MASTER'S PROGRAMME IN URBAN MANAGEMENT AND DEVELOPMENT

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ADAPTATION RESPONSES TO TIDAL FLOODING IN SEMARANG, INDONESIA

Dian Harwitasari
Indonesia

Supervisor:
J.A. van Ast
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Summary

Tidal flood has been threatening Semarang for many years. It occurs periodically due to high tide. The flood has been raising many problems especially in Semarang coastal areas. The flood is worsened by sea level rise due to climate change and land subsidence caused by over exploitation of ground water and the load of constructions. Based on this condition, tidal flood in Semarang is predicted to broaden and inundate not only to the coastal areas, but also the outer coastal areas. This situation increases the risks of tidal flood. Adaptation is needed to respond and to reduce the vulnerabilities due to tidal flood. Moreover adaptation is also needed to react and to anticipate present and future effects of tidal flood.

The study focused on two objectives : defining adaptation responses in order to deal with the negative effects of present tidal flood in Semarang and assessing the adaptive capacity in dealing with the increasing tidal flood.

This is an exploratory case study based on primary and secondary data. The primary data were collected through observational study, questionnaire and semi structured interview. Literature review and contextual data from the Semarang city government were used to extract secondary data. A sample size of 110 was chosen with 60 questionnaires administered to the respondents of inhabitants in present inundated area, and 50 questionnaires administered to the respondents of inhabitants in predicted inundated area. The selection of respondents was based on purposive sampling methods. Semi structured interviews were conducted to Semarang Water Management Agency, Semarang Planning and Development Board, Semarang City Planning Agency, Head of District and Sub District Offices in present inundated areas.

The findings of the study indicated that the tidal flood occurs periodically in 6 sub districts in Semarang and affects the social, economic and environmental problems of the inhabitants. The inhabitants have been suffering for more than 8 years. Usually the flood inundates 4 – 9 times a month. Moreover whenever the flood occurs, it inundates within 24 hours with 0.5 meter height. The worst floods ever happen is when the flood occurs for 1 week and in 1 meter height. Together with the city government, the inhabitants in present inundated areas have been doing adaptation responses to deal with the effects of tidal flood. They develop some adjustments on their houses and on their neighbourhood areas. Meanwhile the city governments place the tidal flood management as a part of flood management in Semarang, which are also focused on dealing with river floods and local floods. The city governments develop planning, management, institutional and also physical measures to cope with the flood problems. Moreover the flood that is predicted will inundate broader areas of Semarang. The people in present and predicted inundated areas and the city government can prepare for the future tidal flood to cope with the expected effects. The ability of adaptation and coping with the future risk of tidal flood is assessed by their economic resources, information and skills, infrastructures, technology and access to resources. As being assessed, the people in present and predicted inundated areas and also the city government are prepared to respond to the future risks of tidal flood. However

they still need to enhance their adaptive capacity especially in order to reduce the vulnerability of low income people.

In summary, adaptation is needed to cope with the effects of tidal flood. The responses are reactive in responding to the present impacts. Meanwhile proactive and implementation of measures in advance to reduce future risks of tidal flood are needed. The ability of people and the city government in dealing with the increase tidal flood depends on their adaptive capacity. Consequently, vulnerability to tidal flood will be decreased by implementing adaptation responses to present impacts and enhancement of the adaptive capacity to react and to cope with future impact.

This research leads to with recommendations to improve the adaptive capacity of the city government and the people to cope with the present and increasing tidal floods. The recommendations are developing Integrated Coastal Management with the aim to protect the coastal areas which in accordance with the Semarang spatial planning and the flood management. Furthermore building capacity for community and the city governments' staffs, initiating financial access for low income people to finance their adaptation responses, and develop financial scheme to fund the flood infrastructures.

Key words : tidal flood, adaptation responses, adaptive capacity

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Dian Harwitasari
Rotterdam – The Netherlands

Abbreviations

WMA	Water Resources Management Agency
PDB	Planning and Development Board
ICM	Integrated Coastal Management
IPCC	Intergovernmental Panel on Climate Change

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CHAPTER 1 INTRODUCTION

1.1 Background

Floods are one of the most threatening natural disastrous phenomena for human societies (United Nations, 1976). Floods can happen in small and large river basins, in estuaries, at coasts and locally. Several causes are responsible for this occurrence of floods for example winter rainfall floods, storm surges, tidal floods, tsunamis, rising ground water floods, urban sewer floods or dam break floods (Penning-Rowsell and Peerbolte, 1994). Floods usually happen in low lying areas like coastal areas which is called coastal flooding. Doornkamp (1998) and Douglas, et.al (2009) mentioned that coastal flooding occurs from a combination of high tides and high river flows inland and is correlated with large low-lying areas such as deltas, the major river inlets, area of dominant coastal wetlands and areas experiencing subsidence on a large scale.

Climate change will increase the risk of flooding in coastal area. According to Nicholls (2004) & Munangsihe & Swart (2005), the estimates of global mean sea level rise in the Special Report on Emission Scenarios of the Intergovernmental Panel on Climate Change (IPCC) range from 22 cm to 34 cm between 1990 and the 2080s, caused primarily by thermal expansion of the ocean and to lesser extent the melting of glaciers. It has also been predicted that a sea level rise of 38cm would increase fivefold the number of people flooded by storm surges (Nicholls, et.al, 1999). However, accelerated sea level rise will deepen the stress of the coastal area, causing flooding of coastal lowlands, erosion of sandy beaches, and destruction of costal structure (Snoussi, Ouchani & Niazi, 2008). The impacts of coastal flooding by sea level rise obviously occurred mostly on low-lying coasts. The risks of flood are increased by some features of urban development (McGranahan, et.al, 2007). In delta regions, land subsidence due to water withdrawal and reduction in the rate of sediment deposition can increase flood risk. High urbanization and rapid development in coastal area is also a push factor of land subsidence. Moreover combination of land subsidence and sea level rise increase the risk of flood.

In the large cities of low elevation countries, many people live in areas at risk to flooding (Hardoy, et.al., 2001). To illustrate, about 10 per cent of the world's population and 13 per cent of world's urban population live in low elevation countries (McGranahan, et.al, 2007). According to IPCC (2001), human settlements are vulnerable to effects of climate change. The effects of climate change to human settlements are through economic sectors, through impacts on infrastructures and through impacts on people's health. Floods due to sea level rise and storm surges contribute the most direct risks to human settlements in coastal areas. Floods could be serious problem when it happens in the urban areas where drainage infrastructures are inadequate and lack of adaptive capacity.

Nowadays, reducing vulnerabilities of climate change has become an urgent issue, especially in low and middle income countries. Adaptation to climate change is a process when a system, individuals and communities seek to reduce vulnerability or enhance resilience in response to observed and expected changes due to climate change (McCharthy, 2001; Adger, et.al, 2007). In many low income and middle income countries, adaptation is the immediate priority in response to climate change impacts. According to Adger, et.al (2007), adaptation involves changes in social and environmental processes, perception of climate risk, practices and functions to reduce potential damages or to realize new opportunities.

Indonesia is one of the vulnerable countries due to profound flooding, and one of most hazardous floods is the coastal flood. Many coastal cities in Indonesia are vulnerable due to coastal flood. Semarang, one of big cities in Indonesia has been suffering from coastal floods for years. Coastal flood in combination with high tide due to tidal movement, wave action and accelerated sea level rise due to climate change cause tidal flood (Marfai & King, 2007). Tidal flood in Semarang is also worsened by land subsidence, due to over exploitation of ground water and rapid development in Semarang coastal area. Combination of sea level rise and land subsidence in increases the risks of tidal flood in Semarang coastal areas.

It should be noted that tidal flood affects city infrastructures surrounding coastal areas. The coastal settlements are the most affected areas because their physical and environment circumstances are affected. This situation therefore threatens the community, household and individuals simultaneously. Adaptation is needed therefore to response and to reduce the vulnerabilities and impacts due to tidal flood. Adaptation depends on the location where people live, the structures of their economic system, and how they derive their livelihoods. Some adaptation measures will be reactive, responding to the impacts as they occur, while others will be proactive and implemented in advance to reduce future climate risk and vulnerability (Smit & Pilifofa, 2001). Tidal flood in Semarang is predicted will broaden to outer of coastal areas of Semarang (Wibowo, 2006). This situation increases risks and vulnerabilities of people living in those areas. Consequently adaptation to flood in Semarang could be both reactive and anticipatory, which means to react the impacts already happened and anticipate the potential impacts if tidal flood. Even when impacts of climate change are not yet noticeable, scenarios of future impacts may be of sufficient concern to justify building some adaptation responses into planning (Adger, et.al., 2007). Adaptation depends on the adaptive capacity or adaptability of affected system or community to cope with the impacts and risks climate change. The adaptive capacity of communities is influenced by their socioeconomic. Enhancement of adaptive capacity can reduce vulnerabilities and impacts of climate change, and also promotes sustainable development (Adger, et.al. 2007).

1.2 Problem Statement

Tidal flood has been threatening Semarang coastal areas for years. It occurs periodically due to high tide, it is worsened when the high tide reach to High Highest Water Level (HHWL). According to Wibowo (2006), the High Highest Water Level occurs only in certain months whenever the earth is in the closest position to the sun, and as a result the sun's power raises the tide to the maximum condition.

The flood is worsened by sea level rise. According to WWF Indonesia and IPCC (1999), the sea level in Indonesia is predicted will raise from 20 cm to 100 cm in 100 years due to increased sea water temperature from 1.3^0 C to 4.6^0C in year 2100. In line with that, the coastal flooding in Semarang is also worsened by land subsidence. Land subsidence is caused by over exploitation of ground water and load of construction from major industrial estate and economic activity which mostly are located in coastal areas. Moreover, land use conversion in coastal area also affects the land subsidence. High urbanization and high population forces embankments, swamps and fields as catchment areas develop into industrial and settlement areas. For the last 20 years, embankments, swamps and fields have been decreasing around 1200 ha (Wibowo, 2006). Increasing of sea level rise does not balance with the catchment areas and it cannot be soaked up by the industrial and settlement

areas, consequently it inundates the areas. Due to land subsidence and sea level rise, the tidal flood in Semarang is worse every year.

Coastal flooding has been raising many problems in Semarang coastal areas. Most of urban infrastructures located in coastal area such as roads, airport, central station, and harbor are damaged due to flood. Settlement along the coastal area are also affected by coastal flooding. Coastal flooding has been damaging many houses and many small and medium business enterprises, consequently impacts the social and economic sector. Moreover coastal flooding also endangers the environment quality in settlement areas. The sea water infiltrates the ground water and turn to be salty. Inundation periodically also affects to degradation of environment condition. The interrelation of causes and effects of tidal flood in Semarang can be seen in problem tree below

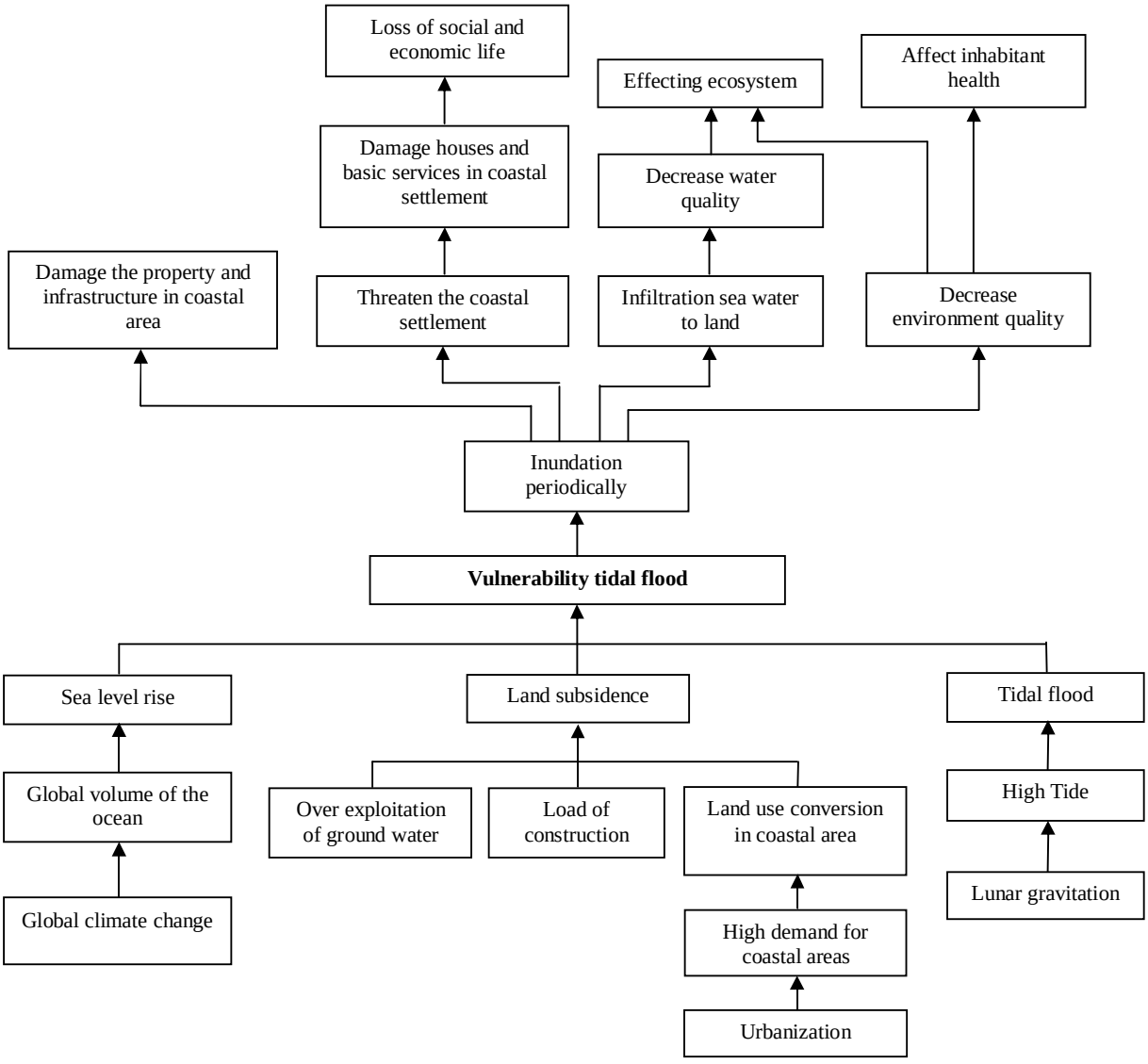

Figure 1 : **Problem Tree**

As described above, tidal flood in Semarang is predicted to be broad and will inundate not only to the coastal areas, but also to the outer coastal areas. Several number of settlement

areas which are not flooded yet, will suffer from tidal flood in few years later (Wibowo, 2006). This condition will threaten and increase risks to people live in flooded areas in the next few years. Adaptation is needed to react and to anticipate the effects of tidal flood which happens now and in the future. Therefore this research is focused on the condition and the effects of tidal flood in Semarang, and how the people deal with the flood so far. The prediction of tidal flood will increase awareness of people and the city government in anticipate the tidal flood.

1.3 Research Objective

The research objectives of this research are :

1. **To define adaptation responses in dealing with the negative effects of present tidal flooding in Semarang.**
2. **To assess the adaptive capacity in dealing with the increasing tidal flood in Semarang.**

1.4 Research Question

The research objective lead to the formulation of the following research question :
"How can be dealt with negative effects of current and increasing tidal flooding in Semarang coastal settlements?

Three sub questions are formulated from the main research questions, which are :

1. What is tidal flooding in Semarang?
2. What are the negative effects of tidal flooding in Semarang?
3. How to adapt to the negative effects of tidal flooding in Semarang?
4. How is tidal flooding predicted to develop in Semarang?
5. How are the adaptive capacities of Semarang in coping with the increasing tidal flood?

1.5 Description of the Research Area

The research areas are divided into two parts, which are the present inundated areas and the predicted inundated areas. The present inundated areas are in 6 sub districts (Sub district Tambakharjo, Tawangsari, Panggung lor, Bandarharjo, Tanjung Mas and Terboyo Kulon) within 3 districts which have been suffering the most inundation (Marfai & King, 2007). Meanwhile the predicted inundated areas are 5 more districts that will be inundated in year 2015 (Wibowo, 2006). Those are Distict Tugu, Semarang Timur, Semarang Tengah, Gayamsari, Genuk and Pedurungan.

1.6 Thesis Structure

This research comprises of six chapters. These chapters are as follows :

Chapter one, **'Introduction'**, introduces the research topic and the definition of problem. This chapter explains the need of this research to overcome the tidal flood in Semarang. The research objective and research questions are also presented in this chapter.

Chapter two entitled **'Adaptation Responses to Tidal Flooding'** reviews literature and theories on tidal flood, climate change, and adaptation to deal with tidal flood. This chapter is concluded with theoretical framework of adaptation to tidal flood.

Chapter three entitled **'Research Method'** gives an overview on how the research will be conducted. It also describes the method adopted to answer the research questions and the analysis of data.

Chapter four entitled '**General Description of Semarang City and Tidal Flood in Semarang'** gives an overview on condition of Semarang city and tidal flood Semarang in general.

Chapter five entitled **'Tidal Flood Condition and Adaptation Responses To Deal With The Present And Incerasing Tidal Flood'** describes findings of the research to answer research questions based on literature reviews and fieldwork.

Chapter six entitled **'Conclusions and Recommendations'** presents conclusions of this research based on the analysis and suggests recommendations to stakeholders involved in tidal flood issues.

CHAPTER 2 ADAPTATION RESPONSES TO TIDAL FLOOD

This chapter explains theoretical review related to the topic and based on the objectives of the study. Therefore it is related to different theories and concepts of coastal flooding especially, the impacts of climate change which is also related to coastal flooding, and practical experiences of some cities to deal with coastal flooding and the adaptation responses to deal with coastal flooding which are related to sustainable development and coastal management

2.1 Tidal Flood

2.2.1 The Overview of Tidal Flooding

Tidal flood is coastal flooding when it caused by high tide (Marfai, 2004). In many countries tidal floods are the damaging phenomena that affect the social and economic of the population (Smith and Ward, 1998). Generally tidal flood is a natural phenomenon happens when it is full moon. The sea water will inundate the land when high tide happens. Moreover it will worse when the highest high water level (HHWL) is reached. According to Hinton (2000), tidal hazards in coastal areas are composed of three parts :

1. Tidal current, which causes sedimentation along the coast. The speed and direction of currents is important for sediment movement, erosion, deposition, and pollutant dispersal.
2. Mixing of fresh-and saline-water when the extent of tides flows up rivers and other watercourses.
3. Tidal inundation includes the height of water level, extent of the tidal range and the duration of inundation.

As same as coastal flood, tidal flood is associated with large low-lying areas. The risk of tidal flood will increase due to sea level rise. Accelerated sea level rise will deepen the stress of the coastal area, causing flooding of coastal lowlands, erosion of sandy beaches, and detruction of costal management (Snoussi, Ouchani & Niazi, 2008). Coastal flooding is the result of infrequent extreme sea levels produced by storms or run off from the land. Moreover the risk zone of coastal flooding will expand time after time. The flood risk will increase within the existing floodplain either expand the floodplain landward (Nicholls, 2002).

2.2.2 Tidal Movement

According to Nontji (1993), tide is rise and fall in the level of the sea, and it caused by the pull of the moon and the sun. The tide always changes due to position of the sun, the moon and the earth which also always change. The time when the sea level has to its highest level is called high tide. Meanwhile the time when the sea level has to its lowest level is called low tide.

According to Nontji (1993), tide is categorized into 4 types, which are :

1. Semi diurnal tide is when high tide and low tide occur twice a day in a row with similar high. In Indonesia it happens in Malaka Strait.
2. Diurnal tide is high tide and low tide occur once in one day. In Indonesia it happens in Karimata Strait.
3. Mixed tide prevailing Semidiurnal, is when high tide and low tide arise twice in one day, but in different high and in different period. In Indonesia it happens in East Indonesia coast.

4. Mixed Tide Prevailing Diurnal, is when high tide and low tide happen arise once in one day, but sometimes occur twice a day in different high and different period. It usually happens in the north coast of Java island, Indonesia.

2.2.3 Sea Level Rise Due To Climate Change

Climate change induced by global warming will widely increase threats on the coasts. Global mean sea level rise results from an increase in the global volume of the ocean. Church et al, (2001), mentioned that sea level rise is primarily due to thermal expansion of the ocean as it warms and water from the melting of small ice caps due to human induced global warming during the 20^{th}-21^{st} century. The estimates of global mean sea level rise in the Special Report on Emissions Scenario (SRES), global average sea level rise will increase 0.09-0.88 m in the next century, caused by thermal expansion of the ocean and a to lesser extent the melting of glaciers (Munasinghe & Swart, 2005). Nicholls (2002) mentioned that sea level is expected to continue to rise beyond 2100 for hundreds or more years into the future, even the global climate is stabilized in the next few decades.

Higher air and seawater temperatures, sea level rise and changes in precipitation, tropical cyclones and marine conditions will all exert various impacts on the health of biophysical environment. Biljsma et.al (1996) stated that sea level rise would produce major impacts in coastal area, which are (1) inundate wetlands and lowlands, (2) erode shorelines, (3) exacerbate storm building and (4) increase the salinity of estuaries and threaten freshwater aquifers. Sea level has affected on flood risks, erosion of the coast and the degradation and destruction of coastal ecosystems. The sea level rise could have a profound impact in the incidence of flooding, the higher the total rise, the greater the increase in flood risk, and all other factors being equal (Nicholls, 2002).

2.2.4 Land Subsidence

Tidal flooding will be increase if there is land subsidence in the particular area. According to Sutanta et.al (2005), land subsidence occurs when the elevation of the land is lowered from its previous position, with respect to a fix height reference system. Land subsidence can be happened by either naturally or human activities or the combination of both factors. Vertical land movement will still be important, move particularly in areas subject to human induced subsidence. Land subsidence relative to sea level is caused by increasing number of human activity, extraction of underground water resources, land reclamation, load of construction and industrialization (Doornkamp, 1998).

Land subsidence can lead to many problems, including changes in elevation; damage to structures such as storm drains, sanitary sewers, roads, railroads, canals, levees and bridges; structural damage to public and private buildings; and damage to wells. Most commonly land subsidence is known for causing an increase in the frequency of flooding (San Jacinto River Authority, 2009).

2.3 Impacts of Tidal Flood to Human Settlements

2.3.1 Impacts of Tidal Flood Related to Climate Change

The impacts of tidal flooding can be associated with the impacts of climate change. Climate change has involved human and nature in many areas. Impacts of climate change are related

to vulnerability, which refers to the intensity of climate change may damage of a system (Houghton, 1997). Vulnerability is depend on a system's sensitivity and on its ability to adapt to a given change. Prasad et.al (2009) mentioned that the major implications of climate change can be structured in three categories, which are :

- Environmental, changes in coastal and marine system, forest cover and biodiversity
- Economic which threats to water security, impacts on agriculture and fisheries, disruption of tourism and reduced energy security.
- Social which are displacement, loss of livelihoods, and increased health problems, the greatest impacts would be on the poorest residents of cities and surrounding areas, such as slums in low lying coastal cities.

