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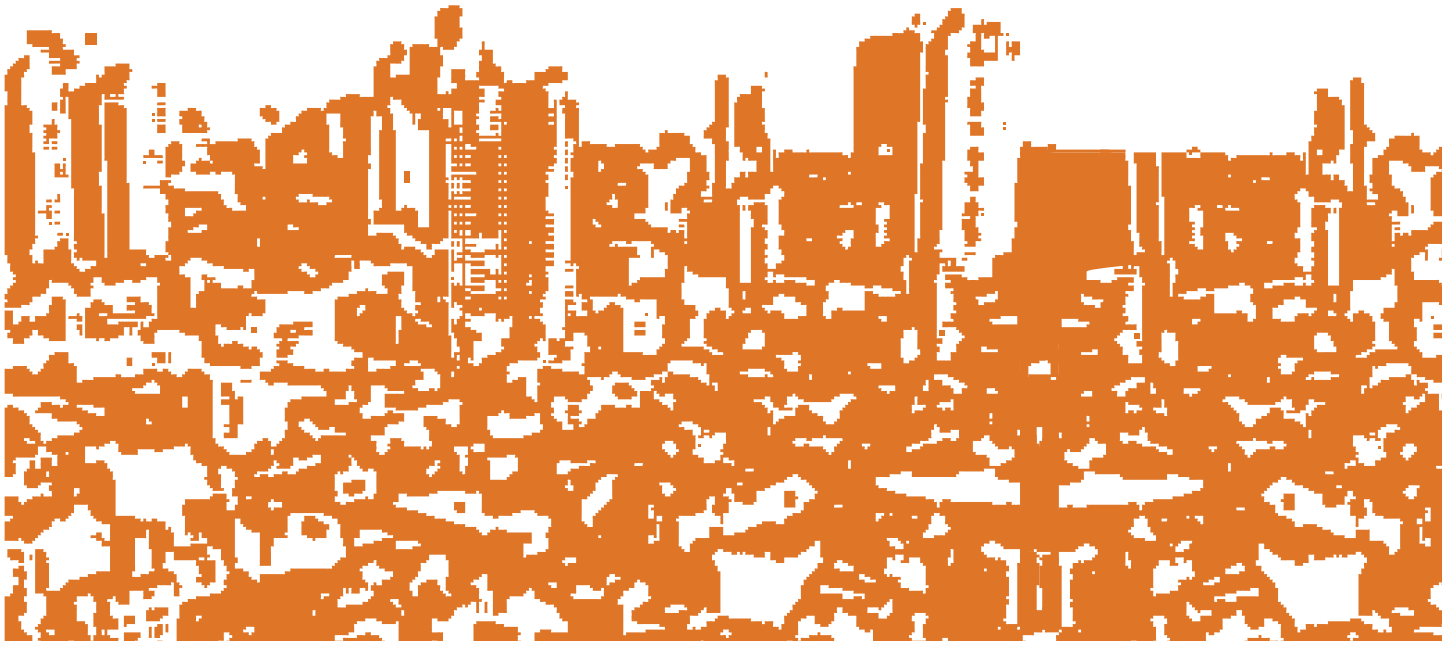
Household economic losses of urban flooding

Case study of Can Tho City, Vietnam

BY VO THANH DANH



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Abstract

This study examines the economic losses caused by urban flooding. It begins by identifying components of economic losses (i.e. direct costs and indirect costs) at different stages of the flood (i.e. before, during and after) and then using appropriate ex-post and ex-ante estimations to measure economic losses. The opportunity-cost method was at the centre of economic analyses. In addition, factors affecting household economic losses were also assessed in the study. The study interviewed 250 households in flooded areas in Can Tho City, Vietnam. Results show that total annual economic losses due to flooding were US$ 642 per household which represented 11 per cent of each household's annual income. Ninety per cent of economic losses were indirect costs. Total annual indirect costs per household were US$ 578 and for before-, during- and after-flood periods were US$ 19, US$440 and US$ 118 respectively. Meanwhile, total annual direct costs per household were US$ 64 and US$29, US$19 and US$ 16 respectively for before-, during- and after-flood periods. Put differently, in the before-during-after flood analysis framework, results show that total annual before-flood costs were US$ 48, of which direct costs were US$ 29 and indirect costs were US$ 19. Total annual during-flood costs were US$ 460 in which direct costs were US$ 19 and indirect costs were US$ 441. Total annual after-flood costs were US$ 134, of which direct costs were US$ 16 and indirect costs were US$ 118. It also revealed that there were differences in cost structure at different stages of flooding. Results indicate that public awareness or concern levels regarding urban flooding, respondents' education status, household location and the probability of moving to another place to avoid the flood were factors statistically affecting the economic losses due to the flood.

1 Introduction

1.1 The extent of the problem

According to the IPCC (2007) Vietnam is among the five countries most seriously affected by the impact of global climate change and sea-level rise (SLR). If SLR is 0.2 to 0.6 metres, 100–200 thousand hectares of Vietnam's plains will be submerged. A one-metre rise will result in 0.3 to 0.5 million hectares of the Red River Delta being under water and 90 per cent of the Mekong Delta (MD) will be flooded. According to the Ministry of Natural Resources and Environment (2009) due to the global SLR impact, 15–20,000km^2 in the MD's coastal areas would be inundated with nine of its 13 provinces completely inundated below the water.

Many low-income populations living in large cities in low altitude countries at risk from flooding are most likely to be affected by climate change-related factors. Can Tho City of Vietnam is located in the centre of the MD which is on average one metre higher than sea level. In recent years, flooding has become a serious problem for its residents. During the monthly high tidal time occurring almost six months in a year, flooding is happening with increasing magnitude and frequency. It is stated that climate change causes the most serious flood risk in the city. In the worst case scenario (sea-level rise of up to one metre and an increased flow from upstream in highly developed areas), the maximum inundation depth may rise up to 1.51 metre. The area of the highest inundation depth (> 0.5m) accounts for 12 per cent of the total inundation area of the city.

