Social and Economic Impacts of Flooding and Land Subsidence in KAMANAVA, Metro Manila

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Many areas in Metro Manila are subjected to heavy and regular flooding. Excessive rains brought by monsoons and typhoons cause flooding in the metropolis and storm surges along its coastal areas. The temporary accumulation of water is also due to insufficient drainage systems and impervious surfaces. In recent years, these flooding events have been exacerbated by land subsidence, especially in the northern parts of Metro Manila or the KAMANAVA area. A survey of households and companies was conducted to understand the flood characteristics in the area and the socio-economic impacts on the community. Results reveal the social and economic consequences and impact of flooding to properties, health and livelihood. The study shows also the factors affecting the annual cost due to floods. The research concludes with policy recommendations to curtail land subsidence and eventually reduce the impacts of flooding.

Introduction

Flooding is a major problem in Metro Manila. The metropolis experiences flashfloods and inundations, especially during the rainy season. The increase in coverage, duration and impacts of flooding is due to a lot of reasons. Rapid urbanization has led to an increase in built-up areas and widespread use of permanent materials such as concrete, which increased impermeability of the ground. Forest in the mountain areas near Metro Manila has been greatly denuded, decreasing the retention rate of watersheds and increasing the volume of water flowing down the plains (Ilago, 2000). The

capacities of rivers and creeks have been reduced by siltation and the use of these waterways for garbage and waste disposal. Housing, commercial establishments and other illegal structures encroached on the remaining natural channels. In the 1960s, about 21 kilometers of small rivers (*esteros*) have already disappeared and many 20-meter wide *esteros* have been transformed into 0.6m-sludge canals (Zoleta-Nantes, 2000). In the last few decades, flooding events have been exacerbated by land subsidence especially in the northern parts of Metro Manila. Based on tide gauge data, the acceleration of land subsidence in the area started in the mid-1960s (Siringan & Rodolfo, 2003). Rodolfo and Siringan (2006) emphasized 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.

The flood-prone areas in the northern part consisting of the cities of Kalookan, Malabon, Navotas and Valenzuela or simply called the KAMANAVA area, are low-lying flat lands with an elevation of -0.5 to 1.5 meters above mean sea level of Manila Bay. The natural elevation of some areas is lower than the sea level, making them more susceptible to inundation caused by high tides in Manila Bay. The cumulative land subsidence area was more than 100 cm from 1991-2003, with a rate of about 5cm/ year (Siringan & Rodolfo, 2003). Low-level regular flooding in KAMANAVA occurs many times a month, especially during high tide. Heavy flooding, with water up to waist-high, usually happens when typhoons coincide with high tides.

These flood events have great social and economic consequences: loss of lives, damages to properties and infrastructure, health and livelihood. Annual estimates of cost of damages due to disaster events are often compiled and calculated in terms of agricultural losses and damages to public infrastructure. However, damage costs due to flood events are not regularly recorded and are often times underestimated. These usually do not include cost of damages to households and business, or the damages incurred during small flood events. These small flood events often do not register on the national scene as disaster events, but consistently affect the assets of the people, especially the poor, who are most

vulnerable to these disasters. In some countries, the effect of these "everyday disasters" is sometimes much greater than those of the larger events formally recorded as disasters (IFRC, 2002).

Public costs due to floods also include the cost of flood protection and mitigation measures. Several national agencies are responsible for flood management in the country but the Department of Public Works and Highways (DPWH) is the main agency with direct responsibility for planning, construction, operation and maintenance of flood control and drainage facilities. In Metro Manila, however, the Metropolitan Manila Development Authority (MMDA) has a similar mandate for flood control and drainage systems, by virtue of Republic Act No. 7924. Since 1991, the Local Government Code has mandated the local governments to be responsible for effective provision of basic services and infrastructure facilities including flood control, drainage, dikes and other infrastructures.