Climate change impacts has impacts in several areas which are health, agriculture and food security, forests, hydrology and water resources, coastal areas, biodiversity, human settlements, energy, industry and financial services (Munangsihe & Swart, 2005). The impacts of climate change can be seen in the figure below :

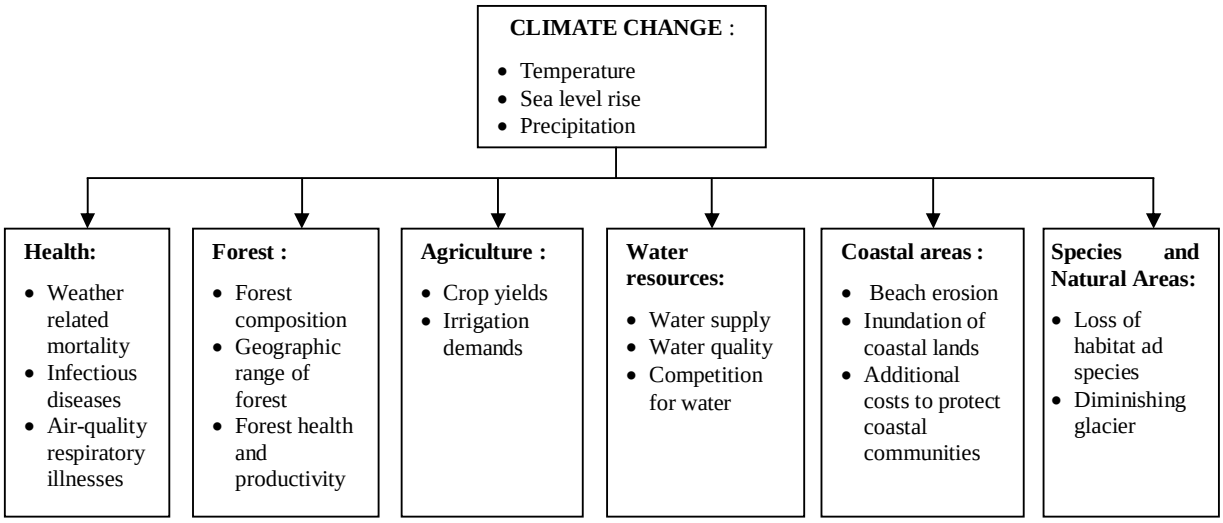

Figure 2: Potential impacts of climate change
Source : UNEP/ GRID in Munangsihe & Swart (2005)

The urban area inhabitant face huge impacts of climate change because concentrations of inhabitants in countries are in urban area. The impacts of climate change in urban areas can be seen on the table below :

Table 1: Impacts of Climate Change in Urban Areas

CHANGE	IMPACTS ON URBAN AREAS
Warm spells and heatwaves frequency	• Heat island with higher temperatures • Large concentration of vulnerable people • Air pollution worsened
Heavy precipitation events	• Floods and landslide risks up • Disruption to livelihoods and city economies • Damage to homes, business and infrastructures • Loss of income and assets • Displacement of population, with risks to social networks and assets

Increased area affected by drought	• Water shortages • Distress migration into urban centers • Lower rural demand for goods and services • Higher food prices
Increased incidence of extreme high sea level	• Loss of property and enterprises • Damage to tourism site • Damage to buildings from rising water table • Loss of livelihoods • Loss of coastal habitats

Source : IPCC, 2007

Human settlements which are most located in urban area are also affected by climate change. Human settlements are affected in the following three ways (Munangsihe & Swart, 2005) :

1. Changes in productive capacity or market demand for goods and services.
2. Physical infrastructure (including energy transmission and distribution systems), buildings, infrastructure and industries (e.g. tourism and construction).
3. Direct effect on population through extreme weather, changes in health or migration.

The general effects of climate change also happen in human settlements such as coastal flooding, precipitation, and sea level rise and also environment effects such as decrease of water quality. Moreover climate change and sea level rise would increase frequency and levels of sea flooding, accelerate coastal erosion and seawater intrusion into fresh water sources (Bird, 1993). Low latitude tropical and sub tropical coastlines, especially in area where high concentration of population are vulnerable to climate change impacts.

2.3.2 Impacts of Tidal Flood

Tidal flooding has affected urban areas in many ways. The impacts of tidal flood can be associated with the impacts of flood in urban areas and the impacts of coastal flood. The impacts are depend on few factors, which are the height of inundation, the duration of inundation, water running velocity, mud deposit, flooding occurrence and the change of weather (Wuryanti, 2001).

Wuryanti, (2001), also mentioned the physical and non physical loss due to flood, which are :

- Loss of life and property
- Damage houses and furniture
- Hamper the livelihood of inhabitants
- Soil erosion
- Damage urban infrastructures such as road, school, hospital and central station
- Threaten water supply and contaminate the water sources
- Cause epidemic diseases such as diarrhea and skin diseases

Moreover, McLean (2001) stated that coastal flooding due to sea level rise effects the socio economic of natural system, which are :

- Increased loss of property and coastal inhabitants
- Increased potential loss of life
- Damage to coastal protection works and other infrastructure
- Loss of renewable and subsistence resources
- Loss of tourism, recreation and transportation functions
- Loss of non-monetary cultural resources and values

- Impacts on agriculture and aquaculture through decline in soil and water quality

Flooding not only impacts the social economy, but also impacts the quality of health. Many diseases increase due to flooding, such as leptospirosis and vector borne diseases. Flooding impacts the quality of drinking water which can be polluted. As mentioned by Ministry of Health of Indonesia (Keputusan Menteri Kesehatan Republik Indonesia Nomor 907/Menkes/Sk/VII/2002**,** 2002), polluted water is identified by three criteria which are physical, chemical and microbiology criteria. Clean, clear, no color, no taste, no smell, in temperature around 10^0C – 25^0C and no residue are the physical requirement for drinking water. Meanwhile the chemical criteria are no hazardous substance, no chemical substance and sufficient iodine element. No microbiology element such as cholera and coli are parts of microbiology criteria. Flooding also infiltrates the sewage system, and consequently valves are fitted. Waste water contains hazardous elements from domestic and industry harms people's health. If it overflow due to flood it may cause diseases (Kusnosaputro, 1985). Moreover the impacts of flood on human health can be seen in the table below :

Table 2*: Impacts of flood on human health*

Causes	Health Implications
Damage to water supply systems, sewage and sewage disposal damage, insufficient supply of drinking water, insufficient water supply for washing	Possible waterborne infections (enterogenic E.coli, hepatitis A, leptospirosis), dermatitis and conjunctivitis
Rodent migration	Possible diseases caused by rodents
Disruption of social networks, loss of property, jobs and family members and friend	Possible psychosocial disturbances
Clean up activities following floods	Injuries, lacerations, skin punctures
Destruction of primary food products	Food shortage
Damage to health services	Insufficient access to medical care

Source : Menne, et.al, 2000

2.4 Adaptation Responses to Climate Change and Tidal Flood

2.4.1 Responses to Climate Change

Climate change response strategies can be made more effective, if they are integrated with broader sustainable development efforts (Munasinghe, 2000; Munasinghe & Swart, 2000). Adaptation, vulnerability reduction and mitigation action can contribute to sustainable development, while sustainable development strategies can help stabilize greenhouse gas concentrations and reduce the risks caused by climate change (Munasinghe & Swart, 2005). A combination of mitigation and adaptation are required in coastal areas and both policies need to be assessed in an integrated approach to develop a response o climate change.

Mitigation is a set of actions that will reduce the likelihood of climate change, whereas adaptation involves actions that will reduce the impacts of climate change (without necessarily altering likelihood that it will occur) (Munasinghe & Swart, 2005). Mitigation can be driven as a national agenda, whereas effective adaptation needs to be locally driven, in part because adaptation measures must be rooted in the pasrticular of each local economic, social, political and ecological context (Moser & Satterthwaite, 2008). Based on Key Conclusions of IPCC report, adaptation is a necessary strategy at all stages and scales to complete climate change mitigation efforts (Munasinghe & Swart, 2005).

2.4.2 Adaptation Responses to Climate Change

According to Smit & Pilisofa, 2007, adaptation to climate change has the potential to substantially reduce many of the harmful effects of climate change and improve beneficial impacts, even though neither without cost nor without leaving residual damage. Adaptation itself is important in the climate change issue in two ways, which are related to the assessment of impacts and vulnerabilities, and also the development and evaluation of response options.

The Intergovernmental Panel on Climate Change (IPCC) has issued many periodic assessments of the causes periodic assessments of the causes, impacts and possible response strategies to climate change are the most comprehensive and up-to-date reports available on the subject. Based on IPCC Fourth Assessment Report: Impacts, Adaptation and Vulnerability, 2007, adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental, processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities. Adaptations include anticipatory and reactive actions, private and public initiatives, and can relate to projected changes in temperature and current climate variations and extremes that may be altered with climate change. In practice, adaptations tend to be on-going processes, reflecting many factors or stresses, rather than discrete measures to address climate change specifically. Burton and Lim (2001) mentioned that in order to achieve economic, social and environmental sustainable as components of sustainable development, the objectives of adaptation should be: (i) economically efficient; (ii) advance social goals, and (iii) environmentally sustainable.

Adaptation refers to the process of adapting and to the condition of being adapted. Adaptation needs the elements of who or what adapt, adaptation to what, how the adaptation occurs and the evaluation of adaptation. The elements of adaptation can be seen on the figure below :

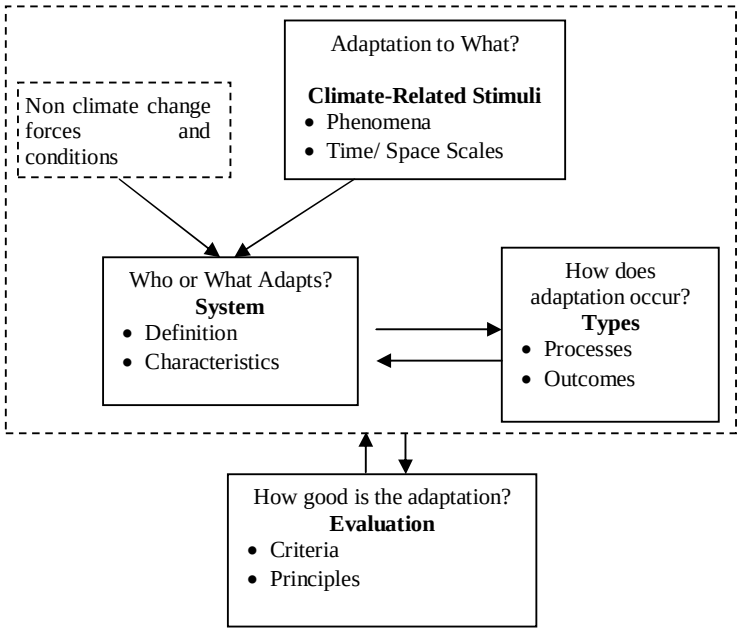

Figure 3: Adaptation to climate change and variability
Source : Smit et.al, 2000

Adaptation is differentiated with autonomous adaptation and planned adaptation. Autonomous adaptation refers to unmanaged and without any interventions form government, whereas planned adaptation refers to adaptation as a part of climate change response strategy (Leary, 1999). Adaptation should take into account the dangerousness of climate change, impact and vulnerability assessment. Figure below presents the places of adaptation to deal with climate change impact and vulnerability.

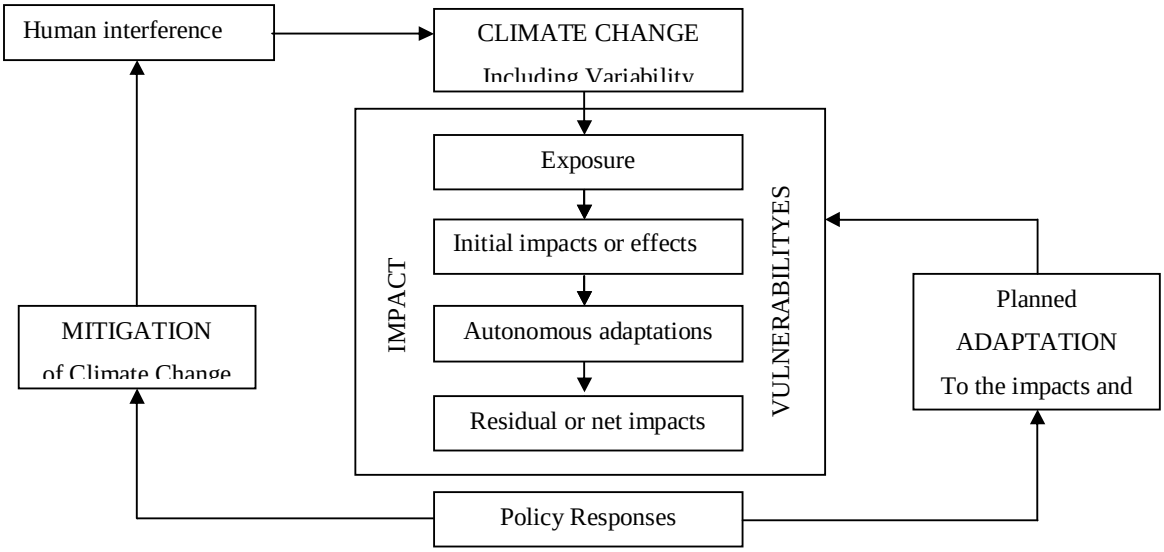

Figure 4: Adaptation in an integrated climate change response framework
Source : Smit e.al, 2001

Moreover adaptation also can be reactive or anticipatory, depending on the timing, goal or motive. Reactive adaptation takes place after the impacts of climate change have occurred. Whereas proactive adaptation is based on the expectation climate will change rather than on its actual impacts. Autonomous adaptation usually is reactive. Planned adaptation can be either reactive or anticipatory. Smit & Pilosofa (2007) mentioned that human system adaptation can be motivated by private and public interest. Planned adaptation is understood as a policy, therefore public agency or government is involved and has a goal to minimize the losses or opportunities from opportunities based on the awareness of climate change (Pittock & Jones, 2000). Autonomous adaptation is understood as initiatives from private sector which triggered by market and welfare changes (Leary, 1999). Distinguishing stakeholders involved in adaptation is important. Both government and private sectors play important role in adaptation, moreover citizens and combination of all actors are possible since adaptation implies behavioral changes, technological solutions, institutional adjustments or mix of them (Munasinghe & Swart, 2005). Table below will present the autonomous and planned adaptation which also mention the role of public and private sector:

Table 3*: Types of adaptation and examples*

		Anticipatory	**Reactive**
Natural systems			• Changes in length of growing season • Changes in ecosystem composition • Wetland migration

Human systems	**Private**	• Purchase of insurance • Construction of house on stilts • Redesign of oil rigs	• Changes in farm practices • Changes in insurance premiums • Purchase of air conditioning
	Public	• Early warning systems • New building codes, design standard • Incentives for relocation	• Compensatory payments, subsidies • Enforcement of building codes • Beach nourishment

Source : McCarthy et. al, 2001

According to Satterthwaite, et.al (2009), adaptation has to address pre-disaster and post-disaster vulnerabilities. In pre disaster, adaptation should focus on reducing the hazards where it possible or reducing people's exposure to the hazards. Moreover it should also focus on reducing the impacts of the hazards, for instance to respond the flood's impacts to people's health, living conditions, assets and livelihoods. In post disaster response, it is not only focus on assisting people to rebuild their homes and livelihood, but also encourage and support measures that reduce risks from likely future hazards.

2.4.3 Adaptation Reponses in Human Settlements

Climate change impacts and adaptation are part of the larger question of how complex social, economic and environmental subsystems interact and shape prospects for sustainable development (Munasinghe & Swart, 2005). Adaptation options especially in coastal settlement must be consistent with economic development, environmentally and social sustainable over time. Sustainable development and adaptation to climate change are interlinked. The sustainable development strategies could make adaptation more successful. Furthermore adaptation policies can be a part of climate change policies which are arranged to help promoting sustainable development.

Munangsihe and Swart (2005), stated to achieve successful adaptation, it should be locally based, technically and institutionally competent and politically supported and good access to national level resources. Moreover, adaptation in human settlements should be focused on non physical strategies which are planning and design, management and institutional changes will be explained in following table.

Table 4*: Adaptation in human settlements*

Planning and Design	• Increase economic diversification • Improve sanitation, water supply, power distribution systems, solid waste collection • Zoning and land use planning • Adapt building codes Reduce flood risks with flood barriers, managed retreat and hazard mapping • Monitoring and evaluation of buildings and infrastructure • Restoring a site that has been vulnerable to flood damage
Management	• Increase environmental and health education • Improve landscape management • Preserve and maintain environmental quality • Develop warning system, evacuation plans and insurance • Increase disaster preparedness • Enforce building codes

Institutional changes	• Improve institutional capacity in environmental management • Establish partnership between stakeholders • Adapt property rights to give access informal settlements to occupy housing in safe sites • Improve access to technology

Source : Munangsihe & Swart, 2005

The adaptation responses should be reactive to reduce flooding in coastal areas significantly. Nicholls (2002) mentioned four broad actions to reduce the impacts of flood in coastal areas:

- Mitigates climate change by reducing greenhouse gas emissions.
- Avoid human enhancement of subsidence. In many coastal cities, groundwater extraction is increasing subsidence which has implications for the incidence of flooding (Nicholls, 1995).
- Upgrade protection against flooding, including additional freeboard for sea-level rise.
- Control growth in exposure by encouraging the expanding coastal population and economy to avoid locating in coastal floodplain.

Meanwhile according to Munasinghe & Swart (2005), adaptation strategies in human settlements in can be developed in physical measurement as follows :

1. Protection which is protects land from sea by constructing hard structures such as seawall as well as using soft measures such as beach nourishment.
2. Accommodation which is continues to occupy the land and make some adjustments, such as elevating building, growing flood or salt tolerant crops.
3. Retreat which is abandons the endangered coastal area.

In the other hand McLean et.al, 2001, to decrease vulnerability and to increase preparedness to sea level rise and other impacts in coastal area, some actions can be done, for instance improvement of coastal defense system, capacity building, avoiding investments in flood plain zone, managed retreat and flood insurance, improving natural coastal protection systems, and disaster-preparedness and prevention programmes.

2.4.4 Adaptive Capacity

According to Satterthwaite, et. al (2009), adaptive capacity is natural capacity of a system, population or individual/ household to undertake actions that can help to prevent loss and can enhance recovery from any impacts of climate change. Adaptive capacity also refers to the ability to prepare for hazards (as anticipatory adaptation) and opportunities and to respond or cope with the effects (as in reactive adaptation) (Smit & Pilofosofa, 2001).

McCharty et.al (2001), mentions determinants of adaptive capacity :

1. Economic resources. Economic asset, capital resources, financial means, wealth, and the economic condition of nations is a determined of adaptive capacity (Burton et.al; Kates, 2000). Vulnerability is related to poverty, and increasing incomes and improving access of poor communities to financial means is to decrease vulnerability to climate impacts.
2. Technology. Adaptation to climate change involves the use of technologies, such as warning systems and flood control structures. Ability to develop and to access technology at various level is important on adaptive capacity.
3. Information and skills. Successful adaptation requires a recognition of the need to adapt, knowledge about available options, the capacity to assess them and the ability to implement the most suitable ones (Fankhauser & Tol, 1997). In general, countries with

higher levels of stores of human knowledge are considered to have greater adaptive capacity than developing nations (Smith & Lenhart, 1996).

4. Infrastructure. Adaptive capacity depends on the strength and weaknesses of physical infrastructures. Moreover adaptive capacity is determined as function of availability and access to resources by government (Kelly & Adger, 1999).
5. Institutions Strong and well organized institutions characterized by effective policy arrangements can support adaptation strategies more easily. Role of institutions are described as a means for holding society together, giving it sense and purpose and facilitate it to adapt (O'Riordan & Jordan, 1999). Smit & Lenhart (1996) stated that in general, countries with well developed social institutions are considered to have greater adaptive capacity than who have less effective institutions.
6. Equitable access to resources. Adaptive capacity not only is dependent on availability of resources, but also on the equitable of individuals and communities those resources.

According to Satterthwaite, et.al. (2009), adaptive capacity of individual, households and communities are determined by city development, since the development has strong influence on household's income, education, and access to information, on people's exposure to environmental hazards in their homes and workplaces and on the quality of provision for infrastructures and services. Adaptation capacity is also one of factor that contributes to vulnerability. The other factor of vulnerability is the risk of being killed, injured and harmed due to hazards. Moreover, people's capacity to avoid the hazard or to cope the effects and to adapt (to reduce future risk) is influenced by individual/ household resources (incomes, asset bases and knowledge) and community resources (the quality and inclusiveness of community organizations that manage short and long term measures).

2.5 Coastal Management

The appropriate response to deal with many problems in coastal area including tidal flooding area is to implement Integrated Coastal Management (ICM). According to Kaluwin and Smith (1997) suggested that ICM is the most effective and realistic strategy to deal with sea level rise that coupled with natural variability. ICM has been proposed as a relevant framework for management of coastal zone. Moreover ICM has become a policy tool that engages a comprehensive framework from all stakeholders at regional, national even local levels of society to address multiple management issues (Mimura, 2006). Cummins, Mahony & Connolly (2009) stated "ICM is a dynamic and continuous process of administering the use, development and protection of the coastal zone and its resources towards common objectives of national and local authorities and the aspiration of different resource user groups". Sustainable development becomes one of objective of ICM. Sustainable development in ICM can be explained into projects and programs goals which are to improve the bio-physical environment and to improve the quality of the human population in coastal area (Olsen, 2003). Moreover sustainable development can be a goal in ICM in order to improve quality of life of coastal inhabitants.

Unmanageable coastal area will be threatened by many problems including tidal flood, therefore it is necessary to manage coastal area in order to face those problems. Integrated Coastal Management (ICM) is one of the methods to deal with tidal flooding. Within ICM framework that involves stakeholders from national level to local community level, sustainability in coastal areas can be achieved.

2.6 Sustainable Development

Responses to climate change have implication to sustainable development. Sustainable development has three main elements : economic, environmental and social. The economic is focused on improving human welfare, through increases in the consumption of goods and services. The environmental focuses on protection of the integrity and resilience of ecological systems. The social focuses on the improvement of human relationship and achievement of individual and group aspirations (Munasinghe & Swart, 2005).

Based on the assessment of IPCC (Munasinghe & Swart, 2005), the changes in the climate system and their impacts on vulnerable natural and human systems, as well as their implications for sustainable development. The assessment of climate change and vulnerability are the key concern to link climate change and sustainable development. Sustainable development is an important tool to ensure balanced analysis of climate change impacts and development and sustainability concerns. Economic, social and environment dimensions as elements of sustainable development provide a framework for analyzing the effects of climate change on future socioeconomic development scenarios. In other term, it can be concluded that climate change impacts are part of the larger question of how complex social, economic and environmental subsystems interact and shape prospects for sustainable development (Munasinghe & Swart, 2005).

Sustainable development and equity also related to adaptive capacity. Enhancement of adaptive capacity is important to sustainable development (Smit & Pilifosova, 2001). It is important for sustainable initiatives to consider hazards and risks associated with climate change (Apuuli et.al, 2000). Moreover, by assessing vulnerabilities of climate change and by working to improve the adaptive capacity of regions and groups, planned adaptation can contribute to sustainable development ((Smit & Pilifosova, 2001).

2.7 Lesson Learned

This chapter will present the lesson learn from Bang Khun Thian District, Bangkok of how they do adaptation strategies to deal with Coastal Erosion and Flooding. Bang Khun Tian District in Bangkok has been suffering from coastal flooding for years. it has been claimed that more than 500 meters of the Bang Khun Thian coast have been eroded. The coastal erosion is caused by sediment yield, land subsidence, sea level rise and waves and storm. Moreover due to land subsidence, the coastal area is projected to be inundated for 6-8 km inland from the current shoreline in the next 100 years. The coastal inhabitants have been doing some autonomous adaptation responses to deal with this problem, which are categorized into three types of adaptation as follow:

- Protection is done with apply hard structures in parallel with the coast in order to protect the inhabitant's aquaculture ponds. They use many kinds of construction in order to reduce the impact of storm and waves.
- Retreat is done by some farmers by move their ponds inland, thus they had to build new water gates and reconstruct the dikes.
- Accommodation is done by rebuilding or renovating their houses in order to avoid the impacts of coastal erosion and flooding.