Urban flooding impacts on the quality of life of urban residents and as a result they incur losses as both direct and indirect costs. Direct costs are monetary expenses e.g. that people pay when preparing for or coping with floods. These costs include labour costs and materials for preparing for, coping with and repairing houses in the periods of before, during and after flooding. Some copings measures may also be seen as forms of adaptation. Indirect costs are losses that people incur due to flooding which are not actual costs that people pay directly for, but are expressed in terms of opportunity costs. To cope with the floods, people adjust their daily activities such as changing their travel route between work and home, allowing a longer time for travel, applying preventative measures, moving their belongings to higher ground and generally preparing for, coping with and recovering from floods before, during and after flooding. Moreover, these measures incur many expenses for coping with or mitigating the flood's consequences. Beside expenses such as hired labour and materials, households also incur opportunity costs due to missed work, reduced revenue (for vendors and owners of retail shops), increased travelling time and health-related costs. These costs are incurred before, during and after floods – costs which are increasingly becoming a large part of a household's total annual expenditure.

This study aimed to examine the economic losses caused by urban flooding. Starting by identifying components of economic losses (direct costs and indirect costs) at different stages of the flood (before, during and after the flood) it then uses appropriate methods of economic measurement to estimate economic losses caused by urban flooding. In addition, the factors affecting the households' economic losses were also assessed. More importantly, this study aimed to explore measures and policy recommendations for reducing losses incurred by households caused by urban flooding in the city.

1.2 Objectives of the study

The overall objective of this study was to measure the household economic losses caused by urban flooding. The specific objectives were:

- to classify categories of economic losses at the household level;
- to measure direct and indirect economic costs at the household level before, during and after flooding;
- to evaluate households' access to flood- warning information before flooding occured and what value it had in reducing losses; and
- to propose policy interventions to help people mitigate economic losses due to flooding.

1.3 Research questions

The key questions to be answered included:

(1) What are the components of economic losses caused by urban flooding?

(2) Which research approaches and methods are appropriate for measuring the costs of economic losses caused by urban flooding?

(3) How does flood-warning information impact on households' losses due to flooding?

(4) What measures/policy options could help people to reduce losses caused by urban flooding?

1.4 Flood situation in Can Tho City

Can Tho City is located downstream of Mekong River. Its urban flooding is caused by upstream flooding and high tides from the East Sea. In recent years, floods occured due to not only Mekong upstream flooding in the delta flood season, but also due to high tides and rain. Floods in the city inundated approximately 30–50 per cent of the city (Huong and Pathirana 2013). Figure 1 is an example of a rain flood in October 2013 in central Can Tho City.

Figure 1. A main street in Can Tho City flooded by rain

Photo: Vo Thanh Danh

In 2008, of the 81 main streets, 21 were inundated by high tides and ten by rain (MONRE 2009). Most were flooded to a depth of 30–50cm. Additionally, hundreds of blind alleys were also inundated during high tides or rains. The peak of the flood of October 2011 reached a water level of 2.15m, above Warning Scale III at 25cm, the highest level since 1940. This flood inundated almost the whole city.

There are a number of factors causing urban flooding in Can Tho City. Firstly, the main factor is when the effects of the Mekong River upstream floods combine with the high-tide regime of the East Sea. Most serious urban flooding happens when these both peak during September to November. A high tide usually happens at the start and middle of the lunar month, causing urban flooding twice a month. At these times, even though the water levels in the rivers is not so high, because of the high tide the city is still inundated. Secondly, rain is also a major factor causing urban flooding, in terms of timing and scale. Rainfall in Can Tho City usually lasts from 30 minutes to 2 hours with precipitation at 40–70mm. In the middle of the rainy season, from August to October, urban flooding usually occurs right after the rain, especially in the lower areas inside the city. Thirdly, the flood protection infrastructure system in Can Tho City has not been invested in adequately. Can Tho City is a new city in the middle of the Mekong Delta region and the water discharge system has not been completely installed. During heavy rains, the rainwater does not discharge easily, causing floods. During the high-tide period, there is no dike to prevent the river breaking its banks. According to ACCCRN (2009), the capacity of the rainwater and sewage discharge systems are less than 50 per cent of demand. Fourth, urbanisation has reduced the natural adjustment of surface wáter and has decreased the natural reservoir inside the city. As rain water has nowhere to discharge, it causes urban flooding. Table 1 presents the results of flood survey in 2009 by the Can Tho People's Committee. Results show that rain and high tides were main causes of urban flooding in Can Tho City.

Table 1. Results of the 2009 flood survey in Can Tho City

No	District	Reasons for flooding	Number of sites flooded	Percentage (%)
1	Ninh Kieu	Rain	12	20
		Rain and high tide	38	62
		Rain, high tide and upstream flood	11	18
2	Binh Thuy	Rain	5	29
		Rain and high tide	8	47
		Rain, high tide and upstream flood	4	24
3	Cai Rang	Rain	2	13
		Rain, high tide and upstream flood	13	87
Total		Rain	19	20
		Rain and high tide	46	49
		Rain, high tide and upstream flood	28	31

Source: Can Tho's People Committee (2011).

According to an ACCCRN assessment (2009), due to sea-level rises, the centre of Can Tho City could be inundated. Currently, roads in the area are 2–2.3m above datum. If the sea-level rise is 30cm, water levels would be 1.9m above datum. If the sea-level rise is 50cm, lower areas and some roads would be inundated. If the sea-level rise is 100cm, whole areas of the city and all roads would be completely inundated.

2 Literature review

To assess the impacts of natural disasters such as typhoons and floods, various studies have used a loss and damage framework. Another approach has been a combination of assessment of vulnerability and adaptation options used in many community-based studies. But impacts at the household level have not yet received significant consideration. Economic losses at the household level in Vietnamese cities due to urban flooding have not yet been taken into account, leaving a gap in research in Vietnam.

According to Huq *et al*. (2013), loss and damage is defined as 'the actual and/or potential manifestation of impacts associated with climate change that negatively affect human and natural systems'. 'Loss' is characterised as the negative impacts of climate change that are permanent, and 'damage' as those impacts that can be reversed. A distinction has also been made between avoidable (through mitigation and adaptation efforts) and unavoidable loss and damage. They also find that in many empirical studies, loss and damage are incurred when the costs of adaptation are not recuperated; or when adaptation efforts are ineffective, maladaptive in the long term, or altogether impossible. Even if current mitigation and adaptation efforts are successful, some residual losses and damages still occur. They recommend that two aspects of loss and damage need to be considered: first, decreasing avoidable losses and damages and averting climate change impacts; and second, addressing unavoidable losses and damages through risk-transfer strategies such as insurance and risk-retention mechanisms. This research study in Can Tho seeks to quantify existing losses incurred by households to understand how these losses might be avoided, with a view to providing recommendations for also addressing unavoidable losses and damages.

