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Communities survival and coping mechanisms in flood-prone KAMANAVA, Metro Manila

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Abstract
The dense population in the northern part of Metro Manila, Philippines which is composed of the cities of Kalookan, Malabon, Navotas and Valenzuela (or KAMANAVA area) has been habitually suffering from floods, due to heavy rainfall, high water level in rivers, poor drainage systems and high tide at Manila Bay. Studies have shown that flooding is aggravated due to relative sea level changes enhanced by ground subsidence which is mainly caused by excessive groundwater withdrawal. Frequent flooding has brought huge economic losses to communities and disruption of commercial, industrial and social activities in the area.
The first part of the study describes the characteristics of KAMANAVA area and the situation of communities affected by flood. Low-level regular flooding occurs many times a month, especially during high tide. Heavy flooding, with water up to waist-high happens when typhoons coincide with high tides. The second part looks closely into the socio-economic impacts of flooding on communities through an interview survey conducted among 300 households in the four cities. This includes an investigation of the cost of damages to properties, costs of transportation, cleaning, illness and other expenses incurred after flooding. Another important aspect is the analysis of economic impacts of regular flooding and the strategies done by households to cope with these floods. People who can afford can place temporary barriers, elevate their lots, raise the level of their house or even build a new house, but poorer households can do little to improve their situation and suffer greater health risks.
With the threat of climate change and impacts of ground subsidence and urbanization, some policy measures are recommended for the regulation of groundwater abstraction, implementation of appropriate on-site infrastructures, land use planning and provision of economic opportunities, housing and other support services to enhance sustainable adaptation strategies of communities.
Key words: climate change, adaptation strategies, damage cost, flooding
Introduction
Although cities have benefited from rapid urbanization, the increase in population and economic activities have also created environmental problems, such as decreasing quality and quantity of surface and groundwater sources, air quality deterioration, increasing solid waste and inadequate sanitation and housing facilities, among others. The subsurface environment may have not been given much attention, but uncontrolled groundwater use has affected many coastal megacities. Jago-on et al. (2009) summarizes problems associated with uncontrolled groundwater use in

some Asian megacities. Uncontrolled groundwater use decreased water levels which can result in land subsidence problems and when areas are at almost sea level, the most serious impact of subsidence is flooding. Land subsidence problems in the northern part of Metro Manila as well as it effects on flooding have been investigated by Siringan and Rodolfo (2003, 2006).

Many parts in Metro Manila are subjected to heavy flooding. The average number of tropical cyclones that pass across the Philippines is 20 and the landing frequency on Central Luzon, where Metro Manila is located is 16% or about 3 times in a year. These typhoons bring heavy rain which causes flooding in the metropolis and storm surges along its coastal areas. The flood-prone areas in the northern part which consists of the cities of Kalookan, Malabon, Navotas and Valenzuela or simply called the KAMANAVA are low-lying flat lands with an elevation of -0.5 to 1.5 meters above mean sea level of Manila Bay. The topographical characteristics make this area prone to flooding caused by heavy rainfall, high water level in rivers, and high tide at Manila Bay. Low-level regular flooding occurs many times a month, especially during high tide. Heavy flooding, with water up to waist-high happens when typhoons coincide with high tides. The people habitually suffer from flooding and these floods carry the heavy polluted water of rivers and seas to streets, homes, schools, companies and other establishments. Residents have developed mechanisms to survive and cope with the effects of flooding. People reconstructed their lot and houses in order to raise the level from the ground. Some placed barriers to prevent floodwaters from coming in. However, those who have less resources cannot afford to make some improvements but continue to stay in the same area despite the health risks of living above stagnant and dirty water. Since the 1980s, the government has implemented several flood control projects in KAMANAVA, however the problems persist since the infrastructures provided offered only palliative solutions to the problems.

In order to understand the social and economic impacts of flooding on the residents and the survival and coping mechanisms of the people, a questionnaire survey was conducted among 300 households in the 4 cities of Kalookan, Malabon, Navotas and Valenzuela. Items in the survey include residents' perception of flooding, the cost of damages from flood and the added burden in terms of transportation cost, health cost and cleaning cost and other expenses. Among the four cities, Malabon and Navotas, are most notably affected by these flood events, and emphasis is given on the situation of these two cities.