The adaptation responses can be done more than one measures, depend on the needs of inhabitant itself. The local government is responsible to take care the coastal area from coastal erosion, therefore they have strategies for coastal erosion protection. In line with that

the local government also has been provided a protective structure to protect the coast. The strategies of coastal area protection are under responsible all of local governments in Thailand coastal area, therefore the national government is responsible to arrange the collective decision of this issue. Another role of national government in dealing with coastal erosion problem is to give compensation for flooding to the coastal inhabitants.

2.8 Theoretical Framework

Figure below explains theoretical framework adaptation responses in dealing with coastal flooding in settlement areas.

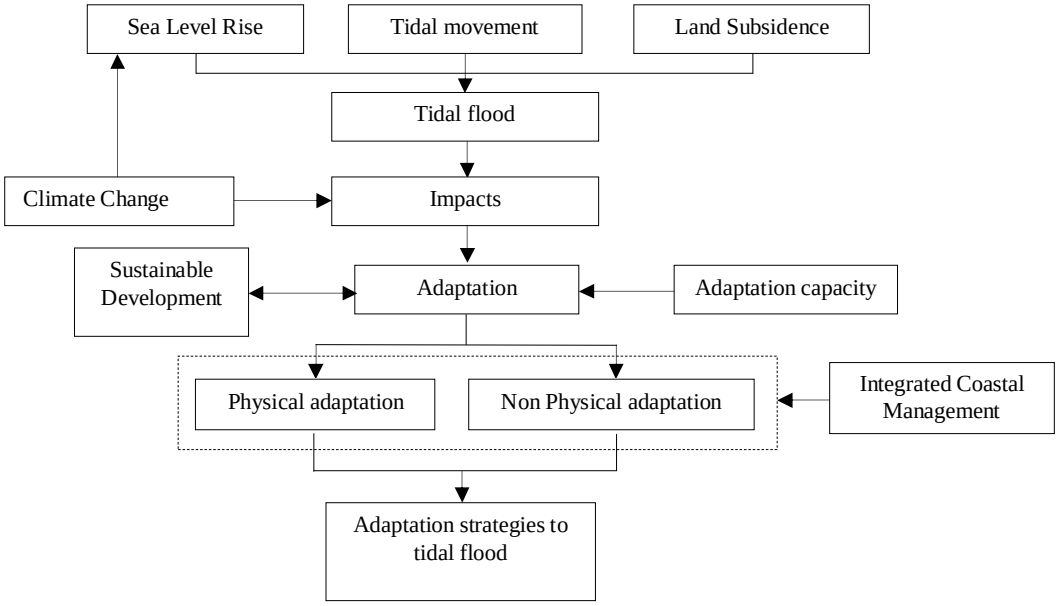

Figure 5: Theoretical Framework

The research focuses on adaptation responses in dealing with tidal flood in coastal settlements. Tidal flood occurs due to tidal movement and it is worsened by land subsidence and sea level due climate change. Tidal floods impacts people live in coastal areas. The impacts of tidal flood can be associated with the impacts of climate change. Adaptation can significantly reduce the adverse impacts of tidal flood. Successful adaptation responses need adaptive capacity in every level from national to local level. The sustainable development dimensions (economic, social and environment) develop into framework to analyze the effects of climate change. Adaptation responses in human settlement can be done in two measures: structural measures and non structural measures. Integrated coastal management can one of method in dealing with tidal flood in coastal settlements.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Research Design

The research design is summarized in figure below giving a general overview of the research process.

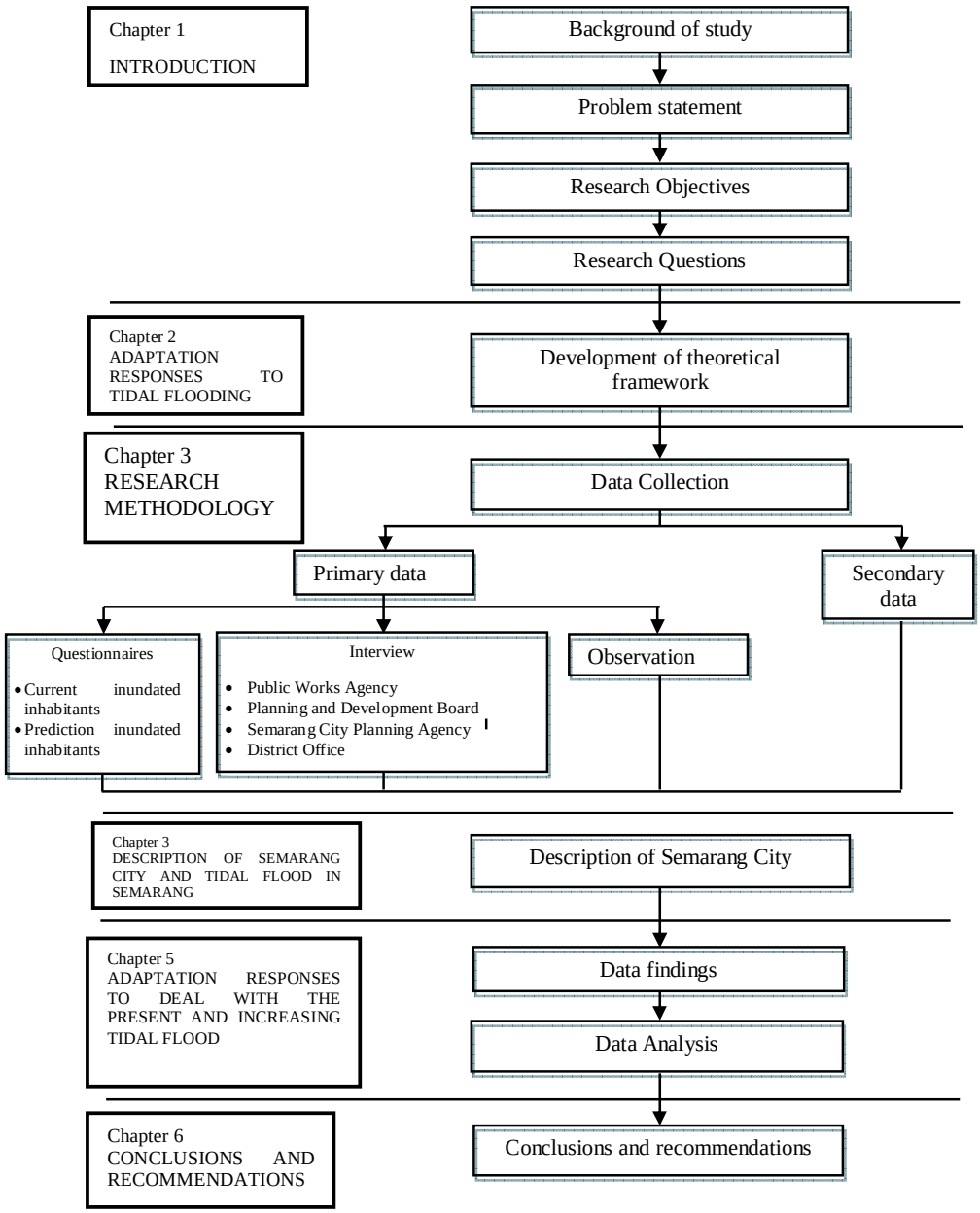

Figure 6: Research design

3.2 Type of Research

The type of research is exploratory. Exploratory research seeks to explore what is the story behind certain occasion or activity and to investigate social phenomena explicit expectations (Schutt, 2006). Exploratory research often relies on secondary research such as reviewing

available literature and/or data, or qualitative approaches such as informal discussions with consumers, employees, management or competitors, and more formal approaches through in-depth interviews, focus groups, projective methods, case studies or pilot studies. This research use exploratory survey as a research strategy. This research strategy seeks to find out the adaptation strategy of inhabitants and Semarang city government in order to minimize negative effects in present time and to cope in the future risks.

3.3 Analytical Framework

Analytical framework is used to organize this research and to analyze the fieldwork information findings. It show the way the data collected and the data analyzed in order to answer all the research questions and achieve the research objective. Figure below presents the analytical framework of this research.

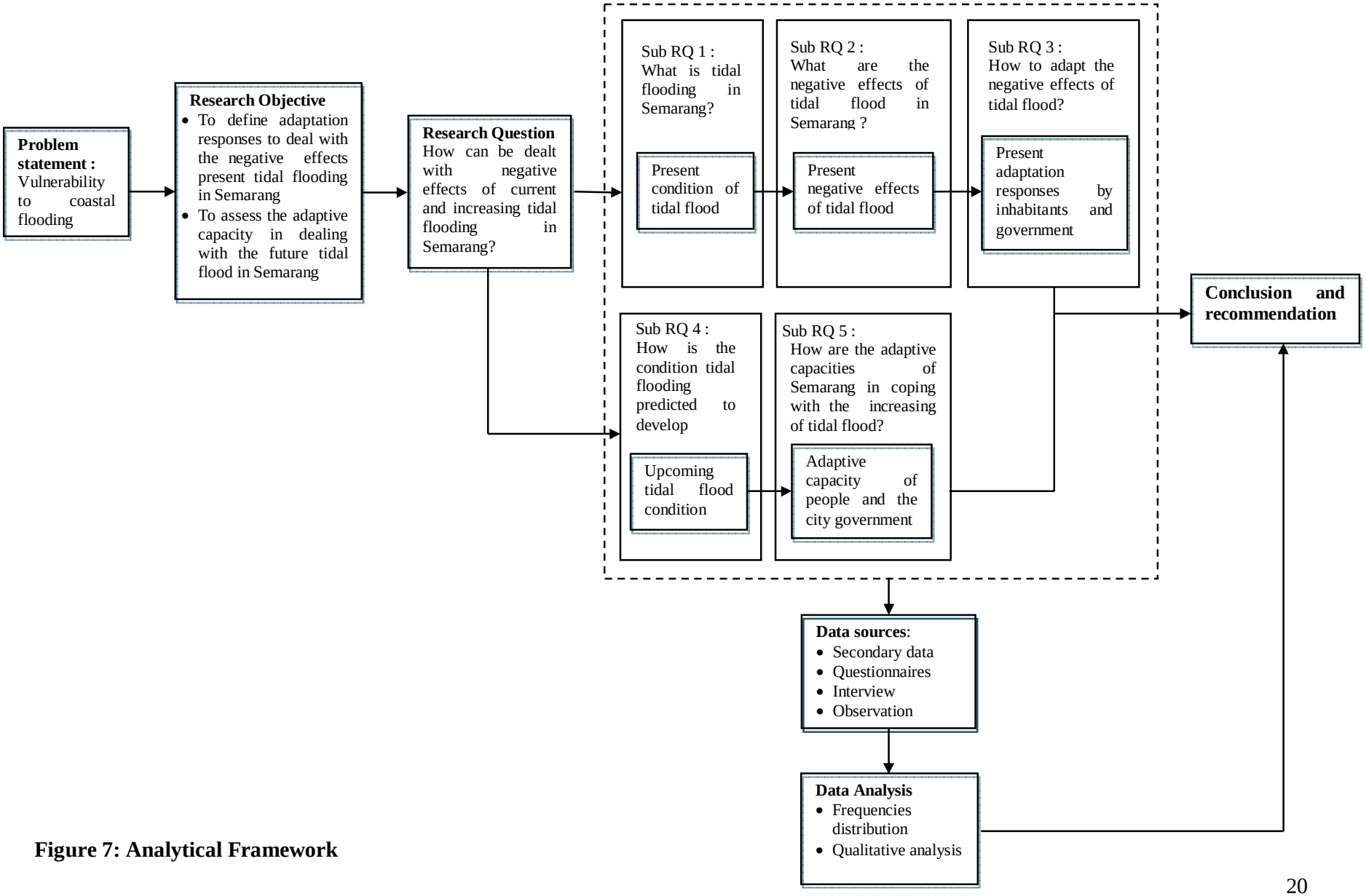

Figure 7: Analytical Framework

3.4 Data Collection

This research is based on primary and secondary data collection to analyze effect of tidal flooding, to understand the adaptation method has been implemented by inhabitants and local government and to analyze people's capacity to adapt the upcoming tidal flood.

3.4.1 Primary data collection

The primary data was collected through observational study, questionnaire and semi structured interview.

- **Semi structured interview with local government**

The semi structured interview was for local governments which are responsible to deal with coastal flooding problems. Interview with some officials from Semarang Public Works Agency, Semarang Planning and Development Board and Semarang City Planning Agency was conducted to collect information related with coastal flooding in the city. The interview was also conducted to Head of District and Sub District Offices in order to gain information of the condition of coastal flooding on the particular district and the way people in dealing with coastal flooding. The list of interviewee is presented in the table below :

Table 5*: The list of respondents in depth interviews*

Name of Organization	Number of respondents
Semarang Water Management Agency	1
Semarang Planning and Development Board	1
Semarang City Planning Agency	1
Head of District	1
Head of Sub District	1

- **Interview with questionnaires**

The questionnaire will be for the coastal settlement inhabitants. The sample of this research is selected with purposive sampling. Black (1993), mentioned that by purposive sampling, the researcher picks the sample on the basic of traits to give what is believed to be a representative sample.

The research area is 8 districts which will be inundated by year 2015, which 3 districts are inundated on this present time and 5 districts predicted will be inundated. Since the limitation of time and resources, the research sample was focused on one sub districts of each district. The sub districts are selected based on the number of population, the settlement areas and the inundated areas. The number of population in existing inundated areas is listed below :

Table 6*: Population in present inundated areas*

Districts	Sub Districts	Population (year 2006)
Semarang Barat	Tambakharjo	1.945
	Tawangsari	6.416
Semarang Utara	Panggung Lor	14.371
	Bandarharjo	19.217
	Tanjung Mas	28.932
Genuk	Terboyo Kulon	514

Source : Statistic Bureau, 2006

The number of population in inundated area by year 2015 is projected with multiple method which predicts the number of population based on population growth ratio in previous year with formula (Perencanaan Kota Indonesia, 2009) :

$$Pt = Po\ (1+r)^n$$

Pt : number of population in year t, in this case is population in year 2015
Po : number of population in year one, in this case is population in year 2006
1 : constantan
r : ratio of population growth
n : difference between year t and year one

The projection of population in year 2015 is presented below :

Table 7*: Population in year 2015*

Districts	Population (year 2006)	Population (year 2015)
Tugu	24.593	43.087
Semarang Barat	75.392	99.170
Semarang Timur	83.733	110.153
Semarang Utara	124.273	148.051
Semarang Tengah	76.026	115.656
Gayamsari	67.522	86.016
Genuk	58.824	87.886
Pedurungan	68.155	76.081

Source : Author, 2009

The research sample was categorized into two groups based on the selected areas. The first group is people live in existing inundated areas which are sub district Tawangsari, sub district Tanjungmas, and sub district Terboyo Kulon. The second group is people live in projected inundated areas which are sub district Rejosari, sub district Gabahan, sub district Tambakrejo, sub district Muktiharjo Kidul and sub district Randugarut. The list of respondents is presented in the table below :

Table 8: List of respondents

Groups	Number of respondents
Existing inundation areas	
Sub district Tawangsari, District Semarang Barat	20
Sub district Tanjungmas, District Semarang Utara	20
Sub district Terboyo Kulon, District Genuk	20
Predicted inundation areas	
Sub district Rejosari, District Semarang Timur	10
Sub district Gabahan, District Semarang Tengah	10
Sub district Tambakrejo, District Gayamsari	10
Sub district Muktiharjo Kidul, District Pedurungan	10
Sub district Randugarut, District Tugu	10
TOTAL	110

The selected research area can be seen in the map below :

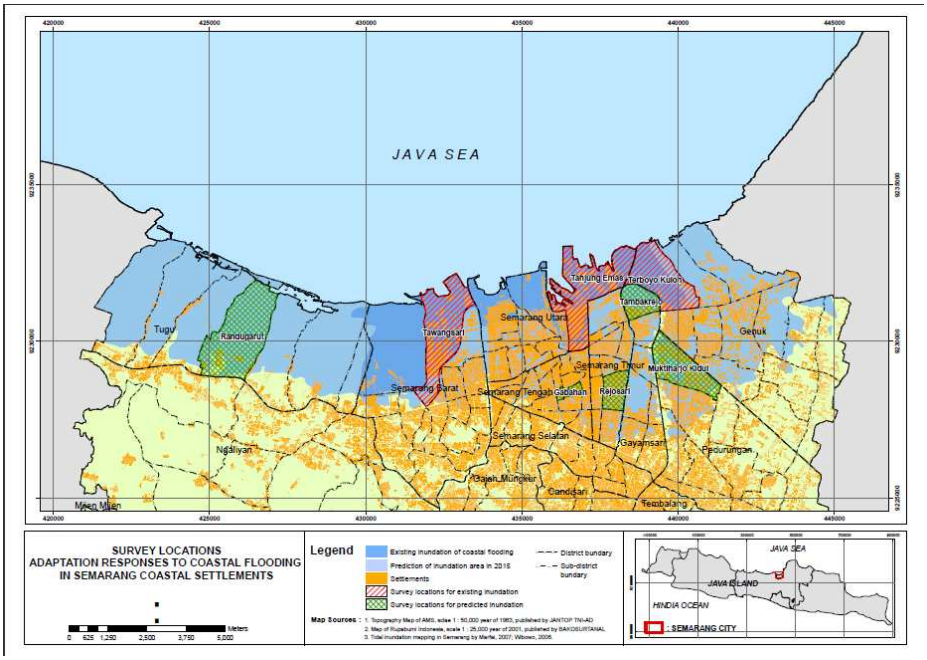

Figure 8: Selected Research Areas

3.4.2 Secondary data collection

The researcher attains secondary data from literature review on climate change, coastal management and sustainable development. Contextual data regarding to adaptation method has been done by local government, especially Semarang Public Works Agency, Semarang City Planning Agency and Semarang Planning and Development Board. Statistical data from Semarang Statistical Office is used in this research to picture the condition of Semarang City and particular the condition of tidal flood. The prediction inundated areas by year 2015 is based on research done by Wibowo, 2006 about Spatial Analysis of Anxious Tidal Flood Area at Semarang City.

3.5 Unit of Analysis and Variables

3.5.1 Unit of Analysis

Scopes of research are:

1. Condition of tidal flood in Semarang.
2. Current negative effects due to tidal flood.
3. Current adaptation responses done inhabitants in present inundated areas in dealing with tidal flooding.
4. Perception of inhabitants in predicted inundated areas about upcoming tidal flood.
5. Assessment of adaptive capacity of people and the city government to response the increasing tidal flood in the future.

3.5.2 Variables and Indicators

The variables and indicators were developed through the development of a theoretical framework for the study. The relationships between the variables and indicators are explained in the table below.

Table 9*: Variables and Indicators*

Research Question	Variable	Indicators	Data Sources	Analysis
What is coastal flooding in Semarang?	Flood plain area	• Number of flooded sub districts • The width of area flooded • Number of inhabitants affected	• Secondary data • Questionnaire to inhabitants in current inundated areas	• Quantitative
	Frequency of flooding	• Flood period • Flood duration • Height of inundation • Frequency of flood	• Secondary data • Questionnaire to current inundated inhabitants	• Quantitative
	Characteristics of inundated inhabitants	• Income level • Education level • Occupation • Housing ownership	• Questionnaire to current and predicted inundated inhabitants	• Quantitative
What are the negative effects of tidal flood?	Illnesses	• Type of illnesses due to flooding	• Questionnaire to current inundated inhabitants	• Quantitative
	Education	• Number of damaged school building • Amount of days in a year children cannot go to school due to flooding	• Secondary data • Questionnaire to current inundated inhabitants	• Quantitative
	Livelihood	• Amount of days in a year without work due to flooding • Percentage of income level decrease	• Questionnaire to current inundated inhabitants	• Quantitative
	Property	• Number of damaged houses	• Secondary data	• Quantitative

	Environment quality	• The effects to quality of drinking water • The effects to sanitation system	• Questionnaire to current inundated inhabitants • Interview • Secondary data	• Quantitative
How to adapt the current negative effects of tidal flooding?	Structural adaptation	• Number of people have been doing protection as adaptation measures • Number of people have been doing retreat as adaptation measures • Number of people have been doing accommodation as adaptation measures • Number of people willing to do adaptation measures. • Number of people willing to compensate for the adaptation measures • The average cost to rebuild the house • Willingness to move to another area • Type of adaptation responses done by the government	• Questionnaire to current inundated inhabitants • Interview • Observation • Literature review	• Quantitative • Qualitative • Financial analysis
	Non structural adaptation	• Type of planning and design method • Type of management method • Type of institutional changes method	• Interview • Observation • Secondary data	• Qualitative
How is tidal flood condition in the future?	Flood plain area	• Number of flooded sub districts • The width of area flooded • Number of inhabitants affected	• Questionnaire to predicted inundated inhabitants	• Quantitative
	Characteristic of inhabitants	• Income level • Occupation • Type of housing • Economic activities	• Questionnaire to predicted inundated inhabitants • Secondary data	• Quantitative
How are the adaptive capacities of Semarang in coping with the increasing tidal flood?	Adaptive capacity	• Economic resources • Infrastructure • Institutional • Planning • Equity to resources • Information and skills	• Questionnaire to current and predicted inundated inhabitants • Interview • Secondary data	• Quantitative

3.5 Data Analysis

Both quantitative and qualitative data are used to analyze for each variable provided. The quantitative data is analyzed by using in form of tables, charts, and frequencies. The impacts of tidal flood are analyzed with financial analysis, in order to calculate the loss of economic, social and environmental sectors in current and future time. The tidal flood will affect the coastal inhabitants, and as consequence it will increase health cost, waste cost, house reconstruction cost etc. The qualitative analysis is used to analyze the effects of tidal flooding and adaptation measures in dealing tidal flooding based on the local government's perspective.

3.6 Data Quality

Qualitative and quantitative data are used in this research. The data quality is evaluated through validity and reliability.

- **Validity**

The researcher has ensured the validity through the use of triangulation technique which using more than one methods which are observational study, questionnaire, interview and secondary data. Questionnaire was designed to suit all respondents with use of open ended questionnaire for purposive respondents. The questionnaire was designed in a logical way and a pilot test with a few respondents before fieldwork start. During the interview with local governments, audio recording will be carried out, in order to expect consistency in collecting data.

- **Reliability**

Reliability of the data collected is developed as data has been collected from different sources, i.e questionnaire to coastal settlement inhabitants and interview to local government. The researcher will design careful questionnaires through an elaborate procedure which involved a series of revisions. The interview was guided with guidelines, so they was not have different meaning of the questions. Respondents was asked different questions but to find similar information. This is the way to ensure the reliability of data gathered from respondents.

3.7 Limitations

- **Time constraints**

Due to limited time, the researcher analyzes the social, economic and economic effects based on research that has predicted coastal flooding in Semarang. The researcher also limit the number of sample, however it still represent the whole population.

- **Limited funds**

Due to limited funds, the researcher conducted research with help from research assistants. The research assistants should have enough experiences in conducting survey in Semarang.

CHAPTER 4 GENERAL DESCRIPTION OF SEMARANG CITY AND TIDAL FLOOD IN SEMARANG

4.1 Introduction

This chapter presents the condition of tidal flooding in Semarang. It begins with description of physical condition, demographic condition and land use in Semarang, followed by a description of tidal flood problems in Semarang.

4.2 General Information

Semarang is a capital city of Central Java Province located in northern part of Java Island. With area 400 km^2, Semarang becomes the fourth biggest city in Indonesia. Semarang consists of 16 districts and 177 sub districts and approximately 1.5 million people live in Semarang. The city is bordered by Java Sea in the north, Semarang Regency in the south, Kendal Municipality in the west and Demak Municipality and Grobogan Municipality in the east.