With regard to previous research in Vietnam relating to floods, Bubeck *et al.* (2012) used a descriptive analysis and regression analysis to assess public flood-risk perceptions in a flood-prone province in central Vietnam. A questionnaire carried out with 300 respondents included four sections: (1) personal and household characteristics; (2) questions on risk perception; (3) knowledge and expectations about climate change; and (4) experience of, and adaptation to, natural disasters. The results show the relation between flood-risk perceptions and flood-risk mitigation behaviour. They found weak to medium correlations between the perceived probability and the perceived consequences of flooding and the intention to adopt flood-mitigation measures. In addition, regression results show that flood-risk perceptions were rather weak predictors of precautionary behaviour, even when previous mitigation behaviour was controlled for by eliciting behavioural intentions. Knowledge of flood-risk perceptions per se did not necessarily provide useful insights for flood-risk management.

In terms of existing analyses of coping strategies, Huraera *et al.* (2010) assessed household and community coping strategies in poor urban areas in Bangladesh, with regards to coping with conditions of increased vulnerability induced by the changing climate as well as extreme weather events such as floods, heavy rains, landslides, heat and drought, and how they respond to weather hazards. Using a before-during-after framework, a small qualitative survey among 35 households was implemented to identify their experiences of climatic variability, hazards and coping strategies. The results found that before a disaster, most households took few preventative actions. Most impact-minimising actions have become an integral part of regular practice, generated through experience. The results discovered that many people accept the risks fatalistically and use so-called 'emotionally oriented strategies of adaptation' during a disaster. After a disaster, most households make alterations while rebuilding their structures, such as changing building and plinth materials, increasing plinth levels, and changing structural, roofing and walling materials. Overall, the study shows how households

use physical, economic and social means to reduce risk, reduce losses and facilitate recovery from flooding and high temperatures, and how grassroots adaptation differs according to the level of risk from flooding.

Orapan *et al.* (2012) used a before-during-after framework to measure the direct and indirect costs that households experienced before, during and after Thailand's historical 2011 flood. This study evaluated the magnitude and composition of the economic losses experienced by 600 households. It explored the actions that people took before the flood arrived, direct and indirect costs incurred during the flood, financial expenses they expected to incur after the floodwaters receded, and health-related costs. The results show that the majority of household losses were incurred in the form of economic damage after the flood. Housing damage was the largest cost component and differed significantly between households. In contrast, indirect costs associated with lost wages were greater for the lower-income households.

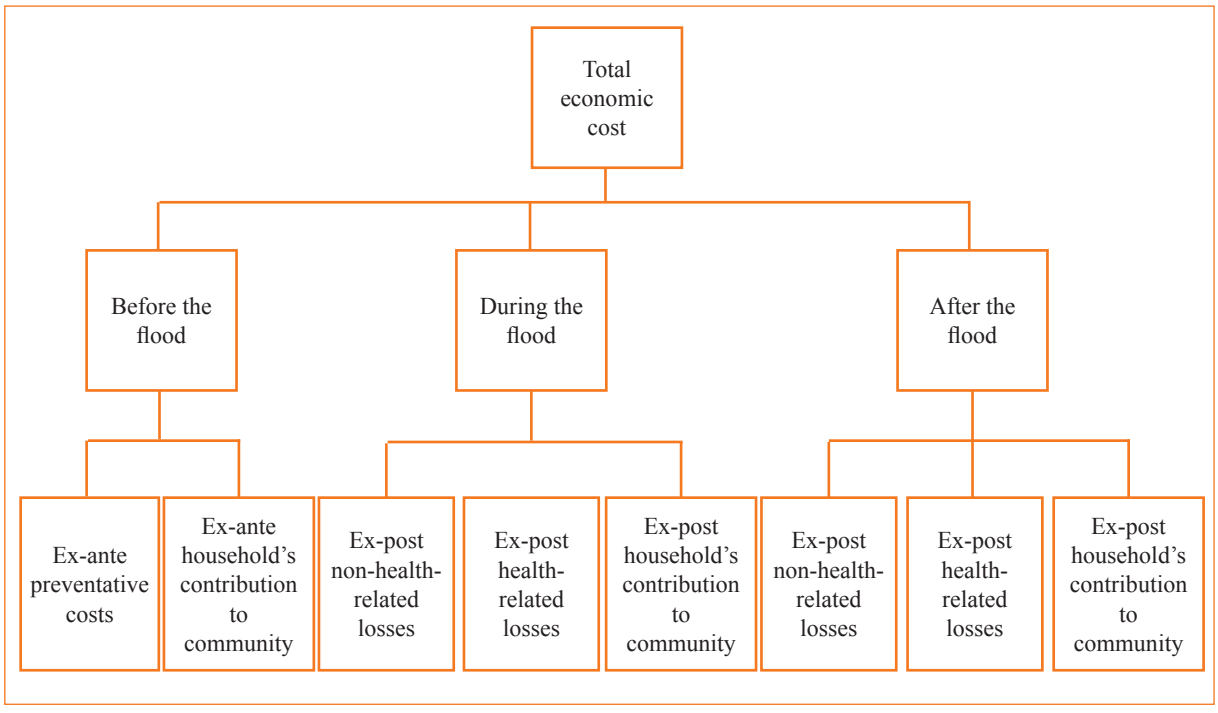
Both of the above studies, whilst from different countries to Vietnam, provide a framework for analysing household losses incurred by climatic events, and for assessing household approaches to preparing for, coping with and recovering from disasters, which this study has adopted to assess household measures in Can Tho, Vietnam.

