A participatory GIS approach for Flood risk assessment in YenBai City, Vietnam

Nguyen Thi Thu Trang

February, 2010

A participatory GIS approach for Flood risk assessment in YenBai City, Vietnam

by

Nguyen Thi Thu Trang

Thesis submitted to the International Institute for Geo-information Science and Earth Observation in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation, Specialisation: Applied Earth Sciences (GeoHazards)

Thesis Assessment Board

Dr. D.G. Rossiter (Chair)
Dr. R. V. Sluizas (External Examiner)
Dr. D. Alkema (First Supervisor)
Prof. Dr. V.G. Jetten (Second Supervisor)

Ms. Thi Hai Van Nguyen - PhD Student (Advisor)

Observer :
Drs. T. M. Loran – Observer (Course Director)

INTERNATIONAL INSTITUTE FOR GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

ENSCHEDE, THE NETHERLANDS

Disclaimer

This document describes work undertaken as part of a programme of study at the International Institute for Geo-information Science and Earth Observation. All views and opinions expressed therein remain the sole responsibility of the author, and do not necessarily represent those of the institute.

Dedication

To my beloved mother!

If only she was there to receive my phone, telling her I'm done, and things are fine,

If only she knew I am now a Master of Science, what she always wanted me to become,

If only she cared for herself more, and less for others,

If only she could hear me say I'm indebted to her

all my life,

If only she knew I'm coming home to see her,

If only she was there to wait for me…

If only…

Abstract

Flooding has long been recognized as the most damaging and costly natural hazard in Vietnam considering the frequency and extent. Due to rapid urbanization in the floodplains, the frequency of devastating floods tends to be higher and the loss of human lives and property show no sign of decreasing. In order to minimize the impact of floods, an effective flood management system is required. However, for an effective risk management plan, we need high level of scientific and remote sensing information. These efforts are highly resource intensive and needs highly skilled man power. On the contrary, in this study participatory approaches were used to bridge the gap of scientists and the local community in disaster management.

YenBai province is located in Nothern part of Vietnam with hilly terrain and is under the influenced of Red River and Chay River basins. Its capital city, YenBai city experiences annual flooding through alluvial flood, urban flood and flash floods. Due to the rapid growth in population, urbanization and lack of proper urban planing, YenBai city has faced with a disastrous flood in 2008. The study focussed on four communes of the YenBai city which are very close to the Red River and faced the flood very closely. In this study we reconstructed the flood event of 2008 using the people's knowledge. Mobile GIS and Participatory-Mapping were used to capture people's perceptions. This iformation is used with basic GIS operations to reconstruct the hazard maps. Simultaneously, vulnerability maps were generated using the people's experiences with the flood event. Combining these two and adding expert's knowledge, we calculated the risk faced by these four communes.

The study concluded that asset base in the study area is very weak. Even though some families have better assets, their wellbeing does not change based on these assets. The savings and the asset creation of the households is being threatened by the chronic flooding events.

Participatory mapping and community participation in Disaster management is worth using, in situations where financial and human resourses are limited.

Keywords: Flood Risk, Hazard Assessment, Vulnerability Assessment, Participatory approach, Participatory GIS, YenBai city

Acknowledgements

It is with particular honour that I express my appreciation and gratitude to all those who gave me the possibility to complete this thesis.

Special thanks are due to my respected supervisor, Dr. Dinand Alkema who has been more than a teacher and a supervisor. I would like to thank him for his enormous encouragement and support since the day I came to ITC. He also gave me the motivation, from the very start, upon the selection of this thesis topic and for his sense of professionalism, for his enthusiastic guidance, constructive comments and persistent patience throughout the process of thesis completion.

I would like to express my deep respect and sincere thanks to my second supervisor and head of ESA Department Prof. Victor Jetten and chairman of ESA Prof. Freek van der Meer. I offer my special appreciation to Drs. Tom Loran for his encouragement and kindness in times of difficulty.

To my wonderful teachers, I would like to dedicate my gratitude to my sweet teacher Mrs. Nanette Kingma, for her usual care and encouragement, to Dr. Robert Voskuil for his friendliness. I highly appreciate Dr. Druba Shrestha and his family for generous acceptance, for always offering me an open door. I received valuable suggestion, comments on my midterm presentation and during my thesis time from Dr. Rossiter. To them, I own not only the knowledge that they have tirelessly conveyed but also the friendship and guidance that they have extended to me outside the classroom.

I greatly appreciate the helps from Mr. Ajay Kumar Katuri, who has offered me worthy advices for my thesis work, especially for PGIS related practical and technical study and also for data processing.

I have special regards to all staff and lecturers in ESA Department and also ITC staff who bring warm atmosphere for the ITC environment. I cannot forget a special friend who had been caring and hard working, Ms. Marion Pierik. I would like to express my gratitude for help and support provided by Mrs. Bettine Geerdink, Mrs. Mary Chantal-Metz and Mrs. Theresa van Boogard.

This thesis would not complete without the help from my advisor Ms. Van, for the valuable data that she gave me, for her continuously suggestions and support like my sister during and out side my thesis time. I would like to thank Dr. Le Quoc Hung, Head of Remote Sensing and Geomatics Department, Vietnam Institute of Geosciences and Mineral Resources for his support during my fieldwork.

This research would not have been a success without the help from people of YenBai city, particular commune leaders, Mr. Tu, Mr Cam, Mr. Thai, Mr. Hoa who had given me very warm welcoming helps during my time on fieldwork. Specially, I am thankful to my assistants Mr. Quy and Mr. Thuan who had spent their valuable time and relationship with local people to carry out interviews and questionnaire survey and also to all participants of four communes where the study was held in.

The data collection and fieldwork would not have been an unforgettable time without the share from my fieldwork colleagues Mr. Niranga Alahacoon and Mr. Ezra Pedzisai. I thank and miss my classmates Gopi, Sashi, Tarick, Nadira, Melanie, Paula, Andry, Dita, Hung, especially to Gopi jee, Tarick for their care and support as my brothers, to a calm and sweet friend Nadira, to the head of AES birthday club, caring and thoughtful Melanie, to lively Sashi, to lovely and smiley Dita, to quite and caring Paula (my daughter), to friendly Andry and mysterious Hung. I appreciate and enjoy very much their friendships, trust and care.

Special thank to my Vietnamese community in ITC, for transforming my intense MSc period into wonderful and unforgettable time. I would give the most heartfelt thank Mrs. Tho and Mr. Bart for their kindness and for their warm family-like care.

Last but never the least, deepest thanks is expressed to my beloved husband, who has always been an unfailing source of strength and support for me. I thank him for always being there whenever I needed somebody. Special thank to my lovely son, who has missed me so much and always being a good boy. My heartfelt gratitude also goes to my beloved father, my parents-in-law, my sisters and brothers-in-law, my nieces and nephews for their unswerving support and never-ending encouragement during my overseas study time.

I dedicate this thesis to my beloved mother who has always been a symbol of courage and determination in me. Without her support, encouragement and most of all love, the completion of this work could not have been possible.

Nguyen Thi Thu Trang

Enschede,
February 2010

CONTENTS

List of figures

Tables

1 Introduction

1.1 Background information

The last decade has witnessed a series of devastating natural disasters in South-East Asia, which have led to severe human and economic losses. Typhoons or intensive rainy periods can trigger landslides and flash floods, which can endanger human lives in this region. Increased storm frequency and intensity, related to climate change, also contributed to exacerbate these disasters. Therefore, intensive measures for disaster management and mitigation are required. Implementation of flood risk assessment demands appropriate data such as hazard inventories and elements at risk data. However, historical records on flood events and rainfall are often missing, particularly in developing countries such as Vietnam where detailed information required for GIS risk analysis data are often not available. Knowledge about hazardous events is generally available within the local communities and (Anderson and Woodrow 1998) argue that much of the information that agencies need for risk assessment and mitigation can be easily obtained from local people. They usually know what the situation is but do not always have the skills for understanding and organizing what they know. It is clearly seen that social science links between operation of local authorities and their knowledge about risk to hazards are insufficient. These obstacles can be addressed by implementing participatory approaches for risk identification and analysis.

Using a participatory approach for flood risk assessment could be an effective and low-cost alternative. This research investigates a participatory approach for risk assessment, focusing on alluvial floods, flash floods and urban flood in a tropical urbanized mountainous setting. YenBai town (Vietnam) is selected as a case study. This area is prone to floods including flash floods, urban floods and riverine floods. In practice, local knowledge and experiences for hazard assessment, the involvement of local community is essential. Therefore, a participatory GIS approach for risk assessment is prepared to gain better understanding of local people about the hazards and their perception on risks. The results from this study might be applied as one important disaster management tool for decision-makers and planners. This approach will raise social awareness in hazardous phenomena and provide the local authorities with better strategies in urban planning. It also improves the local people's ability to cope with natural disasters.

1.2 Problem statement

The participatory approaches are popular in natural resource management and rural development still. Application of these approaches in disaster management has not been so widely in use. In rural Vietnam, especially in the Red River basin, people and properties are prone to recurring flooding and there is no proper risk mitigation strategy. This study aimed at exploring how we can combine the local knowledge in coping with floods with formal scientific knowledge to get better results in handling the disastrous situation? It is proposed to

carry out a participatory approach in a mountainous region in northern Vietnam, in the Red River basin.

YenBai city in Northern Vietnam has a tropical monsoon climate with heavy rain of short duration and high intensity. The study area is also facing typhoons which have caused hundreds of deaths and injuries in recent future. From 1990 to 2005, 28 flash flood events have occurred together with landslides in Northern part of Vietnam, including YenBai city, causing 998 deaths and missing, 698 injured, 13289 collapsed houses, 114889 damaged houses and 180000 ha of damaged crops (VKTTV 2006). The biggest event occurred on 27 September 2005, which caused a loss of approximately 128.4 million Euros.

Although hazard analysis and risk assessment are widely accepted as a helpful instrument to support decision-making, only few studies have been carried out in Vietnam and none of them in YenBai. There are many obstacles in Vietnam especially in mountainous areas like YenBai that make the execution of hazard risk zonation difficult. The main reasons are due to lack of appropriate methods for studying and communicating among physical scientists, local communities and the policy makers. There are also some other reasons such as ambiguous reporting of damages, magnitude, intensity and types of events, unknown triggering factors for each event, etc. This study was carried out by using participatory GIS with the purpose of overcoming those obstacles and give better understanding about flood impacts to the communities.

A major alluvial and flash flood event occurred in YenBai city in 2008 and this study will use this flood event to collect the information within the communities by means of Participatory GIS, for further disaster management studies.

1.3 Purpose

In Vietnam, most mountainous cities are located in areas blessed with favorable conditions for economic development, for example, these cities usually stretch along big rivers. Consequently, they face a regular threat of floods and inundation from the upstream. It is, therefore, essential to understand the causes of floods and inundations to minimize the impacts of these disasters. However, research into this field in Vietnam has not received due attention for the following reasons:

- Development of mountainous cities is spontaneous nature, lacks proper planning and mostly depends on local people's demand and knowledge.
- Tropical areas often have a lot of rain but in the study area there are few meteorological – hydrographic monitoring stations, which are not enough for disaster warning activities.
- Lack of historic data on past disasters and damage to assessing risk;
- Lack of planning on infrastructural construction; sewers are obstructed, etc,.
- Local people's knowledge of disasters and risk is low, etc.
- Immigration/ movement of new comers to the developing cities (no historic, family links with the area)

Therefore, besides other modern facilities, PGIS might be used to collect the above-said information, then put the information in a GIS database so that it can be effectively utilized. This research will show that this information can be used to reconstruct the 2008 flood in YenBai city and its 4 most seriously-hit communes HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong. Combined with a risk evaluation method to roughly estimate the risks of that year's flood, basing on which we can set up more scenarios in the future. At the same time, further investigation will be made into local people's and authority's wishes in disaster reduction measures.

1.4 The aim of the study

To use participatory approaches to *assess flood risk in a tropical urbanized mountainous setting* through a case study in YenBai town in Northern Vietnam.

1.5 Research objectives and research questions

The objectives of the research have been composed as the following:

- To make a qualitative flood hazard assessment using historic events and local knowledge
    - How to collect the local knowledge using a participatory approach?
    - How to assess flood hazard in YenBai using participatory approaches?
    - How can historic data and information be collected through participatory approaches and be synthesized into a qualitative hazard assessment?
- To assess the vulnerability of the elements exposed to floods
    - What are the different elements exposed to floods in YenBai and what is their vulnerability?
- To get a better understanding of the perception of the people and the municipality to flood risks and provide a strategy to incorporate it in to flood related decision making.
    - What is the perception of the people and municipality to floods?

1.6 Literature review

1.6.1 Participatory GIS in risk assessment and mapping

Participatory mapping (P-mapping) and Participatory GIS (P-GIS) are usually assumed to be cost-effective, not with standing that their lower costs may be offset by lower standards of precision and accuracy, than for standard surveys. "Concomitantly P-mapping and P-GIS are considered to have superior effects in terms of relevance, usefulness, sustainability, empowerment, and meeting good governance objectives, due to their eponymous stress on participation and on utilising local knowledge" (McCall 2004).

Mapping of local hazards, vulnerabilities, assessing underlying risk, capacities, and resources is one of the important aspect of decision making. PGIS is a good approach for extraction of information from local level with active participation/involvement of local people.

It is crucial to integrate local knowledge, GIS and maps into the process of disaster risk management. Hazard mapping is one of the first steps of producing a community vulnerability inventory (Noson 2002). The essential goal of the participatory methodology for data collection is to make the invisible visible. Local people know a great deal about their surroundings and are able to indicate which areas are prone to floods and exposed to typhoon damage. The most successful way to do this is to engage in a process that enables local knowledge to be transferred from the mind to the map.

1.6.2 Application of PGIS

Nowadays, PGIS is applied commonly in many fields and purposes such as land management, flood risk assessment, disaster prevention, risk mitigation and preparedness. Flood risk mapping project have been done in QuangTho Commune in ThuaThienHue province, central VietNam (Noson 2002). This paper studied the use of the Geographic Information System (GIS) at the local level and the need for integrating modern technology and indigenous knowledge into disaster management. Another application - Developing Participatory Flood Risk Map and Developing Community Action Plan in Indonesia is described in Narrative progress report, which showed the application of PGIS to create flood risk map in order to increase Capacity of Local Government and Community in Flood Early Warning System at DKI Jakarta (ITB 2008). Risk reduction preparedness using PGIS in Tajikistan is reported in Grant Assistance Report. Communities will be provided with information and encouraged to take charge of the process and express their own views, opinions, and commitments for each step. Participatory rural appraisal work will focus villagers' attention on the risks. They will make their own risk preparedness and evacuation plans and risk mitigation plans, and will decide how they wish to monitor for flood risk (Wilkinson 2008). Application of PGIS and P-mapping suit excellently to the needs for incorporating local knowledge, participatory needs assessment & problem analysis, local prioritising, understanding responses and coping strategies. Some example of participatory mapping and PGIS to risk and hazard problems in Mozambique, Mexico City and Cambodia were given in "Participatory Mapping and Participatory GIS (PGIS) for DRR, Community Risk and Hazard Assessment" (McCall 2008). Participatory photo-mapping is illustrated in Social Forestry development project (SFDP) Song Da, Vietnam. The objective of participatory photo-mapping is to enable villagers to carry out the interpretation of aspects of their land resources. In this process villagers delineate their land use on transparencies laid over an Ortho-photograph. The information on the transparencies will later be scanned or digitised and geo-referenced (Wehr 2003).

1.7 Methodology

The goal of the Flood risk assessment is to measure the potential loss to a community, including loss of life, personal injury, property damage, and economic injury from a hazard event. The risk assessment process allows a community to better understand their potential risk and associated vulnerability to natural hazards.

Generally, (total) risk can be quantified as the following equation (van Westen. et al. 2009):

$$R = H \times V \times A$$

Where:

- **R** is risk, expressed as the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular damaging phenomenon for a given area and reference period;

- **H** is hazard, expressed as probability of occurrence within a reference period (e.g., year, design period of a building).

- **V** is physical vulnerability of a particular type of element at risk (from 0 to 1) for a specific type of hazard and for a specific element at risk;

- **A** is amount or cost of the particular elements at risk (e.g., number of buildings, cost of buildings, number of people, etc.).

Risk assessment provides the framework for a community to develop and prioritize mitigation strategies and plans to help reduce both the risk and vulnerability from future hazard events. In general, the methodology will be described in the flow chart below.

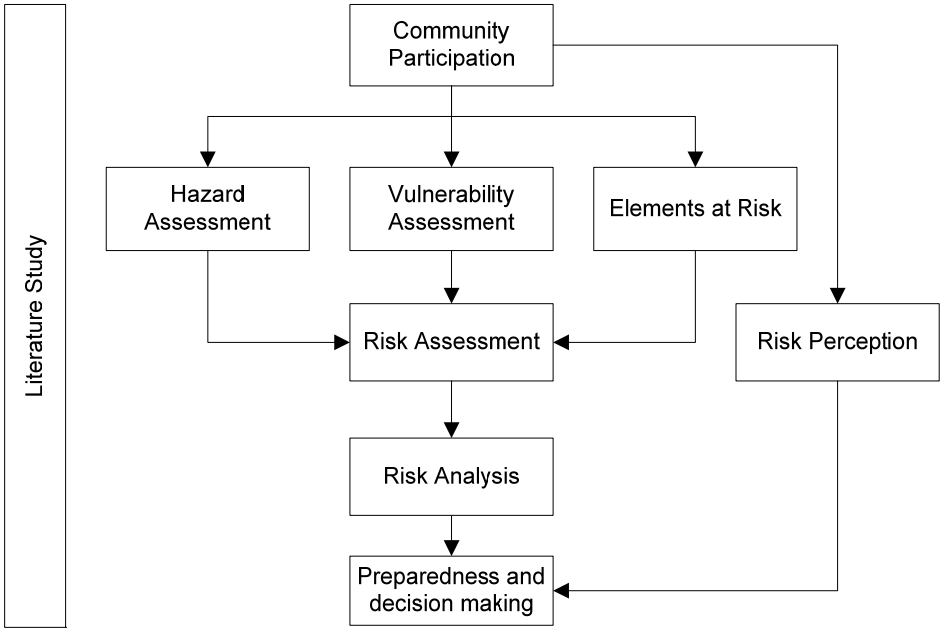


Figure 1. Conceptual framework

The overall work was carried out in three time phases: pre-fieldwork, fieldwork, and post-field work.

1.7.1 Pre-fieldwork

This step was conducted by selecting, gathering and organising available data from variety of secondary sources such as previous studies, public media, technical reports and interpretation of (high-resolution) imagery. Furthermore, preparation for fieldwork is needed including analysis the available data, identifying essential methods, materials, instruments and demands for data collection. All necessary documents such as field surveys, field instrumentation, local interviews and questionnaires should be well prepared and organised in order to obtain the field information effectively.

1.7.2 Fieldwork

Fieldwork was carried out in the study area – YenBai city and surroundings for about a month. Fieldwork was conducted from 9th of September to 16th of October. This is the most important part of the study – for collecting primary and secondary data from the field. During the process, many Govt. Officials were met and discussions were carried out to get a better understanding of the study area and the issues involved. Apart from the officials, meetings were held with the commune leaders and the community members also to get their own perspective on the flooding issue. More about the process of the fieldwork is elaborated in 3.4.

1.7.3 Post-fieldwork

This stage involved processing and analysis the data collecting from the field using participatory approaches. The software to be used during this phase were - ArcGIS, ILWIS SPSS, and MS Office.

By using the formula $R = H \times V \times A$, the methodology of the study was divided in four parts - Hazard Assessment, Vulnerability/Capacity Assessment, Elements at risk (using participatory approaches) and Risk Assessment.

1.7.4 Hazard Assessment

Flash floods and alluvial floods in YenBai occur when typhoons happen and heavy continuous rainfall leads to exceeding the absorptive capacity of soil and the flow capacity of rivers and streams causing floods. Hazard identification will include all factors including topography, rainfall, hydrological conditions, historical floods, soil and land use data, etc. into consideration in order to assess the preliminary flood hazard in the study area. The conceptual framework of the hazard assessment is represented in the 4.2.

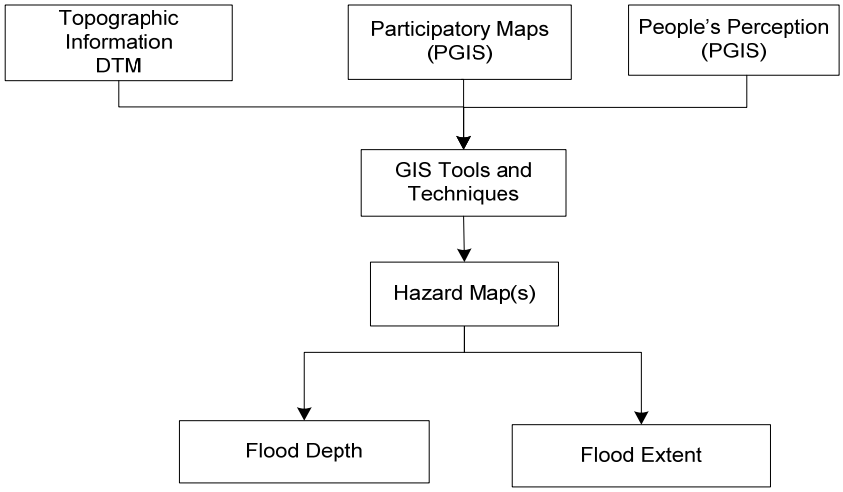


Figure 2 Conceptual framework of Hazard assessment

The results of this step will be some flood parameter maps such as flood intensity, flood depth and flood duration maps. These maps will be used to estimate the temporal and spatial probability of occurrence of the hazardous event. More about hazard assessment is explained in chapter 4, section 4.2.

1.7.5 Elements at risk database

The elements at risk database were created from two sources secondary and primary data.

Secondary data: This step was carried out by collecting land use and emergency facilities information from various sources such as international, national, regional documents or papers from organisations, institutes, offices and communities. Government's flood reports have been a good source for the damage and loss information.

Primary data: The data was collected from community in municipal and local levels by means of Focus Group Discussion (FGD), interview and a Questionnaire survey (PGIS).

- The FGD allowed researchers to understand the knowledge, experiences and perceptions of different people who cope with risk related problem in different perspectives.
- The questionnaire survey was used as an effective tool at individual and household level.
- In-depth interviews and informal conversations were conducted with key person (municipal and local officers, representatives of national institutions at municipal level). These applications also be implemented in community level. These included interviews with officials and interviews with civilians to understand their perceptions about risk and to acquire the data in terms of population, economy and building. The process is shown in **Figure 3**.

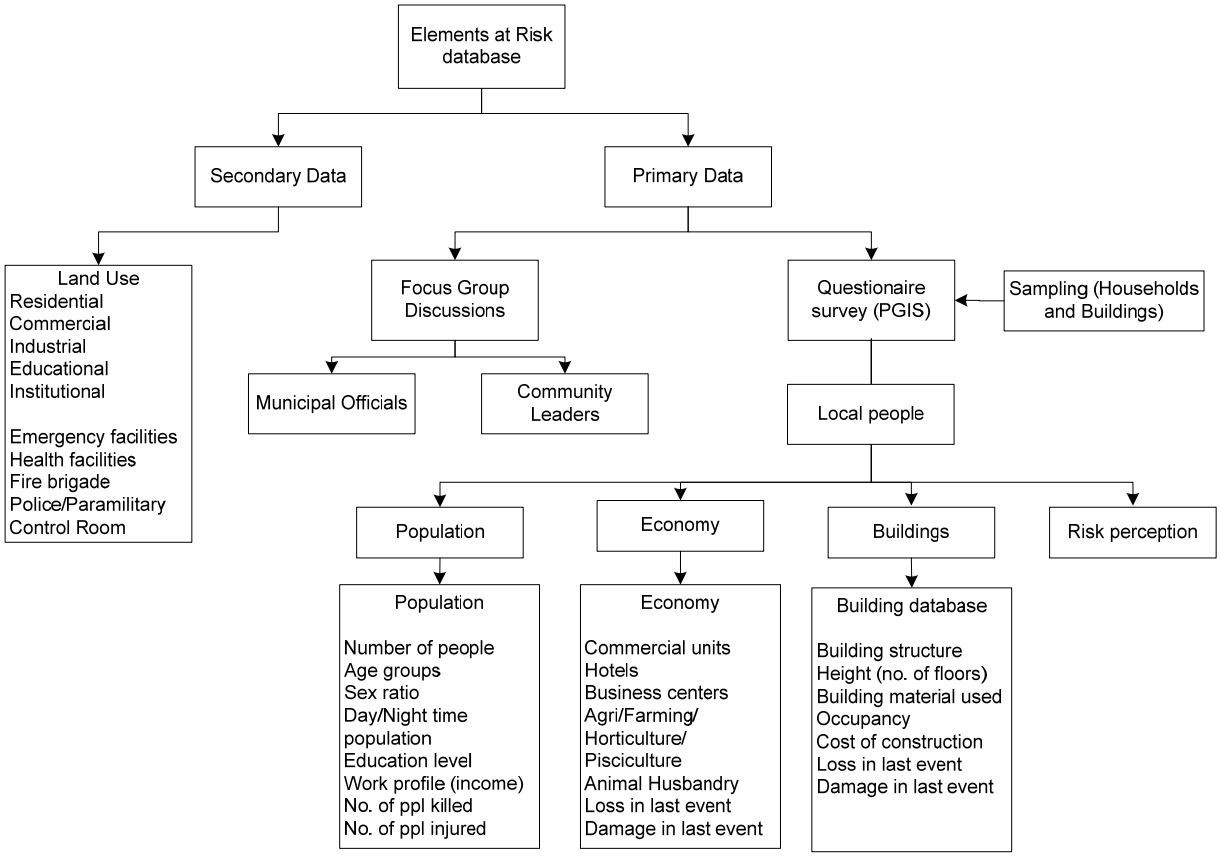


Figure 3. Elements at Risk framework

1.7.6 Vulnerability/Capacity Assessment

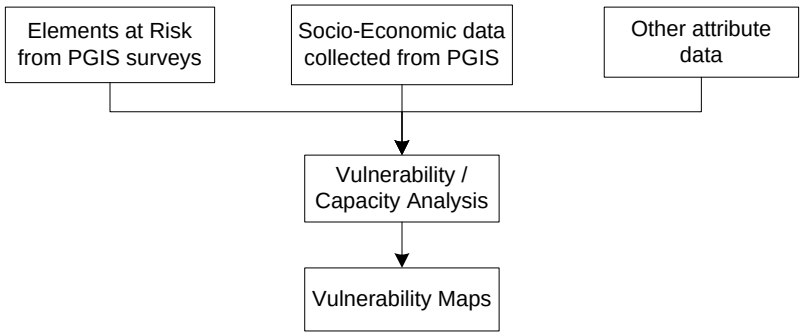


Figure 4. Vulnerability assessment framework

Assessing the community's vulnerability was carried out by means of both analytical and empirical methods. Data was collected from recent and historic events using a variety of assessing methods such as expert opinion, score assignment and analysis of observed damage. Most of the activities involved local knowledge. The participants identified, listed and prioritized the vulnerability indicators which will later be incorporated into the risk analysis. The indicators will then be standardized and weighted according to their influences to the hazard using spatial multi criteria evaluation. Composite index maps for different

factors will eventually be created into final vulnerability maps. The vulnerability/capacity assessment framework is described in Figure 4

1.7.7 Risk Assessment

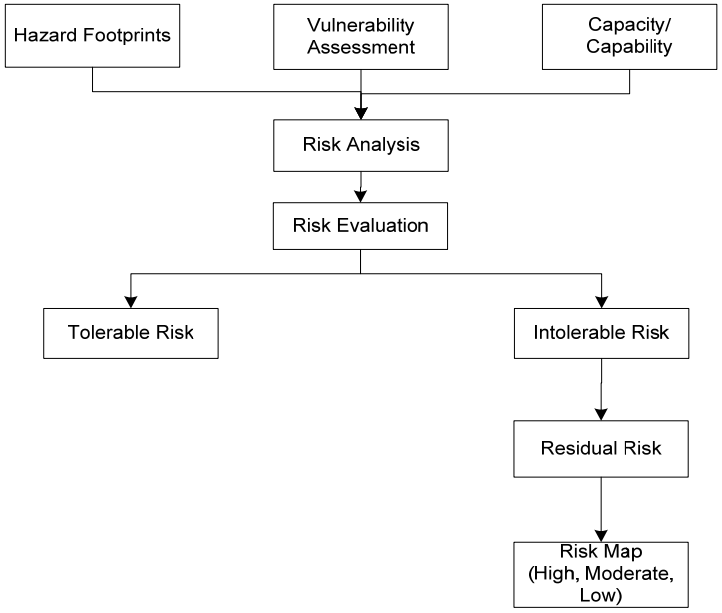


Figure 5. Risk assessment framework

This is a final step, the analysis phase will include the integration of both the primary and secondary data collected. The expected out come is the risk map showing high, moderate and low level of risk in the study area and a flood perception map from indigenous knowledge, please refer to **Figure 5**

The methodology above required data that need to be collected from the field:

- Water depth maps for different return periods.
- Flood frequency data
- Building foot print map (updated by the field observations)
- The number of building affected
- Elevation data(some field point measurements)
- Land use map (update by the field observations value)
- Flood inundation map (flood extent)

In this chapter, the background information of the flooding in YenBai city has been described along with brief review of literature about participatory approaches used in flood risk mitigation. Also the structure of the report has been presented along with the introduction and methodology of the study. In the next chapter the study area will be described in detail in terms of physiology, hydrology, socio-economic condition. The problem flooding will also be discussed in detail.

