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# Adaptation to flood risks in Ho Chi Minh City, Vietnam

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## Abstract

**Purpose** – This paper aims to present part of the research results in developing an adaptation process to cope with flood risk in coastal cities under the impact of climate change variability and rapid urbanization in Ho Chi Minh City, Vietnam.

**Design/methodology/approach** – Two main assessment tools applied in this research are rapid vulnerability assessment and tool for environmental assessment and management.

**Findings** – Under the same natural conditions, people living in more urbanized districts suffer with more inundation and risks from polluted floodwater than those who live in less urbanized districts. Notwithstanding, people in lower urbanized districts are more vulnerable since they have a low capacity to cope with flood and pollution due to flood-prone living conditions, poverty and lack of awareness on the changing variability and water pollution. Gender analysis in this research has found that men and women play different roles in coping with hazards, and women suffer with more risks than men especially in term of health, sexual harassment, and increasing responsibility.

**Practical implications** – The adaptation process should focus on integrating vulnerability assessment findings appropriately with the assessment tools and gender analysis in order to develop as well as implement adaptation measures effectively and efficiently. This adaptation process should also be applied for other countries having different contexts of development under different levels of projected climate change-related risks.

**Originality/value** – This research contributes in developing the process on adaptation to possible hazards related to climate change, especially for coastal communities of Vietnam and developing countries where the urbanization process is increasing rapidly.

**Keywords** Global warming, Environmental management, Floods, Vietnam

**Paper type** Case study

## 1. Introduction

Coastal areas are generally at risk subject to possible impacts from climate change. According to Yanagi and Akaki (1994), together with the global sea level rise in region and the world, the Southern of Vietnam is affected by South China Sea that will increase the water level up to 13 cm in year 2030 at the rate 2.56 mm/year (Pham and Furukawa, 2007), making the country becomes one of the most vulnerable countries to sea level rise (Dasgupta *et al.*, 2007). Moreover, there are increase and trend in population growth in Ho Chi Minh City (HCMC), which is expanding their living in low land areas (International Strategy for Disaster Reduction, 2005) making the city faces rapid population growth within a limited land and resources that may affect HCMC in its development.

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As many other large cities in developing countries, HCMC is facing challenges in developing a better knowledge of the interrelations and social dynamics of flood risk perception, preparedness, vulnerability, flood damage, and flood management (Asian Development Bank (ADB), 2008; Messner and Meyer, 2005), leading to the lack of policies and long-term strategies; absence of appropriate legal framework; inadequate institutional arrangements; ineffective flood forecasting and warning; limited community participation; absence of mechanisms for information/data collection and exchange; and inadequate environment concerns.

Currently, ADB is concerning about the impact of climate change to Southeast Asia (SEA) including identifying the matter of climate change in SEA, adaptation to enhance resilience, mitigation to contribute to global solution, and some ways forward (ADB, 2009). Therefore, in the case of Vietnam, ADB is supporting an analysis of climate change impacts and options in HCMC in cooperation with the World Bank and the Japan Bank for International Cooperation, working with relevant government agencies to better understand the economic, social, and environmental impacts of climate variability and change, and associated vulnerabilities of the urban community, especially the poor, to such impacts; and the need to adapt urban infrastructure to mitigate these impacts and protect urban population (ADB, 2008).

The main concept used in this paper is the relationship among hazard, vulnerabilities to that hazard, and capacities to cope with that hazard in order to reduce the vulnerabilities and enhance the adaptation capacities. This relation is determined as following formulation, meaning that reducing the risk to disaster requires a clear identification of hazard and its potential consequences; measures to reduce the vulnerability; and actions to increase the capacity to adapt and adjust to the impacts of hazard:

$$Disaster\ Risk\,(DR) = Hazard\,(H) \times \frac{Vulnerability\,(V)}{Capacity\,(C)}$$

Besides, vulnerability-capacity assessment (VCA) (Benson and Twigg, 2007) and adaptation policy assessment framework (United Nations Framework Convention on Climate Change, 2005) are key components of disaster risk analysis since it helps in identifying vulnerable groups and factors that make them vulnerable and how they are affected; as well as assessing their needs and capacities, therefore, used for developing adaptation process as main objective of this research. According to this, the exposure and sensitivity of any hazard should be identified to determine its impacts. Based on the identified impacts and understanding of current adaptive capacity, the vulnerability to risks can be determined and assessed. Moreover, after assessing the vulnerability and adaptive capacity to a particular hazard related to climate change, the results can be used to assess the risk to that hazard in order to develop appropriate adaptation measures and strategies to cope with adverse consequences.