Most flood control projects have been done since the 1980s and the costs have greatly increased since the 1990s (Fano, 2000). A project was implemented from 1992-1993 to mitigate flooding in the Malabon, Navotas and Valenzuela areas (MANAVA Flood Mitigation Project), but was not sustained (Pacific Consultants International, 1998). Flooding worsened in the KAMANAVA, which entailed the conduct of another project, the KAMANAVA Flood Control and Drainage System Improvement Project. The construction of flood control facilities started in 2000 and was planned to be finished in 2007, but until now, the facilities are still not fully operational. Controversies surround the construction of this project in KAMANAVA because of less consideration of the land subsidence situation in the project design.

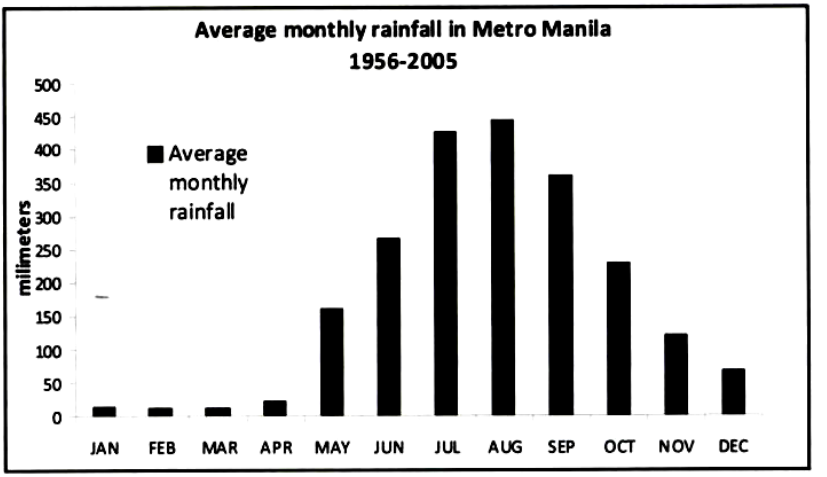
The people in KAMANAVA suffered from flooding and through time, they developed mechanisms to survive and cope with its effects. They reconstructed their houses or raised the level of the ground. Some placed barriers to prevent floodwaters from coming in. Others totally abandoned their houses and left the area. Those who have less resources and cannot afford to make some improvements in their housing unit, had to move their belongings upstairs or elevated areas in the house.

To come up with policy recommendations to mitigate or reduce the impacts of flooding in KAMANAVA area, it is necessary to understand the flood characteristics in the area, the socio-economic impacts on the community, and the flood coping mechanisms of the people. This paper discusses the results of the study conducted on the socio-economic impacts of flooding on households and companies in the cities of Kalookan, Malabon, Navotas and Valenzuela.

Description of KAMANAVA area

The four cities of Kalookan, Malabon, Navotas and Valenzuela (KAMANAVA) occupy a land area of about 123.85 km^2 in Metro Manila. Table 2 shows the land area of each city. The city of Kalookan is composed of 188 "barangays" or villages. Malabon City has 21 barangays and out of these, seven are affected by high tide, two are flooded during heavy rain, and five are affected by both high tide and heavy rainfall (Malabon City Planning and Development Office, 2002). Navotas City is geographically located in the extreme northwest shore of Metro Manila. Navotas is composed of 14 barangays, 11 of which are located along the coast and mostly affected by floods, especially during high tide (Navotas City Planning and Development Office, 2007). Valenzuela City, on the other hand, has 38 barangays.

Figure 1. Average monthly rainfall in Metro Manila (1956-2005)



Source of basic data: Records of normal/ average and annual rainfall of selected rain stations in the Philippines, Philippine Atmospheric, Geophysical and Atmospheric Services Administration (PAGASA)

Monthly rainfall in Metro Manila was heaviest during the months of July and August, with more than 400 millimeters of rain (Figure 1). The highest tide levels reaching two meters occurred from May to August (Table 1). This becomes a critical period when heavy rains occur during high tide.