Climate change, land subsidence and flooding in Metro Manila

Most of the megacities in Asia are located along the coast and they are susceptible to anthropologically-induced climate changes, such as accelerated sea level rise, changes in storm intensity and frequency, more intense rainfall events and different effects on run-off patterns.). In addition to global sea level changes, local uplift or subsidence of ground surface must be considered, and the sum of these global and local changes is described as relative sea level change (Nicholls, 1995). Massive abstraction of groundwater has caused land subsidence in some coastal cities in Asia (Jago-on et al., 2009; Holzer, 1985). When an area is at almost sea level with natural ground elevation, the most serious impact of land subsidence is flooding.

With a coastline of 34,000km, the Philippines is potentially vulnerable to the effects of accelerated sea level rise (ASLR), which include submergence of low-lying wetland and dry land areas, erosion, salt water intrusion, increased risk of flooding and storm damage. Perez et al. (1999) evaluates the possible impacts of ASLR in the Manila Bay coastal area in the Philippines in the context of climate change and examines the adaptive responses to such threats. The scenarios or the boundary conditions set in the study are accelerated sea level rise of 0.3, 1.0 and 2.0 meters by the year 2100. Results show that for a 0.3 m sea level rise, about 2,090 hectares of areas will be affected and for a rise of 1.0m, about 5,555 hectares are projected to be endangered areas.

This area will cover the coastal villages of 19 cities and municipalities of Metro Manila and the neighboring provinces of Bulacan (in the north) and Cavite (in the south). The vulnerability analysis done by Perez et al. (1999) showed that most areas along the coast of will succumb to a 1m sea level rise, specifically about 19 municipalities of Metro Manila and nearby provinces of Bulacan and Cavite. Areas that could be inundated by 0.3m sea level rise already experience flooding during high tides, which includes Navotas, Malabon and Dagat-dagatan areas in Kalookan. Densely populated areas along the coast, especially areas inhabited by squatters in Navotas and Malabon may survive ASLR, but will be severely affected by storm surges that are likely increase in frequency and severity. The number of people estimated to be affected by a 1m rise in sea level is about 2.3 million by 2025.

Rodolfo and Siringan (2006) emphasize that in understanding the phenomena of worsening floods in the northern part of Manila Bay it is necessary to consider not only sea level rise but also land subsidence in the area. Some government sectors which have started to recognize that the sea level rise of 1 to 3 millimeters per year due to global warming is a cause of worsening floods, but still ignore the principal reason that excessive groundwater extraction is lowering the land surface by several centimeters to more than a decimeter per year (Rodolfo and Siringan, 2006).

Many parts in Metro Manila have been subjected to heavy flooding and flood characteristics are discussed in various literatures. The Center for Integrative and Development Studies of the University of the Philippines has produced a monograph which tackles urbanization and flood control and drainage problems in Metro Manila (Liongson et al., 2000). Zoleta-Nantes (2000) shows the changing flood landscape of Metro Manila and provides a historical trend of flooding events, particularly from the period 1953-1998. The main components of flooding in Metro Manila include rainwater runoff, tidal variations, incidence of monsoon rains and changes in groundwater hydrology and periodical storms (Zoleta-Nantes, 2000). Differential impacts of flood hazards among various sectors in Metro Manila have been discussed by Zoleta-Nantes (2002). As what has been mentioned, the topographical characteristics of the KAMANAVA area make it prone to flooding caused not only by heavy rainfall but also by high tide in Manila Bay. The low-lying areas of Navotas and Malabon have been perennially flooded and residents have developed mechanisms to survive and cope with the effects of floods.

Description of KAMANAVA area

Physical characteristics

The four cities of Kalookan, Malabon, Navotas and Valenzuela are parts of the 16 cities composing Metro Manila, Philippines. The total land area of Metro Manila is 636km2 and these 4 cities occupy an area of about 123.85km2. Figure 1 shows the map of Metro Manila and the location of the 4 cities in the northern and outlined in green color in the map. (Please insert Figure 1 here).

KAMANAVA is an acronym, which is a combination of the first 2 letters of the 4 cities. The area that is prone to flooding in KAMANAVA is low-lying flat land with an elevation of -0.5 to 1.5m above mean sea level of Manila Bay. It is located in the estuary delta of Malabon-Tullahan River. In terms of climate, Metro Manila belongs to the Type 1 of the Philippine Climate classification. The two pronounced seasons in the area are the dry season, which comes from the month of November until April, and the wet season which starts from May until October. These 2 seasons are caused by the northeast monsoon from November to February, tradewinds from March to June and southwest monsoon from June to October. The temperature during the northeast monsoon ranges from 220C to 330C and average of 260C. The maximum rainfall recorded at Port Area Station in recent years is 509mm in 2 days (403mm in one day). (Pacific Consultants International,1998).