As part of the adaptation process development objective, this research was limited in studying the negative impacts of rapid urbanization to environment, particularly water resources management under the changing climate and unplanned urbanization causing urban floods in HCMC; hence leading to impacts on human health and livelihood. There was also limitation in using tools for vulnerability assessment and adaptation evaluation; therefore, the simplest tools were used including rapid vulnerability assessment (RVA) adapted from (ZVAC, 2007, 2008) and tool for environmental

assessment and management (TEAM) developed by the United Nation Environmental Protection Agency (Julius and Scheraga, 1999).

## 2. Methodologies

Based on study from literature about the need to have effective adaptation measures, the approach of this research is to develop the adaptation process, using two communities in HCMC as cases to test the process in order to come up with lesson learned and improvement for the adaptation process.

According to the conceptual framework developed in this research (Figure 1), coastal urban areas under the socio-economic development context are damaged by climate change and rapid urbanization, causing vulnerability of coastal urban areas to climate-change-related risks. These vulnerabilities were determined after working on the literature review and finally focus on the vulnerability of water quality and human being to flood. RVA was conducted for the water resources vulnerability, its interaction with human health and urban environmental factors. The adaptation to urban flood risk together with the prevention, preparedness, mitigation, and response to flood risks were determined appropriately with the partial decision support by TEAM in developing adaptation process to minimize these vulnerabilities towards sustainable development for urban coastal areas.

Primary data collected by focused-group-structured-interview to residents in study areas through RVA to understand their awareness on regular and recent unexpected floods, their vulnerability and adaptation capacity to floods, and determine what changes have been taken place in term of urban environmental management within their communities recent years. The fieldwork data collection had been done within

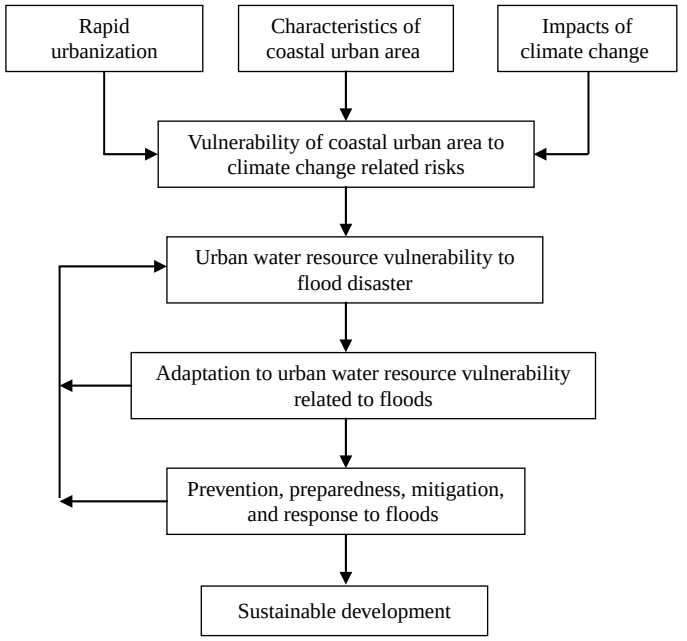



**Figure 1.**
Conceptual framework

five days for 40 households in two communities of District 2 (Thao Dien Ward) and Binh Thanh District (Nguyen Huu Canh Street, Ward 22) with male and female interviews to ensure gender equity in getting information for the research. Secondary data about impacts of floods to the city, existing flooding management, adaptation capacity against vulnerability; and methods to prevent, prepare, mitigate and respond those disasters and hazards that was collected by document review and individual unstructured questionnaire interviews with experts/staffs in related agencies.