2 Study area

Located in the south-eastern extremity of the Indochinese peninsula, with a coastline of 3,444 kilometres (excludes islands), Vietnam has a tropical monsoon climate, and it is prone to floods and storms that kill hundreds of people each year (please refer to **Figure 7**) (Hue 2003). YenBai town - a typical mountainous municipality in Vietnam belongs to YenBai province located at the transition of highlands and midlands in the east of Hoang Lien Mountains, with an area of about 6,890 km2. It lies between latitudes $21^0$40' to $21^0$46' North and longitudes $104^0$50'08'' to $104^0$58'15'' East. Sloping down from the northwest to the southeast, YenBai terrain has a diverse system of mountains, hills, rivers and streams, and has the average altitude of 600m above the sea level. The Red River - the biggest river in the Northern Vietnam - flow across the province and divides it into two parts: the lowland in the left bank of Red River and the catchment of Chay River with physical characteristics of the midland; and the highland in the right bank of the Red River and ranges of mountains between the Red River and Da River, please refer Figure 6.

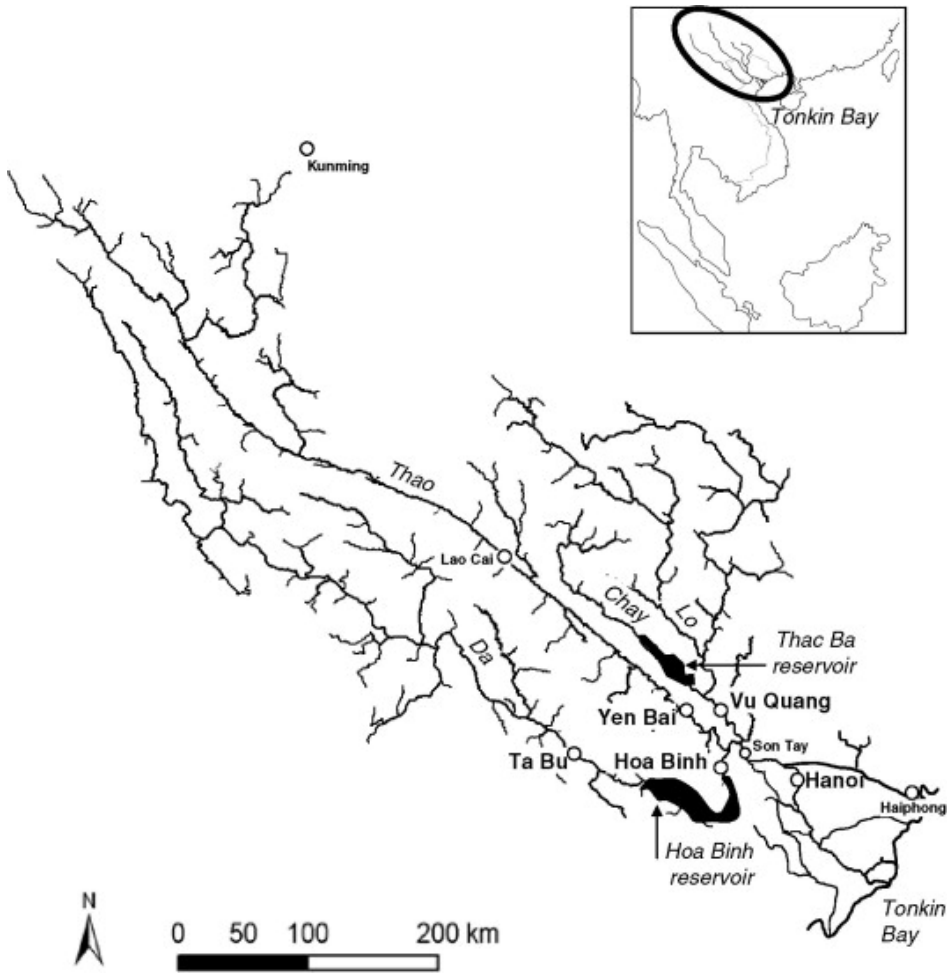


Figure 6. The Red River, Chay river and Da river system

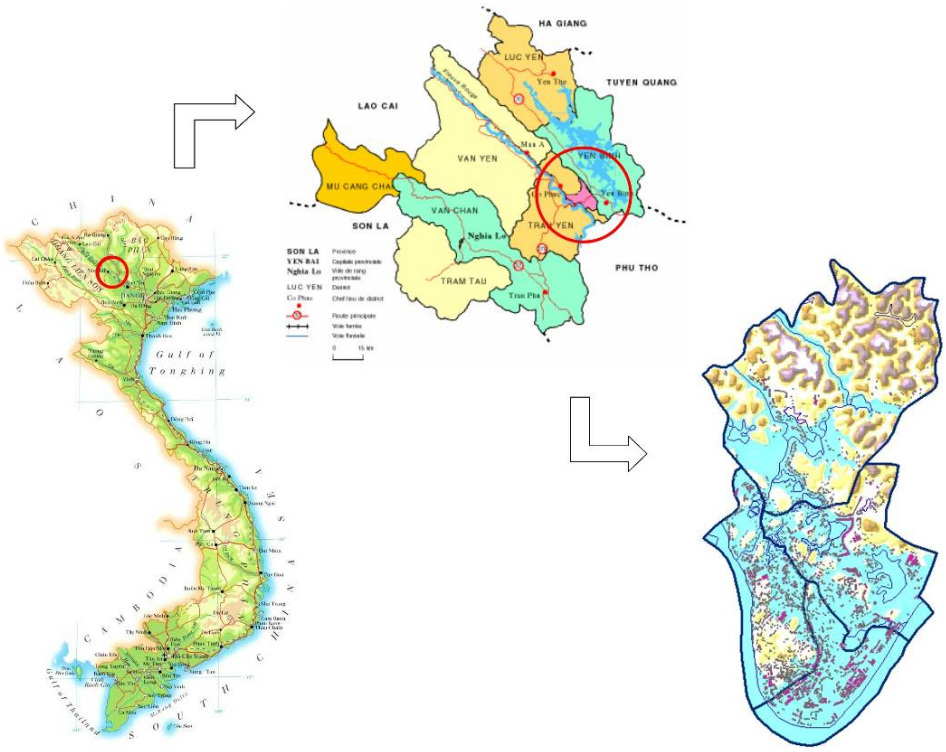


Figure 7. Location of Study area - YenBai city, Vietnam

2.1 Physiology

2.1.1 Geology

According to Vietnam Natural and Mineral Resources (2001)- (Tri 2001), within YenBai city scale, geology can be described briefly as follow, please refer Figure 8.

2.1.1.1 Strata (stratum)

a) PaleoProterozoi (PPnv1)

Elephant Mountain below strata: located in right bank of Red river as medium area along North West – South East direction. It includes lagiogneis biotit-silimanit-garnete, gneis amphibol, amphibolite.

Elephant Mountain upper strata: located in right bank of Red river, it encloses below strata, covers almost all areas. It includes plagiogneis biotit-silimanite, garnet gneis diopsit graphite, quartzite, amphibolite, quartz schist -biotit-silimanit-garnete.

b) PaleoProterozoi – MesoProterozoi (PP-MPnc)

Ngòi Chi Strata (PP-MPnc): Distributes as small areas in Northern part of the area. Components include quartz schist biotite-silimanite-garnet, schist biotite-garnet-silimanite, amphibolite, quartzite and marble.

c) NeoProterozoi (NPtb)

Thác Bà Strata (NPtb): Distributes in North East area, components include quartz schist - bioti-phlogopite, quartz schist 2 mica-garnet mix with quartzite, marble muscovite.

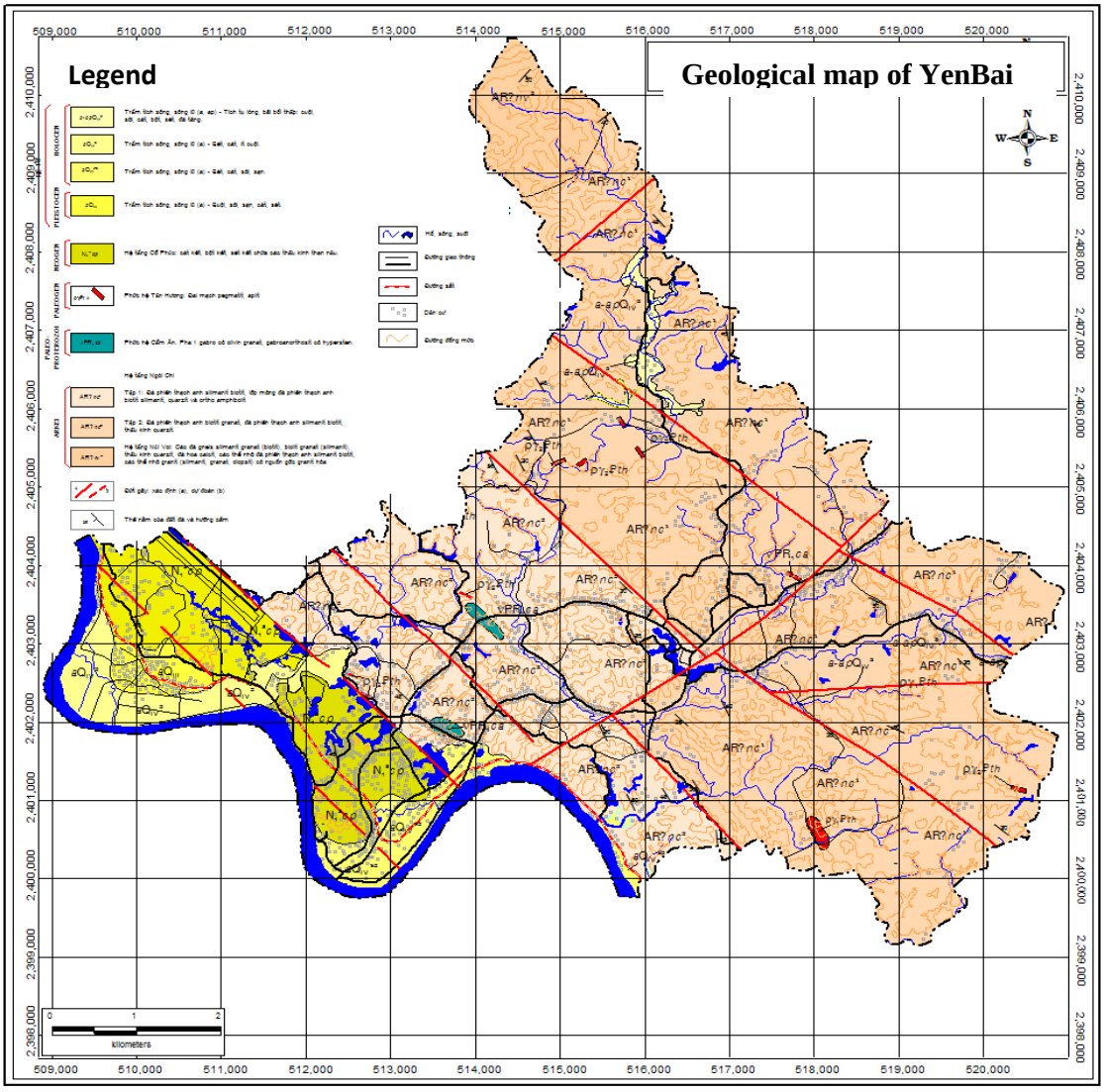


Figure 8. Geological map of YenBai city

d) Devon (D1sm)

Sông Mua Strata (D1sm): Distributes in South West of the city, on the left bank of Red river, includes clay schist, quartzite, limestone.

e) Neogen (N13cp)

Cổ Phúc Strata (N13cp): Distributes along two sides of Red river, components includes gravel, pebble, quartz, clay coal, clay lens.

f) Neogen - Đệ tứ

Distributes along two sides of Red river, components include gravel, pebble, quartz, sand and hydrocarbon materials.

2.1.1.2 Magma

Appearances of magma in this area is not much, they formed small blocks along the fault, Tân Hương - Thịnh Hưng. Components include gabro, gabro olivine, granite biotite, granite biotite as porphyry forms.

2.1.1.3 Faults

In city area, there are the Northwest – South- East fault systems, like the Red river faults and some faults along with Thac Ba faults, Tân Hương - Thịnh Hưng faults and Đào Thanh - Văn Lãng faults and Quy Mông - Âu Lâu faults. Especially, Red river fault systems formed a tunnel system which was filled up by Neogene alluvial sediments. Because of the activation of the systems, fissure was created, stone was weathered caused landslide.

2.1.2 Climate

Generally speaking, YenBai has a tropical monsoon climate but because of the influences of mountainous terrain/topography, the climate is slightly changed, the winter is less cold and dry, the summer is hot and muggy. The yearly average temperature is 22 – 23oC, the average rainfall is from 1,500 to 2,000 mm and the humidity is around 83 - 87%. YenBai has green plants the year. YenBai climate has clearly two seasons: the cold season is within December to March and the hot season is from May to September, hot and moist. In the hot season, it has high frequency of rain and often combining with cyclones and hails which cause frequently flash-floods and inundation.

2.1.3 Wind condition

The wind condition in YenBai is greatly influenced by its geographical location and topographical structure. The north-eastern monsoon, which flows in the north-eastern – south-western direction, is hampered by the mountains in the Lo-Gam arc mountain system and mostly shifts round to the plain and then back to YenBai along the Red and Chay river valleys, as a result its power reduces and temperature rises. The hot and humid summer wind with equatorial climate features flows in the south-eastern direction along the Red and Chay river valleys to the north of the province, hindered by high mountains, causes heavy rain in the front region.

2.1.4 Rain fall pattern

YenBai is located far inland, with a number of rivers, springs, lakes, and is especially influenced by Thac Ba lake, which leads to a great amount of annual rain fall and high humidity in comparison with other provinces in the region (Provincial Govrnment of Yen Bai 1998). As a result, it has a evergreen floristic composition, an evidence of monsoon tropical characteristics. The hydrometeorology figure of 1998 shows that the annual average rain fall of YenBai is approximately 1500 mm. In the city, the rain fall distribution in the area tends to rise gradually from the lowland to the highland and does not equalise in months of the year, with highest rainfall in rainy season from May to September (168.0 to 766.8 mm); and lowest rainfall from December to March (8.0 mm to 91.3 mm). The Figure 9 below shows the monthly rainfall in YenBai city in severe historic flood events in 1968, 1971, 2005 and 2008.

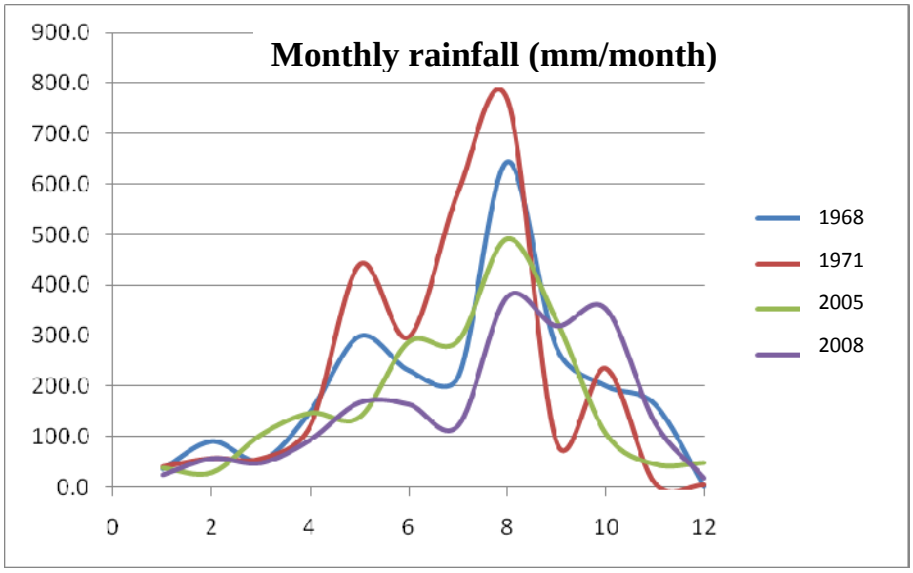


Figure 9. Monthly rainfall in YenBai city in severe flood events

2.1.5 Topography

YenBai topography is located in the lowland, belonging to the left bank of Red river and Chay River catchment. The terrain has the following features:

- Mountainous topography: occupying a large area of YenBai city, altitude more than 60m, including hill and mountain chains lengthening toward North west – South east.
- Valley topography: distributing alternatively between mountain chains, longing toward Spring Valley, the width of this terrain is narrow, the height is from 28 to 35m.
- Delta topography: including fields located at hills, foothills, setting along two sides of Red River, the height are from 28 to 50m.

The old centre of YenBai city includes HongHa, NguyenPhuc and NguyenThaiHoc communes located very close to Red River bank, please refer Figure 16 in section 3.3.1. The topography is continuous low hilly terrain with the elevation from 25 - 65m. When heavy rains occur, the Red River raises quickly, overruns the levees and causes inundation. Simultaneously, water from tributaries cannot drain into the Red River leading to more floods in the area, please refer Figure 10 below.

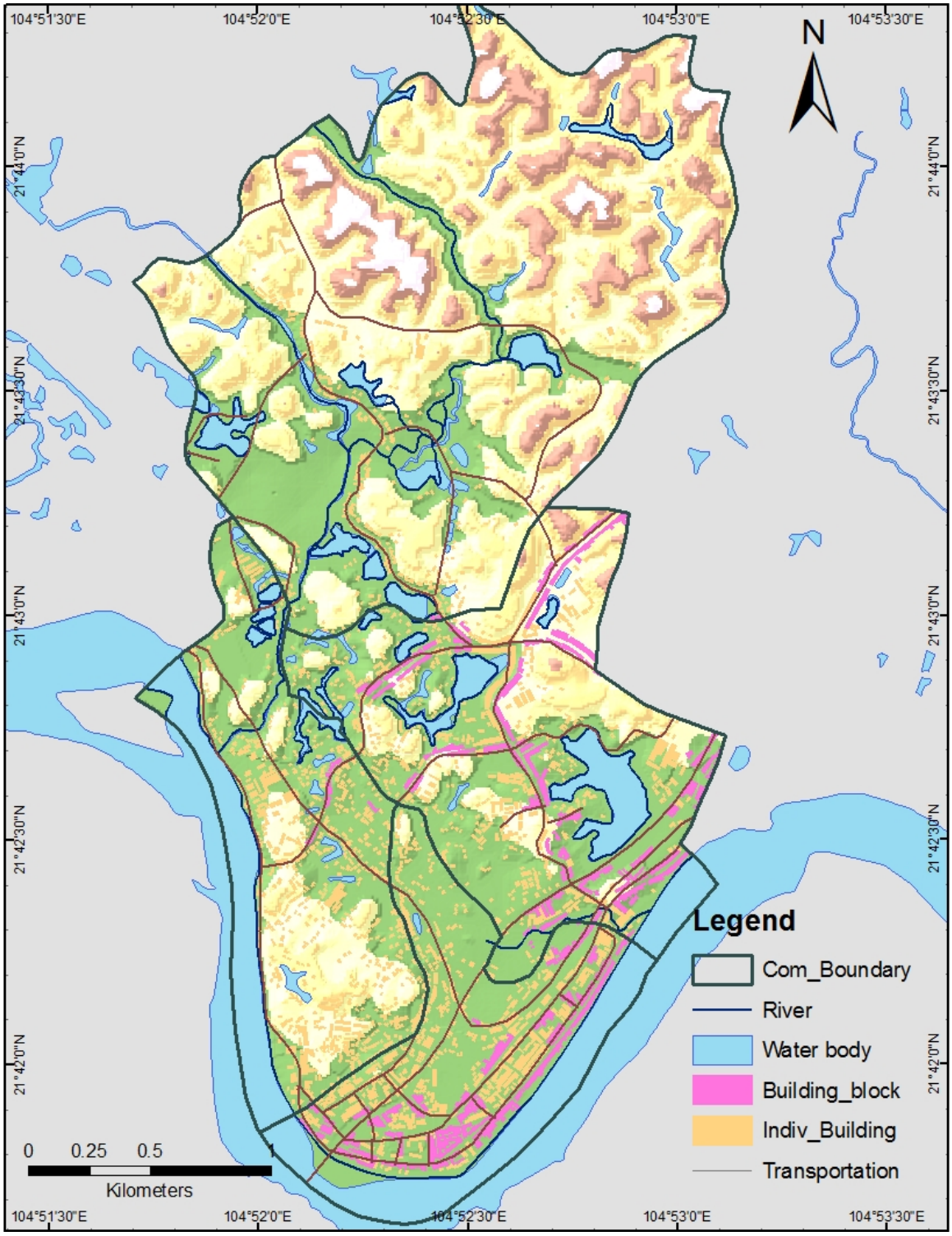


Figure 10. Topographical map of study area

2.1.6 Land use – Land cover

The location of YenBai city has brought the area a floristic composition diversified in categories and rich in reserves. However, due to over-exploitation as local people have cut trees to make fields, a natural balance in floristic development in high mountains no longer exists. There is evidence that the land here is eroded in rainy season, waterless in dry season, with a low ratio of humus. YenBai city and the surrounding areas have steep slope, floristic plant is less which results in potential risk of flash floods. Most of the land cover here is low trees, temporary trees or secondary grass-plots mostly covered with lemongrass, shrubs, and farming fields as rice, vegetable. HongHa, NguyenPhuc and NguyenThaiHoc are located in centre of YenBai city there fore the land cover here is building, office, settlement, industry and service buildings such as stadium, station, market, etc. Apart from that NamCuong still has a lot of rice fields, vegetable, and shrubs as the majority of its inhabitants working in agriculture field.

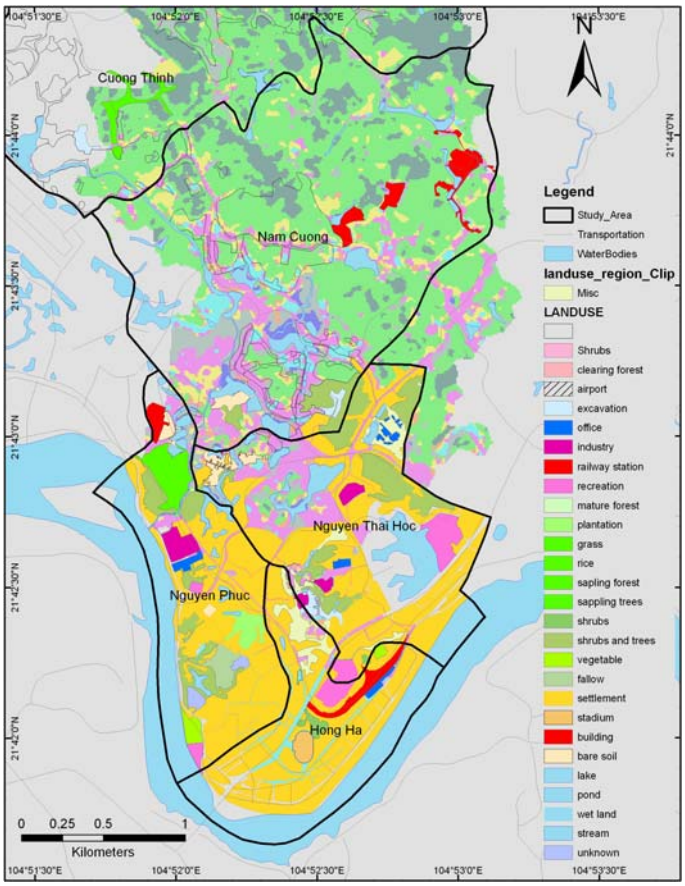


Figure 11 Land use, land cover map of study area

2.2 Hydrology

2.2.1 Drainage systems

YenBai province has two main river systems – Red and Chay River systems. Red river originates in China. It flows through YenBai in North west-South east direction. Chay river originates from Tay Con Linh mountain chain in Ha Giang province, flowing toward YenBai

through Luc Yen and Yen Binh districts then merges with Lo river. Chay river also flows in North-western – south-eastern direction, please refer Figure 6.

YenBai city has two main drainage canals that are Cuong No which originates from upstream of Cuong Thinh catchment and Ngoi Xe and two main springs, Hao Gia and Cuong Thinh which flow towards centre of the city . In addition, in NamCuong commune, Ngoi Yen channel, the section from NamCuong flood preventing dike to the door at Red River also play an important role in conditioning the flow of drainage in the city of YenBai.