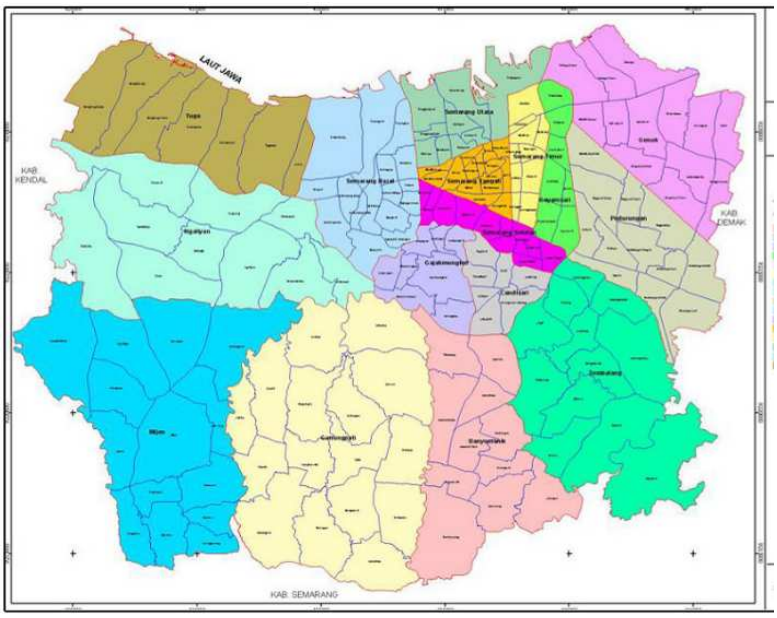

Figure 9: ***Semarang City***

4.3 Climate

Semarang has two seasons, rainy season and dry season which change every 6 months. The annual rainfalls mean is various between 2.215 mm – 2.183 mm, and the maximum rainfalls happens on the months December and January. The annual humidity is also various between 62% - 84%. The temperatures in Semarang is various around 25.80^0C - 29.30^0C.

4.4 Topography

Semarang is divided into three parts, the coastal area, the low lying area and the hilly area. The coastal area and the low lying area which are about 121 km^2 width, is located in the northern part of Semarang. It lies in various elevations from 0 - 25 m above sea level. Meanwhile the hilly are which is about 252 $km^{2,}$ and lies in 25-200 m above sea level, is located in the southern part of Semarang. Located close to the sea, the coastal area of Semarang is vulnerable to tidal flood. The map of topography of Semarang can be seen on the Annex 4.

4.5 Soil Form

From a geological point of view, Semarang has three main lithologies, namely, volcanic rock, sedimentary rock, which is marine in origin, and alluvial deposits (Marfai & King, 2007). The southern part of Semarang consists of volcanic rock consists of volcanic breccias, lava flows, tuff, sandstone, and clay stone. The northern part consists of sedimentary rock originated from marine consists of clay stone and dominated by sandstone in between. Alluvial sediment consists of beach deposits formed by clay and sand with a thickness of more than 80 m with the age of the Holocene period. It is on these deposits (Marin sediment and alluvial sediment) where the land subsidence is occurring, because it cannot carry on the structural development on it. Meanwhile the materials of the lowland area are composed of the alluvial and coastal deposits which are susceptible from land subsidence triggered by extreme groundwater withdrawal (Marfai & King, 2007).

4.6 Land Use

As written in Semarang Spatial Planning year 2000 – 2010, development priority in Semarang is divided into 4 development areas, which has different priority scale. The areas development of Semarang are listed below :

Table 10*: The Area Development of Semarang City*

NO	Area Development	Districts	Priority Land Use
1	Area development 1	District Semarang Tengah, Semarang Timur, Semarang Selatan, Gajah Mungkur, Candisari, Semarang Barat and Semarang Utara	Office complex, education areas, transportation, commercial area
2	Area development 2	District Genuk, Tugu and Ngaliyan	Sub urban area, industrial area, settlement area
3	Area development 3	District Gayamsari, Pedurungan, Tembalang and Banyumanik	Settlement area, education area, military area
4	Area development 4	District Gunung Pati and Mijen	Agriculture area, fishery area, buffer area

Source : PDB, 1999

The table shows that the settlement areas, commercial area, industrial areas and offices centre are mostly located in the northern part of Semarang and some part of southern part of Semarang

(Area development 1 and 2). Meanwhile the southern part is focused on settlement areas, education areas and agriculture areas (area development 3 and 4).

4.7 Demographic Condition

Semarang city is dwelled by 1.454.594 inhabitants (Statistic Bureau, 2006). The most populated district is District Pedurungan which is settled by 160.564 inhabitants or 11.04% from the total population. Meanwhile the least populated district is District Tugu which has 26.454 inhabitants or 1.82% of the total population. The density of sub district is various depend on the number of population and the width of area. The most dense district is Semarang Selatan (14.447 inhabitants/km^2), and the least dense district is Kecamatan Mijen (819 jiwa/km^2). The detailed population number of Semarang is listed in Annex 4.

Semarang inhabitants work in various professions, such as farmer, laborer, fisherman, government officers, trader and entrepreneur. According to Statistic Bureau (2006), most of Semarang inhabitants work as laborer with the amount of 242,877 people. Meanwhile, the least number of people (2,506 people) work as fisherman. The numbers of people work in other profession are almost the same. In terms of education, most of Semarang inhabitants are educated people. About 349,550 people are not educated, meanwhile about 938,774 people are educated, which graduate from various level of education (Statistic Bureau, 2006).

4.8 Flood Problems in Semarang

Flooding is a major problem for the Semarang's people and local government. Many parts of Semarang suffer from flood especially in the northern part of the city. It is estimated that around 15.000 ha of the city is categorized as flood prone area (Dewi, 2007). Semarang faces three types of flooding which are local flood inundation, flooding caused by river flooding (from the hinterland) and flood cause by high tide from the sea (Marfai, 2007). Local flood inundation occurs due to inadequate number and quality of drainage system to catch the larger runoff during the rainy season. It occurs on the low lying and coastal areas. Gatot, et. Al (2001) one of the causal factors of flood in the city is that about 10% of rainfalls infiltrates as groundwater recharge, and most of the rainfall is transferred directly to the runoff and discharge to the lowland and coastal area. River flood occurs during the rainy season due to extremely high over bank discharge from rivers. It happens when the rainfall exceeds the capacity of stream channel and drainage ditch, therefore flood will occur on the lower part of the catchments. Tidal flood occurs when the sea level rise to a critical height above the coastal lands die to tidal elevation. The tidal flood occurs almost daily depending on the tidal oscillation. Inadequate number and quality of drainage system in the coastal areas also contributes to inundation. It will be worsened by the super position of storm surges and wave run-up due to severe weather conditions (Marfai, 2007).

4.9 Tidal Flood in Semarang

Tidal flooding happens periodically when the high tide happens. Generally tidal flood occur when the sea level rise due to tidal movement is above the land. Semarang Development and Planning Board have observed the sea level at Tanjung Mas Harbor, and the result is presented in

the table 11. The data shows that coastal areas with elevation less than 1,26 meters above sea level are vulnerable suffering from the tidal flood periodically.

Table 11: ***Sea Level Observation in Semarang from 1998-2000***

Elevation	Sea Level		
	November 1998 (cm)	**December 1999 (cm)**	**November 2000 (cm)**
Highest high water level	126.4	155.43	145.07
High water level	120.0	143.37	141.43
Mean sea level	60.0	83.37	81.63
Low water level	0.0	23.37	21.63
Lowest low water level	6.4	13.8	15.47

Source : Semarang Planning and Development Board, 2000

Coastal flooding in Semarang is worsened by land subsidence and sea level rise. Land subsidence occurs due to over exploitation of ground water and land conversion. Sea level rise due to climate change will expand the inundated area and increase the inundation level continuously. Moreover the condition of sea level rise and land subsidence in Semarang will be explained in the next chapter.

4.9.1 Sea Level Rise

According to IPCC (1998), a 30 cm rise of the sea level would increase flood damages 36-58%. Indonesia is predicted will be lost land about 34.000 km^2 due to inundation under the scenario of 60 cm of SLR (Nicholls and Mimura, 1998). Sea level rise in Semarang coastal area from year 1985 – 1998 was about 58.2 cm, and the average rate of sea level rise was 4.47 cm/ year (Ministry of Fishery and Marine Affairs, 2009). Meanwhile the sea level rise in year 2003 – 2008 was about 37.2 cm, and the average rate of sea level rise was 7.43 cm / year. There is no data about the sea level rate within period year 1998 – 2003. The table 12 shows the average rate of sea level in Semarang coastal area.

Table 12: ***The average rate of sea level rise (1985 – 1998)***

No	Year	Rate (cm)
Year 1985 - 1998		
1	1985 – 1986	-0.2
2	1986 – 1987	0.7
3	1987 – 1988	7.0
4	1988 – 1989	5.2
5	1989 – 1990	-1.1
6	1990 – 1991	9.3
7	1991 – 1992	4.1
8	1992 – 1993	2.3
9	1993 – 1994	1.0
10	1994 – 1995	17.0
11	1995 – 1996	-
12	1996 – 1997	-

No	Year	Rate (cm)
13	1997 – 1998	3.8
Average		**4.47**
Year 2003 - 2008		
14	2003 – 2004	4,1
15	2004 – 2005	6,6
16	2005 – 2006	17,8
17	2006 – 2007	8,0
18	2007 – 2008 (July 2008)	0,7
Average		**7,43**

Source : Ministry of Fishery and Marine Affairs, 2009

4.9.2 Land Subsidence

Land subsidence in Semarang varies with the maximum rate of land subsidence is about 16 cm per year and the minimum is about 1 cm per year. The land subsidence mostly occurred at a rate of 2 up to 10 cm per year (Public Works Agency of Semarang, 2000). Land subsidence will be worse continuously. Marfai & King, (2007), predicted the land subsidence in Semarang by year 2010 – 2020, as listed below :

Table 13*: The prediction of future land subsidence in Semarang*

Year	Elevation below sea level (cm)				
	0 – 50	**50 – 100**	**100 – 150**	**150 – 200**	**Total**
2010	328.5 ha	31.5 ha	20 ha	-	362.0 ha
2015	1162.0 ha	187.0 ha	25.0 ha	3.5 ha	1377.5 ha
2020	1464.5 ha	607.0 ha	128.0 ha	27.5 ha	2227.0 ha

Source : Marfai & King, 2007

The table shows that by the year 2010, about 328.5 hectare of Semarang area is predicted will be in the elevation 0-50 cm below sea level, 31.5 hectare will be in 50-100 cm under sea level and 20 ha will be in 100-150 cm under sea level. In total 362 hectare of Semarang will be in under sea level. Meanwhile the land subsidence is predicted of being worse with 1377.5 hectare in the year 2015 and 2227.5 in the year 2020.

According to Sutanta and Hobma (2002), land subsidence in Semarang is categorized into 5 zones based on load on the land itself, which is the more the load, the more subside the land. The zones are:

1. The 0 – 3 cm/ year subsidence zone. This zone is commonly located in hilly area of Semarang, which is positioned in more than 3 meters above sea level. District Ngaliyan, Mijen and Semarang hilly area are included in this zone.
2. The 3 – 6 cm/ year subsidence zone. This zone is positioned in less than 3 meters above sea level. District Tugu, Semarang Barat, Semarang Utara, Semarang Timur, Gayamsari and Genuk are sort of this zone.
3. The 6 – 9 cm/ year subsidence zone. District Semarang Barat, Genuk, Semarang Utara and Pedurungan are categorized on this zone.
4. The 9 – 12 cm/ year subsidence zone. District Semarang Barat and part of District Genuk are located in this zone.

5. The 12 – 15 cm/ year subsidence zone. Part of District Semarang Utara and Genuk are situated in this zone.

Land subsidence in Semarang is caused by several factors. One of the causal factors is load of construction from industrial estate and economic activities in coastal area. Consists of sandy and clay material, the soil form is easy to compress and to subside if there are too much load on it (Wibowo, 2006). The other causal factor of land subsidence is over exploitation of ground water, both for household and industrial purposes. Exploitation of ground water Semarang for drinking water was about 0.43 – 106 m^3/ year in 1990 and increased to 35.64 – 106 m^3 / year in 1998 (JICA, 2003). The ground water exploitation increases in line with the urbanization rate and population growth. Since there are most of economic activities, urbanization is more focused on this area. Due to building loads, the clayey sediments layer the ground will be lowered from previous elevation. Therefore land subsidence is a problem in areas with underlying clay-bearing layers such as those in the coastal area of Semarang.

4.10 Remark

Semarang city, topographically, is divided into three parts, which are coastal areas and low lying areas in the northern part of Semarang, and the hilly areas in the southern part. Most of developments such as settlement areas, commercial areas and industrial areas are located in the northern part of Semarang. Tidal flood is one of floods occurred in Semarang, which occurs almost daily due to tidal movement. The development in the northern part of Semarang may lead to land subsidence in coastal areas, consequently it worse the tidal floods in Semarang. Moreover tidal flooding is worsened by sea level rise due to climate change.

CHAPTER 5 ADAPTATION RESPONSES TO DEAL WITH THE PRESENT AND INCERASING TIDAL FLOOD

5.1 Introduction

This chapter answers the main research question of how can be dealt with the present and increasing tidal flood in Semarang. It presents findings and discussions based on condition of present and increasing tidal flood, adaptation measures to present tidal flood and awareness of increasing tidal flood in the future.

5.2 Condition of Tidal Flood

5.2.1 Present Inundated Areas

Tidal flooding has been inundating coastal area for many years. According to Marfai (2007), 6 sub districts in 3 districts have been suffering the worst inundation. The present periodically inundated areas can be seen in the map below.

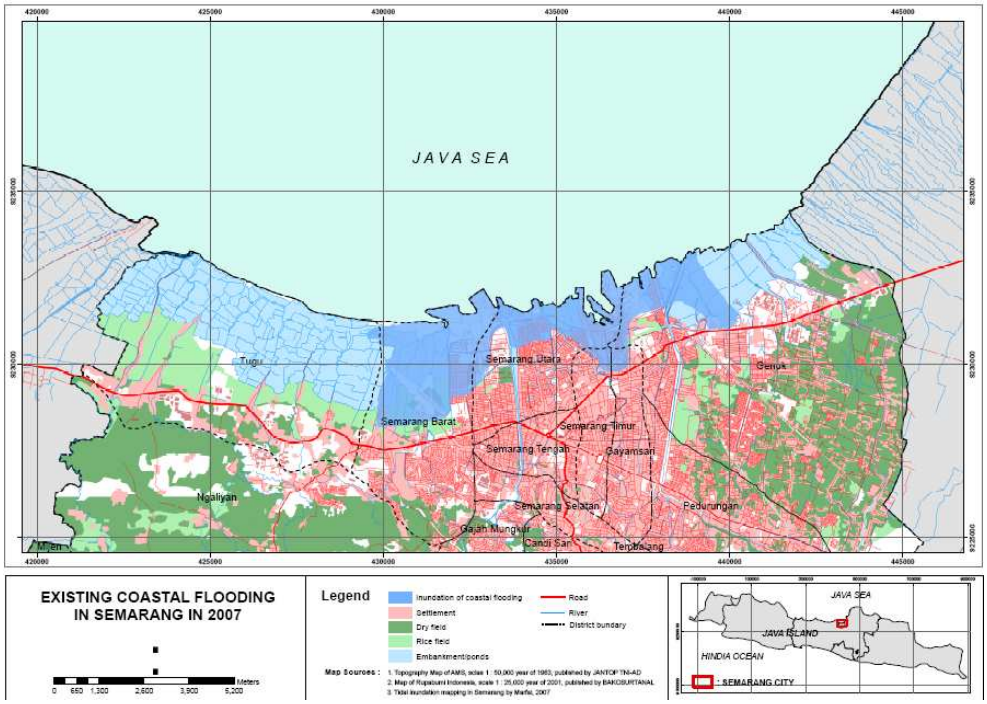

Figure 10 : Present inundated area

The total periodically inundated area is about 1.970 ha. The tidal flood inundates embankments, fields and the most inundated area is settlement areas. Detailed the width of each sub districts are listed below :

Table 14*: Present periodically inundated areas*

Districts	Sub Districts	The width of sub districts
Semarang Barat	Tambakharjo	534 ha
	Tawangsari	362 ha
Semarang Utara	Panggung Lor	191 ha
	Bandarharjo	223 ha
	Tanjung Mas	384 ha
Genuk	Terboyo Kulon	276 ha

Source : Statistic Bureau, 2006

5.2.2 Characteristic of the Tidal Flood

The characteristics of tidal flood are determined from its period, duration, frequency and depth. The information was collected during the fieldwork, based on observation and questionnaires.

Based on the questionnaire use to sampled 60 people, about 25% of respondents confirmed that they have been suffering from flood for more than 8 years. Meanwhile most of respondents have been suffering from tidal flood for less than 4 years. The distribution of flood period can be seen on the figure 4.5 below. Figure 11 shows the number of floods occurrence. Most of respondents experienced that flooding for about 4 – 9 times a month. Meanwhile about 10% of the respondents experienced the worst situation with the flooding every day.

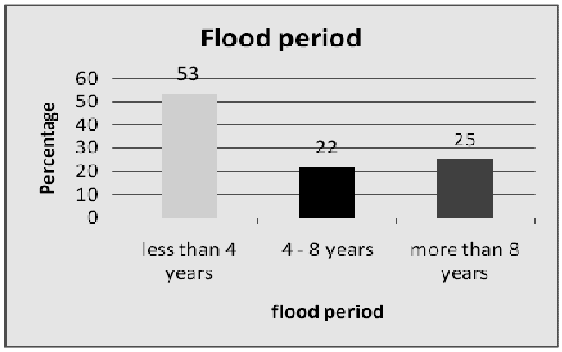

Figure 11: Flood period

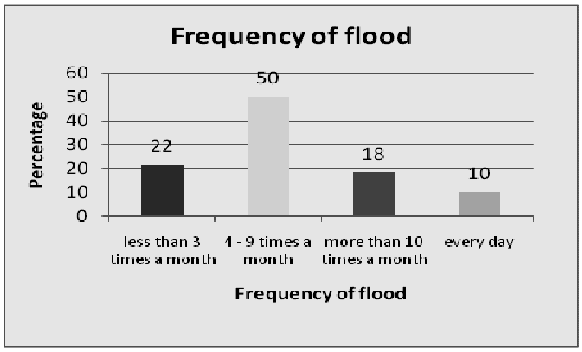

Figure 12: Frequency of flood

It should be mentioned that whenever the flood occurs, it inundates from less than one day to more than 5 days. It shows in figure 13, highest percentage of respondents experienced flood inundates their houses in within 1 day on one occurrence. Meanwhile about 6% of the respondents endure flood for more than 5 days. Table 14 shows that flooding occurs in various height. The most common situation is when the flood inundates in 0 – 0.5 meter height. Meanwhile the worst situation is when the flood inundates more than 1 meter height.

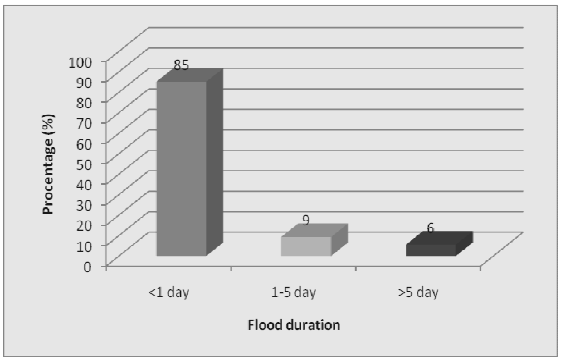

Figure 13 : Flood duration

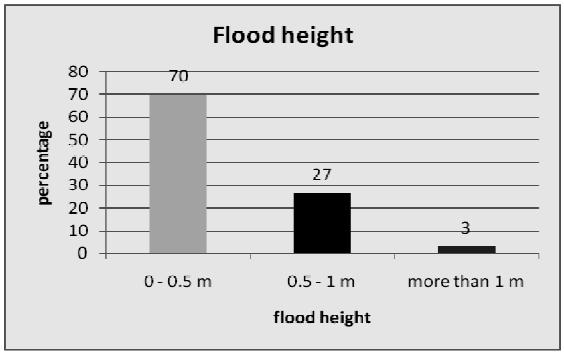

Figure 14: Flood height

The data shows that tidal flood has been suffering people in Semarang for more than 8 years. It is getting wider to other areas therefore some people just have been suffering the tidal flood less than 4 years. Due to tidal movement, the people in inundated areas experienced the tidal flood occur within a range less than 3 times to every day in a month. Commonly, the flood inundates less than 1 day, however it can be more than 5 days length inundation. Normally tidal flood arises in 0 – 0.5 meter height per occurrence; however it can be more than 1 meter height in one occurrence which the depends in the height if the high tide.

5.2.3 Characteristic of Inhabitants in Present Inundated Areas

In Semarang, 71.395 inhabitants in 6 sub districts have been suffering from tidal flood (Statistic Bureau, 2006). Table 15 shows the number of inhabitants for each sub district:

Table 15*: Population in present inundated areas*

Districts	Sub Districts	Population (year 2006)
Semarang Barat	Tambakharjo	1.945
	Tawangsari	6.416
Semarang Utara	Panggung Lor	14.371
	Bandarharjo	19.217
	Tanjung Mas	28.932
Genuk	Terboyo Kulon	514
TOTAL		**71.395**

Source : Statistic Bureau, 2006

The inhabitants of the inundated areas are characterized by their profession, income level, education level and housing ownership. According to the questionnaires, the inhabitants at present inundated areas have various professions. Most of respondents work as small business entrepreneur, meanwhile only few of respondents work as fisherman. Since the survey was held during workdays, about 25% of respondents work in profession that allows people to be at home during the day, like housewife, pensioners and university students. The income level of respondents is various. Most of respondents earn IDR 500.001,00 – IDR 1.500.000,00 (€ 36 - € 100) per month. It means most of respondents are middle income level. Meanwhile only few people are from high income level, which earn income more than IDR 2.500.000,00 (more than €

166) per month. The high income people have larger opportunity for adaptation responses than the low income and middle income people, since they can afford more money for adaptation cost. The relation between income level and adaptation cost will be explained in the next chapter. The occupation category and the income level of respondents can be seen in the figures below :

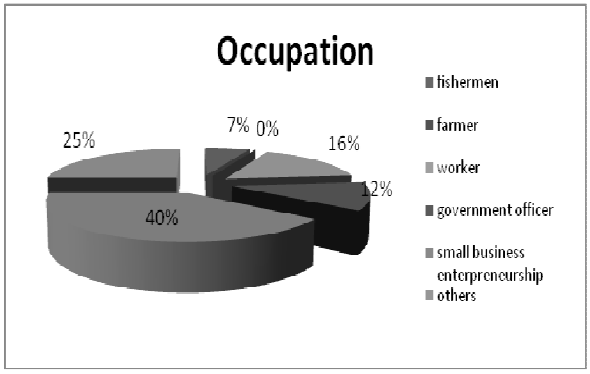

Figure 15: Occupation

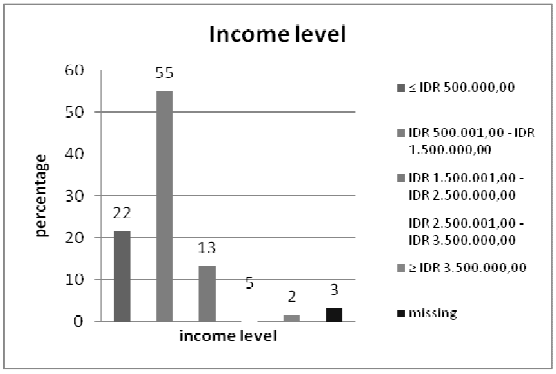

Figure 16: Income Level

In terms of education level, most of respondents graduated from high school, and about 29% are university/ college graduate. Only 3% of respondents are uneducated. The education level influences people's knowledge in dealing with tidal flood. People who are uneducated know about climate change or disaster less than educated people.