Based on information from data collection, data analysis had been done in terms of vulnerability assessment of surface water resource (quantity and quality) and human (health, access to services, transportation) to floodwater and pollution. The analysis results were applied in assessing appropriate adaptation measures to flood risks in HCMC. Moreover, from primary and secondary data collected, the analysis of their current adaptation capacities and determination of factors affecting these adaptation capacities had been finished to provide inputs in using TEAM to conduct adaptation strategies for water resources management under the impacts of flood.

The study area was limited within HCMC especially districts that have regular floods as a natural disaster and the pollution as man-made hazards. Binh Thanh District and District 2 were chosen as representatives for HCMC since these two districts are located close to the Saigon River that is affected directly from river tides and other natural changes. The other reason but not least important for this choice is that Binh Thanh District represents urban district with rapid urbanization and District 2 represents semi-urban district with slow urbanization (Le, 2007). The studies on these districts with different levels of urbanization (Tables I and II) helped to clarify the impacts of rapid urbanization on the urban environment, particularly water resources management and flood risk management, under the same natural conditions.

## 3. Results and discussions

### *3.1 Adaptation process to flood risk in the context of rapid urbanization and climate change*

The approach of developing adaptation process in this research (Figure 2) was based on the fact that most developing countries are lack of effective and efficient adaptation

| Criteria | Unit | District 2 | Binh Thanh district |
|---|---|---|---|
| Location | | Southeast area of east side of Saigon River | Central area of west side of Saigon River |
| Population | Persons | 145,136 | 446,397 |
| Population density | Persons/sq km | 2,917 | 21,674 |
| Total number of ward | Wards | 11 | 20 |
| Total area | $Km^2$ | 49.74 | 20.8 |
| Topography | m | $\leq 1.5$ | $\leq 2.0$ |
| Natural land surface | $Km^2$ | 15 | 3 |
| Total number of road | Roads | 120 | 290 |
| Number of flooded road | Roads | 30 | 116 |
| Total number of houses | Houses | 30,000 | 110,000 |
| Number of flooded houses | Houses | 6,000 | 33,000 |

**Source:** Data collected during interview (2008)

**Table I.**
General characteristics of two focused districts

| Criteria | Community in District 2 | Community in Binh Thanh district |
|---|---|---|
| Location | Along Thao Dien Street | Along Nguyen Huu Canh Street |
| Household size | 6 | 4 |
| Gender ratio (F/M) | 1.04 | 1.06 |
| Average income per household (USD) | 100 | 200 |
| Highest education | High school | University |
| Occupation | Commercial activities, domestic construction and transportation | Commercial and industrial activities, industrial construction and transportation |
| Environment | Solid waste, air pollution (construction), domestic wastewater | Solid waste, air pollution (construction and transportation), domestic and industrial wastewater |

**Source:** Data collected during interview (2008)

**Table II.**
General characteristics of selected communities

measures to climate change-related risks, as well as challenges in integration adaptation into policy processes (ADB, 1991; IPCC-TGICA, 2007). The adaptation process has three main phases of determining and assessing vulnerability and adaptation capacity, identifying adaptation options, and assessing adaptation strategies in order to develop recommendation.

The adaptation process has taken the case of flood in HCMC started with first phase of determining the consequences of rapid urbanization in HCMC; identifying the potential impacts of climate change; understanding the current social, economic, and environmental situation of HCMC along with identifying the impacts of floods to the city by determining subjective and objective factors causing floods. The next step of this stage was to determine direct vulnerabilities to society (including human health, infrastructure, and transportation) and environment (in term of water resources), therefore, determine indirect vulnerability to the economy. This process also deals with identifying adaptation capacity to cope with those vulnerabilities, as well as determining challenges to the adaptation. This phase was support by using RVA tool together with judgment from HCMC's experts and secondary data collected from related agencies such as HCMC Environmental Protection Agency, HCMC Flood and Storm Prevention Agency, Department of Natural Resources and Environment, HCMC Department of Transport and Public Works, Institute for Economic Research, etc.; as well as primary data interviewed from focused communities.