2.2.2 Hydrology causes of floods

2.2.3 Alluvial flood by Red river

YenBai city was built on two sides of Red river, previous time it was developed on the right bank of the river but recent years, it is expanded on both sides. Red river is a big river in Viet Nam, flows through YenBai city with largest flow 8400m^3/s, smallest flow 95m^3/s; velocity max 3,02m/s and min 0,62m/s; amplitude fluctuations in water max 7,53m, min 5,06m. Water level corresponds with annual exceedence probability as follow (Municipality of Yen Bai 2008) -YenBai commune's statistical Year report 2009, the adjustment of general planning for this town till 2020:

P%	1	10	20	90
H(m)	34,92	33,2	32,2	31,0

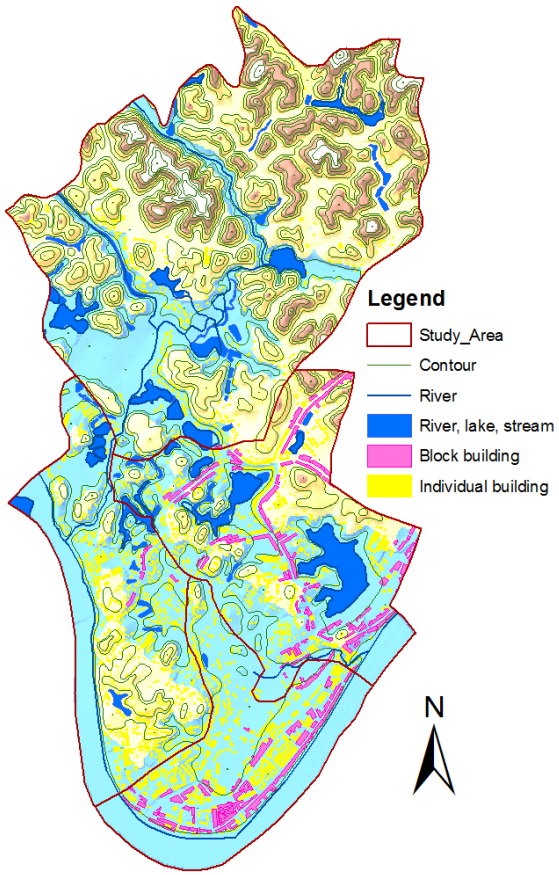


Figure 12 Elevation, drainage system and building location

Further more, in the city there are some small channels and streams flow toward Red river such as Hiền Dương, Âu Lâu, Yên Ninh, Yên Thịnh, Đại Đồng stream and Cuong Thinh from up stream which may cause flash flood for the study area. The flows of these streams are not big, more or less 150 l/s.

The discharge of Red river is changing regularly, in dry season; the discharge is low leading to insufficient source of water for agricultural activities. In contrast, in rainy season, water depth and water discharge may rise up quickly; alluvial and flash-floods overrun the flood plain causing inundation and destroying agricultural lands and other properties. Most historic floods in YenBai city by Red river from 1945-present are shown as table below:

Year	*Starting date*	*Ending date*	*Max discharge (m3/s)*	*Max water level (cm)*	*Alert level*	*Excess of alert level (cm)*
1968	8/8/1968	20/08/1968	10100	3492	3	342
1971	13/08/1971	25/08/1971	9890	3259	3	109
1996	17/07/1996	29/07/1996	7010	3114	2	64
2002	13/08/2002	26/08/2002	6090	3194	3	44
2007	4/10/2007	5/10/2007	0	3138	2	88
2008	7/8/2008	13/08/2008	0	3426	3	276

Table 1. Most historic floods in YenBai city by Red River from 1945 to present

Alluvial floods are the serious problem for YenBai city every year. It mainly caused by Red River floods because of some reasons: firstly, there are no dikes on both sides of the Red River, only a new embankment in some sections of Red river was constructed, and it is insufficient to protect residents when water level rises. Secondly, people are living very nearby of the river where ground elevation is low as the elevation of approximately 30m. Particular in HongHa commune, people are living along and very close to Red River as showing in Figure 16; they suffer from alluvial floods every year. Thirdly, Red river bed was not dredged for long time which leads to reduction of water flow volume, the rapid growth of urban. People have gotten levelling, digging soils on the hill to dump on the land, the swampy water in order to have land for construction. An example of this is the 2008 flood, water level rose quickly, inundated whole HongHa commune with 2.5m to 4,5m of water depth, and sediment covers all roads up to 60 cm.

Houses are very near by Red river

A new embankment in some sections of Red river

Indication of flood water level

Indication of sediment in HongHa commune

Figure 13. Location of houses, embankment – HongHa commune and alluvial flood indications

2.2.4 Flash floods

The situation in the hill and mountainous terrains is different, the high and concentrated rainfall created a high density of drainage systems with high velocity and discharge changing seasonally. In dry seasons, the water depth is low; however in rainy season flash flood occur along the bank of rivers, channels or springs. There were a number of flash floods in YenBai city but no event in the study area so far. However, it may happen in the future. Cause of the condition is due to urban planning in YenBai is not uniform and lack of science. Housing, land planning and land for production has not respect the natural elements A lot of lakes, ponds, swampy water was filled into residential flat, or the overflow field close to spring also is filled land levelled to grow crops. Therefore, the place of water, the flow of the streams is narrow and when heavy rain will cause flooding. In addition, upstream deforestation of the watershed streams is creating flooding situation in the flood season increasingly.

2.2.5 Pluvial/ urban floods

Irrigation systems of communes mainly are works for water drainage such as drainage channel waste systems which flow to Red river. Generally speaking, these systems are still small, narrow and insufficient to carry water in rainy season. This causes pluvial or urban floods in some areas when heavy rainfall in short time happening.

Figure 14. Hollow fields in NamCuong commune

In addition, dispose of waste indiscriminately, in wrong places, particular near by rivers and streams, land encroachment down the flow (Figure 15), leading to local waterlogged during

the rainy season. That is the severe problem for habitants in HongHa commune where local people suffer from pluvial floods regularly. The reasons for that are block water flow because of construction, channel and culvert damage.

Cuong No stream flows along NamCuong commune, creating two hollow fields in Cau Den hamlet and Nam Tho hamlet, where are very easy to be flooded locally, shown in **Figure 14**.

Waste and plastic tubes block water flow at a culvert

Dispose of waste in Ngoi Yen stream, narrow water

Pluvial flood after a short heavy rain in HongHa

Figure 15. Dispose of waste indiscriminately; block water flow and local flood

2.3 Socio – economic conditions

Because YenBai is the political and economic centre of YenBai province, it has received attention and investment in recent years, with quite rapid development but just at infrastructural level. It can be said that the city is now on its way to become a typical midland city in economics, culture, education and tourism.

YenBai is home to 30 ethnic minorities but more Kinh people live in the city of YenBai, where the population density is rather big with approximately 1300 people/km2. A large number of people in the city are civil servants or office workers, the rest are involved in farming, small scale industry, commerce and tourism. Their living condition is improving every day (Municipality of Yen Bai 2006) Report on YenBai city general planning adjustment to 2020.

2.3.1 Social status

2.3.1.1 Gender ratio

In YenBai city, the number of female residents is slightly more than that number for male. According to YenBai city statistical Yearbook, the population is separated as gender or area where they live (urban or rural area) in the table below:

Year	*Total*	*Gender classification*		*Area classification*	
		Male	**Female**	**Urban**	**Rural**
2000	74,598	36,709	37,889	62,701	11,897
2005	78,838	38,873	39,965	66,243	12,595
2006	79,656	39,311	40,345	66,767	12,889
2007	80,492	39,756	40,736	67,297	13,195
2008	96,915	47,918	48,997	68,019	28,896

Table 2. Gender population distribution

2.3.1.2 Literacy

YenBai city has just been taken into account for development within recent decade and now on its growing impetus to become a typical metropolis for economic, cultural, education and tourism. Education is considered a strength of the city compare to surrounding areas.

- The rate of children from 3-5 years old to kindergarten is 100%
- The percentage of students in school-age: In elementary 100%, in secondary school 100% and in high school 90%.
- Maintain national standards for popularizing secondary school, national standards for popularizing primary school at right age.

Source: (Municipality of Yeb Bai 2009)

The literacy of total population is not available in the report, however this study investigated this information by questionnaire survey with the total of 200 households, see more details in chapter 4.

2.3.2 Economic profile

YenBai town, is one of political, economic, social and cultural centres in the northwest mountainous region of Vietnam in general and of YenBai province in particular. According to YenBai communes statistical Year report 2009, the adjustment of general planning for this town till 2020 shows the economic targets.

2.3.2.1 Work profile

YenBai has experienced a very high annual growth, rate of economic growth of around 20%. Economic structure is moved towards reducing the proportion of agricultural, forestry, increasing the proportion of industry, construction and services. The occupations of local people are workers, office-holders, farmers, handicraftsmen and traders (IURP 2006). The table below shows the number of employees in different sectors:

Table 3. Employees distribution in different sectors

Year	*2000*		*2005*		*2006*		*2007*		*2008*	
	Total (Local & Govt)	Govt.	Total	Govt.	Total	Govt.	Total	Govt.	Total	Govt.
Total	**28,153**	**18,158**	**34,581**	**13,546**	**36,086**	**14,001**	**37,573**	**14,365**	**46,843**	**18,014**
1. Primary (farming, agriculture, fishing, animal husbandry, livestock)	5,355	255	5,475	253	5,245	280	5,196	253	6,486	317
2. Secondary (manufacturing, industry and come up processing)	8,858	6,983	11,069	2,232	10,927	2,269	12,139	2,304	15,131	2,886
3. Tertiary business, hotel, support services	13,940	10,915	18,037	11,061	19,914	11,452	20,238	11,808	25,226	14,812

2.3.2.2 Income level

According to YenBai commune's statistical Year report 2009, the average income is increasing. In recent years, GDP per capita per annum is around 850 – 920 Euro, in 2010 the number may reach 960 – 1040 Euro and to 2015, it will be approximately 1540 Euro. Income per capita in recent years has big jumps. In 2007, income per capita was 577 Euro/person/year and the number will reach 960 Euro/person/year in 2010.

2.3.3 Dependency ratio

According to statistics of HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong communes, the population of each area and the number of workers in 2007 are as following.

	HongHa	*NguyenPhuc*	*NguyenThaiHoc*	*NamCuong*
Population	9998	7387	13025	3309
Number of workers	5500	4350	9225	1957

From that data, the number of people not involve in workforce is accounted for around 40%, including the people out of working age, people in working age but incapable to work and unemployed workers. This information does not illustrate the distributions of workers in different sectors, there fore it can be seen in the data of YenBai city (Municipality of Yen Bai 2008) as reference. The table below shows the allocation of workers in YenBai city in 2000, 2005, 2006, 2007 and 2008. Working age, under working age and upper working age are considered from 15 to 60, less than 15 and more than 60 years old.

Year	2000	2005	2006	2007	2008
A - Labour sources	**39,217**	**45,738**	**47,880**	**49,481**	**60,084**
1. The number of people in working age	37,816	44,292	46,384	47,969	57,780
Capable labour	37,438	43,906	45,987	47,568	57,297
No capacity to work	378	386	397	401	483
2. The number of people out of working age actually involve in labour force	1,779	1,832	1,893	1,913	2,304
Upper working age	1,245	1,325	1,395	1,421	1,711
Under working age	534	507	498	492	593
B- Distribution of Labour sources					
1- Trade and economic sectors	28,853	34,581	36,086	37,573	46,843
2- Skilled workers in working age	8,676	8,405	9,042	9,213	10,146
Up to high school	5,268	4,997	4,585	4,666	5,507
Professional	3,408	3,408	4,457	4,547	4,318
3. House workers	1,075	736	712	702	735
4. Non workers	593	282	325	292	342
5. Unemployed workers	2,763	1,734	1,715	1,701	2,018

Table 4. Allocation of workers in YenBai city

2.4 Demographic details

2.4.1 Population

According to annual statistical publication/yearbook 2006 published by YenBai Statistics Office (Statistical Office of Yen Bai 2007), YenBai province had 740,006 residents in which the number of women was 366,922, accounted for 49.56%. The agricultural population was 594,524 equal to 80.34%. The average population density is 107 persons /km^2, unequal distribution between regions; two suburban districts of Tram Tau have the density of 32 persons/ km^2, Mu Cang Chai district has the density of 37 persons/ km^2. YenBai city has very high population density, which is 1.381 persons/ km^2; the number for Nghia Lo town is 903 persons/ km^2, 13 times as much as the average population density of the whole province.

2.4.2 Population projection

According to annual statistical publication/yearbook 2008, the area, population and population density of YenBai city in four studied communes were showed as table below:

Table 5. Area, population and population density statistics 2008

Unit	*Area (km2)*	*Average population*	*Population density(person/km2)*
Total	**8.16**	**8,437.0**	**5,654.5**
1. NguyenThaiHoc commune	1.79	13,047.0	7,289.0
2. NguyenPhuc commune	1.44	7,467.0	5,185.0
3. HongHa commune	1.11	10,451.0	9,415.0
4. NamCuong commune	3.82	2,783.0	729.0

The natural population growth rate in recent years always maintains at around 0,62% - 0,65%/year. Population growth rate of mechanical through years witnessed big changes because of positive social – economic development. Especially investment in construction of infrastructure, opening new residential areas, urban attracted residents from other places.

The population of each commune in the study area was reported in their annual statistical reports. The table below shows the population of 2007 and predicted population of 2015.

Table 6. Population in study area in 2007 and 2015

Year	*2007*	*2015*
1. NguyenThaiHoc commune	13025	14,500
2. NguyenPhuc commune	7387	9,700
3. HongHa commune	9998	11,000
4. NamCuong commune	3309	4,300
Total	**33719**	**9,875**

In this chapter, the study area has been described in detail commune-wise. It is observed that NguyenThaiHoc commune is the largest commune and has more population followed by HongHa, NguyenPhuc and then NamCuong communes. This area is more alluvial because of the Red River sediments and sometimes face land slides as well. In the next chapter, the data collection process is discussed including the secondary data collection, field work and primary data collection. A detailed step-by-step account of the field work – meeting the officials, conducting the focus group discussions, carrying out the primary survey over 200 samples in four communes has been described in the chapter 3, Data Collection.

3 Data collection

Preparation for the empirical investigations started from 14th of September 2009. By means of interviews with decision-makers and documentary analyses, the research locations were selected and the main fieldwork—a standardised questionnaire survey and in-depth interviews with affected residents— was set up. In the first three days, most efforts were directed towards developing the questionnaire which needed to meet proposed demands, and meeting with authorities and key persons in communes. In the following days, the questionnaire survey was conducted in all research locations. In-depth interviews with residents started almost at the same time and were mainly carried out with the helps from two assistants. The mixed-method approach applied will be described and critically assessed in more detail in the course of this chapter.

3.1 People's Perception study

3.1.1 Purpose of perception study

Perception study intends to achieve a deep understanding of flood risk related knowledge that is available within communities. The purpose is to learn how people perceive the flood and its effects. Naturally, people living in flood prone environments, they develop special and practical local flood risk related knowledge on how to face, measure and cope with threats causing by floods, which is transmitted from generation through generation. As a result, the study collected this valuable knowledge by means of questionnaire survey in order to analyse and incorporate into GIS based flood risk assessment.

3.1.2 Collection of perceptions

There is a huge localised knowledge present in flood prone communities, which can be applicable for risk assessment. Collection of this knowledge is the process of collecting people's memories on past events. In YenBai city, there were at least five severe flood events from 1968 to 2008 (please refer to Table 1). It is better if information from all that events can be recorded, the more events residents can recall the more comprehensive picture of changes in flood through time will be reconstructed. However, in the study area, using a participatory approach to collect this information arisen some difficulties, particular for events happened years ago. There is a fact that, many people were asked about 2005 event but they could not provide consistent and accurate information. Consequently, this study only takes the 2008 event in to consideration. The local perceptions were collected such as flood depth, flood extent, triggering factors, the causes and effects of flood, copping methods, etc (please refer to Household questionnaire in Annexure) by individual in–depth interviews and workshops.

3.1.3 Implication of perception study

During fieldwork, local knowledge and perceptions regarding to flood risk were investigated by some methods and tools such as in-depth interview, field mapping, Arcpad, GPS and GIS-assisted household survey, etc. The local people's opinions were pointed out, understood and

learned in order to analyse by modern technology (ArcMap, ILWIS, SPSS software, etc), preparing for making hazard, vulnerability and risk maps.

3.2 Required data

According to (ADPC 2005)the data for flood risk assessment includes:

Meteorological data
Hydrological data
Topographic data
Demographic data
Income profile
Building typology data
Property and land-use data
Infrastructure and lifeline facilities
Cultural and historical sites
Soil and geology of the area
Historical flood data

These data were collected from different sources such as secondary sources, Google, Internet, public reports, etc. This study received meteorological data, hydrological data, topographic data, demographic data and historical flood data from a PhD research in that area and also from other sources. The main data for analysis was collected from the field which was carried out as the following stages.

3.3 Pre-fieldwork

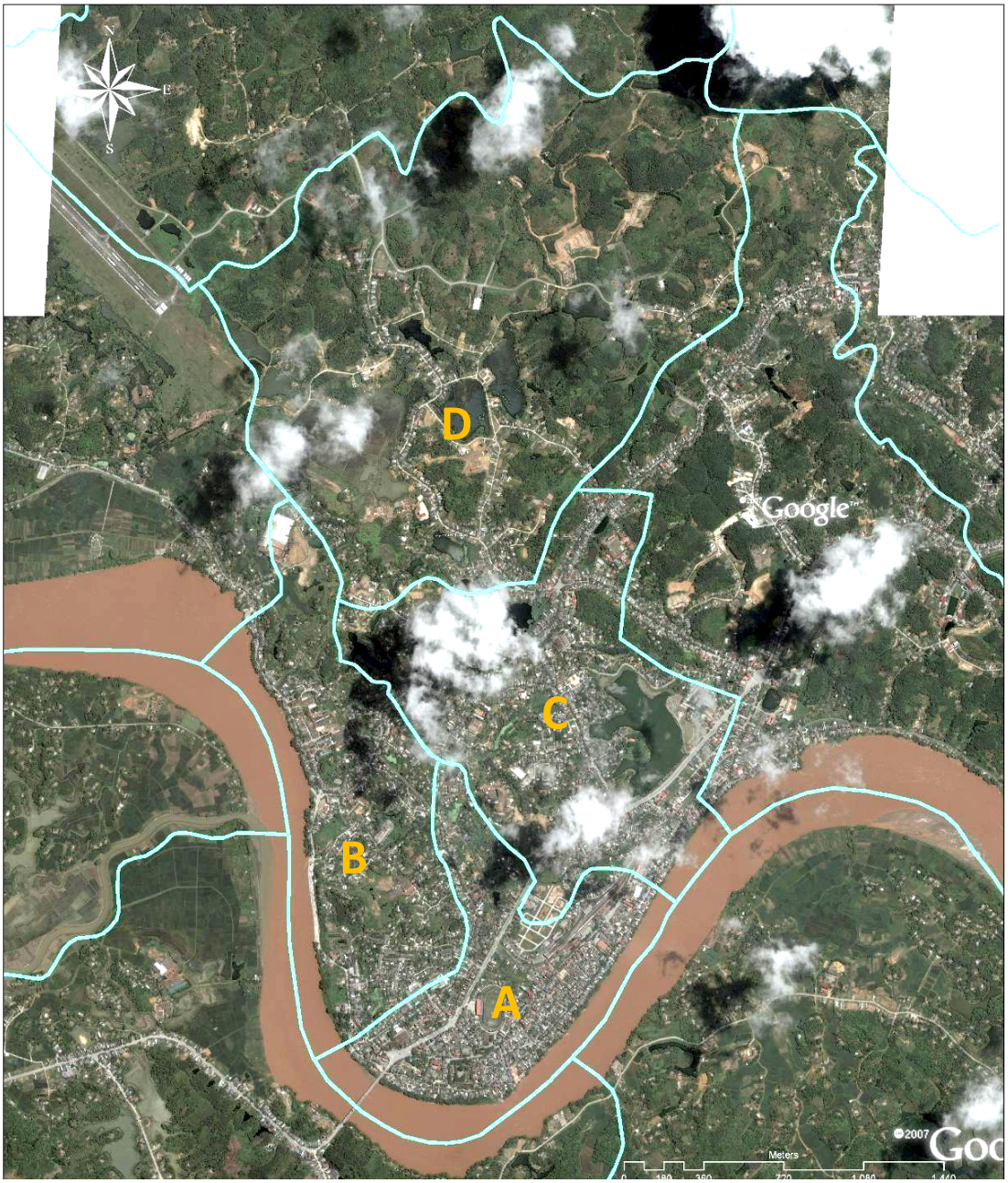
In order to be active and have good results, fieldwork preparation is considered as a essential step in the data collection part. All crucial materials and instruments such as fieldwork maps, GPS, questionnaire, etc. were carefully prepared. Inventory of available information from secondary resource illustrates in Table 7, the other necessary information and data were collected in the field.

Table 7 Available data from secondary sources

Sr.	*Data available*	*Description and format*	*Scale*
1	Rain fall data	From 2000 to 2008, excel format	
2	Catchment map	ILWIS format	10m resolution
3	Contour	ILWIS and ArcGIS format	
4	DEM 10m resolution	ILWIS format	10m resolution
5	Hazard slopes	ILWIS format	10m resolution
6	River network	ILWIS and ArcGIS format	10m resolution
7	Road network (Road types)	ILWIS format	10m resolution
8	Satellite image 0.5m and SPOT image 10m	ArcGIS	
9	YenBai land cover map derived from the spot image	ILWIS format	10m resolution

3.3.1 Preparation of base maps

Using the available data, four commune maps including HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong and one map for the whole study area were created base on ArcGIS, ILWIS software and GoogleEarth.



A HongHa commune B NguyenPhuc commune C NguyenThaiHoc commune D NamCuong commune

Figure 16. The study area map with four communes

The base maps were created base on Google Earth to bring to the field. They were used to mark the investigated position, GPS point or make notes in some special cases. They also were necessary to detect the changes by field observations. Four maps of HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong were printed in A3 size, please refer the Figure 17 below:

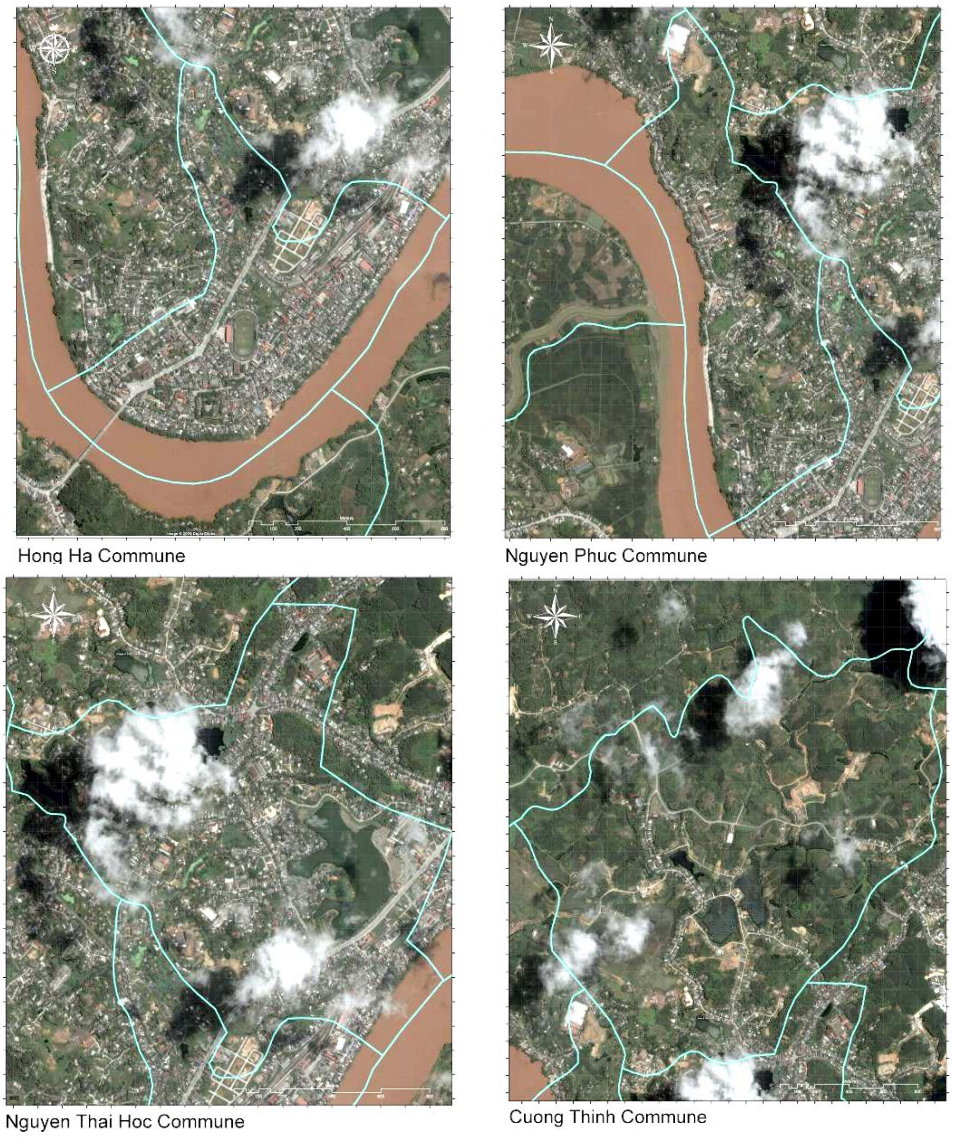


Figure 17. Base maps for HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong communes

3.3.2 Questionnaire preparation

Questionnaire is the tool to collect field information. It is prepared during proposal time continuously developed and adjusted to fit the proposed purposes and real conditions in the field. Due to local people speaks Vietnamese; questionnaires were prepared in English then translated into Vietnamese. Before conducting in all research locations, some testing surveys were carried out in all communes HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong. Base on the results, questionnaire was adjusted for the final format to use in the field. A

number of approximately 250 questionnaires were printed in Vietnamese, prepared for empirical investigations by means of interview local residents.

3.4 Fieldwork

Fieldwork was conducted from 9th of September until 16th of October, with the purpose of collecting relevant data including primary and secondary data from the field. According to (Kienberger and Steinbruch 2005), the Participatory GIS procedure was applied to the community as follows:

1. Pre-contact to local authorities
2. Meeting with local leaders and introducing to them the objectives and expected outcomes of the fieldwork
3. Collection of socio-economic data by means of interviews
4. Mapping of important infrastructure such as public buildings, roads, hospitals, using GPS and topographic base maps. They will also record and map areas that they know are vulnerable to the flood hazard
5. Conducting a workshop and focus group discussions.

Table 8. Applied Participatory tools

Participatory tool	*Target group*	*Proposed purpose*
Interviews	Municipal and local officers, representatives and households	To obtain information on the public's impressions of what flooding are and where they occur, the threat from future floods and how to respond in case of an emergency
Focus group discussion	Local authorities and selected community persons	To collect the information regarding historic events, loss of life and property, etc plus the criteria for assessing the hazard will be obtained through discussions
Join GIS-assisted field mapping	Zone leaders and selected community persons	To produce the risk maps of the area. The community participants will carry out basic mapping of different levels of flood hazards base on high resolution images.
GIS-assisted household survey	Households	To get information from home to home including some basic demands such as health facilities, education, housing and social integrations.
Field workshop	Residents	To have an overview of risk related knowledge and perceptions existing among residents of communities.
Field observation / GIS assisted field transects	Selected community persons	In order to measure and record GPS readings of flood hazards and their characteristics.
Feedback meeting	Community	The results from the above information sources will be presented to a larger audience include government officials and organizations working in the area, the leaders and the villagers with the purpose of getting better and comprehensive results base on the agreement from the whole community.