The other characteristic of inundated inhabitants is housing ownership. Most of the respondents live in their own houses. Meanwhile some respondents live in rented houses or stay in their relative's houses. The housing ownership is used to analyze people's willingness for doing adaptation measures. The distribution of education level and housing ownership can be seen in the figures below:

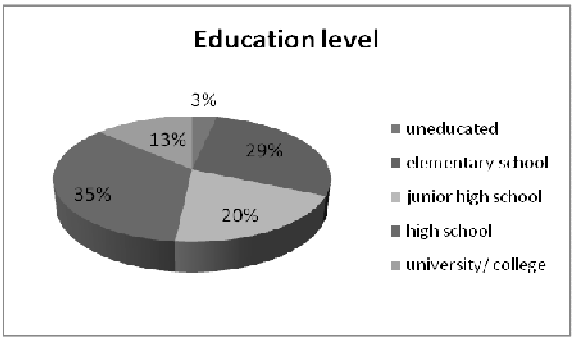

Figure 17: Education Level

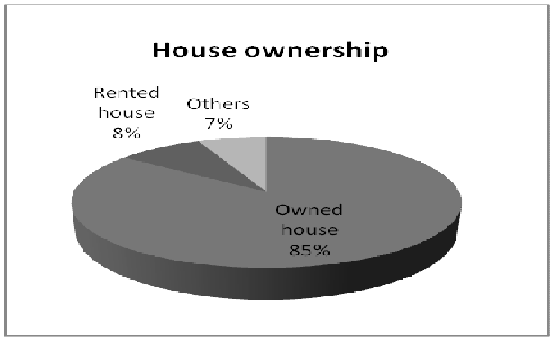

Figure 18: House ownership

According to Satterthwaite (2009), individuals or household resources such as income, asset and knowledge influence people's capacity to avoid the hazard or to adapt the risks. Households or neighbourhoods with higher level of income level are better to manage vulnerabilities and the impacts of tidal flood. The income level is related to the willingness and ability of people to compensate the adaptation measures. Meanwhile the knowledge of people is related to education

level. It is assumed that the higher education level, the more knowledge people have about tidal flood. Houses are people's property that will be protected from hazards. People who live in their own houses are more aware due to tidal flood than people who live not in their own houses.

5.3 The current effects of tidal flood

5.3.1 Social effects

Tidal flooding has been affecting the social condition of inhabitants for years. Based on the observation during the fieldwork and analysis result of the interview to 60 people, in terms of health condition, 47% of respondents or 23 respondents have been suffering from diseases due to tidal flooding (complete information see Annex 6). Figure 19 describes the diseases have been suffered by inhabitants due to flooding. It shows that skin disease is the most suffered diseases with 46% of respondents. Meanwhile people not only suffer from one disease but also two diseases such as diarrhea and skin disease or diarrhea and dengue. The other diseases as a result of tidal flooding are throat and leptospirosis which is caused by rodents.

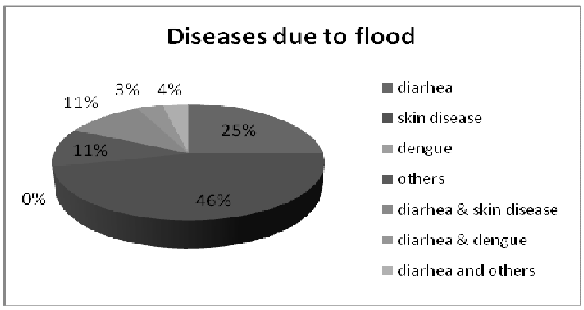

Figure 19: Diseases due to flood

This situation is corresponding with views expressed in the literature review. It is stated that the potential of health impacts due to flood are diarrhea, cholera, skin diseases, dengue, physical disturbances and injuries. Most of these diseases are caused by contaminated water, sewage system and animal diseases. People in present inundated areas are suffering from diarrhea, skin diseases, dengue, throat and leptospirosis due to tidal flood. It can be assumed that occurences of diseases due to flood related to the water and sewage system condition. It also can be said that people in inundated areas are suffering from diseases because their water is contaminated by flood.

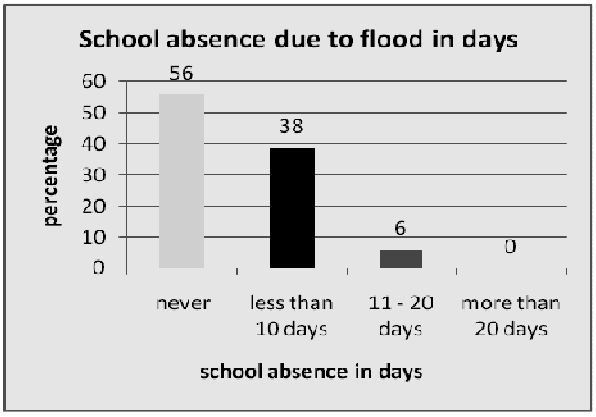

Figure 20: **School absence due to flood in days**

In terms of education, tidal flooding affects the children for going to school. From 50 respondents, most of them have family members that study at school regularly (complete information see Annex 6). Due to tidal flood, the respondents' family member cannot go to school in range 1 – 20 days a year. The most of respondents (56%) indicate their family members are not affected terribly by tidal flooding, so they still can go to school even flood occurs in their neighbourhood. This situation indicates that flood does not hamper all the people to go for studying. They still have motivation and eagerness even if the flood occurs in their area.

According to an interview with Planning and Development Board official, the social effects of tidal flood are various, and education is the most affected sector due to tidal flood. He stated that flood is damaging school buildings. Nevertheless, the school buildings are not only caused by tidal flood, but also by local flood and river flood. There are 58 school buildings from kindergarten to university in research area, and most of them are affected by flood. The effects of flood on school buildings affect to financial cost of the city government to renovate them. This condition is similar with Wuryanti (2001) who stated that in terms of education, flood damage school buildings. The detail number of school buildings in inundated areas are listed below :

Table 16 ***: Number of school buildings***

Sub Districts	School Building				
	Kindergarten	Elementary school	Junior high school	High school	College/ University
Tambakharjo	3	2	1	-	-
Tawangsari	1	-	1	2	-
Panggung Lor	5	3	1	1	-
Bandarharjo	8	9	1	-	-
Tanjung Mas	7	7	3	1	-
Terboyo Kulon	-	-	1	-	1

Source : Statistic Bureau, 2006

Based on the data, it can be observed that tidal flood affects the health condition of people which also related to the condition of water and the sanitation system. In term of education, tidal flood is not significantly affecting people to go for studying. However, many school buildings are damaged due to tidal flood and other types of flood in Semarang which consequently affect the financial cost of the city government to renovate them.

5.3.2 Economic effects

Economic condition of inhabitants in inundated areas is affected by tidal flood. The inhabitants lose their income and cannot go to work when the flood occurs. From 60 respondents, 47% of respondents or 28 respondents lose their income due to tidal flood (complete information see Annex 6). Whereas the rest do not lose their income whenever flood occurs. It can be observed that the loss of income ranges from less than 20% of income to more than 50% of income. Table 17 shows the most of respondents lose 21% - 50% of their income.

Table 17 ***: Distribution of Loss of income***

Income decrease	Frequencies	Percentage
Less than 20%	11	39.29
21% - 50 %	12	42.86
More than 50%	5	17.86
Total	28	100

Since only 47% of the respondents lose their income due to tidal flood, it means that tidal flood affects some professions. Table 18 shows relation between profession and loss of income variable. It describes the loss of income of each professions and the most affected profession.

Most respondents lose their income due to tidal flood work as small business entrepreneur. The least affected professions are fisherman and government officer. As mentioned before many people are working as small business entrepreneur, and they place their business in the inundated area, consequently many of them are affected by tidal flood. Meanwhile only few people who work as fisherman, labor, government officers and others (housewife, pensioners, and university student) lose their income due to tidal flood.

Table 18: Relation between profession and percentage income decrease

			profession					Total
			fisherman	labor	government officer	small business entreprise	others	
persentage_income_decerase	less than 20%	Count	0	3	0	7	1	11
		% of Total	.0%	10.7%	.0%	25.0%	3.6%	39.3%
	21% - 50 %	Count	2	1	1	7	1	12
		% of Total	7.1%	3.6%	3.6%	25.0%	3.6%	42.9%
	more than 50%	Count	0	0	1	3	1	5
		% of Total	.0%	.0%	3.6%	10.7%	3.6%	17.9%
Total		Count	2	4	2	17	3	28
		% of Total	7.1%	14.3%	7.1%	60.7%	10.7%	100.0%

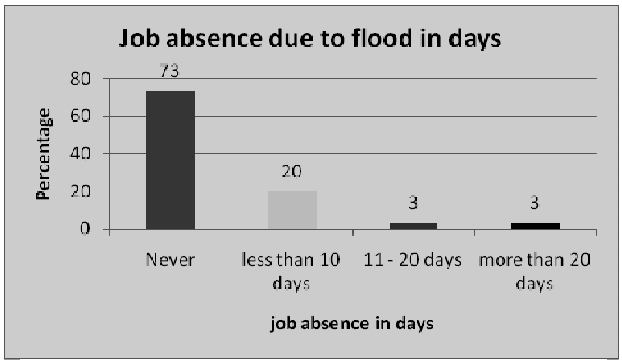

Figure 21. *: **Job absence due to flood in days***

Beside losing their income; the people living in inundated areas also lose their opportunity to go to work. The distribution of inhabitant's experience of this situation can be seen in figure 21 as follows. It can be observed that most of respondents still go to work whenever the flood occurs. It means that the flood does not significantly affect most of respondents to go to work. However, few people cannot go to work whenever the flood occurs more than 1 meter height and cover their way to go to work.

As mentioned before in literature review, floods cause loss of property and damage houses and furniture. According to an interview with the Planning and Development Board official, most of houses in inundated areas are damage due to flood. The number of houses in present inundated areas is about 16759 houses and most of them are damaged due to flood. The detail number of houses in inundated areas is listed below :

Table 19: Number of houses in present inundated areas

Districts	Sub Districts	Number of houses
Semarang Barat	Tambakharjo	469
	Tawangsari	1597
Semarang Utara	Panggung Lor	3392
	Bandarharjo	4399
	Tanjung Mas	6160
Genuk	Terboyo Kulon	137

Based on the data, it can be observed that flood affect people's income significantly especially for small business entrepreneur. However, the flood does not affect people's opportunity to go to work significantly. It shows that even the tidal flood occurs in their neighbourhood, it does not keep them from working. Moreover the damages on houses in inundated areas are not only caused by tidal flood, but also by other types of flood in Semarang.

5.3.3 Environmental effects

In terms of environment, tidal flooding has been affecting drinking water and sanitation systems in inundated areas. Based on the analysis of the result of the 60 respondents, it can be observed 57% of respondents (34 people) experience no effects on their drinking water due to flood. Whereas 26 people experience various effects on their drinking water (complete information see Annex 6). Table 20 shows distribution of effects of drinking water form 26 respondents. Most of respondents experience that their drinking water has changed its colour. Meanwhile some of respondents feel more than one effect in their drinking water.

As reviewed in the literature, good quality drinking water should require physical, chemical and microbiology criteria. People only can notice the physical criteria of drinking water since it is easy to recognize, whereas people cannot determine the chemical and microbiology criteria in drinking water, because it needs laboratorial experiment. The changes in drinking water are related to health condition of inundated inhabitants. Contaminated water can threaten the health condition. However it needs laboratorial experiment to check the quality of drinking water in inundated areas due to flood.

Table 20: Distribution of effects to drinking water due to flood

Effects	Frequencies	Percentage
Color	7	26.92
Smell	3	11.54
Residue	3	11.54
Others	2	7.69
Color & smell	4	15.38
Color & residue	2	7.69
Smell and residue	2	7.69
Color, smell and residue	3	11.54
Total	26	100.00

In line with the drinking water problem, sanitation systems are also affected by tidal flood. Based on the questionnaires of 60 respondents, about 60% of them experience effects to their sanitation system (complete information see Annex 6). Table 21 shows that the highest percentage of the effects is bad smell. Some of respondents also experience more than one effect in their sanitation system such as waste overflow and bad smell.

As mentioned by Kusnosaputro (1985), domestic waste water generally contains hazardous element, and if it overflow it can harm people health. It is in line with the situation in present inundated areas. Due to tidal flood, the sanitation systems are damage affect the waste water overflow and bad smell. Moreover it can threaten the health condition of people in inundated areas.

Table 21*: Effects to sanitation system*

Effects	Frequencies	Percentage
Waste waster overflow	5	13.89
Bad smell	9	25.00
Damage the sanitation system	5	13.89
Others	3	8.33
Waste water overflow & bad smell	6	16.67
Bad smell & damage sanitation system	1	2.78
Bad smell & others	2	5.56
Waste overflow, bad smell and damage sanitation system	5	13.89
Total	36	100.00

To sum up, tidal flood has been affecting environment quality of inundated area. Condition of both of drinking water and sanitation system are decreasing due to flood. According to Wuryanti (2001), flood threatens and contaminates water supply and as result it causes epidemic diseases such as diarrhea and skin diseases. Meanwhile the sanitation system which contains hazardous elements damages and also threatens the health condition of people. It indicates that the environmental effects and health effects of flood are interrelated. Decreasing quality of water and sanitation system will decrease the people's health condition.

5.4 The current adaptation responses to tidal flood

Since the tidal flood occurs periodically, the inhabitants have adapted to the hazard. This chapter focuses on present adaptation responses that have been done by people and the city government in inundated area, both physical and non physical adaptation measures.

5.4.1 Non physical adaptation

As mentioned by Munangsihe & Swart (2005), adaptation strategies in human settlements should be focus on planning and design, management and institutional changes as non physical

strategies. The non physical adaptation strategies are done by the city government, since to achieve successful adaptation it should be locally based (Munangsihe & Swart, 2005). Data from in-depth interview with the city governments and secondary data are analyzed in this chapter. The respondents of in depth interview are Planning and Development Board, Water Management Agency, District and Sub District offices.

Tidal flood management is part of flood management in Semarang, since the inundated areas due to tidal flood are also inundated by local flood and river flood. Therefore discussion of how to deal with tidal flood cannot be separated from discussion about flood management in Semarang. Flood management in Semarang is managed by two main institutions which are Planning and Development Board (PDB) and Water Resource Management Agency (WMA). Planning and Development Board is responsible to plan and to regulate the flood management in Semarang, whereas Water and Management Agency is responsible to implement and manage the flood management. Meanwhile district and sub district offices responsible to support the city government's regulation and implementation to deal with the flood.

According to an interview with the PDB official, in terms of roles and responsibilities of institutions in dealing with tidal flooding, PDB always has coordination with other institutions in Semarang especially WMA in dealing with flood problems. Meanwhile, key person from WMA stated that in terms of authority to the rivers in Semarang, intuitionally flood management in Semarang is under responsibility central government, provincial government and the city government itself. Every level of stakeholders has their own responsibility and share the financing system.

In terms of coordination with other institutions, the key person from the WMA stated that in dealing with flood problems, WMA coordinates with other institutions concerning to financing, legalization, and community participation. In terms of financial problem, WMA has coordination with City Revenue Agency who manages the city government's revenue. Whereas in terms of regulation and legalization, WMA has coordination with the City Law Agency. WMA is also supported by district and sub district offices in terms of operational and maintenance of the drainage systems and also to persuade people to maintenance the drainage system. The Environmental Agency is also involved to manage and keep clean the drainages from waste. Meanwhile to manage land where the flood management system will be located, WMA has coordination with The City Planning Agency and Land Agency.

In dealing with flood problems, the city governments face many constraints. According to the WMA official, the main problem is limited financial capacity of the city government to finance the flood management. Therefore the city government needs financial assistance from the central government and the provincial government. However it leads to another problem which is related to financial responsibilities of the stakeholders. Since to develop flood management infrastructures is financed by the central government, the provincial government and the city government itself, therefore the owner of those infrastructures is undecided. Now, the city government by the City Revenue Agency is developing a financial scheme to solve that problem. In addition the PDB official mentioned that the other problem in developing flood management in Semarang is low awareness of people in inundated areas to maintenance and look after the flood infrastructures. Moreover he added that low of law enforcement in implementing the

zoning and land use planning especially in coastal areas of Semarang is also one of the problems in dealing with flood problems. People can against the planning easily and still occupy and develop the land even though it is regulated not for develop areas. This situation may force land subsidence in coastal areas and consequently it may worse the tidal flood.

As being summarized from interview with PDB and WMA officials, the non physical adaptation measures have been doing by the city government are:

- Announce people in inundated areas about flood infrastructures.
- Announce people living in inundated areas about establish polder systems to.
- Facilitate people in some areas to finance their adaptation measures.
- For now, the city governments under the responsibility of PDB and WMA are developing Semarang Drainage Master Plan Systems which is aiming to integrate all of the drainage systems in Semarang in order to anticipate flooding for the next 20 years. This master plan integrates physical and non physical measures, which developing the drainage systems from upstream to downstream areas and building capacity for people in inundated areas. However, due to complex bureaucracy, until now the master plan has not legalized yet by the city council.

As mentioned earlier non physical adaptation measures should be focused on planning and design, management and institutional changes. The non physical adaptation measures have been done by Semarang city government sorted of into those categories, which are listed below :

Table 22: Adaptation measures done by the city government

Adaptation	Measures	Related Institutions
Planning and design	Zoning and land use planning	City Planning Agency
	Semarang Urban Drainage Masterplan Project (SUMDP) (2000)	Water Resource Management Agency and funded by World Bank
	The Master plan On Water Resource Development And Feasibility Study For Urgen Flood Control And Urban Drainage In Semarang City And Suburbs (1993)	Water Resource Management Agency and Japan International Cooperation Agency (JICA)
	Semarang Flood Control Project-Consolidated Preparation Study (1997-1999)	Water Resource Management Agency
	The Detailed Design of Flood Control, Urban Drainage and Water Resources Development in Semarang in the Republic Indonesia (1998)	Water Resource Management Agency
	Master Plan Drainage Kota Semarang (2007)	Water Resource Management Agency, Planning and Development Board, The Netherland Government
Management	Polder system improvement involving local community	Water Resource Management Agency
	Socialization to people in inundated areas about flood infrastructures	Water Resource Management Agency
	Socialization about polder system	Water Resource Management Agency

Adaptation	Measures	Related Institutions
	Maintenance the drainage cleanliness from waste	Environmental Agency, District and Sub District Offices
	Develop early warning system	Water Resource Management Agency
Institutional changes	Capacity building to improve people's participation in operational and maintenance the flood infrastructures	Water Resource Management Agency, District and Sub District Offices
	Establish partnership between stakeholders (central government, provincial government and the city government)	Planning and Development Board

Adaptation measures done by the Semarang city governments are planned adaptation, since all of them are policies and planning. The city government has goals to reduce the effects of flood and build the awareness of people to deal with flood problems. As mentioned by Munangsihe & Swart (2005), successful adaptation should involve every level of government, private sectors and citizens since adaptation imply changes, technological solutions and institutional adjustments. However in Semarang, the city governments have engaged other level of governments and citizens in implementing their adaptation measures. The private sector is not involved yet, since the private sectors do not consider about adaptation cost in their companies' policies. Therefore to succeed adaptation responses to deal with flood problem in Semarang, it is better if the city government can involve the private sectors in it.

The tidal flood problem is part of the flood management in Semarang. In fact tidal flood is not only related to the flood issues, but also related to coastal areas management issues. One of causal factor of tidal flood is land subsidence which is caused by over development in coastal areas. Therefore in dealing with tidal flood, it is necessary for the Semarang city government to take into account Integrated Coastal Management (ICM). As mentioned in chapter 2, ICM is a policy tool that engages all level of stakeholders to administer the use, develop and protect the coastal zone. By developing ICM, the city government can focus on the development and protection of the coastal zone. ICM in Semarang can be explained into projects and programs which can be in line with flood management and spatial planning of Semarang. Moreover within ICM framework that involves stakeholders from national level to local community level, sustainability in coastal areas can be achieved.

5.4.2 Physical measures

This section explains physical adaptation measures in dealing with tidal flood done by both the inhabitants in inundated areas and the city government. Physical measures are mainly to protect and accommodate the land from flood. The data were collected from questionnaires to people in present inundated areas and in depth interview with the city governments.

Based on the analysis of the interview of 60 respondents, it was observed that 53 respondents or 88% of them have been doing some adaptation measures to deal with tidal flood in their house (complete information see Annex 6). Meanwhile the rest never do some adaptation measures. Many types of adaptation measures have been done by the respondents. Table 23 shows that most people have been elevating their houses and raising their floor level to prevent their houses

from tidal flood. Since one response did not enough protect their houses from flood, therefore people have done some more responses. At the end there are 11 adaptation measures have been doing by people in inundated areas. The responses also depend on the damage and people's willingness to compensate the responses.

Table 23: Type of Adaptation Responses

No	Type of Responses	Frequencies	Percentage
1	Elevate the house	11	21
2	Raise the floor level	11	21
3	Raise the yard level	7	13
4	Build dam to prevent water	4	8
5	Elevate the house & raise the floor level	6	11
6	Raise the floor level & raise the yard level	4	8
7	Elevate the house & build dam to prevent water	2	4
8	Raise the yard level & build dam to prevent water	2	4
9	Elevate the house, raise the floor level & raise the yard level	4	8
10	Elevate the house, raise the floor level & build dam	1	2
11	Elevate the house, raise the yard level & raise the yard level	1	2
	Total	53	100

As mentioned in chapter two, there are three types of adaptation measures can be done by people in coastal area. These are protection, accommodation and retreat which are related to physical measures. Based on the observation and analysis result of questionnaires, the adaptation measures done by respondents are categorized in accommodation. Accommodation is continuing to occupy the land and make some adjustments. People in inundated areas are still living in their houses, meanwhile they are adapting their houses in order to reduce the effects of tidal flood. The respondents did not do protection measure such as build a seawall, since they assume it should be done by the city government. For now they do not prefer moving to other saver areas, since they are still able to accommodate the effects of tidal flood in their houses.

People in inundated areas have been compensating for adaptation cost. Table 24 shows the amount of adaptation measures is costed by the respondents. Cost of adaptation is ranging from less than IDR 1.000.000,00 (≤ € 65) to more than IDR 10.000.000,00 (≥ € 600). Most of the respondents (40%) spend IDR 5.000.001,00 - IDR 10.000.000,00 (€ 301 - € 600) for their adaptation measures. Meanwhile only 2% of the respondents spent more than IDR 10.000.000,00 (≥ € 600). The adaptation costs are various depend on their financial capacity, the damage and the kind of measures. People's capacity to cost their adaptation measures is related to their income level. High people income mostly are able to cost more than the low income people. Meanwhile the damage scale of their houses also affects the amount of adaptation costs. The worse the damage and the more complicated the measures, the more costs people compensate for their adaptation measures.

Table 24: Adaptation Costs

Amount of Adaptation cost	Frequencies	Percentages
Less than IDR 1.000.000,00 (≤ € 65)	17	32
IDR 1.000.000,00 - IDR 5.000.000,00 (€ 66 - € 300)	21	40
IDR 5.000.001,00 - IDR 10.000.000,00 (€ 301 - € 600)	13	24
More than IDR 10.000.000,00 (≥ € 600)	2	4
Total	**53**	**100.00**

Since the damages due to tidal flood are worse the time after time, people living in inundated area have been doing adaptation measures for several times. Based on the analysis of the respondents, they do adaptation responses regularly. The frequencies to do adaptation responses are various. Most of respondents (43%) have been doing adaptation responses one time in two years. The others do it once in a year and more than once a year since the flood is worse every time. Meanwhile some of respondents have been doing adaptation responses once in more than two years for instance once in four years and once in five years. Table 25 shows the frequency of people to do adaptation measures.