Based mostly on HCMC's experts' judgment and secondary data (from both related agencies and literature), the above phases included identifying list of adaptation options and choosing candidate adaptation measures that are most appropriate for the conditions of HCMC, especially in terms of effectiveness and efficiency in planning and implementation to achieve the objectives. After having results of vulnerability and capacity assessment by using RVA, the third phase was to prioritize candidate adaptation measures by using TEAM to evaluate those measures in considering performance criteria such as:

- effectiveness;
- expense;

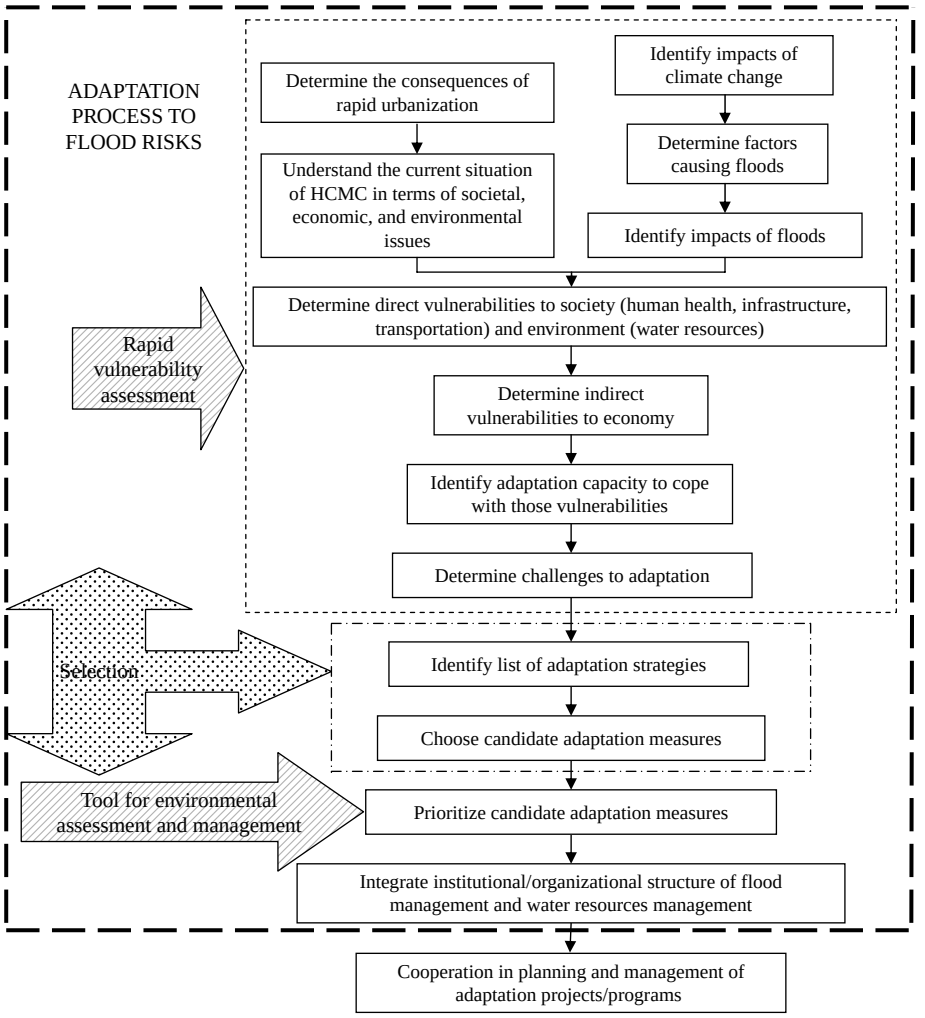



**Figure 2.**
Adaptation process to flood risk

- environmental impact;
- consistency;
- feasibility;
- urgency; and
- robust/flex.

