators**

Normalization							
	EcV1	EcV2	EcV3	EcV4	EcV5	Total	Weights
EcV1	1.8	5.7	0.5	4.8	0.5	13.2	3
EcV2	1.8	5.7	13.5	4.8	4.2	29.9	6
EcV3	9.1	1.1	2.7	4.8	7.0	24.7	5
EcV4	1.8	5.7	2.7	4.8	7.0	21.9	4
EcV5	5.5	1.9	0.5	1.0	1.4	10.2	2
<b>Total</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>		<b>20</b>

**Table 7.13: Indicators and classes for economic vulnerability**

Indicators		Low	Medium	High
		<i>Class 1</i>	<i>Class 2</i>	<i>Class 3</i>
	<b>Weight</b>	1	3	5
Main source of income	3	Formal workers (employee, remittance, pension, business, sailor, operator, waitress, security guard, maintenance, relative support)	Informal employees/services (driver, painter, vendor, carpenter, builder, electrician, housemaid, barber)	Marginal activities (farmer, labourer, rice worker, sarisari store, billar, porter, pili packer, washerwoman)
Location of sources of income	6	Outside the barangay	In the barangay	In house
Number of sources of income	5	More than two	two	one
Daily income	4	>34Pesos/person	29-34P/person	<29Pesos/person
Land tenure	2	owner	Tenant/rented	squatter

**Table 7.14: Economic Vulnerability Limits**

Economic			
Weights	1	3	5
3	3	9	15
6	6	18	30
5	5	15	25
4	4	12	20
2	2	6	10
	20	60	100

The Upper boundaries for every class were obtained by making flexible the location of the income source as in many cases the areas of commercial activities are less flooded (as for they construction many times they are raised from the ground level) or at some places people can continue with their informal activities just moving to other less severe flooded barangays.

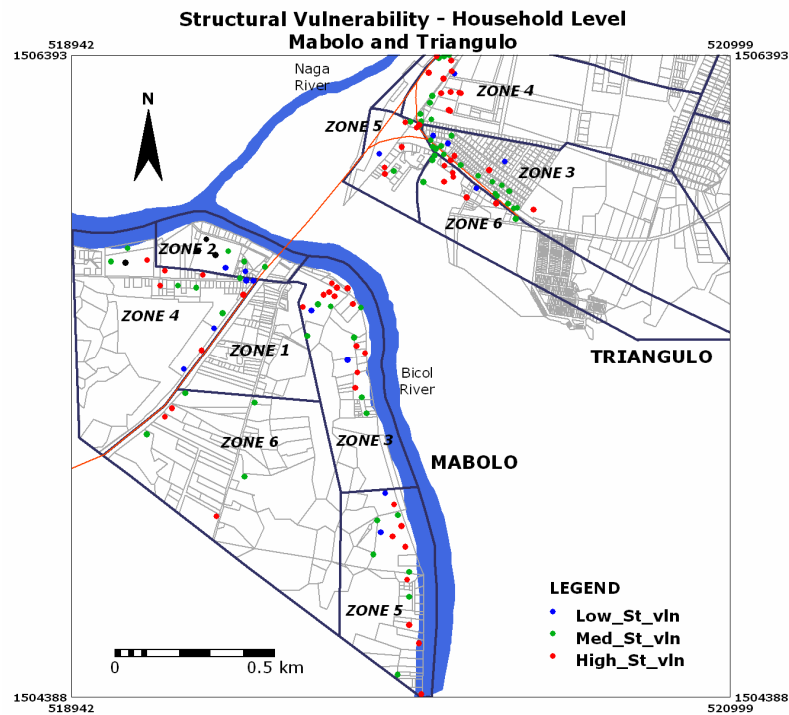


Figure 7.1 Structural Vulnerability Classes at Household Level in Barangay Mabolo and Triangulo

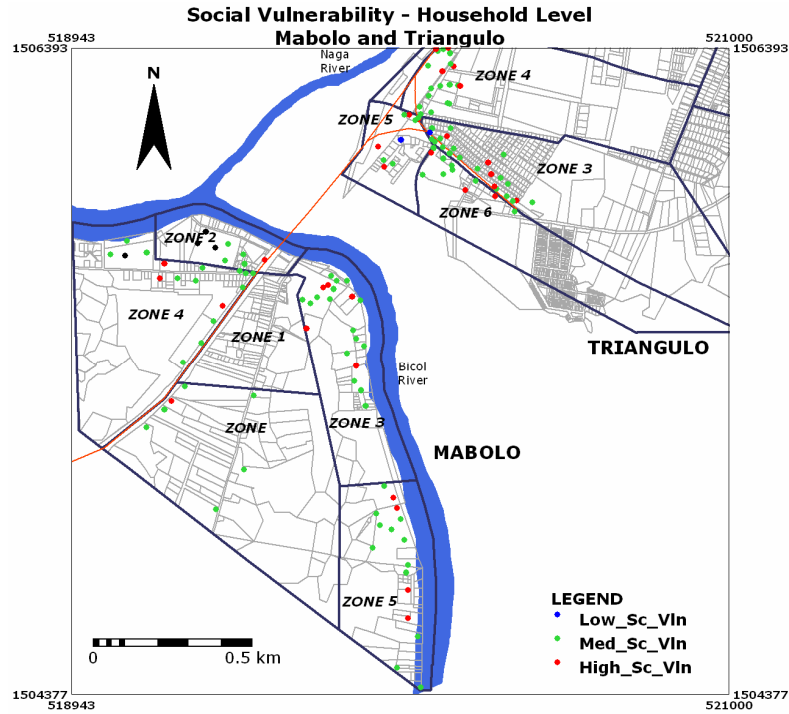


Figure 7.2: Social Vulnerability Classes at Household Level in Barangay Mabolo and Triangulo

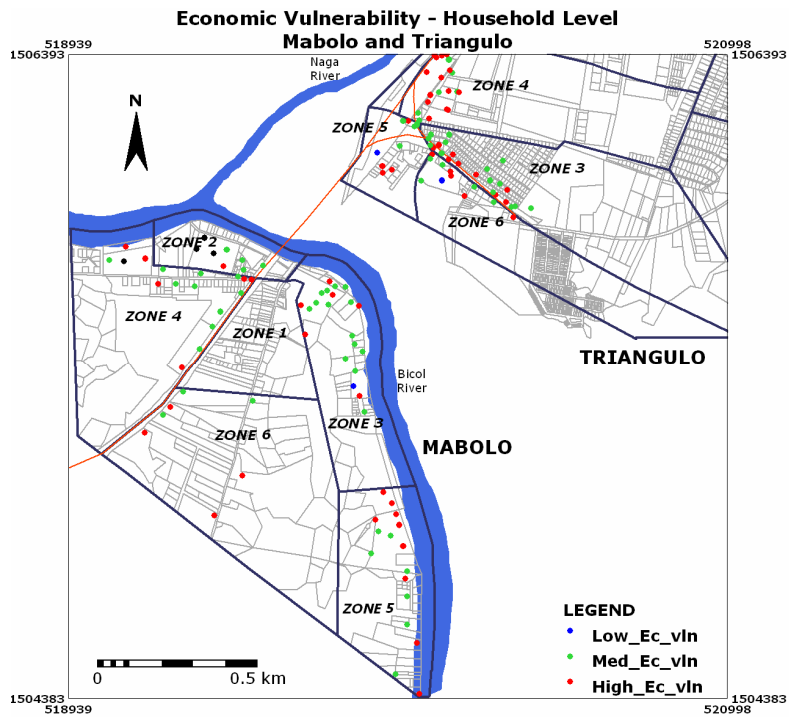


Figure 7.3: : Economic Vulnerability Classes at Household Level in Barangay Mabolo and Triangulo

## **7.5. Comparison between Mabolo and Triangulo**

The statistical comparison of indicators between Mabolo and Triangulo was done to show the predominant classes within each barangay. This gave the illustration of the heterogeneity of the areas, in relation of the structural, social and economic characteristics of the households in the area. It also helps to address important differences or equivalence in terms of pre-hazard conditions within the barangays.