The city of Kalookan is divided into two geographical locations, namely South Kalookan and North

Kalookan and it has a combined land area of 53.33 km2. Malabon has a land area of 15.714 km2 and it is bounded on the north and northeast by Valenzuela. It is composed of 21 “barangays” or villages. The “barangay” is the smallest political unit in the Philippines. Out of the 21 barangays in Malabon, 7 are affected by high tide, 2 are flooded during heavy rain, and 5 barangays are affected by both high tide and heavy rainfall (City Planning and Development Office, 2002). Navotas is geographically located on the extreme northwest shore of Metro Manila. It is an elongated island trip with an aggregate shoreline of approximately 4.5 kilometers fronting Manila Bay. Navotas has a total land area of 10.69 km2 and composed of 14 barangays, 11 of which are located along the coast and mostly affected by floods, especially during high tide (City Planning and Development Office, 2007b). Valenzuela, on the other hand, has a total land area of 44.13km2 and composed of 38 barangays.

Land uses

Table 1 shows the land uses in the 4 cities. Caloocan has the largest area for residential purposes, which is about 62%, while the three other cities almost have the same ratio of around 37 percent. More than 50% of the land area in Malabon and 26% of the area in Valenzuela are dedicated for industries and commerce. More than 20% of the land area in these 2 cities is open or vacant spaces. In Navotas and Kalookan, industrial and commercial areas comprise 16% and 12% of the total land area, respectively. Surprisingly in Navotas however, fishponds, which are concentrated in the northern part of the city (Barangay Tanza) comprise almost half of the land area, about 4.762km2. Currently, these fishponds are not in productive use and left as water-filled open areas. In the past, these fishponds served as an economic base, providing the metropolis with resources and well as sustaining the livelihood of the people. However, due to large-scale trading in fish and sea-based resources in the Navotas Fishport complex, the fishponds slowly lost their economic viability. (Please insert Table 1 here).

City Economy

Kalookan City, with its strategic location, serves as the premier center of trade and industry in the KAMANAVA area. The major economic activities are retail trading, real estate, and import-export activities. Kalookan also boasts it manufacturing industries for metal/ steel, plastic, food, rubber and garments and furniture products (Caloocan City, 2000). The agriculture and fishery sectors in Malabon used to occupy 14.61% of the land area in 1980s, however at present this sector has a minor role in the city’s economy. Lands were converted for establishments of trade, manufacturing and commerce. Fish production has declined in recent years due to the incidences of red tide in the 1990s, the overflowing of fishponds due to flooding and decreasing fish production because of water pollution (City Planning and Development Office, 2002). Agricultural activities in Navotas are concentrated in the fisheries production. Food manufacturing industries are involved mostly in the processing of fish sauce, dried smoked fish, fish meat and fish sauce. These are mostly small scale in nature and usually carried out in the homes. Shipyards involving shipbuilding, repair and maintenance, and while these were major economic contributors in the past, have somehow declined in number. Commercial and trade establishments, on the other hand, comprise mostly of small to medium general merchandise stores, food and beverages and pharmaceutical products (City Planning and Development Office, 2007b).

Population characteristics

According to the latest census, the population of Metro Manila in 2007 is around 11.5 million people and 22% of this population resides in the KAMANAVA area. The combined population of the 4 cities is 2.56 million people. Table 2 summarizes the population characteristics of the four cities. The annual average population growth from 1995-2007 in Malabon and Navotas is less than 0.5%, much lower than the regional average in the National Capital Region or Metro Manila, which is 1.7percent. Except for Valenzuela, all cities have a density of more than 20000 persons/ km2.

The average household size is about 4.5 persons. Official household income for all cities is quite difficult to get and some estimates are taken from the reports of the local government. Navotas has the lowest household income of 60,000 Philippine pesos (PhP) or about 1363 US dollars. In a survey of about 60,000 households conducted by the local government in Malabon, more than half of the respondents have an income ranging from PhP100000 to 249999 (US$2273-5682). In Valenzuela, about 40.58% of the total families belong to the highest income-earning group with an average income level of PhP174000 (US$3954). (Please insert Table 2 here).