The data shows that the frequency of doing adaptation measures depends on people's finance capacity, the damage on their houses and the condition of tidal flood. If the flood occurs continually, it will inundate the houses frequently. Consequently the damages of the houses will be worse time after time. Therefore the people in inundated areas frequently do adaptation measures to their houses in order to minimize the effects of tidal flood. People's financial capacity also affects their reason to do adaptation measures frequently. It can be assumed that if the damages in people's houses are getting worse and they are able to cost the adaptation measures, the adaptation measures can be done more frequently.

Table 25: Frequency to do adaptation measures

Frequency to do adaptation measures	Frequencies	Percentage
Once in two years	23	43
Once a year	9	17
More than once a year	3	6
Once in more than two years	18	34
Total	**53**	**100**

Besides doing adaptation measures to their houses, the inundated inhabitants also do adaptation measures in their neighbourhood. Based on the analysis, it can be observed that most of the respondents have been doing adaptation measures in neighbourhood level in order to protect their neighbourhood and also their houses from tidal flood. Table 26 shows that about 37% of the respondents have been elevating the street level around their houses. Some respondents have been doing more than one adaptation measure. Meanwhile about 15% of the respondents never do adaptation measures in their neighbourhood.

The situation shows that people in inundated areas are able to organize themselves to cope with the tidal flood problems. They also cost the adaptation measures by themselves through collecting money from the community. It can be said that without any intervention from the city governments, the people in present inundated areas can protect themselves.

Table 26 : Adaptation Measures in Neighbourhood Level

No	Adaptation Measures	Frequencies	Percentage
1	Nothing	9	15
2	Elevate the street	22	37
3	Improving drainage system	5	8
4	Creating dyke system	4	7
5	Provide pumps	4	7
6	Others	0	0
7	Elevate the street & improving drainage system	6	10
8	Elevate the street & creating dyke system	1	2
9	Elevate the street & provide pumps	1	2
10	Improving drainage system & provide pumps	5	8
11	Elevate the street, improving drainage system & provide pumps	2	3
12	Elevate the street, creating dyke system & provide pumps	1	2
	Total	60	100

As mentioned in the second chapter, adaptation measures done by community without any intervention from government is categorized in to autonomous adaptation. The condition in Semarang shows that people in inundated areas are willing to do adaptation measures both on their own houses and on their neighbourhood all by themselves even without any forces from the city government.

Besides doing non physical adaptation measures, the city governments also have been doing some physical measures. As mentioned in the previous chapter, tidal flood management is part of flood management in Semarang, therefore all of measures are implementing to deal with all of types of flood. The city government develops flood management more focused on development and management drainage system in Semarang. As summarized from the interview with PDB and WMA officials and Planning and Development Board (2007), the physical measures are being done by the city governments are :

- Development of seawall to protect land from sea water.
- Development of Tawang Polder (done)
- Development of Dombo – Sayung drainage (not been operasionalized yet)
- Develop polder system.
- Provide pumps in several locations to suck out sea water. For now about 28 pump stations are located in inundated areas.
- Clear out the drainages from sediment and waste.
- Development of Jatibarang Dam (will be built in year 2010)

- Development of Banger polder (will be built in year 2010). This project is aiming to deal with tidal flood in the future which is worse continually. Banger Polder system consists of wall barrier in settlement areas to protect from sea water and pumps stations.

In addition, according to the WMA officer, they also do some adaptation measures in neighbourhood areas. They applied adaptation measures in the inundated areas based on their planning and priority, damage in the inundated areas and capacity of the community to do their own adaptation measures. The city government prioritizes to apply structural adaptation measures to the low income communities, since the low income communities have limited financial capacity and ability to do their own adaptation measures. Meanwhile the middle income and high income communities are able to manage themselves to do adaptation measures. The WMA officer added that the low income people can propose to the city government to finance adaptation measures in their area. Moreover people in present inundated areas also can participate to the city government's plan in dealing with the flood problems in their areas.

Meanwhile other interviewees with District Semarang Barat and Sub District Tawangsari officials explained that they only responsible to operate and maintenance the flood infrastructures, such as drainage systems. They are also responsible to stimulate and gain people participation to maintenance the flood infrastructures.

In line with statement from the city government officers, the respondents perceived that the city governments also do adaptation measures in their areas. The city government develops some adaptation measures based on the people's initiatives. Table 27 shows that most of respondents (35%) experienced that the city government has been elevating the street level. The city government not only did one measure in one place, but sometimes the city government did two or more responses in one area. However about 27% of the respondents stated that the city governments never do adaptation measures in their area.

Table 27 : Adaptation measures by the city government

No	Adaptation Measures	Frequencies	Percentage
1	Nothing	16	27
2	Elevate the street	21	35
3	Improving drainage system	1	2
4	Creating dyke system	2	3
5	Provide pumps	5	8
6	Others	1	2
7	Elevate the street & improving drainage system	6	10
8	Elevate the street & creating dyke system	1	2
9	Improving drainage system & provide pumps	2	3
10	Elevate the street, improving drainage system & provide pumps	1	2
11	Elevate the street, creating dyke system & provide pumps	1	2
12	Missing	3	5
	Total	60	100

Regarding to the data and information from the inhabitants in inundated areas and the city governments, it can be concluded that there are 4 types of physical adaptation measures done by both the inhabitants and the city government, which are :

- Adaptation measures that are totally done by the inhabitants in inundated areas, without any interventions from the city government. They plan, apply, finance and maintenance the measures on their houses and on their neighborhood.
- Adaptation measures in the neighborhood level are done by the inhabitants, but with financing from the city government. The communities propose to the city government to finance the adaptation measures in their areas.
- Adaptation measures done by the city government with initiatives from the inhabitants in inundated areas.
- Adaptation measures done by the city government and based on their initiatives and plans. However the city government still involve community participation in operation and maintenance the flood infrastructures.

According to the situation in dealing with tidal flood in Semarang, adaptation measures have been done by people in their houses and neighbourhood are classified as autonomous adaptation, because those are done by people itself. Since people living in inundated areas do the adaptation measures after the impacts of tidal flood have occurred, therefore they can be classified as reactive adaptation. The adaptation measures in neighbourhood level as reaction to tidal flood, shows that community bases adaptation is important. The city government can achieve and increase their effectiveness of their action to deal with tidal flood based on community adaptation.

Adaptation measures done by the city governments can be classified to protection and accommodation strategies. As mentioned by Munangsihe & Swart (2005), protection strategy is done to protect land from sea by constructing hard structures, meanwhile accommodation strategy is done to make some adjustment to still occupy the land. Most of adaptation measures done by the city governments are protection. It is aiming to protect the area and the inhabitants from floods, including tidal flood.

5.5 Predicted Condition of Tidal Flood

This section describes the predicted condition of tidal flood based on the literature review and secondary data. The predicted condition of tidal flood is observed by predicted inundated areas and characteristic of people living in predicted inundated areas.

5.5.1 Predicted Inundated Areas

The inundated area is getting worse every year. Tidal flooding is predicted only to occur in coastal areas, but also will spread to other areas in the city. Wibowo (2006) predicted that 5 more districts will be inundated by year 2015. This prediction is based on analysis of land subsidence and sea level rise happened in Semarang coastal area. Now, tidal flood are inundating 6 sub districts in 3 districts in Semarang coastal area. Moreover based on the prediction, 71 sub districts within 8 districts will be inundated. The number of inundated area increases significantly in 8 years. The predicted inundated area is presented in the figure below :

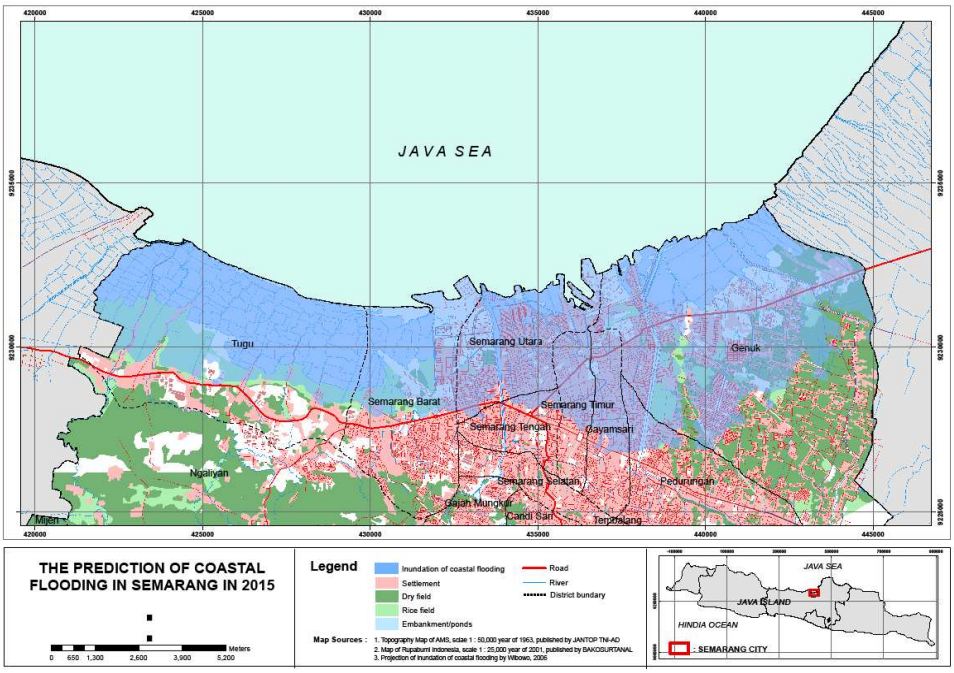

Figure 22: Predicted Inundated Area

The expected area covered by tidal flood by year 2015 is about 8527.78 ha which is about 21.97% of Semarang area. The tidal flood is predicted will inundate the areas far from the coastal areas. Settlement areas, embankments, farms, commercial are and industrial areas will be inundated by tidal flood. The predicted inundated area is listed below :

Table 28 : Districts Predicted will be Inundated by year 2015

No	Districts	The width of districts	The inundated areas
1	Tugu	2997 ha	2498.79 ha
2	Semarang Barat	2202 ha	1013.45 ha
3	Semarang Timur	561 ha	296.88 ha
4	Semarang Utara	1140 ha	1095.95 ha
5	Semarang Tengah	535 ha	76.89 ha
6	Gayamsari	643 ha	338.59 ha
7	Genuk	2730 ha	3008.97 ha
8	Pedurungan	2200 ha	198.26 ha
	TOTAL	**13.008 ha**	**8527.78 ha**

Source : Wibowo, 2006

The prediction shows that tidal flood threatens not only people living in the coastal area, but also people from the other areas in the city. It is necessary that the people in present and predicted inundated areas and the city government to be aware this situation in order to minimize the effects will be happened.

5.5.3 Characteristic of Inhabitants in Predicted Inundated Areas

Based on projection that has been done in chapter 3, by year 2015 tidal flood will inundate about 1.008.219 inhabitants in 71 sub districts in Semarang. The projection of population in inundated area in year 2015 is presented below :

Table 29 :Prediction of Population by the year2015

No	Districts	Number of sub districts	Population (year 2006)	Prediction of population (year 2015)
1	Tugu	7	24.593	43.087
2	Semarang Barat	9	75.392	99.170
3	Semarang Timur	10	83.733	110.153
4	Semarang Utara	9	124.273	148.051
5	Semarang Tengah	15	76.026	115.656
6	Gayamsari	7	67.522	86.016
7	Genuk	11	58.824	87.886
8	Pedurungan	3	68.155	76.081
	TOTAL	**71**	**578.518**	**766.100**

Source : Statistic Bureau, 2006 and Author, 2009

To know the characteristic of the inhabitants in the predicted inundated areas, a survey was held on 50 respondents. They are characterized by their profession, income level, education level and housing ownership. Moreover these characteristics are used to analyze the adaptive capacity of the people in the predicted inundated areas which is presented in the next chapter.

According to the survey, the inhabitants of predicted inundated areas work in various professions. Most of them work as small business entrepreneur. Meanwhile about 30% of respondents are housewives and university students. No respondent work as fishermen because this area is far from the sea. The income level of respondents is various. As same as with people in present inundated areas, most people live in predicted inundated areas earn an income of IDR 500.001,00 – IDR 1.500.000,00 (€ 36 - € 100) per month. They can be categorized as middle income people. Only few respondents are obtain high incomes, earning more than IDR 2.500.000,00 (≥ € 166) per month. The distribution of occupation and income level of people in predicted inundated areas are presented below :

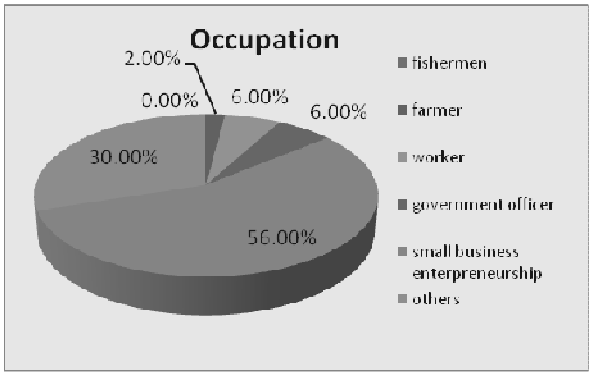

Figure 23 : Occupation

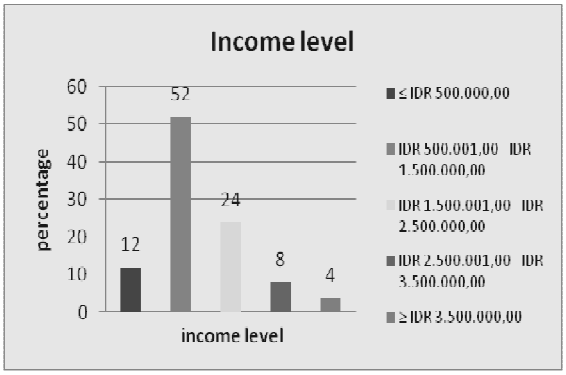

Figure 24 : Income Level

In terms of education level, all of respondents are educated. Most of respondents graduated from high school, meanwhile about 14% are university/ college graduate. The rest of respondents are elementary and junior high school graduate.

Another characteristic of people in predicted inundated areas is house ownership. More than 50% of respondents live in their own houses, meanwhile the other live in rented houses or their relatives' houses.

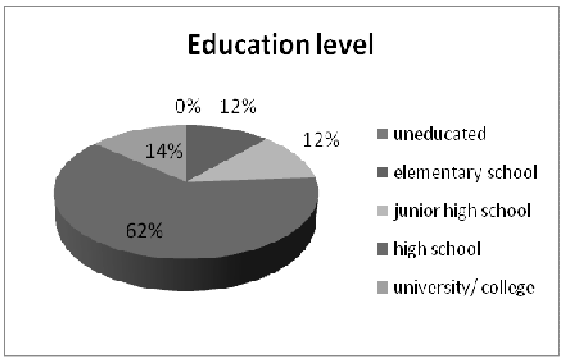

Figure 25: Education level

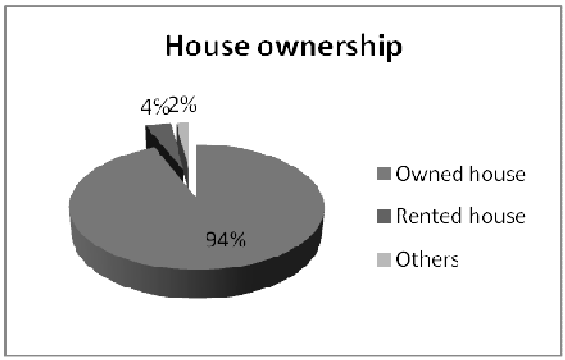

Figure 26: House ownership

Those characteristic of inhabitants in predicted inundated areas are used to analyze the adaptive capacity of people to overcome tidal flood in the future. It will be analyzed in following section.

5.6 Adaptive capacity to coping with increasing tidal flood

As being analyzed earlier, it is found that tidal flood has been affecting people in coastal area and has been driving people to do adaptation measures to minimize the effects of tidal flood. In order to minimize the losses due to flood in the future, both people living in present inundated areas and predicted inundated areas together with the city government should take into account the condition of flood in the future. This chapter focuses on adaptive capacity of people and the city government to overcome the result of the flood in the future. In the end it comes up with adaptation measures that could be done by people and the city government in the future.

As mentioned in the second chapter, adaptive capacity of community or government is determined from economic resources, technology, availability of information and skills, infrastructure, institutions and equity access to resources. Analysis adaptive capacity if the people and Semarang city government to respond and coping with the future risks of tidal flood is assessed from the survey, in depth interview with the city governments and secondary data.

5.6.1 Economic Resources

The economic resources are related to economic asset, financial means and the economic condition. As mentioned also by Sattertwaite et.al (2009), in terms of economic resources, income level influences the adaptive capacity of individual or household.

It has been mentioned in section 5.2 that most of people in present inundated areas are categorized as middle income people, however some of them are low income and high income people. That is exactly the same with the people in predicted inundated areas. As mentioned by McCharty et.al (2001), vulnerability to hazard is related to poverty and increasing income of people can decrease the vulnerability. It means that poor people or low income people are difficult to protect themselves from hazard due to financial constraints. Neighbourhoods with higher level income are better to manage and to cope the tidal flood effects. The income level is also related to the willingness and ability of people to compensate the adaptation measures. Low income people faces financial constraints to finance their adaptation measures and it decrease their vulnerability to the tidal flood. Therefore it is necessary for the city government to reduce the vulnerability of low income people.

Economic asset are determined by housing ownership. As mentioned before in the previous chapter, both people in present inundated areas and predicted inundated areas mostly live in their own houses. Meanwhile the other live in rented houses and their relatives' houses. People live in their own house are more concern to protect their houses from flood than people live in their not owned houses. The property ownership affects people's willingness to do adaptation measures and pay for adaptation cost. It can be said that the amount of adaptation measurement is determined by the property ownership.

5.6.2 Information and Skills

As mentioned in the second chapter that successful adaptation needs necessity to adapt, knowledge about available options and the capacity to assess them. In the context of information and skills, the education level, knowledge and people's capacity to assess the adaptation options are being analyzed.

In terms of education and knowledge about tidal flood, most of people in present inundated areas are educated people, which most of them are high school graduate. Only few of them are uneducated people. Meanwhile all of people in predicted inundated areas are educated people, and most of them are high school graduate. People's education level is related to people's knowledge. It assumed that the higher people educated, the more knowledge people have, and the greater adaptive capacity they have. This is in line with Smith & Lenhart, 1996 who mentioned that in general country with higher levels of store human knowledge are considered to have greater adaptive capacity than developing country. Knowledge about tidal flood effects and the adaptation measures are important to raise people awareness due to flood. Moreover the knowledge base on disaster responses can be helpful in enhancing adaptive behaviour.

People's capacity to assess the adaptation can be seen on their perception and preference of people to do adaptation responses to deal with future risks. People living present inundated areas have been doing some adaptation measures as mentioned in the previous chapter. Based on the survey, facing tidal flood in the future, most of respondents live in present inundated areas are prefer staying in their current location than moving to other save areas (complete information see Annex 6). There are many reasons behind their choices. Table 30 shows their reasons of chosen settle or stay when tidal flood is increasing in the future.

Table 30 : Responses due to tidal flood in the year 2015 by people in present inundated area

No	Responds	Reasons
1.	Settle	Limited financial condition Close to their work place Own inheritance house Only own properties in this particular area Will do more adaptation measures
2.	Relocate	Live away from flood Looking for safer place Rented house High cost to renovate the house to flood prevention

People who chose to stay have to deal with the worse tidal flood in the future. In order to reduce the effects of tidal flood in the future, the respondents tent to do adaptation measures in the future. Figure 31 shows the perception of people to do adaptation measures in the future. The measures are almost the same with what they have been doing so far. Most of the respondents will elevate their houses. Since the tidal worse is getting worse, therefore they are planning to do more than one measures.

Table 31 : Adaptation responses due to incoming tidal flood

Adaptation responses	Frequencies	Percentage
Elevate the house	18	38.30
Raise the floor level	8	17.02
Raise the yard level	3	6.38
Build dam to prevent water	3	6.38
Others	0	0.00
Elevate the house and raise the floor level	1	2.13
Elevate the house and build dam to prevent water	4	8.51
Elevate the house and move	1	2.13
Raise the yard level and build dam	1	2.13
Elevate the house, raise the floor level & raise the yard level	2	4.26
No answer	6	12.77
Total	**47**	**100.00**

The data shows that people in present inundated areas are aware of the increasing tidal flood in the future. Even though the tidal flood will be worse they prefer to stay in present houses. To reduce the increasing risks, they will improve the adaptation measures to their houses. However it still depends on their finance capacity to cost the adaptation measures.

Meanwhile according to survey on 50 people living in predicted inundated areas, about 70% of respondents prefer staying in their current houses than moving to other area in facing the increasing tidal flood (complete information see Annex 6). Even though some of the respondents prefer moving, but they plan to do some adjustments in their houses at first. The respondents plan to do adaptation measures to prevent their houses from flood, even though the tidal flood has not occurred on their areas yet, Most of the respondents (18%) have a preference to elevate their houses. Meanwhile, the other respondents planned to do two or more responses as long as those measures can protect their houses from tidal flood. Table 32 shows people's perceptions and preferences on adaptation measures will be done by year 2015.

Table 32 : People's perception on adaptation measures by year 2015

Adaptation measures	Percentage
Elevate the house	18
Raise the floor level	12
Raise the yard level	4
Build dam to prevent water	10
Others	16
Elevate the house & raise the floor level	8
Elevate the house & build dam to prevent water	4
Raise the floor level & raise the yard level	4
Raise the floor level & build dam	8
Elevate the house, raise the floor level & raise the yard level	4
Elevate the house, raise the floor level & build dam	4
Raise the floor level, raise the yard level & build dam	4
Missing	4
Total	100

To do adaptation measures, people in predicted inundated areas have to prepare to finance their adaptation measures. Figure 27 shows the willingness of respondents to pay for adaptation cost. Most of respondents (40%) are willing to compensate in a range IDR 1.000.000,00 – IDR 5.000.000,00 (€ 66 - € 300). While only few people (10%) are willing to pay adaptation measures for more than IDR 10.000.000,00 (≥ € 600). People's willingness to compensate for their adaptation measures is affected by their income level. Due to limited financial capacity, low income people are willing to pay less cost than middle income and high income people. People's ability and willingness to compensate the adaptation cost influence their adaptation measures.

To reduce the effects of tidal flood in the future, most of the respondents tent to do their adaptation measures start from now, when the flood are not occurring on their houses yet. Meanwhile the other tent to do adaptation measures immediately when the flood start inundating their houses. The people assumed that to prevent and to anticipate from tidal flood, they have to the adaptation measures as soon as possible.

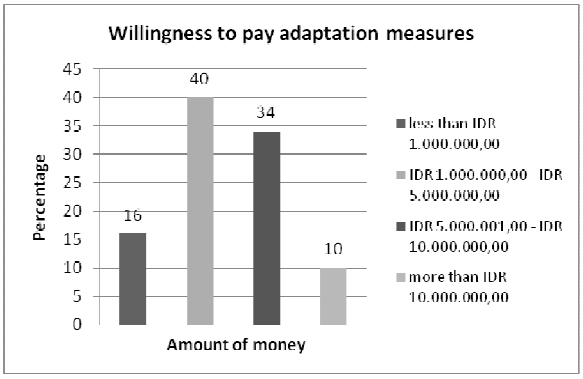

Figure 28 : Willingness to pay adaptation responses

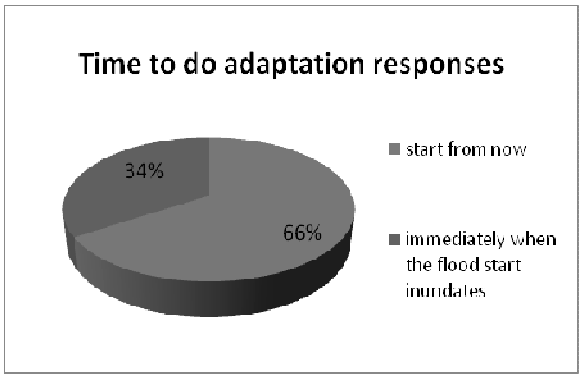

Figure 27: The time to do adaptation responses

Besides doing adaptation measures on their houses, people living the predicted inundated areas are also willing to do adaptation measures in their neighbourhood level in order to cope the effects of tidal flood. Table 33 shows the adaptation measures that are willing to be done by the respondents to cope the increasing of tidal flood by in the future (year 2015).