Table 1. Recorded tide levels in Manila Bay (2007)

Tide levels (meters)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	%
	2	2	1							1	2	2	10	3
1.0						1					1	1	3	1
1.1	4		1	2	2	4	1			1	2	3	20	5
1.2	1	6	3	2	5	2	2		1	2	1	1	26	7
1.3	3	5	3	4	4	2	4	2	1	2	4	3	37	10
1.4	6	3	11	5	1	2	5	5	4	4	2	2	50	14
1.5	2	4	5	6	4	3	1	9	6	9	3	2	54	15
1.6	8	3	4	4	2	1	4	5	8	2	3	3	47	13
1.7	1	2	3	4	3	4	3	2	8	4	3	6	43	12
1.8	1	3		2	6	5	7	5	2	6	4	5	46	13
1.9	3			1	2	3	1	1			5	3	19	5
2.0					2	2	2	2					8	2
2.1						1	1						2	1
	31	28	31	30	31	30	31	31	30	31	30	31	365	100

Source: Navotas City Planning and Development Office

Land uses

Table 2 also shows the land uses in the four cities. Kalookan has the largest area for residential purposes, which is about 62 percent, while the three other cities almost have the same figure of around 37 percent. In Navotas, fishponds, located in the northern part of the city, comprise almost half of the land area. In the past, these fishponds served as an economic base, providing resources as well as livelihood of the people. However, due to large-scale trading in fish and sea-based resources in the Navotas Fishport, the fishponds slowly lost their economic viability. Currently, these fishponds are not in productive use and are left as water-filled open areas.

Table 2. Land uses in the Kalookan, Malabon, Navotas, and Valenzuela

Land use area (sq.km.)	Kalookan	Malabon	Navotas	Valenzuela
Residential	32.79	5.89	4.03	15.99
Commercial	2.5	2.9	0.22	0.86
Industrial	3.9	5.47	1.5	10.61
Institutional	2.26	0.96	0.11	0.35
Agro-industrial	0.12			0.12
Agricultural fishponds & forestland		0.2	4.76	5.95
Open spaces	10.7	0.15	0.06	10.07
Parks and recreation	1.06	0.14		0.17
TOTAL	**53.33**	**15.71**	**10.68**	**44.12**

Source: Kalookan City Planning and Development Office, 2000; Malabon City Planning and Development Office, 2007; Navotas City Planning and Development Office 2007; Valenzuela City Planning and Development Office, 2007.

Kalookan City, with its strategic location, serves as the premier center of trade and industry in the KAMANAVA area. The agriculture sector in Malabon used to play a major role in the economy. However, lands were converted for establishments of trade, manufacturing and commerce. Fish production declined in recent years due to incidence of red tide in the 1990s, the overflowing of fishponds due to floods, and decreasing fish production because of water pollution (Malabon City Planning and Development Office, 2002). Today, agricultural activities in Navotas are concentrated in 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 homes. Shipyards involving shipbuilding, repair and maintenance that used to be major economic contributors in the past, have declined (Navotas City Planning and Development Office, 2007). Valenzuela is primarily an industrial and residential suburb of Manila. The proximity of the city center to the North Luzon Expressway makes it a northern gateway to Metro Manila and a choice for business and industries.

Population characteristics

The population of Metro Manila in 2007 was around 11.5 million and 22 percent of this population resided in the KAMANAVA area. The combined

population of the four cities was 2.56 million people. Table 3 summarizes the population characteristics of the four cities.