### **7.5.1. Structural indicators**

Figure 7.4 shows the structural indicators and the predominant characteristics in classes in percentage of the structural indicators, for each barangay. These classes are the same as the ones that were indicated in Table 7.5. According to the Figure 7.4,

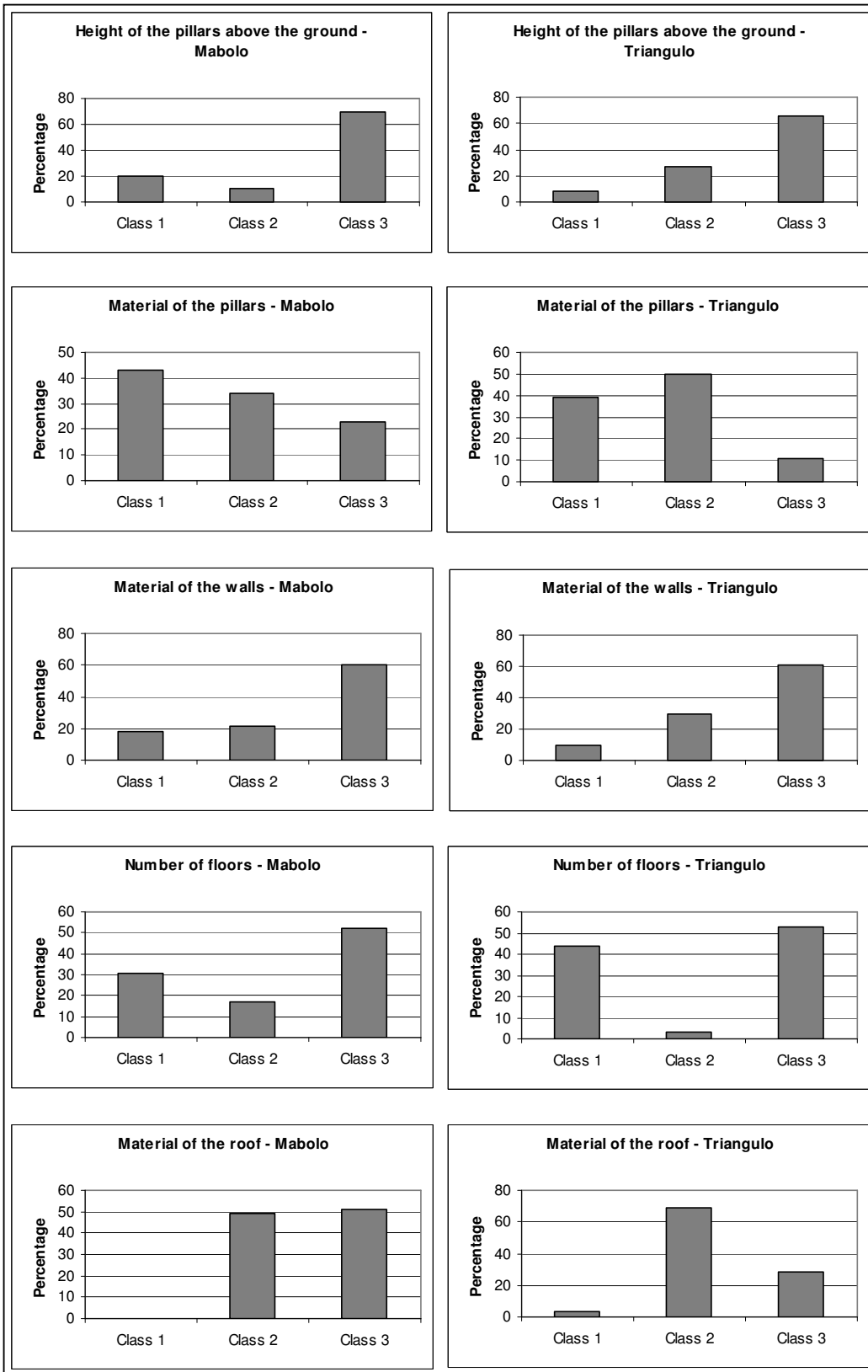
### **7.5.2. Social indicators**

As in the point 7.5.1, Figure 7.5 illustrates the social characteristics of Mabolo and Triangulo. The social characteristics between Mabolo and Triangulo are highly different considering the indicators used, highlighting the heterogeneity of the areas.