Social services

The rate of population growth is increasing much faster than its economic resources. The effect of this uncontrolled growth of people results to high incidence of poverty, increasing unemployment, inadequate water, waste management problems and traffic congestion. Moreover, the extent of urban services, namely housing, school facilities and health services, cannot cover the requirements of the rapidly growing sectors of the population.

The housing shortage in the KAMANAVA area, as well as in the rest of Metro Manila is really alarming. Urban slum areas grow correspondingly with the rate of housing shortage and contribute to the degradation of environmental conditions. Some families live along creeks and rivers and flood plain areas, which endanger their situation, especially during flush floods.

In terms of water supply, Maynilad Water Services Inc., the private waterworks company serving the area, has provided water services to approximately 74% of Malabon residents in 1999, while 12% are serviced through communal faucet systems. About 6% of the population gets water directly from point sources (wells, springs, rain collection) while the remaining 7.7% have doubtful source of water. In Navotas, 82% of the households have access to potable water supply but there is still inadequacy in the volume of water supply in existing service areas. Illegal use of water pipes, particularly in urban poor areas sometimes damages structures and pose hazard to health. Maynilad Water Services Inc. also maintains the Dagat-dagatan Sewerage System which is located along Dagat-dagatan, Kaloocan City but has a service area of only 3.32km2, covering some portions of Navotas, Kaloocan City, Manila and Malabon. The waste generated from domestic usage, commercial establishments and industries in areas not covered by the sewerage systems are discharged into septic tanks, drainage canals or directly to rivers. Since the 1980s, the river system connecting the Malabon-Tenejeros-Tullahan Rivers has already been considered biologically dead due to pollution (Pacific Consultants International, 1998). Garbage collection and solid waste disposal are either handled by the local government or private contractors. However, still a significant amount of garbage is uncollected due to inadequate equipment capacity and improper disposal practice of some residents. Uncollected garbage are either dumped in rivers, drainage channels, roads and open spaces or recovered by scavengers. Furthermore, uncollected waste material and clogging garbage in drainage channels continuously contribute to worsening flooding and spread of diseases. When it floods, these highly polluted waters carry microorganisms and harmful chemicals, come in contact with the people, which endanger their health. The stagnant pool of water becomes breeding ground for insects that carry diseases. The most common causes of morbidity in the area are diseases of the respiratory system, digestive system, skin diseases as well as malaria and dengue fever, which are carried by mosquitoes.

Methodology of the study

In order to assess the social and economic impacts of flooding in the KAMANAVA area, a questionnaire survey was conducted among households in March 2008. This questionnaire served as instrument for initial research on the perceptions and experiences of residents in flood-prone areas in the 4 cities of KAMANAVA. The survey also looked into the coping mechanisms of households to flood and estimated the annual expenses in activities to prevent further damages due to flood, as well as the cost incurred due to the effects of flood. Those who were mostly

affected by floods in different villages in the area were chosen as respondents and about three hundred (300) of them were interviewed. As background information, characteristics of respondents such as gender, age, income, occupation, years of stay in the area, ownership of dwelling and physical characteristics of their houses were asked in the survey. In addition to the information taken from the questionnaire, the physical, socio-economic, demographic and other relevant information on the KAMANAVA area and the characteristics of flooding, were taken from secondary materials, such as official documents from local governments of the four cities in Metro Manila. These documents are included in the reference list.

The questionnaire is divided into two parts. The first part deals with the nature of flooding experienced by people throughout the year and their social and economic impacts. These regular floods are low-level and occur especially during high tide, except during the months from June to September when heavy rains aggravate flooding in the area. Flooding characteristics include the number of days in a month when flooding occurs, perceived causes of flooding, level of floodwater, and duration of floodwaters inside the house. The cost of flood was investigated and this include the amount spent by households to prevent further damage to floods, money spent for treatment of wounds and illness due to floods, the added cost of transportation and cleaning, and other expenses for damages of things. People have been experiencing flood since the past three decades and they have done things to prevent additional damage. These vary from land filling, reconstruction of houses to add another level to the house, or putting barriers outside of the house to prevent floodwater from coming in. Some families who have more resources abandon their houses and settle to another place. Respondents were asked which of these activities they have done, the year they did and the cost of these activities. The second part of the questionnaire mainly focused on the impacts of a heavy flooding which happened in July 2000, when typhoon occurred during high tide. The water level was as high as 2 meters during that time. In this part, the estimated socio-economic impacts focused on the cost of damages to household properties and appliances as well as the cost of health, transportation and cleaning. This paper mostly discusses the results of the first part of the survey.