3 Methodology

3.1 Conceptual framework

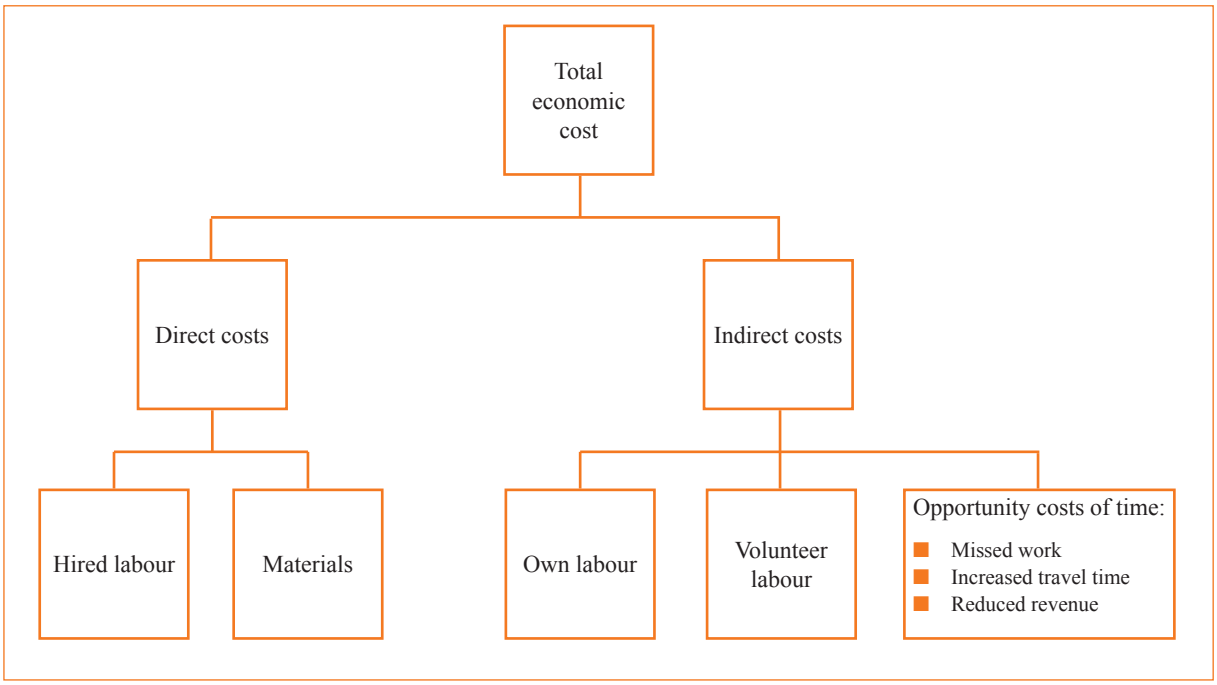
To capture all flood-related costs, following the approach used by Orapan *et al.* (2012), the before-during-after framework was used in this study. According to this approach, all costs – including direct costs and indirect costs – generated in each period were identified, classified and measured. The total economic losses were the product of a monetary assessment of economic damages incurred before, during and after flooding. In each period, either an ex-post or ex-ante approach was assigned to identify and measure the flood-related cost drives. That is, in the period before the flood, the preventative costs including each household's contribution to the community-related costs were estimated with ex-ante values since possible damages were predicted rather than actual calculations. Meanwhile, in the periods of during and after the floods, non-health and health-related losses were estimated with ex-post values since people have experienced flooding before and therefore know how much the losses would be. Figure 2 presents the conceptual framework of the flood-related total economic losses.

Figure 2. Measurements of total economic cost concept used in the urban flooding study



Based on the conceptual framework of flood-related economic losses, the cost drivers were classified in two categories (direct and indirect costs) that were ready for data collection and calculations. Figure 3 shows the cost drivers under the total economic cost. The direct costs include expenses for hired labour and materials to prepare for, cope with, and recover from the flood. Direct costs relate to preventative actions, such moving belongings to higher places, building concrete blocks, installing sandbags outside the house, pumping water, and other similar measures. The indirect costs include own labour and volunteer labour used, and opportunity costs such as losing work, an increase in travelling time, and caring for sick household members affected by flood-related illnesses. The values of opportunity costs were the product of monetary values of lost productivity and days of work missed. The value of lost productivity was estimated based on the respondent's income and the assumption of a minimum daily wage rate for values of lost time, which was calucluated at a minimum unskilled worker's wage of VN$ 150,000 per day (approximately US$7). Besides this, vendors and retail store-worker earnings or revenues lost due to the flood were considered as an opportunity cost and also taken into account.

Figure 3. Categories of direct and indirect costs in total economic cost measurement



3.2 Analytical method

A sum of cost drivers including direct costs and indirect costs estimated with either ex-ante or ex-post values was derived in order to measure the flood-related economic losses. Ex-ante values were estimated based on the concept of opportunity costs related to income lost due to the flood. Additionally, estimating cost components was implemented in the before-during-after framework.

The household's economic losses due to urban flooding depend on exogenous and endogenous factors. Exogenous factors include gender, head of household's education status and age, household income and location. Endogenous factors include flood-warning information exchange, concerns about flooding, and the likelihood of moving to another place.

To assess factors affecting household economic losses, a causality relationship using regression analysis was used as described in the following equation:

$$Flood\_Cost_i = \beta_0 + \beta_1 Inf\_Exgn_i + \beta_2 Con\_Levl_i + \beta_3 Gen_i + \beta_4 Edu\_Levl_i + \beta_5 Age_i + \beta_6 Inc_i + \beta_7 Mov_i + \beta_8 Pos_i + e_i$$

where

$Flood\_Cost_i$: total economic losses due to the flood (1000 VN$)
Inf_Exgn_i: dummy variable of flood-information exchange within neighbourhood (1: yes; 0: otherwise)
Con_Levl_i: dummy variable of concern level regarding flooding (1: yes; 0: otherwise)
Gen_i: dummy variable of gender of household head (1: male; 0: otherwise)
Edu_Levl_i: education status of household head (years of schooling)
Age_i: age of household head (in years)
Inc_i: household income (1000 VN$)
Mov_i: dummy variable of moving to another place within the next five years (1: yes; 0: otherwise)
Pos_i: dummy variable of location (1: main street; 0: otherwise)
e_i: error term

3.3 Sampling

A random sampling method with clustering selection was used in this study. Clusters of households selected in the survey included households living on a main street, in blind alleys (alleys with limited vehicle access), or in a residential estate in the flooded areas in the central part of Can Tho City. Determinination of the flooded areas was based on the flood map and field survey of the research team. These areas were inundated frequently and were the areas most vulnerable to flooding in recent years. Figure 4 shows a map of the study site. Along the streets in the sampled areas, deciding which households to select for interviewing depended on the total number of households living there and the number of households to be selected in that location was done using a system sampling procedure. For example, if 100 households lived on the street and ten needed to be selected, an interval of ten would be applied. The selection of the first respondent was done randomly. If the next household was not willing to participate in the interview, a subsequent household would be selected. As a result, 250 households were selected to be interviewed. Table 2 presents a distribution of households by location in the survey.