In the following sections, these five steps are better elaborated. Following this procedure, some of the participatory tools to be applied (Peters Guarin, Frerks, van Westen et al. 2008) are shown in table 7 below:

3.4.1 Pre-contact to local authorities

The government officers were intimated about the fieldwork through the Vietnam Institute of Geosciences and Mineral Resources. Subsequently, the stakeholders were identified who would participate in the project. Contacts were established with the stakeholders and the information was passed on to them. Appointments were planed to organise FGD, workshops and meeting with inhabitants.

3.4.1.1 Meeting with stakeholders

The study is related to one of researches of Use of Geo-Information Technology for Hazard Risk Assessment (GITHRA) project with special focus on flood and coastal hazards in Vietnam. The Research Institute of Geology and Mineral Resources (RIGMR) is one of partners of the project. It is essential to have meeting with RIGMR and communicating with stakeholders in YenBai city before going to the field.

3.4.1.2 Institute of Geosciences and Mineral Resources

The institute plays an important role in communicating with YenBai city to have the permission for all fieldwork activities. On the first day in Vietnam, a short meeting with Dr Le Quoc Hung, Head of Remote Sensing and Geomatics Deparment, Vietnam Institute of Geosciences and Mineral Resources was conducted to get the information, the procedure in the field. With the assistance of RIGMR, contacts are made with some key government officers who supported and provided useful information for the fieldwork activities, please refer Table 9. For instance, Mr Cao The Hung provided YenBai statistical Year book both in city and commune levels. Mr Le Ding Dao assisted by giving the permission for researchers to go to communes.

Table 9. List contact of Government officials

Name	*Titles*
Mr. Le Quoc Hung	Head of Remote Sensing and Geomatics Deparment, RIGMR
Mrs. Tran Kim Hong	Head of Foreign Affair Division, People's Committee of YenBai
Mr. Le Dinh Dao	Deputy Director of Division of Natural Resources and Environment, YenBai province
Mr. Cao The Hung	Head of Water Resources and Hydro-meteorology Section
Mr. Han Dinh Dong	Chair of Cuong Thinh commune, Tran Yen district, YenBai province

3.4.2 Meeting with commune leaders

Communication with commune leaders is the first step to get into in-depth interviews with residents, organise Focus Group Discussion and conduct workshops. There are some purposes such as asking for assistance, permission to do field survey, field observation, etc.

which only can be done with the help from commune leaders. Firstly, in order to carry out the field activities in each commune, asking for commune leader's permission is crucial in Vietnamese context. For instance, the leader organised all the activities including dominating of supporters, sites and necessary equipments for researcher's study. Finally, they can also provide primary data such as historic flood even data, social-economic data, etc. The table below shows four commune leaders in the study area.

Table 10. List contact of commune leaders

Name	*Titles*
Mr. Pham Quang Tu	Chair of HongHa commune, YenBai city, YenBai province
Mr. Nguyen Van Thai	Chair of NguyenPhuc commune, YenBai city, YenBai province
Mr. Nguyen Xuan Hoa	Chair of NguyenThaiHoc commune, YenBai city, YenBai
Mr. Vo Thien Cam	Chair of NamCuong commune, YenBai city, YenBai province

3.4.3 Collection of data

During the fieldwork, the following essential equipments were used (McCall 2009): Ipaq (Mobile GIS), GPS, tape, recorder, measuring tape, map tube, camera, laptop, etc. All these equipment are important and may need to use in the field anytime when collecting field information.

1. Ipaq: Mobile GIS (Arcpad) is useful tool in the field when doing surveying. In order to use it, first ArcMap was converted into ArcPad, in the next step necessary data were transfer to ArcPad. In the field, ArcPad can be used as small laptop to map field observations. Point's collection was recorded directly in the field by digitizing in ArcPad along with utilizing GPS to locate the point position in Global Positioning System.
2. GPS: is used to record the GPS's positions.
3. Recorder is used to record the local people opinions in workshops or also during doing household surveying and some important talks of officers or key persons in communes.
4. Measuring tape is used in case we want to know the cross section or flood depth when going to the field.
5. Map tube is to carry fieldwork maps which are important to use in the field to mark the investigating point or to direct.
6. Camera is crucial equipment with the function of taking pictures, showing the field indications, observation.
7. Laptop used in the field to prepare questionnaires, testing, entering and store data.

3.4.3.1 Primary Survey

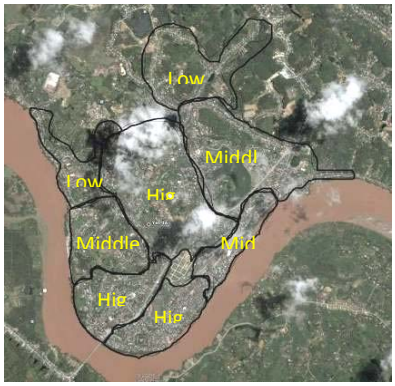


Figure 18 Income groups in study area

With a specific method like participatory approach, primary survey plays an important role in the whole process. It was used to collect the building information, perception of local people, damage, loss, etc.

3.4.3.2 Sampling of questionnaire

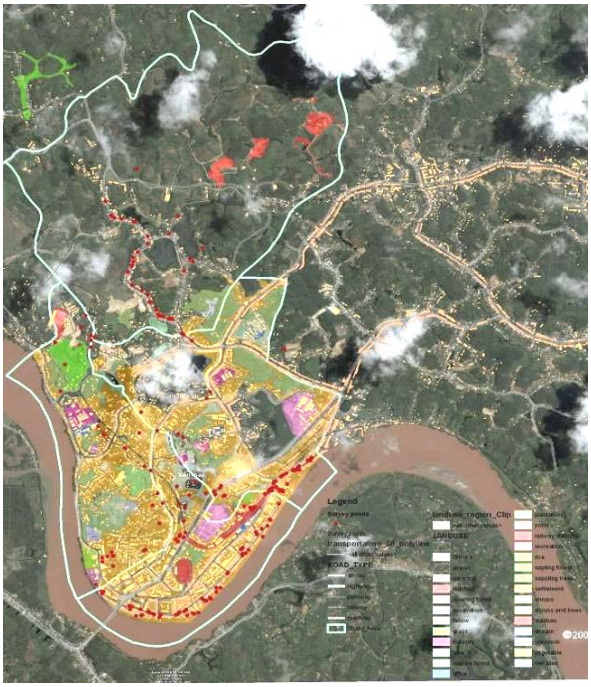


Figure 19. Allocated points survey in four commune and sampling survey

Stratified random sampling is used (based on income levels) to select the samples in the study area. There are two main stages in this: Homogeneous housing units: the study area is divided into homogeneous units based on housing types. Visual techniques like housing fabric, density of the houses, etc were taken into consideration for making these polygons. The

income groups were: high, medium and low income groups. From each of these groups, equal number of samples was selected.

After the preliminary field visit and the subsequent discussions with the commune leaders, the sampling has been changed to incorporate the flood susceptible areas and avoid non-flooded areas.

3.4.3.3 Household interviews

A number of 200 households from four communes were surveyed house by house using questionnaires. After the initial discussions with the commune leaders, the focus of the study was changed to flood-susceptible areas in these communes. The samples were located in the flood prone areas, as described by the commune leaders. The samples were allocated depending on the size, population of four communes (please refer to Figure 19). There were 86, 32, 42 and 40 households selected for detailed study in HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong communes respectively (please refer the Red points in the map). The tasks were done with the help of two assistants, who have deep understanding about the area and the residents in study area.

3.4.4 Mapping, conducting workshop

3.4.4.1 Participatory mapping

Participatory mapping involves drawing the area's flood extent and flood depth as a map, it was conducted in all four communes. In order to organize that, the procedure was applied in each commune as follows: Contact to commune leader to ask for the permission. In the next step, along with the leader, researchers arrange the time, place and attendants. Several groups of all categories of participants, including both man and woman, young and old people who live in different position in the commune. A team was formed with 8–10 participants of all types of community members. Information was given to nominated workshop members about the content of the meeting; provided necessary documents to attendants. Finally, commune maps, pencils, erases, tape, transparency and recorder were prepared for Participatory mapping. All attendants continuously were divided into two groups to do P-mapping. In most of the cases, a local Flood Records Manager attended the discussion. The original P map was made up when all the participants were agreed on a decision about its information.

3.4.4.2 Workshops

In each commune, workshop was organized along with Participatory mapping. The researcher briefly introduced about the goals of the research, the purposes of conducting this workshop and the importance of information that will be collected from local people through this meeting. Simultaneously, content of workshop and responsibility of attendants in the discussion also mentioned. Questionnaires were provided to attendants to fill in; in the next step discussion about flooding issues in that area was carried out, focusing on the 2008 event.

Figure 20. Workshops and P-mapping results in NamCuong (a), HongHa (b), NguyenThaiHoc (c) and NguyenPhuc (d)

3.4.5 Focus group discussions - FGD

3.4.5.1 Identification of stakeholders

In order to organise FGD, stakeholders are identified. They are key persons in the communes, who have valuable experiences in flooding coping mechanism or important influences to the communities or they also can be officers who manage flooding issues in that communes, for example they can be commune's leader or flood records managers.

3.4.5.2 FGD organization

Focus group discussion was organized with the participants from all communes. Each commune nominated one or two persons who are important in flooding related issues. The purpose of FGD is to obtain comprehensive flooding picture in the study area with the understanding and perception from authority level along with the information collected from residents. FGD questionnaires were answered individually by filling in provided documents, after that all attendants involved in discussion about flood losses, flood damage, flood mitigation and future scenarios.

Figure 21 Some glimpses of FGD

3.4.6 Time table

Fieldwork lasted 5 weeks, starting from 9th of September to 16th of October. All fieldwork activities were managed carefully in order to get good and sufficient data for post fieldwork analysis, please refer table below:

Table 11. Fieldwork time frame

Week	*Date*	*Activities*
First week (from 10/10/09)	Thursday	Setting up, Meeting in VIGMR
	Friday	Meeting with WRU and VIGMR
	Monday	Travelling around study area, Taking notes
	Tuesday	Travelling around study area, Taking notes
	Wednesday	Travelling around study area, Taking notes Discussing and making fieldwork plan
Second week	Thursday	Meeting with local officers, Making plan
	Friday	Meeting with local leaders and introducing the work to them
	Monday	Discussing and making plan to do FGD with key persons Doing questionnaire tests
	Tuesday	Updating the questionnaire, Organising FGD in municipal level
	Wednesday	Doing PGIS by asking leaders and officers individually Making plan for meeting with local people
Third week	Thursday	Meeting with local people, Discussing about doing FGD at local level
	Friday	Doing questionnaire and interview, mapping important infrastructure using GPS
	Monday	Doing questionnaire and interview, mapping important infrastructure using GPS
	Tuesday	Doing questionnaire and interview, mapping important infrastructure using GPS
	Wednesday	Doing questionnaire and interview, mapping important infrastructure using GPS Updating plan and do some changes
Fourth week	Thursday	Organising FGD at local level
	Friday	Organising FGD at local level, Doing community mapping
	Monday	Doing questionnaire and interview, mapping important infrastructure using GPS
	Tuesday	Doing field observations at some selected communities
	Wednesday	Doing GIS assisted field transects with some selected persons to know flood hazard and their characteristics
Fifth week	Thursday	Analysis and synthesize the collected data
	Friday	Making updated plan, discussing with leaders and authorities
	Monday	Organising feedback meeting
	Tuesday	Finalising fieldwork data
	Wednesday	Preparing to go back to ITC

3.5 Post fieldwork

3.5.1 Elements at Risk Database

From the field work information, a detailed elements at Risk database has been generated in GIS environment. For this study only people and buildings are considered as the elements exposed. However, in a detailed study, the EaR database would be very lengthy including various work related activities; many types of buildings; land and water resources; transportation networks; water supply and other transmission lines; etc.

Under the attributes of the people, income, literacy, gender have been considered as prime influential parameters. For the buildings, wall materials, roof materials, building structure type, no. of floors, etc. have been considered. The detailed analysis of these attributes as vulnerability is explained in the section 4.3.

3.5.2 Creation of building database

Analyse the buildings to understand element at risk, exposure and vulnerability. This is one of important aspect of element at risk. We made inventory of 200 buildings in the study area where conducted primary survey. Each building belongs to different social – economic group (high, medium, low). Some of the attributes we collected are building age, building height, wall material, roof material, structure details, number of people living in the building, land use, some visual, etc. Generally, all the buildings belong to residential use only. However some buildings have other mix land uses like commercial, industrial and other services.

Table 14. Some data about Roof material and building use

	Roof Material					Building Use		
	Brick Concrete	GI Sheet	RCC	Temporary Material	Total	Mixed	Residential	Total
HongHa	5	20	55	6	86	2	84	86
NamCuong	0	25	14	1	40	9	31	40
NguyenPhuc	0	26	5	1	32	1	31	32
NguyenThaiHoc	0	13	28	1	42	16	26	42
Total	**5**	**84**	**102**	**9**	**200**	**28**	**172**	**200**

3.5.3 Building quality survey

In the study area, buildings are not uniform. They are different in term of material, structure, construction, etc. These differences required to make assessment of building quality with the purpose of understanding wall material, roof material, building structure, etc. Along with that, we took pictures of buildings for future identification, please refer **Figure 23**.

Figure 23. Wall and roof of building observations

Buildings in YenBai city are mainly made of brick and brick concrete (please refer **Figure 24**). General, they are strong in normal condition (please refer Table 12).

Table 12. Building observation data

	Building Observation				
	Fairly strong	**strong**	**weak**	**wooden house**	**Total**
HongHa	8	78	0	0	86
NamCuong	1	33	5	1	40
NguyenPhuc	13	19	0	0	32
NguyenThaiHoc	4	37	0	1	42
Total	26	167	5	2	200

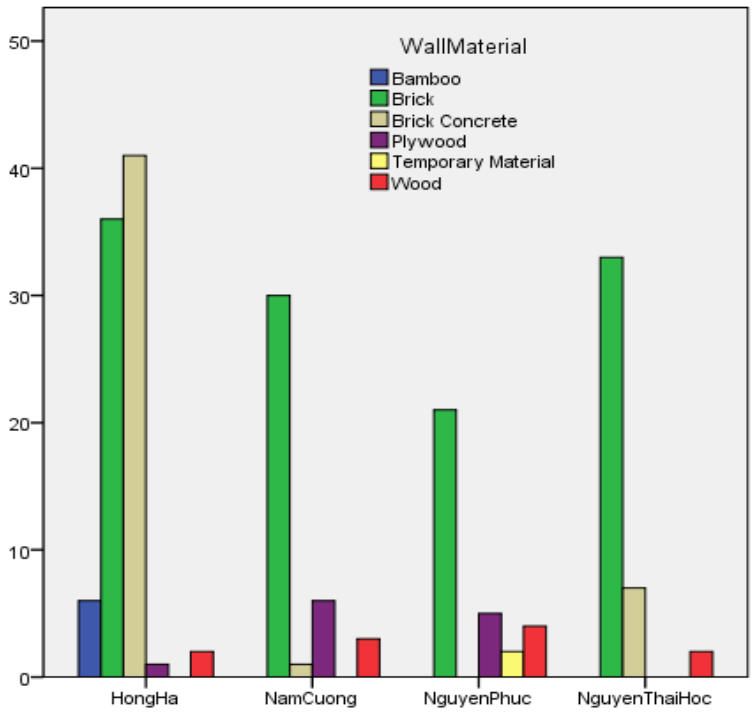


Figure 24 Building wall materials

However, in case severe flood as the 2008 event, many building were flooded in a long time, which weaken their foundations, causing damage for the whole building. If flood duration is smaller, the damage may be limited to household asset. For that reason, in this survey we collected information about both building material and household property. (Please refer to survey questionnaires 8.1)

In this chapter, the detailed account of the data collection has been described. Majority part of the data collection time has been spent in the field work and primary data collection. However, the focus group discussions and participatory mapping have proved to be handy in collecting complex information like flood depth and extent. In the next chapter, Data Analysis, the data processing has been discussed. Basic problems in the data entry, correction of errors, processing of data have been detailed out.

4 Data Analysis

In this chapter, we analyse the data collected from the people of YenBai city, coupled with the secondary data. The local knowledge and perceptions collected were coded in order to create GIS data base. As a result, they can be effectively utilized by software. This chapter demonstrates that information found by a participatory approach can be used to reconstruct the 2008 flood event in YenBai city. The results from participatory practice in terms of water depth, building inventory, occupation, education, income, etc. were taken into account. They will be dealt as hazard analysis, vulnerability/capacity analysis and risk assessment. Each of the analysis is explained below.

4.1 Data entry and cleaning

4.1.1 Data entry and coding

All 200 questionnaire surveys were checked and entered carefully into computer to make a database preparing for analysed process. In order to use the data effectively, some attributes had to be coded for easy calculation. For instant, flood height described in questionnaires is as ankle level, knee level, waist level and chest level. This information only can be used if they are in numeric forms, so as to analyse the data, they had to code into numeric values such as ankle level = 10cm, knee level = 45cm, waist level = 1m and chest level = 1.3m, etc.

4.1.2 Error correction

In data entry step, there are some mistakes like extra spaces, spelling mistake, wrong answers, mixed reported answer, etc. To rectify them, the value had to be changed to appropriate, right answers. This process helps researchers in achieving uniform data type, error numeric and text value.

The local knowledge and perceptions collected were coded in order to create GIS data base. As a result, they can be effectively utilized by software. This chapter serves as a proof that information found by a participatory approach can be used to reconstruct the 2008 flood event in YenBai city. The results from participatory practice in term of water depth, building inventory, occupation, education, income, etc were taken into account. They will be used as important aspects to determine vulnerability factors that will be analysed using a qualitative approach. The result then will be combined with hazard map to obtain a qualitative risk assessment.

4.2 Hazard Analysis

Hazard Assessment is sometimes called *Hazard Evaluation* or *Hazard Analysis* **"**Hazard Assessment is the process of estimating, for defined areas, the probabilities of the occurrence of potentially-damaging phenomenon of given magnitude within a specified period of time" (UNISDR 2006). As Asian Disaster Preparedness Center (ADPC) puts it, the process of collecting information about *Location & Probability* (local hazard), *Severity* (the extent of flood to which it threaten residents), *Manageability* (ease with which their effects can be averted) is called hazard assessment. In the study, the information were collected by means of PGIS and follow the framework as showing in chapter 1, section 1.7.4.

4.2.1 Qualitative flood hazard approach using historic event and local knowledge

A qualitative hazard assessment is the process of collecting information about types of areas, damage caused, severity of flood. Application of actual PGIS techniques to collect this information was preceded by interviews with the public and experts at municipal and local level, workshops, FGD, etc as described in chapter 3, sections 3.4.4 and 3.4.5. Along with local knowledge and perceptions collection, this research also relies heavily on available scientific information, including geologic, geomorphic, soil maps; climate and hydrological data from monitoring stations, stream flow and rainfall; topographic maps, aerial photographs, satellite imagery, etc. Historical information, both written reports and oral accounts from long-term residents are essential.

4.2.1.1 Location & Probability

As mentioned above in chapter 1 section 1, 2, 3, YenBai city is prone to flood hazard yearly including both alluvial and flash floods. By looking at the available data and information such as land use, land cover, topography, geology, rainfall data and historical events, this study focus on risk assessment of the 4 most seriously-hit communes HongHa, NguyenPhuc, NguyenThaiHoc and NamCuong.

4.2.1.2 The extent of flood

Hazard assessment involves the reconstruction of the 2008 flood event with the help of PGIS, please refer 4.2. The study uses a Digital Terrain Model (DTM) of the study area, flood levels indicated by the community in the field work and some statistical and GIS techniques to generate the hazard maps. In traditional Hazard analysis, topography, rainfall, hydrology, historical flood events, soil and land use are taken in consideration. At the end of it, flood intensity, flood depth and flood duration maps are produced. In the current study, however, we make use of non-conventional methods are used in order to produce the same results. The use of people's participation in terms of their knowledge sharing and their presence in the study area during the flood event is used to regenerate the hazard event.

During the fieldwork Participatory mapping was carried out in all four communes which was a simple mapping of local experiences achieved using local knowledge. The method is cost effective and the outcome reflects the local perception of hazard. There are total of seven Participatory maps of four communes. At the workshop in each commune, participants were divided in two groups to deliniate flood extent and flood depth. They created two maps which were marked number 1 and 2 such as HongHa 1, HongHa 2 for group 1 and 2 respectively. Apart from that NguyenThaiHoc was drawn only one map because of insufficient anticipants. These two set of P maps then be used to digitize as procedure shows in **Figure 26** in order to create hazard map of the 2008 flood event.

Map digitizing

GIS was used for digitised map preparation and database management. All the information in Participatory maps of each commune was converted to a digital input system to obtain a final topology of each commune sheet. A record point data of flood depth and shape file of flood extent were given to each feature. For this purpose, Arcmap 9.3, MapInfo and ILWIS 3.6 were used. The flood extent on original Participatory maps were converted into shape files by digitizing in MapInfo. All features were drawn in MapInfo using points and polyline. Figure below depicts the steps for map digitizing using this software.

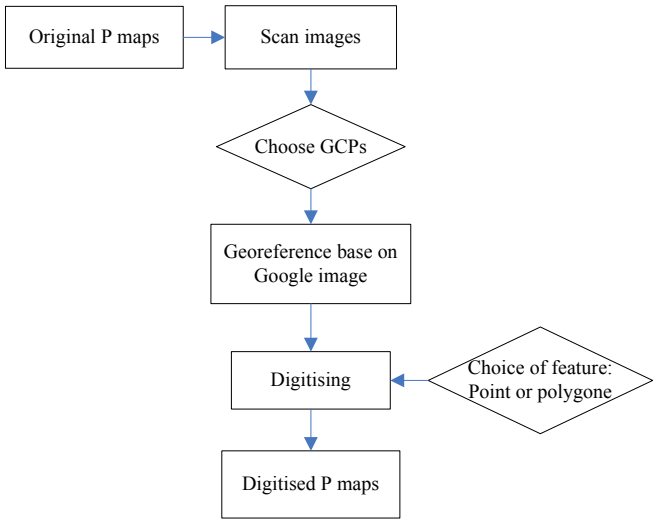


Figure 25 . Digitization procedures for application of GIS in preparing hazard maps

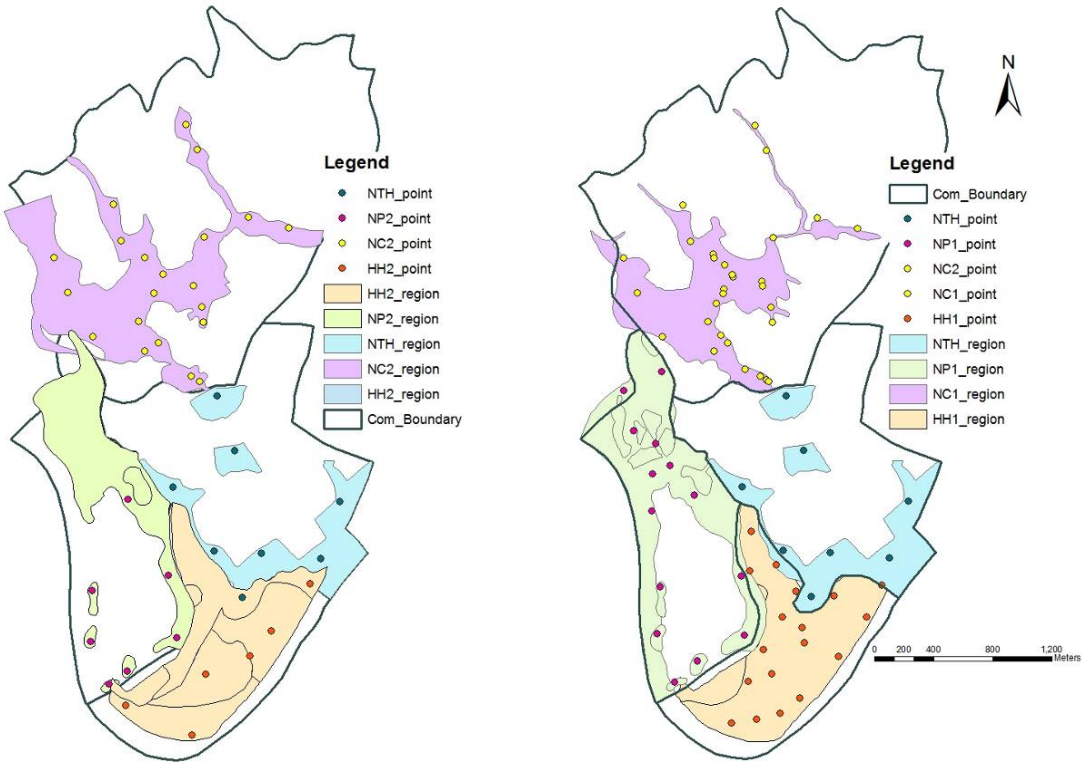


Figure 26. Flood extent maps created by P mapping

In figure 26, the abbreviations of participatory maps as followings:

NHT_point	*The flood depth point were marked in NguyenThaiHoc commune*
NP1_point	The flood depth point were marked in NguyenPhuc commune by group 1
HH1_point	The flood depth point were marked in HongHa commune by group 1
NC1_point	The flood depth point were marked in NamCuong commune by group 1
NTH_region	The flood extent was delineated in NguyenThaiHoc commune
NP1_region	The flood extent was delineated in NguyenPhuc commune by group 1
HH1_region	The flood extent was delineated in HongHa commune by group 1
NC1_region	The flood extent was delineated in NamCuong commune by group 1
NP2_point	The flood depth point were marked in NguyenPhuc commune by group 2
HH2_point	The flood depth point were marked in HongHa commune by group 2
NC2_point	The flood depth point were marked in NamCuong commune by group 2
NP2_region	The flood extent was delineated in NguyenPhuc commune by group 2
HH2_region	The flood extent was delineated in HongHa commune by group 2
NC2_region	The flood extent was delineated in NamCuong commune by group 2

The digitised maps then be put together, overlaying to the study area to please refer the picture of flood extent and flood depth points, showing in the **Figure 29** below. In order to achieve the flood depth map, all seven point maps were combined together.

As a result, hazard maps can be generated by using flood levels indicated through interviews or from Participatory mapping. A comparison will be investigated to assess the accuracy of these two maps. The more accurate one will be used to create final hazard map using qualitative assessment. This method uses ranking such as ‘high’, ‘moderate’ and ‘low ‘to assess a hazard event.

4.2.1.3 Manageability

This term refers to the ability of community coping with floods. The 2008 flood event was the most disastrous event in YenBai city after 5 days continuous heavy rain. Water overflowed very fast from Red river combine with water from upstream causing inundation for the whole area with flood depth of 1 to 4.5 meter within only a night. It was found by interviews that people living in the area seeing the flood as *high disturbance*, *uncontrollable* and *disastrous.*
Below, the reconstruction of flood event of 2008 using the people’s knowledge and perceptions will be presented.