The use of TEAM was simplest tool to access the candidate adaptation strategies; however, more analysis should be done to effectively use the assessment tool for evaluating strategies to cope with flood risks under climate change and rapid urbanization.

*3.2 Flood hazard*

Based on the approach of adaptation process, this research has identified the hazard of flood in HCMC due to its natural lowland (altitude less than +2 m) under inadequate infrastructure system particularly road and drainage system especially when there is high tidal and rains. The climate variability has affected the weather in HCMC, increases the magnitude of rainfall especially the occur of rains in dry seasons, raise the tidal water level, leading to more and more flood occurred in the city. Moreover, impact from South China Sea tide with increasing in the river water level cause difficulty for irrigation in lowland areas. In other hand, beside some benefits, the rapid urbanization process in HCMC has lead to inadequate environmental and infrastructure systems, reduce the natural irrigation of land surface due to lack of good governance in urban planning and management.

In two study communities of District 2 and Binh Thanh District, the risks from urban flood under climate change in District 2 is lower than in Binh Thanh District due to lower levels of urban development. The District 2 is affected by flood and pollution since domestic wastewater is discharged into canals without any treatment. People in District 2 can be divided into two main groups. The first group includes rich people living in resorts and high buildings with good environmental services including new drainage system and high background construction to prevent flood and high tide. Living in lower land with un-upgraded road and drainage system, poor people who did not sell their lands and move to another place, have to live in informal houses under the effects of pollution and flood due to rains and high tides. Therefore, poor people are likely to be more affected by polluted water when flood occurs.

There is no clear difference in term of impacts from flood to residents living in Binh Thanh District since rich and poor are merged together in the community, unless their houses are located in safe area or strengthened to prevent from tide and floodwater. Different from District 2, most of the drainage system in Binh Thanh District is very old and overloaded, and also was blocked by solid waste and garbage that increase the risk of the community to polluted water mostly from industrial activities when inundation occurs. In these two districts, women, children under six year-old and the elderly especially in poor communities seem to be more affected when flood occurs because they stay at home most of the time and have to struggle with floodwater and inundation.

*3.3 Vulnerability assessment*

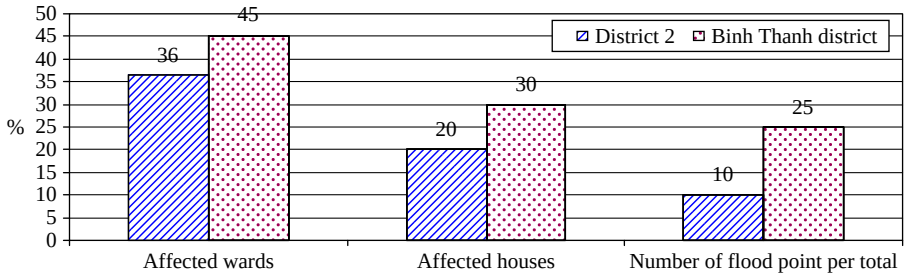
By applying rapid assessment in assessing the vulnerability, this research found that HCMC is vulnerable to climate change under the context of adverse rapid urbanization in terms of urban environment, social factors, infrastructure, water resources, water sanitation, and human health, etc. Moreover, this research also determined factors influencing these vulnerabilities, not only natural but also man-made factors. There is high vulnerability of water resource to flood in terms of quality and quantity since the water in main waterway systems has been polluted while the old piped drainage system has low capacity to cover the wastewater and water flow from development activities and rapid urbanization process. The quality of water supply sources will be more vulnerable, thus leading to the lack of pure water quantity for human utility in the whole city.

*3.3.1 Impact of flood on social factors*. This research has found different vulnerabilities between District 2 and Binh Thanh District in term of social vulnerability, especially

vulnerability of different groups of people (rich and poor) living in vulnerable areas (Figure 3).