Table 3. Population characteristics of the four cities

2007	Population ('000 persons)	Annual population growth rate (1995-2007)	Density (persons/ sq. km)	Number of households	Average household size
Kalookan	1378.86	2.53	25,860	293,374	4.6
Malabon	363.68	0.38	23,150	80,818	4.5
Navotas	245.34	0.58	22,951	53,336	4.6
Valenzuela	568.93	2.23	12,892	126,428	4.5
KAMANAVA	2556.8			553,956	
Metro Manila	11553.43	1.7	18,650		

The annual average population growth from 1995-2007 in Malabon and Navotas was less than 0.5 percent, much lower than the regional average in Metro Manila, which was 1.7 percent. Except for Valenzuela, all cities had a density of more than 20,000 persons/ km^2. The average household size was about 4.5 persons. Table 4 shows the average household income in Metro Manila and the KAMANAVA area in 2000. The average income in the four cities was lower than the average income for Metro Manila. Navotas had the lowest income profile, only half of that of Metro Manila.

Table 4. Average annual household income in Metro Manila and KAMANAVA

Average annual household income in 2000	Amount in PhP (US$)
Metro Manila	300,304 (6528)
Kalookan	231,876 (5041)
Malabon	208,391 (4530)
Navotas	156,526 (3557)
Valenzuela	210,850 (4584)

Social services

Uncontrolled population growth in KAMANAVA results in high incidence of poverty, increasing unemployment, inadequate water, waste management problems, and traffic congestion. Moreover, the extent of urban social services cannot cover the requirements of the rapidly growing population. Due to housing shortage, some families live along creeks, rivers, and flood plain areas, which endanger their situation, especially during flash floods.

Inadequate water supply is evident in Malabon and Navotas. In Malabon, only about 74 percent of residents were served by a private waterworks company, while the rest were serviced through communal faucet system, wells, springs, and rainwater collection (City Planning and Development Office, 2002). In Navotas, 82 percent of the households had access to potable water supply but there was still inadequacy in the volume of water supply in existing service areas (City Planning and Development Office, 2007b). The Maynilad Water Services Inc. maintains the Dagat-dagatan Sewerage System which is located along Dagat-dagatan, Kaloocan City but has a service area of only 3.32km^2, 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). Uncollected waste material and garbage in drainage channels continuously contribute to worsening flooding and spread of diseases. When it floods, these highly polluted waters carrying microorganisms and harmful chemicals, come in contact with the people, which can endanger their health. The most common causes of morbidity are diseases of the respiratory system, digestive system, skin as well as malaria and dengue fever.

Methodology of the study

This research aims to determine the characteristics of flooding in the KAMANAVA area and the economic burden of floods on communities. In order to analyze the social and economic impacts of flooding in the KAMANAVA area, the following methodologies were used:

1. Investigation of flooding characteristics such as flood causes, flood frequencies, flood duration, height of floodwaters and flood coping mechanisms of communities, and

2. Assessment of cost of damages in a one-time flood event in July 2000; annual household cost/expenses due to flooding events in 2007, and household expenses on flood coping activities.

Data sources

A survey was conducted in March 2008 among 300 households in different barangays in the KAMANAVA area. The questionnaire served as instrument for initial research on the perceptions and experiences of residents in flood-prone areas in KAMANAVA. The survey also looked into the coping mechanisms of households to prevent further flood damages, as well as the additional annual expenses incurred because of the effects of flood. A separate questionnaire was also administered to eight companies to determine the impacts of flooding on small and medium companies in the KAMANAVA area. Basic information included characteristics of household respondents and characteristics of companies.

The questionnaire was divided into two parts. The first part dealt with the nature of flooding events experienced by people in 2007 and their social and economic impacts. These regular floods are low-level, occurring especially during high tide, except during the months from June to September when heavy rains aggravate flooding in the area. Flooding characteristics included the number of

flood days in a month, perceived causes of flooding, height of floodwater, and duration of stay of floodwater inside the house. The first part also included questions on the annual cost or added household expenses due to flood events. The annual cost included health cost, added transportation expenses, the cost of cleaning, damage to properties and others. The first part also included the type and cost of coping mechanisms to prevent further damage due to floods.

