THE SOCIOECONOMIC IMPACT ASSESSMENT OF CLIMATE CHANGE IN HO CHI MINH CITY

A thesis approved by the Faculty of Environmental Sciences and Process Engineering at the Brandenburg University of Technology in Cottbus in partial fulfilment of the requirement for the award of the academic degree of Doctor of Philosophy (Ph.D.) in Environmental Sciences.

by

M.Sc. NGUYEN THI PHUONG CHAU

from Ho Chi Minh City, Vietnam

Supervisor: Professor Dr. Dr. h.c. Michael Schmidt
Supervisor: V.Prof. Dr. Britta Rudolff
Day of the oral examination: 07.10.2013

SOZIO-ÖKONOMISCHE ABSCHÄTZUNGEN DER FOLGEN DES KLIMAWANDELS IN HO CHI MINH CITY

Von der Fakultät für Umweltwissenschaften und Verfahrenstechnik der Brandenburgischen Technischen Universität Cottbus zur Erlangung des Akademischen Grades eines Doktors der Philosophie (Ph.D.) in Umweltwissenschaften genehmigte Dissertation

vorgelegt von

M.Sc. NGUYEN THI PHUONG CHAU

aus Ho Chi Minh City, Vietnam

Gutachter: Professor Dr. Dr. h.c. Michael Schmidt
Gutachter: V.Prof. Dr. Britta Rudolff
Tag der mündlichen Prüfung: 07.10.2013

„Gedruckt mit Unterstützung des Deutschen Akademischen Austauschdienstes“

ACKNOWLEDGEMENTS

My dissertation is “The Socioeconomic Impact Assessment of Climate Change in Ho Chi Minh City”. The scholarship is funded by the DAAD program “Study and Research Scholarships of Today for the Megacities of Tomorrow”, under the main supervision of Professor Dr. Dr. h.c. Michael Schmidt, Dean of Faculty of Environmental Sciences and Process Engineering, Head of the Department of Environmental Planning, Brandenburg University of Technology Cottbus-Senftenberg, and Director of Megacity Research Project in Ho Chi Minh City.

I would like to acknowledge Professor Dr. Dr. h.c. Michael Schmidt, Head of the Department of Environmental Planning, Director of the Megacity Research Project, my first supervisor; V.Prof. Dr. Britta Rudolff, Head of the Department of Cultural Heritage Management, my second supervisor; and Dr. Harry Storch, the Megacity Project Coordinator, who supported me to finish proposal writing, conduct the field surveys and fulfill the writing, as well as evaluate every scholarship period.

I would like to acknowledge the BMBF-DAAD, German Academic Exchange Service, who supported me with the scholarship that provided me support for my PhD study. I am very grateful to Mrs. Irmgard Kasperek, who has wholeheartedly supported me through all of the procedure processes and for studying and living in Germany.

I also would like to thank for all of the support from other coordinators of the Megacity Project in Ho Chi Minh City: Nigel Keith Downes and Antje Katzschner; and the Department Secretary, Mrs. Christine Melchet, who helped me to fulfill all procedures for my visa extension, scholarship extension and study, in both German and Vietnam sides.

On the Vietnamese side, I would like to thank Dr. Ho Long Phi, who gave the remarkable comments about the flooding situation in Ho Chi Minh City for me to finish my study. I also would like to thank Mr. Bang Anh Tuan, Head of USSH International Relation Office; and Dr. Pham Gia Tran, Head of USSH Department of Geography, who had supported me to fulfill all study extension procedures with the University of Social Sciences and Humanities in Ho Chi Minh City.

My heartfelt acknowledges to my parents, brothers and sisters, whose prayers and love always were of help to boost up my spirit in finishing my study. And the German Catholic community in Marien Kirche, Cottbus, where we prayed together every Sunday. Finally, I give many thanks to Jesus Christ my Lord and Mother Mary, who have abundantly granted graces to help me all the time.

Nguyen Thi Phuong Chau

Brandenburg University of Technology Cottbus-Senftenberg, Germany

Declaration

I declare that the results in this dissertation "The Socioeconomic Impact Assessment of Climate Change in Ho Chi Minh City" are my own. I worked out the doctoral thesis by myself and that all used aid is listed in the doctoral thesis. This dissertation has never been submitted for any degree and qualification in this or any other University or Institution at national and international level.

Nguyen Thi Phuong Chau

Abstract

Historically as a city situated in a low-lying area a Ho Chi Minh City has been exposed to floods. Ho Chi Minh City is a megacity with uncontrollable urbanization and dynamic economies. In recent years, flood has become a serious problem with a multitude of follow-on impacts. It received more heavy rains affected by tropical storms and cyclones. Further urbanization and future changes in climate are likely to increase flood risks. People have faced the flood impacts on the socioeconomic aspects in recent decades. This study researched on 450 households in different spaces of the inner center (old districts), developed center (urban districts) and new-developing areas (peri-districts) and in different geographical elevations to identify the impacts of flooding in various space and time; and various problems on households' socioeconomic aspects in flood residential areas.

The multi-criteria analyses in GIS and with of the combination SPSS analysis, the surveyed households were identified by their location on the topographic map to clarify the flooding reasons and the types of flood in the areas. The 450 households were chosen in flood residential areas and selected in three categories of characteristics: (1) 150 poor households in flood housing areas; (2) 150 poor households in non-flood housing areas; and (3) 150 higher-income households in non-flood housing areas. This disparity was to analyze the different flood impacts on socioeconomic aspects and on household capitals amongst them. The linear regression in SPSS analysis was used to clarify the relationships between flood types with space factor (geographical elevation) and time factors (flood months in year, and flood years in residential areas). This test gave the supports to the reliability of the study results.

By geographical elevation analysis, flood impacted on the areas in three main types: (1) flood by rain; (2) flood by tide; and (3) flood by both rain and tide. The tidal flood occupied the low-elevation areas; flood by rain invaded the widespread higher-elevation areas; and the mix type of flood occupied the transition areas between flood areas by rain and by tide. Lower land had the deeper flood level, however; many of high-land areas were flooded in this city. Flood in residential areas had caused flood problems on streets, sidewalks (housing pavements), residential drainage system, water supply and electric power. In the poor households of Group One, flood in residential areas impacted their housing areas. To protect housing from flooding, many households had to invest their income for house rising or rebuilding or pavement rising, etc. They also privately invested for repairing or new buying their housing facilities, furniture and other appliances. Their income was lost and deficit. To the household capitals analysis, households were impacted more on physical, financial, natural and human capitals. The poor households in Group One had the most vulnerabilities amongst three groups, whilst there was no support from social organizations and government at levels. The household strategies developed in this study are to support people in flood and flood-prone areas conserving their capabilities to achieve the strategic outcome for sustainable development.

Keywords: *Flood impacts, climatic change, rapid urbanization, socioeconomic impacts, households' capital vulnerability*

Zusammenfassung

Überflutungen durch Hochwasser sind in Ho-Chi-Minh-Stadt, einer Millionenstadt mit unkontrollierbarer Urbanisierung, einer dynamischen Volkswirtschaft und unstrukturierten neuen Siedlungsgebieten zunehmend ein Problem. Der globale Klimawandel setzt der Küstenstadt mit häufiger auftretenden tropischen Wirbelstürmen, Starkregenereignissen und Meeresspiegelanstieg weiter zu. Die Bevölkerung wurde in den letzten Jahrzehnten zunehmend mit den sozio-ökonomischen Auswirkungen von steigenden Hochwasserereignissen konfrontiert. Diese Studie untersucht 450 Wohnungen in verschiedenen Bereichen der Stadt: im Stadtkern (alte Bezirke), im entwickelten Zentrum (urbanes Gebiet) und in neuen Entwicklungsbereichen (Außenbezirke) sowie in Gebieten mit verschiedenen geographischen Erhebungen, um die Auswirkungen von Überschwemmungen in unterschiedlichen Räumen und Zeiten zu erkennen und die verschiedenen sozio-ökonomischen Probleme der Haushalte auf Grund von Überflutungen darzulegen.

Mit Hilfe von Multi-Kriterien-Analysen in GIS in Kombination mit SPSS Analysen wurden die befragten Haushalte auf Grund ihrer Position auf einer topographischen Karte identifiziert. Dadurch konnten die Ursachen und die Art der Überschwemmungen in den jeweiligen Bereichen verdeutlicht werden. Die 450 Haushalte wurden aus überfluteten Wohngebieten ausgewählt und in drei Kategorien mit verschiedenen Merkmalen aufgeteilt: (1) 150 einkommensschwache überflutete Haushalte, (2) 150 einkommensschwache nicht-überflutete Haushalte, und (3) 150 nicht-überflutete Haushalte mit höherem Einkommen. Anhand dieser Differenzierung wurden die verschiedenen Auswirkungen auf sozio-ökonomische Aspekte der Haushalte analysiert. Die lineare Regressionsanalyse in SPSS wurde verwendet, um die Beziehungen zwischen Hochwassertypen, den Raumfaktoren (geografische Höhe) und Zeitfaktoren (überflutet Monate im Jahr, und Jahre der Überschwemmung der Wohnbegiete) zu erklären. Diese Analyse untermauert die Zuverlässigkeit der Ergebnisse der vorliegenden Studie.

Sortiert nach geografischen Höhen, haben drei Arten von Hochwasser die Bereiche beeinflusst: (1) Hochwasser durch Regen, (2) Hochwasser durch Gezeitenfluten, und (3) Hochwasser sowohl durch Regen als auch durch Fluten. Die Gezeitenfluten verursachten vornehmlich in niedrig gelegenen Gebieten Überschwemmungen; Überflutungen durch Regen beeinflussen vor allem die höher liegenden Gebiete und Hochwasser durch Regen und Flut ist in den Übergangsgebieten zwischen höher und niedrig gelegenen Bereichen anzutreffen. Hier verzeichnet niedrig gelegenes Land höhere Überschwemmungen als höher gelegenes Land. Überschwemmungen in

Wohngebieten führen zu überfluteten Straßen, Gehwegen und Hauseinfahrten, der öffentlichen Abwasserkanalisation und der Wasser- und Stromversorgung. In den einkommensschwachen Haushalten der ersten Gruppe hat das Hochwasser direkte Folgen auf die Wohnfläche. Um Gebäude vor Hochwasser zu schützen, haben viele private Haushalte in eine Aufstockung der Gebäude, einen Neubau sowie in den Umbau der gepflasterten Flächen usw. investiert. Nicht nur dafür, sondern auch für die Reparatur von Einrichtung, Möbel und anderer Geräte wurde das monatliche Einkommen ausgegeben, so enstanden viele private Haushaltsdefizite. In der hier durchgeführten Haushaltseinkommensanalyse wurden Haushalte vornehmlich auf das physische, finanzielle, natürliche und menschliche Kapital untersucht. Die einkommensschwachen Haushalte in Gruppe Eins wiesen hier die höchste Vulnerabilität der drei Gruppen auf, dennoch steht diesen Gruppen keine Unterstützung durch soziale Organisationen oder durch die der Regierung zur Verfügung. Die Haushaltsstrategien, die in dieser Studie entwickelt werden, sollen der Bevölkerung in häufig überfluteten und überflutungsgefährdeten Gebieten zugute kommen, sie in ihren Fähigkeiten stärken und so strategisch nachhaltige Entwicklung in den Gebieten unterstützen.

Stichwörter: *Hochwasser, Klimawandel, Urbanisierung, Sozio-ökonomische Auswirkungen, Kapital Vulnerabilität*

Table of Contents

List of Figures

List of Tables

List of Boxes

List of Abbreviations

ADB	Asian Development Bank
AMSL	Above mean sea level
DoC	Department of Construction
DOLISA	HCMC Departments of Labor, War Invalids and Social Affairs
DoNRE	Department of Natural Resources and Environment
DoPA	Department of Architect and Planning
DoT	Department of Transportation
GIS	Geographic information systems
HCMC	Ho Chi Minh City
HEPZA	Export Processing and Industrial Zones Authority, HCMC
ICHARM	International Center for Water Hazard and Risk Management under the auspices of UNESCO
IPCC	Intergovernmental Panel on Climate Change
MoC	Ministry of Construction
OEDC	Organization for Economic Co-operation and Development
SCFC	HCMC Steering Center of Flooding Control Program
SCSFP	HCMC Steering Center of Storm and Flooding Prevention
SEIA	Socio-economic impact assessment
SIHYMETE	Sub-Institute of Hydrometeorology and Environment of South Vietnam
UN-HABITAT	United Nations Human Settlement Programme
UNISDR	United Nation International Strategy for Disaster Reduction
UN-ESCAP	United Nations Economic and Social Commission for Asia and Pacific
USD	US Dollar
VND	Vietnam Dong
VNPM	Vietnam Prime Minister
WB	World Bank
WCRP	World Climate Research Program

1 Introduction

Ho Chi Minh City (HCMC) with its long-dynamic urbanization has caused many problems with over development, planning, and management. Historically, city is situated in a low-lying area has been exposed to floods. However in recent years, flooding has become a serious problem with a multitude of follow-on impacts. In the context related to climate change, it has received more stresses on the environment and other aspects of the city. Flood had caused many problems on social and economic development. Further urbanization and future changes in climate are likely to increase flood risks. Therefore, identifying its problems, reasons, and impacts may help to find solutions for mitigation and adaptation.

1.1 Background of Flooding in Ho Chi Minh City

HCMC in recent years has received more climate pressures with more effects of tropical storms, sea-level rise, and heavy rains. However, the internal force of urbanization has also been the originally important reason that forced flooding increase in this city.

1.1.1 Urbanization as the Internal Force of Urban Flooding

Historically, industrialization was the main driving force to cause a boom of urbanization and encourage the movement population from rural to urban (Gugler & Flanagan, 1978; McGee, 1983; Zhang et al., 2000; ADB, 2001; Kim, 2004; Li & Zchang, 2008). Industrialization and urbanization in most of developing countries are the main factors to the population growth and many other urban problems (Yap, 1992; Setchell, 1995; Goldblum & Wong, 2000; Vincent & Joseph, 2001; Sajor, 2003), such as: over-demand of housing, more built-up land, less open space, lack of urban services, and landuse planning problems (Tran & Yasuoka, 2002). Especially in developing cities, the infrastructure shortage and land and loose of housing management may cause the problems of pollution, cities' resources degradation, loss of life and property, low-standard of living, etc. (Coit, 1998; Nguyen, 2002; Le, 2005; Usavagovitwong & Posriprasert, 2006). These may cause the landuse change and lead the micro climate change of the cities. Urbanization itself does not affect directly on climate change, however; the use-up of energy and the greenhouse gas emissions by people's activities and the downgrading of infrastructures may impact on cities' climate (Tran & Yasuoka, 2002; Tayanç & Toros. 2004; Tayanç et al., 2009; Kahn, 2009; Satterthwaite, 2008 & 2009; Mahmood et al, 2010).

Ho Chi Minh City (HCMC) is the biggest city in Vietnam. In 2011, it had 7,521,138 inhabitants. Its population growth rate is about 2.9% per year, in which the net-immigration rate is two-thirds (average 1.9%) per year (PSO, 2012). HCMC has about 208,000 inhabitant increase each year (Vu, 2010). With the above population growth index, there are about 132,000 migrants coming annually to the city. Since 2004 the migration population was about 30% of the total (DoPA, 2010).

HCMC is still a national hub of economic, education, science, technology, and health care with many experts, researchers, students and workers from other regions of Viet Nam and other countries (Le, 2005&2007; Trinh, 2008; Vo, 2009). There are two main flows of immigrant to HCMC: (1) first is rural – urban migration to looking for a job; (2) second is for educating. In the plan to 2020, the city will have eight more industrial zones and increase the total area to 5,918.47 hectares (Hepza, 2010). Therefore in the near future, the city's immigrants would be more increased. Along with the population growth, the housing issue has become a problem (Coit, 1998; Trinh & Nguyen, 2001). It needs more built-up area and lead the urbanization boomed and expanded to the suburban. There is the disparity of land prices among city. The land price in the inert-districts is higher than in sub-districts, even in the old and new districts (Nguyen, 2006&2008). HCMC had to create new districts and gradually swallow the rural areas (Le, 2007; Nguyen & Duong, 2007; PADDI, 2012). Therefore the sealed surface of built-up areas has been rapidly expanding in suburban areas.

Before the "Doi Moi" Period of 1986, there was not a housing program, but social housing with a few supply, city with high demand of housing had spontaneously developed this time. And because of migration, many illegal houses and slums had been deveoped with various types of housing everywhere (ADB & MoC, 2001). Since 2000 to 2004, city had housing policies and encouraged private enterprises to develop more housing (Department of Cadastry and Housing Land, 2001a,b,&c). However, the loosing urban management and incomplete urban planning additionally caused the seriously spontaneous development. Many new-developed areas have been mixed among the old areas, as the patched-up fabric (DoPA, 2010). HCMC has expanded due to the spontaneous-development because of incomplete infrastructures and services and with various housing types. The various types of housing mixed together with low-rise and high-rise houses, regular-houses as well as villas etc. lead the constraints to urban landscape, urban morphology, and landuse planning (DoPA, 2010). These has caused the urban problems as urban drainage, water supply, and high demand of ground-water using, etc. (Nguyen & Duong, 2007; Vo, 2009; DoPA, 2010). The incomplete drainage system has caused the urban flooding during the tidal time and when the heavy rains come. And the landuse changes improperly have led unequal biochemistry of land and caused the HCMC urban region's climate changes (The National Academies, 2005; Taylor et al., 2006; Lohmann et al., 2009; ADB, 2010).

1.1.2 Climate Change as the External Force of Urban Flooding in Ho Chi Minh City

HCMC is a coastal city in South Vietnam. Most of HCMC is in low elevation. In which, 30% of total area has the altitude ranging between 4 and 32m; 15% of area ranges from 2 to 4m; and the rest 55% range lower than 2m. Most of the areas lower than 1m are in the tidal effect (about 32% of total) (Nguyen & Duong, 2007; Trinh, 2008). Including the downstream areas, the total of under-2m area is about 61%. The city has total rivers and the altitude going down from the Northwest to the Southeast with 16% of total area. More than 7,880 km of rivers and canals (about 33.5 sq.km water surface) link to the large rivers of Saigon, Long Tau, and Soai Rap, where the city is strongly affected by diurnal and semi-diurnal tide regimes. When the rains come this time, heavily or long in duration, the large volume of water causes flooding expansion in large areas. Flooding will be higher and seriously impacted in areas where the drainage systems area inadequate (Trinh, 2008; To, 2008a).

HCMC has two seasons: dry season and rainy season. The rainy season begins from May to November. The average rainfall is about 1,900mm per year, more rain in the inert city (average 2,100mm per year) and less rain in the suburban area (1,500 – 1,700mm per year). The precipitation of long-heavy rains is appeared in the end, concentrated in September and October. Uneven distribution of rainfalls and the rains have caused floods to HCMC because of old and incomplete drainage systems and in tidal flows. The urban pollution and other socio-economic impacts may be increased because of flooding.

HCMC is also significantly impacted by global climate change. Global climate change can be seen with the warming temperature, more droughts and storms, and increasing sea-level (Knutti & Hergerl, 2008; Yusuf & Francisco, 2009; IPCC, 2007a&2010). The anthropogenic greenhouse gas emission leads the global warming and changes the balance of regional meteorology (Taylor et al., 2006; Lohmann et al., 2009). The frequencies and intensities of storms, droughts, and rains are abnormal and uncontrollable (ADB, 2010). Global warming has resulted to raise the sea level. Especially the coastal area, HCMC has more impacts of sea level rise. The sea level rise combined with the diurnal and semi-diurnal tide regimes has caused the big flooding of the city (Trinh, 2008).

Vietnam is located in a Tropical low-pressure area and receives on average 5 to 6 tropical storms each year. Long before, the tropical storms rarely affected HCMC. But in recent decades, HCMC has been affected by 10% of all storms coming to Vietnam each year and has re-occurring heavy rains. The Vietnam Ministry of Agriculture and Rural Development showed during the last thirty years or more, HCMC has received more numbers of abnormal floods. The very high tidal flows often happen and flooding caused by strong storms, winds, and heavy rains impact frequently in the rainy season of HCMC (Trinh, 2008; ADB, 2010).

Source: Developed based on flooding situation in Ho Chi Minh City

Figure 1.1: Process of flooding expansion in Ho Chi Minh City

All those, as well as other social activities and economic development, have impacted HCMC and caused the climate change problems (See the illustration in Figure 1.1 below). The global climate change has brought more heavy rains with high intensive rainfall. The urban temperature change and dynamic urbanization have changed the urban landuse. All have caused high flows of run-off water and flooding increase. Flood has impacted socioeconomic aspects of communities, households, and individuals in flooded areas. Flooding responses to reduce flood impacts caused communities, households and individuals more difficult living situations. Some responses with inappropriate approaches may even cause more flooding to HCMC. The cycle of flooding impact time and again cause the stronger impacts on socio-economic aspects in HCMC (UNISDR, 2004; IPCC, 2007a; Nicholls et al., 2008).

1.2 Problem Statement

Historically, HCMC, a mega-city in low-lying area has been exposed to floods. In recent decades, city is facing climatic problems with more heavy rains and high tide in rainy season. With a high population growth, city has also received the problems of urbanization, lack of urban infrastructure and services that has pushed the flooding exposure. This had seriously impacted on socioeconomic aspects and affected the sustainable development of the city.

Therefore, study of the socioeconomic impacts due to flood problems has been assessed to look for adaptive solutions for flooding control and management out of the effects on the social economic development of HCMC.

1.3 Research Objectives

Research objectives of this study consisted of the main objective and the strategic objectives. They were guides for developing the research questions, research outline, and research questionnaire.

1.3.1 Main Research Objective

Using socioeconomic impact assessment is to analyze and estimate the impacts of flooding on socio and economic aspects in Ho Chi Minh City.

1.3.2 Strategic Objectives

Based on the above main objective, the strategic objectives developed for this study were the following:

1. To generalize the flooding situation in the city.
2. To identify the trend factors in urban vulnerable context of the flooding situation in HCMC.
3. To analyze socio-economic losses by flood in residential area (community level) in HCMC.

4. To compare the socio-economic losses by flooding amongst household groups of housing-flooded poor households, housing-non-flooded poor households, and housing-non-flooded and non-poor households in HCMC.
5. To analyze the different flooding types impacted on households in different geographical elevation areas.
6. To analyze the household capitals impacted by flood.
7. To compare the household capitals impacted by flood amongst groups in flooded areas.
8. To develop strategies for flooding adaptation to support households in flooded areas in HCMC.

1.4 Research Questions

The research questions for this study were:

1. What are the flooding problems in HCMC?
2. What are the trend factors in urban vulnerable context of the flooding situation in HCMC?
3. What and how are the households' social-economic characteristics impacted by floods in the residential area of HCMC?
4. How were socioeconomic aspects impacted by floods? And which group of flooded-housing poor households, non-flooded- housing poor households, and non-flooded-housing and non-poor households was the strongest impacted on the socio-economic aspects by flood in residential/community areas?
5. What are the types of flooding in the flooded areas and in different geographical elevations? And how did they impact on households in the areas?
6. What are the household capitals impacted by flood?
7. How did flood impact on household capitals amongst groups (flooded-housing poor households, non-flooded- housing poor households, and non-flooded- housing and non-poor households) in flooded areas?
8. What are the proper strategies for flooding adaptation to support households in flooded areas in HCMC?

1.5 Research Scopes

The research scopes included scopes of research and scientific fields to help clarify the study area, study limitation as well as the possibility to carry out the study.

1.5.1 Scope of Research Field

The research field focuses on flooding areas in HCMC. It was necessary to spatial analyses for whole flooding area in the city to understand the flooding impacts on the socio-economic aspects in different spaces of center, new urban, and rural areas, and in different elevation of the city area.

To the household level, research field was chosen partly in flooding area but still followed the spatial principle from center, new urban, and rural areas to compare the different impacts on households in different urban areas.

1.5.2 Scope of Scientific Field

The research studied was on the flooding impacts on socio-economic aspects by climate change. The socioeconomic aspects were analyzed in the levels of commune and household.

- In the social aspects: Flood impacted on community environment, housing area, resident areas, and on population, etc.. And to households, flooding impacted on earning activities, living and housing condition, etc.
- In the economic aspects: From losses on earning acitvities, flood caused income losses on community and housing damages. Communities and households lost their incomes on flooding response (for upgrading or repairing housing and street, housing facilities, etc.). Then other capitals and assets of communities, households, and individuals were either affected (such as human and health, social, physical, and finacial capitals).

1.5.3 Scope of Research Limitation

The research had the measurable and immeasurable limitations on the research field and scientific field. The limitations depended on the official data from the city statistic office as well as the flood-related data from official reports and researches; or the official allowance to do surveys at the fieldtrip, etc. They can be in details as follows:

- Limitation on research field: spatial analysis about flooding impact must be linked to the city's statistic data and programming data. The flooding areas where that had no statistic data or programming data must be cancelled.
- Limitation on scientific field: This research was on the significant characteristics of social economic aspects of commune, and households which were linked to the availability of city's statistic data. And the limitation of research was because of time limitation to site visit, difficulties on local government and household contacts, and research financial capacity, etc.

In case of research works would be reached to the working plan, the research results will be fulfilled with all of above research field and scientific field.

1.6 The News of Research, Practice, and Application

This is a topical and urgent event, especially the areas that have been strongly impacted by floods. There were some researches related to physical flooding and technical infrastructure for flooding adaptation in HCMC; whereas there was little information sharing on households' flooding impacts, especially research on households' capital analysis. The research helps to identify the flooding impacts on socioeconomic characteristics, household capitals and their seriousness at current situation and the future scenario (in case of without any adaptation and mitigation).

The results of the research may support to social economic planning and be the references to urban planning at local and city levels.

1.7 Research Outline

Based on the strategic objectives and research questions, the structure of the study was outlined as follow:

1. Introduction
2. Climate Change and Flooding Impacts on Socioeconomic Aspects in Developing Countries
3. Assessment Methodology on Socioeconomic Impacts of Flooding in Ho Chi Minh City
4. Urban Vulnerable Context of Flooding in Ho Chi Minh City
5. Flooding Impacts on Socio-Economic Aspects in Ho Chi Minh City
6. Flooding Impacts on Geographical Elevations in Ho Chi Minh City
7. Households' Capital Analysis to Flooding Adaptation in Ho Chi Minh City
8. Strategies for Flooding Adaptation to Households in Ho Chi Minh City
9. Conclusion and Recommendations

1.8 Summary for Chapter One

The megacity of HCMC has been the center of economic, financial and technical sciences. It has attracted many people for working, educating and researching in many fields. The growing population and immigration from rural as well as neighbor provinces caused the urbanization and urban expansion. The demands of housing, urban functions and services have increased and they need the encroachment on green space, rural and agricultural areas for increasing of built-up coverage.

Global climate change has impacted HCMC with the increase of tropical storms and cyclones, and temperature. It has brought more heavy rains and flooding in the city. On the other hand, long-term urbanization and rapid increase of built-up coverage have occupied many green spaces and parks, and the low-land areas for water storage and infiltration. These processes have caused more serious flooding and have impacted socioeconomic aspects in this city.

From the problem statement of flooding, the research objectives and questions, research scopes and limitation were developed to apply the methods and conduct of the study. The results of this study were used to find solutions for flooding adaptation in HCMC.

2 Climate Change and Flooding Impacts on Socioeconomic Aspects in Developing Countries

2.1 Background on Climate Change

The global climate change has now the widespread information as the basement for many researches and studies. Global climate change has caused many problems on various physical and social aspects, and exposed in various outcomes as well. This study aims to understand flooding, its reason and impact outcomes on socioeconomic aspects in urban area.

2.1.1 Global Climate Change

The topic of global climate has been emerged in recent decades concerning the changes of the global climate. The average pattern of weather which stays the same in centuries is called the climate. The understanding of global climate change is the changes of the patterns of weather and on the climatic variations. The weather evolves and changes all the time, however, many human activities on the earth that have caused the significant changes of the earth and the climate. The climate system can be defined as average pattern of weather. It is the complex and interactive system of the variability of temperature, precipitation and wind over a period of time. The climate system can be changed by its own internal dynamics factors and by the effects of external factors. (Morgan et al., 1994; IPCC, 2007b).

The emergence of the Industrial Revolution has forced the rocketed demand on natural resources and increased the scale of human impacts to the environment. The exploitation of natural resources has changed the balance of the ecosystems and the global environment. Furthermore, the human activities have impacted the change of global climate and the balance of the natural environment (Giron, et al., 2010).

2.1.2 Global Warming

The global warming has also close relation to the above industrial revolution and human activities in centuries. The increasing of anthropogenic greenhouse gases in the atmosphere and the changes of temperature have been scientifically observed (Athar, 2013; Belgacem & Louhaichi, 2013). The global warming may occur in somewhere and in someday, however, it was observed in average that the global is warmer. It will result in the possible changes of global climate: the alternative patterns and the frequencies of rain and snow, the changes of winds' directions, and the seasons' duration, etc (Yang et al., 2010; Soo et al., 2013; Liu et al., 2013). These changes lead to more frequencies of extreme climate events: the increasing of very hot days and the decreasing of colder and frosty days (Harrison & Carson, 2013). It will also cause the alternatives of storms, droughts, floods, and in sea level, in both frequency and intensity. Furthermore, the intense summer heat could result in more severe storms and tropical cyclones, the warmer oceans and more energy stored in the warming atmosphere (Lankao, 2013). The changes of climate then affect the human activities, ecosystems and natural environment. In the situation if the anthropogenic emissions of greenhouse gases continue to increase and to be uncontrollable, the scenarios of climate change and its impacts would be possibly increased (Morgan et al, 1994; Cowell & Consultant, 2000; Tompkins, 2002; Esper et al., 2005; Linden and Mitchell, 2009).

2.1.3 Sea Level Rise

Sea level refers to the ocean's average level over a long time. Physically, sea level changes gradually as the coastal area or the ocean floor rises or falls due to natural geological changes. In some aspects, human activities have pushed the sea level changes faster. If the climate becomes warmer, global warming might cause a general increase in sea level all around the world, to the locations that now occur in sea level (Harrison & Carson, 2013). If warming climate were to continue long and large enough, the melting from the mountain glaciers and polar ice caps could release large amounts of water into the oceans. This results in significant rise of sea level and affects many parts of the world. It causes permanent flooding of very low lying areas, and increased storm damage (Lankao, 2013). The larger problems when storms bring more heavy rains and larger amount of water into the areas. When flood comes more often and more exposure, the dense population of the coastal regions and of very low lying areas may be impacted more rapidly, their building and other structures may suffer greater and more frequent damage (Morgan et al., 1994; Melia, 2010).

During the last glacial maxima, the global sea level was about 120-130 meters below the present-day level. The change rate of sea level was not constant in parts of these periods (Bard, 2010; Colberg & Bindoff, 2010). The various rising of sea level happens in different parts and different regions of the earth. It depends fundamentally on geographically and geologically regional or local sea level conditions impacting the shore lines of the areas (Slangen et al., 2010; Unnikrishnan, 2010). Because of these conditions and the inconstant of sea-level-change rate, the oserved regional sea level changes can be different sign to global estimates. And it also depends on the changes of ocean dynamics of climate time scales, the rising of sea level become variations in large-scale (Stammer, 2010). After the rapid seismic, some areas of land downfall and the sea level may rise up. The sea level may also rise above or below the eustatic values (Slangen et al., 2010; Trisirisatayawong, et al., 2010; Yasuda, 2010). There are coastal areas and islands which have different sea level rise in different parts of the coast, such as the Thailand Gulf (Trisirisatayawong et al., 2010), the North Sea (Zorita et al., 2010), and the Indian coast (Unnikrishnan, 2010).

2.1.4 Droughts, Floods, and Storms

The scientific results of climate observation and modeling projections show the increase of precipitation extremes in the warmer climate. Its intensity increases in almost areas on the earth. And it directly affects the risk of floods, storms, and droughts (Kundzewicz et al., 2007). The precipitation extremes raise more unequal distribution of water resource in different regions. Some regions receive more extreme storms. And the rainfall intensity of heavy rains from storms cause more flash flooding and urban flooding to the areas (Tompkins, 2002; Nicholls et al., 2007). It also results in more heavy storms and tropical cyclones. This could cause greater flooding, mud/land-slides, and damage to buildings, roads, and bridges (Pelling, 1999; UNISDR, 2004). In contrast, some other regions receive less water with more droughts. However, the droughts may be driven by the interaction between the natural condition related to the change of climate and the human actions, such as the changes of land use and land cover, and the increasing demand of water (Kundzewicz et al., 2007).

2.1.5 Other Outcomes of Global Climate Change

The changing of global climate has also affected many other parts in the earth. In the low-lying areas, the sea level rise already causes the changes of groundwater levels in both amount of water and its quality, and submergence during high tides are becoming more frequent. The concerned changing now emerging that many island atolls will become uninhabitable (Kundzewicz et al., 2007; Cruz et al., 2007).

In the mid-latitudes, particularly in inland regions, the long-lasting droughts become more frequent. Droughts could come along with reduced water supply, lost productivity, and possibly famine (Tompkins, 2002). Furthermore, the extreme precipitation brings drier conditions and causes more frequent and higher intense bushfires. Less water in drought areas will affect water supply to farmers, irrigators, and cities, etc. In addition, there will be less water storages or dams of runoff water. Therefore the supply water becomes more difficult to solve these problems (Cruz et al., 2007). Under these conditions, water demand will increases as a precious resource. In the areas with more runoff water of flooding and storm the quality of water will change. And in the less runoff areas of droughts, less water in the rivers and streams, the quality of water will also change, such as the increase of salinity and sedimentation in the water resource. And the high quality water will be particularly valuable. Ecosystems throughout the world are in pressures since climate changes and from human activities that make them increasingly vulnerable and less capable of adapting to the changes (Athar, 2013; Belgacem &

Louhaichi, 2013). These conditions will reduce biodiversity and the function of most ecosystems (Harrison & Carson, 2013).

Sea level rise will relate to the increasing risks of inundation, storm surges, and the failure of sanitation systems, such as storm-water and liquid-waste drainage systems. This can lead to loss of productive land and associated food shortages, increase the disease, and loss of fish nurseries, etc. Flooding has not only impacted to the urban poor, but also made a lager income disparity among groups in the city (Yohe & Hope, 2013; Kunreuther, 2013; Banks et al., 2013).

Climate change will affect the socioeconomic factors, human health, safety and living standards due to the multi-hazard exposures. There are likely to be more instances of heat-wave caused the illness and death (Sharma & Tomar, 2013). In converse, in the Northern Hemisphere the deaths related to cold weather may be fewer. Loss of life and livelihoods, more vulnerability and loss of infrastructure from natural disasters such as fire, flood, drought, landslides and storms could increase as well (Cowell & Consultant, 2000; UNISDR, 2004).

Furthermore, the longer term indirectly impacts include a change in the incidence and distribution of infectious diseases, especially those that are transmitted through animals and insects to human disease. These are as malaria, dengue fever, and rabies, etc. Where the warmer and drier climate develop, the higher risks of respiratory disease associated with pollen and dust can be anticipated (Adelekan, 2013; Hardoy & Pandiella, 2013).

There is growing evidence that human activities are affecting the earth's climate and that climate change. This is the most significant global environmental issue facing the world today. Forcing migration of human populations and extinctions of fauna and flora (Cruz et al., 2007). The future climate effects human activities depend on the future emissions of greenhouse gases, and the impacts of the resulting changes in climate (Arnell et al., 2004). And it also depends on the human actions in developing activities and adapting the climate change.

2.2 Flooding Expansion in Developing Cities

Flood-prone areas contain a high proportion of the world's economic assets and population. It is recognized that climate change and sea level rise will impact seriously upon the natural environment and human society in cities and the coastal zone. The increasing of temperature may change the regional ecosystem, vegetation cover and land cover (Yang et al., 2010; Sen et al., 2013; Blanc & Strobl, 2013). Furthermore, urbanization and industrialization processes lead the dynamic changes of landuse and caused more climate risks and problems on societies (Zhang et al., 2010; Mahmood et al, 2010; Lu et al., 2011). These would change the capacities of evaporation and run-off water on the ground surface. Coasts will be exposed to increasing risks, including coastal erosion, over coming decades due to climate change and sea-level rise with very high confidence (Kahnay & Cai, 2003; Kahnay et al., 2006). The risks from storms and sea-level rise increase hazards from coastal flooding and erosion. The effects of climate change are sudden rather than gradual in these areas (UNISDR, 2004; Cruz et al., 2007; Snoussi et al., 2008; Satterthwaite. 2008; Khan and Inam. 2010).

The present trend of rapid urbanization of coastal zones in most developing countries leads an increasing number of people and property at risk due to climate change and the sea-level rise. The consequential flash flooding and urban flooding are expected to affect most low-lying coastal cities. A series of case studies has been conducted to assess socioeconomic impacts of flooding under climate change conditions in low-lying large coastal cities (Arnell et al., 2004; Adelekan, 2013).

2.3 Impacts of Flooding on Socioeconomic Aspects

For many cities, the scale of the risk from these extreme weather events is much influenced by the quality of housing and infrastructure. The scale of risk depends on which urban planning and land-use management have successfully ensured risk reduction within urban construction and expansion. It also relates to the level of preparation among the city's population and key emergency services (Tucci, 2005). For the coastal settlements, the integrity of coastal ecosystems and, in particular, protective mangrove and salt marsh systems will also influence risk (Satterthwaite, 2008).

Table 2.1: The climate hazard hotspots and dominant hazards in Southeast Asia

Climate hazard hotspots	Dominant hazards
Northwestern Vietnam	Droughts
Eastern coastal areas of Vietnam	Cyclones, droughts
Mekong region of Vietnam	Sea level rise
Bangkok and its surrounding area in Thailand	Sea level rise, floods
Southern regions of Thailand	Droughts, floods
The Philippines	Cyclones, landslides, floods, droughts
Sabah state in Malaysia	Droughts
Western and eastern area of Java Island, Indonesia	Droughts, floods, landslides, sea level rise

Source: Yusuf and Francisco (2009)

Table 2.1 above describes the important impacts of climate change in Southeast Asia. Annual flood events in Asia have three times of economic losses and human casualties have increased by more than five-fold in the last 30 years (Møller et al., 2013). High rate of the urbanization and population dynamic in South and Southeast Asia are likely to lead the situation worsen, especially in low-lying large cities, which are affected by sea water intrusion in the coastal areas. Potentially, sea-level rise will cause the significant impacts in these large coastal cities. And very few countries have planned to deal with these problems (Chan, 1998; Sharma & Tomar, 2013).

It is therefore necessary to assess the socioeconomic impacts of flooding under climate change conditions in low-lying large cities as in South and Southeast Asia. This will also support the policy makers to better understand the vulnerability of developing and coastal cities under the variability of climate and the socioeconomic changes of society (Dutta et al., 2004; Yusuf & Francisco, 2009).

Flood impact is also countable by land vulnerability and land value. It can reduce the land value and people's property. Damageable property values are assumed to increase at the same rate as floodplain land values. Nonetheless, potential human life loss due to flood hazard is critically important. However, it is difficult and controversial to model, and is not evaluated in the objective function. Higher urbanization rates increase total flood management costs, because higher damageable property and land values can be calculated to count the higher flood prevention expenses and raise the costs of losses when inundation occurs (Zhu et al., 2007).

2.4 Socioeconomic Impact Assessment on Flooding

Climate change and flood hazards have been affected in many aspects of cities and urban society. Many adopted solutions and policies to climate and flood disasters, however, they have not been fully adequate to alleviate vulnerabilities. Therefore, in socioeconomic aspects, it needs more knowledge, methods and tools for hazard analysis and assessment (Terakawa et al., 2006; IPCC, 2007c&d; Yohe & Hope, 2013). Especially it is needed in small scales of household and individual levels (Oppenheimer, 2013).

2.4.1 Background of Socioeconomic Impact Assessment

Socioeconomic impact assessment (SEIA) is a useful tool to help understand the potential range of impacts of a proposed change, and the likely responses of those impacted if the change occurs. It can be used to assess impacts of a wide range of changes: from a proposal to develop the infrastructure such as bridge, high-way road, or industrial zones to a proposal to change access to a natural resource such as a mining, forest, or the ocean. This understanding can help develop the impact mitigation strategies to minimize the negative and maximize positive impacts of any change (Australian Bureau of Rural Sciences, 2005; Mackenzie Valley Environmental Impact Review Board, 2007).