4.2.2 Reconstruction of flood depth map of 2008 event

The principle of building flood depth event of 2008 includes three steps. Firstly, from the 200 investigated points with water depth, along with available DTM data, a water level map was created by using the formula: water level = water depth + DTM using ArcMap. Secondly, the assessment of data quality was taken into consideration. The accuracy of water level points was evaluated and outliers were excluded to obtain a better quality for final results. Before

the outliers are excluded, all the water level points are shown in **Figure 27**. Excluding the outliers was carried out by calculating mean and standard deviation. Simultaneously, anomaly index (using SPSS) has been calculated for all the 200 values and the values with maximum anomaly have been excluded. Finally, the new set of data after rejecting outliers was used to interpolate a new water level map using ANUDEM method in ArcMap, which helped to calculate water depth map as: flood depth = water level – DTM. This is the result of flood depth map for 2008 flood event.

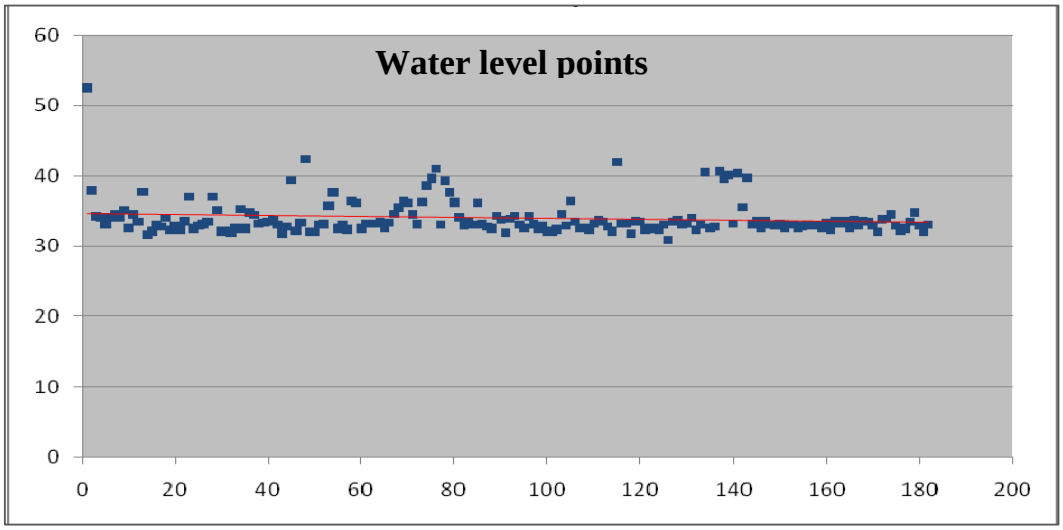


Figure 27. Plot of water level points

From the raw data, mean = 34.0, Standard deviation = 2.57. Mean + StndDev = 36.60. for excluding the outliers, values above the value of 36.57 (Mean + StndDev) have been removed from the data. In total, there are 18 points that were excluded, accounted for 9% of the raw data. After leaving out outliers, the new points are almost on a line (please refer Figure 28). The new data was used to make a new water level map (refer to Figure 30) and then water depth map as mentioned above (please refer **Figure 31**).

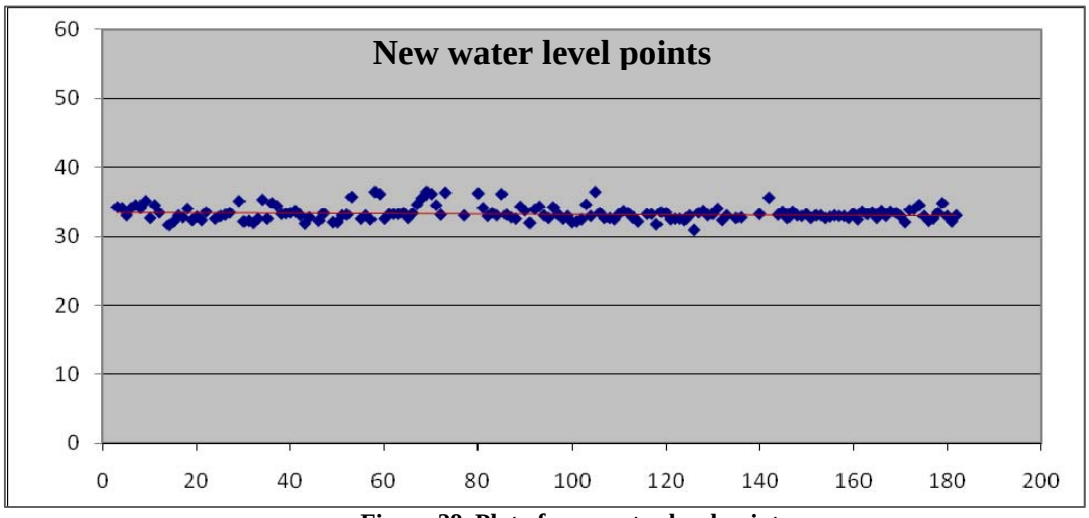


Figure 28. Plot of new water level point

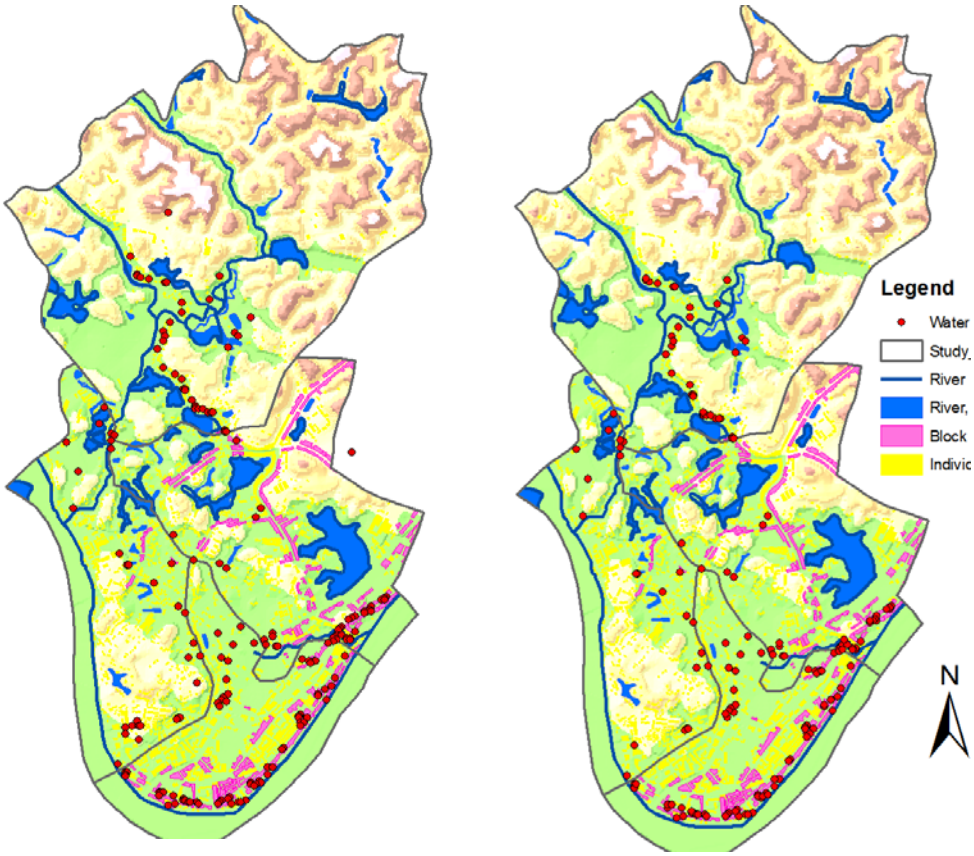


Figure 29. Water level points before and after excluding outliers

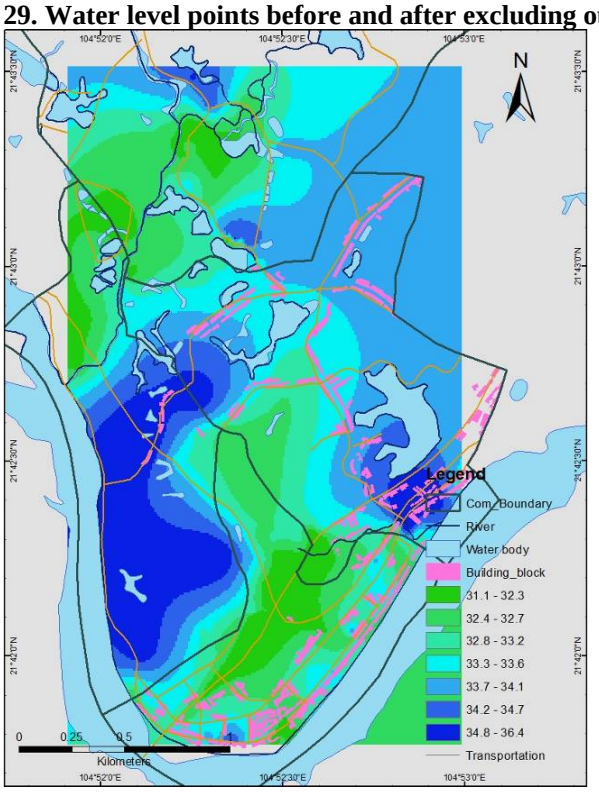


Figure 30. Water level map

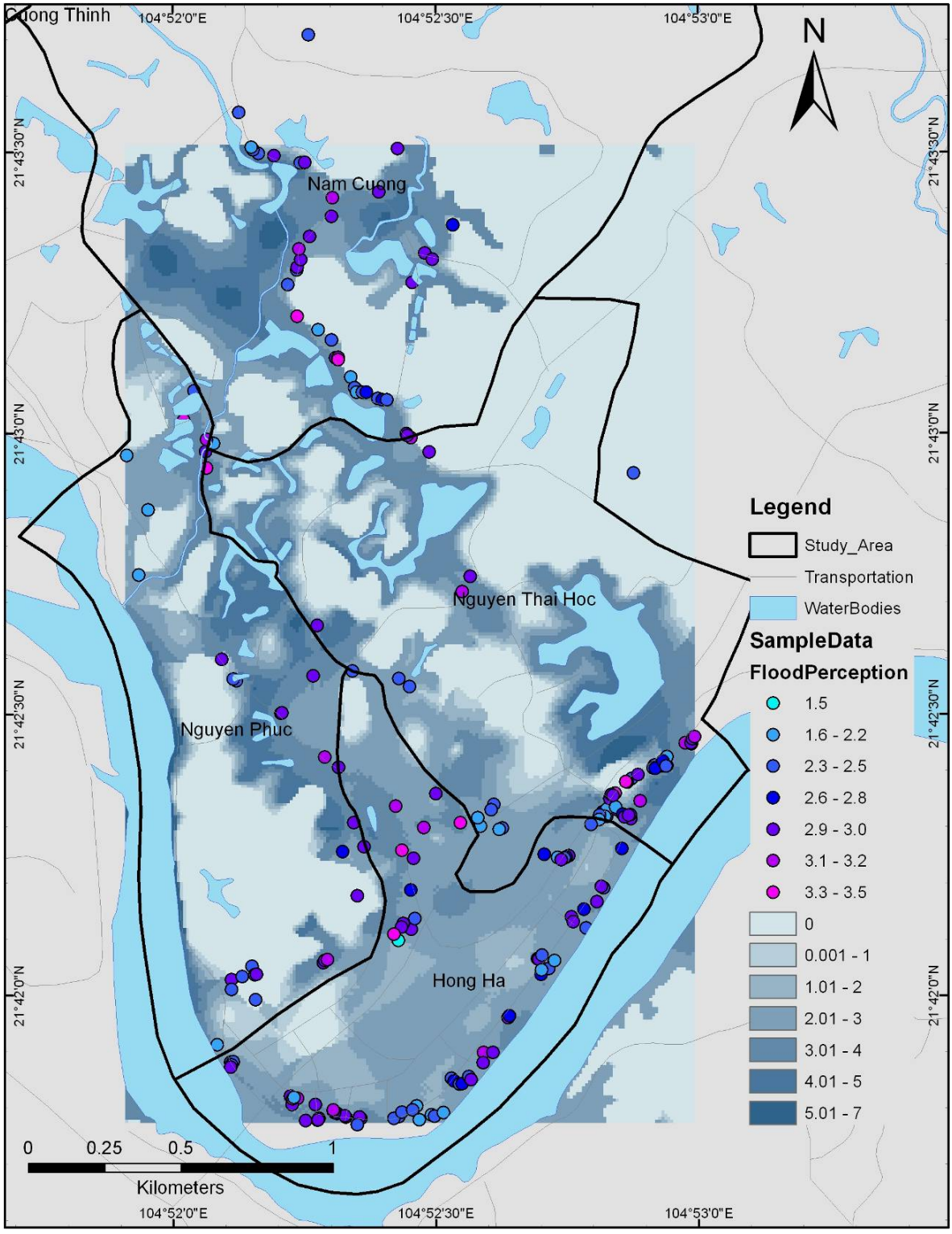


Figure 31. Flood depth map of the 2008 event

The flood depth was classified into 7 classes, from 5 to 7m, 4 to 5m, 3 to 4m, 2 to 3m, 1 to 2m, up to 1m flood depth and class "0" showing the areas which are not flooded.

4.3 Vulnerability/Capacity Assessment

Recent research has been trying to incorporate remote sensing and a Participatory approach into the field of vulnerability assessment. There is no single "correct" method for conducting a vulnerability assessment. A good vulnerability assessment will draw from appropriate disciplines and utilize as much local expertise as possible (Kuban and MacKenzie-Carey 2001). The methodology in this study was designed as a general assessment of the community as social vulnerability including four groups' gender, age, income and literacy. Special consideration areas are those locations (preferably at the neighbourhood level) where individual resources are minimal and personal resources for dealing with hazards can be extremely limited. These areas could be most dependent on public resources.

Vulnerability is the susceptibility of the population for various negative situations[1]. Vulnerability is two types: intrinsic vulnerability and extrinsic vulnerability. ***Intrinsic vulnerability*** is the vulnerability which is due to the inherent weakness of the individual or household, eg., poverty, low immunity, etc. ***Extrinsic vulnerability*** is the susceptibility to the external events caused by the physical proximity or exposure due to intrinsic vulnerability. Intrinsic vulnerability is classified into 4 classes: gender, age, income and literacy. Income and literacy were also dealt under the capacity. Importance of each class is explained and the vulnerable households in each of the communes is explained below.

On the contrary to vulnerability, ***Capacity*** is defined as the ability of the individual or the household to cope with the negative situation. Some of the capacity indicators are: availability of information (through literacy), financial resources (through income or otherwise), number of adult members in a family, properly located house, etc.

4.3.1 Gender

Gender plays an important role in the disaster management. Even though, all the official documents proclaim women are equal to men, in the physical nature, women tend to be weaker compared to men. In other words, the traditions (like curtain system) and customs (women carrying children, etc.) tend to make women dependable and weaker. In this section number of households with higher number of female members is analysed. This step found out the percentage of male and female in each commune, the more female in that commune the more vulnerable they are. The table below shows these data in four communes:

	Male (%)	*Female (%)*
HongHa	28	72
NamCuong	38	62
NguyenPhuc	25	75
NguyenThaiHoc	26	74

Here all the communes have higher percentage of women compared to men. It may cause by the movements of man to work in other places where they can earn more money. In NamCuong commune, the percentage of women is comparatively lesser than the other three

[1] Negative situation is a situation where the individual's or the household's ability is tested to survive. Some of the negative situations are: economic poverty, hazardous situations, conflicts over limited resources, etc.

communes. So here NguyenPhuc and NguyenThaiHoc communes are more vulnerable compared to the other two communes.

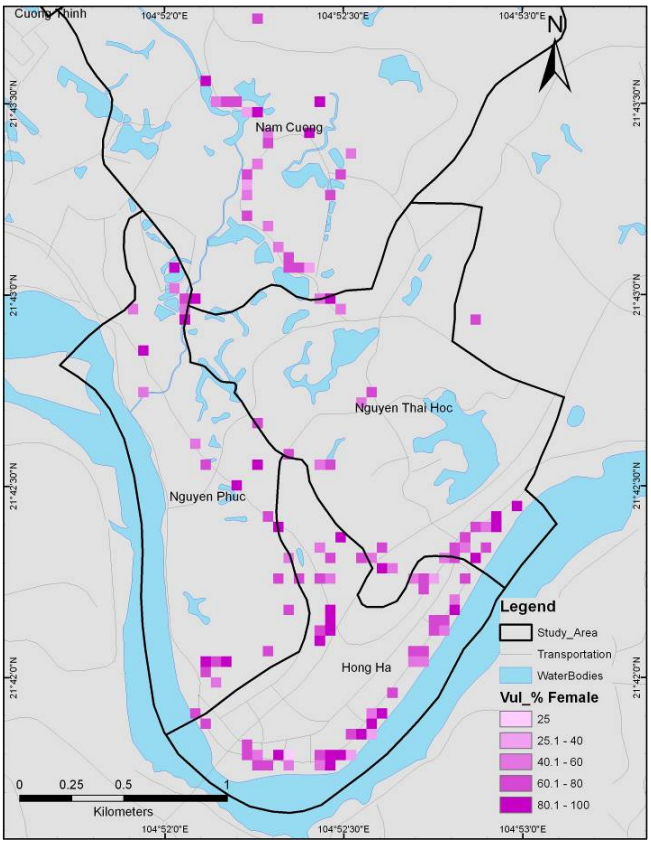


Figure 32 Percentage of females in households

4.3.1.1 Female-headed households

Absence of an adult male member in a household makes the household vulnerable (atleast physically and economically). A household with female-head means that the male counter part of the household is missing either because of death or because of incapability to earn for the family[2].

Table 13 Female-Headed households

	Female headed households
HongHa	16
NamCuong	9
NguyenPhuc	5
NguyenThaiHoc	9

[2] In Vietnam, females as heads of the household is common. Women are equally active in day to day activities compared to men. However, in this context, a female-headed household is only when the adult male member is absent.

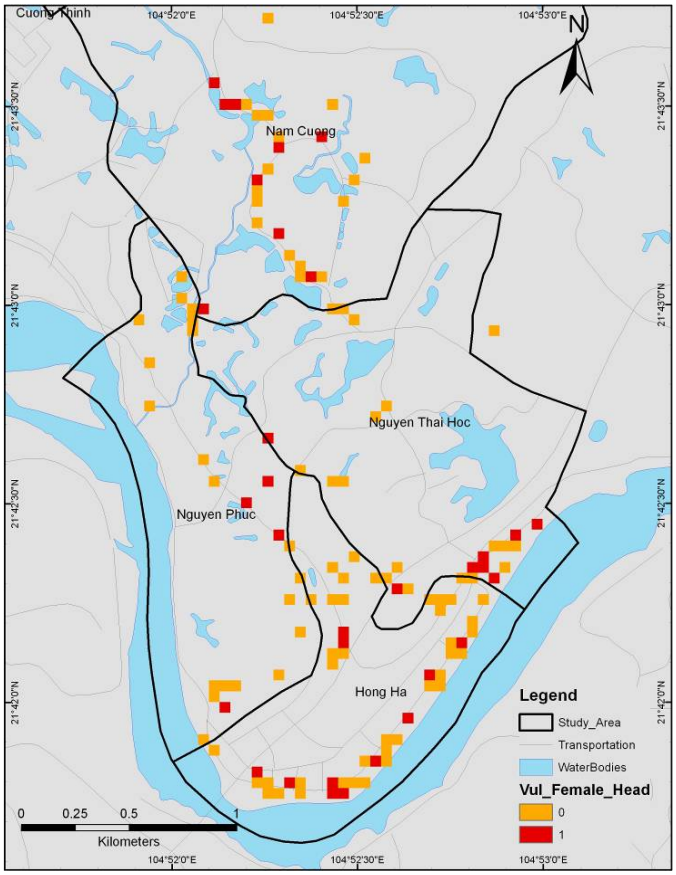


Figure 33 Female headed households

NguyenPhuc commune has least number of households with female-heads. That means these households are better equipped compared to the households in other communes. Location of these households is shown in the map **Figure 33** below.

4.3.2 Age

The population was divided into 6 groups as their mobility to react in case of flood changes, including 0-6; 7-14; 15-25; 26-40; 41-65; and 66-100 years old. The most vulnerable groups are people who depend on others such as elders (people over 65 years old, which indicates possible mobility or cultural considerations) and infants (people less than 6 years old, which indicates child care considerations). However, the study does not take the sick and disabled people into consideration. The presence of sick or disabled people will increase the vulnerability of that particular household. These numbers are described in table below:

	Elders	*Infants*
HongHa	9	0
NamCuong	5	2
NguyenPhuc	1	1
NguyenThaiHoc	2	2

Sort age group: There are total of 38 single parents' families, only husband or wife. They were distributed in four communes as table:

HongHa	NamCuong	NguyenPhuc	NguyenThaiHoc
18	5	6	9

4.3.3 Income

This is an aspect that influences the ability of people in coping with floods. High income family can have more options compared to a low income family. In YenBai city context, monthly income can roughly be separated into three groups as low income (lower than 38 euro per month), medium income (from 38 to 79 euro per month) and high income (more than 79 euro per month). The income data in each commune is illustrated in the **Table 14**.

Table 14 Income classes distribution in the four communes

	Income classes (€ / month)					
Commune	Upto € 38	€38 - 76	€ 76 -114	€144- 152	€152 - 190	€ 190+
HongHa	11	26	15	15	11	8
NamCuong	5	16	8	2	8	1
NguyenPhuc	6	9	6	5	3	3
NguyenThaiHoc	2	11	11	3	6	9
Total	**24**	**62**	**40**	**25**	**28**	**21**

Note: 38Euro is equal to a Million VND, which is assumed as a minimum income for YenBai city.

Considering the income of €38 (equal to 1million VND) as a minimum required income, the income distribution has been plotted. Mean income of the study area is €103 (equal to 2677720 VND). Overall, 125 families lie below the mean income (52, 28, 21 and 24 in each commune respectively) and 75 families lie above the mean income. This shows that the income is not uniformly distributed. The same can be inferred from the **Figure 34**.

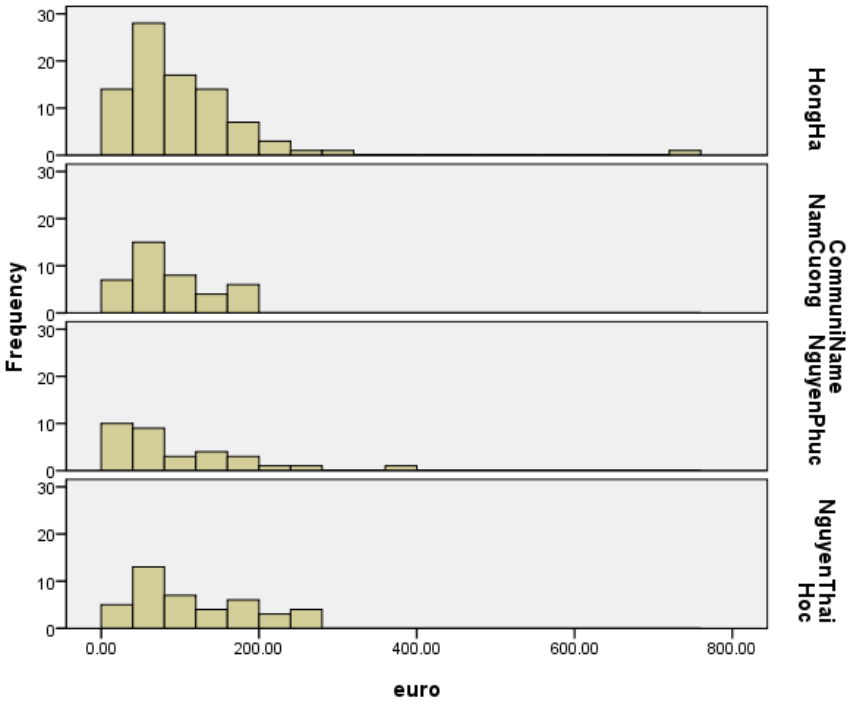


Figure 34 Monthly household Income distribution

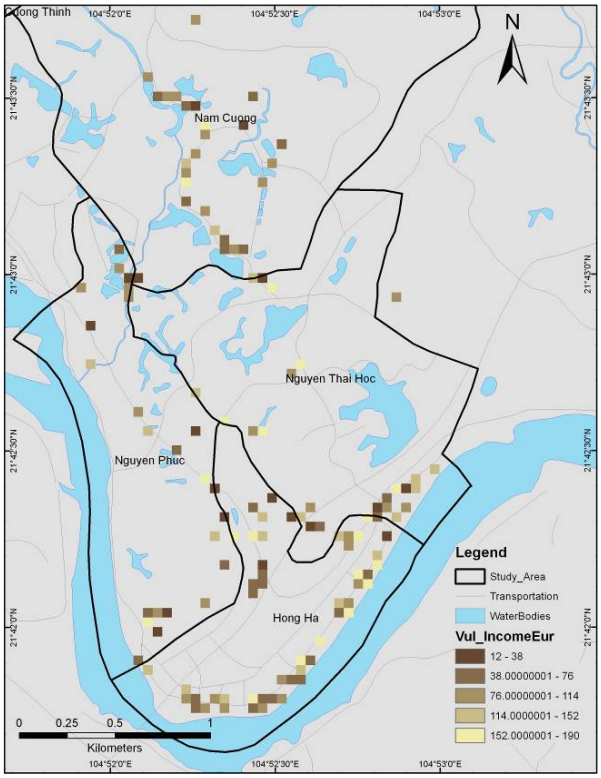


Figure 35 Economic Vulnerable households in the study area

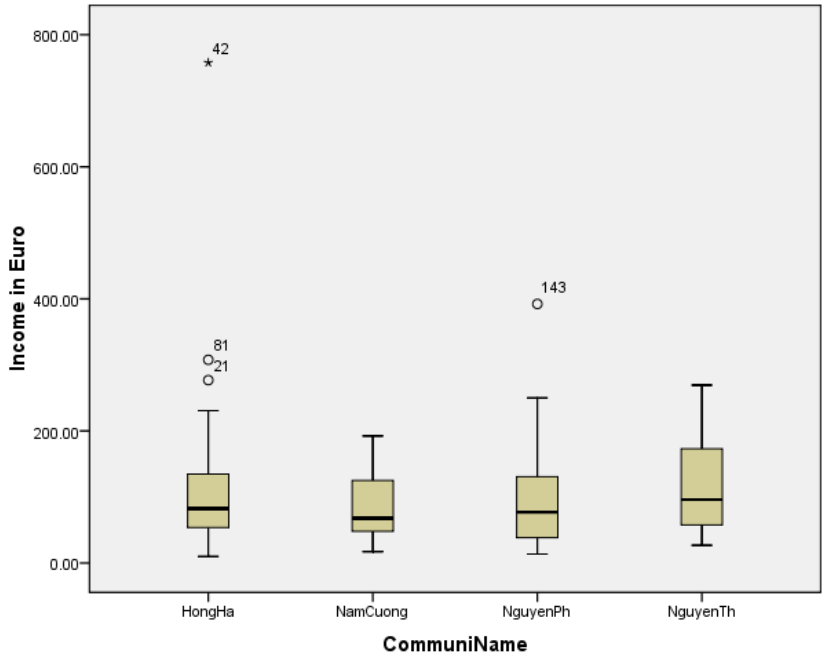


Figure 36 Exploration of income data

In the **Figure 36** income distribution is plotted against the commune. In HongHa and in NguyenPhuc communes, there are some outliers (HongHa – 2, NguyenPhuc -1. The values shown in the plot are the record number of the outliers). Value 21 in HongHa is €276.92, value 81 is €307.69. In HongHa there is an extreme value represented by * (€ 757.69). In NguyenPhuc the value 143 is €392.31. Barring these outliers and extreme values, rest of the data is plotted here.