The second part of the questionnaire mainly focused on the impacts of heavy flooding which happened in July 2000, when typhoon hit the area during high tide. During that time the water level was as high as 2 meters. The damage cost included cost of damages to properties and household appliances; health cost or amount spent for treatment of illness or injury acquired after the flood; and, transportation cost or added transport expenses due to floods.

The following table shows the description of costs incurred during flood events.

Table 5. Description of cost incurred due to flooding events

Type of cost	Description of cost items
1. Damage cost (Flood in July 2000; one-time flood event	1.1 Damage cost (cost of damage to properties and household appliances, etc.) 1.2 Health cost (cost for treatment or injury) 1.3 Transportation cost (added transportation expenses)
2. Annual cost (Added household expenses due to flooding events in 2007)	2.1 Health cost (cost for treatment or injury) 2.2 Transportation cost (added transportation expenses) 2.3 Cost of cleaning, damage, others
3. Cost of coping activities	Amount household spent on flood coping activities

In addition to the information taken from the questionnaire, the physical, socio-economic, demographic and other relevant information on KAMANAVA

and the characteristics of flooding, were acquired from official documents and reports from each local government.

Results and interpretation

Description of the household respondents

Table 6 shows the description of respondents. Among the 300 respondents, 62 percent were females, and 38 percent were males, and the average age was 42. Around 46 percent of the respondents had lived in the area from 5-20 years, 30 percent had stayed from 21 to 40 years and the rest had settled in the area for more than 40 years. A large portion of the respondents came from low to average income groups. Most of their sources of income were located near their homes. Some respondents owned small to medium-size merchandise stores; were self-employed as vendors, drivers or skilled workers; were wage earners working in local government offices; and others were retired employees or did not have regular jobs. Some of those who did not have regular employment depended on remittances of family members working abroad.

Table 6. Profile of respondents (2008)

Gender	Male: 115 (38%)	Female: 185 (62%)
Average age of respondents	42 years	
Average annual household income	Php 77,342.00	US$1,681.35
Average length of stay	25 years	
Dwelling status	Own	203
	Rent	70
	Others	27

Description of business/ commercial respondents

The respondent companies were small or medium-scale establishments and mostly involved in food manufacturing and trading. Table 7 provides some characteristics of the companies.

Table 7. Description of respondent companies (2008)

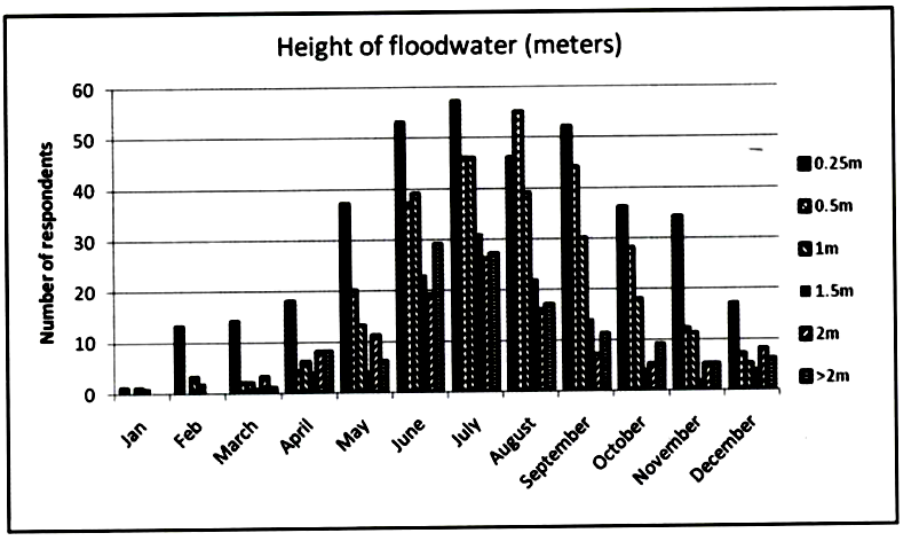
Company	Type of business	Location	Year of establishment	Number of employees	Annual gross income in PhP (US$)
A	Fish processing	Malabon	1975	8	3,500,000 (76,087)
B	Trading	Kalookan	1984	6	1,500,000 (32,609)
C	Manufacturing	Kalookan	1985	16	2,000,000 (43,478)
D	Food manufacturing, export	Navotas	1990	20	3,650,000 (79,348)
E	Furniture making	Kalookan	1991	15	
F	Trading, sales	Valenzuela	1995	9	400,000 (8,696)
G	Trading, sales	Malabon	1997	4	600,000 (13,043)
H	Trading, sales, rental	Kalookan	2001	4	400,000 (8,696)