SEIA is the systematic analysis tool used to identify and evaluate the potential socioeconomic and cultural impacts of a proposed development on the society and circumstances of individuals, their households, and their communities. If such potential impacts are significant and disadvantaged, SEIA can assist the developer, decision-maker, and other parties to the EIA process, to find the solution, and to remove or prevent these impacts from happening.

This tool is used to determine not only the full range of impacts, such as changes to develop the urban services, improve the people income and employment, access to services and quality of life, but it also the implications of smaller scales of impacts in particular change. The impact analysis of this tool to a certain proposal or policy are considered in the aspects of many activities which may be occurring. Therefore, it is necessary to identify the roots of impacts separately from the different sources in the begining (CGG, 2005; MAL, 2007).

As introducing in the above, SEIA can measure the impacts of a proposed development and change in different scales of aspects, however, the significant results of the measuring depend on the. Scientifically, people who are in impacts, directly or indirectly, the impacts on valued socioeconomic factors can be significant. SEIA tool helps not only for reducing or avoiding the impacts, but also for planning and for proposed development. The advantaged measurements of SEIA can help:

- to improve a better standard of living due to increase income, access to employment, create the business opportunities, or skills training and educating,
- to connect the social network amongst individuals, households, and community to other social organizations and development assossiations, and
- to raise funds to improve social infrastructure and services, and cultural maintenance programs.

Furthermore, SEIA can specify how to reduce impacts, manage them, and evaluate the improvement of the process.

The quality criteria for indicator development should be: measurable and relevant, represent an issue that is important to the relevant topic, policy-relevant, only measure important key-elements instead of trying to indicate all aspects, analytically and statistically sound, understandable, easy to interpret, sensitive and specific to the underlying phenomenon, valid/accurate, reproducible based on available data, data comparability, appropriate scope, and cost effective (Vanclay, 2003; Misra, 2005; Birkmann, 2006 & 2007).

2.4.2 Socioeconomic Impact Assessment of Flood Area

Climate change is currently regarded as one of the most important threats to the environment and to human well-being. Flooding is one problem which may have the serious and widespread impacts to human life that can be measured by SEIA. Costs for improvement are highly vulnerable to extreme events, such as storms which impose substantial costs on coastal societies, or damaged infrastructure and urban services in urban areas. If the observed changes of climate continued to occur, climate change will put more burden on society and on natural systems. The mapping of damages and risks of flood can be carried out by applying the means of geographic information systems (GIS) (Cruz et al., 2007; Giron, et al., 2010).

Adaptive capacity is defined as the degree to which adjustments in practices, processes, or structures can moderate or offset potential damage or take advantage of opportunities (from climate change). It can be written in equation form as follow (Yusuf & Francisco, 2009):

Adaptive Capacity = f(socio-economic factors, technology, infrastructure)

The socioeconomic and urban infrastructure impact assessment and analysis will help to achieve the successful adaptation of climate change in flooding areas (Woodruff & Holland, 2008; Giron et al., 2010).

2.4.3 Damage Housing and Infrastructure Calculated by Cost Analysis

Depending on the availability of data, the damage functions will be elaborated or adapted in order to allow the assessment of different categories of damages. The housing damage could be an estimate as in the following fomula:

Housing value = Housing price/Square meter x flat area of house (for each typology)

The economic, social, and ecological impact assessment techniques depend on good quality and detailed input data for both validating the methods as well as analyzing them. The assessment methods should more accurate if information from private as well as public institutions had been made more accessible.

2.5 Flooding Impact on Urban Households' Capitals

2.5.1 Flooding Impacts on Urban Poor

In developing cities, the majority of flooded areas are residential areas where city population are concentrated. The urbanization has occupied the rural-agricultural areas and green spaces. The urban poor tend to move to informal settlement in low-land areas; where infrastructure (such as drainage systems) and urban services are weak (Tucci, 2001; Moser & Satterthwaite, 2008; WB, 2011a; Feiden, 2011). Not only the poor, but higher-income people have also been impacted and become the vulnerable group in flooding cities (Pangilan et al., 2011). People have faced the growing impacts of flooding on social and economic aspects, while many governments have financial deficit to flooding adaptation (Zoleta-Nantes, 2000; Mohamad et al., 2012).

Many flooded cities in developing countries had the encroachment of rivers' tributaries and low-land areas, where they are appropriate for water storage in the peak hour of flooding. The rapid urbanization has resulted in the increase of built-up coverage and reduced the infiltration and permeability of urban environment. It has pushed the flooding crises more in these cities. And the loose urban management as well as incomplete planning has caused cities disorder and increased flooding hazards (Braga, 1998; Tucci, 1998; Mohamad et al., 2012).

2.5.2 Household Capitals and Flooding Impacts

Many previous researches showed that flooding in residential areas has much impact on housing areas. It caused many damages on houses, housing infrastructure, housing drainage, and water supply, etc. (Tucci, 2001; Sigauke, 2002; Parkinson, 2003; WB, 2011a). It also damaged many housing equipments, housing appliances, and facilities.

In developing countries, when low of deficit finance for flooding response from the government, people in flooded areas as well as in flood-prone areas must respond by themselves in their communities and housing areas. People then loss their lives and assets and become more vulnerable (Chan, 1998; Tucci, 2001; Sigauke, 2002; Parkinson, 2003). Housing responses (such as house rising, housing upgrading, or pavement rising, etc.) have reduced their income and financial capital; while most important capitals of people in urban areas are financial and human capitals (Meikle, 2001; Farrington et al., 2002). These weakened capitals would impact other capitals of humans (such and health and occupation, etc.). They then lose their capabilities for sustainable development. Therefore, they really need the social and political supports to achieve their household strategies (Farrington et al., 2002; Carney, 2005; Jha et al., 2011).

2.6 Flood Adaptation Based on the Socioeconomic Impact Assessment

Challenges to adapt to variations and changes in environmental conditions have been a important part of every period of human history and human societies. Applying the flood adaptation and mitigation could reduce its impacts on the societies and the nature environment. Adaptation process may be anticipatory or responsive; may be implemented by self-supported and decentralized, or dependent on the central-hierachy policy changes and social collaboration. The process can be gradual and evolutionary or rooted in abrupt changes in settlement patterns or economic activity (WB, 2011a&b). Historically, adaptations to climate change have probably been carried out mostly in the vulneable areas facing to flooding, storm gathering, and droughts and need to work with water resource and water suppy. However, the dense population and settlements, and their activities are in the most extreme environmental areas. Therefore adaptation has been accomplished successfully depend on the known conditions, given economic and human resources and access to knowledge of the area (IPCC, 2007c & 2007d; Stott & Forest, 2007).

The WWF International (2009) has summarized the definitions to climate change adaptation by the IPCC (2007b) as the follow:

Adaptation: adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation.

Anticipatory adaptation: adaptation that takes place before impacts of climate change is observed, also referred to as proactive adaptation.

Autonomous adaptation: adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems, also referred to as spontaneous adaptation.

Planned adaptation: adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Adaptive capacity: the ability of a system is to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Resilience: The ability of a social or ecological system is to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Vulnerability: vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

The strategies for adaptation are widely vary depending on the exposure and impacts of flooding of an area or sector. They also depend on the sensitivity to such changes of impacts, and the capacities to cope with the such as improving climate and weather forecasting at a local scale, the trends of human actions, and public education. However, the effectiveness of the adaptive strategies applied successfully in most parts of the area and to most of population of the area is uncertain and uneven. And it dependently relates to other developmental strategies of the areas.

To effectively manage each of the key drivers of risk, adaptation strategies must encompass a range of policy options, including, as relevant, a combination of (1) upgraded protection, (2) managing subsidence (in susceptible cities), (3) land use planning, focusing new development away from the floodplain, (4) selective relocation away from existing city areas, and (5) flood warning and evacuation, particularly as an immediate response in poorer countries. Relocation seems unlikely for valuable city infrastructure, and a portfolio of the other approaches could act to manage and reduce risks to acceptable levels (Nicholls et al., 2008). The effective adaptation is essential for managing risks against the background of developing cities and the changing climate. Coastal cities will face great challenges in managing the significant exposure that will come from both human and environmental influences, including climate change (Satterthwaite, 2008; Nicholls et al., 2008).

Regarding to the effective climate change management strategies to the impacted area, landuse practices and protection investments must be involved into the process. The socioeconomic responses have been known as the reactive actions to the changes. Consequently, to the coastal or port cities, the adaptive strategy is suggested to be anticipatory to manage flood risk for impacts (Nicholls et al., 2008). Such action could inform effective management responses, the lesson learned as the knowledge base that could help to advance action in many other locations to developing countries.

Without adaptation, flooding impact is likely to bring ever-increasing vulnerabilities, accidental deaths and serious injuries and increasingly serious damages to people's livelihoods, property, environmental quality, and future prosperity. To policy driven, the adaptive capacity of urban governments must obviously have the national considerations. However, they center around economic and political importance. Therefore, in almost developing countries, the large vulnerability of urban populations are known in new analyses to face the increased risks or new risks related to climate change (Satterthwaite, 2008).

2.7 Role of City Government, District Municipalities, and Stakeholders in Adapting to Climate Change

To climate change adaptation in urban area, city government has a critical role in dealing with the impact problems, as well as in mitigation. In fact, they have the central role in adaptation and mitigation. Although it is obvious that the supportive institutional, regulatory and financial framework is come from higher levels of government, and from international agencies as well. However, unlike most environmental hazards, the impacts of climate change in most of low- and middle-income nations become more exposure that city government has no capacity enough to reduce and manage the problems (Satterthwaite, 2008).

The climate change impacts in developing cities tend to more extreme vulnerability because of their high population densities and urban cross-cuttings that their high adaptive capacities are not enough to moderate their extreme hazards. The urban population who has most vulnerability falled under the poor population living in informal settlements, lack of or low quality of infrastructure, and working within the informal economy (Brugmann, 2013). The low capacity of urban government can also come from the inadequacies and deficiencies in provision for infrastructure and urban services which could reduce risks (Yusuf & Francisco, 2009). However, city and municipal governments generally have the main responsibilities for planning, implementing and managing which can applied to diminish risks. They are able to corporate with private companies or nonprofit institutions who may provide some key services. In some nations, city governments have had constitutional or legal changes to increase the city revenues and strengthened local democracies(Satterthwaite, 2008; Yusuf & Francisco, 2009).

2.7.1 Institutions and Policies for Adaptation Capacity

To achieve the adaptation, the urban governments must understand how to incorporate most aspects of their work and departments, their institutions and policies in most of competentence, capability, and accountability into the adaptation measures. Many needed measures should be considered to be applied to current practices, for instance in adjusting building codes, developing land sub-division regulations, landuse management and infrastructure standards, etc. However, the measures are choosen for minor adjustments over time can build greater resilience without high costs (Jha et al., 2011). There is also the application of imported models of urban planning and government that proved inappropriate to local contexts and possibilities.

However, in most low- and middle-income countries, the institutions and policies for adaptation are strong supported for municipal or local government levels. Large proportion of the urban population and the urban workforce are not supported by and connected to a comparable web of institutions, infrastructure, services and protective regulations. As using the top-down approach, governments normally fail to reach many of their responsibilities or only meet them for particular sections of their population (Yusuf & Francisco, 2009). This can be seen in their inadequacies in provision for the infrastructure and urban services that they have to provide. And in many cases, the homes, neighborhoods and livelihoods of their population cannot reach to their regulatory framework (Satterthwaite, 2008; Yusuf & Francisco, 2009; Brugmann, 2013).

Good adaptation will need to involve a great range of urban government divisions and departments. It will often need to involve many government agencies, departments, institues, and associations etc. that work within sub-city or municipal levels and at higher levels.

2.7.2 Involvement of People and Stakeholders in the Assessment and Optimization of Adaptation Scenarios

Governments should encourage all other relevant stakeholders to participate discussion on the issue of climate change in the region, its potential risks and impacts. The stakeholders have involved in decision what the appropriate polices should be (Carney, 2005; Giron et al., 2010). In some cases, the richer populations want to avoid the higher risk will push local and national authorities to reduce environmental or natural hazardous risks (Giron et al., 2010). For the most part, most citizens involve very little in urban management and adaptation, because government levels will ensure provision, for instance local politicians or lawyers, ombudsmen, and consumer groups. Therefore, the vast majority of urban population are protected from impacts without engaging in the institutions to have protection (UNISDR, 2004; Nicholls et al., 2008; Satterthwaite, 2008&2009).

The process of assessment and optimization of adaptation and adaptive scenarios requires specific deliberations and value judgments. Different stakeholders, especially who are in and around the flood risk area may have their specific ideas regarding the driven reasons, ways of impacts, and the answers to flooding reduce. In contrast, It is assumed that, in some other cases, flood protection measures are complicated and may be delayed by stakeholders trying to defend their proper interests (Farrington et al., 2002; Carney, 2005).

However, all relevant stakeholders should be involved in the adaptive process. The process should be open, equal and fair. Stakeholders should express their point of views and their own values and perceptions. Information should be equally distributed and available to the participants. In the beginning of the process, goals should be clearly communicated in order to follow and reach the streamline expectations. The results of processes may be too slow or go too fast may disappoint the participants. A moderate speed of subsequent meetings is necessary to retain the broad involvement of the stakeholders (LefÈvre, 2013).

There are various methods to enhance participation, such as brainstorming, citizens' panel, focus groups, group model building, public hearings, reframing workshop, review sessions, role playing game, round table conference, and scenario building.

2.7.3 NGOs and International Funding Agencies/Associations

NGOs and the international funding should be available for adaptive investment in the vulnerable areas. This is an important part of new or expanded funding for climate change adaptation. However, there are some disadvantages of the investment of NGOs or the international agencies. If international donors want to focus such funding specifically on adaptation, this would be problematic. It is because of a need for so many cities to climate adaptation when the climate change in such variability is not known. In addition, these funding flows for adaptation will not achieve much unless the local government capacity can use it well and work it well to reduce risks (Brugmann, 2013). Furthermore, official development assistance agencies have to work with and through the national governments. This process often strongly requires the needed changes, especially for the decentralization of decision-making and revenue-raising powers (Satterthwaite, 2008; Nicholls et al., 2008).

2.8 Summary for Chapter Two

This Chapter reviewed the background of global climate change which may cause flooding in urban areas, such as: global warming, sea-level rise, storms and cyclones as well as other relative climate factors. Flooding increase in urban areas is not only by climate change but also by urban development (such as: urbanization, urban expansion), and uncontrollability of urban planning and management of government in urban areas, especially in developing countries.

Flooding has impacted many socioeconomic aspects in cities, such as the losses of economic activities, housing, and assets. And it increasingly causes the social disorder in urban areas. Among communities, households and individuals, the poor had more impacts than others, because of their weakness of capitals (such as: human, financial, natural, physical, and social capitals).

To understand the socioeconomic impacts and losses by flood in developing cities, the methods on socioeconomic impact assessment (SEA) in flooded areas as well as flooding adaptive strategies for cities were reviewed to learn and compare to flooding situation in HCMC.

3 Assessment Methodology on Socioeconomic Impacts of Flooding in Ho Chi Minh City

In this research, some methods were used to assess the socioeconomic impacts and to analyze the problems for figuring out the results. This was a comparative, descriptive, and analyzed research about flooding impacts on the megacity. Flooding expansion was analyzed and described within the city. The flooding impacts were analyzed and compared amongst residential areas and household groups to understand how the socioeconomic characteristics were impacted. To do this, the necessary data, relative documents, and previous researches, etc. must be gathered and analyzed to draw the results.

3.1 Research Hypothesis

In chapter 1, the flood situation and problems in HCMC have already been described and explained. Then, flood expose may cause many problems and impacts on socioeconomic aspects of the city. To confirm this statement, the research tried to prove the follow hypothesis:

"Urban flooding has impacted on socioeconomic aspects in HCMC"

To prove this, the necessary data was collected and some methods and analysis tools were used to carry out the research.

3.2 Data Collection

Data collection consisted of both primary and secondary data. They were gathered from households at research field and from relative departments, government offices, and research institutions, etc. Secondary data was used to enhance the primary data in analyzing the results and developing the adaptive strategies.

3.2.1 Primary Data

This data was built to create the main results of the research. They were analyzed from the household survey, key-informant interviews, and other special primary data during the study.

3.2.1.1 The Household Questionnaires and Survey

The questionnaires, consisted of close and open questions, aimed to ask about the flood impacts on socioeconomic aspects of househols in flood residential areas. The study had 450 households interviewed in flood residential areas. The questionnaire was developed with the following question groups: household profile, flood impacts to residential areas, flood impacts on housing, flood impacts on social and economic aspects, investments for private flooding responses, level support from government, and demands for flooding adaptation.

The household survey was carried out in 3 months, from March to May 2011. The survey areas were selected in flood residential areas in districts where most poor households settled. They were the flood residential areas in District 6 and 8 in urban center; District 7 and Binh Thanh District in developing areas; and District 2 and Thu Duc District in sub-urban areas. The survey areas of the study were described in the map of Figure 3.1 below.

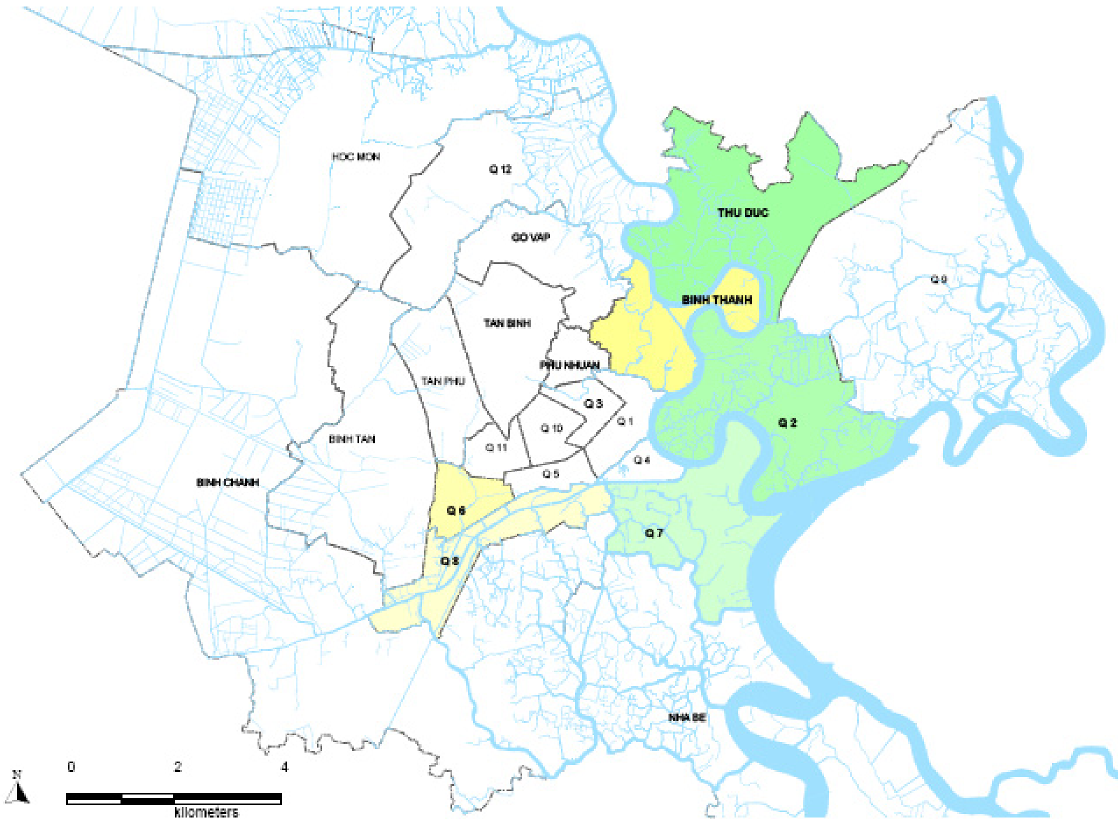


Figure 3.1: The survey areas of the study in Ho Chi Minh City

The survey areas were in where the rivers or canals go through. Such as the survey areas in District 6 and 8 (the inner districts) are near the Kenh Doi – Kenh Te Canal and Tan Hoa – Lo Gom Canal; areas in Binh Thanh District (the urban district) are in surround the Nhieu Loc-Thi Nghe Cana; areas in District 7 (the urban district) are near the Nha Be River; and areas in District 2 and Thu Duc District (the peri-districts) are near the Sai Gon River. The Figure 3.1 above showed the watercourse of HCMC had the widespread network in almost districts. The river network in the city works as the water drainage. The capacity of water collection of the network relates to the volume of run-off water on the ground surface.

The survey areas were chosen in different space of inner districts, urban-districts, and peri-districts. There were some different economic activities of households in these areas. For example, in inner and urban districts some households got incomes by room sharing; and in peri-districts some households earned from agriculture activities.

3.2.1.2 The Key Informants

The primary data was also collected from key informants who were in duty of flood control and flood management in HCMC. The key informants were chosen amongst the specialists who have known much about the flooding situation of HCMC. They helped to figure out the problems and difficulties of the present as well as future suggestions in flood management and adaptation.

3.2.1.3 Other Data

Some other primary data was also important to research such as field notes of phenomena, problems, events at the study field, as well as photos, videos taken and observed at site visits. They helped to understand more about the study area and convince the results.

3.2.2 Secondary Data

To understand the flood situation in HCMC, the secondary data from previous researches, reports, journals and news, etc. were used to describe the problem of flooding, its causation and impacts. The statistic data from the statistic office was put into maps for flood analysis and socioeconomic impacts analysis on households and residential area.

The flood control could be understood through the system of policies, decisions, and instructions etc. published by the national and city governments. However, the instructions from city government were mostly concentrated, because they focused on HCMC's situation, problems, and solutions.

Some departments, institutes, and organizations, which were scientific on climate and flooding, supported documents, reports, maps, and photos to this research. The previous researches, reports, science papers, journals and magazines, etc. were collected from science institutes, research centers, libraries, and universities, etc. Other news and the latest results related to flood were collected from related departments and illustrated from the newspapers and magazines.

3.2.3 Contacts for Data Collection

To have the properly the study fields for household survey, the key informants were appointed to get the information of flood situation, flood in residential and housing areas (CGG, 2005). Then the survey areas were chosen for household interviews as well as taking notes and photos at the fieldtrip. The key informants were also asked for secondary data. The specific secondary data was collected from the specific sources, departments, and institutions. Others were from public sources or various organizations. The collection of data's tentative sources were described as follow:

Table 3.1: The sources of data collection

Sources of data	Departments, Institutes, and Organizations
Primary data	
The selected households' information	Local government at study fields
The selected key informants	Local officers at study fields Urban flooding managers in Department of Resources and Environment (DoRE), Department of Construction (DoC), Department of Architect and Planning (DoPA), Department of Transportation (DoT), Steering Center for Flood Control Programs (SCFC), etc. Scientists, experts with flooding knowledge and experiences
Secondary data	
Statistic data	Local government, HCMC Statistic Office (PSO)
Policies, Decisions, Instructions, etc.	Vietnam government's website and relative ministry's websites. HCMC's website and relative department's websites.
Documents, reports, special researches, maps, etc.	From the above DoNRE, DoC, DoPA, DoC, SCFC, and local government, etc.
Researches, reports, science papers, journals and magazines, etc.	Universities, libraries, internet libraries, papers and journals, etc.
News and magazines	National and city newspapers and magazines, such as the news of Saigon Giai Phong, Saigon Times, Tuoi Tre, Thanh Nien, Viet Bao, etc.

The secondary data were selectively collected to have acceptable and convincible input for data analysis process. Then the results would be believable.

3.3 Data Analysis

Data analysis was the important process to carry out the socioeconomic impact assessment (SEIA) on households of the research. The primary and secondary data was as the input of the process and methods were used to recognize and analyze data. Data was divided into groups to go into different processes and methods. Because this was a comparative, descriptive, and analyzed research, several methods and tools were used to clarify the problems and draw the solutions.

In this research, the spatial analysis method was used in the study. Flood was an impact factor on the ground surface. Different areas had different surfaces depending on their geographical characteristics. Together with the socioeconomic characteristics of households in the areas, flood impacts were identified.

3.3.1 Synthesis, Descriptive, and Comparative Methods

These fundamental methods were used to connect all events, phenomena, and flooding situation etc. together and find out the problems and solutions. Data from many sources and the socioeconomic factors in the areas were selected and synthesized to describe flood situation and problems. With the spatial analysis, the socioeconomic factors were compared to understand the different contexts of flood impacts in the areas. Combining with other methods and tools, flooding problems were analyzed to identify the solutions.

Furthermore, these methods were also used to know the situation and problems of poor households in flood residential and housing areas. Then their situation was compared to higher income group to measure the losses and the capability of the poor facing their flooding problems.

3.3.2 Socioeconomic Analysis

Data from household questionnaires were analyzed to understand the households' socioeconomic characteristics impacted by flood. Different spatial areas and various geographical elevations would have different flood impacts on socioeconomic aspects. These impacts would be different amongst households in three groups of poor households in flood housing areas; poor households in non-flood housing areas; and non-poor (higher income) households in non-flood housing areas.

To know about the ability of households in recovering from flood impacts, the socioeconomic analyses on household's capitals (including financial, human, physical, natural, and social capitals) as well as the political support from government were implemented to figure out what capital was most affected. And the comparison of these capitals in amongst households was also done to understand which group had less ability to survive from flooding.

3.3.3 Spatial Analysis Method

The research was studied on the geographical area, spatial factor was special concerned. Spatial analysis was used to describe spaces in flood areas in two spatial aspects: the in-to-out space of inner, urban and peri-districs, and the elevated space.

The research studied in different areas of inner districts (center area), urban districts (developing area), and peri-districts (rural area) to understand flood impacts to households differently in spaces from inner to peri areas. As these reasons, flood impact on these areas may be different.

Elevation analysis was concerned on the elevation of residential areas. Low-elevation areas normally have higher flood level in the same residential areas. It also depended on the natural, geographical, and built-up characteristics of the areas. Then the flood impact at the same elevation may have different consequences.

3.3.4 Integrated Data and Multi-Criteria Analyses in GIS

These were methods in GIS analysis. They helped to integrate the geographical and spatial factors of the surface to the socioeconomic characteristics and flood factors into maps. The flood problems then were analyzed and indentified.

3.3.4.1 Spatial Data Analysis

This method was used to analyze the distribution and location of studied objects in the research area. Spatial analysis was integrated to attribute data of the object (Burrough, 1986; Carver, 1991; James et al, 2002).

In this research, flood data and socioeconomic characteristics were integrated into elevation map to explain the distribution of flood and its impacts to households and residential areas. From then, the locations of households in flood residential areas were identified and the flood impacts on household's socioeconomic characteristics in flood areas were figured out.

3.3.4.2 Multi-Criteria Analysis

By using a multi-criteria analysis (MCA), the factors of flood and household characteristics in flood residential areas were integrated and identified on the elevation map. This technique helped to analyze impacted problems, measure and calculate the impacts of many objects of the spatial location (Carver, 1991; James et al, 2002).

The characteristics of households, incomes, housing, etc. were overlaid into the reported flood map of HCMC. The MCA in GIS analysis can describe one object that has many attributes linked together on the map to explain their correlations to flood. The MCA in this study described the locations of households together with flood factors in elevated areas. They were also compared amongst households to see the various impacts of flood in the areas.

3.3.5 Mathematic Analysis

To measure the impacts of flooding, the mathematic analysis combined with multi-criteria analysis helped to calculate the economic losses of households, communities, and the entire city (Carver, 1991; Woodruff & Holland, 2008). In this research, the economic losses were counted on the costs of housing upgrading or housing repair and streets' upgrading in the flood areas. Different flood impacts on housing areas had the different upgrading costs. Then the economic losses of households were estimated.

3.4 Analysis Tools

With all the above methods, the research also needed some necessary tools to analyze and find the results. The two important analysis tools were GIS and SPSS.

3.4.1 GIS Tool

The GIS tool on this research was ArcGIS 9.3 with its extension tools, ArcGIS 9.3 allowing to update and analyze the spatial and attribute data. Therefore, the impact factor of flooding and the impacted factors of socioeconomic characteristics could be updated, adjusted, and analyzed during the study.

3.4.2 SPSS Tool

To understand the flood impacts on the socioeconomic characteristics of households, the research used the SPSS, a statistic analysis tool, to analyze the socioeconomic data from the results of households' questionnaires. Through this analysis, the socioeconomic factors of the households impacted by flood were identified and the socioeconomic losses of households in flood areas were also analyzed (Luc, 1992; Winkler, 2009; Yusuf & Francisco, 2009).

With the above research methods and analysis tools, the primary and secondary data were input into the analysis processes to draw out the results. These results, after that, were finally analyzed to develop the flooding solutions for HCMC.

3.5 Research Framework

The research framework was to summarize the whole processes of the study, from the first steps of input data to the last steps of finalizing the results. It also helped to understand logically the necessary of data input and applied methods to implement study.

3.5.1 Background Analysis - DPSIR Analysis

The flooding expansion in HCMC was caused by the two main driving forces: the global climate change and the rapid urbanization in the city. The global climate change was generally understood with the increasing of global temperature, sea-level rise, droughts, and storms. HCMC has increasingly received more storms, stronger storms with heavier rains, and sea-level rise that produced the larger amount of surface water in the period of time and caused flooding exposure (Yusuf & Francisco, 2009).

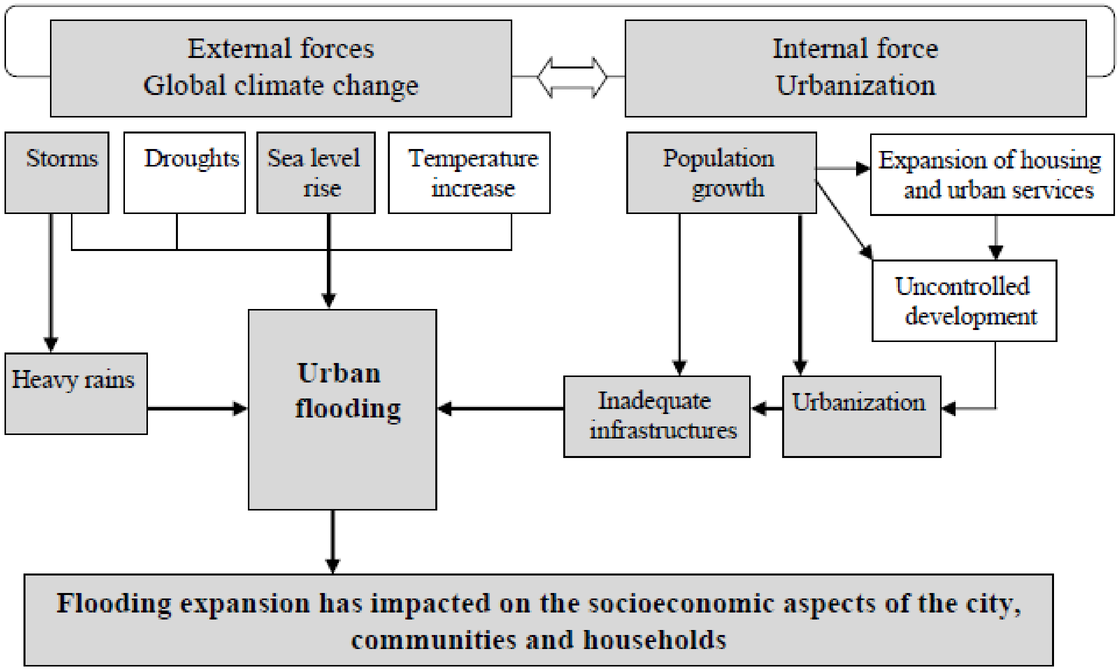


Figure 3.2: Flooding exposure in Ho Chi Minh City

On the other hand, the population growth has caused urbanization and urban expansion. People needed more land for housing and urban services. And the loosing urban management has led urbanization with inadequate infrastructures especially drainage system (as discussed in Chapter 1). As the result, when the large amount of run-off water on the surface comes in rainy season and also in tidal flows, the drainage system could not collect all water and cause flood exposure. Thus, the inadequate infrastructures have made the increasing of flooding in HCMC. The flooding expansion has impacted the socioeconomic aspects of households, communities, and HCMC in general.

3.5.2 Social Impact Analysis

The process of the research was started with putting data for making the reported flood map based on the cadastral and administration maps. First, the flood data was input into administration map to identify the flood areas in communes and districts. Then the socioeconomic statistic data was overlaid with cadastral maps to analyze the socioeconomic factors in flood areas. These socioeconomic factors were compared amongst households by GIS analysis to see different impacts (more or less) of flooding in the areas (Jones, 1997; Woodruff & Holland, 2008; Roggerma, 2009).

Along with the above socioeconomic analysis on flooding, questionnaires were implemented with households selected in the characterized flood areas. The SPSS analysis helped to describe a household's profile and their socioeconomic characteristics related to flooding. The SPSS also helped to calculate the economic losses by flooding of households when they had to pay much for housing upgrading, housing materials, or housing equipments, etc. (Anseline, 1992; Pallant, 2007; Winkler, 2009).

The questionnaires also focused on the target group of poor people living in the flood housing areas. Poor people may have their capitals more impacted by flood than other higher income people, because the poor may live in the areas with lower quality infrastructure. And with low income, their opportunities for upgrading their houses and facilities, etc. may become difficult. Understanding the flood impact of socioeconomic aspects of households, especially the poor, it helped to know how they overcome the flood problems. In case if their capability was very low, the government should do something to support them.

3.5.3 Economic Impact Analysis

From the cadastral and flood maps, the SPSS and GIS analyses counted the housing area and the number of houses in flood areas. With the area of each house in the flooded areas, GIS helped to calculate the household's economic loss for housing repair. The household data from SPSS was counted and calculated to identify the income losses of households in flood residential and housing areas. The socioeconomic analyses to flood impacts of the study was described in the Figure of research methods and process framework below. The framework was also described with research methods, analysis tools, and maps.

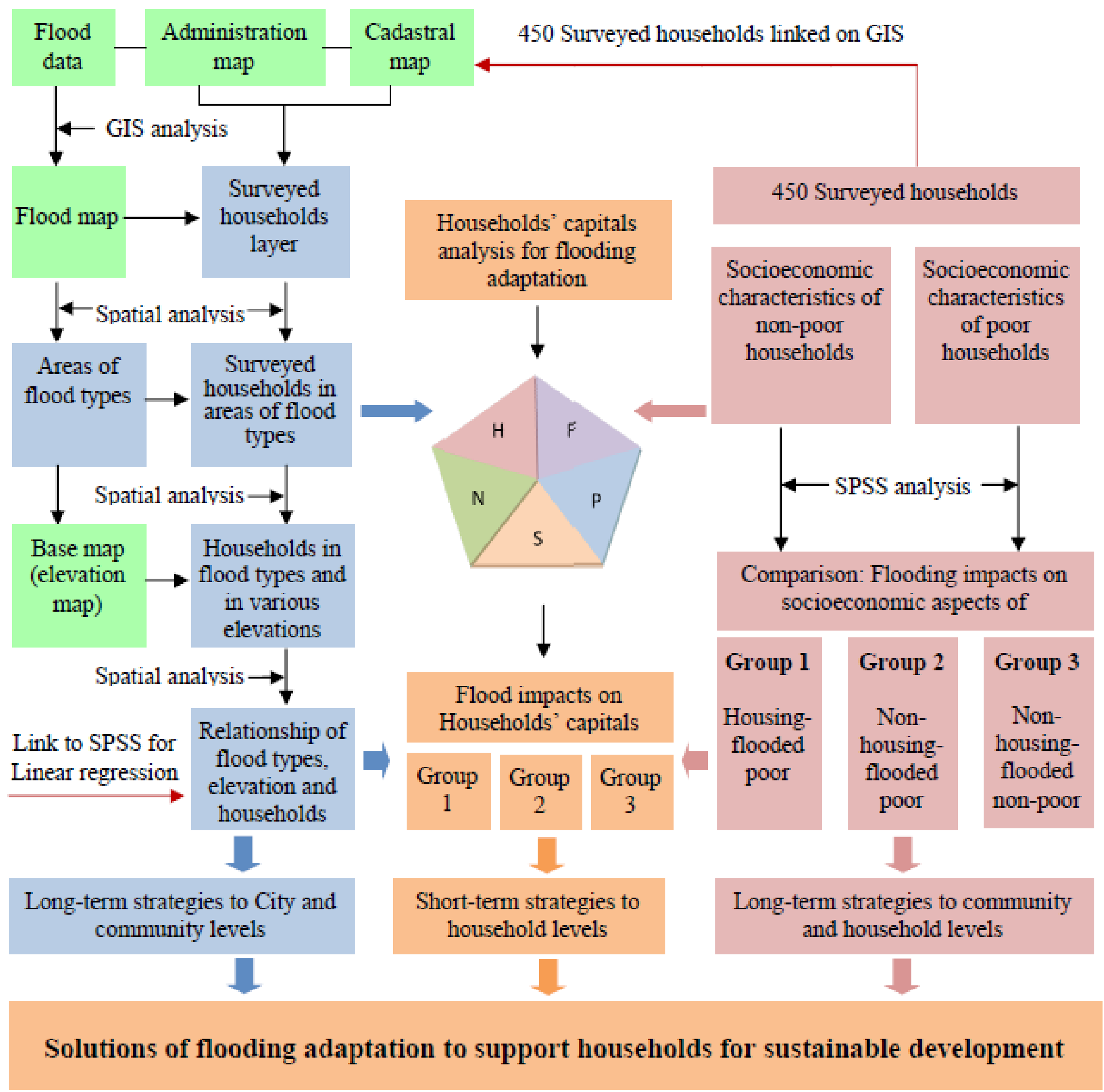


Figure 3.3: The research methods and process framework

The data of household survey was put into SPSS to analyze the socioeconomic characteristics in flood residential areas. The households were divided into three groups of poor households in flood housing areas; poor households in non-flood housing areas; and non-poor in non-flood housing areas. These groups were compared with flood impacts on socioeconomic aspects and on household capitals in flood residential areas to finalize which household group was most impacted. The survey households were also identified the locations on cadastral, administration, elevation, and flood maps by Global Positioning System (GPS) to analyze the types of flood impacted to households in flood elevated areas. This result was analyzed with linear regression in SPSS to understand more about flood history of the areas. From these results, the strategic solutions to flood adaptation were suggested to support households in flood residential areas.

3.6 Research Indicators

To carry out the research, the check list and indicators were prepared to get information from key informants and the households. Indicators were developed both to get results of flooding impacts on socioeconomic factors of households through questionnaires.

3.6.1 Indicators of Flood Impacts to Residential Areas

Flood impacts on socioeconomic aspects were measured in both quantity and quality methods. The impact indicators of floods on the community's socioeconomic aspects were identified as below in Table 3.2:

Table 3.2: Flood impact indicators in flood residential areas

Impacted aspects	Impacted indicators	Measure Unit	Type of indicator	
			Quantitative	Qualitative
Social aspects	Households in flood residential area	Household	✓	
	Households in flood elevation area	Household	✓	
	Households in flood housing area	Household	✓	
	Social support to flooding responses			✓
	Government support to responses			✓
Environ-mental aspects	Household opinions to flood problems in residential area			✓
	Flood months/year in residential area	Month	✓	
	Max level of flood in residential area	Cm	✓	
	Flood years in residential area	Year	✓	
	Flood houses in flood residential areas	House	✓	
	Max level of flood in housing area	Cm	✓	
	Household opinions to flood problems in housing area			✓
Economic aspects	Flood impacts on economic activities			✓
	Income loss from economic activities	VND	✓	
	Income loss from housing upgrading	VND	✓	
	Household opinions to income loss problems			✓

Flood impacts on social aspects were measured with the survey househols in flood residential areas. From economic aspects, flood impacts were estimated the income losses of households. The flooding measure at the community level was used to estimate the flood impacts on natural, physical, and human capitals of households in flood and flood-prone areas of the city.