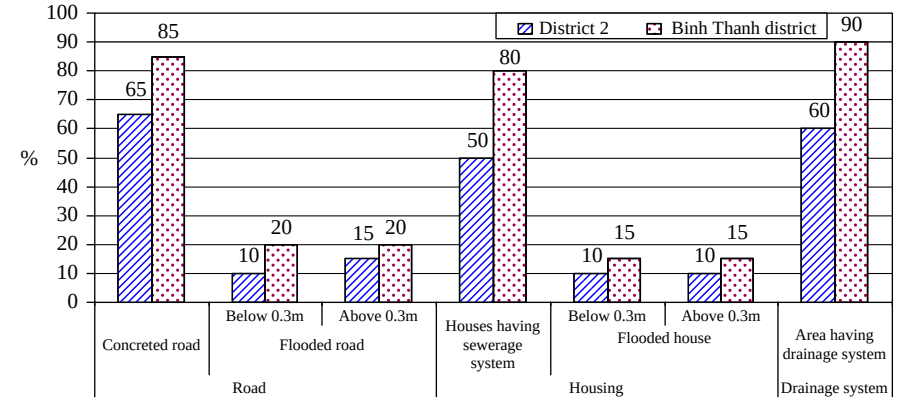
These vulnerabilities are increasing under the impact of rapid urbanization and concretization, reducing the natural condition and environment, and have caused inequity in terms of facilities and services among residents. Poor people with lower living conditions become more vulnerable to flood risks. Even there is less pollution than Binh Thanh District; poor people in District 2 have to face domestic wastewater discharged into canals since there is lack of environmental services within their communities. Besides, rich and poor people live integrated in Binh Thanh District that they experience the same infrastructure condition. However, rich people in Binh Thanh District may not face inundation in their houses since they increase the height of the ground.

*3.3.2 Impacts of flood on infrastructure*. The impacts of flood on infrastructure are easily to be observed. The number of road/land that are concretized, number of household having sewerage system, and number of area having drainage system are some indicators to assess the vulnerability of people to flood in the context of existing living condition. According to results from RVA, Binh Thanh District is more vulnerable to flood than District 2 in terms of road, housing, and drainage system (Figure 4). Having more land and road that are concretized, Binh Thanh District has more flooded road below and over 0.3 m – the water level at which human transport and movement are obstructed. Although Binh Thanh District has more household with




**Source:** Data analyzed from interview (2008)

**Figure 3.**
Impacts of flood on social factors




**Source:** Data analyzed from interview (2008)

**Figure 4.**
Impacts of flood on infrastructure

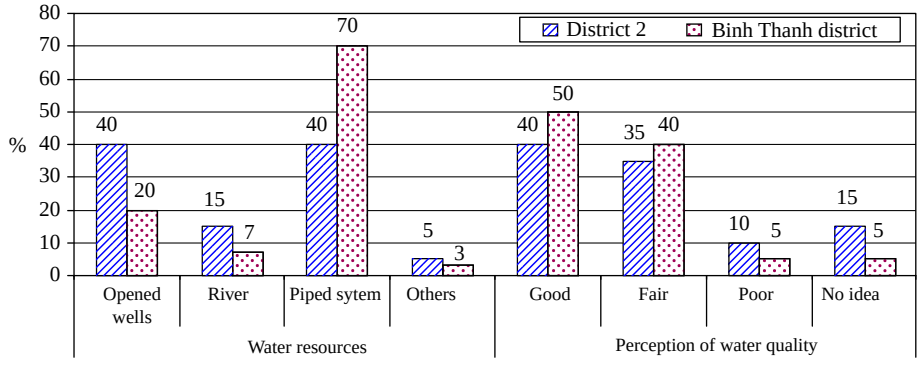
sewerage system and more drainage system, records show that more houses are flooded in Binh Thanh District rather than District 2. Water level at 0.3 m is chosen because above that level, people are more vulnerable to polluted floodwater in terms of their properties, health, and also risk from electrocution.