A questionnaire was designed for face-to-face interviews (Appendix 1). A pilot survey with 16 households was done to test the questionnaire before conducting the field survey. In the interview, the respondents chosen were usually the heads of households. If the head of household was not available or absent during the survey, another family member with a main role in the family was selected for replacement. Nearly 82 per cent of respondents were household heads.

Figure 4. Map of the study site

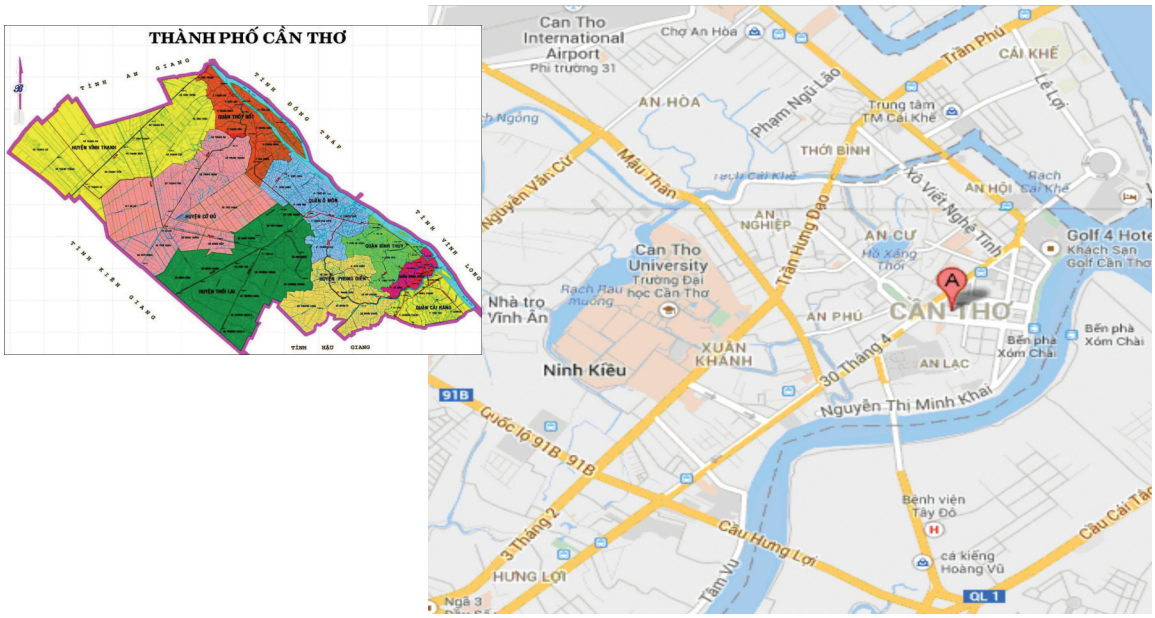


Table 2. Distribution of households by location

Location	Frequency	Percentage (%)
Main street	105	42.0
Blind alley	116	46.4
Residential estate	29	11.6
Total	250	100.0

4 Results and discussion

4.1 Data description

Two hundred and fifty respondents participated in the face-to-face survey. As described in Section 2.3 above, all of these respondents had experienced flooding. The average number of years living in the flooded areas was 20 years. About 83 per cent lived there for more than 10 years and 13 per cent of them for less than 5 years. The size of house, on average, was about 94m^2, of which 32 per cent of households owning a house of less than 50m^2 and 45 per cent owning a house of 50–100m^2. In general, the education status of the typical respondent was quite high. Approximately 20 per cent, 31 per cent, 29 per cent and 19 per cent of them had received a bachelor degree or were educated to high school, secondary or primary levels respectively. It was expected that with higher education backgrounds they would provide reliable answers during the interviews. Among the 250 respondents, 82 per cent were household heads and 57 per cent were female. The mean age of respondents was 51 years and the mean annual household income was VN$ 122 million (US$ 5800).[1] Table 3 gives some statistics of households participating in the survey.

Table 3. Statistics of households participating in the survey

	Minimum	Maximum	Mean	Std. Deviation
Time living in house (years)	1	78	20	16.4
Size of house (m^2)	5	1,200	93.6	116.5
Household head's education (years of schooling)	0	13	9.2	3.4
Household head's age (years)	20	78	50.5	12.6
Annual household income (1000 VN$)	12,600	900,000	121,638	99,748

Results of the survey show that the mean size of household was 4.66 people. Families with 1–5 members represented 55.6 per cent of the respondents (Table 4). In terms of age, 52 per cent had family members of under 15 years of age and 40 per cent of households had members who were over 60.