3.6.2 Indicators of Flooding Impacts to the Households

The flood impacts to households were identified in both quantity and quality measures. The impact indicators on households' socioeconomic aspects, for both poor households and higher-income households of this research were the followings:

Table 3.3: Flood impact indicators on households' socioeconomic aspects

Impacted aspects	Indicators	Measure unit	Type of indicator	
			Quantitative	Qualitative
Social aspects	*Household's profile*			
	Household numbers	Person(s)	✓	
	Household's total income	VND	✓	
	Income per capita	VND/pers.	✓	
	Job, labor, education, etc.		✓	✓
	Housing condition			
	Flood area of house	m^2	✓	
	Problem with infrastructure			✓
	Damage with housing materials			✓
	Damage with housing equipments			✓
	Social support to flood responses			✓
Economic aspects	Looses of economic activities	VND	✓	✓
	Cost for housing upgrading	VND	✓	✓
	Cost for housing facilities:	VND	✓	✓
	- Freeze, electric-stove, fans, etc			
	Loss of vehicles, motobikes	VND	✓	
	Capability to solve the problems			✓
	Social supports		✓	✓
	Government finance support		✓	✓
Household capitals	Natural capital		✓	✓
	Human capital		✓	✓
	Financial capital		✓	✓
	Physical capital		✓	✓
	Social capital			✓
	Political support			✓

The household's characteristics were analyzed to see their relations to flooding. These socioeconomic measures were also used for analysing the flood impacts on capitals of households (the human, physical, financial, social, and political capitals). The capitals analysis helped to understand the capabilities and abilities of households and individuals, even of communities to survive from flooding and achieve to their sustainable development. In comparison between flood impacts of the poor households and the higher-income households, the comparative indicators were:

Table 3.4: The comparative indicators amongst groups of households

Impacted aspects	Indicators	Measure unit	Type of indicator	
			Quantitative	Qualitative
Social aspects	Household members of the poor and the higher-income households		✓	✓
	Job, labor, education, etc. in comparison amongst groups		✓	✓
	Job risk in flood situation of the poor and the higher-income households			✓
	Housing quality of the poor and the higher-income households			✓
	Quality of housing infrastructures of poor households to others			✓
	Social support to flood responses			✓
	Government support to responses			✓
Economic aspects	The income disparity between the poor households and the others	%	✓	✓
	Income disparity per capita between the poor and the others			✓
	The income loss because of flood of the poor in comparison to the others	%	✓	✓
	Income risk because of flood in comparison to others			✓

The household capitals were also compared amongst groups to understand which capital of which group would be impacted or seriously impacted in flooded areas. The results from this part helped to develop the support strategies for the vulnerable groups to overcome the impact situation.

3.6.3 Check List for Key Informants

To the key informants, the check list were focused on flood control and management.

Table 3.5: Check list for key informants of the study

	The concerned information
On flooding expansion	Situation of flooding in HCMC Reasons of flooding The main reasons of flooding expansion in HCMC
Flooding impacts	The socioeconomic problems by flooding How to measure the socioeconomic impacts by flooding Responses of city's government on flooding increase to the socioeconomic problems Responses of city's government on infrastructure problems when flooding increase Advantages and disadvantages of city's responses
Flooding control and management	Existing programs for flood control and flood prevention (on physical and social aspects) Advantages and disadvantages of control programs Management system of urban flooding (such as: urbanization, built-up area and housing expanding, infrastructure development, etc.) Advantages and disadvantages on flood management system Policy and institution system for reducing flooding impacts to households in flooded areas Any program and policy to support poor households to solve the flooding problems
Toward flooding adaptation and mitigation	Adaptation and mitigation approaches for flooding Program(s) and action plans for flooding adaptation and mitigation in HCMC Program(s) for households in flooded areas and flood-risk areas to avoid the flood impacts Program(s) for poor households in flooded areas and flood-risk areas to avoid the flood impacts

From the objectives and research questions in Chapter 1 and with data collection and research methods of this chapter, the research tried to prove the hypothesis of "Flooding expansion has impacted socioeconomic aspects of HCMC". Follow the above indicators, the tentative results might be found to develop the flooding solutions for flooding adaptation on socioeconomic aspects for HCMC.

3.7 Summary for Chapter Three

This study wanted to understand what and how flood impacts on socioeconomic aspects in HCMC. The analyzed process was based on the primary data of 450 households in flood residential areas in HCMC. Some primary data were from key informants in flooding- relative departments, government offices, and research institutions, etc. Some other primary data were such as field notes of phenomena, problems, events, etc. as well as photos taken and observed at fieldtrips. The secondary data was also used in this study collected from city statistics, previous researches, reports, journals and news, etc. to describe the problems of flooding, its causation and impacts.

Surveyed households were divided into three groups. Each group was 150 households selected in categories of poor households in flood housing areas, poor households in non-flood housing areas, and non-poor (higher income) households in non-flood housing areas. The survey was implemented in flood areas of different spaces of urban-center districts, urban districts and peri-districts. These different spaces had some different socioeconomic activities and different flood impacts. The indicators for socioeconomic analysis on households and community (residential area) were developed in this chapter. They were also used to compare the different flood impacts amongst household groups.

The socioeconomic impact assessment by flooding in this study was mainly analyzed through socioeconomic and spatial analysis. SPSS analysis was used to analyze the households' socioeconomic characteristics, which were impacted by flood. It was also used to understand the ability of household's capitals for suffering the flood. And the mathematic method was added for calculating the housing loss in flood residential areas. The different impacts of flooding in different spaces of urban center to peri-districts and in various geographical elevations were analyzed by spatial analyses of GIS. The GIS and SPSS analyses were combined for linear regression to understand more on flooding reasons and household's opinions about flooding in the city. The results from these analysis processes were applied for developing flood adaptive solutions to households in flood residential areas in HCMC.

4 Urban Vulnerability Context of Flooding in Ho Chi Minh City

The vulnerability context of flooding in HCMC could be understood as the trends and shocks on natural environment and urban society in the flooding context. The environmental change has caused the changes or shocks of social and economic conditions that individuals, households or communities have to face the risks of their lives and their capability for development (DFID, 1999; Farrington et al., 2002). The role of government at levels base on policies and institutions in flood control and management could enhance the resilience; or people face more threats and uncertain development.

4.1 The Trends of Natural Environment

The natural trends on the environment are the changes of climate factors that affect the physical characteristics of the environment and cause the problems. The physical elements of urban environment may be changed by the impacts of development and cause shocks on the environment.

4.1.1 Storms, Heavy Rains and Flooding Exposure

The climate change has brought more rains and storms in HCMC in recent decades, with more heavy rains in the rainy season and more droughts in dry season (SIHYMETE, 2008&2011; Nicholls et al., 2008; ADB, 2010). The higher frequency of heavy rains with high volume of rainfall was concentrated in the middle to the end of the rainy season, especially from August to November. The rainy season tends to start sooner and last longer. Therefore, in the dry season, there were even some rains with large-area flooding (SIHYMETE, 2008; Ho, 2010).

Flood normally has widespread expansion in the rainy season, especially when heavy rain meets tidal flow in HCMC. The city has about 55% of total area (2,095sqkm) below 2 meter above-mean-sea-level (AMSL), mostly in the locations of Nha Be and Can Gio sub-districts, and some areas in inner center. By the distribution of geographical elevation, flood would impact at the lower elevation area. However, flood impact in geographical areas in HCMC, which will be analyzed in Chapter 6, is not only in the low-land areas, but also in higher elevation above 2 meter AMSL. In the flood statistic data in 2010 showed the total flood area was about 3.1% of area below 2 meter AMSL (DoT. 2010b). Many areas in the inner city had been flooded, because heavy rains tend to concentrate in central areas. And flood tends to expand from central areas to new urban areas, where the residential density and built-up density are being increased.

Therefore, flood in HCMC has tended to expose in various elevation areas and caused the problems on the environment, livelihoods of households, and communities in HCMC.

4.1.2 Flooding Problems for River Catchments

There are two main rivers running through HCMC, Dong Nai and Sai Gon Rivers, with their widespread networks in city area. Most of the tributaries are affected by the hydraulic regime (Nguyen & Duong, 2007; Trinh, 2008). And they are also the main part of city drainage system (Nguyen & Duong, 2007).

The tributaries' water surface has become narrow by being filled-up for housing as well as by carrying more sediments and waste during urbanization (Le, 2009; SCFC, 2010). Therefore they were very sensitive when heavy rains and tidal flows come. Flooding on river network has pushed more water on the drainage system. Flood-water and waste-water became the reasons to the overload drainage and pressed the run-off water expanding on the ground surface (e.g. on streets, residential, and housing areas).

4.1.3 Flood Hazard

The long-lasting flood has brought more waste and sediments to residential and housing areas and caused the environmental pollution. The increase of flood hazards lead to environmental shocks and health risks to households and communities.

The river system during the long-time urbanization is burdened with carrying siltation, rubbish and solid waste (Ho, 2010; Le, 2009). More sediment in the river beds has lessened their carrying capacity of flood-water and adjusting the micro-climate. Moreover, flood brings more inundated waste and causes more hazards to rivers and their catchments.

The high frequency of heavy rain has resulted in the overload drainage and river systems and caused the large volume of run-off water on the surface (Ho, 2008). And the long-lasting of water surface has made flood hazard exposure in larger areas in HCMC.

4.1.4 Sea-level Rise and Tidal Flow with Flooding

The fluctuation of sea-level in HCMC is affected by the sea-level at Vung Tau Sea and Bien Dong Sea. According to the SIHYMETE (2008&2011), the sea-level rise in Bien Dong Sea is about 0.1 cm each year; and in Vung Tau Sea is about 0.32 cm each year.

However, the yearly max-tide levels in Sai Gon River are increasing in recent years. The max-tide levels at Phu An and Nha Be meteorological stations in Saigon River are increasing 1.45 and 1.17 cm each year, respectively (SIHYMETE, 2008&2011; Ho, 2010). These numbers do not match the numbers of Vung Tau and Bien Dong above.

By statistical analysis of the frequency of the max-tide level in Sai Gon River at the Phu An meteorological station, there was no increasing frequency of max-tide level by time, but only the thirty-years-cycle of level. It might conclude that the increasing of max-tide level in recent years was not mainly by the sea-level rise, but by the urbanization and the filling-up of river's ditches and the low-land areas (Nguyen & Duong, 2007; Ho, 2008; DoPA, 2010). And along with the increasing frequency of heavy rains (with the rainfall intensity over 100mm within three hours) in a year, they caused the flood exposure in HCMC.

4.1.5 The Built-up Coverage and the Resilience of Urban Land

The rapid urbanization process in this city has caused many problems on urban high densities and built-up coverage that led the increasing the surface of soil ceiling and more inundation in these areas. According to Luong (2008), the dynamic development of the city with high population growth and urbanization has resulted in the big changes on the land surface. These were the cutting of green space, increasing of sealed surfaces, and reducing of water evaporation (Le, 2005&2007; DoPA, 2010). This has caused the micro-climate disorder that brought more heavy rains and flooding in the urban center.

Furthermore, the city is still expanding down to the low-land areas and the built-up coverage would be increased. The weakness of land management and the resilience of city's land resource would be limited.

4.2 Social Trends

The social trends in HCMC are the changes in social pattern and structure, and in the urban development process. The migration from rural to urban has increased the population and changed the social structure. In the megacity of HCMC, the trend of nuclear family leads the social fragment and the social network loss (Farrington et al., 2002; Carney, 2005; Moser & Satterthwaite, 2008). The social complex then results in the urban management and welfare losing. Therefore, flood impacts tend to threat the vulnerable groups and increase the poverty risk in the city.

4.2.1 Population and Housing Development in Low-land Areas

The population growth with high migration has driven the problem of flooding in HCMC as already discussed in Chapter 1, Section 1.1.1. Before 1975 the city population was about 2 million people and mainly settled in the high-land areas (mostly in District 1 and 5) (Ho, 2008). In 1975 to 1999 the city expanded on to the remaining high-land, mostly in the inner-districts. The low-land districts such as District 8 and Binh Thanh District, etc. were the sub-districts of this period. From 1999 to 2005, the low-land sub-districts of the previous period became the inner districts. And the lower-land areas as in Nha Be, Can Gio, and Binh Chanh became sub-districts. Since 2005, the low-land areas in District 7 and 2 have even become the new urban areas (Vu, 2010; VNPM, 2010; and PADDI, 2012). These low-land residential areas would become the flood-risk areas in HCMC.

Along with the city developing, housing has also expanded (DoPA, 2010). There is the encroachment of rivers' small tributaries and low-land areas for housing development (Ho, 2008&2010; and SCFC, 2010). Many settlement areas in new districts and sub-districts have inadequate infrastructure, such as drainage and sanitation systems (Nguyen & Duong, 2007). And to the informal housing areas along the canals and river bank, the low-quality of infrastructure and urban services have become more serious. And these areas would be the high-risk sector of flood impacts.

4.2.2 Demographical Change and Urban Densities

Population growth leads the increasing of housing and urban services. The small-size households lead the housing demand increased (DoPA, 2010). The diversity types of households have resulted in weak link of families, communities, and social network. The social diversity in urban areas lead to the increase of social fragmentation. Rapid increase of urban densities causes the weakness and lack of urban services, and low quality of infrastructure. More immigrants brings more informal sectors and with low social ties (DoPA, 2010). Because of high demand, but low supply of urban services, poor households normally locate in high density areas but low living conditions (e.g. low quality of urban infrastructure, housing condition and sanitation), such as the temporarily houses along the canals of Tan Hoa – Lo Gom and Kenh Doi – Kenh Te in inner Districts 6 and 8.

The risk normally falls in the areas of low-quality infrastructure and service provision with high density of population (Moser & Satterthwaite, 2008). This high-risk site has more effects of flood hazard and flood impacts, more risks of life, and socioeconomic vulnerabilities to households and communities. The inequality of income among social groups in the city is the difficulty in striking to flooding response in HCMC.

4.2.3 Social Networks

Social network is the closest web to communities and households in shaping the livelihoods. It helps to link to the local government in solving any sock and trend of the community.

However, all the social organizations in HCMC (such as the Women Union, the Red Cross, the Elderly association, NGOs, etc.) are close to the local government and normally follow the government commands. Or they link to local government to support the urban poor in specific situations. This connection always needs the directions from the higher level of government.

Flooding hazard and its expansion in residential areas have caused impacts on households' and communities' socio-economic aspects. It really needs the supports from local government and social organizations in flooding response and control, especially to poor communities.

4.3 Governance in Flooding Context in Ho Chi Minh City

In the flooding context, governance mainly includes in urban planning, urban management, policies, and institutions.

4.3.1 Urban Planning and Master Plan

Urban planning is the very important sector in developing the defenses for flooding adaptation and mitigation (Moser & Satterthewaite, 2008; Jha et al. 2011). Based on planning, urban management and flood control would be implemented.

HCMC has persuaded the general planning of the master plan for each period of time of the city. In the master plan, the sector plans, local plans, and strategic plans have also followed. Each sector plan has been directly implemented by one of specific Department. Such as landuse plan is done by the Department of Natural Resource and Environment, waste-water system is planned by the Company of Urban Drainage, etc. In fact, one sector may relate to some Departments or Centers[1]. These Departments and Centers may not share data and information, because their planning point of views sometimes may go in different ways (WB, 2010a). On the other hand, their data may be stored and collected in different sources and period of time. This results in the master plan may not achieved with the legal plan (DoPA, 2010).

Since 1990s, HCMC government has implemented many flood control programs and projects (Ho, 2007; Trinh, 2008; and SCES, 2010). Many big projects have been funded by or corporate to the international non-governmental organizations and divided into many parts for each period. And many of them have not yet finished. However, urban planning in HCMC is very easy to be failed in the context of rapid urbanization and dynamic development. Many parts of above projects were being inadequate planning for flooding control in HCMC (To, 2008a).

Furthermore, lack of planning capacity has led the weak directions and strategies in flooding adaptation and mitigation. The vast amount of data relating to current flood

[1] For example in housing sector: housing data is collected by and stored in the Department of Natural Resources and Environment, Department of Land Survey and Housing, Department of Construction, and Department of Planning and Architect, etc. Their data fields are also the fields of their management.

situation and not enough meteorological monitoring have resulted in the inadequate planning for flooding adaptation (WB, 2010a). City planning in many cases has even brought more floods to urban area.

HCMC has decentralized the urban planning at district level. With this decentralization, the local government has planned for sectors in their own district. However, the district planning has many insufficiencies on their abilities of planning, and the local development needs. Considerably, the top-down planning that the stakeholders, such as households and communities, are not involved into planning and flooding programs. Their products in many cases do not serve to people in the area[2]. And they sometimes are against those on the city master plan and city's sector plans (PADDI, 2012).

4.3.2 Urban Management and Urban Cross-cuttings

The unclear responsibilities in urban management of government at levels and departments, and even the loosing relationships among departments and institutions make the increasing of urban cross-cuttings in the city. They, therefore, need more time for implementing, making decisions, and posing the difficult problems in estimating future scenarios to find solutions (WB, 2010a)[3].

The city planning on infrastructure and drainage system has also obstacles due to the involvement of organizations and urban cross-cuttings (DoPA, 2010; PADDI, 2012). The drainage system is managed by the Public Company of sewage and drainage system. Most of the canals and ditches in the city are used as the drainage system. However, rivers and canals are under the responsibility of the HCMC Branch of Vietnam Inland Waterways Administration and Department of Transportation. In the flood situation, the Steering Center of Urban Flooding Control Program (SCFC) and the Steering Center of Storm and Flood Prevention (SCSFP) are responsible for the flood river network. This makes the planning issue more complex, especially in situation of flood control and management (To, 2008a&b)[4].

[2] Most of local governments do not want to save much land for green space and open space or parks instead of residential areas and high-rise office buildings, especially in the new Districts where still have stored land for development.

[3] According World Bank (2010), in master planning, the landuse planning is done by DoNRE (Department of Natural Resource and Environment); the strategic plans and urban master plan is prepared by DoPA (Department of Planning and Architecture); the socio-economic development plan is prepared by DoPI (Department of Planning and Investment); and the transportation planning is done by DoT (Department of Transportation); etc. Different Departments and different time scales with little data and information sharing between them have brought the more difficulties in estimating future development and scenarios to the City.

[4] For example, there were some projects implemented by some organizations on this system, such as the Nhieu Loc – Thi Nghe project (by DoT), the Tham Luong – Ben Cat project (by Department of Agriculture and Rural Development), the Tan Hoa – Lo Gom project, etc. Each project must have data source for pre-searching, implementing, and evaluating. When the Steering Center of the Urban Flooding Control Program (SCFC) took over this system for flooding control and adaptation, the Center had no in-

The participation of departments, institutions, and organizations in planning is necessary to have proper planning. However, lack of planning leader in decision-making, sharing data banking, and the participation of other stakeholders (scientists, specialists, and people's representatives, etc.), planning may become patchy or not achieve to the benefit of city community (Luong, 2006).

The above planning context in Section 4.3.1 showed the difficulties to city government in urban control and planning. The loosing of urban management has led the built-up areas rapidly increased; housing has swallowed the canals and ditches and low-land areas; river beds are being smaller and polluted; and the downgrade drainage system; etc. However, the dynamic development in the megacity often causes the problem of management and the combination among Departments. Ho Chi Minh City needs a leader for planning and management (DoPA, 2010; PADDI, 2012).

4.3.3 Policies and Institutions

There are many policies and institutions for flooding adaptation to Ho Chi Minh City released by the national and city governments. However, with the matter of urban planning and management, as discussed above in Sections 4.3.1 and 4.3.2, policies and institutions bring the government's wills into planning.

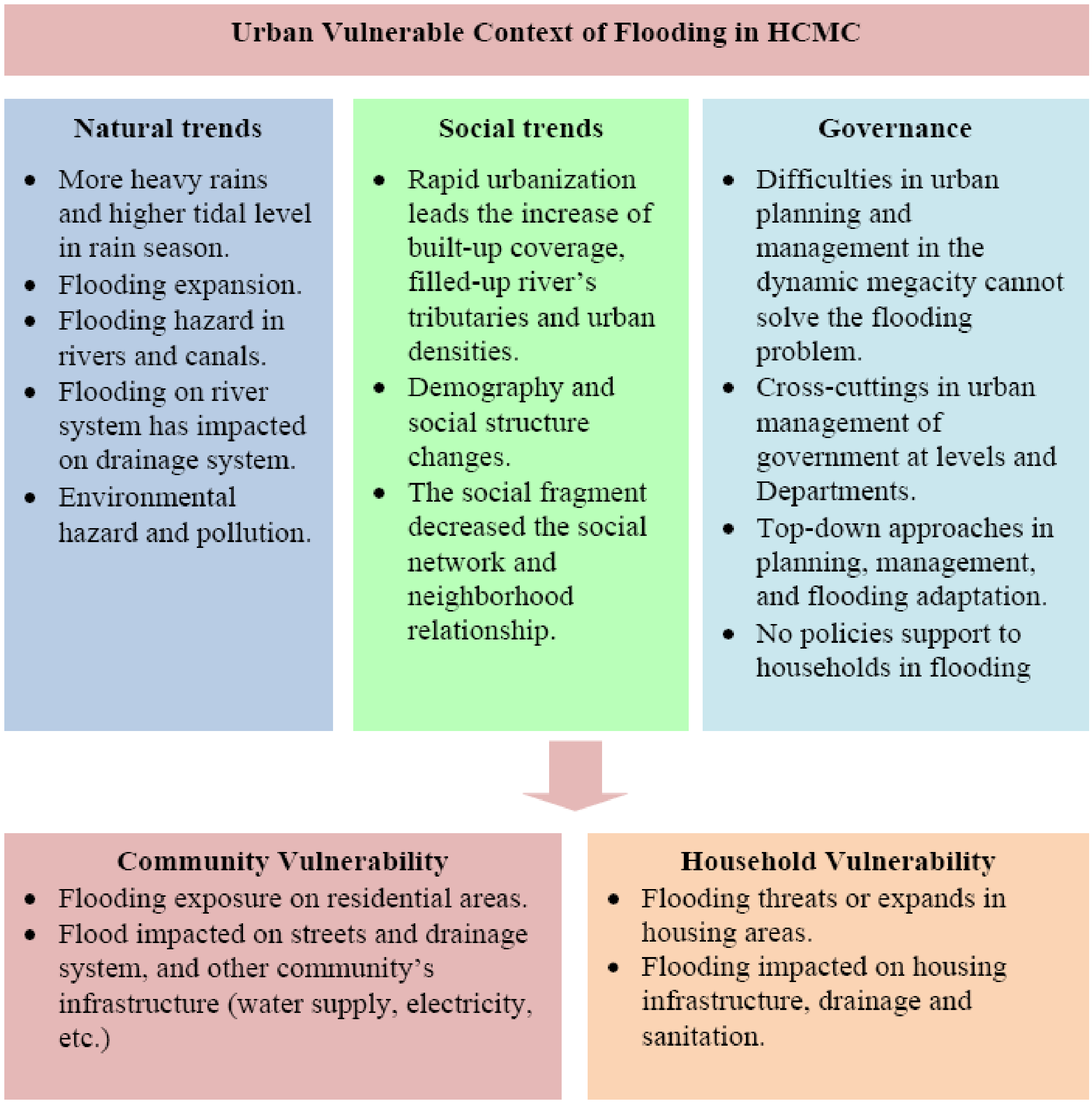
Policies and institutions in the flooding context need to have a close relationship to urban vulnerabilities and communities (Farrington et al., 2002). They help to solve the vulnerable problems to support the households and shape the livelihoods. Therefore, it needs the participatory of households and communities in the processes of adaptive planning, developing strategies, and evaluating processes. This section is further discussed in Chapter 7. The urban vulnerable context of the flooding situation in HCMC is shortly described in the Table 4.1 on the following page.

The trends and shocks of the environment in HCMC have changed the socioeconomic aspects and brought more difficulties to livelihoods. The social trends weaken the links of social web and increase the social fragmentation.

Population growth with high immigration brings more informal housing in the low quality infrastructure and urban provision. Urbanization with housing expanding has caused the increases of built-up coverage and the encroachment of river catchment and low-land areas. The less permeable surface and water-storage areas make the looding more exposure. With this vulnerable situation, households and communities need the supports of government and social network in flooding responses. However, the top-down approaches in urban planning, urban management, and flooding adaptation lead the government to fail in flood control in HCMC. It is necessary to consider a important rela-

formation sharing from previous parts of those organizations. It will be difficult for SCFC to solve the continuous problems of flooding.

tionship between the urban-flooding vulnerability context and the livelihoods with the support of policies and institutions (Farrington et al., 2002).



Source: Developed from DFID, 1999 and Farrington et al., 2002

Figure 4.1: The urban vulnerable context in flooding situation in Ho Chi Minh City

4.4 Summary for Chapter Four

The vulnerability context of flooding in HCMC was extreme with the trends of natural environment, society and urban management. The trends of natural environment were the increase of tropical storms and cyclones, which brought more heavy rains, and flooding exposure. Flood has caused many problems on river system, its catchment, and sent more sediment to river beds and drainage systems. These had caused problems with water collection and storage in flooding time. Therefore the run-off water was kept longer on the ground surface and it caused flood exposure and pollution to urban surface.

HCMC was affected by global sea-level rise, however, this factor was not the main reason of flooding in the city. The max level of tidal flow, either, was not mainly related to the climate change, but the long-term process of urban development. And the trend of urban land surface with more density of built-up coverage led the decrease of infiltrated areas and increase of flooding.

The population growth and demographic change have increased the residential and urban function areas. They pushed the urban expansion on rural and low-land areas. During the urbanization process, the city has filled-up many green trees and parks, lakes and ponds, and rivers‘ tributaries. More built-up coverage and less permeable surface have caused flooding. HCMC has a large social network to help the poor in improving their lives. It is the network of many government organizations, social associations and non-government organizations. However, there was less support to poor households in flooding response.

Furthermore, the uncontrolled planning and management in dynamic city, and urban development aimed for economic growth did not take into account the flooding control for future development. And the ability of government at levels as well as the co-ordination among them (local governments, Departments and Institutions) in urban planning and management has caused the flooding control more difficult. The understanding of the vulnerability context of flooding would support to understand the flood impacts on socioeconomic aspects in HCMC.

5 Flood Impacts on Socioeconomic Aspects in Ho Chi Minh City

From the urban context of Ho Chi Minh City in Chapter 4, the city has a dynamic change of society. It increases the rapid urbanization and causes problems on urban infrastructure and service provision, such as housing expansion and overload drainage systems. The urbanization with high coverage density has increased the impermeable surface in the inner center, which affects the micro-climate in the inner center. Furthermore, the general effect of global climate change with more tropical storms and heavy rains, together with local urbanization, has brought the climate crisis in HCMC. And the main emerging problem was flood expansion.

Flooding increase has impacted socioeconomic aspects of communities (residential areas) and households in HCMC. In one community, flooding may have different impacts depending on space and time. Within a flood community, the households in there may be even impacted differently in combination to socioeconomic characteristics. This chapter described the general flooding in HCMC and analyzed the impacts of flooding to residential areas. And in comparison among households in different income groups, flood also impacted differently on socioeconomic characteristics of households.

5.1 General Impacts of Flooding Exposure in Ho Chi Minh City

The reports from the Steering Center of Flooding Control Program (SCFC, 2010&2012) and the Steering Center of Storm and Flooding Prevention (SCSFP, 2011) showed flood increased every year. It can be seen that the tidal flows and flood areas increased during last ten years. The above two centers and other departments and institutions have tried to control flooded points and reduce flood level, though, flood was still increasing.

5.1.1 General Flood Impacts on the Economic Aspects

Most of districts' centers were impacted by floods. They were centers of administration, finance, and trade. Besides the flood centers, the city has many flooded commercial streets, some of them were main commercial streets (such as: Ly Tu Trong and Hai Ba Trung Streets in District 1; Vo Thi Sau and Le Van Sy Streets in District 3; Street 3/2 in District 10; etc.).

The city has about 376 traditional markets. Fifty percent of those were normally flooded in rainy season. Especially, since recent years, the Sai Gon Market has been wildly flooded with 20 cm in 2007. Surrounding of Sai Gon Market was the center Streets with many commercial buildings and squares, office buildings, hotels, shops, and restaurants, such as Nguyen Hue, Le Loi, Dong Khoi, etc., have been flooded onto the streets' pavement. Some other big traditional markets were also flooded and left many losses and damages. Many goods and commodities of the small traders and shopkeepers in the markets had been ruined. The customers do not want to go to markets and go shopping in flood time. It seems that city has the big loss on the economy when flooding comes.

The income losses on businesses and trades lead the reduction of city funds from the businesses' income tax. The losses from other city's economic activities by flooding (e.g. power shortage for production or companies, etc.), city's income was reduced seen as the reduction of city's GDP.

5.1.2 General Flood Impacts on Social Aspects

Flooding exposure has brought many problems and obstacles to the city and people. Long floods and heavy rains have damaged the city's infrastructure (streets, drainage system, flood control dikes, etc.), affected transportation, and urban environment. It has also disordered the people's living, working, and education, etc.

Transportation becomes difficult on the streets when flood increases. The traffic-jams normally happened after the heavy rains and on the flood streets. These jams sometimes lasted several hours and took people more time on the streets to get to the office, to school, or go home after working. They make the bad feelings and tiredness to have a good working day, school day, etc. Or people have less time at home for relaxing, work preparation, house-works, children caring, etc.

The long floods on the streets may damage to have holes or cracks on the street surface. People may get in accidents, because they cannot see these holes or cracks on the full-water streets. They also may be worn and damaged their transport means, working materials, and personal belongings.

The drainage system was over-capacity to carry more waste water and sediment during flooding. It becomes older and cannot bear its responsibility. The tidal flow has destroyed the river bank and flood control dike system. It made the heavy floods on the areas surrounding. City budget has to face more for upgrading or renewing these infrastructures.

Flood also impacts schools and affects the education of children. Children were easy to slip and fall in the flood areas. Some schools had to cancel the classes because pupils could not go to school. Or they had to close because the schools were wildly flooded. All these problems may effect people's awareness about the social environment, especially children, and reduce the belief on city government.

5.1.3 General Flood Impacts of Natural Resources

Most of the rivers and canals in the city were responsible as drainage canals. By time, they have received much waste water and solid waste from residential and industrial areas. The sludge and sediment have made this system more polluted and narrower (Vo, 2009; Le, 2009). They now, therefore, cannot do well their responsibilities on natural landscape and water storage for the city (Nguyen & Duong, 2007). They also cannot be used for agricultural irrigation. Furthermore, flood on agricultural land has made crops fail and loss of agriculture resource. The polluted rivers would impact the ecosystems of Can Gio Mangrove and agriculture activities there. And in the long run, it may impact the underground-water system of the city.

5.2 Flood Impacts on the Residential Areas in Ho Chi Minh City

HCMC has 322 wards and communes. In which, 154 of them with about 12% of the city population have the history of regular flood. These areas were about 110,000 hectares (Le, 2009; ADB, 2010). To understand more about flood impacts of residential area/ community level, some residential areas were chosen for the survey.

5.2.1 Community Scope

Most of the selected residential areas were located in areas where the river or canal goes through. They were spread with different spaces, terrains, and altitudes. The areas were chosen with Districts 6 and 8 in the inner center (inner districts), Binh Thanh District in the center (urban district), Districts 2 and 7 in the new urban districts, and Thu Duc District in the mix new-urban and rural area. With the range of this spatial difference, the socioeconomic characteristics of the residential areas and households will be varied.

Districts 6 and 8 were the low-land areas and concentrated with poor people. There were some very poor communities along the canals of Tau Hu (District 6), Tan Hoa – Lo Gom and Kenh Đoi – Kenh Te (District 8). These communities have been known with the problems of polluted environments and flooding in the surroundings of canals for many years (Nguyen, 2002). The drainage system here was very old and narrow. These areas have long-standing development with various small-scale industries. The waste-water in these activities was not separate collection but was directly flowed out to the canals (Nguyen et al., 2007; Vo, 2009). This waste has become sludge for years and made canals narrow. Canals cannot carry all the water when tidal flow comes from the Sai Gon River.

Table 5.1: The characteristics of selected areas

District	6 and 8	Binh Thanh	7	2	Thu Duc
Spatial area	Inner center	Center	New-urban	New-urban	New-urban and rural
Terrain	Inner low land	Low land near river	Low land near river	Low land near river	Low land near river
General elevation	≤ 1.5m	≤ 4.0m	≤ 3.0m	≤ 2.0m	≤ 4.0m
River system	Tau-Hu canal, Kenh-Doi-Kenh-Te canal, Tan Hoa – Lo Gom canal	Nhieu-Loc canal, Thanh Da River, and Sai Gon river	Nha-Be river	Sai Gon river, Dong-Nai river	Sai Gon river
Tide regime	impact	Strong impact	Strong impact	Strong impact	impact
Drainage system	Old, overload	Old, overload, and incomplete	Incomplete	Incomplete	Incomplete
Development	Developed	Developed	Urbanizing	Urbanizing	Urbanizing
Flooding impact	Strong	Strong	Strong	Strong	Strong
Income	Poor	Poor and middle	All income	All income	Poor and middle

Source: Developed from fieldtrip and the HCMC typographical map

The residential areas surrounding the Nhieu Loc – Thi Nghe Canal in Binh Thanh District also had the same problems as the above areas. City government has invested big environmental projects on this canal, though, the pollution problem has not been completely treated yet (Vo, 2009). Binh Thanh District was in the center, however, developed in several periods along with its center sprawl. Loose management in many years in this district has grown many unplanned residential areas with incomplete infrastructure, especially drainage systems (Nguyen & Duong, 2007; Trinh, 2008; PADDI, 2012). And the more destruction of river systems by filling the small ditches for housing building, the drainage systems here was getting smaller and creating more flood problems (Nguyen & Duong, 2007; DoPA, 2010). Most of the surveyed residential areas were in the low-land and near rivers and canal (See Figure 5.1 below). The tidal flow affects the rivers and canal, and drainage system, also affects the surrounding residential areas and causes flooding.

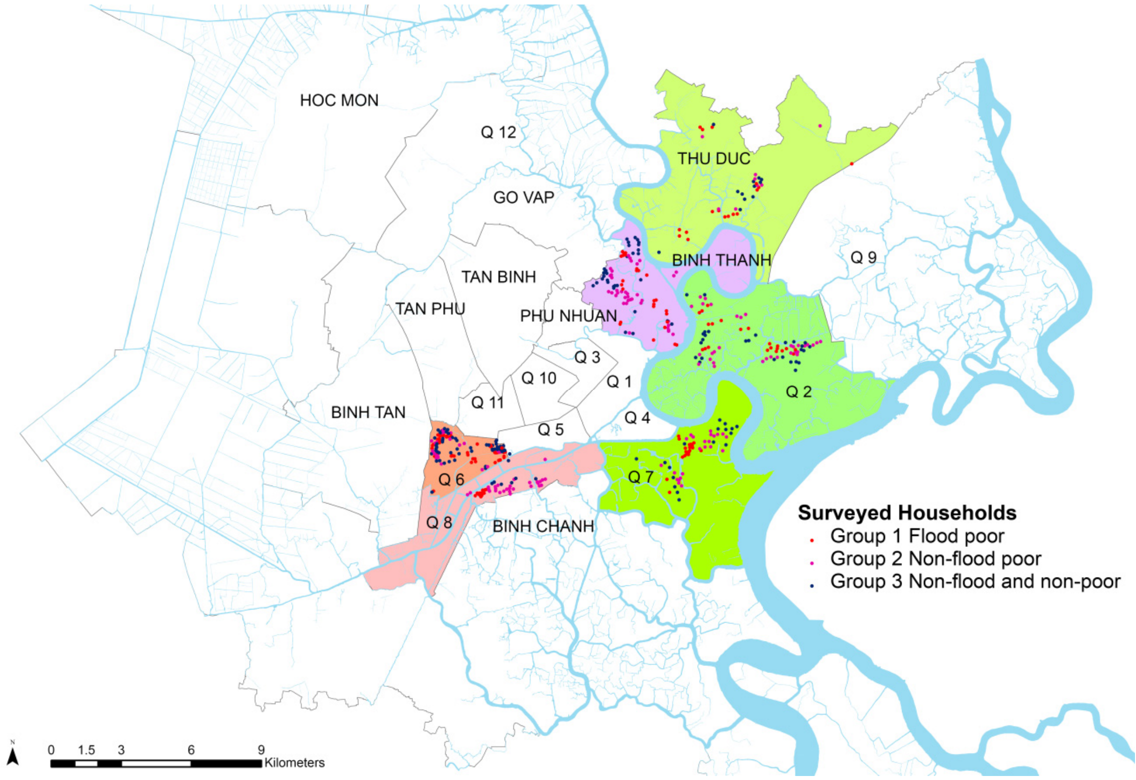


Figure 5.1: Survey households in flood residential areas of the study

Districts 2 and 7 were the new-urban areas developed from the former rural areas. There were many new housing projects built in these districts, however; most of them were for the high-income persons, such as: the housing areas of Phu My Hung and Nam Long new urban areas in District 7; the housing areas of An Phu, Thao Dien, and Thu Thiem new urban areas in District 2; etc. Coming between them was the middle- and local low-income communities. Though there were areas planned to have the new urban, many other residential areas were unplanned. The filled-up of canals and ditches was also happening in these districts and caused the narrowing of the river and drainage system (Nguyen & Duong, 2007; DoPA, 2010). Even the new-urban of Phu My Hung was planned on the low and wet land of the city in about 2,600 hectares[5], and had filled up many canals and ditches in this area. It has caused the flood increase in District 7 in recent years. Furthermore, the rapid urbanization in these areas has developed many residential areas with incomplete drainage systems; and/or the new drainage was not connected to the current drainage in the same level (Nguyen & Duong, 2007; Ho, 2008). All of these reasons have made the tidal flows from the Sai Gon, Nha Be Rivers more impactful on the districts.

Thu Duc District was the urbanizing area with partly urban and partly rural. The agricultural activities were mainly in vegetable, aqua, and pot-plant. The agriculture here

[5] The Phu My Hung housing area was introduced on the Phu My Hung Join-Stock Company's website: http://www.phumyhung.com.vn/introduce.php

was protected from floods by the dike system. For a long time, this district was not impacted by floods. However, flooding was fast coming recent years in this area. Thu Duc District has the same problems to other new-urban districts with rapid urbanization, incomplete drainage system, and filling-up ditches (Nguyen & Duong, 2007). Furthermore, most of the dike system was built by simple soil and sand. When the tide comes, the dike was easily broken and it has impacted residential and agricultural areas.

In general, selected residential areas in these districts have several same characteristics: they were in the low-land and the average elevation ranged from 1.5 to 4.0 meter. Some areas have the higher elevation, over 5 meters as in Binh Thanh and Thu Duc Districts. Most of them were near or surround rivers or canals and affected by semi-inundate tidal regime from river system. The drainage system, old and overload or incomplete, though, cannot collect all run-off water when heavy rains and tidal flows come.

5.2.2 Impacts of Flooding on Residential Areas in Ho Chi Minh City

On the above selected areas, 450 households were chosen for the survey. The survey focused on the flood problems and impacts on some socioeconomic aspects both at community and household levels. Depending on the terrain and elevation of area, along with the climate factors (rains and tides), flood level on the areas may be varied. Even in the same residential area, the altitude of each constructed position of street or house was also different. Flood has impacted differently in each part of the residential area, street and housing.

In Table 5.2, among households, 63.7% of households lived in flood residential area. It could be understood as flood in the streets or alleys, and the neighbor households in residential areas. In HCMC, one Ward includes several communities. Other households (31.3%) lived in non-flood residential area.

About the flooding time, 45.8% of households have their areas flooded within ten years. 17.1% have their areas flooded within twenty years. And only 0.9% of households (4 households) were flooded in more than twenty years. By this result, flood was widespread expanding in HCMC. The households in within-ten-year-flooded areas were larger than households in over-ten-year-flooded areas said flood was increasing, especially in recent decade. The over twenty-year-flooded areas were in the low-land in the tidal-effect areas.

Asking about reasons of flooding, 34% of 450 households said floods come by heavy rain in tidal flow and by the drainage system problem. 11.3% of households said floods come by rain and drainage problems. About 20% of them thought flood comes to their residential areas only by heavy rain. By this result, most of people thought that, the city drainage system had problem and pushed flooding increased. This happened to the highland areas flooded just in recent years and the areas without tidal effect. This was reported and explained by some flood specialists of HCMC (Ho, 2008; SCFC, 2010; Nguyen, 2010). Therefore, flood in the surveyed areas may come by heavy rain, tidal and incomplete drainage system.