*3.3.3 Impacts of flood on water sanitation and health.* Interviewing people in chosen communities, there were different perspectives about the impacts of flood to water quality and their health. Different groups of people have different options for water utility. Rich people use pure water from piped water supply system, basically treated in septic tank, and discharge wastewater into sewerage system, through drainage system and to the Saigon River. Poor people mostly use water from wells (either protected or unprotected) and river, and they discharge wastewater directly into canals and Saigon River without any treatment. Therefore, poor people are more vulnerable to floodwater and pollution when flood occurs. However, in some ways, the vulnerabilities of rich people are also increased due to pollution caused by poor people. In other words, poor people create their own vulnerabilities because of low capacity, thus leading to increase in vulnerabilities of rich people. Their perception about water quality and risk from water contamination to health is still low because they are not really aware that polluted floodwater may damage their health (Figure 5).

Results from RVA showed that both communities are vulnerable to water pollution because they have to face regular flood bringing polluted water closer to their lives, and lack of health facilities as well as access to existing facilities. Residents in Binh Thanh District seem to be more aware about water pollution and impacts on health, while people in District 2 have to live more vulnerable but less health facilities (Figure 6).

*3.4 Adaptation capacity assessment*

In order to know the perception of people to flood risks in their areas in terms of frequency, intensity, possible impacts, and their vulnerabilities; a list of questions were asked in the RVA of data collection period. This research also assessed the adaptation capacity of community and organization/institution to flood risk. According to the interview, residents in the focused communities, they are concerned about their properties, access to services, and transportation and communication rather than health impacts when flood occurs. Therefore, their basic adaptation solutions were to prevent and reduce




**Source:** Data analyzed from interview (2008)

**Figure 5.**
Impacts of flood on water sanitation

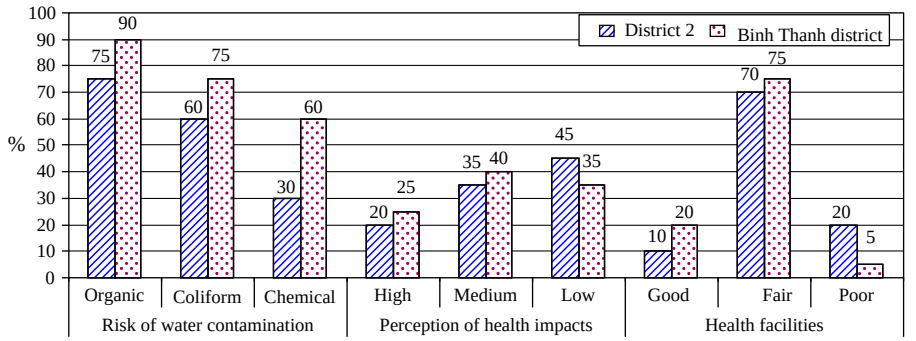



**Figure 6.**
Impacts of flood on health

**Source:** Data analyzed from interview (2008)

floodwater flow into their houses by sand bag barriers or concreted walls in order to priory protect their properties, rather than protecting water resources from flood. Low awareness in preventing water supply resources from pollution also challenge the adaptation capacity in pollution prevention and flood risk mitigation. Moreover, this research also determined factors affected adaptation capacity of two focused communities in study areas of HCMC that are: living condition (location, housing, and infrastructure condition), occupation, traditional living culture, physical ability (gender, age), and their poverty (income). Because of these reasons, people are not aware of pollution and flood risk; therefore reduce their capacity to adapt to flood related risks.

Beside, one of the most important issues that limit the organizational adaptation capacity at city level is the lack of appropriate attention and investment to make changes in reducing and minimizing flooded points. Moreover, this research identified the organizational/institutional factors that affect the adaptation capacity to flood risk in HCMC as well as the actual capacity in adapting to flood risk and water pollution issues, including economic activities of the city, organizational structure in developing project management, legislation, as well as administrative structure and institutional arrangements.

### *3.5 Adaptation measures to flood in HCMC*

After determining what systems, places, people that are vulnerable and why; the next steps were to develop appropriate and effective adaptation options to reduce the vulnerabilities and risks; assess and evaluate potential adaptation measures; choose preferred adaptation measures; develop action plans that contain a portfolio of adaptation measures and incorporate means to address barriers to adaptation, as well as how to implement and monitor the adaptation measures for effectiveness and for further reassessment and development of those measures. Multi-attribute approach used in TEAM is method used for this research to evaluate different adaptation strategies on a wide range of attributes and to prioritize objectives while evaluating strategies.