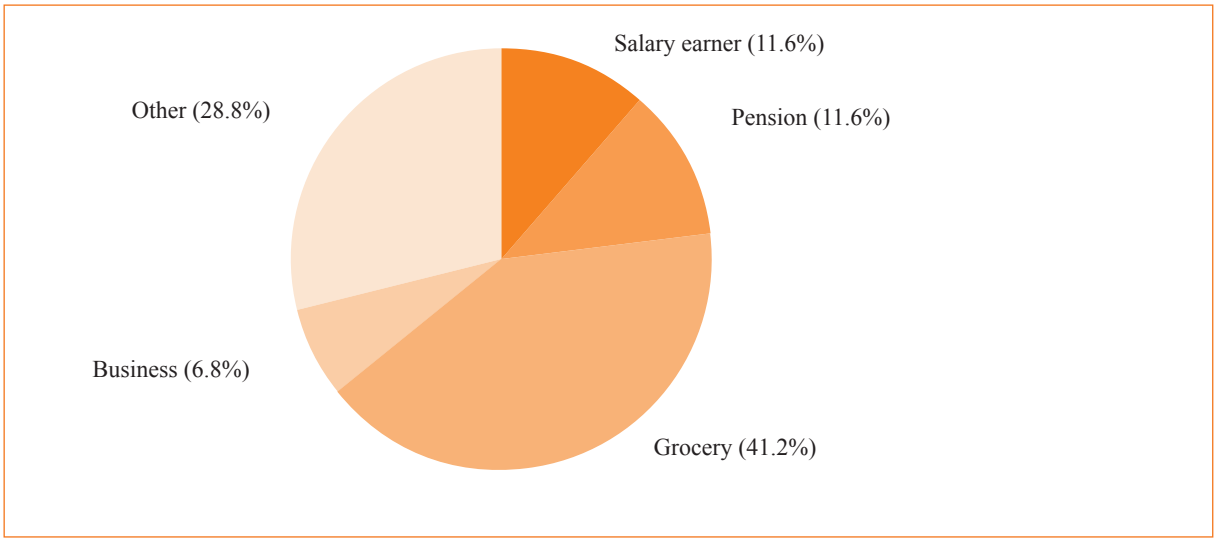
1 With a mean family size of 4.66 people, income per capita is about US$ 1247.

Table 4. Labour characteristics of households participating in the survey

			Number of households	Proportion (%)
Number of family members		Less than 5	139	55.6
		5–10	104	41.6
		More than 10	7	2.8
		Total	250	100.0
Age of family member	Under 15 years of age	None	120	48
		1–2	117	46.8
		3–6	13	5.2
		Total	250	100
	Above 60 years of age	None	149	59.6
		1–3	101	40.4
		Total	250	100.0

Table 4 provides statistics relating to the labour force in the survey. Nearly half of respondents are private business owners, with 41 per cent of respondents working as grocery store owners. Grocery stores are found everywhere, in both main streets and blind alleys. Urban floods are a source of nuisance to them in their daily business. Another 29 per cent of respondents are workers such as carpenter and bricklayers. Salary earners and pensioners are also included, accouting for nearly 12 per cent each. Figure 5 presents the respondents' different careers in the survey (shown in percentages).

Figure 5. Distribution of respondents by career



Eighty per cent of respondents own their own houses privately. The remainder rent their house for business purposes. One-storey houses account for nearly 76 per cent of the sample. A large proportion of houses were newly built in recent years. Table 5 presents the characteristics of households in the area of the survey.

Table 5. Characteristics of types of homes of survey participants

		Number	Proportion (%)
Home ownership	Owned	201	80.4
	Rent	38	15.2
	Other	11	4.4
	Total	250	100.0
Number of storeys	1 storey	189	75.6
	2 storeys	48	19.2
	3–5 storeys	13	5.2
	Total	250	100.0
Year of construction	1935–65	7	3.0
	1965–95	57	25.0
	1995–present	166	72.0
	Total	230	100.0

Eleven per cent of respondents reported that they would consider relocating to another place to live and/or work. This demonstrates that the floods could cause major changes in their lives. Table 6 shows the proportion of respondents who could consider relocating within the next five years.

Table 6. Proportion of households deciding to relocate either for living or business purposes

	Number	Proportion (%)
No, I have no plans to relocate	222	88.8
Yes, I will relocate within the next five years	28	11.2
Total	250	100.0

The results of the survey show that during times of flood, private sector respondents such as business owners and grocers incurred the most income losses. Meanwhile, salary or wage earners were not affected by the flood. Table 7 shows the proportion of different income earners affected by urban flooding.

Table 7. Proportion of income earners affected by urban flooding

Type of work	Number	Proportion (%)
Worker	4	3.2
Business owner	54	42.5
Grocer	69	54.3
Total	127	100.0

4.2 Public awareness and flood risks

Survey results show that urban flooding in Can Tho City usually happens between August and November. Inundation happens heavily in October. The number of days of inundation and number of households affected by flooding were highest in October. Serious floods continue to happen until November. Table 8 shows the levels of inundation caused by urban flooding in Can Tho City.

Table 8. Number of days of inundation each month during flooding in Can Tho City

		Not inundated	Inundated		
			Less than 5 days	5–10 days	More than 10 days
August	Number of days	246	3	1	0
	Proportion (%)	98.4	1.2	0.4	0
September	Number of days	52	28	93	77
	Proportion (%)	20.8	11.2	37.2	30.8
October	Number of days	30	24	75	121
	Proportion (%)	12	9.6	30	48.4
November	Number of days	69	12	76	93
	Proportion (%)	27.6	4.8	30.4	37.2

Source: 2013 survey.

The survey shows that during the floods, 48 per cent of houses were heavily inundated. That is, water from the flood came inside the house, creating a serious problem. Among those houses inundated, 72 per cent and 11 per cent of them had 20–50cm or more than 50cm of water, respectively. The level of inundation depended on the area and time of flood. The serious inundation happened when heavy rains happened in combination with a high tide. When both of these happen simultaneously, the length of time of the flood could be longer. According to respondents, damages and losses caused by urban flooding were serious: 77 per cent of respondents thought that urban flooding had become very serious during the last five years. Additionally, 57 per cent also thought that urban flooding would remain a serious problem over the next ten years.

Sixty-five per cent of households had a plan to cope with urban flooding before it happened. Results show that 22 per cent planned to raise the base of their house, 20 per cent planned to build a concrete wall outside their house, 19 per cent planned to move their furniture to a higher place, 15 per cent planned to place sandbags outside the house, 6 per cent planned to repair their sewage discharge system, and 4 per cent were preparing to install a pumping machine in preparation for the floods. Many of these actions can be considered forms of adaptation rather than coping, as they are planned and more permanent measures. Using Chi squared (χ^2) testing there was statistically significant evidence to show the relationship between inundation status, concern levels regarding flooding and schedule of flood resistance in this study. The more serious the flood was predicted to be, the higher the probability of preparedness was. The more concern about the flood there was, the higher the probability of preparedness. Similarly, using Chi squared (χ^2) testing there was statistically significant evidence to show the relationship between education levels and concern levels about urban flooding in this study. The higher the education level, the more concern a respondent had. Table 9 presents an assessment of public awareness of and attitudes towards urban flooding.