Table 5.2: Flood impacts and responses in residential areas

	Frequency	Percent	Other cases
Flood impacts in residential areas			
Flood houses in residential area	287	63.7	36.3% were not flooded
Flooded within 10 years	206	45.8	17.1% were flooded in 11 - 20 years; 0.9% flooded in more than 20 years
Flooded by rain – tide – incomplete drainage	153	34.0	11.3% flooded by rain and incomplete drainage; 20.2% flooded by rain.
Flood impact seriously to streets	156	54.4	45.6% said flood impacts but not seriously.
Drainage was very old	137	47.7	50.9% said it was old or incomplete
Flood impacted seriously to housing area	93	32.4	63.1% said flood slightly impacted on housing area
Long time of flood in residential area	83	28.9	36.6% said flood went after rain or not so long.
Flood caused serious accidents	17	10	54.7% said flood caused accident sometimes
Flood impact seriously on water supply system	36	20.9	58.2% said not serious
Flood impact seriously on power supply	25	17.0	48.9% said not serious
Residential areas were flooded in six months	172	60.0	40% flooded in more 6 months; 54% in 3-6 months; 34.8% in 7-9 months
Community responses to flooding			
Pavement rising	164	57.1	
House rising	87	12.9	
Threshold rising	68	23.7	
Drainage dredging	66	23.0	
Housing upgrading	45	15.7	

About the transport problems in residential areas, 54.4% of answered households said transportation has problem when flood come: traffic-jam and accidents. However, other households (45.6% of 287 answered households) said the flood impact to residential streets was not seriously.

The traffic-jam during and after the heavy rain normally keeps people to be on the street in several hours. They will take more time to go to work or to school, etc. They will have bad feelings at work or at school. Or they will have less time at home for family, housework or child-care. In the long run, flood may impact jobs, incomes, and living of city people. Flood could cause accidents to people on the street, because they cannot see the right way. Then the people's transport means would be damaged as well as the personal belongings of people in flood streets. Even streets would be ruined by flood and causes more accidents.

Another serious impact of flooding in residential area was flood in housing area. 32.4% households (93 households) said flood strong impacted to housing area; while 63.1% of them (181 households) said housing area was just slightly impacted. The group of households with 28.9% had long flooding in their residential areas. Some households said flood had caused the serious problems to electric power and water supplies. While some others said it was not a serious problem. However, long time of flooding could impact on the quality of water supply as well as the safety of power electric system.

All poor households in Group One were in flood residential areas. Group Two and Three had less flood impact in residential areas. About 48% of households in Group Two and 32% of households in Group Three had the residential areas flooded.

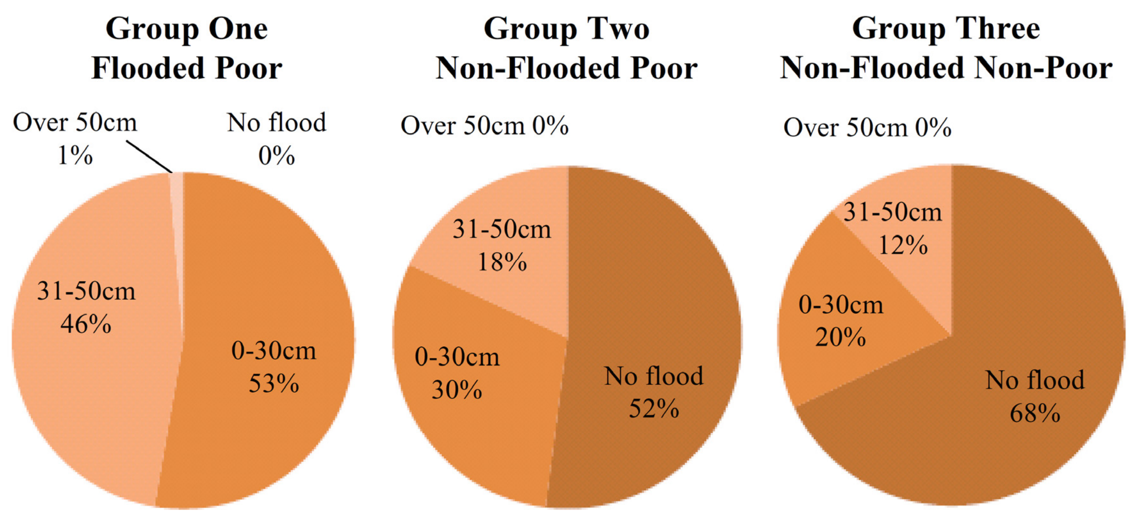


Figure 5.2: The max-flood level in flood residential areas

The Figure 5.2 showed the average of the max-flood level in residential areas was up to 30cm. Group One had the most cases with flood level from 30 to 50cm. The max-flood level happened when heavy rain came with tidal flow, normally concentrated in the month which had most heavy rains in year and in those residential areas. The flood level from 30 to 50cm happened in the areas affected strongly by tide regime. There were only some households in Group One that had the max-flood level over 50cm. These households lived in areas where the flood-control-dike broken. Especially the residential area in the Ward of Hiep Binh Chanh, Thu Duc District, the dike system there was broken in every rainy season recent years. This made the flood expose in the large areas. The yearly max-flood level was appeared only in rainy season and only when heavy rain with tidal flow in the city. Depending on the geographical elevation and development factors of the areas, max-flood level and the time of flooding would be different.

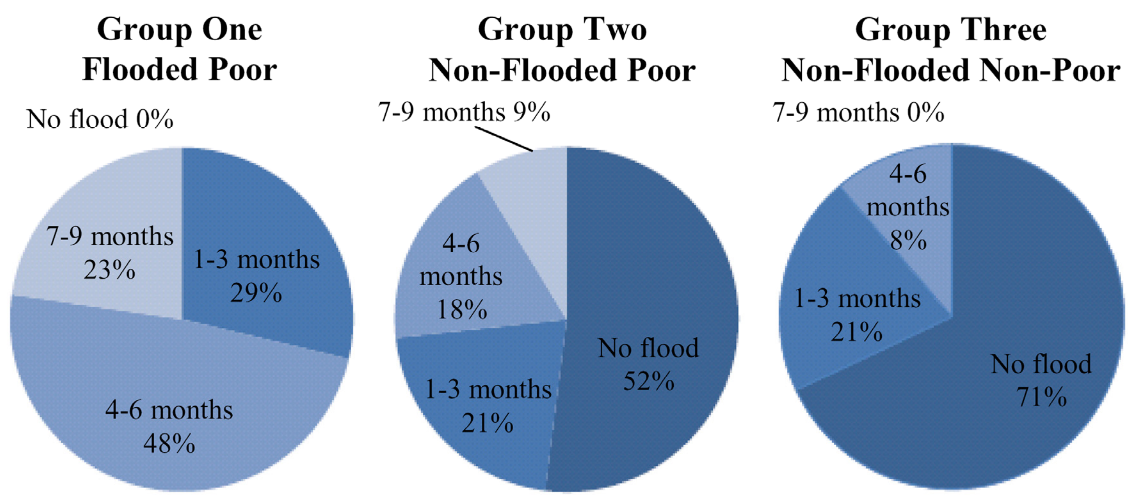


Figure 5.3: The yearly-flood-months in flood residential areas

Among the surveyed households in flood residential areas, most of households of Group Two and Three who lived in flood residential areas were flooded within 3 months in rainy season; some were in 6 months. Figure 5.3 showed in Group One, nearly half of the households (48% of total) lived the areas flooded in 4 to 6 months; 30% impacted in within 9 months. A few of households in Group Two and Three also had flooded in residential areas within 9 months. They lived in areas where tidal flood visited the dry season. Some high-income households were located in the low-land areas along the rivers where flood comes even in the dry season with impact of daily semi-tidal regime (such as the villa areas in An Phu and Thao Dien Wards of District 2). In these areas, the average tidal flood level in the dry season was about 30 to 50cm.

To the flooded years in residential areas, there were more households in Group One flooded in residential area more than 10 years, then came the households in Group Two. In Figure 5.4, Group One had also the most households (72% of total) of all groups flooded within 10 years. The Figure indicated most of households had flood residential areas within 10 years. This said that flood became serious problem and widespread expose in recent decade in the city. And the poor seemed to have more flood impact rather than the higher income households.

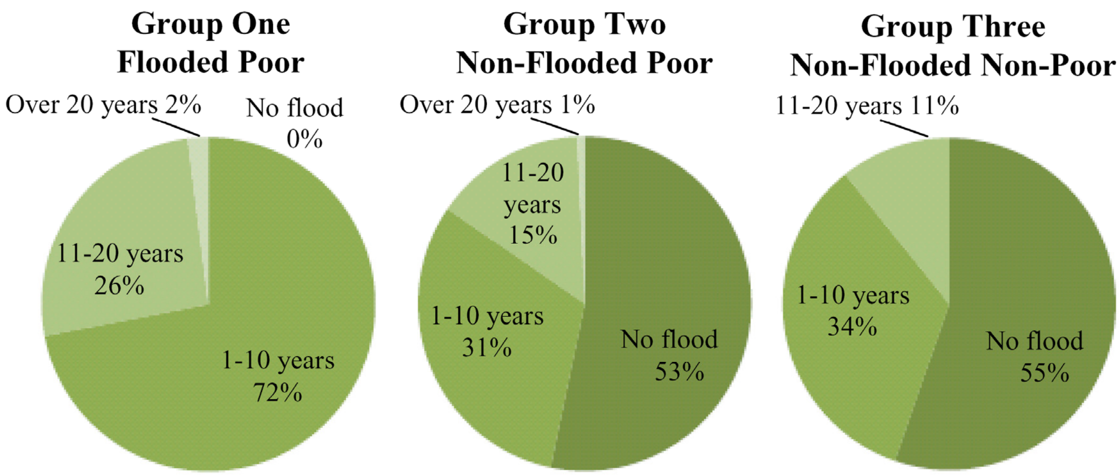


Figure 5.4: The number of years flood visited in residential areas

In comparison among selected areas, the flood problems and impacts were not so different in the space of center, urban districts, and rural areas. Just in some aspects of geographical conditions. As mentioned in the Table 5.1, the differences on physical characteristics (terrain, elevation, rivers and canals, etc.) and social factors (urbanization and urban infrastructure) in these areas had caused the different flood problems. In the low elevation area and in surrounding rivers and canals, flood almost affected the area by tide, and by tide and rain in rainy season. Flood then had impacted directly or indirectly on some socio and economic aspects of the residential areas. And amongst groups, Group One had the strongest flood impact in residential area, both in max-flood level and flood time. Some households in Group Two had less impact than, and the households in Group Three had the weakest impact of flood in residential areas.

5.2.3 Flooding Responses of Communities in Ho Chi Minh City

Flood had exposed in resident and housing areas and had impacted directly or indirectly the communities. Though, there was no support from city and local government to the communities to reduce the impacts. Many households had private activities to protect them in housing and in residential areas such as: pavement rising, house rising, threshold rising, drainage dredging, or housing rebuilding/ upgrading, etc. as already demonstrated in Table 5.2 above.

The pavement rising or threshold rising were their first solutions to prevent their houses. Second solution was house rising or house rebuilding when flood went over the sidewalk (or housing pavement). Many poor households chose threshold rising, because this activity had a low construction cost. Some other households had rebuilt or upgraded their houses. This solution was the last choice of poor households, because of high construction cost. However, when housing level was deeply lower than flood level, housing upgrading or rebuilding was the only choice to households. Other problems on power or water supply, they also had to pay themselves for repairing.

Asking about the government support to all of the above responses, all households said they had not received the fund or support from the government. However, amongst the adaptive projects, the city has programs for street rising and drainage dredging. The drainage dredging was implemented partly and only in the serious flood areas. The street rising program also has many problems to households and communities. This will be discussed in Chapter 7 of this study. More details for households' flood impacts and responses were analyzed in the following Section 5.3.

5.3 Flood Impacts to Households in Ho Chi Minh City

The residential areas have been chosen in different spatial areas, terrains, and some different socioeconomic characteristics (as already discussed in Table 5.1). Flood visited the residential area and had the similar impacts on spatial areas. However, in comparison among income groups in flooded and non-flooded housing areas, flood had some different impacts between them. The poor households in flooded housing area were selected as the target group (Group One) to compare the socioeconomic aspects impacted by flood to other poor households in non-flooded housing area (Group Two), and to the non-poor households in non-flooded housing area (Group Three). Then impacts of flooding on these groups would be clarified.

5.3.1 The Households Profiles in Surveyed Areas

The poor households were identified by the poverty line of HCMC (HCMC People Committee, 2012). In 2005, HCMC established the poverty line, 6 million Vietnam Dong (VND) per person per year, for the whole city. However, the new poverty line for 2009 - 2015 was published in 2009, is 12 million VND/person/year (about 575 USD[6]/person/year, and 1.57 USD/day). While world poverty line was 1.25 USD/person/day (WB, 2010b), and 456.25 USD/person/year (about 9.525 million VND/person/year). With this poverty standard, the HCMC poverty line is little higher than the world poverty line. Once the households are identified to be the poor, they receive the 'Poverty book' from the government[7] to have opportunity for special supports. However it needs time to update the poor households and renew the books for the next

[6] The money exchange between VND and USD was counted in the surveyed time and followed the exchange rate of the Vietcom Bank in May 2011. One US Dollar was about 20,875 VND.

[7] Vietnam Government has promulgated the 'Poverty book' to poor households based on the rural or urban poverty line. This book will help the poor to access the special credits or special supports from government and social associations to improve their economies and livings. This book was re-promulgated yearly to control poverty and update the poor household data. However, this process always needs time and during this time, poor household cannot use this book.

year. Therefore, many of poor households had no 'Poverty book', while some higher income households had as in the survey result in Table 5.3 below.

Table 5.3: The households' profiles of the three selected groups.

		Group One	Group Two	Group Three
		Flooded-poor	Non-flooded-poor	Non-flooded-non-poor
Household's economic characteristic (US Dollar) – (% households)				
Income per capita of households	x ≤ 456	73.0	84.8	-
	456 < x ≤ 575	27.0	15.2	-
	575 < x ≤ 719	-	-	28.0
	719 < x ≤ 5,174	-	-	68.6
	x > 5,174	-	-	3.3
Household's socio characteristics - (% households)				
Poor household	With poverty book	17 (11.3 %)	20 (13.3 %)	3 (2 %)
Family members	1 to 4	64.7	59.3	76.7
	5 to 10	33.3	37.3	23.3
	More than 10	2.0	3.4	0.0
Education: average (%) of members:	Secondary	53.4	58.0	33.7
	High school	28.7	28.9	30.8
	College at least	17.5	13.3	35.6
Non-incomers: average (%) of members:	Elderly, pupils, housewives, etc.	35.5	31.6	28.5*
	Unemployed	3.0	1.0	0.2
Occupation	Quite different between poor and non-poor households	Teachers, government officers, securities, etc. Temporary workers, sewers, small sellers, etc.		Company officers, doctors, skill workers, businessmen, …
(*) Most of non-incomers in this group were children and pupils or students.				

(Notes: Group One – The flood-housing poor households; Group Two – The non-flood-housing poor households; and Group Three – The non-flood-housing and non-poor households)

The income disparity among poor households was divided into two categories: the first rank was under the World Bank's poverty line (less than 456 USD/person/year); the second was under the HCMC poverty line (less than 575 USD/person/year). Table 5.3

showed about three-fourths of households in Group One and nearly 85% of households in Group Two below the world poverty line.

The income of people in Group Three was above the city poverty line, however, nearly one-third of households closed to city line[8]. City people who earned more than 108 million VND/year (5,174 USD), they were the high-income person and had to pay the income tax. In this group, only 3.3% of households (4 of 150 households) had to pay the income tax. This said the majority of people in Group Three were the low- and middle-income people.

In households' socio-characteristics, the family members and education in the two poor groups were nearly the same, while almost higher-income households group had four-members family and higher education. The jobs and professions in this higher income group were quite stable to the poor groups. They mostly were company officers, professors, businessmen, doctors, or skilled workers, etc. To the contrary, the stable occupations in the poor groups normally were teachers, government officers, unskilled and temporary workers, etc. The non-incomers were elderly, housewives, mostly pupils or students. And un-employee in Group Three was fewer than in poor households in Group One and Two.

5.3.2 Flood Impacts on Socioeconomic Aspects of Households

The socioeconomic characteristics among poor were not quite difference, however; there were some differences among them when combined to flood factor. With the above flood problems in residential areas, it had impacted on some socioeconomic aspects of households. These impacts were evaluated by the households in the surveyed fields. About 50% of households in Group One thought that flood impacted seriously on streets, drainage system, and sidewalks. The drainage had problem because it was old and incomplete. About 25% of them had their residential areas flooded in rainy season half a day, quarter in the morning and quarter in the evening. This caused frequently the transport traffics and accidents sometimes. The residential areas of poor households in Group Two had less flood impact than of Group One. Some households said they had serious problem with flood streets (20.9% of households), drainage system (16% of households), and accident sometimes (9% of households). The higher-income households in Group Three had the fewest impact of flooding on residential area. Their evaluation on flooding was not much serious (see Figure 5.5).

[8] This income group categorized by the author of this study was ranked from above City line (12 million VND – 575 USD) to 15 million VND (719 USD), just 3 millions VND higher the City poverty line. According to the author, the households in this income group may have the same socioeconomic impacts of flooding to the poor households.

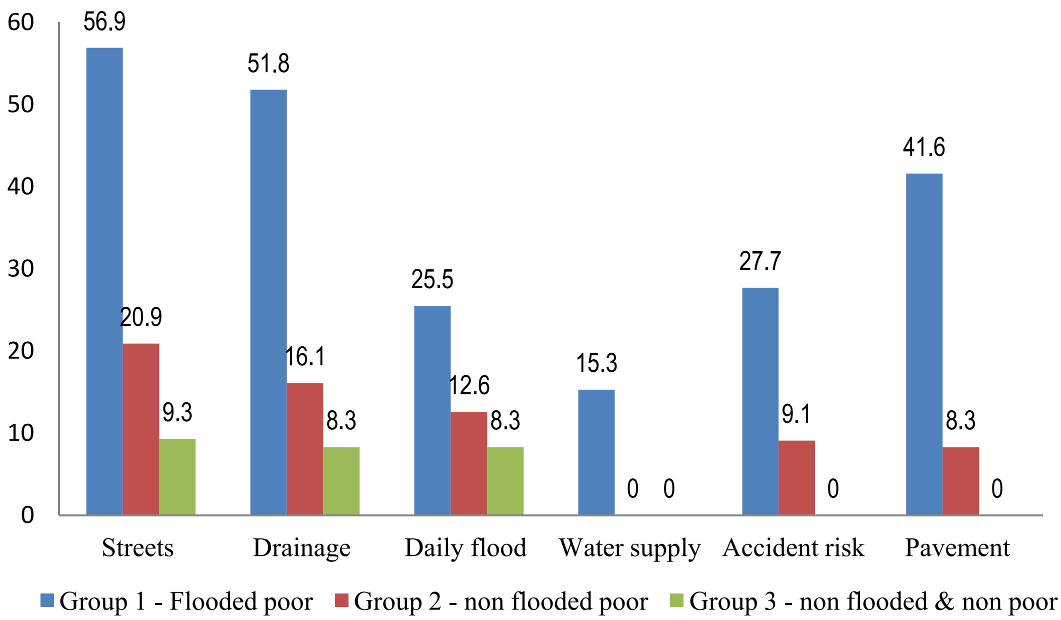


Figure 5.5: Household's opinions of flood impacts on residential areas

Nevertheless, almost households said that flood would be increasing. Some households in Group Two and Three had some responses to the near future flood, while many poor households in Group One had paid for flood impacts (see Figure 5.6). Flood will long affect their income, because the cost for upgrading was high. Furthermore, flood also impacted on other social aspects and disordered their daily activities.

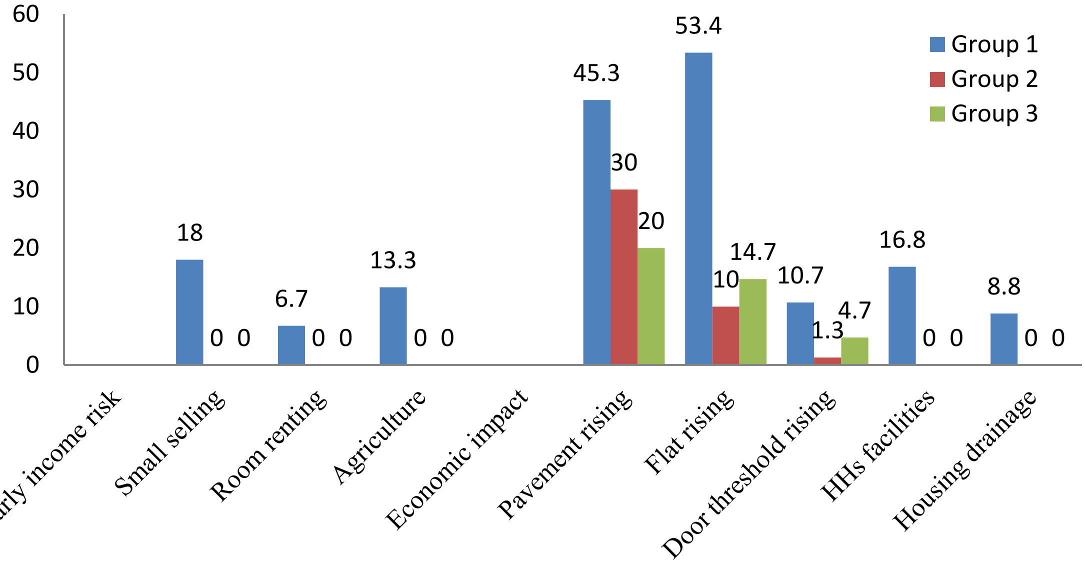
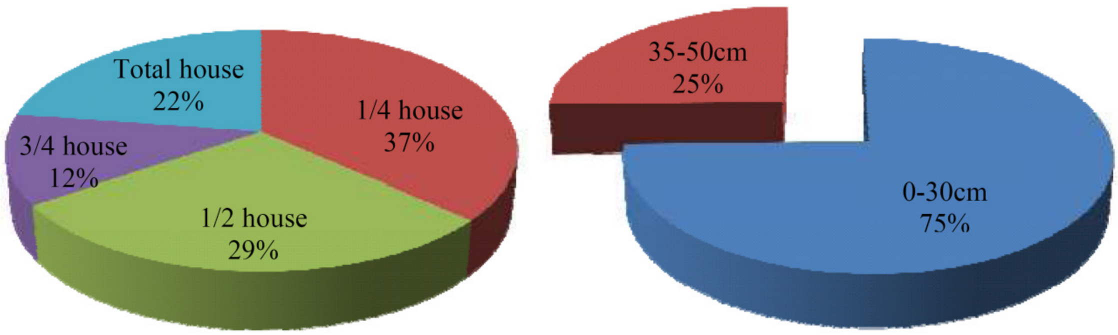


Figure 5.6: Flood impacts to residential areas

(Notes: Group One – The flooded-housing poor households; Group Two – The non-flooded-housing poor households; and Group Three – The non-flooded-housing and non-poor households)

5.3.3 Socioeconomic Impacts of Flooding on the Target Group of Poor Households in Flood Housing Areas

Poor households in Group One were impacted on both flooded residential area and flooded housing area. Flood impacted to housing area in three directions: (1) flood from street went into the house; (2) waste water from housing flooded-drainage flew up to the house; and (3) both of them. The last two ways happened when the housing level was lower than or equal to the street level; or housing drainage was lower than the residential drainage system. Depending on the housing level, each household had different housing impacts. The Figure 5.7 below showed the flood area and flood level in housing level of the poor households in Group One. Among households of this group, 36.7% of households had one-fourth of their house area flooded; 28.7% had half flooded area; and 36.6% of households had 75% to 100% of flooded housing areas. The 100-percent-flooded houses were mostly small and located in the center districts, such as District 6, 8 and Binh Thanh District. To the houses flooded less than 50% were normally constructed with unequal parts of house. Then flood went to the lower house area.



(a) Flooded areas of housing (b) The housing max-flood level

Figure 5.7: Flood impacts to poor housing area

The average flood level of housing area of poor households in Group One was about 30cm. About 74.7% of households had the housing flood level over 30cm. Some households had flood level over 50cm in the broken-dike area in Hiep Binh Chanh Ward, Thu Duc District. Most of the flooded-control-dikes were built to protect the agriculture area in years. They were built with the simple technique and materials. When river-dike was rebuilt or upgraded, the flood level would be lower.

Flood in housing area caused the living of households disordered. With 30cm flood, the furniture and housing equipment was damaged. Flood water may ruin the house, the doors, and the walls. If they had no time or condition for moving up furniture and all housing equipment, the impacts would be stronger. The Figure 5.8 evaluated the flood impact to housing areas and other assets of poor households in Group One.

Floods may be gone in few hours, though, it led the sludge and polluted environment in the house. People had to spend time for cleaning and repairing. In the long run, it would strongly impact on their health and other human assets. Or they had to rise up the houses and will lose their income.

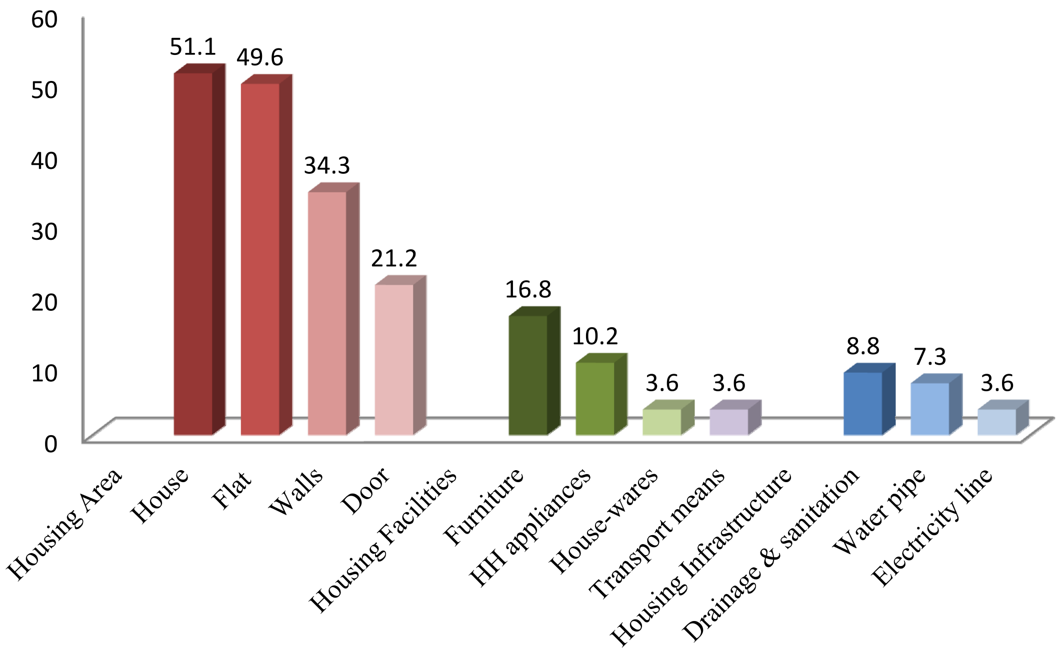


Figure 5.8: Households' opinions to flood impacts on housing areas

Flood in the house caused the bad feelings to households. To the poor households with no money for housing repairing, they had to live with flood and spend time for waiting and cleaning, etc. They had less places for living, working. Children had less places for learning and studying. And flood residential area surrounds brought more stresses to their lives more and more difficult.

To the economic aspects, some economic activities or occupations of the poor were not clearly identified with flood impact (such as: teachers, tailors, barbers, workers, securities, etc.). But some were impacted significantly (such as agriculture activities, small sellers, food sellers, temporary workers, etc). Agriculture activities were concentrated in the new-urban and rural area as in District 2 and Thu Duc District. Farmers here cultivated aquaculture, vegetables, and pot-planting. The floods and tidal flows in recent years had damaged many areas of vegetable, pot-plant and aqua-ponds, and impacted their income loss.

The small sellers and food sellers were mostly in inner center or new-urban districts. It was not easy to the sellers to sell their goods in rainy times. When their houses were flooded, people did not wanted to go out for buying. The sellers may lost their goods and reduced their income. To the temporary workers, they might be easily unemployed and hardly to find a new job. The Table 5.4 below indicated the income losses from economic activities in the flooded housing area of the poor households of group One.

Another economic activity, which had stronger impact, was room renting. Some poor households had only income from room renting. Without renters, their income was totally lost. In this situation, they had to rise up their house and wait for the new renters.

Table 5.4: Economic and income losses by flood on the poor households

	Impacted households		Economic losses	
	Frequency	Percent	Mil. VND	USD
Yearly economic loss				
Small selling	27	18.0	3.2 – 7	153 – 335
Room renting	10	6.7	16.8 – 24	805 – 1,150
Agriculture	23	15.3	12 – 36	575 – 1,725
Investment for privat flooding response				
House/flat rising	80	53.4	20 – 30	958 – 1,475
Pavement rising	68	45.3	1 – 2	48 - 96
Threshold rising	16	10.7	0.5 – 2	24 – 96
Water pumping	5	3.3	2	958
Do nothing	49	32.7	-	-
Other flooding responses				
Furniture			1 - 2.5	48 - 120
Wash machine			3 – 5	143.7 – 240
Ventilator			0.2 - 0.3	10 - 14
Refrigerator			3	144
Motorcycle			0.5 – 1	24 - 48

To keep away of flooding, the common flooding responses by the households in HCMC are pavement rising (sidewalk rising), house rising and threshold rising, etc. or they used water pump to remove water. Most of households, who had money, chose the house rising or rebuilding. However, these activities were expensive and they spent much income. The poorer normally used the cheaper responses such as threshold rising, pumping, etc. To the very poor households, they did nothing or just used some sandbags to prevent flood.

House rising was the expensive solution; however, 53.3% of households used this way. The average cost for this response was ranged from 20 to 30 million VND in this group. This cost was at least two times higher than their yearly income. To do this, they had to save money in several years or borrow from relatives with or without interest rate. Threshold rising was cheaper; however, it was temporary and ugly, and it made people difficult to move in and out of the house. Water-pump using had a disadvantage: they had to wait until flood lower or gone on the street; and then cleaned the house after pumping.

Flood impacts on poor households in poor community in Ward 1, Binh Thanh District, Ho Chi Minh City:
In 2011, all the streets in this community were announced to be raised up to 0.5 meter. Most of houses were planned to rise up or re-build in higher level by the households. Many households had to borrow money to rise their houses as the household of Ms. Nguyen Thi Gai in the address of 128/13/25 Dinh Tien Hoang Str. Ward 1, Binh Thanh District, HCMC. She had borrowed 10 million VND (about 480 USD) for house rising. This case will be more discussed in Chapter 7 of this study.

(a) Most of houses were being raised up or rebuilt

(b) house raising up one meter higher than the current street

(c) One rebuilding house in the community

Source: Data analysis and pictures taken from sample data 2011

Box 5.1: Flood impacts on economic aspect to poor households in poor community

Other households did nothing to response. But they spent for damaged housing equipment and transport means. Or they would spend more if flood would be increasing.

5.4 Summary for Chapter Five

Flood had many impacts on socioeconomic aspects in residential areas and on housing areas in HCMC. In different geographical areas and depending on the socioeconomic characteristics of the areas, flood had different expressions by space and time, and on the socioeconomic aspects. Households in flood residential areas had flood impacts on streets, transportation, and accidents. Flood impacted to housing areas of poor households, it impacted on housing infrastructure, housing drainage, water supply and electricity. It also damaged on housing equipment, furniture and transport means. Therefore, people had to privately invested for housing repairing and upgrading as well as their other assets, etc. And they lost their income.

Amongst three groups, households in Group One had the highest flood impacts in residential and housing areas as well as on household's socioeconomic aspects. They had spent much time living with floods and standing with stresses. Many of them had house-rising, threshold rising, pavement rising, etc. to protect their houses. Their yearly income was too low to upgrade the house. And there was no financial support from government, though; they borrowed from relatives or close friends and return later.

Some poor households and higher-income households in non-flooded housing areas (Group Two and Three) also raised their houses to prevent the future flood. In the future, when the frequencies of heavy rains and tidal flows would increase, flood would be more heavily impacted to housing area. Then the poor households in Group One would be more impacted. Even the poor in non-flooded housing area of Group Two and the higher-income households of Group Three would be impacted by flood in the near future.

6 Flood Impacts of Geographical Elevations in Ho Chi Minh City

HCMC is in the monsoon climate area. In recent decade, the frequency of tropical storms and cyclones is increasing. It has brought more heavy rains to the city each year. In the low-land area, the sea-level rise and tidal flows have brought more floods into the city (WWF, 2009; ADB, 2010; and WB, 2010a). Flood has increased the run-off water on the ground surface. By elevation, water runs from the higher land down on the lower land. However, different typography may cause the various types of flooding in the city (Gill & Collins, 2010).

6.1 Geographical Elevations of Ho Chi Minh City

HCMC locates mostly in lowland area, therefore it has the high risk of flooding by elevation. Understanding the city's geographical elevation and the previous flooding projections helped to clarify flooding situation, its reasons and impacts to the city.

6.1.1 Natural Typography in Ho Chi Minh City

HCMC has a slope terrain to the Bien Dong Sea. It slopes gently from the North down to the South and from the West down to the East. The highest altitude is 32m and the lowest is 0m above mean sea level (AMSL). The areas with over 30m are scattered as the small hills and mostly located in the North and Northeast. The terrain of HCMC can be categorized as follows (Nguyen & Duong 2007; Trinh, 2008):

- The high altitude areas - from 10 to 32m: Most are hills and mounds. They concentrate in the city North (the North part of Cu Chi Sub-district) and partly in the Northeast (in District 9 and Thu Duc District). These areas occupy 11% of total city area. They are wavy surfaces and intermix with small hills. The average height is about 25m.
- The mean altitude areas - from 4 to 10m: they are distributed in the center area, mostly in the inner districts. They are also located in some new districts like partly District 2 and Thu Duc District, the whole District 12 and Hoc Mon Sub-district. These areas occupy 19% of the total city area.
- The first low altitude areas – from 2 to 4m: They are even and flat areas, concentrated in the Southwest areas (District 8 and Binh Chanh Sub-district) and Southeast areas (District 7 and 9, etc.) of the city. It is about 15% of total city.

- From 0 to 2m: the sunken and marsh areas in the South (such as Can Gio and Nha Be Sub-districts) and Southeast (such as partly District 2, Binh Thanh and Thu Duc Districts). It is about 55% of the total city area. Most of these areas are impacted by daily tidal system.

Another typical terrain of HCMC is river and canal system widespread over the city with about 16% of total area. With the low-land area of river system, the total land below 2m of the city is about 61%. Along with the semi-diurnal-tidal-flow regime as well as the water works in the upstream areas, this city is of high risk to be inundated (Trinh, 2008). This is now the big obstacle for development of the city.

6.1.2 Flooding Projects in Ho Chi Minh City

Flooding projects in HCMC were based on the IPCC's climate change scenarios by changing of temperature and sea-level rise (IPCC, 2007 a&b). Since 2007, several projects were implemented by some organizations (Ho, 2007; IFAD & UNCCD, 2008; UN, 2009; MoNRE, 2009; WB, 2010a). In these projects, flood increased by elevation when the sea-level rose.

The Asian Development Bank project (ADB, 2010) forecasted to 2050 HCMC would have about 65% of flooded area within 2 meter AMSL. In the World Bank project (WB, 2010a) there are four flooding scenarios to HCMC in 2050: there would be about 54% of area regularly flooded in the situation with no climate change and 68% of area with climate change of low emission scenario. When extreme flood time, there would be about 61% of flooded area in the situation with no climate change and 71% of flooded area with climate change of high emission scenario.

Vietnam Ministry of Natural Resource and Environment suggested the national flooding projects following the IPCC's scenarios of B1, B2, and A1F1 (MoNRE, 2009). In which, the sea-levels in the 2050s will be 28cm, 30cm, and 33cm; and in 2100 will be 65cm, 75cm, and 100cm. The projected sea-level rise from IPCC for the South and Southeast Asia to the end of twenty-first century is only up to 40cm (Cruz et al., 2007). And the projected sea-level rise in the 2050s suggested by World Bank (2010a) for B2 and A2 scenarios in HCMC are 24cm and 26cm, lower than the MoNRE's scenarios.

However, the current flood level in rainy season of HCMC reaches to 50cm in many areas. And the reasons for this flooding were not by sea-level only, as discussed in Chapter 4, Section 4.1.4. There are some other reasons of flooding in HCMC. This was discussed in details in the following sections of this chapter.

6.2 Flood Impacts of Geographical Elevation Areas

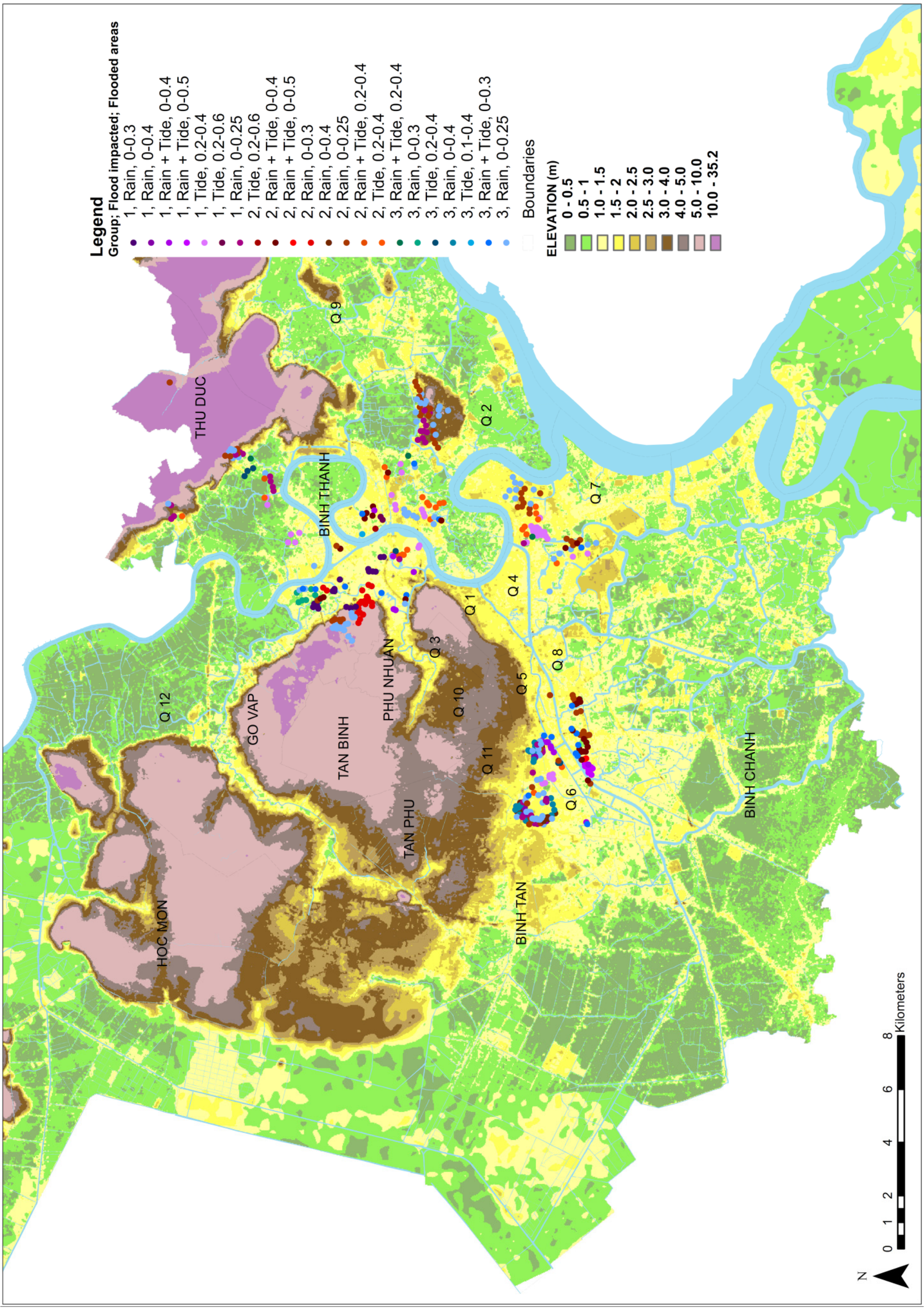
By elevation, typically, flood had more impacts on low-land areas and less impact on higher areas. However in this megacity, flood was driven by various reasons of climate change and urbanization. Flood by geographical elevation may have different impacts even in the same level of elevation in this city.