Results of the Survey

Description of household respondents

Among the 300 respondents, 62% were females and 38% were males, and the average age is 42. Females were more available during the time of interview and they represent most of the households interviewed. Around 46% of the respondents have lived in the area from 5-20 years, 30% have stayed from 21 to 40 years and the rest have settled in the area for more than 40 years. With regards to income, 45% of the respondents belong to the low-income group, 49% have average income, and only 5.3 belong to the higher income group. Figure 2 shows the ratio of respondents according to income. A large portion of the respondents came from low to average income groups, as these households lived in vulnerable places and are mostly affected by floods. Most of their sources of income are located near their residence. Some respondents own small to medium merchandise stores; are self-employed as vendors, drivers or skilled workers; are wage earners working in local government offices; and others are retired employees or do not have regular jobs. Some of those who do not have regular employment depend on remittances of family members working outside of the country. (Please insert Figure 2 here).

Socio-economic impacts of flooding

The respondents have experienced flooding many times since the year they have settled in the area. They perceived that the main causes of floods during the early months of the year are high tide and garbage that blocks the regular flow of water in waterways. During the rainy seasons starting in June until October, heavy rains and the occurrence of typhoons, aggravate flooding in the area. Respondents experienced a minimum of 16 to a maximum of 34 flooding days in a year.

However, in Malabon, there is a certain area with around 120 residents whose grounds and first level of the houses are flooded with a meter-high of water since 2004. The place is only accessible by small outrigger canoe or locally called “bangka”, instead of land transport. Because of no alternative place to stay, these people continue to live above stagnant and dirty water. Depending on the location, the level of water during floods varies from 0.25 meters to more than 2 meters, especially during heavy downpour. Figure 3 shows the variation of height of floodwaters as experienced by the respondents throughout the year. The number of respondents being affected with higher floodwater started to increase from May until September. (Please insert Figure 3 here).
Due to floods, respondents through the years have invested in activities to prevent further damage from floods such as land filling, reconstruction of houses to increase elevation from the ground or adding another level of the house, and placing barriers such as sandbags, wooden planks or concrete blocks. Some people sometimes transfer to another place or evacuation centers. However, some people who cannot afford any improvements in their lot do nothing. Some residents are already used to the impacts of floods that they chose not to do any action. Among the respondents, around 27% have not done significant prevention activities to avoid damage from flooding. Respondents also indicated the year these improvements have been done, which started in some people in the 1980s up to the present. Of those who indicated the year they have done preventive activities, 9% have done it in the 1980s, 36% in the 1990s and more than half of the respondents, have done the improvements from 2000-2008. Table 3 shows the types of activities and the corresponding average cost in the four cities. Because these preventive activities have been done in different years, the values have been adjusted to 2007 values. The average cost is about PhP61455 (US$1,397). When comparing the 4 cities, respondents from Navotas and Malabon spent more for these improvements in their homes. These two cities are the most affected by floods in the area. (Please insert Table 3 here.)
Other costs incurred during the year are the cost for treatment of illness or injury during and after floods, the added cost of transportation, cost of cleaning and fixing damaged properties and others. The cost for illness and injury is simply referred here as health cost. When the area is flooded, transport cost varies and most often is increased by as much as 200%. The regular transportation in the area are buses and “jeepney” (modified American jeep popularly used as a means of local transportation), which are used for inter-city transfer; motorcycle and “pedicab” (cycle rickshaw, human-powered small-scale local means of transport) are use for short distances. During heavy floods, alternative modes of transportation include “bangka”, improvised styrofoam boxes or old lifeboats. Some people also walked through the flooded streets or sometimes got free ride provided by government trucks. Although the prices for “bangka” and other alternative transportation vary, respondents have indicated the usual amount that they spent. Transportation cost is estimated here as the added cost during flood days. The cost of cleaning includes cost for repairs of damaged things or transfer and evacuation. The respondents’ average annual cost is about PhP17,089 (US$388), of which 69% of the amount covers health cost, 23% is for cleaning and repairs and 9% is for transportation. Table 4 summarizes the annual cost of flood impacts. It is important to note the health impacts of flooding in the area and the cost to the residents. Mostly affected by illness are the children and the elderly and the most common diseases indicated by respondents are common colds, pneumonia, diarrhea, dengue fever, skin diseases and leptospirosis. Leptospirosis is usually transmitted to humans through rats and their urine (Easton, 1999). Bacteria in the water can also infect people by entering the body through cuts and abrasions (Ahem and Kovats, 2007) These illnesses are also reflected in the health situation of the cities, especially in Malabon and Navotas, wherein the top 10 causes of morbidity are illnesses of the respiratory system, digestive system and skin diseases. (Please insert Table 4 here.)
During the heavy flood in 2000, majority of the cost (81%) was the damage to properties and