Table 9. Respondents' awareness of and attitudes towards urban flooding

		Number	Proportion (%)
Assessment of urban flooding status during the last five years	Quite serious	192	76.8
	Not very serious	58	23.2
	Total	250	100
Assessment of urban flooding status during the next ten years	Quite serious	142	56.8
	Not very serious	108	43.2
	Total	250	100
Plans to cope with flooding	Has plans to cope	162	64.8
	Has no plans to cope	88	35.2
	Total	250	100
Concern re. level of flooding	Quite concerned	122	48.8
	Not very concerned	128	51.2
	Total	250	100
Flood information exchanges	Has flood information exchanges	174	69.6
	Has no flood information exchanges	76	30.4
	Total	250	100

Urban floods also pose a risk to human health. Direct and indirect effects on health were usually caused by a polluted environment and poor hygiene behaviour. For instance skin disease, influenza and petechial fever were indirect effects on health while accidents due to working in a flooded environment were direct effects. Thirty-eight per cent of respondents said that family members had become ill during floods. Among those, 43 per cent and 35 per cent suffered from skin diseases or influenza respectively. Additionally, negative mental health impacts caused by flooding were also found in the survey, with20 per cent of respondents saying that they had felt unwell and suffered from stress during times of flood. Table 10 shows the frequency of flood-related diseases found in the survey.

Table 10. Flood-related diseases found in the survey

Type of illness	Number	Proportion (%)
Flu	33	35.1
Skin diseases	40	42.6
Petechial fever	2	2.1
Other	19	20.2
Total	94	100.0

4.3 Flood-warning information systems

Respondents reported having many flood-information and early-warning systems. Results of the survey show that in most cases, people knew about the likely flood from their own experiences. This is because floods usually happen immediately after a high tide or in combination with rain. Approximately 21 per cent knew about the floods via media such as weather forecasts and news. Table 11 presents the types of flood-warning information systems that respondents use.

Table 11. Types of flood-warning information systems

Type of information system	Number	Proportion (%)
Media	53	20.8
Past experience	178	70.1
Word of mouth (neighbours, relatives, friends etc.)	22	8.7
Other	1	0.4
Total	254	100.0

These results suggest that a flood-warning information exchange could be a useful way for people to prepare to cope with impending floods. As section 4.2 shows, the more awareness people have of an expected serious flood, the more measures they take to prepare beforehand. Exchanging early flood-warning information could also help in recommending appropriate measures they should take in advance. Table 12 shows measures used immediately after early flood-warning information was released. Over half of the households surveyed applied emergency measures such as moving furniture to higher places for safety, cleaning sewage discharge systems, installing sandbags around the house and elevating the base of the house.

Table 12. Measures taken after flood-warning information released

Measure used to cope with and adapt to the flood	Frequency	Proportion (%)
Installing sandbags	24	8.7
Elevating base of house	18	6.5
Building a wall/barrier	33	12.0
Moving furniture to higher places	42	16.8
Cleaning sewage discharge system	8	3.0
Buying a water-pumping machine	7	2.5
Other	20	7.2
Doing nothing	124	44.9
Total	276	100.0

4.4 Economic losses caused by urban flooding

Urban floods cause damage and loss not only for society but also for livelihoods and investments. Floods destroy, damage and depreciate public infrastructure. This study does not consider the impact of urban flooding on public infrastructure, focusing instead on assessing the impact on livelihoods. However, we must recognise that any damage to public infrastructure may also have a negative impact on households and their livelihoods. Urban floods trigger both direct and indirect costs to households. Direct costs include monetary damage or expenses that households incur in preventing, coping with and mitigating the effects of flood. Damages to equipment or durable assets were estimated based on their time of use. In this study, based on accounting rules, rates of depreciation at 5 per cent (over a timeline of 20 years) and 20 per cent (over a timeline of 5 years) were applied to calculate the costs of fixed assets and durable assets respectively. Indirect costs refer to losses that households have incurred indirectly due to flooding. Identifying and calculating the indirect costs were based on the concept of opportunity costs. An opportunity cost represents the change in net income or value due to flooding, such as the loss of revenue by grocery stores or lost wages due to the floods. To calculate the value of opportunity costs for lost income, a daily wage rate of VN$ 150,000 (approximately US$ 7) was used in this study. Both direct and indirect costs were defined within the timeframe of before-during-after the flood, and both were also classified into fixed costs and variable costs in calculations. A combination of both direct and indirect costs was considered as economic costs or economic losses. Cost classifications used in Tables 13–19 followed this framework.

First, cost calculations were based on the classification of direct and indirect costs. Identification and classification of cost components were made at the stage of preparation for the flood (before-flood period), of coping with the flood (during-flood period), and cleaning the house (after-flood period). All of the direct costs were actual costs. The average annual direct costs per household were VN$ 1,339,000 (approximately US$ 64), of which VN$ 601,000 (approximately US$ 29) were before-flood costs; VN$ 393,000 (approximately US$ 19) were during-flood costs, and VN$ 345,000 (approximately US$ 16) were after-flood costs.

Cost components in the before-flood period included investments and materials to mitigate or prevent flood damage, such as elevating the base of the house or buying a water-pumping machine. Fixed costs accounted for 72 per cent of before-flood costs. In contrast, in the during-flood period, variable costs comprised a large proportion, at 96 per cent. This was because during the floods people did not invest much to prevent flood damage. Instead, they used materials to repair damage or to cope with the flood, depending on its severity. In the after-flood period, all of direct costs were variable costs, which were cleaning costs. Table 13 presents the direct costs calculations.