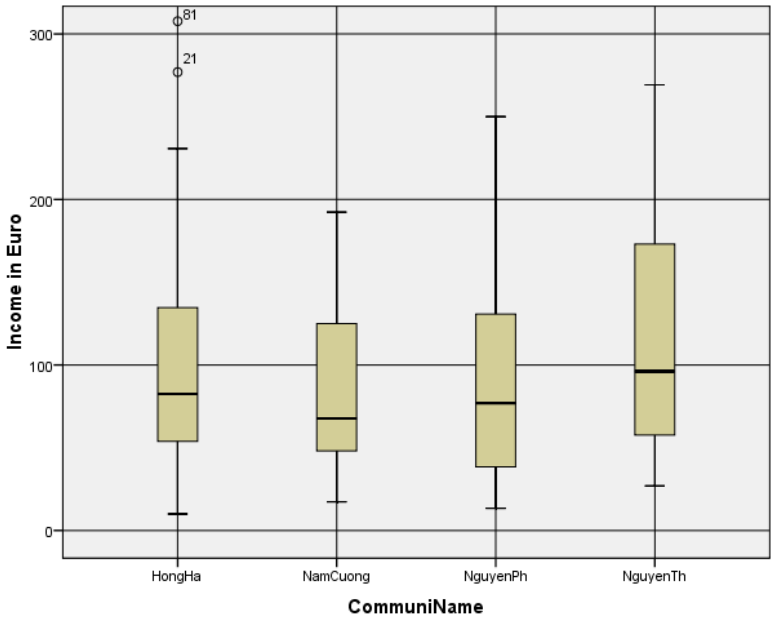


Figure 36a Exploration of Income data

Here we can see that the median of NamCuong is lowest compared to all other communes. NguyenThaiHoc has a better median distribution showing that the income is well distributed. The top and bottom edges of the box shows the 75th and the 25th percentile of the data. So NguyenThaiHoc's lower 25% of the population is still better than the population of other communes. The bottom most population in terms of income is better off than the other three communes. Overall, NamCuong is the commune with lowest income and thereby lowest means of resources. Individuals within these communes might have different income values.

4.3.4 Literacy

Literacy says something about how people can be informed through written information; there fore it influences the awareness of the commune and the surrounding areas. A well educated person can avail information about the government policies and information provided by local authorities in times of emergency. Higher education means, better understanding of flooding related issues, which help them in reducing negative effects of flood risk. Literacy was considered in different level of education that indicated their awareness of flooding. Five groups were taken into account are uneducated people (0) , up to primary school (1), up to high school (2), up to Intermediate level (3) and higher level (4). This data is shown in **Table 15**.

Table 15 Literacy classes

No education	0
Kindergarten	1
Primary School	1
Secondary School	2
High School	2
Elementary School	3
Intermediate	3
University	4
Post Graduate	4

Table 16 Literacy levels in each household and commune

No. of Literate persons per household	HongHa	NamCuong	NguyenPhuc	NguyenThaiHoc	Total
0	4	3	2	0	9
1	32	11	8	12	63
2	24	11	8	14	57
3	17	14	9	12	52
4	7	1	3	3	14
5	2	0	2	1	5
Total Households/people	86/290	40/145	32/119	42/155	200/709

There are a total of 39 families which have people with university degrees, while 9 families without any education. In four households, the head of the household is not educated.

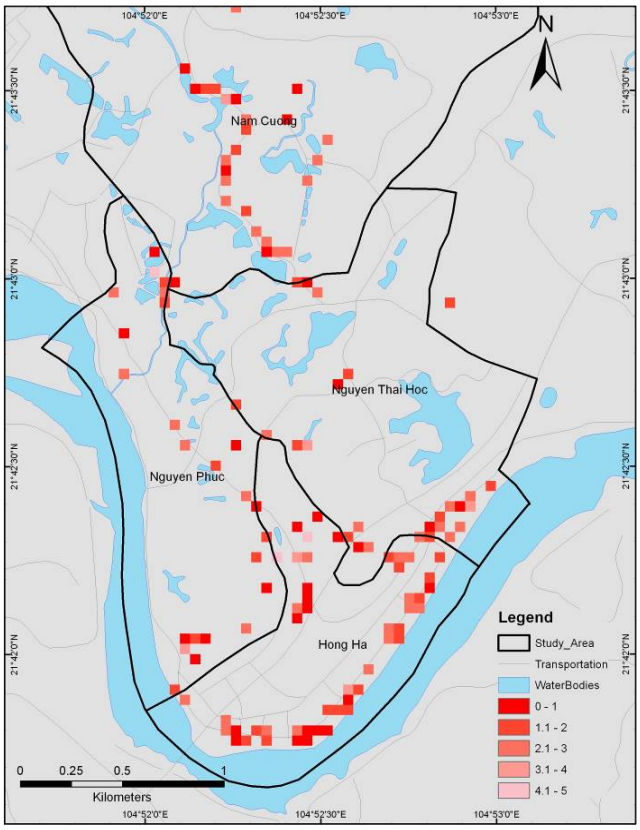


Figure 37 Vulnerability because of no education among the households in the study area

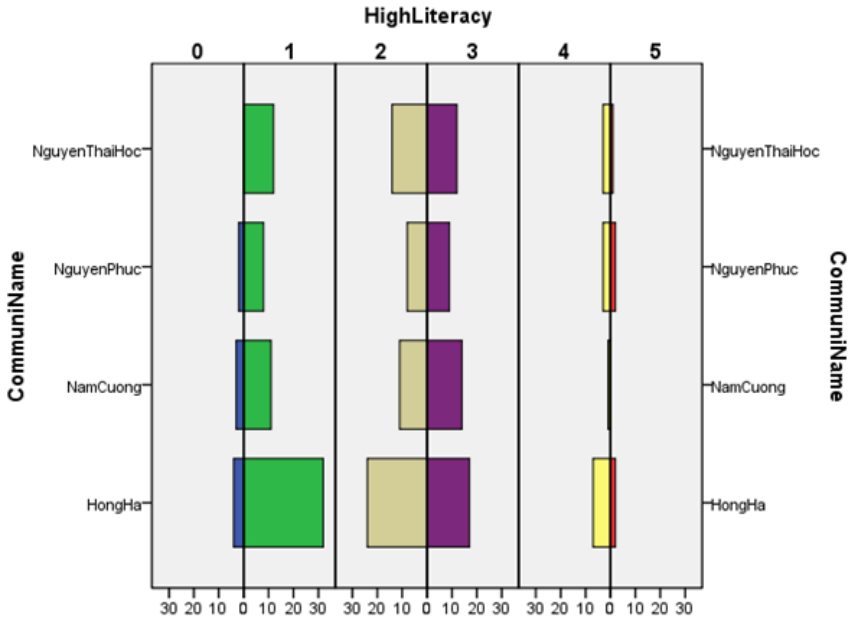


Figure 38 No. of literate members (beyond high school) per household in four communes

HongHa commune: From the analysis, it is clear that the HongHa commune has higher number of people with high education. From the **Table 16**, it is evident that out of 290 members of the HongHa commune, 82 households have at least one is educated beyond high school. 32 households have one member who finished high school, 24 households with 2 people finished high school and 17 households with 3 members finished high school. There are nine households with 4 or 5 members educated more than high education. Apart form high school educated, there are nine members with university education in this commune, while 3 families with at least 2 members having university degrees. In HongHa commune, there are seven families with no education in the age group from 14 years onwards.

NamCuong Commune: In NamCuong, average literacy rate is less. There are only 37 households with at least high school educated members. Around 25 households have 2-3 members educated beyond high school. There is only 1 family with more than 4 members educated beyond high school. Surprisingly, even though there are eight households with more than 4-5 members in the family, there is no house with 5 educated members. In this commune, there are eight members with university education. These people are the strength of the commune in interpreting the local authority's early warning messages. In NamCuong, there are three families with no education in the age group 14 years onwards.

NguyenPhuc commune: In terms of education, NguyenPhuc is the most vulnerable commune. Number of families with educated people is least in this commune. There are only 8-8-9 households with at least 1-2-3 members who crossed high school. There are only 5 households with four or five members who are educated beyond high school. There are seven people in this commune who have attained university education. There are two families with two members having university degrees. There is one family with 3 persons having university degree. In this commune, there are two families without any education in the age group above 14 years.

NguyenThaiHoc commune: In this commune, there is no household without education. Every member is at least enrolled in a school. There are about 12-14-12 households with 1-2-3 members educated at least till high school. There are three households with 4 members and one family with 5 members educated beyond high school. Four members of this commune have university degrees. In this commune, there 3 families with at least 2 members having a university degree, while there is one family with 3 members having university degree.

4.4 Capacity assessment

A Vulnerability Capacity Assessment strives to find out who is vulnerable, why they are vulnerable, what are the major factors that trigger their suffering and what their potential capacities are to decide how to help them. Assessing capacities helps choose the right strategy to reduce the risk (IFRC 1993). According to (ADPC 2005) capacity framework includes three groups which are physical / material, social / organisational and motivational / attitudinal. In this study, base on questionnaire and interview results capacity was considered in terms of resources, institutional and perceptional capacities.

4.4.1 Resources

Resources refer to individual family's capacity in terms of money, assets, land, jobs, good health, protected location, skills and expertise etc. that they used to prepare for or to mitigate the affects of floods. In the study area, all people were asked by means of questionnaire or interview, they have their own houses with assets, some with land. Most of houses here are located in the position where is prone of flood so that they have their own experiences in coping with floods. When flood occur, they used to move their properties to higher places in their houses (second floor if it is available) or to their neighbour's house.

4.4.2 Institutional capacity

This capacity can include community support, leadership, institutions, political structures, adequate management, community cohesiveness (ADPC 2005). The 2008 flood event in YenBai city has witnessed the strength and weakness of authority. The government supported communities in warning, evacuation, rescue etc., like providing fresh water, food, noodle or evacuating people to safer place, etc. However, some in needed people still not yet received any necessary goods. There are some possible reasons for that such as inadequate management resources both in facility (boats, canoe, etc.) and human (supporters, officers who work in flood mitigation section in each commune) or can be political structure that require the top-down permission in every operation. Each commune also gave warning to people but because of lack of warning system the warning seems not accurate and not on time, which reduced the activation of residents in coping with the event.

4.4.3 Perceptional capacity

Located in the flood prone area, YenBai city facing with flood yearly, both alluvial and flash floods. Consequently, residents experienced flood regularly which accumulated their understanding and knowledge in coping with flood. The fieldwork result both from data collected and researcher's observation expressed that the local people with confidence, dignity and independence in case flood happening. They have the ability to influence their environment and also aware of how disasters affect them.

4.5 Risk Assessment

It may not be necessary to rely on sophisticated technologies and outside specialists in surveying. Visual surveys by experienced people can identify areas at risk from landslides; simple stream gauges or flood marks can be used to monitor water levels and identify areas likely to be flooded; and local people's knowledge of hazards is often more accurate and extensive than outsiders appreciate. Many community projects carry out participatory surveys (e.g., transect walks, community mapping, timelines and seasonal calendars) that complement or compensate for more formal scientific data.

4.5.1 Assessment of Damage/Loss for homogeneous unit

4.5.1.1 Building damage losses

The event in 2008 is a flash flood and all the communes were flooded. However, the HongHa commune was one of the worst effected being in proximity to river. In HongHa the average building damage suffered by each family was more than € 300 per household. At the same time NamCuong has € 41, NuyenPhuc has € 84 and NguyenThaiHoc has €111. Being next to the river caused enormous damage to the houses in HongHa commune. All the houses surveyed in the commune were inundated entirely in the floodwaters. The minimum flood level was 1.5 meter and the maximum is 3.5 meters. In NamCuong, 16 houses were flooded while in 24 houses, there was no flood due to the higher terrain. The water leve was from 0.6 to 4.2 meters. In NguyenPhuc, 21 houses were inundated completely while 11 houses were slightly inundated. The water reached from 1.0 meter to 3 meters. In NguyenThaiHoc, 32 houses were completely inundated while, 10 houses were slightly inundated. Here the water level reached is 1.2 meters to 2.5 meters.

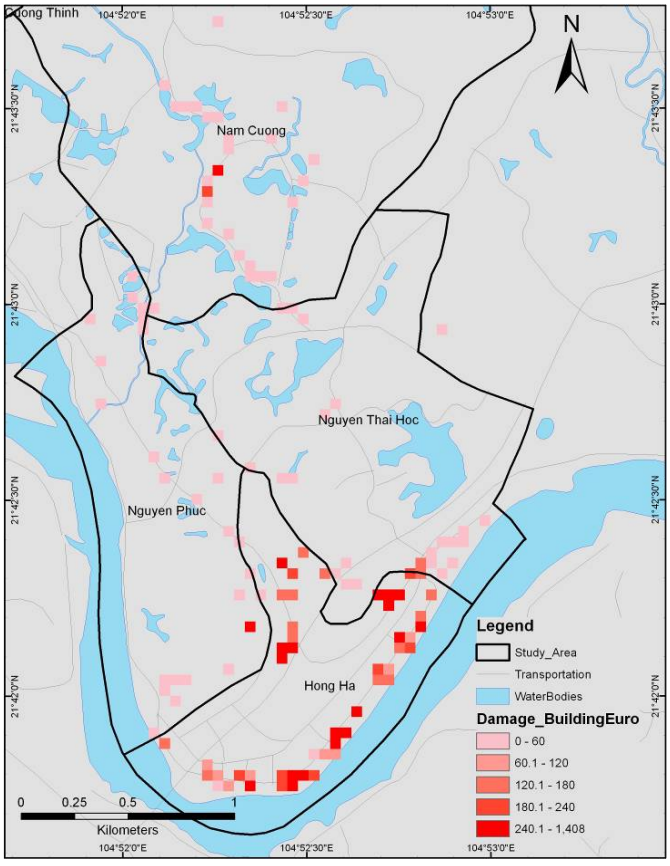


Figure 39 Building damage in Euro because of the flooding event in 2008

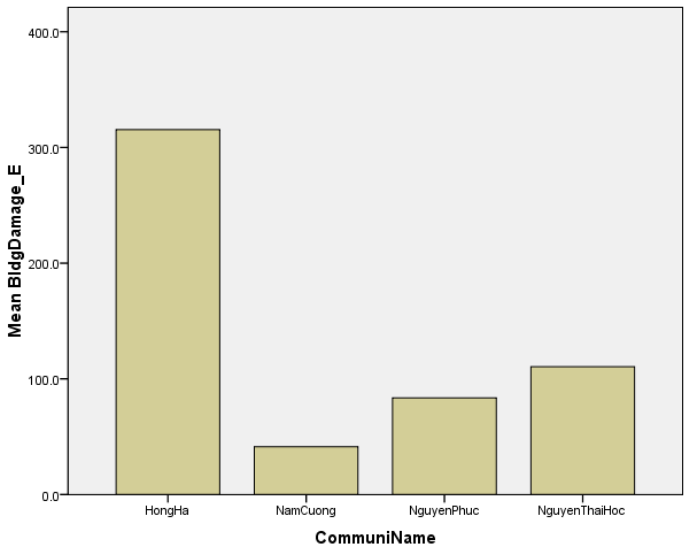


Figure 40 Building damage in Euro

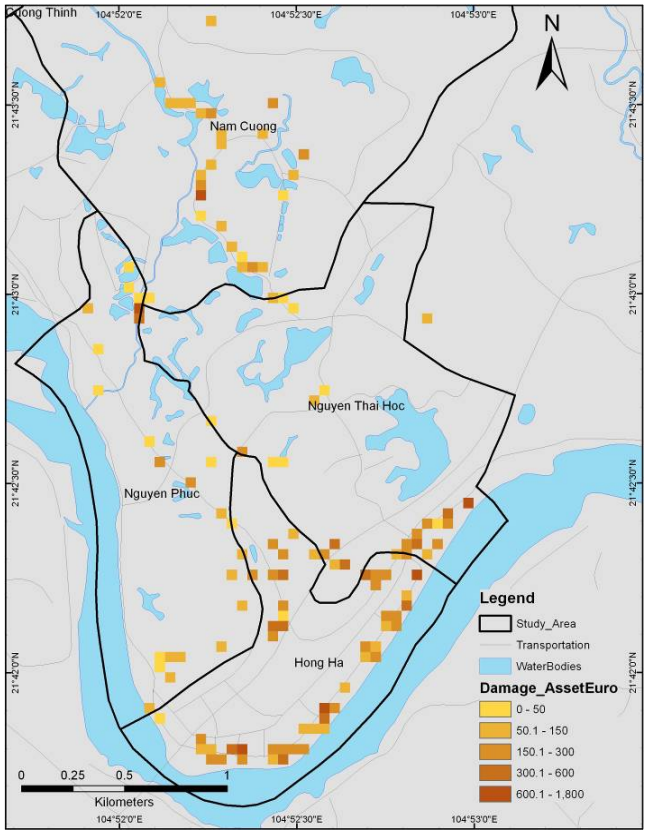


Figure 41 Damage to assets in Euro in flooding event of 2008

Apart from the buildings, the contents of the buildings were also reported as damaged in the primary survey. The average amount of assets damaged in HongHa was €239 while in NamCuong it was €144. In NguyenPhuc and NguyenThaiHoc it ws €185 and €369 respectively. That shows that even though the building values in HongHa were higher, the

asset base is better in NguyenThaiHoc. It also shows that the people in NguyenThaiHoc have invested in their houses compared to other communes. From the **Figure 41** it is observed that even though the number of houses which reported the assets damaged, the average value of the assets is not as much as that of NguyenThaiHoc, where the number of houses reported assets damaged is much lesser.

4.5.1.2 Number of people injured

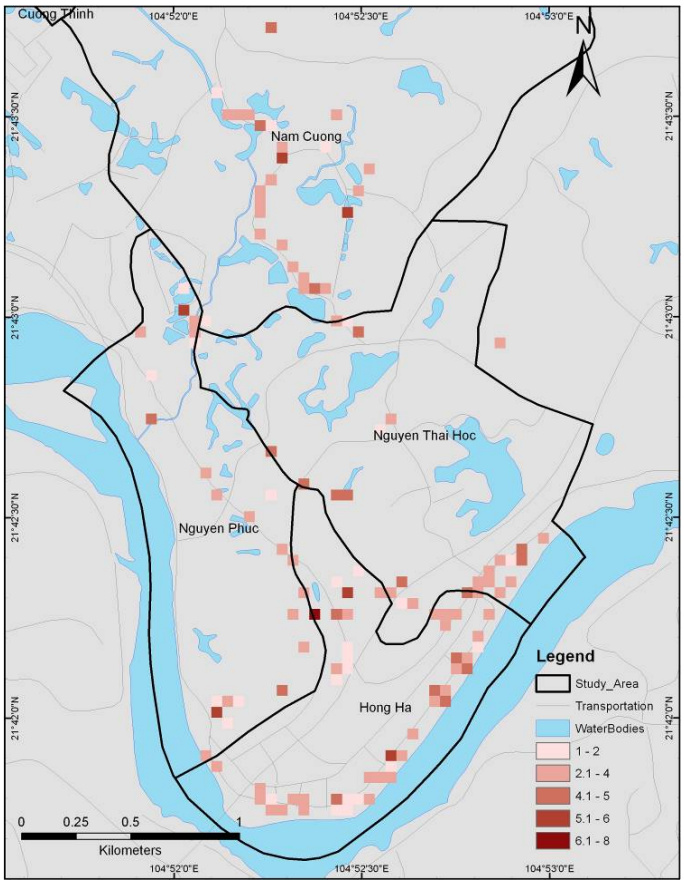


Figure 42 No. of injured people per household

In NamCuong 145 people. This figure is more or less equal in other two communes at NguyenPhuc at 118 and NguyenThaiHoc at 155. In HongHa commune in 2008 there were 280 people injured (within the surveyed area) making this commune the worst hit area in 2008.

By overlaying the hazard maps and the vulnerability maps, we can visualise the 'risk' areas. To assess the quantity of risk, we need to use the formula, $Risk = H \times V \times A$ which is carried out in the next chapter, Results and Discussion.

5 Results and discussion

In the previous chapter, water depth has been calculated using survey information as well as participatory maps. The accuracy of the participatory maps has been acceptable as a consensus has been reached by the government officials and the communes about the flood levels and the extent of the flood. Though the information provided by the families in the primary survey is acceptable, exaggeration of the flood levels has been observed during the focus group discussions. So finally the water level map developed from the participatory mapping has been used for further calculations.

5.1 Results

5.1.1 Hazard Classes

Water depth map shown in **Figure 31** shows the water depth in various parts of the study area. Considering the depth of the flood water, these flooded areas are divided into 5 classes, High flood area, Medium flood area, Low flood area and No flood area. The **Figure 43** shows the flooded areas and their hazard class. The flood depth is observed from 0.1 meter to 7.2 meter in parts of HongHa. One of the reasons for this is the proximity of this commune to the Red River and another reason is the low terrain. The process of calculating the waster depth has been discussed in the previous chapter in page: 41. Parts of NamCuong and NguyenThaiHoc have elevated land where the inundation did not happen. The result of the Hazard map has been displayed in the following section.

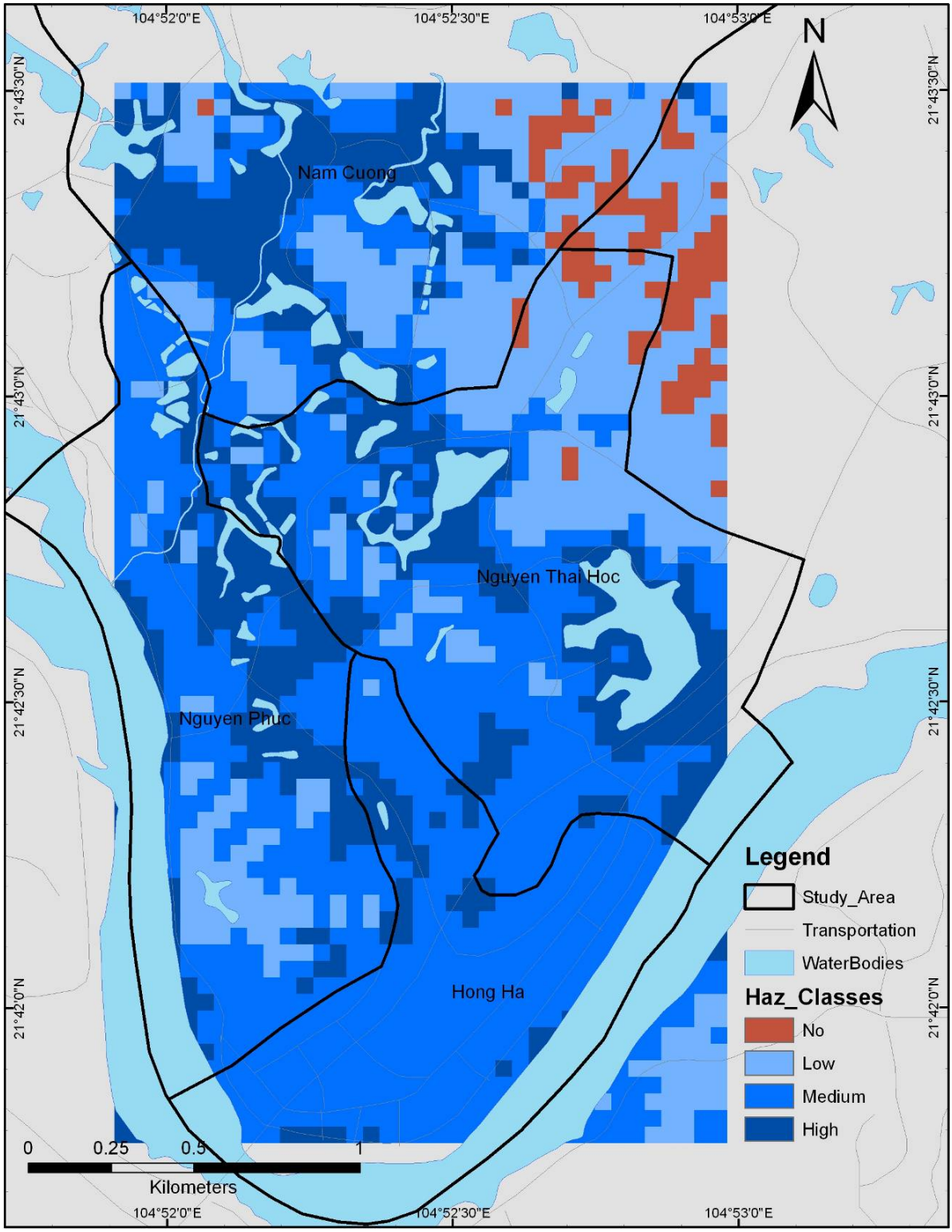


Figure 43 Hazard classes of 2008 flood event based on depth

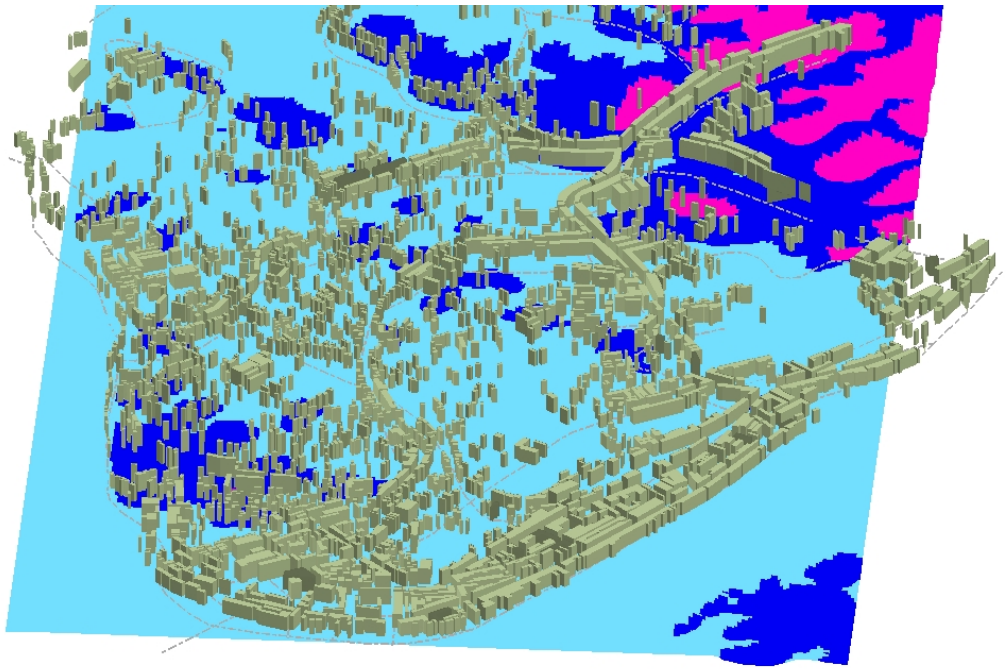
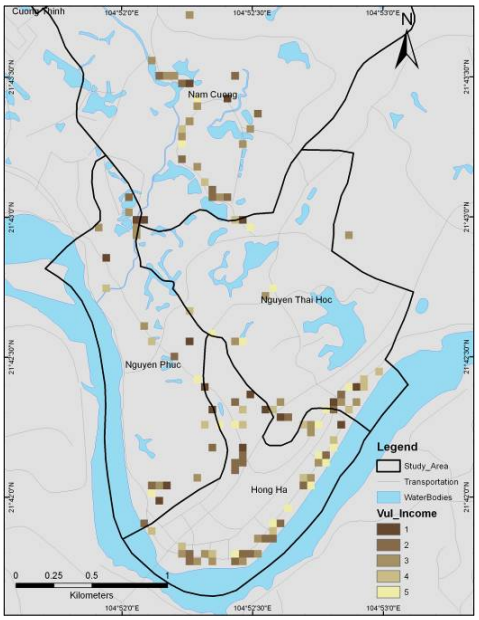


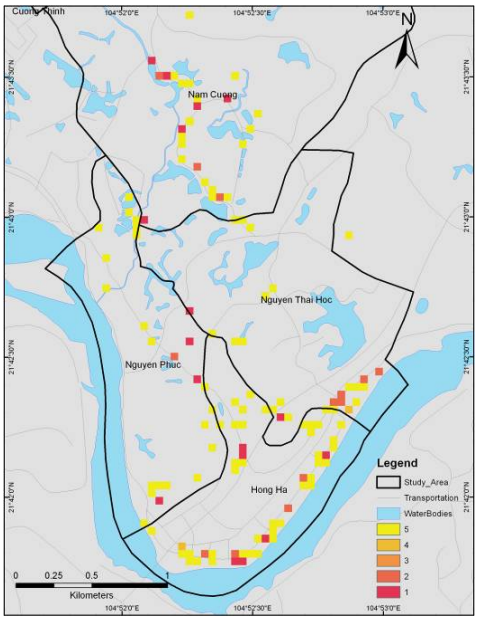
Figure 44 A Visualisation of the flooded areas in the study area

5.1.2 Cumulative Vulnerability Assessment

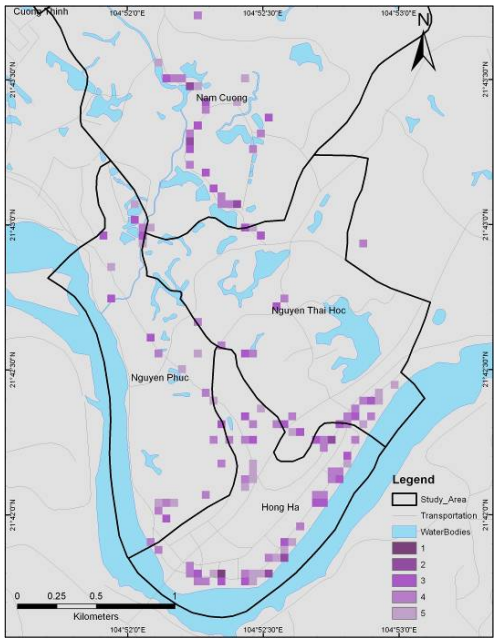
In this study, Vulnerability has been defined by income, literacy and gender. These individual aspects have been discussed in the earlier sections. In this section, these individual aspects have been combined into an index, cumulative vulnerable index. For this purpose, all the individual parameters have been normalised in to 5 classes and then using Raster Calculator, they are combined into one raster. Each of the vulnerability classes have been rasterised individually and presented in Figure 45. The combined raster of the cumulative analysis has been shown in **Figure 47**.