6.2.1 Surveyed Households in Flood Residential Area

The interlacing network of rivers and canals in HCMC is effect by the monsoon climate with monthly semi-inundation regime (To, 2008; and Le[2], 2009). This results in the large inundation of the low-land areas surrounding rivers and canals. These flood areas will be larger in rainy season.

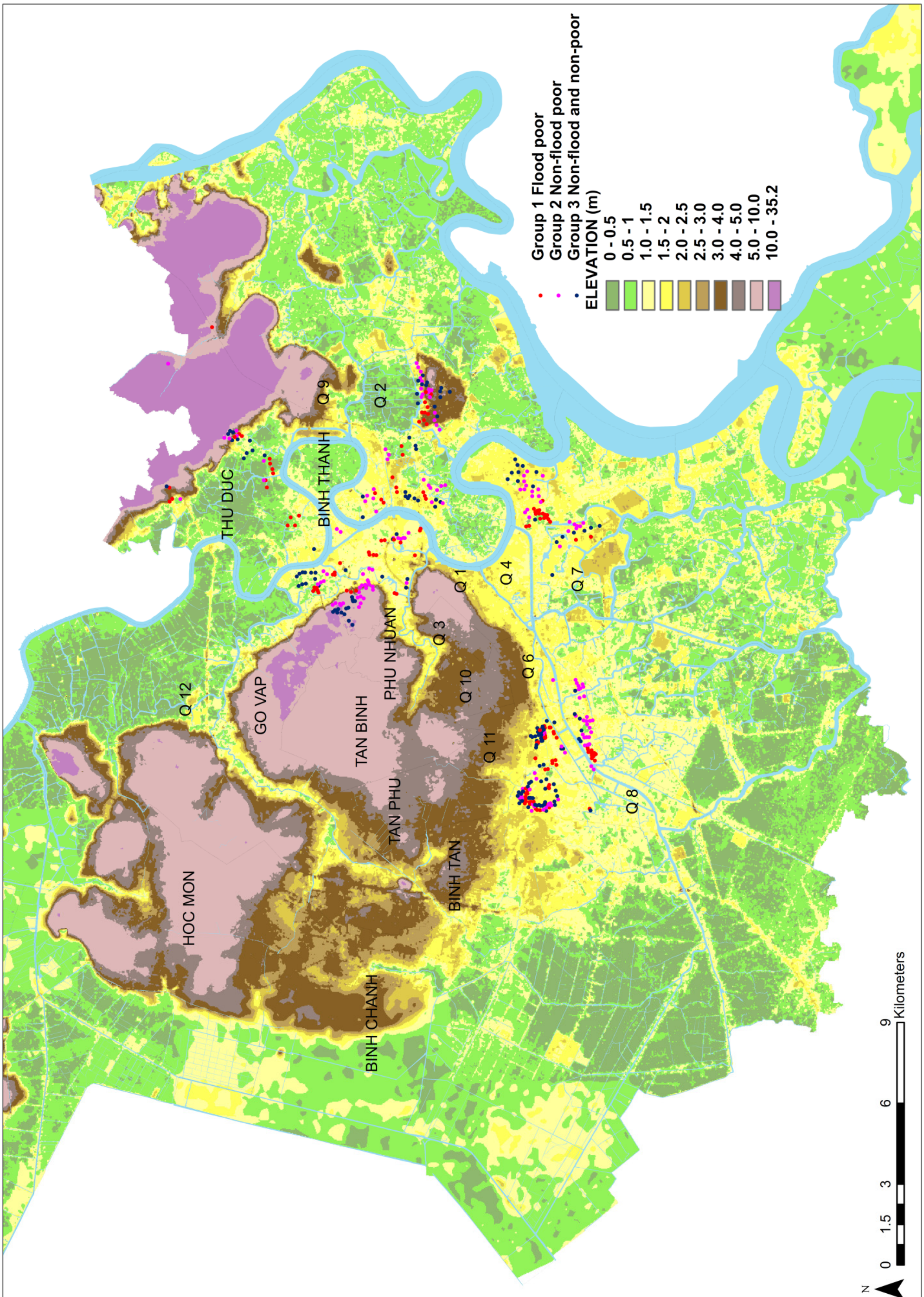
The 450 surveyed households were selected in the flood residential areas. They mostly were located in the area above 1 to 2m AMSL and in the areas effect by flood. The positions of surveyed households were linked into the elevation map by using GPS (Globla Position System) and were showed on the map in the Figure 6.1 above and Figure 6.2 below. However, because of the topographic disparity, some households were not impacted by flood in the same area. Flood even impacted differently in one area in HCMC, even on one side to another side of the street.

Amongst the households in three groups, more poor households in Group One and Group Two located in lower area and nearer the river or canal than households in Group Three. In which, people in Group One located in more vulnerable areas than others. And in contrast, the higher income people (in Group Three) tended to live in the higher land.



Source: Flooding statistic data in the map collected from DoT (2010) and SCFC (2010)

Figure 6.1: Surveyed households in flood types and in various geographical elevations



Source: Flooding statistic data in the map collected from DoT (2010c) and SCFC (2010)

Figure 6.2: Surveyed households in groups and in elevation areas

Table 6.1 showed only some households of Group One lived in area lower 0.5m AMSL, while few households in Group Two and Three lived in the elevation from 0.5 to 1m AMSL. Group One has only 11.3% of households located above 2m. But people in this elevation area of Group Two and Three are 23.3% and 29.3%.

Table 6.1: Households in elevation areas

Elevation	Group 1		Group 2		Group 3		Total	
	HHs	%	HHs	%	HHs	%	HHs	%
$x \leq 0.5$	4	2.7	-	-	-	-	4	0.9
$0.5 < x \leq 1$	16	10.7	3	2.0	4	2.6	23	5.1
$1 < x \leq 1.5$	63	42.0	33	22.0	16	10.7	112	24.9
$1.5 < x \leq 2$	50	33.3	79	52.7	86	57.3	215	47.8
$x > 2$	17	11.3	35	23.3	44	29.3	96	21.3
Total	150	100.0	150	100.0	150	100.0	450	100.0

Because of the typographic disparities, there were different impacts of flooding even in the same area. In flood residential areas, some households were located in flood areas, but some others were in non-flood areas. The Table 6.2 described the distribution of households in surveyed areas. In this Table, all poor households in Group One were in flood residential areas. The 52.7% of poor households in Group Two lived safer area in in flood residential areas. And the households in flood residential areas of Group Three were 38.7%.

Table 6.2: Households in flood residential areas

Elevation	Group 1	Group 2		Group 3		Total		
	Flooded HHs	Flooded HHs	Non-flooded HHs	Flooded HHs	Non-flooded HHs	Flooded HHs	Non-flooded HHs	Total HHs
$x \leq 0.5$	4	-	-	-	-	4	-	4
$0.5 < x \leq 1$	16	3	-	4	-	23	-	23
$1 < x \leq 1.5$	63	31	2	14	2	108	4	112
$1.5 < x \leq 2$	50	31	48	34	52	115	100	215
$x > 2$	17	14	21	6	38	37	59	96
Sub-total	150	79	71	58	92	287	163	450
Total	150		150		150			450

By effects of urbanization and rural immigration, the poor tended to settle in low-land area. This was the most vulnerable area of flooding and low infrastructure connection. Higher income people tended to live in high-land area with better urban provision. However, flood expansion in this megacity with inadequate infrastructure, as discussed in Chapter 4, Section 4.1 had a complex sequence and caused many tangible and intangible impacts.

6.2.2 Is Flooding in Ho Chi Minh City Regularly Done by Geographical Elevation?

The monsoon flooding in HCMC was regularly done by geographical elevation. The tidal flood follows the river flow into the low-land area. It caused the inundation in the catchment area. This flood came to HCMC two times a month, even in the dry season (with lower level) (To, 2008; Trinh, 2008; Le[2], 2009). And it tended to increase in recent years, especially in the rainy season (Ho, 2008; SCFC, 2012).

However, the flooding sequence in HCMC was more complex and impacted in various elevation areas. According to Ho (2008), based on the flood statistic data from HCMC Steering Center of Flooding Control Program, flooding in HCMC was not only in the low-land areas, but also in the higher-land areas.

Table 6.3a: The multiple correlation coefficient (R) and the coefficient of determination (R Square) of the relation model of Flood type and Elevation.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.631[a]	.398	.397	.784

a. Predictors: (Constant), Elevation

b. Dependent Variable: Flood types

Table 6.3b: The model's ability of Flood type and Elevation variables.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	182.445	1	182.445	296.621	.000[a]
	Residual	275.555	448	.615		
	Total	458.000	449			

a. Predictors: (Constant), Elevation

b. Dependent Variable: Flood types

In this research, the house's locations of households were positioned on the elevation map. This map was overlaid with the flood-data layer and then linked back to the SPSS for running crosstab and linear regression. The results in Table 6.4a&b showed the relationship between the variables of flood type and geographical elevation in flood areas.

The multiple correlation coefficient (R) in Table 6.4a described just more than 60% of surveyed cases fixed with the model. However, the Pearson Chi-Square test with Asymptotic Significance (2-sided) in Table 6.4b was 0.000. It explained that, the variables of flood type and elevation had the close relationship amongst the fixed cases of the model. This relationship was explained more in the Table 6.5a&b below.

Table 6.4a: Flood types in geographical elevation in Ho Chi Minh City

Crosstab

			Elevation					Total
			x≤0.5m	0.5<x≤1m	1<x≤1.5m	1.5<x≤2m	x>2m	
Flood types	No flood	Count	0	0	3	98	53	154
		% within Flood Types	.0%	.0%	1.9%	63.6%	34.4%	100.0%
	Rain	Count	0	2	33	77	38	150
		% within Flood Types	.0%	1.3%	22.0%	51.3%	25.3%	100.0%
	Tide and Rain	Count	4	5	46	38	3	96
		% within Flood Types	4.2%	5.2%	47.9%	39.6%	3.1%	100.0%
	Tide	Count	0	7	34	9	0	50
		% within Flood Types	.0%	14.0%	68.0%	18.0%	.0%	100.0%
Total		Count	4	14	116	222	94	450
		% within Flood Types	.9%	3.1%	25.8%	49.3%	20.9%	100.0%

Table 6.4b: Pearson Chi-Square tests of the relationship between Flood types and Geographical elevation variables

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.872E2[a]	12	.000
Likelihood Ratio	209.543	12	.000
Linear-by-Linear Association	144.444	1	.000
N of Valid Cases	450		

a. 8 cells (40.0%) have expected count less than 5. The minimum expected count is .44.

The flood type in Table 6.5a has generally changed by the elevation. Most of the households in low elevations were affected by tide or by both tide and rain. And most of the households in higher elevation were effect by rain. However, some households below 1 meter AMSL (2 cases) were affected by rain, and some others (9 cases) were affected by rain and tide. These cases located in the low area far from the river catchment, therefore the tidal flood has less impact, or they were only flooded when heavy rains come in the rainy season.

Nevertheless, the variables of flood types and elevation had the close relationship when combining to time factors which will be discussed in the following section.

6.2.3 Types of Seasonal Flooding in Ho Chi Minh City

From the above discussion on flood types and geographical elevation, the flood types in HCMC are categorized as follows: In general, HCMC has the following flood reasons: (1) Flood by tide; (2) Flood by tide and rain; (3) Flood by rain/or heavy rain; and (4) Flood by the adjustment from the up-stream reservoirs.

1. Flood by tide happens in the low terrain areas of rivers' surroundings. HCMC is strong affected by semi-inundated tidal regime. The tidal water from the rivers increases two times per day. And the tidal flow comes two times per month. Therefore, most of these areas are flooded two times per day (soon in the morning and late in the evening), even in the dry season. And the very low terrain areas will be flooded during the year. The tide in rainy season is higher and more rains cause the high volume of run-off water on the ground surface. Flooding in these areas is higher.
2. Some areas are just flooded by tide in the rainy season. These areas are in surroundings of the rivers and canals but higher altitude than the above type. When the heavy rains come, these flood areas may expose in larger areas.
3. Some other areas are flooded only in heavy rains. The heavy rains with high intension can produce the large volume of water on the ground surface. When the run-off water is highly increased and the drainage system cannot quickly receive all surface water. Most of these areas are temporary flooded in the short time. And they have higher elevation than the above two types. However, if the drainage system in these areas has a problem and cannot collect all rain water, then flood level will become higher and longer.
4. Other flood areas are come from the adjustment of the upstream reservoirs. When the water levels in these reservoirs are over the safe level, it then must be let out to save the works. Areas which receive this water would be flooded, especially the low land areas.

However, the city development and urbanization have driven flood expansion, such as the inadequate infrastructure and drainage system and pushed more flood exposed in the city. In general, the flood in HCMC is by the following reasons (Nguyen & Duong, 2007; Trinh, 2008; To, 2008):

- Flood by rain with rainfall over 40mm in the short time may cause flood in many areas, even in the high elevations. The rain with higher volume of water in the long time will cause serious flooding. This flood depends on the quality of drainage system and the density of sealed surface in the areas (Ho, 2008).

- Flood by tide or tidal flow goes far into the rivers and canals in the inert center, or flood by tide with rain. The area surrounding the rivers, where land has lower than river level, will be flooded.
- Flood by up-stream flood (from Mekong and Dong Nai Rivers) or by adjustment of up-stream reservoirs. If the rain or heavy rain, tidal flow, and/or incomplete drainage system come at the same time, flood will be higher.

The subjective reasons:

- Flood by rapid urbanization and high population growth: This causes the increase of sealed areas and reduces the water absorbability of the ground surface.
- Flood or inundation by old and incomplete drainage system of this city: The drainage system of HCMC is both out-of-date and incomplete. And it is narrowing and carrying much of sediments. Therefore, with the rain with only 40mm intension, this drainage system cannot receive all water at the same time and cause the run-off water on the ground surface.
- Flood by loosing in urban management in the mega-city: Lack of a leader in coordinating organizations in flood control. Some implementing projects are out-of-date, some others are very slowly implemented. The uncontrolled urbanization has made the rapid increase of sealed areas and the flood increases.

Table 6.5: The factors caused the flood types in Ho Chi Minh City

Flood Types	Type 1: By Tide	Type 2: By Tide and Rain	Type 3: By Rain
Main characteristics	Flood when tide comes, even in dry season	Less effect by tide, or flood when tidal flow and rain	Flood in rainy season
Main reasons	By elevation	By elevation and urbanization	Mostly by urban development
Areas of invasion	The low-land areas of catchment basin	The transition area of tidal rainy flood	High-land, more than two meter
Times of visiting	More than 15 years (9 to 12 months)	More than 10 years (7 to 9 months)	Within 10 years (within six months)
Type 4: Flood by the adjustment from the up-stream reservoirs It was unclear by households and residential areas. However, this comes from the up-stream area, outside the city by the adjustment from the up-stream reservoir.			

At the household level, all people easily recognized the flood of type two (flood by tide and rain) and type three (flood by rain). The type one (flood by tide) was by the households living in the tidal inundation areas. It was difficult to recognize the type four by the households, because the original of flooding come from outside the city. Therefore, it was understood through the newspapers or the science magazines or by the science reports.

To verify the above flood types analyzed from the survey to the flood statistic data on the elevation map, testing the model of flood types and space variable (elevation) and time variables (flood months and flood years) was implemented in this research. The linear regression analysis was run for testing the ability of the relationship. The test results were presented in Table 6.6 a&b and in Figure 6.3.

Table 6.6a: The multiple correlation coefficient (R) and the coefficient of determination (R Square) of the relation model between the variables of Flood type, Elevation, and Flood months per year.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.906[a]	.821	.820	.429

a. Predictors: (Constant), Residential flood months per year, Elevation

b. Dependent Variable: Flood types

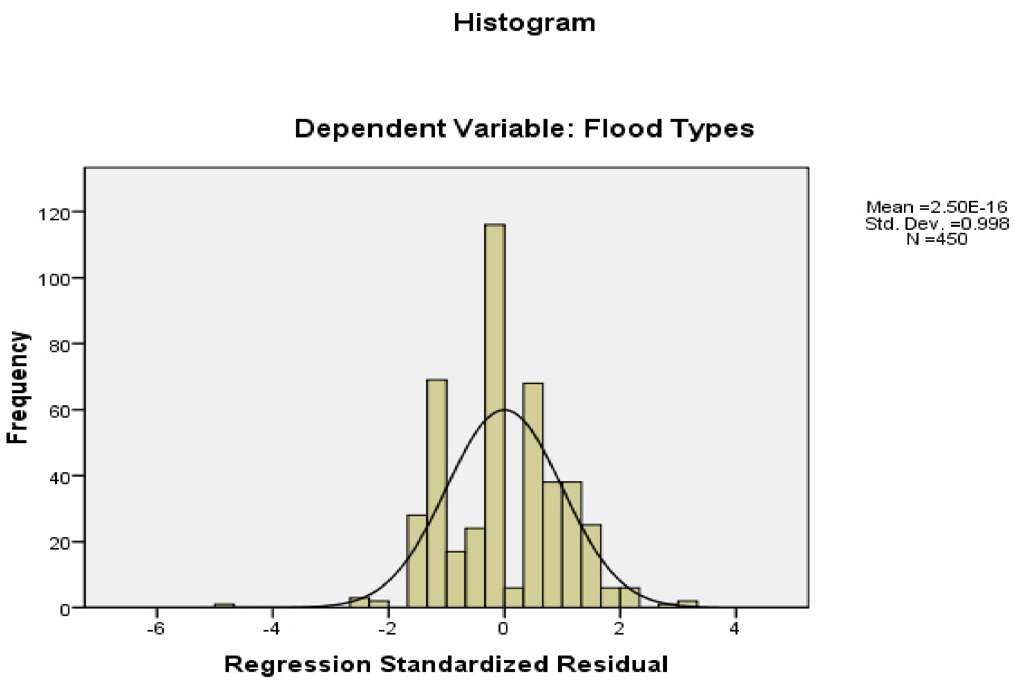
Table 6.6b: The model's ability of Flood type to Elevation, and Flood months per year

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	375.903	2	187.951	1.023E3	.000[a]
	Residual	82.097	447	.184		
	Total	458.000	449			

a. Predictors: (Constant), Residential flood months per year, Elevation

b. Dependent Variable: Flood types



Source: Data analysis from field data 2011

Figure 6.3: The P-P plotted residuals of the model

The multiple correlation coefficient (R) and the coefficient of determination (R Square) of the relation model reached to 0.906 and 0.821said that, there was the strong relationship between variables. In comparison to the Table 6.4 above, it explained the importance of time variable (the flood-months-per-year variable) to link to the space variable (the geographical elevation variable) and the flood-type variable in the model. The anova-test result in Table 6.6b also proved the acceptance of the model with the significant reached to 0.000. And the histogram in Figure 6.3 with the normal curve supported for the suitability of the model. Similarly, one more of linear regression was analyzed with adding more flood-year variable into the above model (see Table 6.7a&b).

Table 6.7a: The multiple correlation coefficient (R) and the coefficient of determination (R Square) of the model between Flood type, Elevation, Flood months per year, and Flood years.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.918[a]	.842	.841	.403

a. Predictors: (Constant), Residential flood years, Elevation, Residential flood months per year

b. Dependent Variable: Flood types

Table 6.7b: The model's ability of Flood type to Elevation, Flood months per year, and Flood years.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	385.640	3	128.547	792.314	.000[a]
	Residual	72.360	446	.162		
	Total	458.000	449			

a. Predictors: (Constant), Residential flood years, Elevation, Residential flood months per year

b. Dependent Variable: Flood types

The result in Table 6.7a had R with 0.918 and R Square with 0.842, little higher values than the result in Table 6.6a. It demonstrated that the time variables of "Flood months per year" and "Flood years" had the relationship with the types of flood and with elevation in residential areas.

Flooding has impacted on various geographical elevations in the city. The type of flood depended on spaces of elevations: low-land area was flooded by tide and high-land area was flooded by rain. Flood types also related to time. Flood by rain occurs in rainy time, and flood by tide occurs in the catchment areas. The tidal flood occurs in both rain and dry seasons, and it lasts longer time in the area. The areas with flood by tide had flood visited in more months in year and in more years rather than in the areas with flood by rain. Therefore the above models showed the relationship between flood types with the space of elevation and with the time of flood months per year and flood years. However, some cases of the survey did not fix to this relation, because there were other factors affected in. This will be analyzed in below section.

6.3 Communities' Perceptions to Flooding in Ho Chi Minh City

Scientifically, flooding in HCMC was come from many reasons as discussed in Chapter 4 and in the above sections of this chapter. And depending on the characteristics of space and time, and socioeconomic aspects, flood had different impacts on various areas in the city. However, the awareness on flooding, flood impacts and reasons may be different amongst opinions of households and individuals in flood and non-flood areas. This was also the input information for flood impact analysis and flooding adaptation processes to HCMC.

6.3.1 Elevated Flooding in the Residential Areas

The flood time can help to understand the relationship of flood types and geographical elevation of the surface. Flood by tide was mostly in the low-land area and in surround the river and canal catchments as discussed in the above section. And flood by rain was normally in higher elevation and in far of river and canal catchments. The Tables 6.8 and 6.9 below showed the long-flood time in the low-land areas.

Table 6.8: The flooding history by elevation in residential areas

		Geographical elevation					
		x≤0.5m	0.5<x≤1m	1<x≤1.5m	1.5<x≤2m	x>2m	Total
Flood years in residential areas	No flood	-	-	4	100	59	163
	%			*3.6*	*46.5*	*61.5*	*36.2*
	1 - 5 years	-	1	14	24	21	60
	%		*4.3*	*12.5*	*11.2*	*21.9*	*13.3*
	6 - 10 years	-	9	54	68	15	146
	%		*39.1*	*48.2*	*31.6*	*15.6*	*32.4*
	11 - 15 years	1	10	31	23	1	66
	%	*25.0*	*43.5*	*27.7*	*10.7*	*1.0*	*14.7*
	16 - 20 years	3	3	5	-	-	11
	%	*75.0*	*13.0*	*4.5*			*2.4*
	> 20 years	-	-	4	-	-	4
	%			*3.6*			*0.9*
	Total	4	23	112	215	96	450
	%	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
	Pearson Chi-Square test with Asymptotic Significance (2-sided): 0.000						

The above relationship between flood history and elevation area could be understood, because the low-land areas in the river catchment were strongly effect by the hydraulic regime. And in higher-land area, flood visited just in the recent decade. It was matched with the meteorological data of HCMC in the recent years (Ho, 2008; SIHYMETE, 2008; SCFC, 2010).

The months of flooding in a year had close relationship to flood types in the elevation areas. Flood by rain impacted the area in the rainy season, about six months from May to November. The flood areas by both rain and tide had the longer time of flood than flood areas by rain, maximum in nine months per year, but shorter than in flood areas by tide. Flood by tide may affect the areas even in the dry season. It could last during a year in the very low-land areas, or within nine months depend on the elevation of the areas.

Table 6.9: The yearly flood time in residential areas

		Flood Types				
		No flood	Rain	Tide & Rain	Tide	Total
Residential flood months per year	No flood	163	-	-	-	163
	%	*100.0*	-	-	-	*36.2*
	1 - 3 months	-	21	5	-	26
	%	-	*14.4*	*5.6*	-	*5.8*
	4 - 6 months	-	122	64	3	189
	%	-	*83.6*	*71.9*	*5.8*	*42.0*
	7 - 9 months	-	2	19	44	65
	%	-	*1.4*	*21.3*	*84.6*	*14.4*
	10 - 12 months	-	1	1	5	7
	%	-	*0.7*	*1.1*	*9.6*	*1.6*
	Total	163	146	89	52	450
	%	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
	Pearson Chi-Square test with Asymptotic Significance (2-sided): 0.000					

The Pearson Chi-Square test with Asymptotic Significance (2-sided) in the above two tables both were 0.000. It meaned that the variables had the strong relationship to each other. And these results could explain and support to the models in Section 6.2.3.

6.3.2 Communities' Perception on Flood Reasons

Scientifically, the flood experts and NGOs had proved that flood in HCMC were from many physical and social reasons. The HCMC experts said that the social factors as urbanization and incomplete planning had pushed flood expose in the city (To, 2008a&b; Trinh, 2008; Ho, 2008 & 2010; Le, 2009; ADB, 2010; WB, 2010a).

The analysis results pointed out from households' opinion about one important reason of flooding in HCMC was the overload-urban-drainage system. Many interviewed households thought that flood came by rain or by rain and tide, though, most of them believed flood came by heavy rains, tidal flows, and the overload drainage system.

Many households thought that flood came by rain (91 answers, about 30.7% of 296 answers). However, 153 answers, about 51.7% of 296 answers, thought that flood came only by rain and tidal flows, but also by the inadequate and old drainage system (See Table 6.11). Therefore, the urban drainage system was one of the important reasons of flood expose in HCMC.

Table 6.10: The households' opinions on flood reason in comparison to flood types and geographical elevation in Ho Chi Minh City

	Criterion		Elevation						Flood Types				
			x≤0.5m	0.5<x≤1m	1<x≤1.5m	1.5<x≤2m	x>2m	Total	No flood	Rain	Rain + Tide	Tide	Total
Flood reasons by households	No flood		-	-	4	95	55	154	154	-	-	-	154
		%	-	-	3.6	44.2	57.3	34.2	94.5	-	-	-	34.2
	By Rain		-	7	25	41	18	91	3	57	23	8	91
		%	-	30.4	22.3	19.1	18.8	20.2	1.8	39.0	25.8	15.4	20.2
	By Rain + Tide		-	-	1	-	-	1	-	-	1	-	1
		%	-	-	0.9	-	-	0.2	-	-	1.1	-	0.2
	By Rain + Drainage		-	2	16	30	3	51	1	18	21	11	51
		%	-	8.7	14.3	14.0	3.1	11.3	0.6	12.3	23.6	21.2	11.3
	By Rain + Tide + Drainage		4	14	66	49	20	153	5	71	44	33	153
		%	100.0	60.9	58.9	22.8	20.8	34.0	3.1	48.6	49.4	63.5	34.0
	Total		4	23	112	215	96	450	163	146	89	52	450
		%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Pearson Chi-Square test with Asymptotic Significance (2-sided): 0.000								Asymp. Sig. (2-sided): 0.000				

6.4 Summary for Chapter Six

The complex hydraulic regime of the rivers and urbanization in the low-land areas has caused the various flooding in HCMC in the climate change situation. The flooding projects were designed for the areas below 2 meter AMSL; however, current flood has impacted even in the higher land. Flood was categorized into three main types: (1) flood by tide, (2) flood by tide and rain, and (3) flood by rain.

Most of the poor in the surveyed areas located in the high vulnerable area of flooding, while the higher-income people trended to live in the safer land. The model of flood type and elevation variables showed the weak relationship, because of typographic disparities.

However, when adding the time variables (residential flood-month-per-year, and the residential flood year) into the model, the model became stronger. And it showed the close relationship between elevation, flood months per year, flood year to flood types. Though flood exposure in the city by heavy rain, many households thought that flooding came by heavy rains, tidal flows, and by the overload drainage system. Therefore, urban drainage system would be the important additional factor in the adaptive planning programs in HCMC.

7 Households' Capitals Analysis to Flooding Adaptation in Ho Chi Minh City

Households' capital analysis in this research is developed from DFID (1999) based on the sustainable livelihoods approach. This approach helps to understand the capabilities of households based on their assets to flooding responses and maintain their living. And to understand how people, especially the poor, can manage their assets within the vulnerable and institutional contexts as described in Chapter 4. The assets were affected by floods, then effected to each other and pushed the pressure on households and communities. The comparison amongst three groups helped to find out which asset of which group were affected and could be resilient. And which groups could manage and maintain their assets for future development. Then the roles of government and organizations were analyzed in helping people to cope with the situation and support the policies.

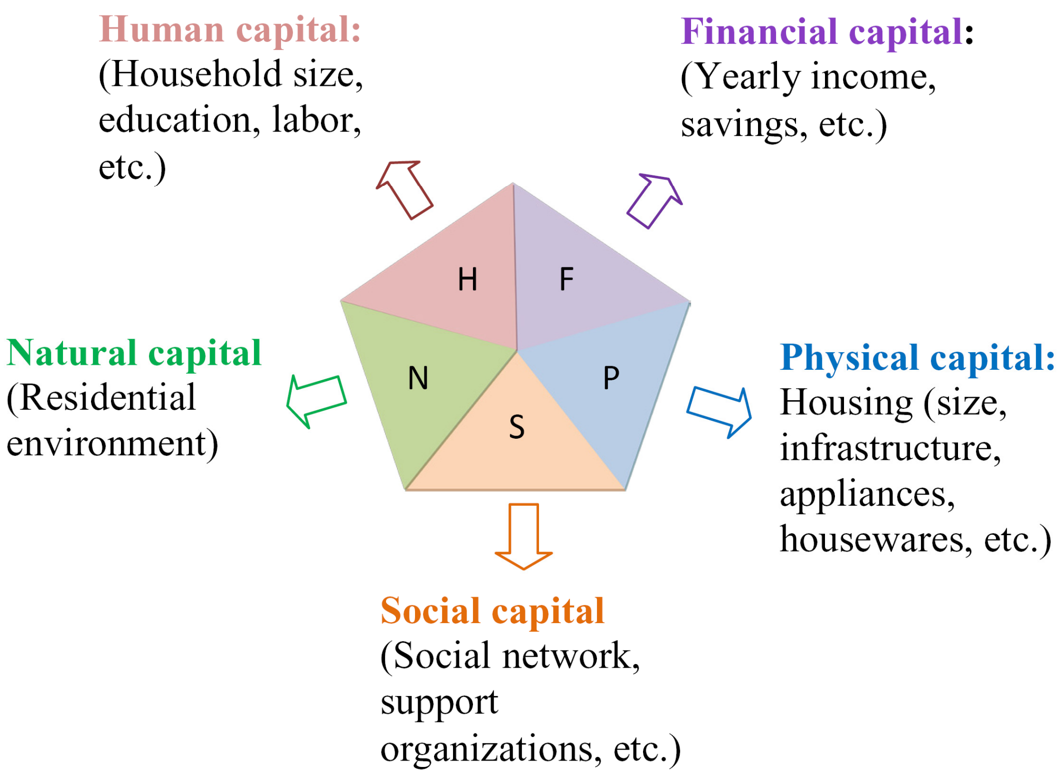
7.1 Households' Capitals of Sample Population

According to DFID (1999), each household has five main capitals, can be called assets: Human, Social, Natural, Physical, and Financial capitals. The strengths or the weaknesses of capitals depended on the situation of the areas and the socioeconomic characteristics of the households. In cities, the financial and human capitals are the most important capitals, especially to the poor (Meikle *et al,* 2002; and Farrington *et al,* 2002). With these two capitals, people can access and improve the physical and other capitals. The political is the one important capital to urban households. It supports to access other capitals and helps to achieve the household's strategies (Farrington *et al,* 2002; Carney, 2005).

To the surveyed households, the finance was also the important capital and it was much impacted by flood as analyzed in Chapter 5, Section 5.3.3. In general, the capitals of the interviewed households could be described as follows:

1. **Financial capital:** The main finance of households was the monthly or yearly income. By this income, they could do the savings or save as jewelry, etc.
2. **Human capital:** Labor was the most importance to people accessing the jobs. Skilled labor may help to find the good jobs. More labor may earn more income for household. High education and good health can enhance the skills and maintain the occupation. However, the big family with many children and elderly may be the problem to household.

3. **Physical capital:** It included housing, appliances and equipment and other properties that the household owned, and housing as well as urban infrastructure. In the megacity like HCMC, housing was a very important property to poor household. It was the place for shelter and for reproducion as well. It could also be the pledge to loan in the bank. Housing could have high value when its position in the area with best infrastructure and urban services.
4. **Natural capital:** There was not natural capital belonging to the community's management. However, in some aspects, households and communities could use this capital as beneficiaries or it might have impacts to them. For example, the flood canal might affect the residential environment. And flood in residential area could bring bad environment to housing area, and impact on other capitals of household.
5. **Social capital:** It was the related networks which could support individuals, households, and communities to access and improve their capitals. They consisted of local government, social organizations, NGOs, and even individuals within community. The social network could support and share information to households, especially in the crisis time of shocks and trends of urban vulnerable context.
6. **Political capital:** It is the system of politics and institutions that brings more rights and opportunities to people in accessing and improving their capitals/assets.



Source: Developed from DFID (1999) and Farrington et al. (2002)

Figure 7.1: Household's capitals of the sampling population

The capitals may be different between household groups and may have different impacts in flooded residential and housing areas.

7.2 Financial Capital

The main financial source of interviewed households was their yearly income. It included the net income of family members after excluding the monthly expense. This expense was paid for all expenditure such as daily food, basic services, clothes, household facilities, etc. The rest would be the yearly income of the family.

7.2.1 Financial Ability of Households

The yearly household's income had shortly discussed in household profile, Section 5.3.1 of Chapter 5. Most of the poor were under the world's poverty line. People in Group Three were mostly the middle-income people. There were only four high-income households (3.3%) in group Three.

Table 7.1: The financial ability and losses of households in flood areas

Financial capital	Group 1 (%)	Group 2 (%)	Group 3 (%)
Yearly income per capita			
- Under world poverty line, less than 456 USD/year	73.0	84.8	-
- Under HCMC poverty line, less than 575 USD/year	27.0	15.2	-
- Close to city poverty line, less than 719 USD/year	-	-	28.0
- Middle income, less than 5,174 USD/year	-	-	68.6
- Income with tax payment, more than 5,174 USD/year	-	-	3.3
Yearly income loss of flood on:			
- Trading (small selling, shop)	18.0	2.7	1.3
- Room renting	6.7	-	-
- Agriculture	15.3	-	-
Financial risks by:			
- House rising	45.3	30.0	20.0
- Pavement rising	53.4	10.0	14.7
- Threshold rising	10.7	1.3	4.7
- Households' facilities repairing	16.8	-	-
- Housing drainage repairing	8.8	-	-
Access to loans/credits			
- Credit for the poor's flooding responses	-	-	-
- Loan from bank	-	-	-

The first two groups were the poor under the poverty line. Their incomes just supported to the daily and basic needs. And it was difficult to have savings for future, or for the potential problems.

Amongst three groups, the poor people in Group One had the most losses of income than other groups. And higher-income households in Group Three had the fewest loss of income amongst groups. The flood-response activities of Group Two and Three were done in the past, or done to prevent the future flood as answered by the households. For example of households in Group Three had the respond activities before coming of flood in the residential area. Their income was lost; however, they could controlled the flood risks into their houses. However, their financial ability would be reduced after the responses.

7.2.2 Flood Impacts on Household's Finance

The household incomes may be lost when flood coming. About 40% of poor households in Group One were lost their income on daily small selling, room renting, and agriculture[9] (see Table 7.1 above). Households in Group Two and Three had less income loss than in Group One, just some households in trading activities (4 households in Group Two and 2 in group Three). Their losses were from 2 to 5 million VND per year (about 95 to 239 US dollars).

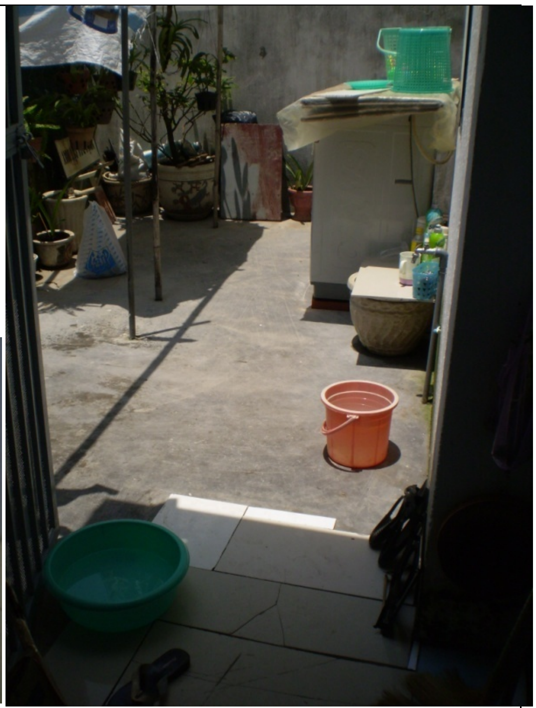
Furthermore, this income had more losses when people used to pay for housing repairing. Normally, households chose threshold rising as the first choice when flood had weak impact to their houses. The second choice was pavement/side-walk rising. And the third was house rising (or flat rising)[10] when flood had strong impact on street and trended going into the housing area. In this case, most of households chose the house-rising. They had risen the threshold or pavement, or both in the past; Or they built-up the pavement and threshold in the same time with rising up the house's flat.

Inversely, Group One had stood with flood impacts on their houses before rising, because the rising-up activities needed to invest the big amount of money that they did not save enough. Flood impacts on housing area of poor household of Group One was already discussed in Section 5.3.3 of Chapter 5. There was no official channels of financial support to the poor in housing upgrading. Therefore, the financial ability of the poor of Group One, even of Group Two, was limited for respond activities.

[9] Small selling of the poor in Group One had two types: (1) A very small store of basic commodities for daily food or stationeries for school; (2) A small stand for breakfast or supper. All these types just raised small income to households.

[10] The activity of "House-rising" and "House-rebuilding" were explained at the footnote part in Chapter Five, Section 5.3.2

Ms. Pham Thi Gai - 128/13/25 Dinh Tien Hoang Str. Binh Thanh District, HCMC
Poor household with 'Poverty book' received
Housing area: 21sqm
Main income: by room renting
Her house was flooded from 2008
To 2010: income lost in3 years
In 2011: borrowed 10 mil. Vnd (480usd) for house rising and waiting for new renters



After upgrading, her house has three rooms: two nine-square-meter rooms in the ground floor, and one wooden-nine-square-meter garret. She now lives in the second room in behind. The first room was being rented with 0.9 mil. Vnd/month (about 43US dollars). And the garret was waiting for the new renter.

Source: The interview data and photos from households surveyed, May 2011

Box 7.1: Flood impact on financial capital of poor household

7.2.3 The Financial Capability of Households to Housing Upgrading

The Table 7.1 also showed the weakening ability of financial asset because of flood impact. In the future when flood would have more exposure, poor households in Group Two would be the next vulnerable group to pay more expense for flooding. This section analyzed the relationship of yearly income and the private investments for housing upgrading to evaluate the financial capability to flooding response. Amongst the households who had risen the houses, the average costs per square meter of house rising were calculated to estimate the total expense for one house risen-up. It was then compared with yearly income to identify the ability of households in flooding response.

By the household survey, the average housing area was about 30 to 100 square meters. The average cost of house rising in Group One was 43.1 USD per square meters. The Table 7.1 showed the household sub-group closed to poverty line in Group Three were 28%. The house-rising cost of this sub-group was about 52.7 USD per square meters. The next group with higher income, they had also the higher cost of house rising. Therefore, Table 7.2 below divided house-rising cost into three groups: one for both households in Group One and Two, and two for households in Group Three. The only five households in the highest income would be analyzed outside the Table.

Table 7.2: The estimation of financial losses of house rising to households in flood areas.

Housing area	Group 1&2 Poor households	Group 3 Closed to city poverty line	Group 3 Higher income households
1. House rising (unit: 1000 USD)			
Cost/sqm (*)	0.043	0.053	0.072
x ≤ 30sqm	≤ 1.3	≤ 1.5	≤ 2.2
30 <x≤ 50sqm	1.3 - 2.2	1.5 - 2.6	2.2 - 3.6
50 <x≤ 80sqm	2.2 - 3.5	2.6 - 4.2	3.6 - 5.7
80 <x≤ 100sqm	3.5 - 4.3	4.2 - 5.3	5.7 - 7.2
x>100sqm	> 4.3	> 5.3	> 7.2
2. Time of income savings for house rising (unit: years)			
x ≤ 30sqm	≤ 2.8	≤ 2.2	≤ 0.4
30 <x≤ 50sqm	2.8 - 4.8	2.2 - 3.6	0.4 - 0.6
50 <x≤ 80sqm	4.8 - 7.6	3.6 - 5.8	0.6 - 1.1
80 <x≤ 100sqm	7.6 - 9.4	5.8 - 7.3	1.1 - 1.3
x >100sqm	> 9.4	> 7.3	> 1.3

(*) The price of house rising was analyzed from the data survey of the research in 2011.