household appliances. Health costs and cleaning costs which include transportation cost, make up 11% and 8% of the total costs, respectively.

Discussion

The flood in KAMANAVA is a recurring problem caused by various factors, which can work in combination with each other: high tide levels, overflow of riverbanks and inadequate drainage which prevents regular flow in waterways. Most rivers and canals are heavily polluted with solid waste and sewage from households and wastewater disposed by industries nearby. These floods have placed burden on the lives of the people, especially, on the cost for the damages of household properties, amount spent for illnesses and injury, transportation, cleaning, transfer and evacuation and others. On top of these, is the added loss of income when people cannot go to work due to inaccessible roads or lack of transportation. When compared with income, the ratio of the annual cost of flood effects is about 28% of the annual income of an average family in Navotas. Given the economic situation of most families in the area, this amount is significant and would have been spent for other basic necessities in the household, such as food, clothing, education, health or sanitation. For poorer households, amount spent on illnesses due to floods takes a greater portion of the expenses as they have less protection from infections or less access to clean water after floods. Poorer households also live in vulnerable and unsanitary areas, making them more susceptible to microorganisms in waste carried by floodwaters. Damages of things are less as they have kept less things or appliances in their households. Given the regular floods in KAMANAVA, households have spent money for improvements in their houses to prevent floodwaters from coming in. These are ways to cope with the flood effects in order to continue to live normally in the areas. These improvements have been done as early as the 1970s until present time. On the other hand, government reconstructed and raised the levels of some streets to avoid floodwaters. However, in some cases these road improvements are detrimental to households which cannot afford to raise their lots up to the level of the streets. Floodwaters eventually go to lower areas, causing more damage.

Although flooding in KAMANAVA has been a perennial problem, some people get used to the effects and continue to stay in the area. Most of the respondents' means of livelihood are near their residences. With the growing population in Metro Manila, it is quite difficult to find a more affordable place to live. Others chose to live because of their personal attachment to the area. They have been born and raised in the area. However, other people who can afford to settle in other places chose to abandon their homes.

The KAMANAVA area plays a significant role in the country's economy in terms of fishery, industry and commerce, and tourism. However, frequent floods in the area have disrupted economic activities, especially in Malabon and Navotas. Even the population growth from 1995-2007 in these 2 cities is quite compared with other cities in the metropolitan. From 1995-2000, Malabon experienced a negative population growth, while Navotas only increased its population by a thousand residents. Flooding makes it more difficult for residents to find alternative livelihood in the area.

Since the 1980s the government has implemented several flood control projects, but these are only palliative measures. With the impact of land subsidence and the added threat of climate changes which can result to sea level rise, as well as increased intensity and frequency of rainfall, people in the KAMANAVA will continue to suffer from inundation if appropriate solutions are not implemented. To curtail subsidence and eventually reduce the impacts of flooding, Rodolfo and Siringan (2006) suggested two measures: 1) to slow the rate of subsidence by replacement of groundwater with surface sources; and 2) if groundwater is to continue to be exploited, it must be regulated. In the Philippines, regulations on groundwater use are integrated under the Water Code of the Philippines, however the policy lacks provision on land subsidence issues contrary to some

other cities in Asia where such is integrally considered in groundwater policies.

For other long-term flood mitigation measures, the country must refrain from using waterways as garbage dumps and housing sites. Proper land use planning of areas vulnerable to floods and provision of alternative housing, economic opportunities, and other social services are needed to enhance the adaptation strategies of affected communities. Appropriate on-site infrastructures on flood prevention and control and improvement of drainage and sewage systems are also needed in the area.