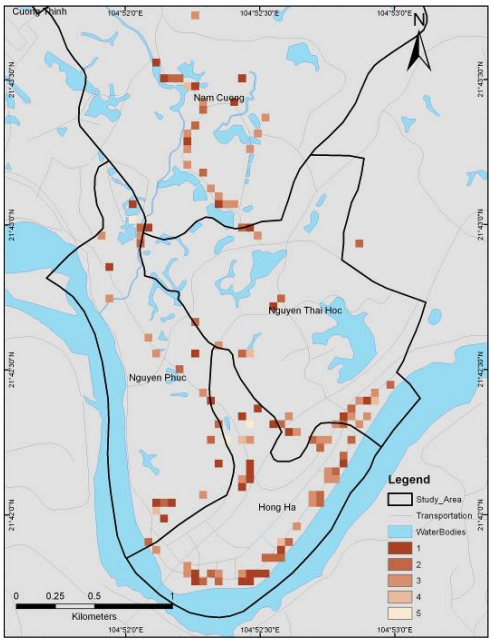
Vulnerable Income classes



Female headed households



Vulnerability from Gender



Vulnerability from Literacy

Figure 45 Individual Vulnerability Maps

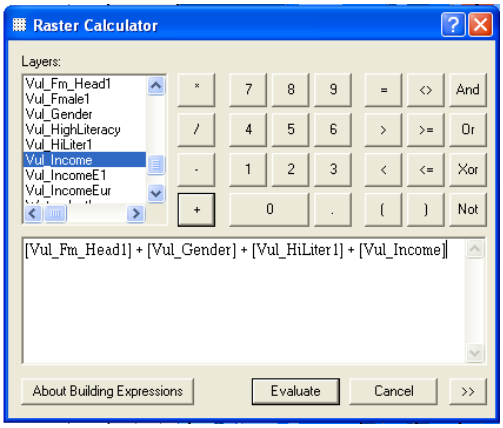


Figure 46 Raster calculator used for combining various rasters into one

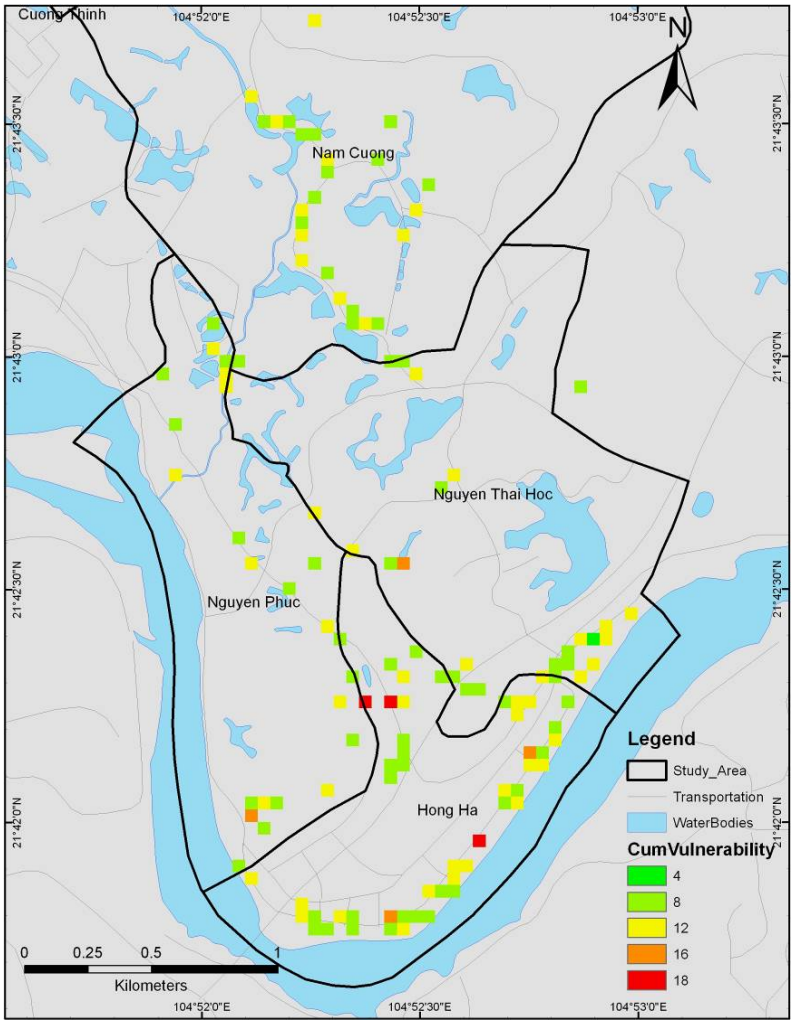


Figure 47 Cumulative Vulnerability map

5.1.3 Cumulative damage assessment

In the primary survey, building damage information and the asset damage information has been collected. In order to calculate the risk, cost of the buildings in the study area is required. In the absence of such information, the value reported as the building damage has been assumed as the building value and the same has been used for the risk assessment. Technically, it may not be a proper way to do it. However, given the data scarcity on the economic value of the houses, the study has considered the above mentioned method.

The cumulative damage value of assets and the houses is shown in the flowing **Figure 48**.

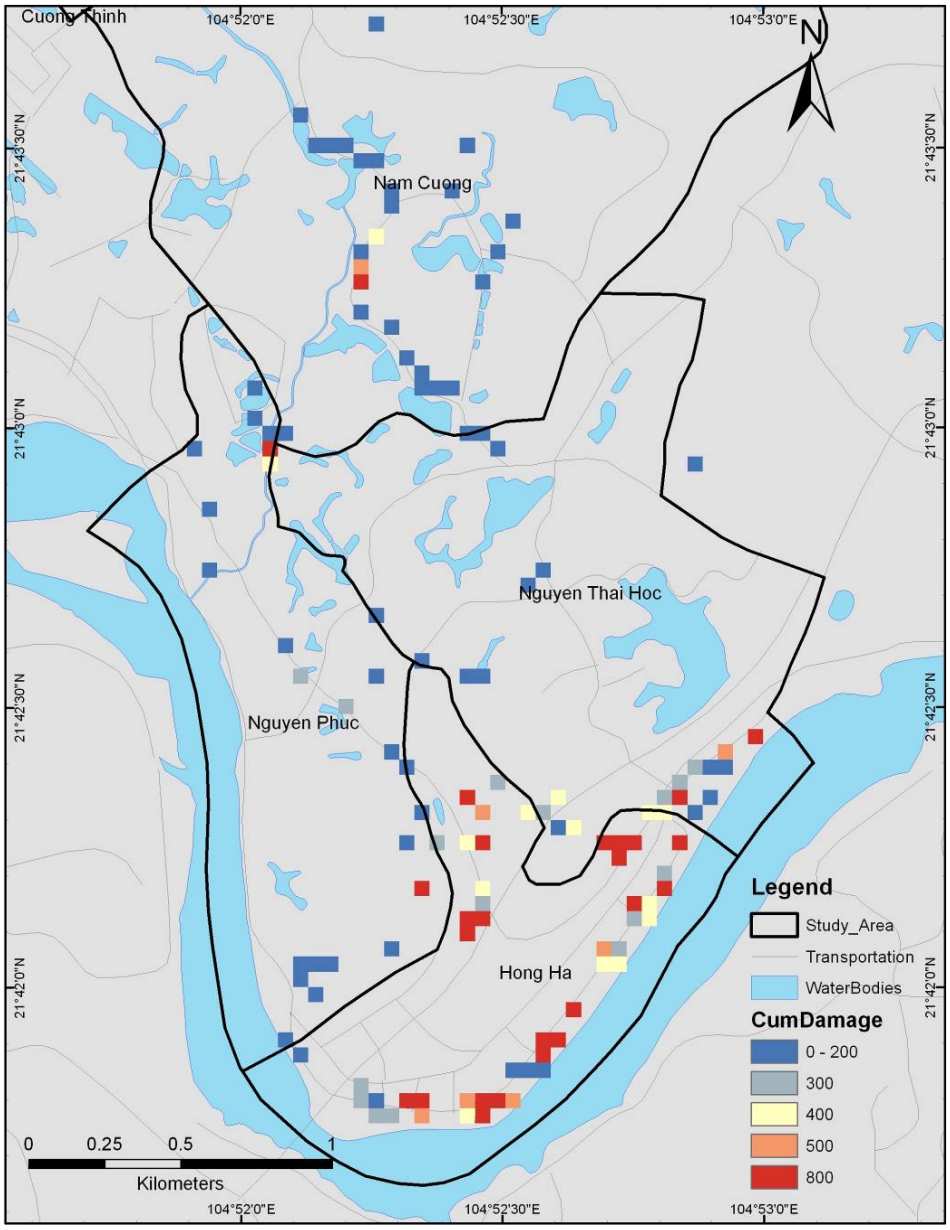


Figure 48 Cumulative Damage assessment map

5.1.4 Risk Assessment

In the previous section, Hazard, Vulnerability and Damage maps have been described and created. As a final step of the map preparation, these three sub-products have been combined to get a Risk map as shown in Figure 49. This map shows the risk faced in these four communes in a range from High Risk to Low Risk. It is evident from this map that the HongHa commune has been most vulnerable and is also in high risk zone. From the following map it is also clear that NamCuong commune has least risk.

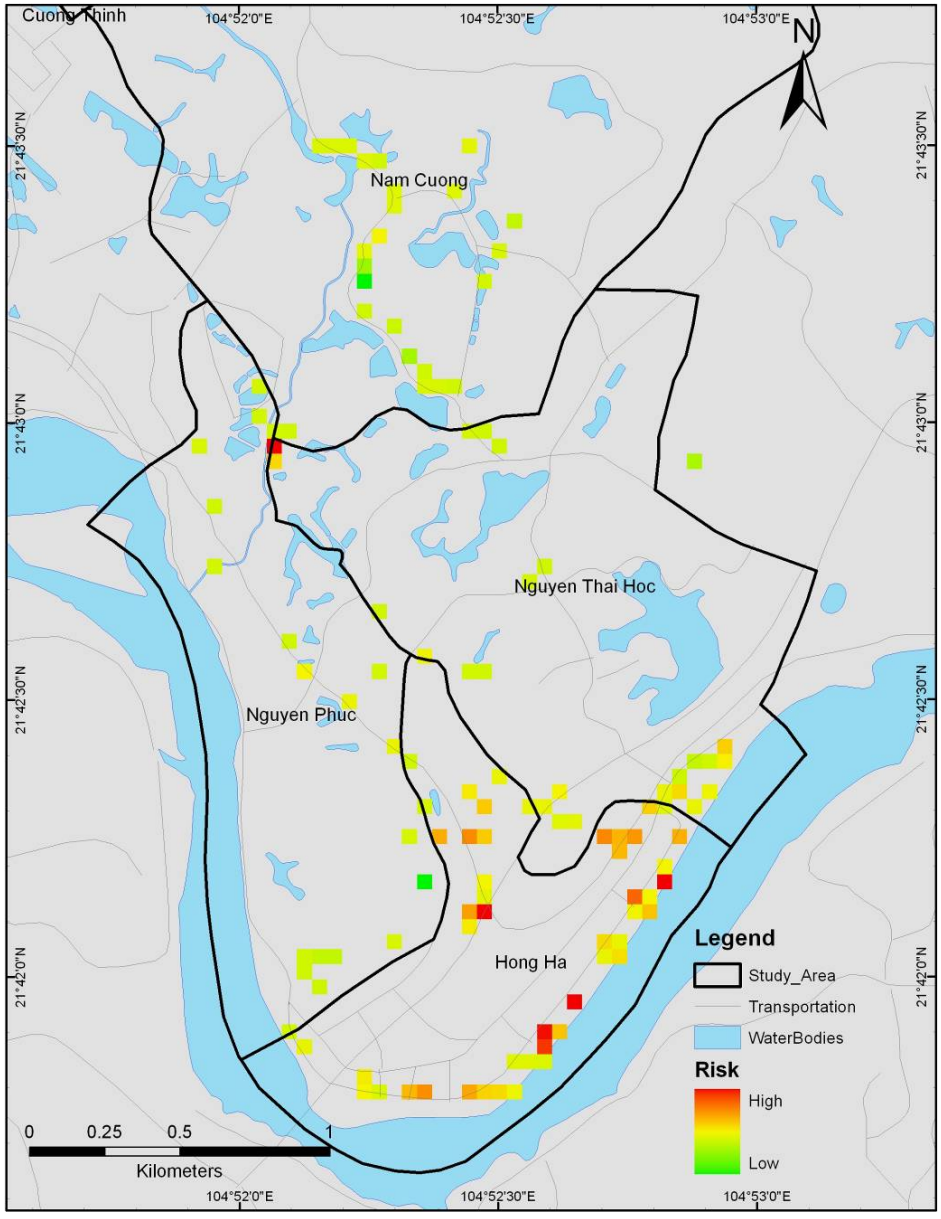


Figure 49. Risk map

5.2 Discussion

In this section the observations from this study are discussed. Discussion is organised according to the sub products of this study.

5.2.1 Hazard assessment

For hazard assessment, people's perception and the participatory maps have been used. Initially both the data were considered accurate. However, the people's perception has been observed to be over estimation or slightly exaggerated in anticipation of possible financial gains (even though the survey was carried out with a proper introduction of the study). So after the initial rounds of creation of water depth map, the perception study data has been discarded and the participatory maps data has been adopted for the final hazard map preparation. For converting the elevation points to a digital elevation model, ANUDEM has been used. On the fly DEM generation has considerable Advantages of using ANUDEM are visible in the output.

5.2.2 Vulnerability assessment

Vulnerability assessment shows the number of people susceptible for the flood event. That is a basic function of the proximity to the river and the economic status of the family. In the present study, the proximity to the river has not been considered as well as the relationship between the vulnerability and the parameters selected for this analysis has not been established. For the current study period, reasonable judgement has been made in selection of the attributes for the vulnerability analysis. However, the results are very close to the field observations.

5.2.3 Damage assessment

Damage assessment has been used in lieu of proper building cost information. For a detailed risk analysis the building cost information is very crucial. Here, as explained earlier in the damage assessment, we used the damage figures from the 2008 event as the cost of the buildings. This section can be further improved if the building cost data can be incorporated

5.2.4 Participatory approach and Community perception for Risk assessment

Community participation, as observed during this study is one of the strong aspects in assessing the risk, particularly to flood. For other hazards, this may not be true, especially for earthquake because of involvement of many building structural aspects. It is observed that the people's perception regarding the hazard has been a little exaggerated compared to the fact. However, the vulnerability and damage part has been observed as accurate. This statement has been confirmed by the final result of the Risk Map with the author's field observation. Further this result can be verified in the field after this study is finalised and this process can be further utilised in other process or rather for a comprehensive Disaster Management cycle of preparedness, mitigation, assessment and relief.

6 Conclusion and recommendation

6.1.1 Conclusions

The study was brought some valuable experiences in conducting a Participatory approach. On how to collect the local knowledge and perception which are really helpful for this study, it is essential to be well prepare for going to the field. The field data collection of the research was successful as most of the necessary information was obtain as mention in chapter 3. Data collection should be considered as one of the most important parts of a Participatory assessment due to all steps of the data processing was relied on this information. A plan to carry out PGIS should be developed in consultation with the community, particularly its leaders. Their understanding and ownership of the process is very important for its success and future outputs. It is also important to gain as much support from the government as possible. Therefore, it may be appropriate to invite government officials to be involved at this stage of the process, and at other appropriate stages throughout the process.

In Vietnamese, general speaking and in YenBai city in particular the political system follows the "top-down" procedure. Consequently, to assess the lower level of community it is inevitable to ask for the permission from top level. In order to assess flood hazard here, the researchers had to consult with the leaders from provincial level to the heads of each group population in commune level. This process was very important as the conveniences of field data collection also depend on this step. The trusts from local people to the researchers played a crucial role through out the approach. This research had received the valuable supports from four commune leaders and from two assistants in carrying out the interviews, questionnaires and organising workshops. To get better understanding from local people, it is important to explain what the Assessment can offer local people in terms of helping them to reduce risk. Briefly explain what the process involves and explain the relationship between hazard and vulnerability. Point out that the process involves both assessment and action. Seek permission to carry out this work in the local area and to access various groups. There are some questions were asked the local people to get general understanding of the study area to help data analysis part such as:

- What is the population of the community? Is it increasing or decreasing? Is there any migration?
- How would 'rich' and 'poor' be defined by local people?
- Have the hazards and their characteristics changed over time?
- Who are the people most in need, especially in times of crisis? Why do they suffer more than others?
- Ask about the role of the community leaders, church leaders, the local government system and how decisions are made.

This information was applied in chapter 4 of this research (please refer section 4.3.3, 4.3.4)

The data collected from the field then is synthesized in to a qualitative hazard assessment by applying some steps. First, all the data were entered in an excel file, they were coded as numeric format to make a database for the analysis in ArcGIS, SPSS, ArcMap, etc.

Vulnerability and capacities varied between different groups within a commune based on the perceptions of disaster risk. However, it is not practical to meet with every person in the local area. This study therefore to meet with a selection of people in focus groups. When setting up focus groups for workshops and FGD, it is important to consider how different categories of people within the local area are likely to be affected by disaster. Community leaders helped by identifying specific people who could join focus groups. Groups could consist of women, man, older people, young people. From this process of assessing vulnerability in the field, the research took the people and building as element exposed to the 2008 flood event. In which literacy, gender, age, income, etc were considered attributes of the elements exposed, this step was analysed in chapter 4, section 4.3.

The result from this study shown that the participatory approach can be used to assess the hazard, vulnerability and risk assessments. However, we need to have a proper knowledge of the study area. Help of the local residents in this study is very much appreciated.

1. Even though all the households in a commune are more or less at the same level, the change in their individual vulnerability has changed their risk values.
2. The houses in YenBai city have suffered much loss in the flood event of 2008. The loss was in the tune of € 2500 for one household. That shows that even though located in the rural setting, these families have invested their life long investments in their houses. So risk mitigation efforts need to be strengthened.
3. Many of the families are economically vulnerable. In some families, only one member is earning, making the family vulnerable in case of adverse events, like illness or flood, etc.
4. Literacy is one of the weak aspects in the study area. Except HongHa commune, all other three communes have lesser education levels among the population. This leads to lesser awareness and access to govt. programmes.
5. Asset base in the study area is very weak. Main assets shown by the families are motorbikes. Even though some families have more than one motor bike, their wellbeing does not change based on these assets. The savings and the asset creation of the households are being threatened by the chronic flooding events.

6.2 Recommendations

From the study, the study team recommends that:

There are many problems in life about which people are worried. Based on this study and in line with other research carried out, we want to highlight to the municipal officers:

1. Detailed topographic survey need to be carried out coupled with a detailed disaster management plan. Currently there is no effort made for a wholistic approach in disaster/risk mitigation.
2. The community, being faced with so many flood events is well versed with the hazard scenarios and the preparedness. So community participation in preparation of a detailed disaster management plan would be very useful.
3. Govt. relief and rescue operations need to be routed by the community in order to encourage the solidarity among the commune.

4. Hazard mitigation efforts need to be carried out in order to reduce the number of flood effecting the study area. As the study area is inside of a river curve, the frequency of flooding is more. Making a bund/dijk along the residential area would help the communes a lot.
5. Keep the issue hot in times of no flood event.
6. Find regular, repeated ways to raise flood risk awareness.
7. Use different modes and media to raise flood risk awareness (newsletters, handouts, leaflets, SMS, radio and TV spots.)

6.3 Scope for further study

A technical hazard map can be used to compare the accuracy of flood map prepared by the participatory approach. If we can incorporate the technical aspects of the flood simulation, the result of the flood would be more accurate.

For incorporating the people's knowledge a streamlined method need to be developed which can help in disaster related activities.

In this study we successfully used community participation in the creation of hazard and vulnerability. However, we could not make use of the data for a proper damage and loss assessment. In a future study, we can make use of the community knowledge in a complete disaster management.

7 References

ADPC (2005). Capacity Building in Asia using Information Technology Applications (CASITA). ADPC.

ADPC (2005). A primer on Intergrated Flood Risk Management in Asia. Bangkok.

Anderson, M. and P. Woodrow (1998). Rising from the ashes: Development Strategies in Times of Disaster, IT Publications.

Hue, T. T. (2003). Current situations of geological hazards in the North provinces of Viet Nam. Vietnam, Institute of Geology.

IFRC (1993). Vulnerability and Capacity Assessment. Geneva, IFR.

ITB (2008). Promise Project Indonesia Bandung, Indonesia, Center for Disaster Mitigation.

IURP (2006). Report on general urban planning adjustment for Yen Bai city till 2020. Yen Bai, Vietnamese.

Kienberger, S. and F. Steinbruch (2005). P-GIS and disaster risk management: assessing vulnerability with P-GIS methods – experiences from Búzi, Mozambique. Mapping for Change: International Conference on Participatory Spatial Information Management & Communication, PGIS '05. Nairobi.

Kuban, R. and H. MacKenzie-Carey (2001). "Community-Wide Vulnerability and Capacity Assessment (CVCA)." Office of Critical Infrastructure Protection and Emergency Preparedness.

McCall, M. K. (2004). Can participatory-GIS strengthen local-level spatial planning? Suggestions for better practice. GISDECO 2004, 7th International Seminar on "GIS for Developing Countries". Skudai, Johor.

McCall, M. K. (2008). Participatory Mapping and Participatory GIS (PGIS) for DRR, Community Risk and Hazard Assessment. Enschede, Netherlands, ITC.

McCall, M. K., et al. (2009). Participatory GIS course material. Enschede, ITC.

Municipality of Yeb Bai, M. (2009). Adjustment of General Planning for Yen Bai till 2020, Vietnamese.

Municipality of Yen Bai, M. (2006). General Planning Adjustment to 2020. Yen Bai, Vietnam Vietnamese.

Municipality of Yen Bai, M. (2008). City Statistical Year Book. Yen Bai, Vietnam, Vietnamese.

Noson, L. (2002). Hazard Mapping and Risk Assessment. Regional workshop on best practices in disaster mitigation: lessons learned from the Asian urban disaster mitigation program and other initiatives, Bali, Indonesia.

Peters Guarin, G., G. p. Frerks, et al. (2008). Integrating local knowledge into GIS based flood risk assessment, Naga city, The Philippines. ITC Dissertation;157. Wageningen, Enschede, Wageningen University, ITC**:** 352.

Provincial Govrnment of Yen Bai, P. (1998). Yen Bai yearly report. Yen Bai, Vietnamese.

Statistical Office of Yen Bai, S. (2007). Annual statistical publication yearbook 2006 Yen Bai, Vietnam, Vietnamese.

Tri, T. V. (2001). Vietnam Natural and Mineral Resources. Hanoi, Vietnam, Vietnamese.

UNISDR. (2006). "Glossary of Risk Reduction." Retrieved 15 January 2010, from http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm.

van Westen. et al. (2009). Multi Hazard Risk Assessment ITC, Enschede.

VKTTV (2006). Zonation and Early Warning of Flash Floods in Mountainous Areas of Vietnam. Hanoi, Vietnamese.

Wehr, C. (2003). Manual on Participatory Village Mapping using Photomaps. Trainer's guide. Song Da, Son La, Vietnam.

Wilkinson, B. (2008). Community Participatory Flood Management. Republic of Tajikistan.

8 Appendix

8.1 Sample questionnaire

Note: The questionnaire used in the field is translated into Vietnamese for practical purpose.

Survey Questionnaire

All responses are confidential and will be used for scientific research as a tool in the vulnerability and risk assessment of the flood hazard in YenBai catchment, Vietnam.

1. **General information**

Name of interviewer: ……Date: …….