From the average costs of house rising and the house area categorized into five groups, the total cost for one house was estimated. Then the household's income was compared to estimate the investment.

In Group One and Two, the cost for one house was ranked from 1.3 to 4.3 thousand US dollars to the households with income close to the world poverty line. In comparison to their yearly income, it needed at least 2.8 years to rise up thirty-square-meter house and 9.4 years of savings for one-hundred-square-meter house. In such a case, they must wait until having enough money and must live with flood during this time; or have to borrow money for upgrading and return later. furthermore, their earnings were impacted (on economic activities) when flood came, the time for saving would be longer.

To the poor households with the income upper the world poverty line but under the city poverty line of Group One and Two, they needed at least 2.2 to 7.4 years for saving; and maximum 9.4 years. About the households in Group Three with income closed to the city line, and to the higher-income households in Group Three, the rising cost was about 71.8 square meters. Though they were in the same income group, however; to the sub-group close to the city poverty line, they had to save their income for upgraging from 2.2 to maximum 7.3 years. The saving time of the five highest-income households in group Three was just within one or more than year.

In comparison to housing construction cost promulgated by Moc (2004 and 2011) and by the Vung Tau People Committee (2011)[11], the construction price of one square meter of lower-income housing (Group One and Two) was about 1.5 times higher than the house-rising cost, and for the higher-income housing (Group Three) was about 3.0 to 3.5 times. Therefore, the investment for housing rebuilding in flood residential areas would be higher.

In summation, Group One had the highest vulnerability with financial capital rather than Group Two and Three. To the high-income households in Group Three, though flood would be able to visit their houses, their finance could help them to solve the problem.

7.3 Human Capital

Human capital can be seen as the second important capital of households in urban area. It has a mutual relationship to financial capital. The high education and good skill could help to find a good occupation. The high income would help to improve health and educated quality to people. Then, these capitals would support to other human capitals. In flooding situations, this relationship becomes more important to maintain the household's strategies, especially to the poor households.

7.3.1 Human Capability of Households

The population of Group One or Two was bigger than of Group Three. The family types trended to have two generations with one parent and two or three children; or one generation with brothers and sisters. Some families still remained three generations with grandparent. And some households in Group One and Two had the family size more than ten people. This was presented in household profiles in Chapter 5, Section 5.3.1, and Table 5.3.

Group One and Two had more population under high-school degree. However, in the description in Figure 7.2, these two groups had more children than Group Three. Inversely, Group Three had more high-education population. The labor analysis described in Table 7.3 and Figure 7.2 said the first two groups had more non-income persons (include elderly, housewives, unemployed, and children), and more unskilled workers. The earning population in the last group was bigger with more officials, traders and skilled workers. While the officials in the first two groups mostly worked in the lower levels (such as company securities, receptionists, etc.).

[11] These housing prices were promulgated for housing compensation and for housing resettlement in cities of Vietnam.

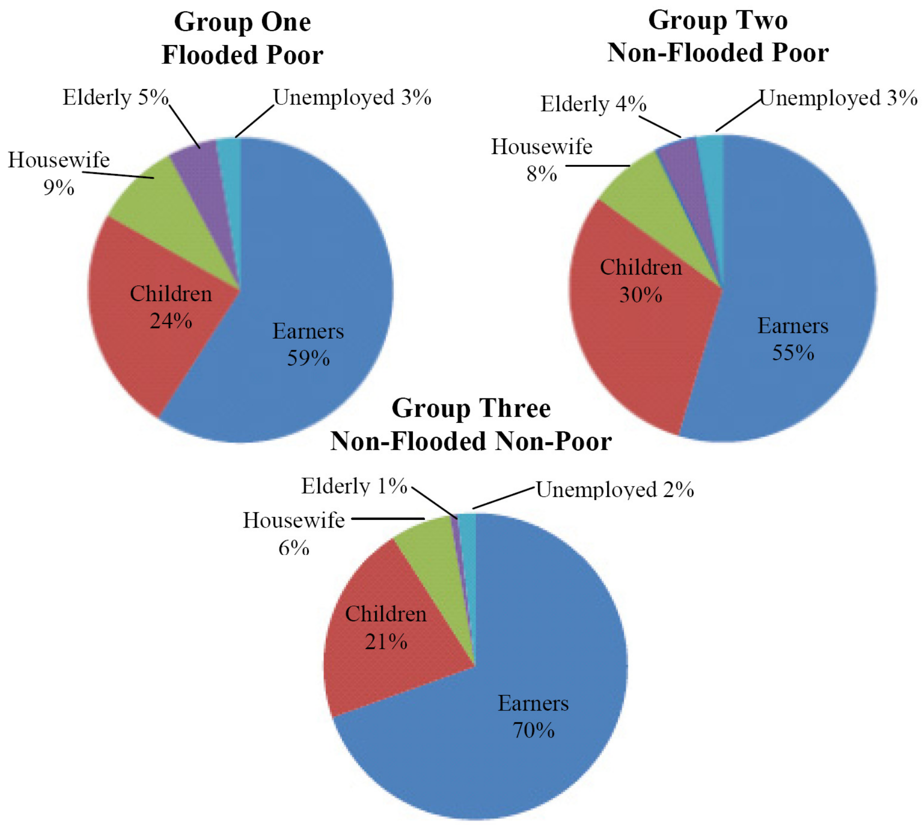


Figure 7.2: The households' labor analysis of surveyed households

Table 7.3: Household analysis of the study

Human capital	Group 1	Group 2	Group 3
Total households	150	150	150
Group population (pers.)	687	720	620
Household size (pers.)	4.4	4.7	4.0
Education level (%)			
- Secondary school	53.4	58.0	33.7
- High school	28.7	28.9	30.8
- College or higher	17.5	13.1	35.5
Occupation (%)			
- Earned person	59.1	54.7	70.3
- Non-income person	40.9	45.3	29.7
Labor analysis (%)			
Official labor	11.6	6.9	25.0
Skilled labor	16.1	16.1	11.1
Unskilled labor	30.6	19.9	20.4
Trader, seller	0.3	11.8	13.8

Generally, the human resources in Group Three was the strongest. Otherwise, Group One and Two had more vulnerable population. The lower educated and less skilled had restricted them from accessing the good occupation with stable income. As well, households needed more investment for children to go to school.

7.3.2 Flood Impacts on Human Capital

Human capital may be weakened by flood impacts. The bad environment of flood residential and flood housing areas would bring more stresses and affect people‘s health. There was no more open space in flood residential area for children playing and for people walking. And in housing areas, flood had occupied the space of living, working and relaxing. Children had no place for learning and playing. People had spent time to move up the housing facilities and appliances, and waited until the flood gone. They had less time for taking care the family, enjoying life, and preparing for work. Especially in the tidal-flood areas, flood visited two times a day. It caused disorders to the daily activities and their lives.

Amongst the groups, Group One was the most vulnerable group. They lived in flood residential and housing areas. With the financial ability as discussed above, they had to spend time living with flood until the available finance for housing repairing. The poor in Group Two had the similar human resources to the poor in Group One. They would be the next vulnerable group when flood visit to their houses. More children in this group would face the difficulty of healthcare and education.

7.4 Physical Capital

The physical assets also are the important capital of households in urban areas according to Farrington et al. (2002). Housing is the shelter and the area for labor reproduction. Housing with good conditions may help to increase the financial capital and improve the human resources.

7.4.1 The Households' Capability on Physical Capital

Housing and other physical assets (such as housing facilities, housing appliances and jewelry, etc.) were like the properties which strongly supported to the household's life in Ho Chi Minh City. The housing asset, beside the shelter, in another aspects, can help households to access the financial supports. It can be the mortgage property at the bank for loans and credits. These loans and credits are for daily consumption or for investment. The size of housing and its quality will be the values for getting the high or low loans from the banknk.

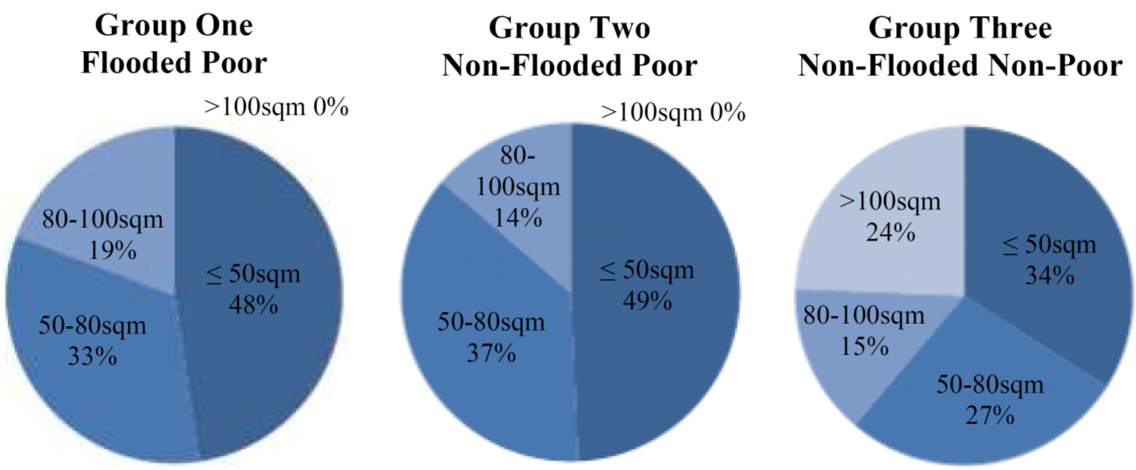


Figure 7.3: The housing size of households in surveyed areas

All the poor households in Group One and Two had the housing area no more than 100sqm. Nearly half of them lived in the houses 50sqm or less. And about one-third of them had housing areas over 50 to 80sqm. While in Group Three, only one-third of households had the houses about 50sqm or less, and one-fourth of them had more than 100sqm.

The house is the property only when it belongs to household. All households in Group Three owned their houses; while some of households in Group One and Two lived in rent and state houses. The surveyed areas were in the urban center or new-urban areas. Therefore, households who owned the houses, they all had the 'Red book' or 'Pink book' of house or land[12]. Amongst the households, only 10% of households in Group One and 12% of households in Group Two lived in the rent and state house.

Other physical assets with high values, such as jewelry or high-quality furniture, etc., could be used to access loans from the bank or the financial organizations. Otherwise, the rent-house cannot be used to get loan or credit from bank system.

In comparison amongst three groups, households in Group Three had more valuable capital than others. The physical assets of households in Group One and Two were nearly the same. However, Group One was in the flood housing areas, the value of their houses would be lower than the houses in Group Two.

7.4.2 Flood Impacts on Physical Capital

As discussed in Section 5.3.3 of Chapter 5, all housing of Group One was flooded. In which, 12% of housing was flooded in three-fourths of areas, and 22% was flooded in

[12] In Vietnam, 'Red book' or 'Pink book' is the real-estate certificate to prove that household has right to use their real estate or transfer it to other person. The 'Red book' is for the land ownership, and the 'Pink book' is for the house ownership.

total housing areas. The widespread flood level was less than 30cm. However, flood in housing areas even with low level, caused many serious problems to households such as bad environments, difficulties for moving, living and working, etc. The households who had the economic activities at home as small shops or food stands, customers do not like to go to shops, restaurants, or services in the flood areas. Especially room-renting activity, the room-renters tended to find the non-flood housing area to move out. And the house-owners would lose incomes.

Flood impacts on housing might impact housing infrastructure (drainage and sanitation, water supply and electricity, etc.). Households in Group Two and Three had no flood in the housing areas, however, their housing infrastructure was also damaged (see Table 7.4 below). The problem with housing drainage would bring more floods and longer floods in housing areas. The problem with water supply would directly impact people's health. And the problem with electricity would disorder the households' daily activities.

Table 7.4: Flood impacts on physical capital of households in surveyed areas

Physical capital	Group 1 (%)	Group 2 (%)	Group 3 (%)
On housing			
- Housing ownership			
Household owner	70.8	71.3	88.8
State owner	18.3	16.5	11.2
Renter	10.9	12.2	-
- Flood Impact on Housing area			
Flooded floor 25%	37	-	-
Flooded floor 50%	29	-	-
Flooded floor 75%	12	-	-
Flooded floor 100%	22	-	-
Housing pavement	80.3	21.6	16.7
- Flood Impact on Housing Infrastructure			
Drainage system	17.6	-	-
Water supply	37.9	11.8	11.1
Electric line	23.3	7.7	8.4
- Housing facilities			
Furniture	37.2	-	-
Appliances	22.6	-	-
House wares	11.6	-	-
Transport means	16.0	-	-

In flood housing areas, households may lose their housing facilities (such as wash machines, refrigerators, electronic stoves, etc.) and transport means (as motorcycles, bicycles, etc.) as well as furniture and other belongings. Section 5.3.3 of Chapter 5 had discussed in detail these damages on the poor households of Group One.

In flood residential areas, the housing value may be lower than in non-flood residential areas. And the flood housing is of course of lower value than non-flood housing. In comparison amongst three groups, households in Group One had the most impacts on physical capital. The weakness of physical capital would weaken the human capital, and then, would cause the risk on the financial capital of households. The households in Group Two would be the second vulnerable group when flood would more expose in their residential and housing areas.

7.5 Natural Capital

The natural capital in this research was considered as the environment of the residential area where people live in. It was not the directly asset of households, however, flood impacted on residential area could damage on housing areas and affect on household's socioeconomic activities.

7.5.1 Flood Impacts on Natural Capital

Flood in residential area had impacted to housing areas as 100% of cases of poor households in Group One (see Table 7.5). It brought many problems and weakened other households' capitals.

Table 7.5: Flood impacts on natural capital

Flood impact on natural asset	Group 1 Flooded poor (%)	Group 2 Non-flooded poor (%)	Group 3 Non-flooded and non-poor (%)
Flood residential area	100	53	56
On residential infrastructure			
- Flood streets	84.6	36.6	20.4
- Downgraded drainage	79.5	32.6	17.6
Tidal floodin residential area			
- By rain + tide	32	12.7	14.7
- By tide	20	11.3	3.3

Flood in residential areas had caused problems on flood streets and the residential's drainage system. Flood on the streets may cause the traffic problems. People took more time on the streets to work or back home. Flood damaged streets and caused more accidents. The large amount of water in residential area burdened and ruined the streets and drainage system (Ho, 2008; Nguyen, 2011).

To the poor households in Group One, about 84.6% of households had the flood streets in their residential area. And 70.5% of them thought that their communities' drainage were overload and damaged. The households in Group Two and in Group Three had less flooding problems on their residential areas, and had no flood in their housing areas. However, flood damaged on streets and drainage system in some areas of their residential areas.

Flood rivers and canals had impacted in some surveyed residential areas. This flooding became stronger when it was in the rainy season and occupied the larger areas. Group One had 55% of households in this area; Group Two had 20%; and Group Three had 18% of households in these areas. This type of flood also caused the problems to flood streets and drainage system of the areas.

7.5.2 The Vicious Cycle of Flood Impacts on Natural and Physical Capitals

The analysis on physical and natural capitals in the above sections explained the complex impacts of flooding on the household's capitals. Flood increased on the streets would push water into the housing areas. The flooded households had to rise up their houses to the higher level rather than street level to remove flood water. The streets were flooded again and they caused more transportation problems. (See Figure 7.4 below).

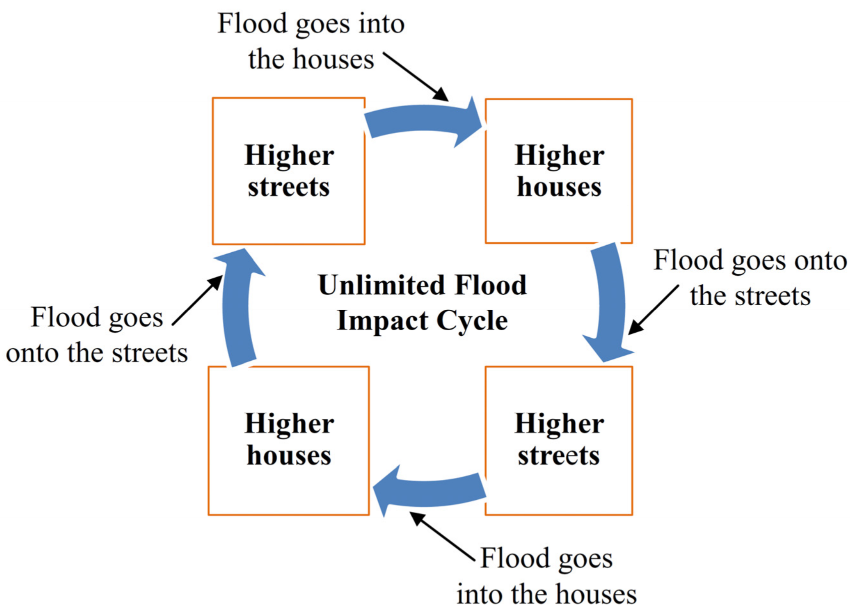


Figure 7.4: The vicious cycle of flooding on the natural and physical capitals

Therefore, the Vietnam Prime Minister had promulgated the Decisions on planning the elevation for urban streets over 2 meters above mean sea level for city adaptive strategy to control flooding (VNPR, 2008&2010; HCMC People's Committee, 2008; Nguyen, 2008). By these Decisions, all flood streets were risen up and many housing areas were lower than the streets (VNPM, 2010).


Streets raised up to 2m AMSL
Source: An, 2010


Higher street made lower housing
Source: Trieu, 2010


Household's economic problem
Source: Le, 2010


House became cellar
Source: Nhu, 2009


Households' protested against street rising at Hiep Binh Chanh Ward, Thu Duc District
Source: Viet, 2010


Households' protested against higher-level drainage at Ward 14, Go Vap Dist.
Source: Quang et al., 2010

Box 7.2: The illustrations on the unlimited cycle of flood impacts on natural and physical capitals.

This made the back flows of flood from streets running again into the houses. This rise-up cycle was carried out several times in the same streets and on the same housing areas. Households had been in flood houses again and had to pay much more for upgrading. The city government had also spent more for street rising. And it would be the unlimited cycle of flooding impact as well as the unlimited loss of income from households and city government. Box 7.2 inllustrated the impacts of government‘s flood control program by rising up all flood streets in flood areas. And because of these umlimited impacts, the communities had objected the project of street rising after they had risen up their houses, even in several times in some residential areas.

7.6 Social Capital

The social capital of households in this research is the networks of government at levels, social organization at levels, civil organizations, non-government organizations, bank for the poor, religious organizations, and the individuals amongst the communities, who can share information and support households improving the capitals as well as achieving the households' strategies.

Administratively, the government is the closest network to solve any administrative and political issues. The local government regularly manages and coordinates other organizations to support households. Social organizations, such as, Women Union, Red Cross, Youth Union, Vietnamese Fatherland Front, etc. are all closed to the government. And their activities must be regularly approved by the government at levels before contacting to households.

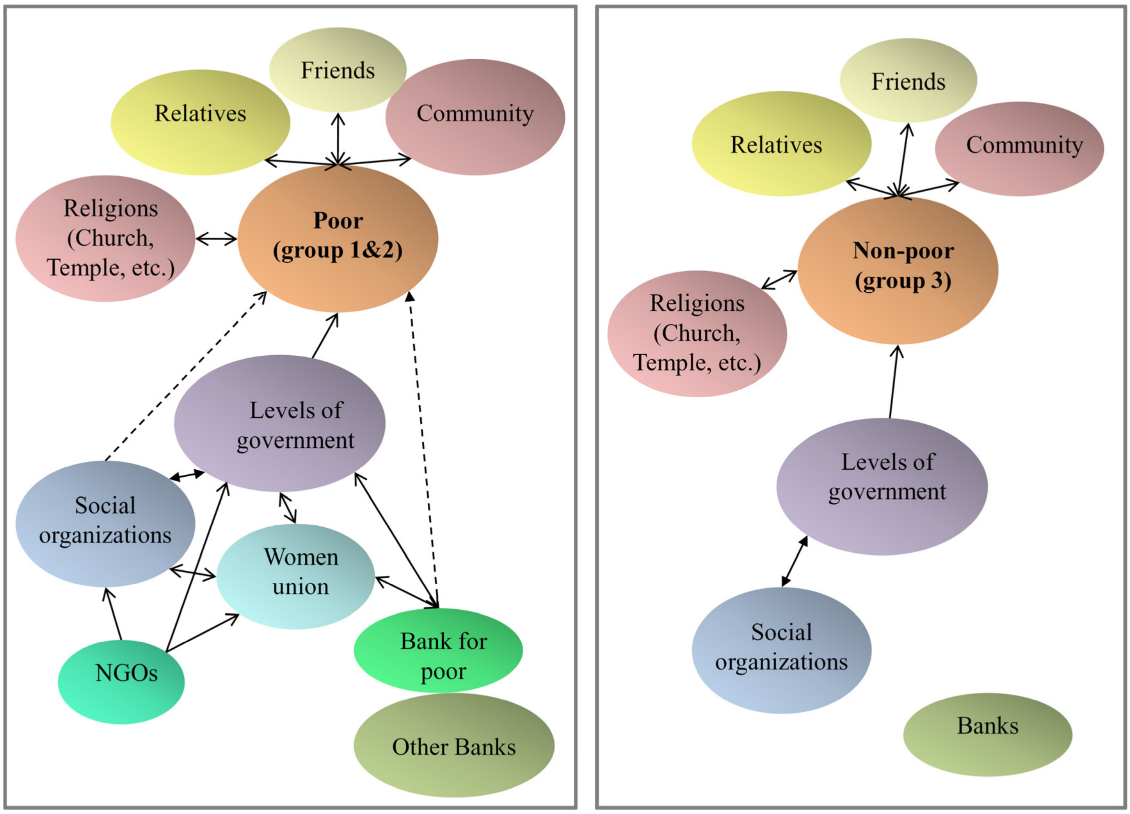
Most of the NGOs are international organizations. Their activities normally link to the social organizations and local government. The civil organizations (such as elderly association, veteran's organization, etc.) have little activities in urban areas. And the same to the social organization, all activities from these organizations must be approved by the government.

In general, all organizations must be approved by the government to do something officially. Therefore, in any case, people go to the local government for the support. However, it needs some documents and approving process. This support sometime could not reach the household's needs. In this situation, people often go to other organizations as churches or temples, or the communities for a help.

City government established the bank for the poor to support them housing and economic activities. To access this bank, the poor must have the 'Poverty book' promulgated by the local government. And to reach the big loans, households must additionally deposit the 'Red book' or 'Pink book' for housing support or economic investment.

All households in Group One and Two in this research were identified to be the poor based on their income under the city poverty line, though, just some households among them received the 'Poverty book' as analyzed in Table 5.3 in Section 5.3.1 of Chapter 5:

Group One had 17 households and Group Two had 20, while the higher-income households in Group Three had 3. Without the 'Poverty book', poor households cannot access the supports from the bank.



Source: Analyzed from the interviewed households' opinions, May 2011

Figure 7.5: The social networks to poor households and the higher-income households of the flooding situation

However, according to the interviewed households, there was no support from the government as well as organizations to poor households in flooding response. The Figure 7.5 above demonstrated the relationship of households in three groups to the social network of the city with no support related to flooding. This will be further discussed in the Section 7.7 below. And according to the Women Union of city government and local government in the surveyed areas, there were many programs to support poor households improving their lives, however, no officially program for supporting the poor in flooding response[13]. Amongst the surveyed households who had upgraded their houses, most of them used their own money and did with all their capabilities. Other households had to borrow money from their relatives or friends and returned later.

[13] This was interviewed by the author to the representatives of the Women Union at levels in surveyed areas in April, 2011. According to the Women Union representatives in District 6, they did not receive any Direction from government for this support to the poor in flood areas of District, though the Union had the support fund. However, flooding response needed a large amount of money and they could not support the poor in flood residential areas.

7.7 Political Support

The Section 7.6 above had discussed the relationship of households and social networks. Almost all support is for the poor. However, in the flood situation, there was no support activity to flooding response to communities and to households. All flooding adaptive programs and projects were planned and implemented by the city government (Ho, 2007&2008; Trinh, 2008; To, 2008b; SCFC, 2010a&2013). The projects were decentralized to district government without the community participation.

According to the interviewed households, city and local government had done some flooding adaptive programs to communities such as dredging and repairing the residential drainage system, and rising up the flood streets. To the housing upgrading, households had to invest by themselves and there was no support from government. The Table 7.6 below summarized the household opinions in supporting to flooding response in surveyed areas.

Table 7.6: The household opinions on government support to flooding responses in flood areas

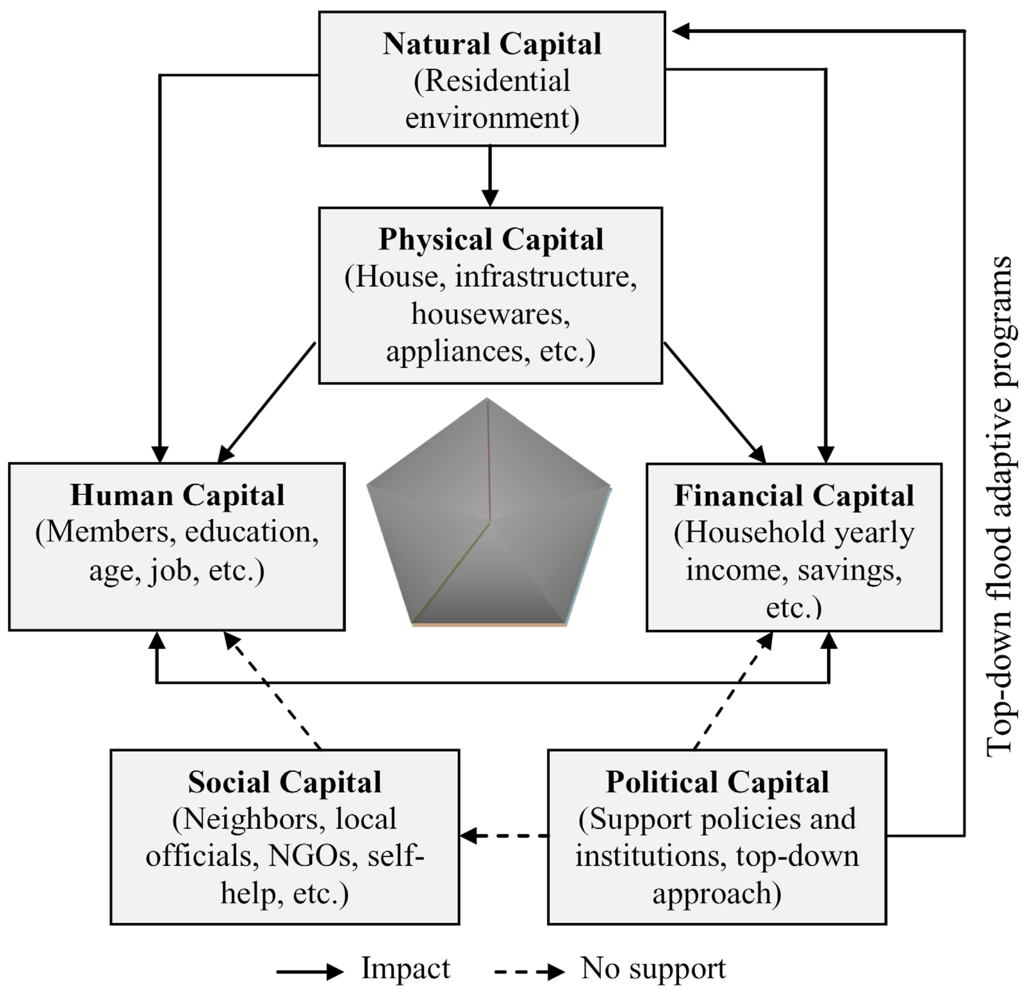
Political capital	Group 1	Group 2	Group 3
Financial support to flood residential areas			
- Residential drainage	Done by Gov't	Done by Gov't	Done by Gov't
- Residential street rising	Done by Gov't	Done by Gov't	Done by Gov't
Financial support to flood housing			
- House rising	No support	No support	No support
- Pavement rising	No support	No support	No support
- Threshold rising	No support	No support	No support
- Housing appliances	No support	No support	No support
- Housing infrastructure	No support	No support	No support
- Housing transport means	No support	No support	No support
Financial support to special poor	No support	No support	No support

The top-down approach in the government's planning and programs have brought many problems to households in flood residential areas, as discussed in the Section 7.5 above and caused the unlimited cycle of flood impact on residential areas (natural capital) and housing area (physical capital). In some flood areas, people had to rise up their houses several times because of several times of street rising. However, the street-rising program did not solve the flood problems in residential areas. Therefore some projects of this program were strongly objected by households in some flood residential areas in HCMC.

With no support from government, households in flood residential and flood housing areas cannot access the financial supports from the social organizations as well as NGOs, and other organizations for their housing upgrading and other damaged facilities, especially to the poor households. The weakened financial capital led poor households to stand longer in the flood situation. And it may burden other capitals of households.

7.7.1 The Mutual Relationship of Household Capitals in Flood Areas

By analyzing the capabilities of household capitals in flood situation in the above sections, the capitals have close relationship to each other and have the 'domino effects' from one capital to another capitals.



Source: Analyzed from the interviewed households' opinions, May 2011

Figure 7.6: The mutual impacts of household capitals in flood area in Ho Chi Minh City

The Figure 7.6 explained the mutual relationship amongst capitals and they affected to each other when flood come. Flood impacted to the residential area (natural capital), it caused flood on the streets and brought bad environment to the area. Flood from the street might go to the housing area (natural capital versus/vs physical capital) and damage the house as well as housing facilities. The households who had the economic activites at home might lost their income (physical capital vs financial capital). Flood also impacted on the financial capital when the households had to invest for upgrading housing, repairing the facilities and other belongings (physical capital vs financial capital). They might have less savings for health care and future needs (financial capital vs human capital). Bad environment from flood resident and housing areas could bring more stresses and impact on people's health (natural and physical capitals vs human capital). And bad housing environment brought the bad settlement to human productivity (physical capital vs human capital).

The social organizations and local governments were weak in supporting households, because there was no political and/or policy support from the government (social and political capitals vs financial and human capital). Furthermore, the top-down approach in flood adaptive planning and programs of city government had burdened more flood problems to residential and housing areas (political capial vs physical and natural capitals). Flooding adaptation and responses in HCMC need the bottom-up approaches to community participation. More bottom-up policies and political supports would bring more social network and organizations in sharing government burdens and supporting households in flooding responses.

Amongst the capitals in urban area, in general, the human and financial capitals are very important because they could support to each other and enhance the physical capital. However, in flood urban area as in flood residential area in HCMC, the physical capital is also important to households to have better human capital, and maintain the stably financial capital. The supports of social organizations, policies and institutions to households in flood residential areas depending on the socioeconomic strategies of the city government.

7.8 Summary for Chapter Seven

Household capitals by DFID include human, social, natural, physical and financial capitals. In urban area, the financial and social capitals are the most important capitals (Meikle et al*,* 2002; and Farrington et al, 2002). In HCMC, flood impacted residential environment (natural capital) which would impact to their housing area (physical capital). They had to invest for housing repair or upgrading and they lost their income (financial capital). Therefore, in flood urban area, the financial, human, and physical capitals were the most important capitals of households in flood areas.

About the human capital of households in three groups, many households in higher-income group (Group Three) had the yearly income close to the city poverty line. All households in the two poor groups (Group One and Two) had yearly income under the city poverty line, however; many of their income were far under the poverty line. Therefore, households in Group One, who had flood housing in flood residential areas; they had the weakest physical capital amongst three groups. And their financial capital was also mostly lost for housing upgrading. They were even in high risk of income loss because of instability in working and economic activities.

Flood impacted on the natural capital may impact on the physical capital (housing area). The physical capital of household includes housing, its equipment and facilities. Financial capital was lost for housing upgrading and facilities repairing or new buying (furniture, housing equipment and appliances, etc.). The damaged housing would affect human health (human capital). Then, the weakness of human capital would affect jobs and occupations and household finance might be cut down. These vulnerabilities of households really need the social supports to flooding responses. However, the social organizations always need the directions from city government to support households in flood areas.

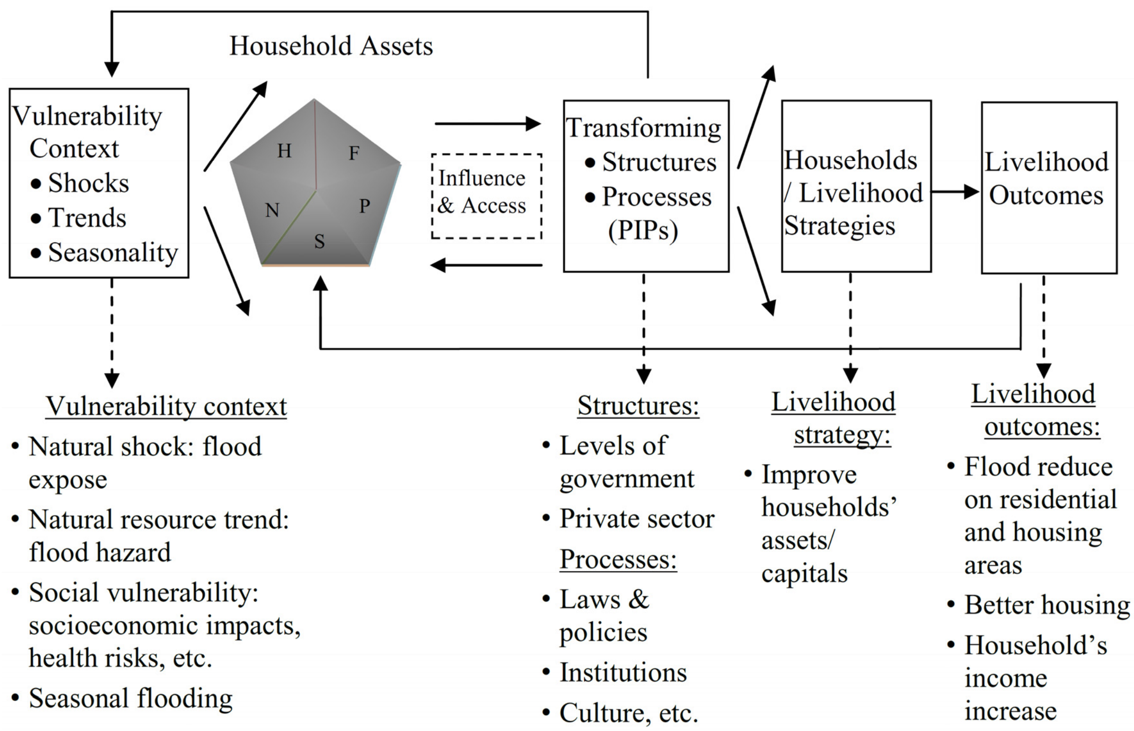
Amongst groups, the poor households in Group One had most vulnerabilities on physical, financial, natural and human capitals. Their yearly income was deficit. Flooding problems and financial deficit brought more stresses, depress and health risks to people. They may also impact on labor's reproduction for working and earning.

The current flood did not impact housing areas of the poor in Group Two yet. However, when flood would increase in the near future, they would be the next vulnerable group. The higher-income people in Group Three would be even the vulnerable group after Group Two. Flooding responses really need the supports form social organizations (such as: Red Cross, Women Union, Bank for the poor or NGOs etc.) and local government, especially to poor households. However, there was no support from government as well as policy to the social organizations in flood residential areas. Even in some city flood-controlling projects (such as street rising and drainage upgrading), with top-down approaches, had brought more problems to households. Therefore, it needs the social and political supports to households in flood areas, and the bottom-up approaches applied in flood controlling programs in HCMC.

8 Strategies for Flooding Adaptation for Households in Ho Chi Minh City

The flood impact analyses in Chapter 5, 6, and 7 highlighted that different socioeconomic characteristics of households had different flood impacts. The weak capitals the household had, the less capability they could come through the flood situation. Households in flood residential and housing areas need to have the strategies to enhance their capitals to overcome the current impacts as well as the future flood risk. Household strategies for flooding adaptation were based on the livelihood strategies of DFID (1999) developed for households in flood areas of HCMC.

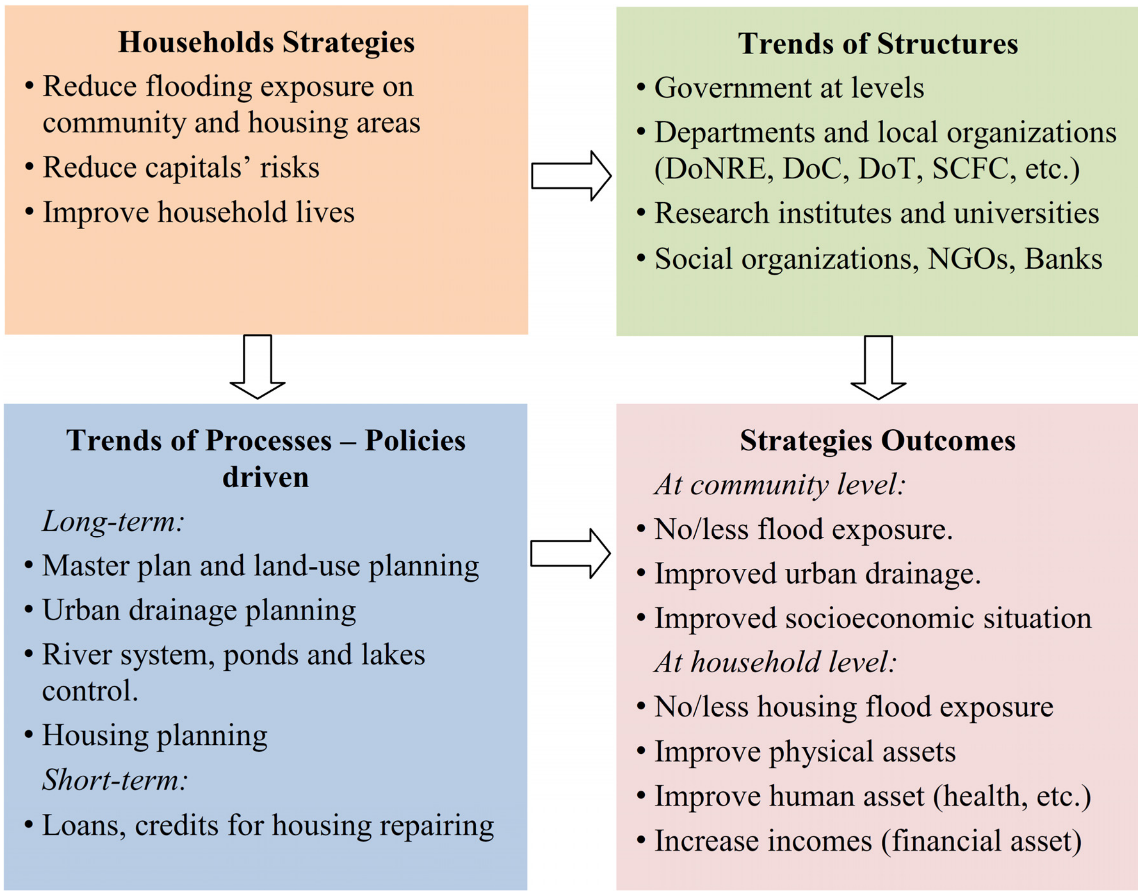
8.1 Households Strategies to Flooding Adaptation Framework



Source: Adapted from the sustainable livelihood strategy framework of DFID (UK, 1999)

Figure 8.1: Households' strategy framework for flooding adaptation

The urban vulnerable context discussed in Chapter 4 showed that flood has brought more shocks on the environment and increased more social crisis. It has pushed the poor, even non-poor into more vulnerable situation and particularly in low-elevation areas. This part of the research suggests the household strategies to people in flood residential and housing areas, and even people in flood-prone areas conserving their capitals to achieve the sustainable development. The adaptive strategies were developed from the adaptive framework in Figure 8.1 above. Flood impacted to residential areas as the household's natural capital by elevation and flood types (presented in Chapter 6). By time, floods brought more shocks to the residential areas. Floods then have impacted socioeconomic aspects and on capitals of households, as discussed in Chapter 5 and 7, and caused more shocks on people lives. To reduce vulnerability of urban context and enhance the household capitals in flood residential areas of HCMC, the flood adaptive strategies for households were developed in Figure 8.2 below.