Flood characteristics and experiences of flooding

The respondents perceived that the major causes of floods during the early months of the year were high tide and the massive amount of garbage that blocked the flow of water in waterways. During the rainy seasons, heavy rains and typhoons aggravated flooding in the area. Land subsidence, however, was least perceived as one of the causes of flooding in KAMANAVA. 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 have been flooded with a meter-high of water since 2004. The place can only be accessible by small outrigger canoe or "bangka", instead of land transportation.

Depending on the location, the level of water during floods varied from 0.25 meters to more than two meters. Figure 2 shows the height of floodwaters experienced by the respondents throughout the year. The number of respondents being affected with higher floodwater increases from May until September.

Figure 2. Average height of floodwater in the area (2008)



Socio-economic impacts of flooding

Table 8 shows the cost incurred by households during the heavy flood in July 2000. Majority of the cost (81 percent) was the damage to properties and household appliances.

Table 8. Assessment of damage cost of household after the heavy flood in July 2000, PhP (US$)

Costs incurred during heavy flooding in 2000 - Amount in PhP (US$)				
	Kalookan	**Malabon**	**Navotas**	**Valenzuela**
Damage cost	5261 (114)	18521 (403)	13422 (292)	7670 (167)
Health cost	2297 (50)	1264 (27)	2117 (46)	518 (11)
Transportation & other costs	1156 (25)	179 (4)	1862 (40)	1216 (26)
Total costs	8713 (189)	19964 (434)	17400 (378)	9404 (204)

The additional household expenses incurred during the year were the cost for treatment of illness or injury during and after floods, cost of transportation, and cost of cleaning and fixing damaged properties and others. The cost of illness and injury was simply referred to in Table 8 as health cost. Transportation cost was estimated as the added transport cost during flood days. The cost of cleaning included cost for repairs of damaged things or transfer and evacuation.

In terms of health impacts, mostly affected by illness were the children and the elderly. The most common diseases reported by the respondents were 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 & Kovats, 2007). These illnesses were also reflected in the health situation of the cities, especially in Malabon and Navotas, wherein the top 10 causes of morbidity were illnesses of the respiratory system, digestive system, and skin diseases.

During floods, transportation cost varied and most often increased by as much as 200 percent. The regular modes of transportation in the area were buses and *"jeepney"*, which were used for inter-city transfer, while tricycle and *"pedicab"* (cycle rickshaw, human-powered small-scale local means of transport) were used for short distances. Alternative modes of transportation such as *"bangka"* (outrigger canoe), improvised styrofoam boxes or old lifeboats, were also used. Some people also walked through flooded streets or sometimes got free ride provided by government trucks. The prices for *"bangka"* and other alternative transportation varied. The respondents indicated the average amount that they spent as shown in Table 9 which summarizes the annual cost or expenses of households due to flood events.