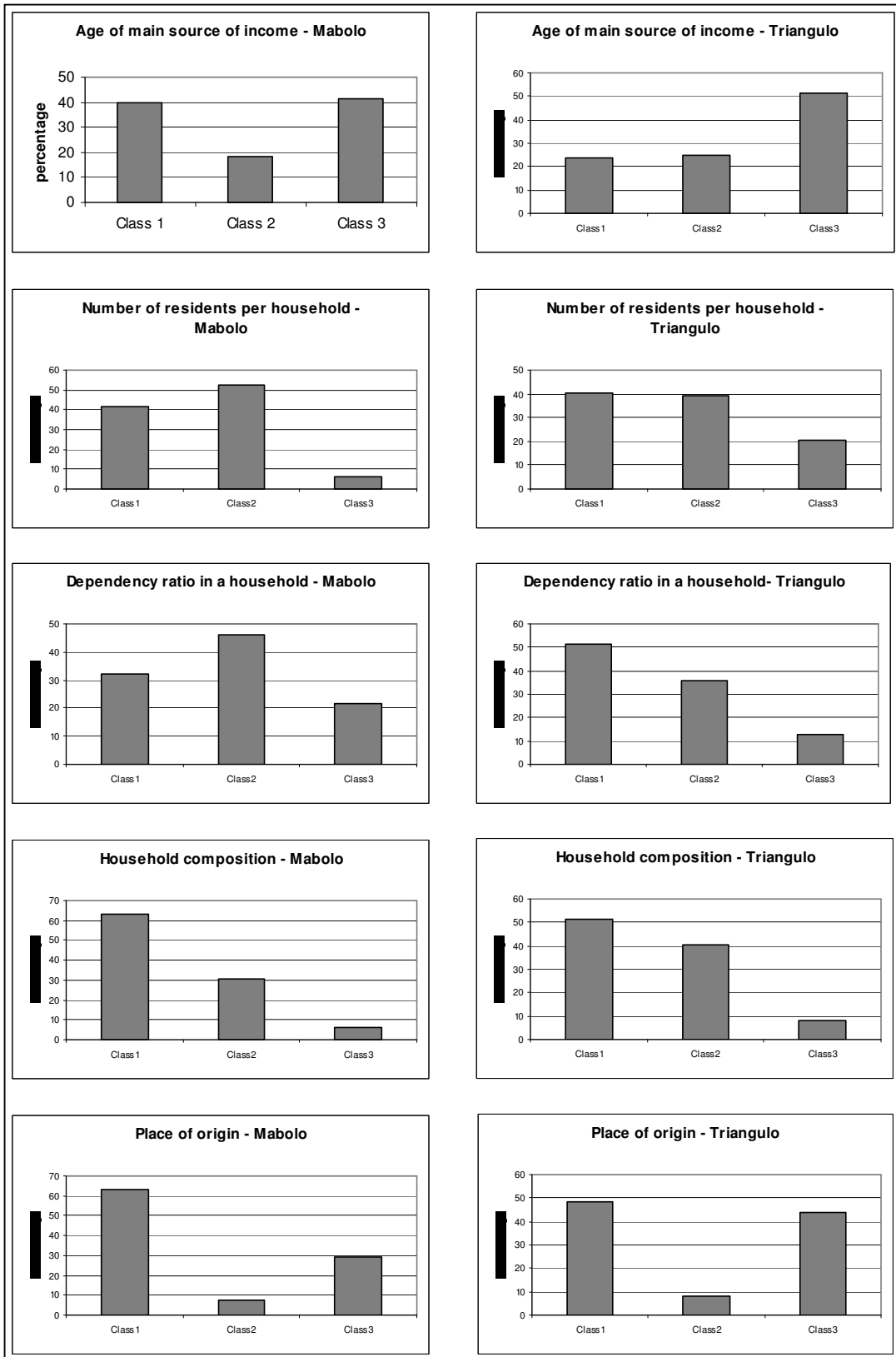
### **7.5.3. Economic indicators**

In this case, both barangays have almost the same percentage in the *main livelihood mean, number of sources of income and the daily income*.

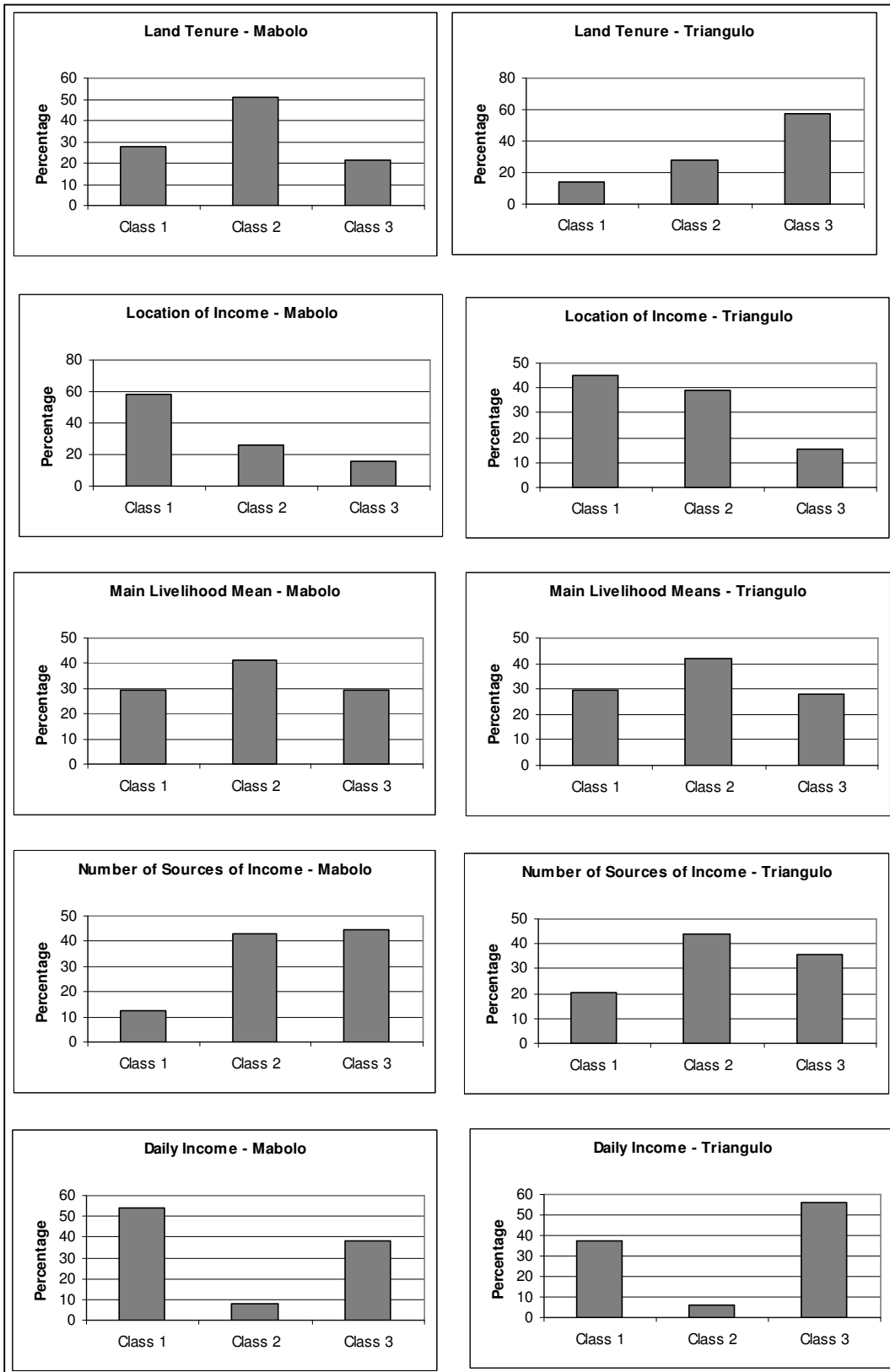
**Figure 7.4 : Comparison of structural indicators between Mabolo and Triangulo**



**Figure 7.5: Comparison of social indicators between Mabolo and Triangulo**



**Figure 7.6: Comparison of economic indicators between Mabolo and Triangulo**



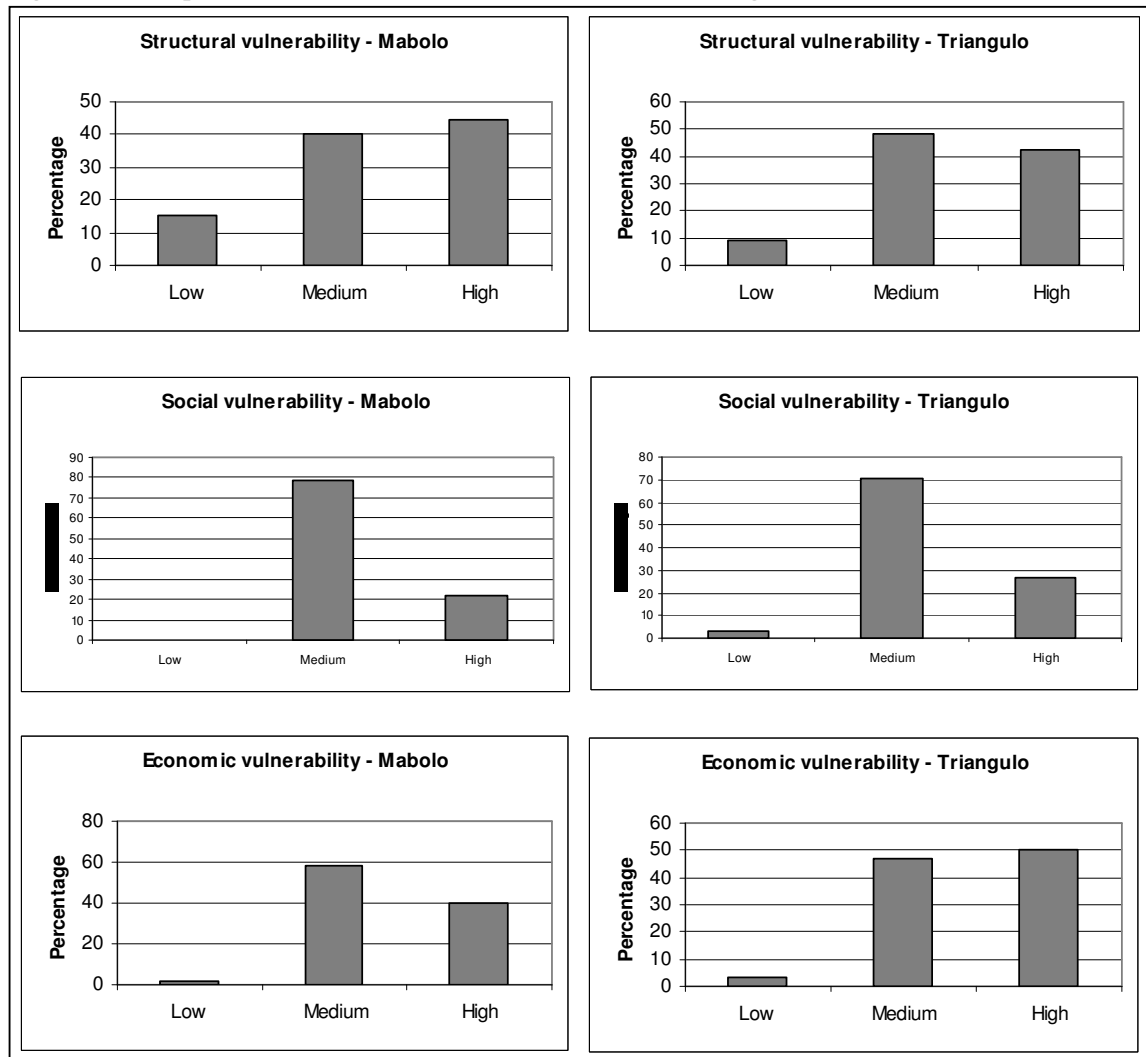
### 7.5.4. Vulnerability comparison between Mabolo and Triangulo