Source: Developed from analysis results of the study

Figure 8.2: Strategies process for flooding adaptation to households in flood areas

The main strategy is to improve the household's capitals. In the 'causes-and-effects' relationship between capitals in flooding context, when reducing the flood impacts to residential area (as the natural capital), the housing area of physical capital would have less flood impacts. Household would not invest much their income to flood responses; the financial capital then would be improved. The better housing environment would lessen flood impact on human capital. Furthermore, the enhancement of social and political supports from the governments would improve the households' social and political capitals.

For success of this strategy, it needs the transforming structure from government at levels and stakeholders' involvement of the processes, and the political machine of policies, laws and institutions. The important departments should take their roles in improving the household capitals, such as: Department of Natural Resources and Environment (DoNRE), Department of Construction (DoC), and Steering Committee for Flood Control Program (SCFC) in land-use planning and infrastructure upgrading to improve the natural capital (as the residential environment); Department of Construction and Department of Planning and Architect (DoPA) in housing design and upgrading to improve the physical capital; and the Center for Poverty Reduction and social organizations for flood-response supports (as loans and credits), etc. These driven factors would help to achieve the strategic outcomes with reducing flood in residential and housing areas, and improving the finance and human capitals. The outcomes would press down shocks and negative trends on natural environment; reduce flood hazards and the socio-economic vulnerabilities.

These processes should be evaluated and monitored by related stakeholders to improve and adjust the structure for motivating the outcome-formed-processes. And of course, the processes require the participation of individuals, households or community representatives (DFID, 1999; Meikle et al., 2001; Farrington et al., 2002; Carney, 2005; WB, 2011).

According to Farrington et al., (2002) and Carney (2005), the political resource is as one important capital to households in urban areas, especially the urban poor. With strong political support, it helps to attract more stakeholders into the processes and pursue the sustainable strategies. The main strategy is to improve the household's capitals. In the 'causes-and-effects' relationship between capitals in flooding context, when reducing the flood impacts to residential area (as the natural capital), the housing area of physical capital would have less flood impacts. Household would not invest much their income to flood responses; the financial capital then would be improved. The better housing environment would lessen flood impact on human capital. Furthermore, the enhancement of social and political supports from the governments would improve the households' social and political capitals.

8.2 Flood Risk Management in Adaptive Processes – Driven Policies and Institutions

Households are linked into the larger scale economic, social and political process operating in the city (Meikle et al., 2001). Flood risk management and adaptation therefore should take account the sustainable livelihood of households in residential areas. And structure planning and non-structure planning should be considered in the community level.

8.2.1 Structure Measures in Flood Risk Management

Structure measures are heavily-engineered interventions. They can be highly effective that policy-makers may consider for mitigating flood risk in urban environments. The heavily-engineered measures need high investment, however in some circumstances; they are appropriate to long-term strategy for flooding adaptation. The city structure planning to protect households in residential areas in HCMC from flooding could be considered as follows:

1. **Developing the city's drainage systems.** The current drainage system of HCMC is used to dealing with both waste-water and storm-water in residential areas. In long-term urbanization, it has been burdened with the increasing waste-water, solid waste and sediment, and storm-water as discussed in Chapter 4, Section 4.1. The households in flood residential areas thought that one of flood reasons was from the residential drainage system (in Section 6.3.2 of Chapter 6). Furthermore, higher-level of new drainage in rise-up streets as discussed in Section 7.5.2 has caused more drainage problem to residential areas. The complete drainage system therefore should be the most consideration in residential areas and even in whole city to flooding adaptation. This suggestion was also proposed by the HCMC experts (Ho, 2008; To, 2008 a&b; Trinh, 2008). The drainage system should be upgraded at the same level to be able to collect the run-off water in flood residential areas. The current drainage should be dredged permanently to reduce flood in residential and housing areas, especially in low-elevation residential areas. The appropriate drainage systems should be separate in two systems: waste-water drainage system and storm-water drainage system (Tucci, 2007; Jha et al., 2011) to better collect water in flood residential areas. Waste-water is collected to the waste-water treatment plant, whereas storm-water is discharged direct to the nearest watercourse. Better drainage would reduce flood and improve environment in residential areas (as the natural capital of household), then it could reduce flood in housing area (as physical capital), and improve the household income (as the financial capital), especially to poor households in flood residential areas. Better residential and housing environment would improve the health (as the human capital) of households.

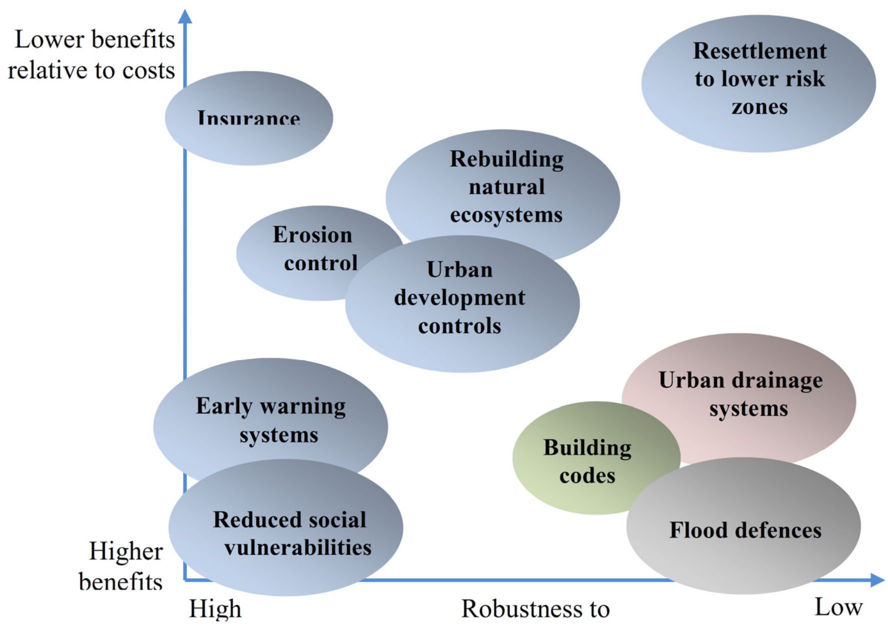
2. **Planning areas for flood storage.** This structure measure is suggested to reduce water in the peak hour of flood flow in residential areas. The appropriate areas for this planning are in the low-land areas of the river catchments (Tucci, 2007; Jha et al., 2011). Many of these areas in HCMC were encroached for housing development, such as filled-up tributaries, natural lakes and ponds (as discussed in Chapter Four, Section 4.1.2 and 4.1.3). To improve the current river system, the current filled-up areas of rivers, lakes and ponds with temporary works (such as temporary houses or slumps) should be removed. And the current river system should be totally dredged for widening the river beds.

3. **Increasing the permeability in residential areas.** This structure planning is to increase infiltrated and permeable areas in residential areas such as green space and green trees. A part of sidewalks along the streets in residential areas should be used for developing green space. In low-elevation residential areas, especially, the green-space could collect some run-off water in flood time.

4. **Designing housing standard (building codes).** This is an important part in housing planning. In flood residential areas, housing standard should be designed with appropriate infrastructure to reduce flood impact. To the poor households in flood and in low-elevation residential areas, the housing standard should be increased to lessen their expose to flood, such as elevated housing (UN-HABITAT, 2010; WB, 2011). Housing design can be used for building resilience in flood and flood-prone areas. And

5. **Developing flood defences.** This planning can be costly to design, the same as drainage systems. However, it could prevent flood impact to households and to residential areas. Flood defences such as river embankments and dykes in low-elevation areas can reduce the tidal flood going into residential and housing areas. The households, then, could save their capitals for sustainable development.

According to Jha et al. (2011), there are many options for flooding adaptation (See Figure 8.1 below). However, the application of urban drainage system, flood defenses, and building codes would be the best options to developing cities with the higher benefits related to costs and lower uncertainties.



Source: Abhas K Jha et al. (2011)

Figure 8.3: Relative costs and benefits of flood management options

8.2.2 Non-Structure Measures in Flood Risk Management

These measures do not require the high cost for extensive investment in heavily-engineered infrastructures, as the above structural measures, but provide a good understanding for avoiding flooding, planning and managing flood emergencies, and recovering from flooding. The non-structure measures suggested to protect households in residential areas in HCMC from flooding could be considered as follows:

1. **Land-use planning:** This measure could re-arrange the urban function areas to flood adaptation. It helps to understand the potential flood hazard and risk, the river catchment, the watercourse and the floodplain areas that are necessary for flooding adaptive planning. Especially in the rapid-urbanization and over-development megacity as HCMC. The official land-use planning should seek the potential areas for water storage to reduce flood in residential areas, such as: the green space along the streets, the permeable sidewalks, the areas where could be planned as lakes and ponds, etc. It should also localize the flood risk areas and provision the safe residential areas, especially for poor households. Proper planning and regulation could be the long-term vision for sustainable development (UN-ESCAP, 2010). Land-use planning should apply the bottom-up approach to understand the flooding problems and household responses in flood residential areas. The flood adaptive planning, then, could reach to the household demands in flooding responses.
2. **Solid waste and liquid waste management:** is the important part of flood risk management in HCMC. It helps to reduce burden to current drainage system as well as river and canal system. Well-management on solid waste and liquid waste at community level could lessen sediment in residential drainage and increase the drainage capacity for water collection. Furthermore, good management in solid and liquid wastes can bring more benefits for city economy.
3. **Early warning system:** is the forecasting system. The forecasting system at the community level should include the hot-line system for gathering the flood information from households in residential areas. The information from this system could be considered in flood adaptive planning to protect households, especially the poor in residential areas. And
4. **Flood awareness increase:** can help to reduce the flooding impact upon the individuals and households in the flood and flood-prone areas. With full awareness of flooding, households may have the proper responses of flooding and conserve their capitals as well as survive from flood impacts. And specially, this awareness will help households involve more in the flooding adaptive processes (WB, 2011).

8.3 City Government and Stakeholders in Flooding Adaptation Processes

The adaptive processes are to reduce and mitigate the impacts and support for sustainable development. The stakeholders have the important roles in gathering the information as well as evaluating and controlling the adaptive processes. In flooding adaptation to households in flood residential areas, the stakeholders of the processes as household or community representatives, who directly benefit from the processes, should be involved at the beginning to analyze the flooding impacts and evaluate the adaptive solutions in flooded areas.

8.3.1 Government and Effective Policies and Institutions

According to Farrington et al. (2002), the adaptive strategies should consider in the close relationship between the urban vulnerable context, the households' capitals, and the government (policies, laws, institutions and processes - PIPs). And flooding adaptation for flood residential areas should apply the 'Right-Base Approach' to involve the vulnerable households in the planning processes (Farrington et al., 2002; Carney, 2005). The top-down approaches in adaptive planning in HCMC has caused many problems to households and communities as discussed on Chapter 7, Section 7.5.2. According to Farrington et al. (2002), the adaptive strategies should consider in the close relationship between the urban vulnerability context, the households' capitals, and the government (policies, laws, institutions and processes - PIPs). And flooding adaptation for flood residential areas should apply the 'Right-Base Approach' to involve the vulnerable households in the planning processes (Farrington et al., 2002; Carney, 2005). The top-down approaches in adaptive planning in HCMC has caused many problems to households and residential areas as the rise-up street program discussed on Chapter 7, Section 7.5.2. Therefore, households in rise-up-street communities should be granted or compensated by government for housing upgrading. Government should have support programs to poor households in flooding responses.

Social capital is a key for households to cope with the economic crises and reverse downward spirals. Policies should encourage and support social networks to maintain and expand various types of social capital (Meikl et al., 2001). Poor households in flood areas in HCMC had flood impacts on their physical, financial, natural and human capitals (as discussed in Chapter 7); however, no support from local government and social organizations had forced them into more vulnerable situation. Therefore, it needs the support policies to social organizations to help the poor households in their capitals improving.

8.3.2 Stakeholders in Flood Adaptation Processes

To achieve the strategic outcomes, besides the supports from government at levels, the participation of relevant departments and institutions should have mainly involved in the adaptive processes. For example, the related-important departments of DoNRE, DoC, DoT, DoPA, and SCFC are in the analyzing, developing, and decision-making processes; the Sub-Institute of Hydrometeorology and Environment of South Vietnam (SIHYMETE), the Steering Center of Storm and Flooding Prevention (SCSFP), other research institutes and universities are as the scientific informants and consultants to support the processes. And the social associations as non-government-organizations (World Bank, Asian Development Bank, etc.) have involved as funds, methods and technological supports.

Flood adaptation processes to communities and to households in residential areas requrie more involvements of government at levels, social organizations and representatives of communities and household groups (One, Two, and Three). City government should encourage the social organizations, such as the international non-government-organizations, who can raise fund to help poor households of group One in flooding responses, and even to poor households of group Two in flooding prevention. Government should develop the poverty-reduction programs related to flood-response and flood-risk activities. From then, the social organizations of the Center for Poverty Reduction and the Women Union, etc. could raise their roles in helping the poor households in flood residential areas. And the representatives of households and communities in flood areas should be involved as stakeholders of the processes to support the adaptive strategies reaching to their demands and their sustainable development.

Then the long-term and short-term strategies would be developed. The achieved outcomes of flood mitigation in residential and housing areas and risk reduction on households' socio-economic aspects would help to improve the households' capitals and reach to the livelihood sustainable development.

With the 'Right-Based Approach', the adaptive planning should apply the bottom-up approach with the special participation of vulnerable individuals, households and communities in flood residential areas. Flooding adaptation planning then can access to support flooded vulnerable groups and achieve the city's long-term development strategy.

8.4 Summary for Chapter Eight

The current top-down approach of city government in urban planning and flooding controlling has caused problems in implementing and provisioning to people, as mentioned in Chapter 7. The projects sometimes did not meet the demand of households and communities in flood residential areas. The adaptive strategies should consider households and communities as the center for adaptation (Farrington et al., 2002; Carney, 2005; and Moser & Satterthwaite, 2008).

The main strategy is to improve the household's capitals of households in flooded residential and housing areas. The supports of policies and institutions to improve household capitals will help people (individuals), households and communities by themselves to survive from flooding. They, then, could develop their own strategies for sustainable development in the future.

For success of the strategies, it needs the transforming structure from government at levels and stakeholders' involvement of the processes, and the political machine of policies, laws and institutions. These driven factors of polices, institutions and process (PIPs) would help to achieve the strategic outcomes with reducing flood in residential (at the community level) and housing areas, and improving capitals of finance and human, two most important capitals of households (at household level).

The outcomes would reduce shocks and negative trends on natural environment and flooding hazards (natural capital); and the socioeconomic vulnerabilities in flooded areas. The driven factors should include both structure- and non-structure measures. The city structure planning to protect households in flood residential areas in HCMC from flooding could be included the residential drainage system development, flood storage planning, increases of infiltration and permeability of residential areas, building codes and flood defenses. And the non-structure planning was included landuse planning, solid and liquid wastes management, early warning system and flood awareness increase.

Finally, the adaptive processes should be based on the bottom-up approaches with the involvement of relative stakeholders and beneficiaries (at least the representative of communities and households in flood residential areas). The adaptive strategies, then, could meet the households' and communities' demands and achieve the outcomes.

9 Conclusion And Recommendations

A mega-city of Ho Chi Minh City, with high population growth rate, is facing to the problems of urbanization, unmanageable housing expansion, weakness of urban infrastructure and services, and the increasing impacts of climate change with more effect-tropical storms and heavy rains. They have caused the flood increasing and brought serious problems on households' socioeconomic aspects in the city. This part was presented in Chapter 1 to solve the strategic Objective 1 and Question 1 of the study.

This study is on the socio-economic impact assessment of flooding to look for the adaptive solutions for flood control and management to households and communities in HCMC.

The study had used reviews from previous researches and studies on climate change impacts on people's socioeconomic aspects in developing countries or cities and adaptive strategies for flooding adaptation. The gathered references were focused on the following information fields:

- Flooding situation and expansion in developing countries and cities to figure out the similar to Ho Chi Minh City in flooding situation, flooding types and social economic aspects impacted by flood.
- Flooding impacts on geographical elevation and in various geographical areas. In different area and different geographical elevations have different impacts on households and on residential/community areas.
- The social economic characteristics of households impacted by flood in developing countries and cities and in different levels of vulnerable households.
- Households' capitals and their impacts in urban flooding areas.
- Strategic options for flooding adaptation in urban flooding in developing countries and cities.
- Sustainable strategies for flooding adaptation and sustainable development in flooding situation of developing countries and cities.
- Lesson learns from governmental approaches and capabilities in flooding adaptation and mitigation to households in urban flooding.

The researches and studies on climate change impacts on people's socioeconomic aspects in developed countries or cities were also reviewed to find out the sustainable strategies for flooding situation of HCMC.

Methods and approaches in urban flooding researches on households' social economic impacts in urban flooding areas.

The study had surveyed for primary data on 450 households selected in three areas (center, new urban, and rural areas) to understand the different flooding impacts on households in different flooded areas. Some key informants in duty of flood control and flood management, flood specialists and in social organizations in HCMC were asked in discussion to figure out the flooding problems, social and political supports and suggestions for flooding adaptation. Other primary data of field notes and photos, and secondary data (included statistic data, documents, the previous researches, reports, journals and news related to flooding problems in HCMC) were also collected to use in this research.

The surveyed data was analyzed to understand flooding impacts on different social economic characteristics of households in residential area of the community level. And the comparison among groups of flooded-housing poor households, non-flooded- housing poor households, and non-flooded-housing-and-non-poor households to finalize which group were mostly impacted by flood. The 450 surveyed households were linked by GIS on administrative, cadastral and flood maps to have the surveyed household layer on the flood map. Flood data from flood maps showed the flood types in different areas and on the surveyed households. The elevation maps (base maps) were applied to analyze the surveyed households in different flooding types in various geographical elevation areas.

Spatial analysis method was used to describe spaces in flood area in two spatial directions: the in-to-out space of center, new-urban, and rural areas; and the top-to-down space of geographical elevations. It helped to understand flooding impacts on households in different areas. Integrated data and multi-criteria analyses in GIS were used to integrate the geographical and spatial factors of the surface and flood data to the socioeconomic characteristics into maps. The flooding problems of households among groups at the commune level and on household capital at household level were then indentified. The data results from the maps were linked back to SPSS for linear regression to understand the relationship between flooding types and geographical elevation on the surveyed households.

The second strategic objective and second question of the study were discussed in Chapter 4. The vulnerability context of flooding in HCMC was the trends and shocks on natural environment and urban society in flooding context. The environmental change has caused the changes or shocks of social and economic conditions that individuals, households or communities faced to the risks of their lives and their capability for development (DFID, 1999; Farrington et al., 2002). The global climate change has caused the climate crisis on HCMC by more effects of storms and cyclones (Nicholls et al., 2008; ADB, 2010) and more heavy rains in rainy season (SIHYMETE, 2008 & 2011).

Heavy rains have caused more floods on urban infrastructure, rivers and river catchments. Flooding hazards have brought more pollution to urban environments. The sea-level rise is not the main reason of flooding in HCMC; but other social factors like urbanization and loose management have pressed flooding increase in the city (Nguyen & Duong, 2007; Ho, 2008).

The trends of rural-urban migration and the dynamic society with more nuclear and extended families have caused the expansion of residential areas. Urban poor tend to locate in the low-land areas with low-quality infrastructure and urban services. Along with the encroachment of rivers, lakes and ponds for housing expanding, these low-land areas become the high-flood risk areas in the city (Moser and Satterthwaite, 2008). The social fragmentation in the megacity with the low-social tie and management leads urban poor close to flooding vulnerability. Therefore the social network in urban area is very important, especially to the poor, in accessing the essential supports to maintain the households and achieve to the sustainable development. Most of the social organizations in HCMC are linked to government to support people. However, without support policy, government cannot bring the social organizations to people in flooded areas (Farrington et al., 2002; Carney, 2005).

Urban planning is the very important sector in developing the defences for flooding adaptation and mitigation (Moser & Satterthewaite, 2008; Jha et al. 2011). Based on planning, urban management and flood control would be implemented. However, urban planning is easily failed in the dynamic megacity of HCMC. The master plan needs the involvement of government at levels, departments and institutions, etc. Different disciplines and abilities among them need time to complete. The top-down approach in planning process without households' or communities' participation leads the planning fail to reach the people's benefits. Even the lack or low relationship and information sharing among departments and institutions bring the cross-cuttings in urban planning and management (WB, 2010).

Chapter 5 discussed flooding impacts on socioeconomic aspects in residential areas (community level) and on household level in HCMC, and helped to answer the third and fourth of strategic objectives and questions of the study. In different geographical areas and depended on the socioeconomic characteristics of the areas, flooding had different expressions by space and time, and on the socioeconomic aspects. The research households were surveyed in flooded areas in different space of inner-urban, new-urban, and new-urban-rural areas of districts and within the geographical elevation up to 4 meters. By these characteristics, flood expandsion is differently among areas. Flooding impact on socioeconomic aspects also had the different expressions in areas and among household groups.

About the household profiles, poor households in Group One and Two were both under city's poverty line. Though city set the poverty line higher than the world poverty line, most of them were under the world line. Households in Group Three were above the city's poverty line, however, most of them were middle-income households. The family structure was nearly the same among groups with 4 to 5 persons per family in average. The children population was nearly the same, but the labor structure was different between two poor groups and the higher-income group. Group Three had more high-education and skilled labors with more stable of household income.

Households in flooded communities said flood increased by heavy rain, tide and incomplete drainage system. It visited long time in the residential areas and caused serious problems on streets, transportation, and accidents. Floods tended to increase in recent years and many of them were flooded within 10 years. Many households lived in communities flooded within 6 months per year, while others were flooded more than 6 months per years. It depended on the areas effect by rain or tide. In the housing areas, it impacted on housing infrastructure such as, floor, door, housing drainage, water supply and electricity. It also damaged housing equipment, furniture and transport means. People had to pay for housing repairing such as house rising, housing rebuilding, pavement rising and their other assets, etc. And they lost their income.

Among three groups, households in Group One had the highest flooding impacts in the community with higher max-flood level, longer flood and flood in all community. They were all flooded in housing area and damaged on their housing assets. They had spent much time living with flood and standing with stresses. Therefore, they lost much income for housing upgrading. Most of them chose the house-rising solution as the best and safe choice. The yearly income was too low to upgrade the house and no any financial support from government, though; they borrowed from relatives or close friends and return later.

Poor households and higher-income households in non-flooded housing areas (Group Two and Three) had no flood in housing areas, however, some of them raised their houses to prevent flood in the near future. Otherwise, when flood increase in higher level, households among groups may receive more impacts and spend much more for flooding responses.

Chapter 6 analyzed flooding compared to space (geographical elevation) and time (months and years) factors of the areas had impacted on areas in different flood types. And of course its impacts on households were also different in the areas. This chapter helped to answer the fifth strategic objective and the fifth question of the study.

The widespread elevation in HCMC is below 2 meter AMSL. There were some previous studies on flooding by sea level rise in HCMC base on the IPCC scenarios (ADB, 2010; WB, 2010; and MoNRE, 2009). The complex hydraulic regime of the rivers and urbanization in the low-land areas has caused the various flooding in HCMC in the climate change situation. The flooding projects were designed for the areas below 2 meter AMSL. However, the current flooding level in rainy season of HCMC reaches to 50 cm in many flooding areas. And the reason for this flooding was not by sea-level. It was proved in this study by analysis of flood expansion on geographical elevation.

Flooding types in this study were categorized into three main types: (1) flood by tide, (2) flood by tide and rain, and (3) flood by rain. To analyze the vulnerability of floods on households in the elevation areas, the house's locations of surveyed households were positioned on the elevation map. This map was overlaid with the flood layer and then linked back to the SPSS for running crosstab and linear regression. The flood layer helped to identify the location of households in each type of flooding. Crosstab and linear regression were used to test and understand the relationship between flood types, space (geographical elevation) and time factors in the areas.

The poor in the surveyed sample mostly live in more vulnerable area of flooding (in low-land areas, close to the rivers or canals), while the higher-income people trend to live in the safer land (in higher elevation areas). The relationship between flood types and space factor (geographical elevation) showed they had the relation but not so strong ($R = 0{,}631$). It is because some below 1.5-meter-AMSL areas far from river system not effect by tide but by rain. Therefore some cases did not fix to the model. However, when adding the time variables ('flooded-month-per-year', and 'flooded year') into the model; it showed the strong relation ($R = 0.906$ by adding the 'flooded-month-per-year' variable; and $R = 0.918$ by adding more the 'flooded year' variable). It concluded that flooding affected on areas differently depended on space and time factors. The lower areas were mainly flooded by tide in longer time (years and months per year); and higher areas were flooded by rain with shorter times.

Scientifically, the flooding experts and NGOs had proved that floods in HCMC were from many physical and social reasons. The HCMC experts said that the social factors as urbanization and incomplete planning had pushed flooding increase in the city (To, 2008a&b; Trinh, 2008; Ho, 2008 & 2010; Le, 2009; ADB, 2010; and WB, 2010). The analysis results pointed out from households' opinion about one important reason of flooding in HCMC was the overload-urban-drainage system. Many households thought that flooding came by rain or by rain and tide, though, most of them believed flooding came by heavy rains, tidal flows, and the overload drainage system. Urban drainage system is the important factor in the adaptive planning in HCMC.

The sixth and seventh of strategic objectives and questions were discussed in Chapter 7 of the study about the flooding impacts on household capitals (at household level). Households in urban area, especially the poor, the financial and social capitals are the most important capitals (Meikle *et al,* 2002; and Farrington *et al,* 2002). In flooding situation of HCMC, floods on residential areas (community) impacted housing and its facilities. People spent to repair their houses and lost income. By this way of impact, physical and financial capitals were most important of households in flooded area. The natural capital here could be seen as the natural environment of residential area where households live in. Flood impacted natural capital and may impact housing area (the physical capital). Physical capital of household includes housing, its equipment and facilities. Financial capital was reduced for upgrading the damaged housing and other household's belongings. The damaged house would affect health of human capital. Then, human capital would affect jobs and occupations and household finances and may be cut down. These vulnerabilities really need social network supporting households in flooding response. All social organizations always need the political policy from government to support the flood-impacted households.

Among groups, poor households in Group One had most vulnerabilities on physical, financial, natural and human capitals. They all lived in flooded residential and housing areas. Their houses and facilities were strongly impacted and they had to upgrade the houses as well as repair furniture, housing equipment and appliances. Their yearly income was deficit for these responses. So they had to live with flood or borrow money for house rising or rebuilding. Flooding problems and financial deficit brought more stresses, depress and health risks to people. They may also impact on labor's reproduction for working and earning.

The current flood did not yet impact on housing areas of the poor in Group Two, but some households had some responses on house rising or pavement rising etc. However, flooding increase in the near future, they would be the next vulnerable group. The higher-income people in group Three would be even the vulnerable group in the future.

For activities of flooding responses, households, especially poor, really needs the supports form social organizations (such as: Red Cross, Women Union, Bank for the poor or NGOs etc.) and local government. However, there was no support from government as well as policy to the social organizations in helping the poor in flooded areas. Even in some city planning projects such as street rising and drainage repairing had brought more problems to households in flooded residential areas.

The strategies for flooding adaptation to households discussed in Chapter 8 had answered the eighth strategic objective and the eighth question of the study. The main strategy is to improve the household's capitals of households in flooded residential and housing areas. To successfully carry out this strategy, it needs the transforming structure from government at levels and stakeholders' involvement of the processes, and the political machine of policies, laws and institutions. These driven factors of polices, institutions and process (PIPs) would help to achieve the strategic outcomes with reducing flood in residential and housing areas, and improving capitals of finance and human. The outcomes would press down shocks and negative trends on natural environment; reduce flooding hazards and the social economic vulnerabilities. The driven factors should include both structure- and non-structure measures. The city structure planning to protect households in residential areas in HCMC from flooding could be included urban drainage system development, flood storage planning, increases of infiltration and permeability of urban areas, building codes and flood defenses. And the non-structure planning was included land-use planning, solid and liquid wastes management, early warning system and flood awareness increase.

The adaptive strategies should consider in the close relationship between the urban vulnerability context, the households' capitals, and the government. And flooding adaptation for flooded communities should apply the 'Right-Base Approach' to involve the vulnerable households in the planning processes (Farrington et al., 2002; Carney, 2005). Poor households in flooded areas in HCMC had many impacts on their capitals. No support from local government and social organizations had forced them into more vulnerable situation. Therefore, it needs the policies to social organizations in supporting poor households to conserve their capitals for development.

To achieve the strategic outcomes, it needs the supports from government at levels, the participation of relevant Departments and Institutions. The achieved outcomes would help to improve the households' capitals and reach to the livelihood sustainable development. The adaptive planning should apply the bottom-up approach with the special participation of vulnerable groups in flooded areas. Flooding adaptation planning then can access to support flooded vulnerable groups and achieve the city's long-term development strategy.

Finally, all the results in the above chapters had shown that: Flooding increase has impacted households' socio-economic aspects in Ho Chi Minh City. This had proved the hypothesis of the study to be true.

Literatures

ADB (Asian Development Bank). (2001). Asian environment outlook (no. 020600). S. T. Qadri (Ed.). Manila, Philippines: ADB. Retrieved from http://www.adb.org/publications/asian-environment-outlook-2001

ADB (Asian Development Bank). (2010). Ho Chi Minh City adaptation to climate change, summary report (publication No. RPT101580). Philippine: ADB.

ADB (Asian Development Bank) & MOC (Ministry of Construction, Vietnam). (2001). Low income housing and secondary towns urban development needs assessment (TA No. 3487-VIE). Hanoi, Vietnam: ADB.

Adelekan, I. O. (2013). Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. *Environment and Urbanization*, 22 (2), 433–450. doi: 10.1177/0956247810380141

Anseline, L. (1992). *Spatial data analysis with GIS: An introduction to application in the social sciences*. California, MA: University of California.

Arnell, N.W., Livermore, M.J.L. & Kovats, S. (2004). Climate and socio-economic scenarios for global-scale climate change impacts assessments: characterising the SRES storylines. *Global Environmental Change*, (14) 3–20. doi:10.1016/j.gloenvcha.2003.10.004

Ascough, J. C., Rector, H. D., Hoag, D. L., McMaster, G. S., Vandenberg, B. C., Shaffer, M. J., et al. (2002). Multicriteria spatial decision support systems: overview, applications, and future research directions. In A. E. Rizzoli & A. J. Jakeman (Eds.) Proceedings of the 1st biennial meeting of the iEMSs: Integrated assessment and decision support on June 24-27, 2002, (pp. 175-180). Lugano, Switzerland: iEMSs (International Environmental Modelling and Software Society).

Athar, H. (2013). Seasonal variability of the observed and the projected daily temperatures in northern Saudi Arabia. Climatic Change, 119 (2), *Climatic Change*, 119 (2), 333–344. doi: 10.1007/s10584-013-0717-4

Australian Bureau of Rural Sciences. (2005). Socio-economic impact assessment toolkit. A guide to assessing the socio-economic impacts of marine protected areas in Australia. Canberra, Bureau of Rural Sciences: Social sciences program: Author. Retrieved from http://www.environment.gov.au/coasts/mpa/publications/pubs/nrsmpa-seia.pdf

Banks, N., Roy, M. & Hulme, D. (2013). Neglecting the urban poor in Bangladesh: research, policy and action in the context of climate change. *Environment and Urbanization*, 23 (2), 487–502. doi: 10.1177/0956247811417794

Belgacem, A. O. & Louhaichi, M. (2013). The vulnerability of native rangeland plant species to global climate change in the West Asia and North African regions. Climatic Change, 119 (2), 451–463. doi: 10.1007/s10584-013-0701-z

Blanc, E. & Strobl, E. (2013). The impact of climate change on cropland productivity: Evidence from satellite based products at the river basin scale in Africa. Climatic Change, 117 (4), 873–890. doi: 10.1007/s10584-012-0604-4

Braga, B. (1998). Urban water resources management in tropical climate. In A. I. Johnson & C. A. Fernández-Jáuregui (Eds.) Hydrology in the humid tropic environment (pp. 277-286). Wallingford, Oxfordshire, UK: IHAS.

Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions. In J. Birkmann (Ed.) Measuring vulnerability to nature hazards – Toward disaster resilient societies (pp. 9-54). Hongkong: United Nation University Press.

Birkmann, J. (2007). Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications. *Environmental Hazards*, 7 (2007), 20–31. doi:10.1016/j.envhaz.2007.04.002

Brugmann, J. (2013). Financing the resilient city. *Environment and Urbanization*, 24 (1), 215–232. doi: 10.1177/0956247812437130

Burrough, P. A. (1986). *Principles of geographical information systems for land resources assessment.* Oxford: Clarendon Press.

Caballero, Y., Chaouche, K., Neppel, L., Melia, D.S.y, Martin, E., Terrasson, I., et al. (2008). Vulnerability of Mediterranean hydrosystems to climate changes and human activities: the VULCAIN project: Assessing potential impacts of likely future precipitation and temperature modifications for the 2020-2040 and 2040-60 periods over a Mediterranean basin (20pp.). Retrieved June 26, 2013 from http://agire.brgm.fr/to_download/Vulcain_WWC_Caballero_et_al_Septembre2008.pdf

Carney D. (2005). *Sustainable livelihoods approaches: Progress and possibilities for changes.* O. Sattaur (Ed.). Toronto, Canada: Finesse Print.

Carver, S. J. (1991). Integrating multi-criteria evaluation with geographical information systems. *International Journal Geographical Information System*, 5 (3), 321-339.

CGG (Center for Good Government). (2005). *Social audit: A toolkit – A guide for performance improvement and outcome measurement*. USA, CGG: Author. Retrieved June 30, 2013, from http://www.cgg.gov.in/publicationdownloads2a/Social_Audit_Toolkit_Final.pdf

Chan, N. W. (1998). The physical geography and flooding of peninsula Malaysia. In A. I. Johnson & C. A. Fernández-Jáuregui (Eds.) Hydrology in the humid tropic environment (pp. 303-311). Wallingford, Oxfordshire, UK: IHAS.

Coit, K. (1998). Housing policy and slum upgrading in Ho Chi Minh City. *Habitat International Journal*, 22 (3), 273-280.

Colberg, F. & Bindoff, N. L. (2010). Pathways and impacts of Southern Ocean currents on Antarctic icesheet melting in response to global warming. In T. Stocker, Q. Dahe, G.K. Plattner, et al. (Eds.) *IPCC Workshop on sea level rise and ice sheet instabilities.* Working group 1 – The physical science basic (pp. 57-58). Kuala Lumpur, Malaysia: IPCC.

Committee on Radiative Forcing Effects on Climate, Climate Research Committee, & National Research Council. (2005). Radiative forcing of climate change: expanding the concept and addressing uncertainties. Washington DC: The National Academies Press.

Cowell, O. & Consultant, F. (2000). Gathering storm - The human cost of climate change. Amsterdam, Netherland: Friend of the Earth International Publication.

Cruz, R.V., H. Harasawa, M. Lal, S. Wu, Y. Anokhin, B. Punsalmaa, Y. Honda, M. Jafari, C. Li and N. Huu Ninh. (2007). Asia. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson (Eds.) Climate change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) (pp. 469-506). Cambridge, UK: Cambridge University Press.

Department of Cadastry and Housing Land. (2001a). Ho Chi Minh City Housing development program 1991-2000 and orientation to 2010. HCMC: Department of Cadastry and Housing Land.

Department of Cadastry and Housing Land. (2001b). Program of removing and evacuating 10,000 slums on Ho Chi Minh City canals 2001 – 2005. HCMC: Department of Cadastry and Housing Land.

Department of Cadastry and Housing Land. (2001c). Housing development in Ho Chi Minh City during ten years (1991-2000) and strategies for housing development in Ho Chi Minh City to 2010. HCMC: Department of Cadastry and Housing Land.

Deschamps, P., Durand, N., Bard, E., Hamelin, B., Camoin, G., Thomas, A. L., et al. (2012). Ice-sheet collapse and sea-level rise at the bølling warming 14,600 years ago. *Nature*, 483, 559-564. doi: 10.1038/nature10902

DFID (Department for International Development). (1999). Sustainable livelihoods guidance sheets. London, UK: DFID.

DoPA (Department of Planning and Architect). (2010). Construction planning and urban management in Ho Chi Minh City toward urban sustainable development. In HIDS (Eds.) Proceedings on urban sustainable development on May 17, 2010, (7pp.). HCMC: HIDS.

DoT (Department of Transportation). (2010a). Developing parks, flower parks for Ho Chi Minh City – The real situation and solution. In HIDS (Eds.) Proceedings on urban sustainable development on May 17, 2010, (8pp.). HCMC: HIDS.

DoT (Department of Transportation). (2010b). The Ho Chi Minh City flooding statistic data in 2010. HCMC: DoT.

Duong, L. (2002). Housing development in Ho Chi Minh City. Case study: Bong Sao residential area project. Retrieved from Lunt Tekniska Hoegskola Web site: http://www.lth.se/fileadmin/hdm/alumni/papers/hd2002/hd2002-22.pdf

Dutta, D., Babel, M. S. & Gupta, A. D. (2004). An assessment of the socio-economic impacts of floods in large coastal areas - Scientific capacity building and enhancement for sustainable development in developing countries (Final Report for APN CAPaBLE Project: 2004-CB01NSY-Dutta). Bangkok, Thailand: Asian Institute of Technology.

Esper, J., Wilson, R. J. S. & Frank, D. C. (2005). Climate: past ranges and future changes. *Quaternary Science Reviews*, 24, 2164–2166. doi:10.1016/j.quascirev.2005.07.001.

Farrington J., Ramasut T. & Walker J. (2002). Sustainable livelihoods approaches in urban areas: General lessons, with illustrations from Indian cases. SIDA (Swedish International Development Cooperation Agency). Stockholm, Sweden: SIDA.

Feiden, P. (2011). *Adapting to climate change: Cities and the urban poor*. Washington DC: IHC (International Housing Coalition, Housing for All).

Gill, T. E. & Collins, T. W. (2010). Differential impacts of flash flooding across the Paso del Norte. Urban Watershed Management: Southwest Hydrology, January/February 2010, 20-33.

Giron, E., Joachain, H., Degroof, A., Hecq, W., Coninx, I., Bachus, K., et al. (2010). ADAPT - towards an integrated decision tool for adaptation measures. Case study: Floods. Bruxelles, Belgium: Belgian Federal Science Policy.

GM & IFAD (Global Mechanism & International Fund for Agriculture Development). (2008). *Confronting climate change and degradation in Vietnam – Increasing finance for sustainable land management*. Rome, Italy: GM. Retrieved from http://global-mechanism.org/es/GM-Publications/GM-Publications/Confronting-Climate-Change-and-Land-Degradation-in-Viet-Nam/Download

Goldblum, C. & Wong, T. (2000). Growth, crisis and spatial change: a study of haphazard urbanization in Jakarta, Indonesia. New York: Oxford University Press.

Gugler, J. & Flanagan, W. G. (1978). Urbanization and social change in West Africa. USA: Cambridge University Press.

Hardoy, J. & Pandiella, G. (2013). Urban poverty and vulnerability to climate change in Latin America. Environment and Urbanization, 21 (1), 203–224. doi: 10.1177/0956247809103019

Harrison, D. E. & Carson, M. (2013). Recent sea level and upper ocean temperature variability and trends; cook islands regional results and perspective. Climatic Change 119 (1), 37–48. doi: 10.1007/s10584-012-0580-8

HCMC People's Committee. (2006). Construction prices system for Ho Chi Minh City (Decision No. 103/2006/QD-UBND). Ho Chi Minh City: People's Committee.

HCMC People's Committee. (2006). Construction prices system for capital construction in Ho Chi Minh City (Decision No. 104/2006/QD-UBND). Ho Chi Minh City: People's Committee.

HCMC People's Committee. (2008). Direction on organizing and implementing the Decision No. 589/2008/QD-TTg on the approval of regional planning for Ho Chi Minh City to 2020 and the vision to 2050 (Direction No. 15/2008/CT-UBND). Ho Chi Minh City: People's Committee.

HCMC People's Committee. (2008). Direction based on Decision 589/2008/QD-TTg for Ho Chi Minh City regional urban planning to 2020 and vision to 2050 (Direction No. 15/2008/CT-UBND). Ho Chi Minh City: People's Committee.

HCMC People's Committee. (2012). Decision on poverty line for Ho Chi Minh City in 2012 – 2015 (Decision No. 37/2012/QD-UBND). Ho Chi Minh City: People's Committee.