Table 9. Average annual cost/ expenses of households due to floods (2008)

Annual cost of flooding in PhP (% to total)	**Kalookan**	**Malabon**	**Navotas**	**Valenzuela**
Health	5,116 (60%)	2,174 (32%)	5,446 (50%)	1,042 (40%)
Transportation	2,538 (29%)	1,446 (21%)	1,840 (17%)	506 (19%)
Cleaning, damage, other	1,015 (11%)	3,146 (46%)	3,617 (33%)	1,089 (41%)
Total	**8,670**	**6,766**	**10,904**	**2,639**
Total (US$)	188	147	237	57

Through the years, families invested in coping activities to prevent further damage, and shown in Figure 3 are mostly physical improvements such as land filling, reconstruction of houses to increase elevation from the ground, adding another level of the house, and placing barriers such as sandbags, wooden planks or concrete blocks. Some families transferred to another place or evacuation centers. Some people who had less resources could hardly afford any improvements in their lot and some residents also felt so resigned to the impacts of floods that they chose not to spend for physical developments in their houses. In Figure 3, they were classified under the category "Did nothing." The category on "Others" include activities such as transfer of belongings and appliances in higher parts of the house, transfer of vehicles in higher places, the placement of sandbags, and temporary evacuation. Table 10 shows the average cost of these coping activities for the whole year. Because these coping activities had been done in different years, the values had been adjusted to 2007 values. The average cost was about PhP61,455 (US$1,397) in that year. Comparing these four cities, respondents from Navotas and Malabon spent more for these improvements on their homes. These two cities are the most flood-affected areas in KAMANAVA.

Figure 3. Flood-coping activities

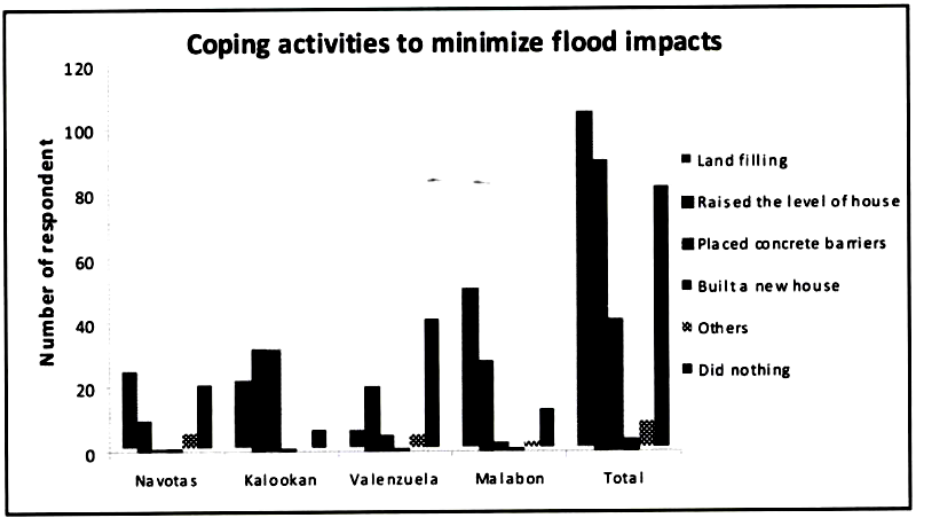


Table 10. Average annual cost of flood coping/ flood alleviation activities

Cost of coping activities	PhP (US$)
Kalookan	44,542 (968)
Malabon	88,359 (1,921)
Navotas	99,561 (2,164)
Valenzuela	13,357 (290)
Average	**61,455 (1,336)**

Flood impacts on companies

Companies or business establishments affected by flood had also improved their buildings and surroundings to prevent flood waters from coming in to their business areas. Filling the land and raising the level of buildings were commonly done. Most of these activities were done after the heavy floods in 2000. Table 11 shows the damage cost incurred as well as the cost of coping activities.