Recommendations for further study

This study is an initial undertaking to assess the social and economic impacts of floods on households in the KAMANAVA area in Metro Manila, Philippines. The impacts are measured by estimating cost of damages, expenses for transportation, health, cleaning and others. Improvements made by residents in their houses to cope with the effects of floods, have also been investigated. In order to fully assess the economic impacts of flood, it would be necessary to see the costs incurred by other sectors of society, which includes industries, business and institutions such as schools, churches or hospitals. It is also worthwhile to see the amount spent by government agencies to reduce impacts or prevent floods. These issues will be taken in future research on flood impacts on the KAMANAVA area.

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Figure 1. Map of Metro Manila and location of KAMANAVA area

Map of Metro Manila and location of KAMANAVA area

Table 1. Ratio of land uses in Kalookan, Malabon, Navotas and Valenzuela (2000)

Land Uses	Percent of total area			
	Kalookan	Malabon	Navotas	Valenzuela
Residential	61	37	38	36
Commercial	5	19	2	2
Industrial	7	35	14	24
Institutional	2	6	1	1
Utilities	2			
Agri-forestland				2
Fishponds		1	45	12
Cemetery	2	1		0
Parks and Recreation	0			2
Vacant land	20	1	1	23
Total	100	100	100	100

Source of basic information: City Planning and Development Office (2002, 2007a, 2007b, 2007c).

Ratio of land uses in Kalookan, Malabon, Navotas

Table 2. Population characteristics in KAMANAVA (2007)

	Area (sqkm)	Population (000 persons)	Annual population growth rate (1995-2007)	Density (persons/ sqkm)	Number of households	Average household size
Kalookan	53.32	1378.9	2.53	25860	293374	4.7
Malabon	15.71	363.7	0.38	23150	80818	4.5
Navotas	10.69	245.3	0.58	22951	53336	4.6
Valenzuela	44.13	568.9	2.23	12892	126428	4.5
KAMANAVA	123.85	2556.8		21213	553956	
Metro Manila	636	11553.4	1.70	18166	2511615	4.6

Population characteristics in KAMANAVA (2007)

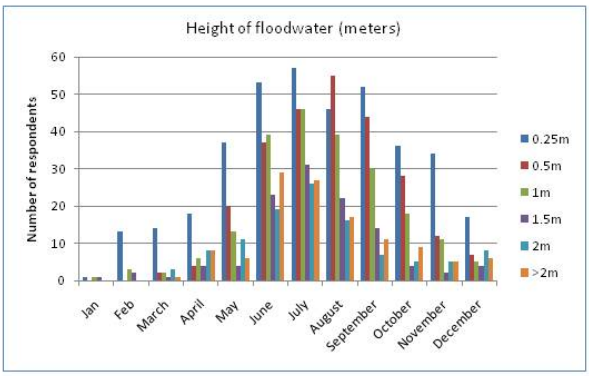

Figure 3. Height of floodwater throughout the year

Height of floodwater throughout the year

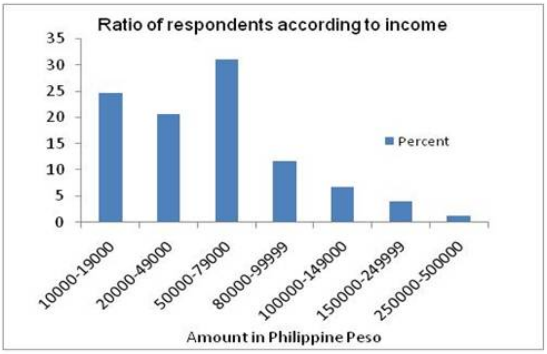

Figure 2. Ratio of respondents according to income

Ratio of respondents according to income

Table 3. Preventive action and estimated costs

Preventive action	Number of respondents	Percent		Cities	Average expenses PhP (US$)
Land filling	105	44		Kalookan	44542 (1012)
Raised level of house	90	38		Malabon	88359 (2008)
Barriers	41	17		Navotas	99561 (2263)
Build another house	4	2		Valenzuela	13357 (304)
Total	240	100		Average	61455 (1397)

Preventive action and estimated costs

Table 4. Annual cost of flood impacts

Annual cost	Amount in PhP (US$)	Percent
Health	11755 (267)	69
Transport	1454 (33)	9
Cleaning and others	3880 (88)	23
Total	17089 (388)	100

Annual cost of flood impacts

Presentation Preference
Additional information