Figure 7.7 shows the predominance of structural, social and economic vulnerability classes in each barangay. As can be seen from the structural point of view Mabolo is slightly more vulnerable than Triangulo.

In contrast the social vulnerability of Triangulo is slightly higher than Mabolo. This can be due to the fact that Triangulo is basically an urban environment while Mabolo still has a big area formed by rural inhabitants who tend to be more homogeneous and create more social ties within their communities.

Regarding the economic vulnerability, Triangulo is highly vulnerable compared to Mabolo. Household activities in Triangulo are characterized for being marginal and informal, and also for a high amount of in-house small business such as sari stores.

**Figure 7.7: Comparison of vulnerabilities between Mabolo and Triangulo**





## 7.6. Correlations and histograms

### 7.6.1. Correlations of vulnerabilities

For purposes of further application of the findings in this research, the Pearson correlations between types of vulnerabilities were done. The relationship by pairs of vulnerability type is shown in Tables 7.15, 7.16 and 7.17.

The result of the correlations shown that there is a significant dependency between the pair of vulnerabilities correlated. This is a highly remarkable finding as, in terms of further applications, it can be assumed that at least for cartographical and extrapolation purposes in similar environments when assessing the structural vulnerability of a given household, the social and the economic vulnerability can be predicted with some level of confidence. However it should be highlighted that the level of correlation are not equal for each pair of vulnerability type, and therefore caution should be take into account.

**Table 7.15: Correlations between Structural and Social Vulnerabilities**

		St_Vln	Sc_Vln
St_Vln	Pearson Correlation	1	.182(*)
	Sig. (2-tailed)	.	.039
	N	129	129
Sc_Vln	Pearson Correlation	.182(*)	1
	Sig. (2-tailed)	.039	.
	N	129	129

\* Correlation is significant at the 0.05 level (2-tailed).

**Table 7.16: Correlations between Structural and Economic Vulnerabilities**

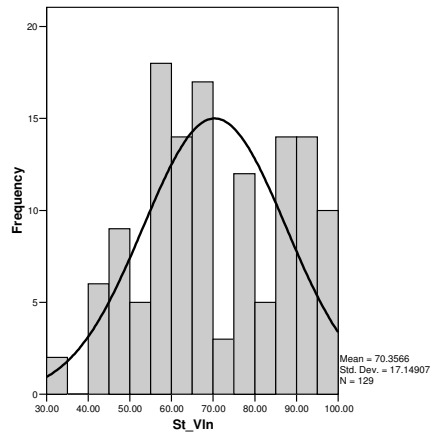
		St_Vln	Ec_Vln
St_Vln	Pearson Correlation	1	.171
	Sig. (2-tailed)	.	.053
	N	129	129
Ec_Vln	Pearson Correlation	.171	1
	Sig. (2-tailed)	.053	.
	N	129	129

**Table 7.17: Correlations between Economic and Social Vulnerabilities**

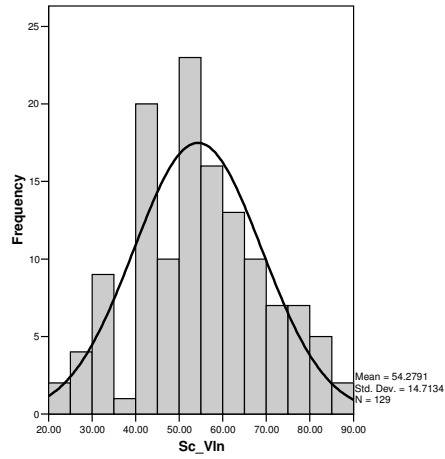
		Ec_Vln	Sc_Vln
Ec_Vln	Pearson Correlation	1	.012
	Sig. (2-tailed)	.	.895
	N	129	129
Sc_Vln	Pearson Correlation	.012	1
	Sig. (2-tailed)	.895	.
	N	129	129

### 7.6.2. Histograms of vulnerabilities

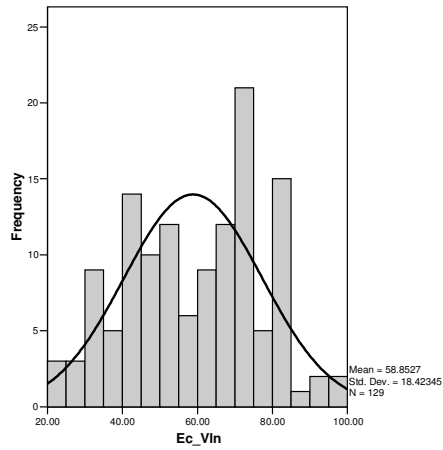
The histograms were done to show the frequency of the data set in relation with its structural, social and economic vulnerability.



**Figure 7.8 : Histogram of the Structural Vulnerability distribution in both barangays**



**Figure 7.9: Histogram of the Social Vulnerability distribution in both barangays**



**Figure 7.10: Histogram of the Economic Vulnerability distribution in both barangays**

## 8. Discussion, conclusions and recommendations

### 8.1. Discussion

During the last fifteen years several debates and theories have been tried to explain the increasing vulnerability to disasters especially in developing countries. Nowadays is becoming more evident that disasters are the result of interaction between natural events and ongoing social and economical processes occurring at global, regional and local level.

Several methodologies and models, most of them implemented under GIS environments, have tried to explain the impact of hazard events mostly in terms of expected damages and losses. However to be able to carried out this type of applications enormous amount of good quality data need to be available. On the other hand these types of approaches are generalized and do not address the differences in vulnerability, adaptation and coping mechanism that different groups of people have.

Over the last decade approaches to household security, human rights and human development have been adapted to look for adequate and sustainable access to income and resources to meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing, and time for community participation and social integration) as a way to reduce vulnerability to natural hazards such as floods at grassroots levels.