GPS : …….....Lat:…….....Long:……..

Parcel area:…….....House ID:……

2. **Household information:**

Name:	Age:
Religion:	Length of stay:
Residence: Owned_____Rented _____Other	Land: Owned _____Rented_____ Other
Immigrant: Yes No	Previous place of residence:

Household members (total number):

Name (optional)	Relationship to respondent	Gender (F or M)	Age	Education	Job

3. **Household socio-economic status**

Occupation	Household member	Income (Daily / monthly)	Assets of the family
Farmer			
Self employed			

Formal employee			
Informal employee			
Dependant on			
Other			

Assets/Properties owned

No	Item	Type	Size
1	Cultivable land		
2	Livestock		
3	Building		
4	Vehicle		
5	Other		

General feature

No. of Floors	Overall Maintenance	Elevation(above ground level)
1	Very good	
1 1/2	Good	
2	Moderate	
3	Bad	
More than 3	Very Bad	

4. Building inventory

Use	Observations	Wall material	Roof materials
Residential		Brick-concrete	
Commercial		Concrete-wood	
Mixed residential – Commercial		Wood	
Education		Ply wood	
Health		Bamboo	
Institutional		Other	
Other			

Note: *1. RCC* *2. Brick concrete* *3. Brick* *4. Wood* *5. Ply wood* *6. Bamboo* *7. GI sheet* *8. Temp* *9. Other*

5. Perception of flood risk

<table>
<tr><td colspan="3">What level of water is considered as flood?</td><td colspan="3">How can you describe it?</td></tr>
<tr><td colspan="3">How often do you experience flooding?</td><td colspan="3">Date of the last one experienced?</td></tr>
<tr><td colspan="3" rowspan="2">What is the associated triggering effect? Describe?</td><td colspan="3">What was the extent of the impact?</td></tr>
<tr><td>1-local</td><td>2- Commune</td><td>3- city</td></tr>
<tr><td colspan="3"></td><td colspan="3">What was the flood depth of the impact?
(m)</td></tr>
<tr><td colspan="6">What was the level of flood? (tick one)
1- Ankle 2- Knee 3- Waist 4- Chest 5- Higher</td></tr>
<tr><td colspan="2">What do you think are the causes of flooding in your opinion?</td><td>1- Rainfall</td><td>2- Typhoon</td><td>3- Moonsoon</td><td>4- Flashflood</td><td>5- Others</td></tr>
<tr><td colspan="2">What do you think is responsible for the increased rate of occurrence of the hazard?</td><td colspan="5">During which seasons do the flooding commonly occur?</td></tr>
<tr><td colspan="2"></td><td colspan="5">What actions do you take in order to avoid or minimize flood damage and losses?</td></tr>
<tr><td colspan="2" rowspan="2">What has been done to reduce the occurrence of flooding in the area?</td><td colspan="2">1-Terracing</td><td colspan="3">2-Mulching</td></tr>
<tr><td colspan="2">3-Afforestation</td><td colspan="3">4-Commune awareness groups</td></tr>
<tr><td colspan="2">What is usually done to reduce the level of damage by flooding?</td><td colspan="5">What do you think should be done to reduce the effects of flooding?</td></tr>
<tr><td colspan="2">For how long have you tried to solve the problem?</td><td colspan="5">Is the method you are using working?</td></tr>
</table>

Visual indicators

Visual indicator	Level (m)	Notes
Flood depth		

Flood extent		
Any other indicator		

Surveyors should identify the characteristics of useful indicators

Damage / loss experienced:

Event	Damage / loss experienced	Amout in USD or EUR
Building description		
Assets description		
Number of people injured		
Number of people killed		
Other losses		

- How do you consider the damage to your house / building? (little, much, disastrous or other):
  ……
- If no damage has been experienced, why?
  ……
- Is your work affected by the flooding? Why do you think so?
  ……
- Do the flooding affect or disrupt transportation, the road network or local activities?
  ……

Support / assistance received

	Before	During	After	Remarks
Relatives				
Neighbors				
Community				
NGO				
Other				

Has the government provided any form of assistance to the victims affected by flooding? **1**-Alternative areas that are safer, **2**-Education to minimize flooding, **3**-Relief aid, **4**-Other
Are you willing to be resettled elsewhere if possible? **0**-No, **1**- Yes
If the answer is no, please give reasons why. **1**-Lack of confidence in Government to fulfil their promise, **2**- Cultural reasons

In case you know of anything relevant to this study but it's not included in the questionnaire please write it in the space below.

Survey Questionnaire – FGD

Questionnaire Flood hazard, Vulnerability, Risk perception and Coping machanism

Questionnaire No: .....Interview: …….....Date.....Time.....

Researcher : Nguyen Thi Thu Trang
Contact : nguyen22322@itc.nl
Research title: A participatory GIS approach for Flood risk assessment in YenBai town Vietnam

All the collected information will only be used for scientific research

1. Flood hazard related information

Type of flood experienced:

Event	Y/N	Water depth	Duration	Period of the year	Name	Date
Heavy Rains						
Typhoon						
Super typhoon						
Flash Flood						
Other:						

How often do you experience flooding?

Date of the last flood experienced:

Water depth:

Duration:

How do you consider flooding at:

Ankle level:

Knee level: _____

Hip level: _____

Waist level: _____

Chest level: _____

Above chest level: _____

Other: _____

Visual indicators

Visual indicator	Level (m)	Notes
Flood depth		
Flood extent		
Any other indicator		

Damage / loss experienced:

Event	Number/year	Damage / loss experienced	Amout in USD or EUR
Heavy Rains			
Typhoon			
Super typhoon			
Flash Flood			
Other:			

Note: *1. Building description, 2. Assets description, 3. Number of people injured, 4. Number of people killed, 5. Other losses*

- How do you consider the damage to your house / building? (little, much, disastrous or other):

  _____

- If no damage has been experienced, why?

  _____

- Is your work affected by the flooding? Why do you think so?

  _____

- Do the flooding affect or disrupt transportation, the road network or local activities?

  _____

2. Risk Perception and coping mechanism

<table>
<tr><td>How often do you experience flooding?</td><td colspan="5">Date of the last one experienced?</td></tr>
<tr><td rowspan="2">What is the associated triggering effect? Describe?</td><td colspan="5">What was the extent of the impact?</td></tr>
<tr><td colspan="2">1-local</td><td colspan="2">2- Commune</td><td>3- city</td></tr>
<tr><td></td><td colspan="5">What was the flood depth of the impact? (m)</td></tr>
<tr><td colspan="6">What was the level of flood? (tick one)
1- Ankle 2- Knee 3- Waist 4- Chest 5- Higher</td></tr>
<tr><td>What do you think are the causes of flooding in your opinion?</td><td>1- Rainfall</td><td>2- Typhoon</td><td>3- Moonsoon</td><td>4- Flashflood</td><td>5- Others</td></tr>
<tr><td>What do you think is responsible for the increased rate of occurrence of the hazard?</td><td colspan="5">During which seasons do the flooding commonly occur?</td></tr>
<tr><td></td><td colspan="5">What actions do you take in order to avoid or minimize flood damage and losses?</td></tr>
<tr><td rowspan="2">What has been done to reduce the occurrence of flooding in the area?</td><td colspan="3">1-Terracing</td><td colspan="2">2-Mulching</td></tr>
<tr><td colspan="3">3-Afforestation</td><td colspan="2">4-Commune awareness groups</td></tr>
<tr><td>What is usually done to reduce the level of damage by flooding?</td><td colspan="5">What do you think should be done to reduce the effects of flooding?</td></tr>
<tr><td>For how long have you tried to solve the problem?</td><td colspan="5">Is the method you are using working?</td></tr>
</table>

Support / assistance received

	Before	**During**	**After**	**Remarks**
Relatives				
Neighbors				
Community				
NGO				
Other				

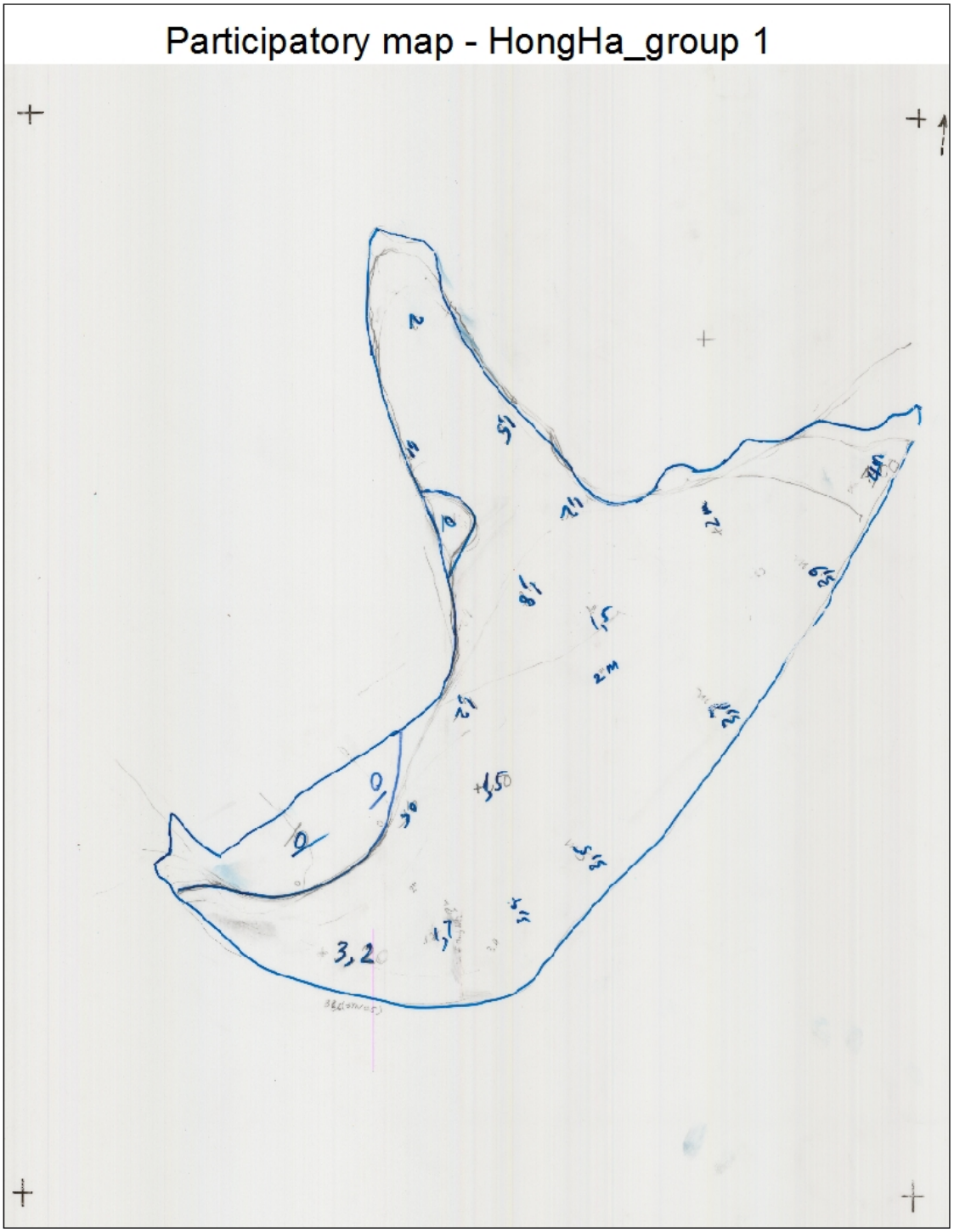
Has the government provided any form of assistance to the victims affected by flooding?

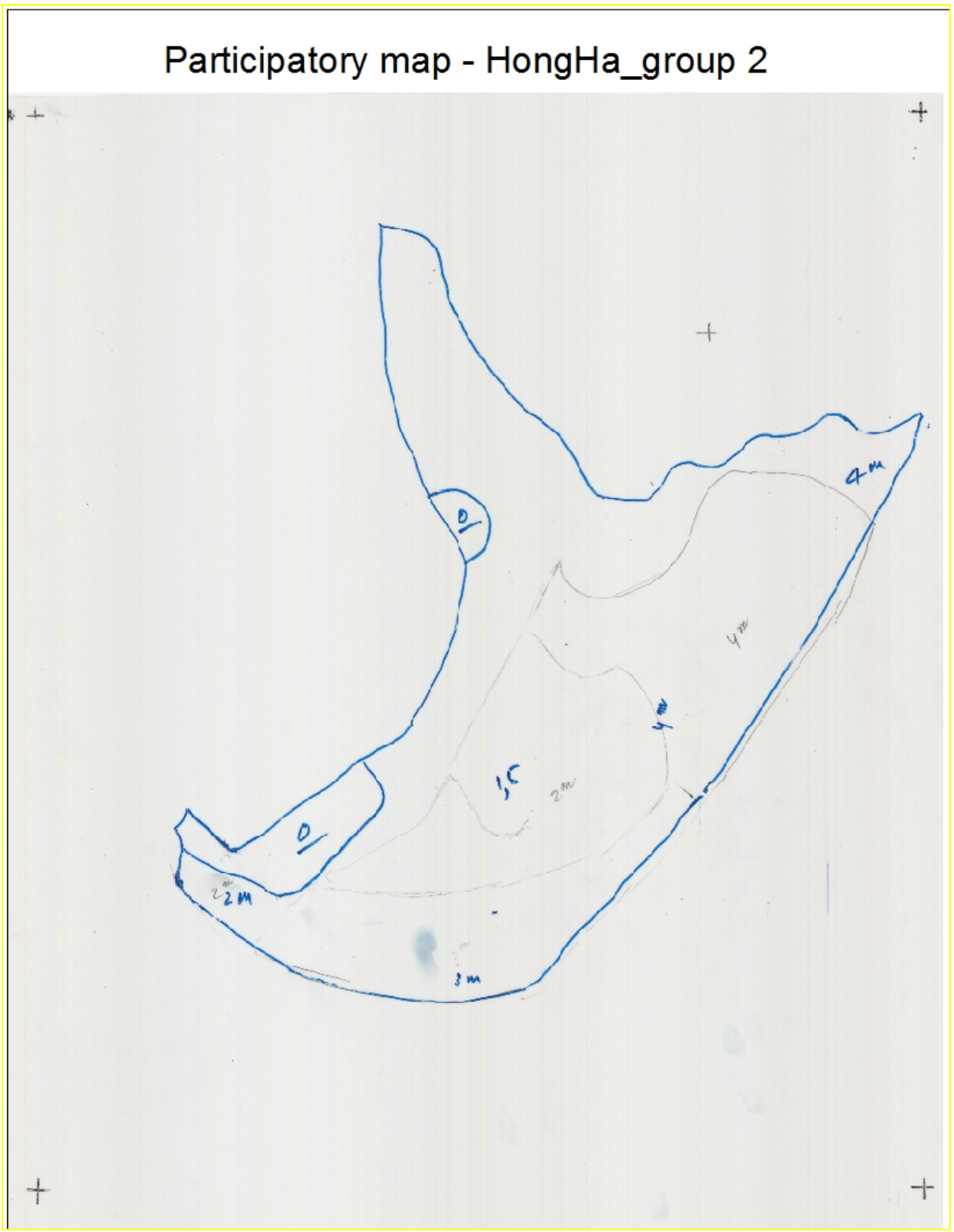
1-Alternative areas that are safer, **2**-Education to minimize flooding, **3**-Relief aid, **4**-Other

Are you willing to be resettled elsewhere if possible?	**0**-No,	**1**- Yes
If the answer is no, please give reasons why. **1-**Lack of confidence in Government to fulfil their promise, **2-** Cultural reasons		

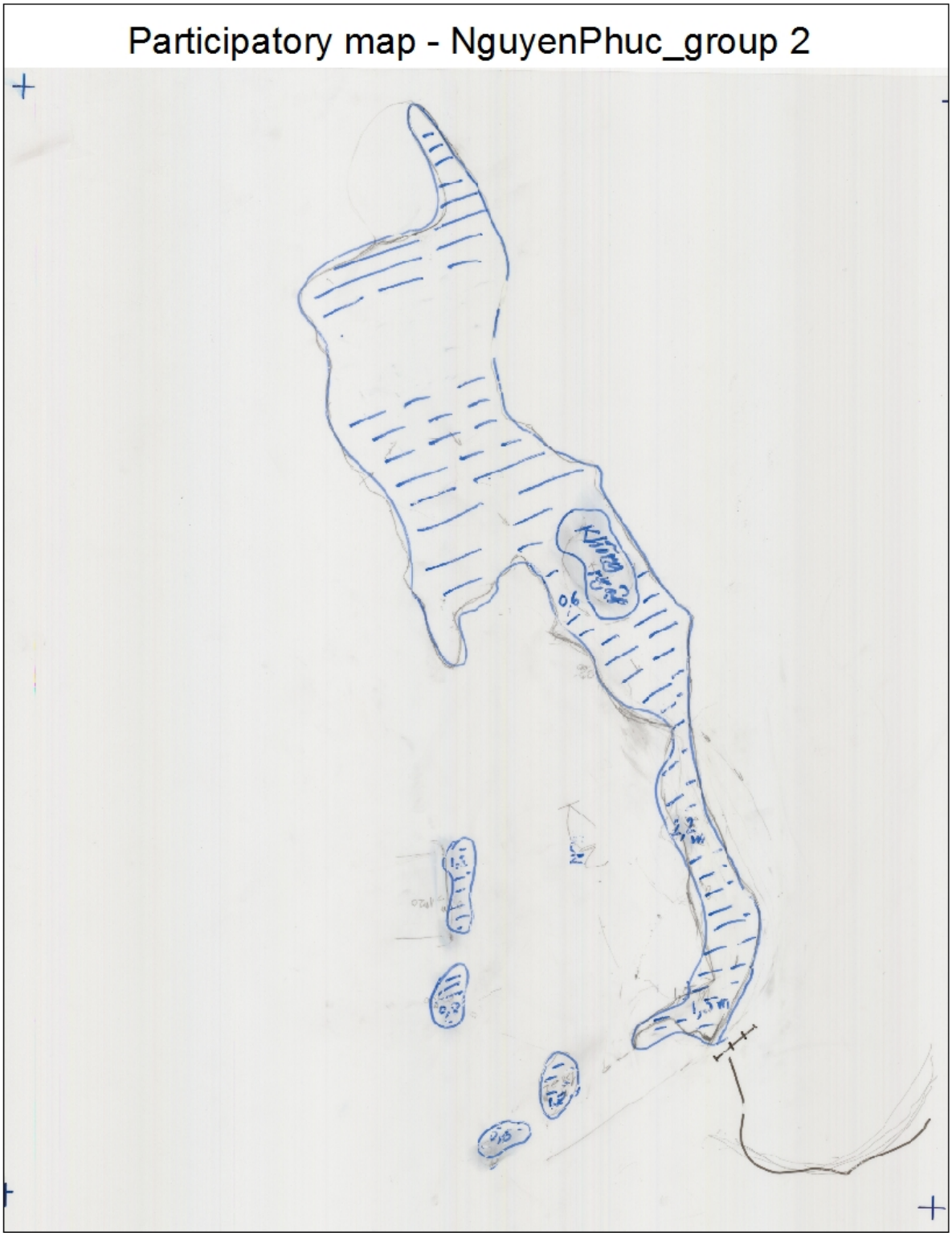
In case you know of anything relevant to this study but it's not included in the questionnaire please write it in the space below.

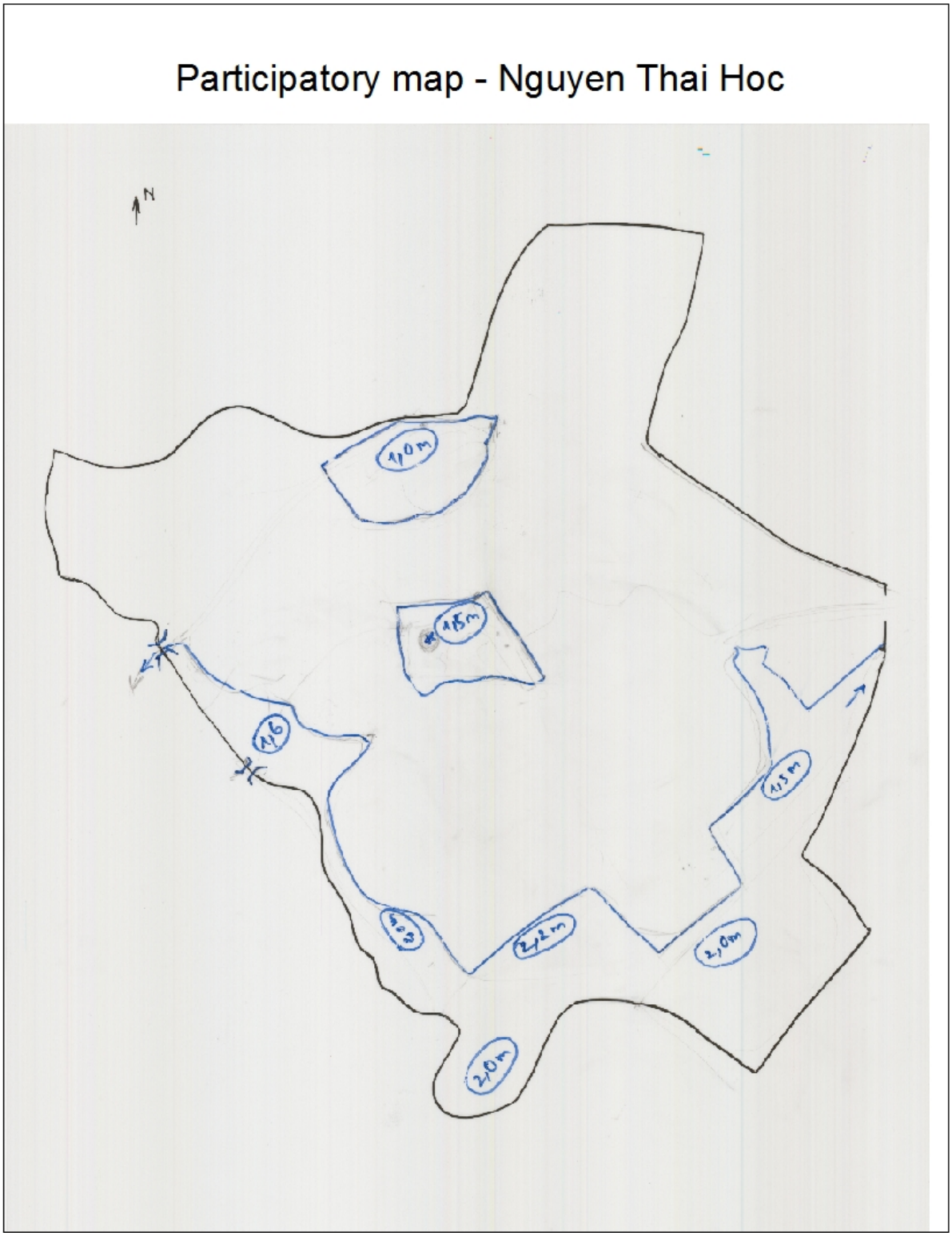
8.2 Participatory maps

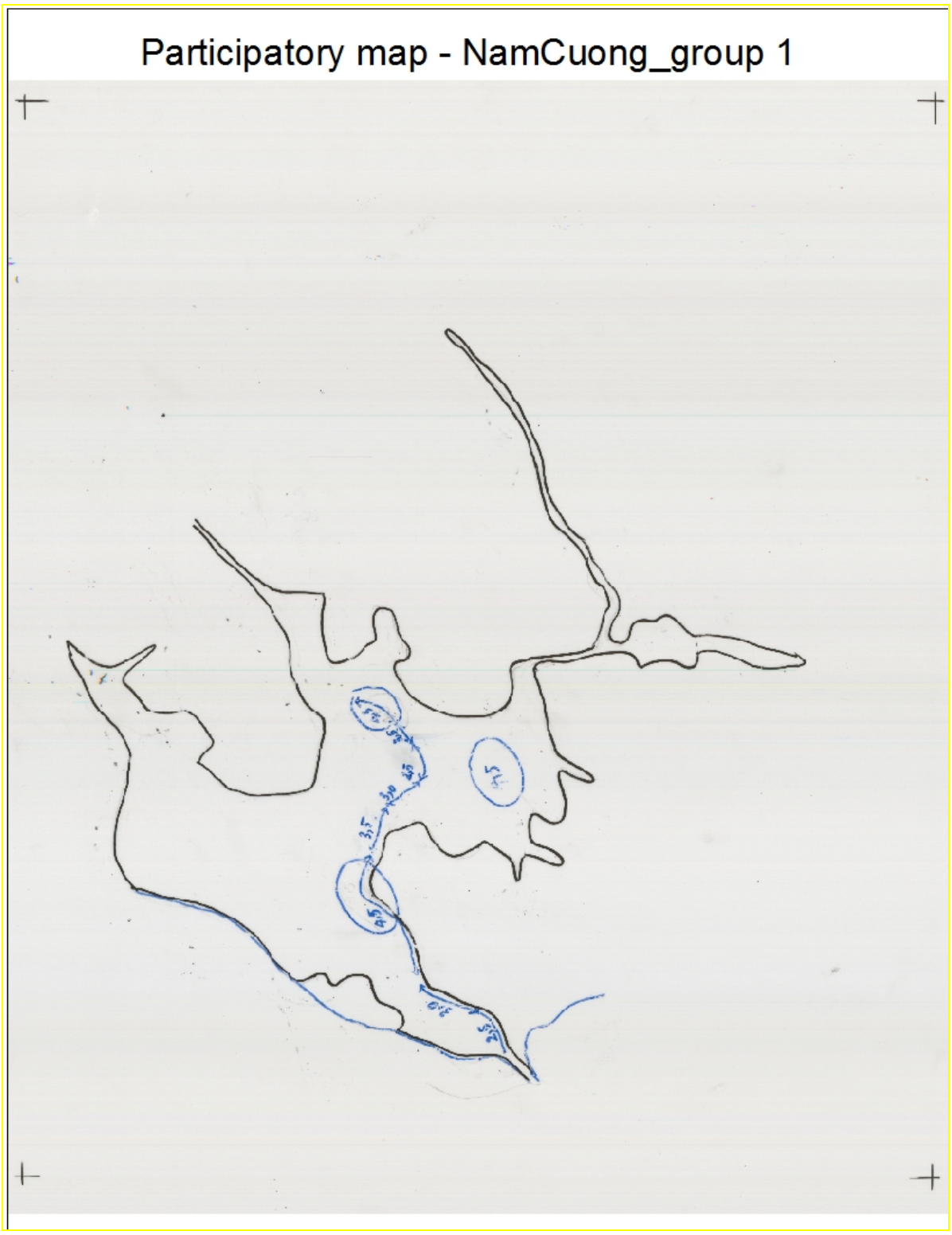



Participatory map - HongHa_group 2
4m
0
4m
4m
1,5
2m
0
2m
3m


Participatory map - NguyenPhuc_group 1
Vùng
Không
Ngập


Participatory map - NguyenPhuc_group 2


Participatory map - Nguyen Thai Hoc
N
1,0m
1,5m
1,6
1,3m
2,2m
2,0m
2,0m


Participatory map - NamCuong_group 1


Participatory map - NamCuong_group 2