Table 33: People's initiatives in the neighbourhood level

Adaptation measures	Frequencies	Percentage
Nothing	5	10
Elevate the street level	8	16
Improving drainage system	10	20
Creating dyke system	0	0
Provide pumps	3	6
Others	2	4
Elevate the street level & improving drainage system	12	24
Elevate the street level & provide pumps	1	2
Improving drainage system & provide pumps	1	2
Creating dyke system & provide pumps	1	2
Elevate the street level, improving drainage system & provide pumps	1	2
Elevate the street level, creating dyke system & provide pumps	1	2
Socialization, elevate the street level, improving drainage system & creating dyke system	1	2
Missing	4	8
Total	**50**	**100**

The data shows that people in both present and predicted inundated areas are prepared to cope with the risks of tidal flood. They can assess the possible adaptation options and willing to compensate the adaptation cost. They also are willing to do adaptation measures in their

neighbourhood and at the end their initiatives may apply on the city government's planning in dealing with tidal flood problems.

5.6.3 Infrastructure

As stated in the second chapter, adaptive capacity depends on availability the physical infrastructures. The Semarang city government has provided physical infrastructures to deal with floods problem in Semarang, such as polders, drainage systems, sea walls, pumps and dam. Those flood infrastructures are developed to deal with the present and future situation of flood problems in Semarang.

Moreover, as mentioned in the section 5.4.1, the city government has been developing a master plan drainage system which is aiming to deal with flood problems in Semarang for the next 20 years. This planning integrates the development of flood infrastructures and the building capacity of people. The construction will be done by the city governments, however, the they will involve the community to participate on the operation and maintenance part.

To sum up, the city governments of Semarang have been assessing the future condition of the flood problems in Semarang. They design and build the flood infrastructures by estimating the future condition in order to reduce the future risks of flood, including the risks of tidal flood.

5.6.4 Technology

As mentioned in the second chapter, adaptive capacity is depending on the availability and access to technology. Many adaptive capacities are identified by the using of technology such as early warning system and protective structures.

The Semarang city governments have been applying the use of technology on their flood management systems. The use of technology in flood management in Semarang is focused on the early warning system and the flood infrastructures. According to the interview with the WMA official, the early warning system in Semarang is combination of method to give real time information to citizens by website and short service messages (SMS). The main process of the system is to give real time information to citizens about river water level rise and amount of rainfall from 21 rivers in Semarang. Then the information is delivered to Head of Districts, Head of Sub Districts and community leaders, and next it is delivered to people in inundated areas. In fact the early warning system is only focused on river flood and local flood warnings. The city government have not developed yet early warning system that also focused on the tidal flood problem.

Moreover, the WMA official also stated that the other use of technology in dealing with tidal flood and flood problems in general is in constructing the flood infrastructures. The city governments are using technology to build dams, sea wall, polders and drainage systems. Nevertheless the city governments still need assistance from the central government and international funds to apply and to develop the technology using.

To sum up, the Semarang city governments have been developing the use of technology in dealing with flood problems in Semarang, even though they depend on the other actors. It can be said that their ability to develop technology have enhance their adaptive capacity to cope with the future risks of flood.

5.6.5 Institutions

As mentioned in the second chapter, the role of institutions are to hold society together and giving it capacity and enabling to adapt. The strong and well organized institutions can easily support adaptation strategies.

The Semarang city government is the institution who responsible to deal with tidal flood. As mentioned in the section 5.4.1, the flood management in Semarang is under responsible of WMA and PDB. They are responsible in planning, implementing and operating and maintenance the flood management, and also associate coordination with the other institutions in Semarang. Meanwhile the central government and the provincial government also involved in Semarang flood management in terms of financial responsibility and technical assistance. However as mentioned in chapter 5.4.1, this condition lead to other problems related to the ownership of flood infrastructures.

According to interview with the PDB official, his institution has organized capacity building programs in order to develop the capacity of PDB and WMA staffs in dealing with flood problems. The PDB and WMA arrange cooperation with academic institution to improve the capacity of their staffs. Meanwhile they also arrange cooperation with countries that succeed in dealing with flood problems. This cooperation is aiming to improve their knowledge and technology use to cope with the flood and tidal flood problems in Semarang. In addition the WMA official mentioned that to integrate and manage the flood management in Semarang, the city government will develop an organization named ‘Semarang City Water Board’ consists of local institution, community, and other actors who are involved in flood management.

To sum up, institutions which involved in dealing with flood problems in Semarang are prepared to cope with the future condition of the flood. The capacity building of the city governments staffs’ help to deal with associated risks of flood. However it is necessary for the city government to deal with managerial problems with the central government and the provincial government.

5.6.6 Equitable access to resources

As mentioned in the second chapter, the adaptive capacity is dependent on the equitable access of people to resources. Low income people are vulnerable to the risks of tidal flood, since they have limited access to financial resources.

The Semarang city governments have been initiating the access of financial to the low income people to deal with tidal flood. The low income people can propose to the city governments to finance adaptation measures in their neighborhood. In line with that the city governments also prioritize to realize the physical adaptation measures in the area of low income people. However

limited financial capacity of the city government can increase the vulnerability of the low income people.

In brief, according to analysis on adaptive capacity, it can be said that people both live in present and predicted inundated areas and the local government are prepared to cope with the future risks of tidal flood. The people can assess the adaptation responses they will do in the future and willing to pay the adaptation cost. The condition of low income people is vulnerable to the tidal flood, comprehensive strategies are from the city government are necessary to deal with tidal flood and to reduce the vulnerability of low income people.

5.6.7 Remark

According to analysis on adaptive capacity, it can be said that people both living in present and predicted inundated areas and the local government are prepared to cope with the future risks of tidal flood. The Semarang city governments have been considering the future conditions to develop their strategies, planning, infrastructures and the use of technology to deal with tidal flood problems. Meanwhile people's knowledge and initiatives are valuable to develop strategies to deal with tidal flood. However the low income people who are vulnerable can affect ability Semarang city to react and to adapt the future impacts of tidal flood.

As mentioned in chapter two, adaptive capacity is related to sustainable development. Enhancement of adaptive capacity can be effective to sustainable development. By enhancing adaptive capacity, the vulnerability to tidal flood hazards can be reduced. Strategies to enhance the adaptive capacity can be corresponding to promoting sustainable development. Consequently, enhancement adaptive capacity strategies are needed to reduce the vulnerability to tidal flood hazard in Semarang and also to promote sustainable development.

CHAPTER 6 CONCLUSION AND RECOMMENDATION

6.1 Conclusions

This concluding part contributes to answering the main research question : *how can be dealt with the current and upcoming tidal flood in Semarang ?*

Sub question 1 : What is tidal flood in Semarang?

The study has revealed that the tidal flood occurs in coastal areas of Semarang. There are 6 sub districts in 3 districts with total inundated areas of 1.970 ha that have been suffering from tidal flood for many years.

Tidal flood is one of the flood problems in Semarang. Semarang faces three types of floods which are local flood, river flood and tidal flood. All of those floods occur in low lying and coastal areas. Tidal flood occurs when the sea level rises to a critical height above the coastal land, due to tidal elevation. The tidal flood occurs almost daily, depending on the tidal oscillation. It is worsened by land subsidence and sea level rise due to climate change.

Tidal flood have been occurring in Semarang coastal areas for more than 8 years. It is periodically occurs every month, which 4 – 9 times the flood inundates the people's houses. Moreover whenever the flood occurs, it inundates within 24 hours, and in average height 0.5 meter. The worst inundation is when tidal flood inundates 2 – 6 days and in 1 meter height.

Up to now the houses of about 71.395 people have been inundated by tidal flood. Most of people in inundated areas are middle income, however there are also low income and high income people. Most of them work as small business entrepreneur, meanwhile the others work as government officers, fishermen and others. Most of the people in inundated areas live in their own house, which is later influence the adaptation measures in coping with tidal flood.

Sub Question 2 : What are the effects of tidal flooding in Semarang?

Tidal flood has been affecting the social, economic and environmental condition of society in present inundated areas for years. In terms of social effects on people, health and education are the most affected by tidal flood. People are suffering diseases (diarrhea, skin disease, dengue and others) which are related to the water condition. Contaminated water affects the health condition of people in inundated areas. In terms of education, tidal flood affects children in the way that they cannot go to school. However the education terms are not significantly affected by tidal flood. Most of the children in inundated areas mostly still can go to school when the flood occurs. Meanwhile tidal flood also damage the school buildings located in the inundated areas.

In terms of economic effects, the tidal flood has significantly affected the condition of people in inundated areas. People lose their income and cannot go to work on day of flood. The most affected profession is small business entrepreneur, since most of these are located in inundated areas. However the flood does not affect people's opportunity to go to work significantly. They keep going to work even when the tidal flood occurs in their neighborhood.

In terms of environmental effects, tidal flood has been affecting drinking water and sanitation systems in inundated areas. People in inundated areas experience their water changed its color, taste and smell due to tidal flood. The changes in drinking water are related to health condition of inundated inhabitants, since contaminated water can threaten the health condition. Meanwhile people also experience effects to their sanitation system. The commonly effects are waste overflow, bad smell and damage in sanitation infrastructures. Consequently the environment effects and health effects of flood are linked each other, and the decreasing quality of water and sanitation system will decrease the people's health condition.

Sub question 3 : How to adapt to the effects of tidal flooding in Semarang?

In dealing with tidal flood problems, people in inundated areas and Semarang city government have been doing adaptation responses. The city government has been doing planned adaptation which in form non physical and physical measures. The adaptation measures are considered to react the present impacts (reactive adaptation) and to anticipate the future impacts (anticipatory adaptation). The tidal flood management is part of general flood management in Semarang, which is aiming to deal with all types of flood in Semarang. Non physical adaptation measures focuses on planning, management and institutional. Meanwhile for the physical measures, the city government focuses on protection and accommodation, such as develop drainage systems, sea walls, polders, dams and also provide pumps.

The city governments have been carrying out the adaptation measures based on their own planning and people's initiatives. The city government prioritizes to apply structural adaptation measures to the low income communities, since they have limited financial capacity and ability to do their own adaptation measures. Beside limited financial capacity, low of people awareness to maintenance the flood infrastructures and low of law enforcement in implementing the spatial planning are hampered the flood management in Semarang. For now, the adaptation measures both physical and non physical done by the city government are still inadequate to solve the entire tidal flood problems in Semarang. The people are still suffering from tidal flood.

People in present inundated areas have been doing physical adaptation measures on their own houses and in their neighbourhood areas without any intervention from the city government. People in inundated areas are still living in their houses, meanwhile they are adapting their houses in order to reduce the effects of tidal flood.

Sub question 4 : How is tidal flooding predicted to develop in Semarang?

Tidal flood is predicted to inundate not only the coastal areas, but also the other low lying areas in Semarang. The forecast is that by year 2015 tidal flood will inundate 71 more sub districts in 8 districts. Meanwhile based on projection, the habitat of about more than 7 hundred thousand people will be inundated.

The same as people in present inundated areas, the people in predicted inundated areas also characterized with profession, income level, education level and house ownership. Most of them are middle income and educated, that work in various professions such as government officers, housewives, university students and small business entrepreneur. In terms of housing ownership,

most of them live in their own houses. Moreover those characteristics are used to assess the adaptive capacity of people in predicted inundated areas to cope and anticipate the effects of tidal flood.

Sub question 5 : How are the adaptive capacities of Semarang in coping with the increasing tidal flood?

In order to minimize the losses due to tidal flood in the future, both people live in present inundated areas and predicted inundated areas together with the city government should take into account the condition of flood in the future. For that reason, it is important to recognize the adaptive capacity of people both live in current inundated areas and predicted inundated areas and the city government.

The ability of people and the local government to adapt and cope with the future risk of tidal flood is assessed by their economic resources, information and skills, infrastructures, technology and access to resources. It can be concluded that both people in present and predicted inundated areas and the Semarang city government are ready to cope with the increasing of tidal flood in the future. The city government's strategies to deal with tidal flood have been considering the future conditions. Meanwhile the people in present and predicted inundated areas are able to assess the future conditions and prepare to deal with the future risks. Considering the vulnerability of the low income people and the future condition, it still needs enhancement of the adaptive capacity. Moreover promoting sustainable development also can be achieved by enhancing the adaptive capacity.

6.2 Recommendation

This study leads to several recommendations especially to enhance the adaptive capacity of the city government and the people to cope with the present and increasing tidal floods.

Dealing with flood problem especially tidal flood should be not only about the flood infrastructures development. The tidal flood which occurs mostly in coastal areas should be understood as a development issue. The city government should focus to manage and to protect the coastal areas, since it is very vulnerable to tidal flood and other climate change variability. The Integrated Coastal management (ICM) can be implemented in Semarang coastal areas to develop and protect the coastal areas, which should be in line the spatial planning of Semarang and the flood management. Moreover within ICM framework that involves stakeholders from national level to local community level, sustainability in coastal areas can be achieved.

Building the capacity of the local government and the community is important to succeed the adaptation to tidal flood. Capacity building for the city government's staffs should be arranged continuously to keep up with the latest technology and trends in dealing with tidal flood. The city governments should also build the capacity of the people in present and predicted inundated areas by creating community organization to participate in operation and maintenance the flood infrastructures. Moreover providing information about floods and manual of emergency action will be improve the people's capacity to deal with flood problems.

Adaptive capacity is related to economic resources. There is a need to prioritize low income people to in dealing with tidal flood in Semarang, since the low income people are very vulnerable to the hazards. The city government should develop strategies to deliver financial aid to the low income housing to finance their adaptation measures. Consequently it will reduce the vulnerability of low income people to tidal flood. In line with that, the city government should develop financial scheme to fund the flood infrastructures. It should involve not only the central government and the provincial government, but also the private sectors.

References

Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, 2007, 'Assessment of adaptation practices, options, constraints and capacity' 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*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Cambridge University Press, Cambridge, UK, 2007, pp 717-743.

Apuuli, B. Wright, J., Elias, C., Burton, I., 2000, 'Reconciling national and global priorities in adaptation to climate change: with an illustration from Uganda' in *Adaptation to Climate Change in the Context of Sustainable Development and Equity,* Smit, B. & Pilifosova, O. (et al). 2001

Belperio, A.P., 1993, 'Land Subsidence and sea level rise in the Port Adelaide estuary-implications for monitoring the greenhouse effect' in *Coastal flooding, global warming and environmental management*, Doornkamp, J.C., 1998, Journal of Environmental Management, pp 327-333.

Biljsma, L. Ehler, C.N., Klein, R.J.T, Kulshrestha, S.M, McLean, R.F., Mimiura, N., Nicholls, R.J., Nurse, L.A., Perez Nieto, H., Stakhiv, E.Z., Turner R.K., Warrick, R.A., 1996, 'Coastal zones and small islands' in *Impacts, Adaptation, and Mitigation of Climate Change*, Watson, R.T., Zinyowera, M.C., Moss, R.H. (eds). Cambridge University Press, Cambridge, pp 289-324

Black, T.T. 1993. *Evaluating social science research.* Sage, London

Burton, I. & Lim, B., 2001, 'An Adaptation Policy Framework: Capacity Building for Stage II Adaptation, A UNDP-GEF Project' in *Primer on Climate Change and Sustainable Development Facts, Policy Analysis and Applications,* Munasinghe, M & Swart, R. 2005, Cambridge University Press, Cambridge

Burton, I., Smith, J.B., Lenhart, S., 1998. 'Adaptation to climate change: theory and assessment' in *Adaptation to Climate Change in the Context of Sustainable Development and Equity,* Smit, B. & Pilifosova, O. (et al). 2001

Church, J.A., Gregory, J.M., Huybrechts, P., Kuhn, M., Lambeck, K., Nhuan, M.T., Qin, D., Woodworth, P.L., 2001, ' Changes in sea level ' in *Climate Change 2001 The Scientific Basic,* Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Xiaosu, D (eds). Cambridge University, Cambridge, pp 639-693

Cummins, V. O, Mahony, C., & Connolly, N, 2009, *Review Of Integrated Coastal Zone Management & Principals Of Best Practice.* Available: http://www.heritagecouncil.ie. [12 February 2009]

Dewi, A., 2007, *Community-based analysis of coping with urban flooding: a case study in Semarang, Indonesia*, MSc. Thesis, ITC, Enshede

Doornkamp, J.C., 1998, 'Coastal flooding, global warming and environmental management', *Journal of Environmental Management* , pp 327-333.

Fankhauser, S., & Tol, R.S.J., 1997, 'The social costs of climate change: the IPCC second assessment report and beyond' in *Adaptation to Climate Change in the Context of Sustainable Development and Equity,* Smit, B. & Pilifosova, O. (et al). 2001

Gatot IS, Duchesne J, Forest F, Perez P, Cudennec C, Prasetyo T., Karama, S., 2001, 'Rainfall-runoff harvesting for controlling erosion and sustaining upland agriculture development' in *Coastal flood management in Semarang, Indonesia,* Marfai, M. A. & King, L., 2007, *Environmental Geology* vol 55, Springer, pp 1507-1518

Hardoy, J.E., Mitlin, D., Satterthwaite, D., 2001, 'Environmental Problems in an Urbanizing World', in *The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones,* McGranahan, G., Balk, D., Anderson, B., 2007, *Environment and Urbanization* vol 19

Hinton, A.C., 2000, Tidal Changes and Coastal Hazards: Past, Present and Future, *natural Hazards*, vol.21, pp 173-184

Hoozeman, F.M.J, Marchand, M, Pennekamp, H.A., 1993, *A global vulnerability analysis, vulnerability assessment for population, coastal wetlands and rice production on global scale,* 2nd edition, Delft Hydraulics and Rijkswaterstaat, Delft

IPCC, 1998, *The regional impacts of climate change, an assessment of vulnerability,* Cambridge (A Special Report of IPCC Working Group II)

Japan International Cooperation Agency (JICA) , 2003, 'Master plan on water resources development and feasibility study for urgent flood control and urban drainage in Semarang City and suburbs' in *Tidal inundation mapping under enhanced land subsidence in Semarang, Central Java Indonesia*, Marfai, M. A. & King, L. 2007, *Natural Hazard* vol 44, Springer, pp 93-109

Jarungrattanapong, R. & Manashoonphempool, A. 2008. 'Adaptation Strategies for Coastal Erosion/ Floofing: A Case Study of Two Communities in Bangkok Khun Thian District, Bangkok', *TDRI Quarterly Review* vol. 23, pp 11-18

Kaluwin, C. & Smith, A., 1997, 'Coastal vulnerability and integrated coastal zone management in the Pacific island region' in *Coastal Management in the Asia Pacific Region*, Harvey, N. & Hilton, M. in *Global Change and Integrated Coastal Management The Asia Pacific Region*, ed. Harvey, N., Springer, Dordrecht, pp 17-35

Kates, R.W., 2000, 'Cautionary tales: adaptation and the global poor' in *Adaptation to Climate Change in the Context of Sustainable Development and Equity,* Smit, B. & Pilifosova, O. (et al). 2001

Kelly, P. & Adger, W.N., 1999., 'Assessing Vulnerability to Climate Change and Facilitating Adaptation' in *Adaptation to Climate Change in the Context of Sustainable Development and Equity*, Smit, B. & Pilifosova, O. (et al). 2001

Keputusan Menteri Kesehatan Republik Indonesia Nomor 907/Menkes/Sk/VII/2002

Kusnoputranto, H.,1985, In http://creasoft.files.wordpress.com/2008/04/sanitasi.pdf [2009, 5 August]

Leary, N., 1999, 'A framework for benefit-cost analysis of adaptation to climate change and climate variability' in *Primer on Climate Change and Sustainable Development Facts, Policy Analysis and Applications,* Munasinghe, M & Swart, R. 2005, Cambridge University Press, Cambridge

Marfai, M.A**.** 2004. 'Spatial Modelling of Tidal Flood Hazard on East Semarang Coastal Area', *Journal of Forum Geografi, Indonesia*. Vol 18, ISSN 0852-2682. Page 60-69.

Marfai, M. A. & King, L. 2007. 'Coastal flood management in Semarang, Indonesia', *Environmental Geology* vol 55, Springer, pp 1507-1518

Marfai, M. A. & King, L. 2007. 'Tidal inundation mapping under enhanced land subsidence in Semarang, Central Java Indonesia', *Natural Hazard* vol 44, Springer, pp 93-109

McCarthy, J. Canziani, O.F., Leary, N.A., Dokken, D.J., White, K.S., 2001, 'Climate Change 2001: Impacts, Adaptation and Vulnerability' in *Primer on Climate Change and Sustainable Development Facts, Policy Analysis and Applications,* Munasinghe, M & Swart, R. 2005. Cambridge University Press, Cambridge

McGranahan, G., Balk, D., Anderson, B., 2007, 'The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones', *Environment and Urbanization* vol 19, International Institute for Environment and Development (IIED), pp 17-37

McLean, R., Tysban, A., Burkett, V., Codignotto, J.O., Forbes, D.L., Mimura, N., Beamish, R.J., Ittekkot,, V., 2001. 'Coastal zone and marine ecosystem' in *Climate Change 2001: Impacts, Adaptation, and Vulnerability.* McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. White, K.S (Eds), 2001. Cambridge University Press, Cambridge

Menne et al. 2000, 'Floods and public health consequences, prevention and control measures' in *Floods: Climate Change and Adaptation Strategies for Human Health,* WHO Regional Office for Europe, 2002, London.

Mimura, N., 2006, 'State Of The Environment In The Asia And Pacific Coastal Zone And Effects Of Global Change' in *Global Change and Integrated Coastal Management The Asia Pacific Region,* ed. Harvey, N., Springer, Dordrecht, pp 17-35

Ministry of Fishery and Marine Affairs, 2009, *Strategi Adaptasi Dan Mitigasi Bencana Pesisir Akibat Perubahan Iklim Terhadap Pesisir Dan Pulau-Pulau Kecil*, Ministry of Fishery and Marine Affairs, Jakarta

Moser, C. & Satterthwaite, D. 2008. *Towards pro-poor adaptation to climate change in the urban centres of low and middle income countries.* Human Settlement Program. International Institute for Environment and Development. London

Munasinghe, M & Swart, R. 2005. *Primer on Climate Change and Sustainable Development Facts, Policy Analysis and Applications*, Cambridge University Press, Cambridge

Nicholls, R.J. 2002. 'Analysis of global impacts of sea level rise: a case study of flooding', *Physics and Chemistry of the Earth*, vol 27, pp 1455-1466

Nicholls, R.J., 2004, 'Coastal flooding and wetland loss in the 21st century: Changes under the SRES climate and socioeconomic scenarios', *Global Environmental Change*, Vol. 9 pp 69-86

Nicholls, R.J., Hoozemans, F.M.J., Marchand, M., 1999, 'Increasing flood risk and wetland losses due to global sea level rise: Regional and global analysis', *Global Environmental Change*, vol. 9, pp 69-87

Nicholls, R.J. & Lowe, J. A. 2004. 'Benefits of mitigation of climate change for coastal areas'. *Global Environmental Change* , 229-244.