From the information point of view, new methodologies are trying to reflect the pre-hazard conditions of a community in terms of safety, security, exposure, resistance etc. one of the main constraints for the application and combination of these methods will be always the lack of adequate information at micro-scale and by using indicators that in one hand reflect the situation at hand and in the other hand allows further monitoring of the conditions set as baseline.

Community-based tools have the capacity to render information that can be converted into layers and manipulated under GIS environments. In addition this combination of methods has the possibility to foster participation, empower communities and provide authorities with place-based information that support their search for adequate responses to the threats that natural hazards pose to their society.

In flood-prone environments such as Naga communities do have knowledge and perceptions that are important inputs for hazard, vulnerability and risk identification. There is a need for include new sources of knowledge into traditional risk analysis as well as develop new GIS applications and tools that address the usefulness of the combinations of these types of approaches.

## 8.2. Conclusions

The final stage of this research consist in analysis of what has been done and conclusions that are possible to drawn from it. After the development of this study, it is possible to indicate the following conclusions:

- According to Communities settled on Mabolo and Triangulo these Barangays are highly prone to be affected by several type of flood events, being them riverine flood from Naga and Bicol rivers, combination of riverine and high tide, flash flood and typhoons.
- Meteorologically, the area is highly affected by floods every year during the rainy season between October and January.
- Communities have their own way of expressing or reference water depths, most of the times they refer to by anatomical terms depending on the level reach by the water such as ankle, knee level, waist level. These terms or ` expressions' become important and should be included in information or plans designed to reach back the community for instance in hazard maps, alarm levels, training modules etc
- The risk communities perceived from a given flood is determined by the degree of interruption in their daily livelihood. However communities also made trade-offs between the costs and benefits that occupying flood-prone areas represent for them. Most of the people in the barangays prefer to continue living there instead of being resettled due to the proximity of income sources, schooling and transportation facilities. Availability of free land is another benefit.
- Communities identify land tenure as a key issue that shapes vulnerability in many ways. If they do not have tenure rights on the land they are not willing to invest in stronger materials or building safest dwellings and therefore become more expose to flood damage.
- In order to characterize the most affected barangays combination of community-based tools and GIS renders detailed and valuable information that allows to characterize vulnerability at micro-scale (household) level
- By including participative processes into traditional risk and vulnerability assessment a better understanding of the pre-hazard situation is gained and therefore a better representation of the problem.
- In heterogeneous communities simple purposive random sampling ensures that the diversity of conditions becomes part of the analysis.
- Mapping allows the community to spatially analyze hazards and vulnerabilities and make informed decisions about risk reduction.
- During the processing of converting analogue to digital information and modelling some of the heterogeneity usually found at community level has to be sacrificed. The idea however is that this information can be digitally introduced later on and become part of the database as attached documents.
- Structural vulnerability is directly related with levels of pre-hazard safety conditions of the society under study. A high structural vulnerability partly indicates inadequate supplies from the formal housing sector, reflecting mass poverty, underdeveloped housing finance systems, and inadequacies in land policy and land delivery systems.
- Event tough the results of this research are considered as satisfactory and clearly addressed the pre-hazard structural, social ad economical situation of the

communities, a broader application of the method as well as a proper cartographic representations and extrapolation to similar is required if risk scenarios are to be constructed.

- Simultaneously to hazard and risk assessment communities are able to set up mitigation, awareness and preparedness plans in order to minimize the impact by a given flood event. However they seldom seen themselves as part of the solutions.

### **8.3. Recommendations**

- In order to validate the application of this methodology is necessary to evaluate other context in order to set up a series of indicators that reflect the conditions in areas with different socioeconomic and structural environment.
- The local governments should be involved in the participatory and community based assessment, in order to approach and understand the needs that different communities require.
- The local governments can apply this methodology for risk identification, risk assessment and risk management in order to come up with Mitigation Plans which are going to be suitable for the communities.
- The implementation of a methodology to generate a database is a tool for the local governments to be updating the data according the time goes on.
- For a better representation of a flood scenario a larger set of data is required in order to represent as in the environmental is.

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# Appendices

## Appendix A: Workshops results of Mabolo and Triangulo

### BARANGAY MABOLO

#### 1. Identification of flood scenarios – Mabolo

Type of flood	Zone	Depth	Duration	Time of occurrence
Rain flooding	5	Ankle (20 cm)	• 1 day (after one hour of continuous rain) 2 days (after two hours of continuous rain)	Start of may (rainy season) 2 – 3 times in a year -Overflowing of water from drainage system - clogged canals
	1	Waist (80- 100 cm)		
	3	Waist (80- 100 cm)		
	4	Waist (80- 100 cm)		
	6 (right side)	Waist (80- 100 cm)		
Flash flooding	6	6 feet (>180 cm)	4 days (no outlet)	No warning Last occurrence was on Dec 2000 Some of them seem to be related with opening of upstream Buhi/Bato dam gates
	5	eye length (>160 cm)	2 days	
	3	Chest (140 cm)		
	4	Chest (130 -140 cm)		
	1	Up waist (120)		
	2	Hips ( aprox. 80 cm)	1 day (closest to the river)	
Rain + high tide	4 (part)	Ankle (20 cm)	4 hours	Monthly (high tide during full moon) Zones closer to the river
	3			
	5 (left side)			
Super typhoon	6	7 feet	4 weeks (PNR barrier)	Super typhoon Rosing (Nov 1/ 95) Others: Monang (Dec 5/ 93) Sinning (Nov 17/ 70)
	4	> 6 feet	3 weeks(no outlet)	
	1	6 feet	2 – 3 weeks	
	5	7 feet	1 week	
	2	6 feet	1 week	
	3	< 6 feet (150 cm)	1 week	

#### 2. Flood impact in different flood scenarios - Mabolo

Flood Scenario	Damages	What they do/ not to do	
		avoid losses	Regain/recover

			<b>losses</b>
Riverine flood (Bicol – Naga river)	<ul style="list-style-type: none"> <li>• Bamboo houses (partially to totally destroyed)</li> <li>• Roofing (nipa)</li> <li>• Concrete/wooden walls get wet</li> <li>• Muddy roads</li> <li>• Intrusion of sediments and garbage into houses</li> <li>• Ambulant vendors loss capital and stock</li> <li>• Appliances (specially refrigerators and heavy stuff)</li> <li>• Water borne diseases</li> <li>• Stop working and schooling</li> <li>• Economic status (food first)</li> </ul>	<ul style="list-style-type: none"> <li>• Rise awareness at the beginning of rainy/typhoon season (Oct-Dec)</li> <li>• Follow PAGASA forecast/broadcast through radio/TV</li> <li>• B'gay disaster council informs residents on the event</li> <li>• Cleaning of the drainage system (community program)</li> <li>• Packing and plastic wrapping of valuable items/appliances to be put in elevated mezzanines or moved to safest relatives/ neighbors houses</li> <li>• Reinforce wooden/ thatch houses by tying it with wires/nylon</li> <li>• Do not buy perishable goods</li> <li>• Stocking drinking water and non-perishable food (rice, noodles, sardines, coffee, sugar)</li> <li>• Evacuate women/children to shelters/evac centers/ relatives/neighbors specially those in lowland areas</li> <li>• 'leave as is'</li> <li>• More IEC</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing in prices (vendors)</li> <li>• Selling food during flooding</li> <li>• rising tables and stands for selling</li> </ul>
Heavy rains	<ul style="list-style-type: none"> <li>• walling materials (indigenous material- thatch and wooden houses) become brittle (zones 4 and 5)</li> <li>• Books from school</li> <li>• Appliances set on the ground floor</li> </ul>		Sari sari stores open frequently with more income