Table 11. Cost estimates of flood impacts on companies and business establishments

Company	Prevention activities	Year undertaken	Cost of prevention activities in PhP (US$)	Damage cost (flood in 2000) in PhP (US$)
A	Land filling	1990, 2001	127,974 (2,782)	22,684 (493)
B	Land filling Raised the level of building	2000	34,026 (740)	– 82,230 (1,788)
C	Land filling Raised the level of building	2000	425,325 (9,246)	42,533 (925)
D	Built another building	2003	1,619,574 (35,028)	36,862 (801)
E	Land filling Raised the level of building	2001	109,226 (2,374)	35,444 (771)
F	Raised the level of building	2001	33,000	
G	Raised the level of building	2001	43,807 (952)	11,058 (240)
H	Raised the level of building Placed concrete barriers	2002	16, 755 (364)	20,699 (450)

Summary and discussion

Flooding in KAMANAVA is a recurring problem caused by various factors: high tide levels, overflow of riverbanks, and inadequate drainage. Land subsidence due to excessive groundwater withdrawal has also aggravated flooding in the area. But this phenomenon is least understood. In the survey, only few respondents identify land subsidence as one of the causes of flooding. There is a need, therefore to increase awareness of the subsidence problem, one cause of which is over-extraction of groundwater.

These floods have placed a burden on the lives of the people, given the cost of damages to 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 work due to inaccessible roads or lack of transportation. These annual costs increase with the rise in the height of floodwaters. But these are reduced when household spends for flood coping or preventive activities. When compared with income, the ratio of the annual cost of flood effects is about 28 percent 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 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 to household appliances are less as they have kept less things or appliances in their households.

Households have spent for improvements in their houses to prevent floodwaters from coming in. These are ways to cope with flood impacts in order to continue to live normally in the areas. The higher the cost of damage in heavy flooding, the more households spent on flood coping activities. But this capacity to make improvements at home is highly dependent on income. The fact that government reconstructed and raised the levels of some streets to avoid floodwaters also caused problems. 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.

In this study, the damage cost and annual expenses incurred due to floods were estimated as average amount among households. The results can be improved if different impacts of flooding on households with different social and economic conditions are considered. In Brouwer et al. (2007), a complex relationship between poverty and damage costs was shown. The poor suffer more in relative terms, but not in absolute terms. Higher income households suffer higher damage costs in absolute terms. But because the coping capacity of these households is greater than poorer households, as reflected in the fact that the proportion of the damage cost to their income is lesser, the relative damage cost is lower than in poorer households. Aside from the damage assessment, further studies on the effects of flood on temporary displacement of people, population movements or migration, would also be necessary to understand the social impacts of disasters on people's lives.

The results of the survey were validated through a group discussion. There was a common understanding among the group of the recurring problem of flooding in the area and the added burden it gave to the household. However, land subsidence, which can be caused by over extraction of groundwater, was least understood as one of the factors that aggravate flooding. This was also reflected in the results of the questionnaire survey. People noticed that their lots become lower than the roads, but they assumed that this happened due to the landfilling of roads, eventually raising its level compared to their house lots. Given the inadequate understanding on the relationship between groundwater level decline and land subsidence and flooding, it is necessary to raise awareness on these issues to help residents understand the complex factors causing frequent floods in the area.

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 choose to stay because of their personal attachment to the area. They were born and raised in the area. However, other people who can afford to settle in other places already abandoned their homes.

The KAMANAVA area plays a significant role in Metro Manila's economy in terms of fishery, industry and commerce. However, frequent floods in the area have disrupted economic activities, especially in Malabon and Navotas. Even the population growth from 1995-2007 in these two cities was quite low compared with other cities in the metropolitan area. 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 and drainage projects, but these are only palliative measures. With the impact of land subsidence and the added threat of climate change which can result in 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. There is a need to improve drainage systems and

flood control structures. The use of waterways as garbage dumpsites or construction sites should also be prohibited. To curtail subsidence and eventually reduce the impacts of flooding, it is necessary: 1) to slow the rate of subsidence by replacement of groundwater with surface water sources; and, 2) if groundwater is to continue to be exploited, it must be regulated. In the short-term however, there is a need to provide alternative housing sites for residents heavily and regularly affected by floods or are living in dangerous zones. Economic opportunities, social and cultural services should be provided to enhance smooth adaptation of affected communities to their new location.

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