Nicholls, J.R. & Mimura, N., 1998., 'Regional issues raised by sea level rise and their policy implications' in *Potential vulnerability implications of coastal inundation due to sea level rise for the coastal zone of Semarang city, Indonesia*, Marfai, M.A & King, L., 2007, Environmental Geology

Nontji, A., 1993, 'Laut Nusantara' in *Spatial Analysis of Anxious Tidal Flood Area at Semarang City*, Wibowo, D.A., 2006, Diponegoro University, Semarang

Olsen, S. B., 2003, 'Frameworks and indicators for assessing progress in integrated coastal management initiatives' in *Coastal Management in the Asia Pacific Region*, Harvey, N. & Hilton, M. in *Global Change and Integrated Coastal Management The Asia Pacific Region*, ed. Harvey, N., Springer, Dordrecht, pp 17-35

O'Riordan, T. & Jordan, A., 1999, 'Institutions, climate change and cultural theory: towards a common analytical framework', *Global Environmental Change*, pp 81- 93

Penning-Rowsell, E. and Peerbolte, B. 1994. 'Concepts, Policies and Research' in *Floods across Europe. Flood Hazard Assessment,Modelling and Management*, Penning-Rowsell E. and Fordham M. (eds.), 1994, Middlesex University Press, London, pp 1-17

[Homepage of Perencanaan Kota Indonesia] [Online]. 2009. http://perencanaankota.blogspot.com/2009/02/metode-analisis-jumlah-penduduk.html [2009,8 June)

Pittock, B & Jones, R.N. 2000, 'Adaptation to what and why', *Environmental Monitoring and Assessment*, vol 61, pp 9-35

Planning and Development Board (PDB), 2000, *Profile of Semarang coastal area (in Indonesian),* Planning and Development Board, Semarang

Planning and Development Board (PDB), 2000, *Semarang Spatial Planning year 2000 – 2010,* Planning and Development Board, Semarang

Prasad, N., Ranghieri, F., Shah, F., Trohanis, Z., Kessler, E., Sinha, R., 2009, *Climate Resilient Cities: A Primer on Reducing Vulnerabilities to Disaster*, The World Bank, Washington DC

Public Works Agency of Semarang (PWD), 2000, *Semarang urban drainage master plan*. Public Work Department, Semarang

Schutt, R. K. 2006, *Investigating the Social World: The Process and Practice of Research*, Pine Forge Press, Nettville.

Statistic Bureau, 2006, *Potensi Desa*, Statistic Bureau, Semarang

Sutanta,H., Hobma, T.W., 2002, 'Preliminary Assessment of the Impact of Land Subsidence and Sea Level Rise in Semarang' in *Spatial Analysis of Anxious Tidal Flood Area at Semarang City*, Wibowo, D. A, 2006, Thesis, Marine and Fisheries Faculty. Diponegoro University, Semarang

[Homepage of San Jacinto River Authority] [Online]. 2009. Available http://www.sanjacintoriverauthority.com/index.html [2009,20 May)

Sarbidi, 2001, *Pengaruh Rob Pada Permukiman Pantai. Kerugian Pada Bangunan Dan Kawasan Akibat Kenaikan Muka Air Laut Pada Kota-Kota Pantai Di Indonesia*, in *Building and Area Loss due to Sea Level Rise in Coastal Cities in Indonesia: proceeding of seminar held in Bandung, 2001*

Satterthwaite, D., Huq, S., Reid, H., Pelling., Lankao, P.R., 2007, 'Adapting to Climate Change in Urban Areas : The Possibilities and Constraints in Low- and Middle-Income Nations' in *Adapting Cities to Climate Change; Understanding and Addressing the Development Challenges,* eds. Bicknell, J., Dodman, D., Satterwhaite, D. Earthscan, London/ Sterling, 2009, pp 1-47

Smit, J.B. & Lenhart, S.S., 1996, 'Climate change adaptation policy options' in *Adaptation to Climate Change in the Context of Sustainable Development and Equity,* Smit, B. & Pilifosova, O. (et al). 2001

Smit, B. & Pilifosova, O. (et al). 2001. 'Adaptation to Climate Change in the Context of Sustainable Development and Equity' in *Climate Change 2001, Impacts, Adaptation and Vulnerability, International; Panel On Climate Change Chapter 18* ,pp 879-906

Smith, K. and Ward, R. 1998. 'Floods', in *At Risk Second Edition Natural Hazards, people vulnerability and disasters,* 2005, Wisner, N., Blaikie, P., Cannon, T., & Davis, I. Routledge , New York

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, Journal Estuarine', *Coastal and Shelf Science* vol 77 , pp 206-213.

Sutanta**,** H., Rachman, Arif., Sumaryo, Diyono., 2005, *Predicting Land Use affected by Land Subsidence in Semarang based on Topographic Map of Scale 1:5000* [Homepage of GIS Development], [Online]. Available :
http://www.gisdevelopment.net/application/natural_hazards/overview/ma05118.htm
[2009, 12 September]

United Nations. 1976. *Guidelines for Disaster Prevention Vol. 3 Management of settlements.* Geneva

Wheaton, E. & MacIver, D., 1998, 'Working Paper on Adaptation to Climate Variability and Change' in Munasinghe, M & Swart, R. 2005. *Primer on Climate Change and Sustainable Development Facts, Policy Analysis and Applications,* Cambridge University Press, Cambridge

Wibowo, D. A, 2006, *Spatial Analysis of Anxious Tidal Flood Area at Semarang City.* Thesis, Marine and Fisheries Faculty. Diponegoro University, Semarang

Wilbanks, Tom et.al, 2007, 'Industry, settlement and society' in *Towards pro-poor adaptation to climate change in the urban centres of low and middle income countries,* Moser, Caroline & Satterwhite, David, 2008, International Institute for Environment and Development, London, pp 1-14

Wisner, B. et al. 1999. 'Toward a Culture of Prevention in Two Coastal Communities: A Comparison of the Hazardousness of San Pedro and Laguna Beach', in *At Risk Second Edition Natural Hazards, people vulnerability and disasters,* 2005, Wisner, N., Blaikie, P., Cannon, T., & Davis, I. Routledge , New York

Wuryanti, W. 2001. 'Identifikasi Kerugian Bangunan Rumah Di Pantai Akibat Kenaikan Muka Air Laut', in *Building and Area Loss due to Sea Level Rise in Coastal Cities in Indonesia: proceeding of seminar held in Bandung,* 2001

Annexes

Annex 1

Questionnaires addressed to respondents in present inundated areas

Dear respondent,
I am Dian Harwitasari a master student at the Institute of Housing and Urban Development Studies in Rotterdam-Netherlands. I am conducting a study on adaptation responses of coastal settlements to coastal flooding in Semarang. The findings of this research will be focused on the current and year 2015 prediction effects of coastal flooding, adaptation responses of inhabitants who have been facing coastal flooding and inhabitants who are predicted will be inundated and recommendation to local government to deal with the coastal flooding problem. This study is a requirement for me to accomplish a master degree in Urban Management and Development. I therefore kindly ask for your time to respond the flowing questions.

District :
Sub District :

Number of questionnaire :
Date :

CHARACTERISTIC OF INHABITANTS

1. Profession
   a. Fisherman
   b. Farmer
   c. Industrial labor
   d. Government officer
   e. Small business enterprise
   f. Others ……..
2. Income level
   a. ≤ € 35 (≤ Rp. 500.000,00)
   b. € 36 - € 100 (Rp. 500.001,00 – Rp. 1.500.000,00)
   c. € 101 - € 165 (Rp. 1.500.001,00 – Rp. 2.500.000,00)
   d. ≥ € 166 (≥ Rp 2.500.0001,00)
3. Education level
   a. Non educated
   b. Elementary school
   c. High school
   d. University
4. The house ownership
   a. Own
   b. Rent house
   c. Others …….

FLOOD CONDITION

5. Have your house ever been inundated by coastal flooding?
   a. Yes
   b. No
6. How many years have you been suffering from coastal flooding?
   a. Never
   b. ≤ 3 years
   c. 4 – 8 years
   d. ≥ 8 years

7. How many times in a month your house has been inundated?
   a. ≤ 3 times
   b. 4 – 9 times
   c. ≥ 10 times
   d. Every day
8. How many centimeters is the most common flood depth?
   a. 0 – 0.5 meter
   b. 0.51 – 1 meter
   c. more than 1 meter
9. How many centimeters is the worst flood depth?
   a. 0 – 0.5 meter
   b. 0.51 – 1 meter
   c. more than 1 meter
10. How many takes are the average hours of the flood?
    a. < 1 hour
    b. 1 - 24 hours
    c. More than 1 day
11. How many hours is the worst flood?
    a. < 1 hour
    b. 1 - 24 hours
    c. More than 1 day

IMPACTS OF COASTAL FLOODING

12. Have you or your family member ever suffered from illnesses due to coastal flooding?
    a. Yes
    b. No
13. If yes, what kind of illnesses have you suffered? (the answer can be more than one)
    a. Diarrhea
    b. Skin diseases
    c. Dengue
    d. Others ……
14. Do you have child who go to school?
    a. yes
    b. No
15. How many days in a year could your child not go to school due to coastal flooding?
    a. never
    b. ≤ 10 days
    c. 11 – 20 days
    d. ≥ 21 days
16. How many days in a year could you not go to work due to coastal flooding?
    a. never
    b. ≤ 10 days
    c. 11 – 20 days
    d. ≥ 21 days
17. Do you lose your income due to coastal flooding?
    a. Yes
    b. No
18. If yes, how much percent did you lose at your income in a year?
    a. < 20%
    b. 21% - 50%
    c. > 50 %
19. How do you get your drinking water?
    a. Well
    b. Water supply
    c. Others……

20. Does flooding affect your drinking water?
    a. Yes
    b. No
21. If 'yes', what is the effect? (the answer can be more than one)
    a. Color changed
    b. Bad smell
    c. Residue
    d. Others……..
22. If yes, what did you do to get fresh water? (the answer can be more than one)
    a. Nothing
    b. Buy fresh water
    c. Others……
23. Does flooding affect your sanitation system?
    a. Yes
    b. No
24. If yes, what happens with your sanitation system? (the answer can be more than one)
    a. The waste overflows
    b. Bad smell
    c. Others ……....

ADAPTATION RESPONSES DUE TO COASTAL FLOODING

25. Have you been doing some adaptation measures in dealing coastal flooding?
    a. yes
    b. No
26. What kind of adaptation measures have you been doing so far to deal with coastal flooding? (the answer can be more than one)
    a. Elevate the house
    b. Raise the floor level
    c. Raise the yard level
    d. Build dam to prevent water
    e. Others ……..
27. How often you have been doing that measure?
    a. once in two years
    b. once in a year
    c. more than once in a year
    d. others……
28. How much did pay to do your adaptation measures in question 24th?
    a. ≤ € 65 (< Rp 1.000.000,00)
    b. € 66 - € 300 (Rp 1.000.000,00 – Rp 5.000.000,00)
    c. € 301 - € 600 (Rp 5.000.001,00 – Rp 10.000.000,00)
    d. > € 600 (> Rp 10.000.000,00)
29. What kind of adaptation measures have your community been doing on your neighborhood? (the answer can be more than one)
    a. Nothing
    b. Elevate the street
    c. Improving the drainage system in the neighborhood
    d. Creating a dyke system in neighborhood
    e. Provide pumps
    f. Others……
30. Do you think that adaptation measures can reduce the effects of coastal flooding effectively?
    a. Yes
    b. No
31. What kind of adaptation measures has government been doing in your neighborhood? (the answer can be more than one)
    a. Nothing
    b. Elevate the street

c. Improving the drainage system in the neighborhood
d. Creating a dyke system in neighborhood
e. Provide pumps
f. Others……

32. Do you think that adaptation measures done by government can reduce the effects of coastal flooding effectively?
    a. Yes
    b. No
33. If 'no', what should government do to deal with coastal flooding in your neighborhood?
    a. Elevate the street
    b. Improving the drainage system in the neighborhood
    c. Creating a dyke system in neighborhood
    d. Provide pumps
    e. Others……
34. Based on prediction by 2015 this area will be worse inundated, do you think the adaptation measures you have done can reduce the effects effectively?
    a. Yes
    b. No

35. If 'no', what will you do to deal with that problem in year 2015? (the answer can be more than one)
    a. Elevate the house
    b. Raise the floor level
    c. Raise the yard level
    d. Build dam to prevent water
    e. Others ……..
36. If your house is getting worse affected by coastal flooding, do you consider moving to another area that is not vulnerable to flooding?
    a. Yes
    b. No
37. Please give your reason for your answer
    ……
    ……

Thank you for your answer.

Annex 2
Questionnaires addressed to respondents in predicted inundated areas

Dear respondent,
I am Dian Harwitasari a master student at the Institute of Housing and Urban Development Studies in Rotterdam-Netherlands. I am conducting a study on adaptation responses of coastal settlements to coastal flooding in Semarang. The findings of this research will be focused on the current and year 2015 prediction effects of coastal flooding, adaptation responses of inhabitants who have been facing coastal flooding and inhabitants who are predicted will be inundated and recommendation to local government to deal with the coastal flooding problem. This study is a requirement for me to accomplish a master degree in Urban Management and Development. I therefore kindly ask for your time to respond the flowing questions.

District :
Sub District :
Number of questionnaire :
Date :

CHARACTERISTIC OF INHABITANTS

1. Profession
   a. Fisherman
   b. Farmer
   c. Industrial labor
   d. Government officer
   e. Small business enterprise
   f. Others ……..
2. Income level
   a. ≤ € 35 (≤ Rp. 500.000,00)
   b. € 36 - € 100 (Rp. 500.001,00 – Rp. 1.500.000,00)
   c. € 101 - € 165 (Rp. 1.500.001,00 – Rp. 2.500.000,00)
   d. ≥ € 166 (≥ Rp 2.500.0001,00)
3. Education level
   e. Non educated
   f. Elementary school
   g. High school
   h. University
4. The house ownership
   a. Own
   b. Rent house
   c. Others …….

IMPACTS OF COASTAL FLOODING

5. Do you know about coastal flooding?
   a. Yes
   b. No
6. If yes, what do you know about coastal flooding in Semarang? (the answer can be more than one)
   a. Flooding because of sea level rise
   b. Flooding because of land subsidence
   c. Flooding because sea water intrude to land
   d. Flooding which happen periodically because of lunar gravitation
   e. Others ……
7. In your opinion, will your house be inundated in the next five years?
   a. Yes
   b. No
8. In your opinion, what will be the loss if there is coastal flooding in your neighborhood? (the answer can be more than one)

a. Damage houses and building
b. Decrease income
c. Cannot got to work
d. Children cannot go to school
e. Decrease health quality
f. Decrease environment quality
g. Decrease drinking water quality
h. Others ……

ADAPTATION RESPONSES

9. It is predicted that in year 2015 your neighborhood will be inundated by coastal flooding. What will you do to deal with this problem?
   a. Stay
   b. Move to other area
10. Please give your reason of your choice of question 10^{th}.
    ……
    ……...
11. In your opinion, when is the proper time to do adaptation responses to deal with coastal flooding?
    a. Start from now
    b. Immediately when your neighborhood is start inundated
12. What is adaptation respond you will do in dealing with coastal flooding? (the answer can be more than one)
    (a). Elevate the house
    (b). Raise the floor level
    (c). Raise the yard level
    (d). Build dam to prevent water
    (e). Others …….
13. How much do you want to spend for doing your adaptation measures in question 13^{th} ?
    (a). ≤ € 65 (< Rp 1.000.000,00)
    (b). € 66 - € 300 (Rp 1.000.000,00 – Rp 5.000.000,00)
    (c). € 301 - € 600 (Rp 5.000.001,00 – Rp 10.000.000,00)
    (d). > € 600 (> Rp 10.000.000,00)
14. When is the proper time for government to do adaptation responses?
    a. Before coastal flooding inundates your neighborhood
    b. Immediately when your neighborhood is start inundated
15. What kind of adaptation responses should be done by government in dealing with coastal flooding in your neighborhood? (the answer can be more than one)
    a. Socialization about coastal flooding
    b. Elevate the street level
    c. Improving the drainage system in the neighborhood
    d. Creating a dyke system in neighborhood
    e. Provide pumps
    f. Others ……..
16. What kind of adaptation measures will your community do on your neighborhood to deal with coastal flooding? (the answer can be more than one)
    a. Nothing
    b. Elevate the street level
    c. Improving the drainage system in the neighborhood
    a. Creating a dyke system in neighborhood
    b. Provide pumps

    Others ……..
17. In your opinion, who is the most responsible actor in dealing with coastal flooding in your neighborhood?
    a. Government
    b. Community
    c. Government and the community

Thank you for your answer.

Annex 3

INTERVIEW QUESTIONS TO THE INTERVIEWEES

INTERVIEWEES:
1. Semarang Planning and Development Board
2. Semarang Water Resources Management Agency
3. Semarang City Planning Agency
4. District Office
5. Sub District Office

Name :
Position :
Department :

List of questions

1. ORGANIZATION
   a. What are roles and responsibilities of your organization in dealing with coastal flooding?
   b. What are your organization's policies in dealing with coastal flooding?
   c. What are your organization's planning in dealing with coastal flooding?
   d. Does your organization have coordination with other institutions in dealing with coastal flooding?
   e. Does your organization undergo any financial constraints in dealing with coastal flooding?

2. FLOODING CONDITION IN SEMARANG COASTAL AREA
   a. How would you estimate the condition of coastal flooding in Semarang for last 3 years?
   b. Where was the worst inundated area for the last 3 years? How large is the inundated areas?
   c. Does the flood worsen every year?
   d. Could you explain about the social and economic effects of coastal flooding in coastal settlements?
   e. Coastal flooding affects the environment condition of coastal settlement. Could you explain how are the impacts of coastal flooding to environment, such as water, sanitation and soil?

3. ADAPTATION RESPONSES
   a. What has your organization been doing for the last 3 years in dealing with coastal flooding?
   b. Do the measures succeed to minimize the effects of coastal flooding?
   c. What does your organization do when coastal flooding occurs?
   d. Does your organization involve the coastal settlement communities in doing the adaptation measures?
   e. Does your organization aware that coastal flooding will be worse time after time?
   f. Does your organization make predictions about coastal flooding in the future?
   g. Does your organization establish adaptation strategies to deal with coastal flooding problems in the future?
   h. Based on research by Wibowo, 2006, some of districts (District Semarang Timur, Semarang Tengah, Gayamsari, Pedurungan and Tugu) are predicted to be inundated by coastal flooding by year the 2015, what do you think about this situation? Has your organization considered this prediction?
   i. What measures will your organization do in dealing with the prediction of coastal flooding?

Annex 4 : Demographic Data

Table : ***Demographic Condition of Semarang City***

Districts	Population	Household number	The wiedth of area (km^2)	Density
01. Mijen	47.154	13.532	57.55	819
02.Gunungpati	63.192	17.565	54.11	1.168
03. Banyumanik	114.631	29.385	25.69	4.462
04. Gajah Mungkur	61.147	14.377	9.07	6.742
05. Semarang Selatan	85.625	19.286	5.93	14.447
06. Candisari	80.561	16.594	6.54	12.318
07. Tembalang	122.300	32.891	44.20	2.767
08.Pedurungan	160.564	36.784	20.72	7.746
09. Genuk	77.196	18.781	27.39	2.818
10. Gayam sari	69.613	15.947	6.18	1.264
11. Semarang Timur	82.317	21.257	7.70	10.691
12. Semarang Utara	125.800	28.660	10.97	11.468
13. Semarang Tengah	74.649	19.361	6.14	12.158
14. Semarang Barat	158.566	36.696	21.74	7.294
15. T u g u	26.454	6.778	31.78	832
16. Ngaliyan	104.825	25.035	37.99	2.759

Annex 5 : The condition of tidal flood in Semarang

Location : Tanjung Mas sub district

Location : Tanjung Mas sub district

Location : Tawangsari sub district

Location : Tawangsari sub district

Location : Terboyo Kulon sub district

Location : Terboyo Kulon sub district

Annex 6 : Data compilation from questionnaires

- Respondents in present inundated areas

Health effect due tidal flood	Frequencies	Procentage
No	32	53.33
Yes	28	46.67
Total	**60**	**100.00**

Health effect due tidal flood	Frequencies	Procentage
diarhea	7	25.00
skin disease	13	46.43
dengue	0	0.00
others	3	10.71
diarhea & skin disease	3	10.71
diarhea & dengue	1	3.57
diarhea and others	1	3.57
Total	**28**	**100.00**

School absence due tidal flood	Frequencies	Procentage
No family member still go to school	8	13.33
Have family member still go to scool	52	86.67
Total	**60**	**100.00**

School absence due tidal flood	Frequencies	Procentage
never	29	55.77
less than 10 days	20	38.46
11 - 20 days	3	5.77
more than 20 days	0	0.00
Total	**52**	**100.00**

Income decrease due tidal flood	Frequencies	Procentage
No	28	46.67
Yes	28	46.67
Missing	4	6.67
Total	**60**	**100.00**

Income decrease due tidal flood	Frequencies	Procentage
Less than 20%	11	39.29
21% - 50 %	12	42.86
More than 50%	5	17.86
Total	**28**	**100.00**

Drinking water effect due tidal flood	Frequencies	Procentage
No	34	56.67
Yes	26	43.33
Total	**60**	**100.00**

Drinking water effect due tidal flood	Frequencies	Procentage
colour	7	26.92
smell	3	11.54
residu	3	11.54
others	2	7.69
colour & smell	4	15.38
colour & residu	2	7.69
smell and residu	2	7.69
colour, smell and residu	3	11.54
Total	**26**	**100.00**

Sanitation effect due tidal flood	Frequencies	Procentage
No	24	40.00
Yes	36	60.00
Total	**60**	**100.00**

Sanitation effect due tidal flood	Frequencies	Procentage
waste overflow	5	13.89
bad smell	9	25.00
damage the sanitation system	5	13.89
others	3	8.33
waste overflow & bad smell	6	16.67
bad smell & damage sanitation system	1	2.78
bad smell & others	2	5.56
waste overflow, bad smell and damage sanitation system	5	13.89
Total	**36**	**100.00**

Adaptation responses due tidal flood	Frequencies	Procentage
No	8	13.33
Yes	52	86.67
Total	**60**	**100.00**

Adaptation responses due tidal flood	Frequencies	Procentage
elevate the house	11	21.15
raise the floor level	11	21.15
raise the yard level	7	13.46
build dam to prevent water	4	7.69
elevate the house and raise the floor level	6	11.54
raise the floor level and raise the yard level	4	7.69
elevate the house and build dam to prevent water	2	3.85
raise the yard level and build dam to prevent water	2	3.85
elevate the house, raise the floor level and raise the yard level	4	7.69
elevate the house, raise the yard level and raise the yard level	1	1.92
Total	**52**	**100.00**

Adaptation responses due predicted tidal flood	Frequencies	Procentage
Move	13	21.67
Stay	47	78.33
Total	**60**	**100.00**

Adaptation responses due predicted tidal flood	Frequencies	Procentage
elevate the house	18	38.30
raise the floor level	8	17.02
raise the yard level	3	6.38
build dam to prevent water	3	6.38
others	0	0.00
elevate the house and raise the floor level	1	2.13
elevate the house and build dam to prevent water	4	8.51
elevate the house and move	1	2.13
raise the yard level and build dam	1	2.13
elevate the house, raise the floor level & raise the yard level	2	4.26
No answer	6	12.77
Total	**47**	**100.00**

- Respondents in present inundated areas

Adaptation responses due predicted tidal flood	Frequencies	Procentage
Stay	35	70
Move	15	30
Total	**60**	**100.00**