	<ul style="list-style-type: none"> <li>• Chairs and tables (schools)</li> <li>• Rice plants</li> <li>• Vegetables/flowers gardens</li> <li>• No schooling (1 week aprox.)</li> <li>• Intrusion of sediments and garbage into houses</li> <li>• Farming (1 cropping season)</li> </ul>		
Flash flood	<p><u>Physical</u></p> <ul style="list-style-type: none"> <li>• walling materials (indigenous material- thatch) partially damaged</li> <li>• content (almost total)</li> <li>• sofas, chairs, beds</li> <li>• Appliances (specially refrigerators and stoves)</li> <li>• Books, papers, documents</li> <li>• Closets, cabinets</li> <li>• Floor mats</li> <li>• Comfort rooms</li> <li>• Water pumps</li> <li>• Public faucets</li> <li>• River bank/sidewalk/paved roads erosion</li> <li>• Domestic animals (drowned)</li> <li>• Plantations</li> <li>• Rice/ vegetable seeds</li> <li>• Computers (school)</li> <li>• Intrusion of sediments and garbage into houses</li> </ul> <p><u>Economical</u></p> <ul style="list-style-type: none"> <li>• Farming activities</li> <li>• Public transportation (going to inner zones in the B'gay)</li> <li>• Regular employees stop working (1 -2 days)</li> <li>• Continuous activities</li> </ul> <p><u>Social</u></p>		

	<ul style="list-style-type: none"> <li>• Schooling (1 day)</li> <li>• Sentimental activities</li> <li>• Mobilization inside the B'gay</li> </ul>		
Heavy rains + high tide	<p><u>Physical</u></p> <ul style="list-style-type: none"> <li>• Backyard gardens</li> <li>• Livestock &amp; Poultry</li> <li>• Fishponds</li> <li>• Plants</li> </ul>		
Super typhoon	<p><u>Physical</u></p> <ul style="list-style-type: none"> <li>• Indigenous material houses (thatch) totally damaged</li> <li>• Semi-concrete houses partially damaged</li> <li>• In zone 5 aprox. 50% of the houses where washed away (highest velocity of the water)</li> <li>• Roofing (aprox 70% of houses with nipa as roof material)</li> <li>• Wooden pillars and walls became brittle</li> <li>• Comfort rooms</li> <li>• Appliances (specially refrigerators and heavy stuff that cannot be easily moved or lifted)</li> <li>• Kitchen utensils</li> <li>• School books/ utensils</li> <li>• Domestic animals (drowned)</li> <li>• Lost of lives (4-6 persons)</li> <li>• Minor injures (snake bites, wounds, slashes due to broken glass, nails, sharp objects)</li> <li>• Fallen trees/electricity poles</li> <li>• Intrusion of sediments and garbage into houses</li> </ul> <p><u>Economical</u></p>	<p><u>Water at knee level/ signal # 1</u></p> <ul style="list-style-type: none"> <li>• Packing and plastic wrapping of valuable items/appliances to be put in elevated mezzanines</li> <li>• Residents place all things in elevated areas/places</li> <li>• Children, women and elderly evacuate to in-laws, neighbors or evac. Centers</li> <li>• Usually husband/eldest son left to guard the house</li> <li>• Guide B'gay (5)</li> <li>• Roll calls to count the people</li> </ul> <p><u>Water above knee level/signal # 2</u></p> <ul style="list-style-type: none"> <li>• Store water for drinking/domestic use</li> <li>• Store food (rice + viands)</li> <li>• Store firewood/gas</li> <li>• Install 'papag' movable table</li> <li>• Listen to radios/CP/ tells for forecasting</li> </ul> <p><u>Water at waist length + strong wind / signal # 3</u></p> <ul style="list-style-type: none"> <li>• Some of the people that are still at place call for evacuation (b'gay + LGU) usually by</li> </ul>	

	<ul style="list-style-type: none"> <li>• Farming activities</li> <li>• Public/ normal transportation (only by boat)</li> <li>• Regular employees stop working (about 1 week)</li> <li>• Non-regular employees/ activities in lower lands stop until the water recedes (usually 1-3 weeks)</li> <li>• Sari sari stores are closed (except those in higher areas)</li> </ul> <p><u>Social</u></p> <ul style="list-style-type: none"> <li>• No schooling (1-3 weeks)</li> <li>• No electricity/water supply</li> <li>• No social activities</li> <li>• Dislocation of 'normal life' status and social networks</li> </ul>	<p>means of 'banca' (wooden boat)</p> <ul style="list-style-type: none"> <li>• The ones that still refuse to evacuate go to roof top</li> <li>• No current wait till am</li> <li>• B,gay officials periodically visit the left residents</li> </ul>	
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### 3. Vulnerability perception - Mabolo

Vulnerability	Characteristics	
	Urban	Rural
Houses	light materials	light materials
Household composition	10 to 12 members (father, mother, 6 kids, in-laws)	10 to 12 members (father, mother, 6 kids, in-laws)
Livelihood means	<ul style="list-style-type: none"> <li>• Construction workers</li> <li>• Porters</li> <li>• Fish/vegetable vendors (small scale)</li> </ul>	<ul style="list-style-type: none"> <li>• Poor farmers</li> <li>• Rice field/rice drying laborers</li> </ul>
Land tenure	Squatters	Tenants
Zones	Evenly distributed across the B'gay	5 and 4, part of zone 6

### 4. Risk perception - Mabolo

Risk Perception			
Depth/ Duration	1 day	1 to 2 days	> 2 days
Ankle	Normal	Normal	Disturbing (skin diseases)
Knee	Manageable	Highly disturbing	
Waist	Intolerable		
Breast	Unmanageable		
Breast + high wind	Disastrous (< 5 hours)		

**5. Programs and Projects - Mabolo**

<b>Programs/projects needed to</b>	
<b>avoid flood losses</b>	<b>regain flood losses</b>
<ul style="list-style-type: none"> <li>• Drainage system (centralize</li> <li>• Maintenance of the existing drainage system</li> <li>• De-clogging of canals and drainages</li> <li>• Dredging of rivers (yearly)</li> <li>• Proper waste disposal programs (continuous education programs</li> <li>• Commitment and discipline of the community (specially women for fixing HH</li> <li>• Use of biodegradable wrappers (?)</li> <li>• Eradication of water lilies</li> <li>• Reactivation of 'Bantay Salog program' (river cleaning started by ladies in green NGO)</li> <li>• Construction of evacuation center inside the B'gay</li> </ul>	<ul style="list-style-type: none"> <li>• DA recapitalization</li> <li>• Low interest credits for seed &amp; fertilizers</li> <li>• Close monitoring of livelihood projects of the government</li> <li>• Negotiation of land ownership tenants/occupants</li> </ul>

**6. Policies and Ordinances - Mabolo**

<b>Policies and ordinances needed to avoid flood losses/ regain flood losses</b>
<ul style="list-style-type: none"> <li>• Ordinances in waste segregation</li> <li>• B'gay ordinance of not allowing to throw garbage/waste in the river</li> <li>• Declaration of second Saturday of the month as 'clean up day'</li> <li>• Refuses waiver for not evacuating/claiming damages</li> <li>• Institutionalization of flood prevention &amp; preparedness programs in schools'</li> <li>• Capacity Building for community association and cooperativeness (lack of time ...formation)</li> <li>• Policies of regulation for land tenure</li> <li>• Ordinances for adequate (structural) designs of roads and streets</li> </ul>