HEPZA (HCMC Export Processing and Industrial Zones Authority). (2013). Planning and tentative development for export processing zones and industrial parks in Ho Chi Minh City to 2020. Retrieved June 27, 3013 from http://www.hepza.hochiminhcity.gov.vn/web/guest/quy-hoach-va-du-kien-phat-trien

Ho, L. P. (2007). Climate changes and urban flooding in Ho Chi Minh City. In Finnish Environment Institute Syke (Eds.) The Third international conference on climate and water. Helsinki, Finland: Finnish Environment Institute Syke.

Ho, L. P. (2008). Inundation and storm-water drainage in Ho Chi Minh City. In HCMC University of Technology (Eds.) Conference proceedings of technical sciences, (pp. 476-482). HCMC: University of Technology.

Ho, L. P. (2010). The local climate changes and urban inundation in Ho Chi Minh City. In HIDS (Eds.) Proceedings on urban sustainable development (11 pp.). HCMC: HIDS.

IPCC. (2007a). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

IPCC. (2007). Summary for Policymakers. In: Climate Change 2007: *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. (2007c). Summary for Policymakers. In: Climate Change 2007: *Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.

IPCC. (2007d). Summary for Policymakers. In: Climate Change 2007: *Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. (2010). Meeting report of the Intergovernmental Panel on Climate Change expert meeting on detection and attribution related to anthropogenic climate change. Stocker, T.F., C.B. Field, D. Qin, V. Barros, G.-K. Plattner, M. Tignor, P.M. Midgley, and K.L. Ebi (Eds.). (55 pp.). University of Bern, Bern, Switzerland: IPCC working group I technical support unit.

Jha, A. K., Bloch, R. & Lamond, J. (2011). Cities and flooding – a guide to integrated urban flood risk management for the 21st century. Washington D.C, USA: WB.

Jones, C. B. (1997). *Geographical information systems and computer cartography*. Essex, USA: Addison Wesley Longman Limited.

Kahn, M. E. (2009). Urban growth and climate change. *The Annual Review of Resource Economics*, (2009) 1: 16.1-16.17. doi: 10.1146/annurev.resource.050708.144249

Kahnay, E. & Cai, M. (2003). Impact of urbanization and land-use change on climate. Nature, 423, 528-531.

Kalnay, E., Cai, M. & Li, H. (2006). Estimation of the impact of land-surface forcings on temperature trends in eastern United States. *Journal of Geophysical Research*, 111 (D06106), (13 pp.). doi:10.1029/2005JD006555

Kim, S. (2004, September 20). Industrialization and urbanization: Did the steam engine contribute to the growth of cities in the United States? (39 pp.). Berkeley USA: University of California.

Knutti, R. & Hergerl, G. C. (2008). The equilibrium sensitivity of the earth's temperature to radiation changes. Review article. Journal of Nature Geosciences. 1 (11), 735-743.

Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I.A. Shiklomanov. (2007). Freshwater resources and their management. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.

Kunreuther, H., Michel-Kerjan, E. & Ranger, N. (2013). Insuring future climate catastrophes. *Climatic Change*, 118 (2), 339–354. doi: 10.1007/s10584-012-0625-z

Lankao, P. R. (2013). Water in Mexico City: what will climate change bring to its history of water-related hazards and vulnerabilities? *Environment and Urbanization*, 22 (1), 157–178. doi: 10.1177/0956247809362636

Le, C. S. (2010, October 25). Street rising – flooded housing: the legal proceedings for compensation. Retrieved from http://tuoitre.vn/Chinh-tri-xa-hoi/Phap-luat/407638/Nang-duong-ngap-nha-Co-the-kien-doi-boi-thuong.html (last accessed on December 2012)

Le, V. Thanh. (2005). Urbanization, environment, development and urban policies in Ho Chi Minh City, Vietnam. In Iussp (Eds.) The 25th IUSSP international population conference on July 18-23, 2005. Retrieved from Princeton University, International Union for Scientific Study of Population (IUSSP) Web site: http://iussp2005.princeton.edu/papers/50030

Le, V. Thanh. (2007). Economic development, urbanization and environmental changes in Ho Chi Minh City, Viet Nam: Relations and policies. In Cicred, Pern & Ciesin

(Eds.) The PRIPODE workshop on urban population, development and environment dynamics in developing countries (20 pp.). Nairobi, Kenya: CICRED.

Le, V. Trung. (2009). Outline of the waterlog and flood prevention solutions in Ho Chi Minh City. In FIG (Eds.) The 7th FIG regional conference spatial data serving people: Land governance and the environment – Building the capacity, (9 pp.). Hanoi, Vietnam: FIG (International Federation of Surveyors).

LefÈvre, B. (2013). Incorporating cities into the post-2012 climate change agreements. *Environment and Urbanization*, 24 (2), 575–595. doi: 10.1177/0956247812456359

Li, Y. & Zchang, C. (2008). Promoting industrialization and urbanization: migration of rural labor force in China. In Eropa (Eds.) EROPA seminar "Governance in triptych: environment, migration, peace and order" on October 23-25, 2008 (10 pp.). Manila, Philippine: EROPA.

Linden, P. van der & Mitchell, J. F. B. (2009). Climate change and its impacts at seasonal, decadal and centennial timescales. Summary of research and results from the Ensembles project. Execter, UK: ENSEMBLES.

Liu, Z., Yang, X., Chen, F. & Wang, E. (2013). The effects of past climate change on the northern limits of maize planting in Northeast China. *Climatic Change*, 117 (4), 891–902. doi: 10.1007/s10584-012-0594-2

Lohmann, U., Storelvmom, L., Rotstayn, T., Jones, A., Quaas, J., Ekman, A., et al. (2009). Total aerosol effect: radiative forcing or radiative flux perturbation? Atmospheric Chemistry and Physics Discussions, 9 (2009), 25633–25661.

Lu, Q., Liang, F. & Bi, X. (2011). Effects of urbanization and industrialization on agricultural land use in Shandong Peninsula of China. *Ecological Indicators*, 11 (2011) 1710–1714. doi:10.1016/j.ecolind.2011.04.026

Luong, V. V. (2008). City development and the trend of climate change in Ho Chi Minh City. In IMHEN (Eds.) The 10th science proceedings of IMHEN, (pp. 369-375). Hanoi: IMHEN (Vietnam Institute of Meteorology Hydrology and Environment).

Mackenzie Valley Environmental Impact Review Board. (2007). *Socio-economic impact assessment guidelines* (2nd ed.). Canada: Yellowknife.

Mahmood, R., Pielke Sr., R. A. & Hubbard, K. G. (2010). Impacts of land use/land cover change on climate and future research priority. In American Meteorological Society (Eds.) (pp. 37-46). USA: BAMS.

MAL (Ministry of Agriculture and Lands). (2007). Guidelines for socio-economic and environmental assessment (SEEA) – Land use planning and resource management planning. British Columbia: MAL: Author. Retrieved from http://www.al.gov.bc.ca/clad/strategic_land/econ_analysis/projects_pubs/cabinet/SEEA_guidelines.pdf

McGee, T. (1983). Prolerarianization, industrialization and urbanization in Asia: a case study of Malaysia. *Journal of Humanities and Social Sciences University Kebangsaan Malaysia. Akademika*, (23), 3-20.

Meikle S., Ramasut T., & Walker J. (2001). Sustainable urban livelihoods: concepts and implications for policy (Working paper No. 112). London, UK. Retrieved from http://www.ucl.ac.uk/dpu-projects/drivers_urb_change/urb_society/pdf_liveli_vulnera/DPU_Meikle_Sustainable_Urban_Livelihoods.pdf

Misra, V. (2005). Social impact assessment methodology. Retrieved June 30, 2013 from http://www.sasanet.org/documents/Tools/Social_Impact_Assessment_Methodology.pdf

MoC (Ministry of Construction, Vietnam). (2004). Vietnam construction standard 323:2004 "High-rise buildings – Design standard" (Decision No. 26/2004/QD-BXD). Hanoi: MoC.

MoC (Ministry of Construction, Vietnam). (2010). Construction price index (Decision No. 778/QD-BXD). Hanoi: MoC.

MoC (Ministry of Construction, Vietnam). (2011). Promulgation of invested capital collection of construction for 2010 (Decision No. 295/2011/QD-BXD). Hanoi: MoC.

Mohamad, S., Hashim, N. Md. & Aiyub, K. (2012). Flash flood and community's response at Sg. Lembing,Pahang. *Advances in Natural and Applied Sciences International Journal*, 6 (1): 19-25.

Møller, K. A., Fryd, O. & de Neergaard, A. (2013). Economic, environmental and socio-cultural sustainability of three constructed wetlands in Thailand. *Environment and Urbanization*, 24 (1), 305–323. doi: 10.1177/0956247811434259

MoNRE (Ministry of Natural Resource and Environment, Vietnam). (2009). The climate change, sea level rise scenarios for Vietnam. Hanoi: MoNRE.

Morgan, G., Smuts, T. & Dowlatabadi, H. (1994). Global warming and climate change. Pennsylvania, USA: Carnegie Mellon University.

Moser, C. & Satterthwaite, D. (2008). Towards pro-poor adaptation to climate change in the urban centres of low- and middle-income countries. Human Settlements discussion paper series – themes: Climate change and cities – 3. Manchester, UK: IIED (International Institution for Environment and Development). Retrieved from http://pubs.iied.org/pdfs/10564IIED.pdf

Naeije, M., Trisirisatayawong, I. & Simons, W. (2012). Sea level rise and subsidence in delta areas of the Guft of Thailand. In ESA (European Space Agency) (Eds.) Symposium on the 20 years of progress in radar altimetry on 24-26 September 2012 (6 pp.). Venice, Italy: ESA Special Publication.

Ngoc, A. (2010, November 8). Higher street – lower house. TuoiTre Online. Retrieved from http://tuoitre.vn/Ban-doc/409838/Nang-duong-len-cao-nha-dan-E2-80-9Clun-E2-80-9D-xuong.html (last accessed on June 27, 2013)

Nguyen, D. S. (2010, April 8). Disorder housing by lacking of urban design in Ho Chi Minh City. Khudothimoi.com. Retrieved from http://khudothimoi.com/tintuc/dau-tu-quy-hoach/2299-nha-xay-hon-don-vi-thieu-thiet-ke-do-thi-tai-tphcm.html (last accessed on June 27, 2013)

Nguyen, D. T. & Duong, V. V. (2007). Some solutions for flooding control to Ho Chi Minh City. Retrieved June 15, 2013 from http://www.vncold.vn/Modules/CMS/Upload/10/KhoaHocCongNghe/60-Giai-Phap-Chong-Ngap-TPHCM_24_12_07/60-Giai-Phap-Chong-Ngap-TPHCM.pdf

Nguyen, P. D., Nguyen, T. V. H., Bui, X. T., Nguyen, V. N. & Le, V. K. (2007). In IGES (Eds.) Sustainable Groundwater Management in Asian Cities (1st ed.) (pp. 68-92). Hayama, Japan: IGES (International for Global Environment Strategies).

Nguyen, T. H. (2002). Housing and infrastructure constraints faced by the urban poor (final report). Hanoi, MA: WB – Cities Alliance. Retrieved from http://isted.ville-developpement.org/villes-developpement/cities_alliance/task1_report.pdf

Nguyen, T. P. C. (2006). Privatization in low-income housing in Ho Chi Minh City. Master thesis. Bangkok, Thailand: AIT (Asian Institution of Technology).

Nguyen, T. P. C. (2012). The impact of urban land price to the housing development programs in Ho Chi Minh City. In CEFURDS (Eds.) The trends of urbanization and urbanization in sub-urban areas in Southeast Asia. HCMC: CEFURDS (Center for Urban and Development Studies).

Nhu, T. (2009, October 30). Street rising, housing became cellar. Diaoc Online. Retrieved from http://www.diaoconline.vn/tinchitiet/7/16896/-nang-duong-nha-bien-thanh-ham-/ (last accessed on June 27, 2013)

Nicholls, R.J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., et al. (2008). Ranking of the world's cities most exposed to coastal flooding today and in the future (Environment working paper No. 1 (ENV/WKP(2007)1). CA, USA: OECD.

Oppenheimer, M. (2013). Climate change impacts: accounting for the human response. *Climatic Change,* 117 (3), 439–449. doi: 10.1007/s10584-012-0571-9

PADDI (City Urban Development Management Support Center in HCMC). (2012). How to have urban planning in Vietnam more effective? Case study: Ho Chi Minh City. HCMC, PADDI: Author Retrieved from http://www.paddi.vn/IMG/pdf/Eng_Urban_Planning_in_Vietnam_final.pdf

Pallant. J. (2007). *SPSS survival manual – a step by step guide to data analysis using SPSS for Windows*. Sydney, Australia: McGraw Hill

Pangilan, R. S. & Lau, T. L. (2011). Flooding in Sungai Maka catchment in the town of Tanah Merah, Kelantan. In REDAC (Eds.) The 3rd international conference on managing rivers in the 21st century: Sustainable solutions for global crisis of flooding, pollution and water scarcity. Penang, Malaysia: REDAC (Rivers Engineering and Urban drainage research center).

Parkinson, J. (2003). Drainage and stomwater management strategies for low-income urban communities. *Environment and Urbanization: Drainage and Stormwater Managemnt*, 15 (2), 115-126. doi: 10.1177/095624780301500203

Pelling, M. (1999). The political ecology of flood hazard in urban Guyana. *GEOFORUM*, 30, 249-261.

PSO (HCMC Statistic Office). Yearly Statistic Data of Ho Chi Minh City from 2009 to 2012. Available assess on http://www.pso.hochiminhcity.gov.vn/web/guest/home

Quang K., Lan, V. & Vy K. (2010, October 16). Urban flooding: The endless race? TuoiTre Online. Retrieved from http://tuoitre.vn/Tuoi-tre-cuoi-tuan/Chuyen-de/405943/Ngap-do-thi---cuoc-dua-bat-tan.html. (last accessed on June 27, 2013)

Roggema, R. (2009). *Adaptation to climate change: a spatial challenge*. Washington DC, USA: Springer.

Sajor, E.E. (2003). Globalization and the urban property boom in Metro Cebu, Philippines. *Development and Change*, 4 (34): 713-741.

Satterthwaite, D. (2008). Climate change and urbanization: Effects and implications for urban government. UN expert group meeting population distribution, urbanization, internal migration and development on December 27, 2007 (29 pp.). New York, USA: UN.

Satterthewaite, D. (2009). The implication of population growth and urbanization for climate change. *Environment and Urbanization*, 21 (2): 545–567. doi: 10.1177/0956247809344361

SCES (Steering Committee for Environmental Sanitation). (2010). The Ho Chi Minh City's environmental sanitation project: The Nhieu Loc – Thi Nghe Balley. In

HIDS (Eds.) Proceedings on urban sustainable development on May 17, 2010 (7 pp.). HCMC: HIDS.

SCFC (Steering Center of Flooding Control Program). (2010). The current situation and solution for flooding prevention in Ho Chi Minh City. In HIDS (Eds.) Proceedings on urban sustainable development on May 17, 2010 (8 pp.). HCMC: HIDS.

SCFC (Steering Center of Flooding Control Program). (2012). *The current situation of rain, tide, and flood*. Retrieved June 15, 2013 from http://www.ttcn.hochiminhcity.gov.vn/chuong-trinh-du-an-chong-ngap/-/ext/articleview/article/64476/10182

SCSFP (Steering Center of Storm and Flooding Prevention, HCMC). (2011). Results of disaster prevention – victim rescue of first nine months and mission, action plan for last three months of 2011 (report No. 288/BC-PCLB). HCMC, SCSFP: Author. Retrieved from http://www.phongchonglutbaotphcm.gov.vn/?id=11&cid=3760

Sen, O. L., Bozkurt, D. & Vogler, J. B. (2013). Hydro-climatic effects of future land-cover/land-use change in montane mainland Southeast Asia. *Climatic Change*, 118 (2), 213–226. doi: 10.1007/s10584-012-0632-0

Setchell, C. (1995). The growing environmental crisis in the world's mega cities. The case of Bangkok. *Third World Planning Review*, 1 (17), 1-18.

Sigauke, N. (2002). Improving urban livelihoods: Epworth sustainable livelihoods Benchmark study. Retrieved from https://practicalaction.org/docs/region_southern_africa/Epworth_Benchmark_Study.pdf

Sharma, D. & Tomar, S. (2013). Mainstreaming climate change adaptation in Indian cities. Environment and Urbanization, 22 (2), 451–465. doi: 10.1177/0956247810377390

Slangen, A.B.A., van de Wal, R. S.W. & Katsman, C.A. (2010). Local Ssa level estimates based on IPCC SRES Scenarios. In T. Stocker, Q. Dahe, G.K. Plattner, et al. (Eds.) *IPCC Workshop on sea level rise and ice sheet instabilities.* Working group 1 – The physical science basic (pp. 193-194). Kuala Lumpur, Malaysia: IPCC.

Snoussi, M., Ouchani, T. & Niazi, S. (2008). Vulnerability assessment of the impact of sea-level rise and flooding on the Moroccan coast: The case of the Mediterranean eastern zone. *Coastal and Shelf Science*, 77 (2008) 206-213. doi:10.1016/j.ecss.2007.09.024

Shoo, L. P., Hoffmann, A. A., Garnett, S., Pressey, R. L., Williams, Y. M., Taylor, M., et al. (2013). Making decisions to conserve species under climate change. Climatic Change, 119 (2), 239–246. doi: 10.1007/s10584-013-0699-2

Stammer, D. & Asrar, G. (2011). WCRP White paper: Sea-level rise and regional impacts. In WCRP (Eds.) Workshop on regional sea-level change on February 7-9, 2011, Paris, (4 pp.). Paris: WCRP (World Climate Research Program).

Storch, H. & Downes, N.K. 2011. A Scenario-based approach to assess Ho Chi Minh City's urban development strategies against the impact of climate change. J. Cities, doi:10.1016/j.cities.2011.07.002.

Storch, H., Downes, N.K. & Katzschner, A. 2011. Building Resilience to Climate Change through Adaptive Landuse Planning in Ho Chi Minh City, Vietnam. In K. Otto-ZIMMERMANN (Ed.) Resilient cities: cities and adaptation to climate change. Proceedings of the Global Sustainability. Vol 1, (pp. 349-363). Berlin: Springer.

Stott, P. A. & Forest, C. E. (2007). Ensemble climate predictions using climate models and observational constraints. Philosophical Transaction of the Royal Society A. (2007) 365, 2029–2052. doi:10.1098/rsta.2007.2075

SIHYMETE (Sub-Institute of Hydrometeorology and Environment of South Vietnam). (2008). Results of hydrometeorology characteristics for flooding control in Ho Chi Minh City. HCMC: SIHYMETE.

SIHYMETE (Sub-Institute of Hydrometeorology and Environment of South Vietnam). (2011). Statistic monitored results on meteorology and hydrology in Ho Chi Minh City. HCMC: SIHYMETE.

Tayanç, M. & Toros, H. (2004). Urbanization effects on regional climate change in cases of four large cities in Turkey. Earth and Environmental Sciences, 66, 127-134.

Tayanç, M., Im, U. & Dogruel, M. (2009). Climate change in Turkey for the last half century. *Climatic Change*, 94 (2), 483–502. doi: 10.1007/s10584-008-9511-0

Taylor, K.E.; Crucifix, M. & Braconnot, P. (2007). Estimating shortwave radiative forcing and response in climate models. *Journal of Climate*, 20 (11), 2530-2543. doi: 10.1175/JCLI4143.1

Terakawa, A., Yoshitani, J. & Ikeda, T. (2006). Sustainable development and emerging research programs in flood hazard mitigation and risk management. In ICHARM (Eds.) Proceedings of international workshop on flood risk assessment and management: preparing for the worse events & designing for the better solutions" (6 pp.). Tsukuba, Japan: ICHARM (International Centre for Water Hazard and Risk Management).

Tol, R. S. J. (2013). The economic impact of climate change in the 20th and 21st centuries. *Climatic Change*, 117 (4), 795–808. doi: 10.1007/s10584-012-0613-3

To, V. T. (2008a, October 17). *Drainages in Ho Chi Minh City.* Retrieved June 15, 2013 from http://www.vncold.vn/Web/Content.aspx?distid=136

To, V. T. (2008b). The recommendation to the irrigation planning to find the flooding adaptive solutions for Ho Chi Minh City. Retrieved June 15, 2013 from http://www.vncold.vn/Modules/CMS/Upload/10/YKien_BinhLuan/PbienQHTLTPHCM_24_06_08/PbienQHTLTPHCM.pdf

Tompkins, H. (2002). Climate change and extreme weather events: is there a connection? *Ciceron,* 3 (2002), (5 pp.). International Institute of Sustainable Development (IISD).

Tran, L. B. (2009). Innovative strategies towards flood resilient cities in Asia-Pacific. In UNESCAP (Eds.) Proceedings of economic and social commission for Asia and the Pacific expert group - Meeting on innovative strategies towards flood resilient cities in Asia-Pacific on July 21-23, 2009 (12 pp.). Bangkok: UNESCAP.

Tran, H. & Yasuoka, Y. (2002). Remote sensing to analyze the changes of surface biophysical parameters in Vietnam’s urbanized area. In AARS (Eds.) Proceedings of 23rd Asian conference on remote sensing on November 25-29, 2002 (6 pp.). Kathmandu, Nepal: AARS (Asian Association on Remote Sensing).

Tran, N. H. P. (2010). The immigration and the development resources in the current situation of Ho Chi Minh City. In HIDS (Eds.) Proceedings on urban sustainable development on May 17, 2010 (5pp.). HCMC: HIDS.

Trieu, N. (2010, October 23). The on-street-flooding control caused housing flooding. TuoiTre Online. Retrieved from http://diaoc.tuoitre.vn/Index.aspx?ArticleID=407206&ChannelID=450 (last accessed on June 27, 2013)

Trinh, C. V. (2008). The irrigation planning against flooding in Ho Chi Minh City.). Retrieved June 15, 2013 from http://www.wrd.gov.vn/Modules/CMS/Upload/10/PhatTrienNuoc/TCVanQHTLTPHCM_03_08_08/TCVanQHTLTPHCM.pdf

Trinh, D. L. & Nguyen, Q. V. (2001), Socio-economic impacts of 'Doi Moi' on urban housing in Vietnam. National center for social sciences and humanities, University of British Colombia, Canada: Social Sciences Publishing House.

Trisirisatayawong, I., Naeije, M. & Simons, W. (2011). Sea level change in the Gulf of Thailand from GPS-corrected tide gauge data and multi-satellite altimetry. *Global and Planetary Change*, 76 (2011), 137-151. doi:10.1016/j.gloplacha.2010.12.010

Tucci, C. E. M.. (2001). Urban drainage issue in developing countries. In E.M.C. Tucci (Ed.). Urban drainage in humid tropics. UNESCO's international hydrological programme. Urban drainage in specific climates (Chief Ed.: C. Maksimovic), Vol.1 (40), (pp. 23-41). Paris: UNESCO.

Tucci, C. E. M. (2007). Urban flood management (WMO/TD No. 1372). WMO (World Meteorological Organization): Cap-Net.

Tucci, C. E. M. & Aldofo V. (2005). Land use and urban flood in developing countries. In András Szöllösi-Nagy, Chris Zevenbergen (Eds.) Urban flood management (pp. 11-26). Great Britain: A.A Balkema Publishers.

Tucci, C. E. M. (1998). Urban drainage planning in Brazil. In A. I. Johnson & C. A. Fernández-Jáuregui (Eds.) Hydrology in the humid tropic environment (pp. 295-301). Wallingford, Oxfordshire, UK: IHAS.

UNESCAP (United Nations Economic and Social Commission for Asia and Pacific). (2010). Developing innovative strategies for flood-resilient cities - policy options for effective implementation of the Hyogo framework for action in Asia and the Pacific. Water Resource Series No. 86. Bangkok, Thailand: UNESCAP.

UNISDR (United Nation International Strategy for Disaster Reduction). (2004). Visions of risk – a review of international indicators of disaster risk and its management. M. Pelling (Ed.). A report for the UNISDR inter-agency task force in disaster reduction - Working group 3: Risk, vulnerability and disaster impact assessment. London: UNISDR.

Unnikrishnan, A.S. & Shankar, D. (2007). Are sea-level-rise trends along the coasts of the north Indian Ocean consistent with global estimates? Global Planet Change, 57(3-4) 301-307. doi:10.1016/j.gloplacha.2006.11.029

Usavagovitwong, N. & Posriprasert, P. (2006). Urban poor housing development on Bangkok's waterfront: securing tenure, supporting community processes. Environment and Urbanization, 18 (2), 523–536. doi: 10.1177/0956247806069629

Vanclay, F. (2003). SEA principles. International principles for social impact assessment. *Impact Assessment and Project Appraisal*, 21 (1), 5-11.

Viet, H. (2010, October 1). People against the street rising. Phapluat Online. Retrieved from http://phapluattp.vn/20100930102611254p0c1085/dan-phan-doi-chuyen-nang-nen-duong.htm (last accessed on June 27, 2013)

Vincent, I.O. (1998). The dynamics of informal housing in a traditional West African city: The Benin City example". *Third World Planning Review*, 4 (20), 419-439.

VNPM (Vietnam Prime Minister). (2008). Approved decision on the regional planning for Ho Chi Minh City to 2020 and vision to 2050 (Decision No. 589/2008/QD-TTg). Hanoi: VNMP.

VNPM (Vietnam Prime Minister). (2008). Decision for Ho Chi Minh City regional urban planning to 2020 and vision to 2050 (Decision No. 589/2008/QD-TTg). Hanoi: VNMP.

VNPM (Vietnam Prime Minister). (2010). Master plan adjustment for Ho Chi Minh City to 2025 (Decision No. 24/2010/QD-TTg). Hanoi: VNMP.

Vo, L. P. (2009). Water resource in Ho Chi Minh City, Viet Nam: An overview. *Journal of Sciences and Technology Development, University of Technology*. 12 (2), 51-63.

Vu, D. Q. (2010). Experiences and solutions in compensation and evacuation for industrialization and urbanization in Ho Chi Minh City. In HIDS (Eds.) Proceedings on urban sustainable development on May 17, 2010 (7 pp.). HCMC: HIDS.

Vung Tau People Committee. (2011). Regulations for housing quality, housing category, prices of housing and architectural works in Ba Ria – Vung Tau Province (Decision No. 08/2011/QD-UBND). Vung Tau: Vung Tau People Committee.

WB (The World Bank). (2010a). Climate risks and adaptation in Asian coastal megacities. A synthesis report. Washington DC, USA: WB.

WB (The World Bank). (2010b, February 6). Extreme poverty rates continue to fall. Retrieved from http://data.worldbank.org/news/extreme-poverty-rates-continue-to-fall (last assessed on June 29, 2013)

WB (The World Bank). 2011a. Climate change, disaster risk and the urban poor. Cities building resilience for a changing world. Summary. Washington DC, USA: WB.

WB (The World Bank). 2011b. Guide to Climate Change Adaptation in Cities. Washington DC: WB.

Woodruff, A. & Holland, P. (2008). Economic tools for flood risk reduction: bridging the gap between science and policy in Pacific Island countries. In SOPAC (Eds.) Proceedings of 2nd Australasian natural hazards management conference on July 29-30, 2008 (10 pp.). Wellington, New Zealand: SOPAC.

WWF International. (2009). Mega-Stress for the Mega-cities - A Climate Vulnerability Ranking of Major Coastal Cities in Asia. Vote Earth! - For a Living Planet. Gland, Switzerland: WWF International.

Yang, X-C., Zhang, Y-L. & Ding, M-J. (2010). Observational evidence of the impacts of vegetation cover on surface air temperature change in China. *Chinese Journal of Geophysics*, 53 (2), 261-269.

Yap, K.S. (1992). Low income housing in Bangkok. A review of some housing sub-markets: trends and Options. Bangkok, Thailand: AIT (Asian Institute of Technology).

Yohe, G. & Hope, C. (2013). Some thoughts on the value added from a new round of climate change damage estimates. Climatic Change, 117 (3), 451–465. doi: 10.1007/s10584-012-0563-9

Yasuda, T. & Sakurai, K. (2006). Interdecadal variability of the sea surface height around Japan. Geophysical Research Letter, 33, L01605, doi:10.1029/2005GL024920

Yasuda, T. & Sueyoshi, M. (2011). Interdecadal variability and linear trend of sea level around Japan in the 20th and 21st centuries. In WCRP (Eds.) Conference of climate research in service to society on October 24-28, 2011. Denver, USA: WCRP (World climate research program).

Yusuf, A. A. & Francisco, H. A. (2009). Climate change vulnerability mapping for Southeast Asia. Singapore: EEPSEA (Economy and environment program for Southeast Asia).

Zhang, X., Mount, T. D. & Boisvert, R. N. (2000). Industrialization, urbanization and land use in China (Discussion paper No. 58). Washington DC, USA: International Food Policy Research Institute. Retrieved from http://ageconsearch.umn.edu/bitstream/16051/1/ep000058.pdf

Zhu, T., Lund, J. R. & Jenkins, M. W. (2007). Climate change, urbanization, and optimal long-term floodplain protection. *Water Resources Research*, 43, (11 pp.) W06421. doi:10.1029/2004WR003516

Zoleta-Nantes, D. B. (2000). Flood hazard in Metro Manila: recognizing commonalities, differences and courses of actions. *Social Science Diliman*, 1 (1), 60-105.

Appendix

THE HOUSEHOLD SURVEY

For the PhD research title:

"The Socioeconomic Impact Assessment of Climate Change

in Ho Chi Minh City, Vietnam"

Supervisor: **Prof. Dr. Dr. Hc Michael Schmidt and Dr Harry Storch**

PhD student: **Nguyen Thi Phuong Chau**

Part I: Introduction

Climate change is the global environmental problem. It has various impacts on many aspects in many countries, especially on developing countries, where there is less technological intervention for climate-change mitigation and adaptation. Ho Chi Minh City (HCMC), a coastal city, is in the top twenty cities with the highest risk of flooding by climate change in the world (rank 16 by OECD, 2007). The heavy rains from storms come to HCMC every year have caused flooding expansion. Furthermore, the increasing of built-up areas because of high population growth and pseudo urbanization with inadequate infrastructures has led the increasing trend of flooding in HCMC.

Flooding expansion has caused many social-economic problems to HCMC, especially people and households who live in the flooding areas. This research is to try to understand the flooding impacts on the socio-economic aspects of households in order to know their difficulties in responding the impacts as well as their expectation on City Government's adaptation solutions.

Therefore, the author would like to do this research. To carry out, the Government supports and Households' contribution are really important and necessary. Otherwise, the research author also wishes this research results may be good reference to the City Government to know more about the households' problems and to develop the flooding solutions. To households, the research may be the representative voice for their expresses.

Finally, the author would like to thank to the Government officials, institute researchers and managers, scientists, and households who help this field research to be successful achieved.

-------------------- -------------------

Interview information: Code No.:

Name of Interviewee: ………

……………………………………………… ☐ Male
Household's address: ☐ Female
…………………………………………………

Name of head of household: ……………………………………………………………

Part II: Questionnaire survey

I. Household's profile

I.1. Housing information

1.1. Household member: ……………… persons.

1.2. Poverty household: ☐ Yes ☐ No

1.3. Household's members: ages, professions, and incomes

No.	**Name - relatives**	**Birth year (age)**	**Sex (*)**	**Education (**)**	**Profession**	**Income/month (thousand VNĐ)**
1						
2						
3						
4						
5						
6						
7						
8						
					Total income:	

(*) Sex code: 1 – Male; 2 – Female

(**) Education code:

1 – Elementary; 2 – Secondary; 3 – High-school; 4 – Graduate; 5 – Post-graduate; 6 – Higher or other

1.4. Expenditure of household per month

List of expenditures	**Total (thousand VNĐ)**	**Notes**
Electricity		
Water		
Gas		
Rice		
Food, drinks and vegetables		

Medicine		
Education		
Others, please specify: ………………….		
………………………………………….…		
………………………………………….…		

Total: (2)

1.5. Other expenditures in year

List of expenditures	**Total (thousand VNĐ)**	**Notes**

Total: (3)

1.6. The household net income per year = [12 x ((1) – (2))] – (3) = …………………… thousand VNĐ

I.2. Housing characteristics

1.7. What is your type of house?

☐ Type 1 ☐ Type 2 ☐ Type 3 ☐ Type 4 ☐ Type 5

☐ Other, please specify: ....

Please describe more details on your house:

1.8. The land/housing area

Land area (m^2)	Housing area (m^2)	Living area (m^2)	Number(s) of floor

1.9. The main material of wall

☐ Brick and cement ☐ Stone ☐Wood ☐ Metal-ware/ tole

☐ Other, please specify: ....

1.10. The outer cover of wall

☐ Waterproof paint ☐ Paint ☐ Cement ☐ Lime

☐ Other, please specify: ....

1.11. The main flat/floor material

☐ Ceramic tiles ☐ Cement ☐ Parquet ☐ Earth

☐ Other, please specify: ....

1.12. The main roof material

☐ Concrete ☐ Tiles ☐ Metal-ware ☐ Oil paper

☐ Wooden frame ☐ Bamboo & leaves

☐ Other, please specify: ....

1.13. The year of construction: ....

I.3. The ownership of housing

1.14. What is the ownership state of your house?

☐ Red/Pink book ☐ Transfer paper ☐ No paper ☐ Hire

☐ Other, please specify: ....

I.4. Other economic activities

1.15. Do you use part of house for income? ☐ Yes ☐ No

If yes, please answer the following questions of 1.16 and 1.17:

1.16. What kind of economic activities?

☐ Commercial ☐ Room renting ☐ Shop-house renting

☐ Other, please specify: ....

1.17. Total area for these activities

	Commercial	Rent-rooms	Shop-house renting	Other
Area (m^2)				
Income (thousand VNĐ)				

II. Flooding situation

II.1. Flooding in residential area (neighborhood)

2.1. Did you know the flooding history in this residential area? ☐ Yes ☐ No

2.2. If 'Yes', please specify the flooding increases since: ....

- Previous years: ....
....
....

Last year: ....

....

....

2.3. According to you, what were the reasons of flooding in this residential area?

....

....

2.4. Time of flooding in year:

a. From (month) ………… to (month) ………… b. Duration: ………… days

c. Which day was highest: ……………… d. Which day was lowest: ...

2.5. What are the reasons of flood in this area?

☐ By heavy rains ☐ By tidal flow ☐ By infrastructure
☐ Others (please specify): ....

II.2. Flooding in household housing

2.6. Did you have experiences with flooding with your house? ☐ Yes ☐ No

2.7. If 'Yes', please specify the flooding increase since: ....

- Previous years: ....
  ....
  ....
- Last year: ....
  ....

III. Flooding impacts

III.1. Flooding impacts on social characteristics

On residential area (neighborhood)

3.1. As your estimation, what flood impacts on your residential area?

Difficulties	Normal	Much	Very much	% impact	More information
Residential area	☐	☐	☐		
Streets and alleys	☐	☐	☐		
Transportation time	☐	☐	☐		
Street accidents	☐	☐	☐		
Drainage system	☐	☐	☐		
Water supply	☐	☐	☐		
Power/electricity problem	☐	☐	☐		
Other, pls specify: …………	☐	☐	☐		

On households

3.2. What are social characteristics of household impacted by flood?

Difficulties	Normal	Much	Very much	% impact	More information

Housing area	☐	☐	☐		………….. m^2
Land area	☐	☐	☐		………….. m^2
Housing materials:					
Walls	☐	☐	☐		
Floor	☐	☐	☐		
Doors	☐	☐	☐		
Windows	☐	☐	☐		
Furniture	☐	☐	☐		
Others: ………….....	☐	☐	☐		
Housing equipment:					
Refrigerator	☐	☐	☐		
Wash-machine	☐	☐	☐		
Electric fan	☐	☐	☐		
Electric stove	☐	☐	☐		
TV	☐	☐	☐		
Others: ……………	☐	☐	☐		
Vehicle (motorcycles, cars..).	☐	☐	☐		
Drainage & sanitation	☐	☐	☐		
Water problem	☐	☐	☐		
Power/electricity problem	☐	☐	☐		
Others: …………….	☐	☐	☐		

III.2. Flooding impact on economic characteristics

On residential area

3.3. Did the communities do with flooding in residential area?

Repair/ upgrade	Yes	No	Amount (m)	Total cost (thousand vnd)	More information
Streets	☐	☐			
Alleys	☐	☐			
Drainage system	☐	☐			
Water pipeline	☐	☐			
Electric line	☐	☐			
Other, pls specify:	☐	☐			

……………...................					

On households

3.4. What are the economic activities of your household impacted by flood?

Economic activities	Normal	Much	Very much	Econ. Loss (thousand vnd/month)	More information
Commercial	☐	☐	☐		
Shop-house	☐	☐	☐		
Rent-rooms	☐	☐	☐		
Agriculture	☐	☐	☐		
Vegetables	☐	☐	☐		
Aquaculture	☐	☐	☐		
Poultry	☐	☐	☐		
Others: ……………	☐	☐	☐		
	☐	☐	☐		
	☐	☐	☐		

3.5. What did you do (or must do in the future) to the flooding impacts?

Repair/ upgrade	Yes	No	Total cost (thousand vnd)		Do in the future	More information
			Repaired	New buy		
Housing area	☐	☐			☐	………….. m^2
Land area	☐	☐			☐	………….. m^2
Housing materials:	☐	☐			☐	
Walls	☐	☐			☐	
Floor	☐	☐			☐	
Doors	☐	☐			☐	
Windows	☐	☐			☐	
Furniture	☐	☐			☐	
Others: ……………..….	☐	☐			☐	
Housing equipment:	☐	☐			☐	
Refrigerator	☐	☐			☐	
Wash-machine	☐	☐			☐	
Electric fan	☐	☐			☐	
Electric stove	☐	☐			☐	
TV	☐	☐			☐	
Others: ……………..	☐	☐			☐	

Motorbike, cars ...	☐	☐			☐	
Drainage & sanitation	☐	☐			☐	
Water problem	☐	☐			☐	
Power/electricity problem	☐	☐			☐	
Others: ………….………	☐	☐			☐	

Government supports

In case you did nothing or did partly to response to the flooding impacts, what are your difficulties/seasons?

Response	Difficulties
To repair/upgrade the house	☐ No money ☐ Nobody helps to repair the house ☐ Others, please specify:
To repair housing materials	☐ No money ☐ Nobody helps to repair housing materials ☐ Others, please specify:
To fix the furniture	☐ No money ☐ Nobody helps to fix the furniture ☐ Others, please specify:
To change the economic activities	☐ Do not know how to change ☐ No policy to support for new activities (such as ……………) ☐ ☐ Others, please specify:
To change the job	☐ Do not know what to do ☐ No policy to support for new job (such as …………………..) ☐ Others, please specify:

4.2. Did City government/local government support to upgrade the residential area?

☐ Yes ☐ No

4.3. If yes, what parts of the residential area had been supported?

Part of support	Total cost (thousand vnd)		More information
	By City government	By local government	
☐ Streets			
☐ Alleys			
☐ Drainage system			
☐ Water pipeline			
☐ Electric line			
☐ Others: ……………			

4.4 Did City government, local government or community support to household?

☐ Yes ☐ No

4.5. If yes, what parts of the impacts had been supported?

Part of support	Total cost (thousand vnd) by			More information
	City government	Local government	Community	
☐ Housing upgrading				
☐ Loss of housing materials				
☐ Loss of housing equipment				
☐ Loss of vehicles				
☐ Drainage & sanitation				
☐ Water problem				
☐ Electric problem				
☐ Others: ……………				

4.6. Other supports from government:

a. Job loss: ....

....

b. Loss of economic activities: ....

....

c. Others, please specify: ....

....

IV. Suggestion from Household

5.1. Do you want to move to another area for living? ☐ Yes ☐ No

5.2. If yes, where would you want to move?

Place to move: ....
Reason to choose this place: ....

5.3. If no, why don't you want to move? Please give at least one option.

☐ Land of parents	☐ Have stable jobs here	☐ Children learn/study here
☐ Do not know where to go	☐ No paper to sell the house	☐ Other: ……………………..

5.4. Do you think what should the City government or local government do for people or household in flood areas?

☐ Financial support to upgrade the house and repair housing materials
☐ Financial support to fix the housing equipment or furniture
☐ The place to move
☐ Others, please specify: ....
....

--------------------------- **Thank you very much for your cooperation!** ----------------