By understanding the vulnerability and capacity to flood risks, there would be clear understanding on how to choose appropriate adaptation measures to prevent, reduce, mitigate, and respond to flood risk in HCMC. The vulnerability assessment results from applying RVA were integrated into TEAM as inputs and information for further selecting and evaluation appropriate adaptation strategies. After analyzing the candidate strategies

based on their effectiveness in solving problems of water supply, irrigation, water quality, and flooding; as well as their performance on effectiveness, expense, environmental impact, consistency, feasibility, urgency, and robust/flex; TEAM helped in prioritizing the adaptation strategies as follows:

- Enhance water efficiency and conservation/protection programs: to increase the efficient use of water and reduce the water pollution.
- Create and improve floodwater and rainwater storage facilities: to reduce the water overflow and reuse rainwater for irrigation and other utility purposes.
- Improve water treatment: update the wastewater treatment facilities together with treatment regulation for industrial zones, buildings, and households before discharge wastewater into canals/river.
- Urban planning and infrastructure development: consider flood risk in land use planning and the design of new projects in HCMC; improve the infrastructure (mainly road and drainage systems) to increase the infiltration capacity and decrease the water overflow in the urban landscape.

## 4. Conclusions and recommendations

### *4.1 Conclusions for improvement*

This research contributes in developing the process on adaptation to possible hazards related to climate change, especially for coastal communities of Vietnam and developing countries where the urbanization process is increasing rapidly. Generally, the adaptation process takes into account the understanding of current situation and impacts of climate change-related risks, determining direct and indirect vulnerability to these hazards, selecting and evaluating appropriate adaptation measures for short-term, medium-term and long-term solutions in coping with hazards, especially in the context of coastal cities and water resources management under climate variability. The adaptation process developed in this research is considered as part of mitigation since it recommends measures not only to adjust to risks but also to minimize the impacts from risks by looking at higher level for long-term strategies.

This research has developed better understanding on the vulnerability of representative communities in different levels of urbanization to flood risk as well as their adaptation capacity under the same natural conditions. It was found out that HCMC, due to its location near Saigon River, is vulnerable to flood under the impacts of climate change especially South China Sea level rise in relations with rapid urbanization in the city that increase its own vulnerability, to water resources, human health and livelihood in particular, as well as economic activities. Moreover, this research has contributed for better understanding on the theme "Vulnerability, impact, and adaptation assessment" identified by Great Lakes Water Quality Board for researches on climate change, beside monitoring, surveillance, and analysis; climate change scenarios; model development; economic assessment; adaptation; and communication.

### *4.2 Recommendations*

It is better to have the combination of tools support for particular sectors in order to fulfill some limitation of adaptation process in term of applying TEAM because it is not a powerful tool for vulnerability assessment but it is good for decision-making process. Therefore, in order to effectively use TEAM, multiple disciplines are required

to participate in the decision-making process from the beginning; involving of people from different backgrounds to understand the feasibility of different options and for providing an overall sense of the importance of different criteria in the policy-making process. Furthermore, stakeholders' participation especially women with deeper cross-checks is needed to reduce the manipulation in using this tool.

The adaptation process including the VCA can be applied for other countries having different contexts at different levels (from national and/or program level to community and household levels) under different projected climate change-related risks. Moreover, it can also perform a range of functions in scoping and screening, baseline studies, as well as in monitoring and evaluation of projects. This process should be supported by additional effective tools that require good baseline data, higher trained skills and finance such as multiple vulnerability assessment tool and benefit-cost-effectiveness analysis.

The HCMC Government should cooperate with local government and other related agencies in providing warning systems to inform people about the flooded road line to avoid congestion, especially during out-of-work time. Not only considering the vulnerability of surface water resources to flood risks, there is also a need of further research about the impacts of flood to groundwater resources, especially at the shallow level; mostly direct impacts from flood to surface water quality, and direct effect from surface water quality to groundwater quality.

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