**Barangay Triangulo**

**1. Identification of flood scenarios – Triangulo**

<b>Identification of Flood Scenarios</b>				
<b>Type of flood</b>	<b>Zone</b>	<b>Depth</b>	<b>Duration</b>	<b>Time of occurrence</b>
Rain + Riverine (Naga + Bicol) flooding	6	Up waist (4 feet)	7 days	Last quarter of the year (Oct to Dec) sometimes during April 1 – 2 times in a year
	3	Up Waist (4 feet aprox)		
	5	Waist (2-3 feet)	2 to 3 days	
	4	Waist (2-3 feet aprox)		
Flash flooding	6	Chest (4 - 5 feet)	2-3 days	No warning 2 events: the first on 1997 and last one on 2000 the whole Naga was flooded Muddy flood apparently related with opening of upstream Nabua dam gates
	3	Chest (4 - 5 feet aprox)		
	4	Hips (3- 4feet )	1 day	
	5	Hips (3- 4feet )		
Rain + high tide	6	knee (1 – 2 feet)	6 hours	Monthly (combination of heavy rains and high tide during full moon) This zones are lower than Naga river
	3	knee (1 – 2 feet aprox)		
Super typhoon	6	> 6 feet	3 weeks	Last quarter of the year during rainy season (Oct to Dec) Super typhoon: Sinning /70 (240 kmph) Ruping/80's Onsang Rossing/85 Diding/ 87 Monang/95 Loleng/96
	3	> 6 feet	3 weeks	
	4	5 feet	1 week	
	5	< 5 feet	1 week	

**2. Flood impact in different flood scenarios – Triangulo**

Flood Scenario	Damages	What they do/do not to	
		avoid losses	Regain/recover losses
Super typhoon  Knee level (inside houses)	<ul style="list-style-type: none"> <li>• Concrete/wooden walls get wet</li> <li>• Muddy roads</li> <li>• Intrusion of sediments and garbage into houses</li> <li>• Appliances (specially refrigerators and heavy stuff)</li> <li>• Water borne diseases</li> <li>• Stop schooling</li> </ul>	<ul style="list-style-type: none"> <li>• Evacuate (try to continue with normal life)</li> <li>• Packing and plastic wrapping of valuable items/appliances to be put in elevated mezzanines or moved to safest relatives/ neighbors houses</li> <li>• Stocking drinking water and non-perishable food (rice, noodles, sardines, coffee, sugar)</li> <li>• 'leave as is'</li> <li>• Electricity is cut off</li> <li>• Buying&amp; Stocking candles as emergency lights</li> <li>• Do not walk on barefoot to avoid injuries</li> <li>Wear short pants</li> </ul>	<ul style="list-style-type: none"> <li>• Selling food during flooding</li> <li>• rising tables and stands for selling</li> </ul>
Waist level		<ul style="list-style-type: none"> <li>• Waning for evacuation</li> <li>• VCD, TV, clothes, are wrapped in plastic bags and placed in highest places in the house</li> <li>• Before typhoon strike each family stores food and water enough for (at least) three days</li> <li>• pets, animals and vehicles are placed in Diversion road</li> <li>• Small children are evacuated first and not allowed to swim in the floodwaters</li> <li>• Males (husband, eldest son) remain at place taking care of the house &amp; assets (usually they know how to swim)</li> <li>• The b'gsy make use</li> </ul>	

		of one banca (wooden boat)	
Breast	•	<ul style="list-style-type: none"> <li>• Rescue teams roam the b'gay taking into consideration that many people still remain at home (specially men left behind)</li> <li>• Most of the people finally moves to evacuation centers as they prefer to save their lives</li> <li>• Members of the navy provide transportation inside the b'gay by means of bamboo or kawagan rafts</li> <li>• LGU provide trucks in diversion roads for transportation?</li> <li>• They stay in 'vintaas'</li> </ul>	<ul style="list-style-type: none"> <li>• At this point the situation is not manageable, assistance from LGU, NGO's etc</li> <li>•</li> </ul>
Beyond head	<ul style="list-style-type: none"> <li>• No work</li> <li>• Complete destruction of houses build in light materials</li> <li>• Semi-concrete houses partially destroyed</li> </ul>		

### 3. Vulnerability perception – Triangulo

Vulnerability	Characteristics
	Urban
Houses	light materials semi-permanent houses
Household composition	8 to 10 members (father, mother, 5 to 7 children, in-laws)
Livelihood means	<ul style="list-style-type: none"> <li>• Porters</li> <li>• vendors (small scale)</li> </ul>
Land tenure	Squatters People that doesn't own the ;and People that have moved from other municipalities
Zones	6, 4 and 3

### 4. Risk perception – Triangulo

Risk Perception			
Depth/ Duration	1 day	1 to 2 days	> 2 days
Ankle	Normal	Normal	Get used to the situation
Knee	Manageable	disturbing	Not tolerable

Waist	manageable	Highly disturbing	disastrous
Breast	Unmanageable	disastrous	
Breast + high wind	Disastrous		

**5. Programs and Projects – Triangulo**

<b>Programs/projects to</b>	
<b>Existing to avoid flood damage/losses</b>	<b>Needed to avoid flood damage/losses</b>
<ul style="list-style-type: none"> <li>• Health programs (b'gay)</li> <li>• Evacuation centers close to the b'gay</li> <li>• Contingency plan (hypothetic)</li> <li>• UFM program</li> <li>• Calamity fund at b'gay level (10%)</li> <li>• Master plan</li> <li>• Warning system (PAGASA)</li> <li>• Organization at B'gay</li> <li>• Community vigilants and volunteers</li> <li>• Drainage system</li> </ul>	<ul style="list-style-type: none"> <li>• Financial loans/assistance to rebuild housing for marginalized people</li> <li>• Funding for drainage improvement (upgrading-expansion)</li> <li>• Dredging of Bicol and Naga rivers</li> <li>• Leveling (earth filling) of some areas inside the b'gay</li> <li>• Provide 'banca' for rescuing activities to the b'gay</li> <li>• Construction of evacuation center (multipurpose building) inside the b'gay</li> <li>• More budget for assisting people in evacuation centers</li> </ul>

**6. Policies and ordinances – Triangulo**

<b>Policies and ordinances needed to avoid flood losses/ regain flood losses</b>
<ul style="list-style-type: none"> <li>• Strengthening of waste disposal system</li> <li>• Drainage system maintenance</li> <li>• Ordinances to make evacuation compulsory at a given water level (shoulder – pinot size)</li> <li>• B'gay ordinance of not allowing to throw garbage/waste in the river</li> <li>• Restoration of old creeks blocked by engineering structures such as diversion road and PNR to allow the floodwater to flow</li> <li>• Ordinances for adequate (structural) designs of roads and streets</li> <li>• Institutionalization of rescue teams, with incentives on duty basis</li> <li>• Policies of regulation for land tenure/ownership</li> </ul>

**Appendix B: Questionnaire**

**Vulnerability and Coping Mechanisms Questionnaire**

Barangay: Triangulo  
 Block ID: \_\_\_\_\_ Coordinates: \_\_\_\_\_  
 Building ID: T-323 Block Area: \_\_\_\_\_  
 Parcel Area: 5 X 10 Built Area (ground floor): \_\_\_\_\_  
 Plot perimeter: \_\_\_\_\_ Front length: \_\_\_\_\_

Responder name: Lourdes de Zal  
 Age: 40 Religion Roman Catholic  
 Length of stay: 40 Owned \_\_\_\_\_ Rented PNR  
 Immigrant: \_\_\_\_\_ Where did you live before: \_\_\_\_\_

Household members No.: 7

Name:	Gender	Age	Education
	<u>Father</u>	<u>45</u>	<u>Driver / High School</u>
	<u>m (son)</u>	<u>18</u>	<u>High School</u>
	<u>m (son)</u>	<u>15</u>	<u>" "</u>
	<u>F (daughter)</u>	<u>14</u>	<u>" "</u>
	<u>F ( " )</u>	<u>10</u>	<u>School</u>
	<u>F ( " )</u>	<u>5</u>	<u>School elementary</u>
	<u>F</u>		

**FINANCIAL STATUS**

Source of income:

Primary:	Who?	How much?
Agriculture		
Poultry		
Business		
Employment		
Private		
Government		
Services <u>Driver - tricycle (rented)</u>	<u>Father</u>	<u>600 / month</u>
Others		

**Secondary:**

Agriculture		
Poultry		
Business <u>Vendor (Food and drinks)</u>	<u>Mother</u>	<u>1500 / month</u>
Employment		
Private		
Government		
Services		
Others		

Other sources: Mother therapeutic massage (P. 450 / week)



Properties	No.
Land-agri	
Business	
House rented	
Vehicle	
Others	

**Hazard Information:**

Type of flood:

Rain fall flood	10 cm Land
Typhoon flood	more than 1.80 mtr.
Flash flood	1.80 mtr.

Date of the last flood: 2004 June

Water depth: (ankle deep, knee deep or >knee deep) 1.80 mtr.

Duration of the flood: 3 days

How often do you experience flooding? 2 times / year

At what flood extent you consider as:

Slightly flooded: 10 cm in the main street

Moderate flooded: 50 cm no water into house

Severely flooded: 1.80 mtr. total flood

**Vulnerability**

**Building inventory**

BUILD\_ID:

<p>Type:</p> <table border="1"> <tbody> <tr><td>House</td><td><input checked="" type="checkbox"/></td></tr> <tr><td>Building</td><td><input type="checkbox"/></td></tr> <tr><td>Institution</td><td><input type="checkbox"/></td></tr> <tr><td>Recreational</td><td><input type="checkbox"/></td></tr> <tr><td>Church</td><td><input type="checkbox"/></td></tr> <tr><td>Education</td><td><input type="checkbox"/></td></tr> <tr><td>Hut</td><td><input checked="" type="checkbox"/></td></tr> <tr><td>Plot (empty)</td><td><input type="checkbox"/></td></tr> </tbody> </table>	House	<input checked="" type="checkbox"/>	Building	<input type="checkbox"/>	Institution	<input type="checkbox"/>	Recreational	<input type="checkbox"/>	Church	<input type="checkbox"/>	Education	<input type="checkbox"/>	Hut	<input checked="" type="checkbox"/>	Plot (empty)	<input type="checkbox"/>	<p>Land use Area:</p> <table border="1"> <tbody> <tr><td>Residential</td><td><input checked="" type="checkbox"/></td></tr> <tr><td>Commerce</td><td><input type="checkbox"/></td></tr> <tr><td>Health</td><td><input type="checkbox"/></td></tr> <tr><td>Industry</td><td><input type="checkbox"/></td></tr> <tr><td>Recreation</td><td><input type="checkbox"/></td></tr> <tr><td>Other:</td><td><input type="checkbox"/></td></tr> </tbody> </table>	Residential	<input checked="" type="checkbox"/>	Commerce	<input type="checkbox"/>	Health	<input type="checkbox"/>	Industry	<input type="checkbox"/>	Recreation	<input type="checkbox"/>	Other:	<input type="checkbox"/>	<p>Use:</p> <table border="1"> <tbody> <tr><td>Residential</td><td><input checked="" type="checkbox"/></td></tr> <tr><td>Commerce</td><td><input type="checkbox"/></td></tr> <tr><td>Education</td><td><input type="checkbox"/></td></tr> <tr><td>Health</td><td><input type="checkbox"/></td></tr> <tr><td>Transport</td><td><input type="checkbox"/></td></tr> <tr><td>Institutional</td><td><input type="checkbox"/></td></tr> <tr><td>Parking</td><td><input type="checkbox"/></td></tr> <tr><td>Recreational</td><td><input type="checkbox"/></td></tr> <tr><td>Other:</td><td><input type="checkbox"/></td></tr> </tbody> </table>	Residential	<input checked="" type="checkbox"/>	Commerce	<input type="checkbox"/>	Education	<input type="checkbox"/>	Health	<input type="checkbox"/>	Transport	<input type="checkbox"/>	Institutional	<input type="checkbox"/>	Parking	<input type="checkbox"/>	Recreational	<input type="checkbox"/>	Other:	<input type="checkbox"/>
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<b>Build pillars:</b> <table border="1"> <tr><td>yes</td><td><del>A</del></td></tr> <tr><td>no</td><td>B</td></tr> </table>	yes	<del>A</del>	no	B	<b>Pillar Mat:</b> <table border="1"> <tr><td>Wood</td><td><del>A</del></td></tr> <tr><td>Bamboo</td><td>B</td></tr> <tr><td>Concrete</td><td>C</td></tr> </table>	Wood	<del>A</del>	Bamboo	B	Concrete	C	<b>Pillar Height:</b> 80 cm																								
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What are the loses that you have experienced? none

If no experienced loses, why? Placing electric things on table (there is no refrigerator, no washing machine) their belongings are very few.

Why your house is located here? They use to live here.

Would you like to be relocated? No.

**Economic loss:**

What are the means of your livelihood? Vendor, driver, masseuse



Father save money to buy food because in evacuation center there is not enough to eat.

Where is the location of your work?(in the same area or outside) Same barangay.

Why your business is located in that area (flooded) Before she has a place in the bus terminal (rent = 30 pesos/day) now she sell in the street (no rent) and  
 Can you work during the flood? is close to her house.

Mother can't, father can, income is lesser.  
 Is your business in a building or in the street? Mobile? Street mobile.

What are the losses that you have experienced in your work? No capital, no products to sell. Family goes to evacuation centre which is not flooded and the father can go to work.

**Social loss:**

Is there any family member sustain injuries? No.

Ages: \_\_\_\_\_

Did you experience diseases after flooding? Which member?  
Fever, cough, skin disease - children.

Did you experience life loss? No

Ages: \_\_\_\_\_

**Physical loss:**

How do you consider the damage of your house/building (little/much/disastrous): little → floor drenched, roof no affected only drenched. 200 pesos to repair floor.

Do you consider your content losses as little/ much/ disastrous: Little → no things to loss. They lost containers.

What are your losses in case of disruption in road services?  
Use the structure of the refrigerator with woodboards for transportation converted as boat. 1 year to recover their normal life.

**Coping mechanisms:**

With those losses and flood events, what are the mechanisms or remedies you are undertaking in order to avoid incurring damages or to regain the losses from flooding? (Use field interview form)

At what flood extent you consider your coping mechanism be applicable?  
 \_\_\_\_\_

Are these mechanisms were developed through learning from your neighbor or group or through your practices? \_\_\_\_\_

How long are you practicing these mechanisms? \_\_\_\_\_

If you are going to be asked, among those mechanisms you mentions, which mechanisms you prefer and why? \_\_\_\_\_

What motivate or encourage you to have this kind of coping mechanisms? \_\_\_\_\_

Note: Family very poor. No things to lose  
They got one woodplan to rebuild the house →  
maximum provided by government.