Table 13. Total economic costs due to urban flooding: direct costs

	Per event (1000 VN$)			Per year (1000 VN$)		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost***	**Fixed cost**	**Variable cost**
1. Before flooding						
Fixed assets (depreciation @ 20 years)	375	375	0	375	375	0
Durable assets (depreciation @ 5 years)	59	59	0	59	59	0
Materials	28	0	28	167	0	167
Subtotal	*462*	*434*	*28*	*601*	*434*	*167*
2. During flooding						
Durable assets (depreciation @ 5 years)	14	14	0	14	14	0
Vehicle damage	9	0	9	56	0	56
Materials	32	0	32	191	0	191
Other	22	0	22	132	0	132
Subtotal	*77*	*14*	*63*	393	*14*	*379*
3. After flooding						
Cleaning costs	58	0	58	345	0	345
Subtotal	*58*	*0*	*58*	*345*	*0*	*345*
Total direct costs	*597*	*506*	*91*	*1,339*	*793*	*546*

**The calculation of total costs per year is based on the observation that there are three months of flooding (October, November and December) during a year with two floods per month. The variable costs are calculated on the per event basis while the fixed costs are calculated on the per year basis.*

A large proportion of indirect costs were respondents' own labour costs, which comprised 59 per cent of total indirect costs. The remainder were lost income or lost revenue due to flood. All indirect cost components were variable costs. Total annual indirect costs per household were VN$ 12,150,000 (approximately US$ 578), comprising of VN$ 405,000 (approximately US$ 19) before-flood costs; VN$ 9,270,000 (approximately US$ 440) during-flood costs, and VN$ 2,475,000 (approximately US$ 118) after-flood costs.

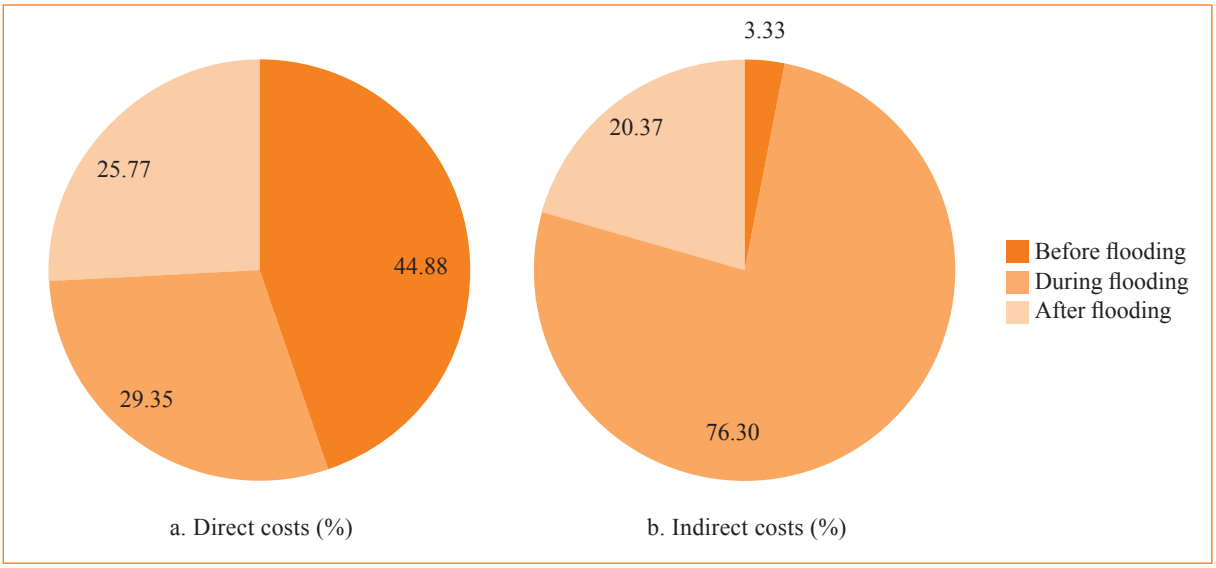
Before flooding occurs, people spend time preparing for the flood, such as moving assets and furniture to higher places, repairing the outside of the house and installing sandbags around the house. As residents use their own labour, this again highlights the importance of early warnings to allow sufficient time to carry out these preparations, which would also minimise the post-flood labour costs. During the floods, lost income (wages and revenue) accounts for the largest proportion at 42 per cent, while health costs and other variable costs account for 23 and 30 per cent respectively. Labour costs account for just 5 per cent of the total during-flood indirect costs and it was dominated by pumping water. In the after-flood period, all the indirect costs were labour costs, of which approximinately 82 per cent was derived from activities to clean and repair the house. Table 14 presents the results of the indirect costs calculations.

Table 14. Total economic costs due to urban flooding: indirect costs

	Per event (1000 VN$)			Per year (1000 VN$)		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost**	**Fixed cost**	**Variable cost**
1. Before flooding						
Own labour: moving assets to safer places	26	0	26	153	0	153
Own labour: outside repairs	3	0	3	18	0	18
Own labour: installing sandbags	9	0	9	54	0	54
Own labour: cleaning sewage discharge system	2	0	2	9	0	9
Own labour: others	29	0	29	171	0	171
Subtotal	*68*	*0*	*68*	*405*	*0*	*405*
2. During flooding						
Missed work	180	0	180	1080	0	1080
Revenue loss	472	0	472	2830	0	2830
Other losses	468	0	468	2808	0	2808
Health cost	362	0	362	2174	0	2174
Own labour: pumping water	42	0	42	252	0	252
Own labour: moving assets to safer places	6	0	6	36	0	36
Own labour: outside repairs	8	0	8	45	0	45
Own labour: installing sandbags	2	0	2	9	0	9
Own labour: other	6	0	6	36	0	36
Subtotal	*1545*	*0*	*1545*	*9270*	*0*	*9270*
3. After flooding						
Own labour: outside repairs	338	0	338	2025	0	2025
Own labour: cleaning sewage discharge system	75	0	75	450	0	450
Subtotal	*413*	*0*	*413*	2475	*0*	*2475*
Total indirect costs	*2025*	*0*	*2025*	*12,150*	*0*	*12,150*

In summary, the direct costs of the before-flood period account for the largest proportion of costs at 45 per cent, while direct costs incurred in the during-flood and after-flood periods were approximately the same, with the edge belonging to the during-flood cost component. Most before-flood costs were investment costs, and as many of the actions undertaken in preparation could be considered forms of adaptation, can be seen as a longer-term investment to be recouped over a number of years of flood events. Meanwhile, the indirect costs incurred in the during-flood period comprised the largest proportion at 76 per cent and the before-flood costs were only at 3 per cent. A large proportion of cost components of during-flood and after-flood periods belonged to labour costs or income or wages lost due to flooding. Figure 6 shows the proportion of direct costs versus indirect costs within a before-during-after flood framework.

Figure 6. Comparison of direct and indirect costs in the before-during-after framework

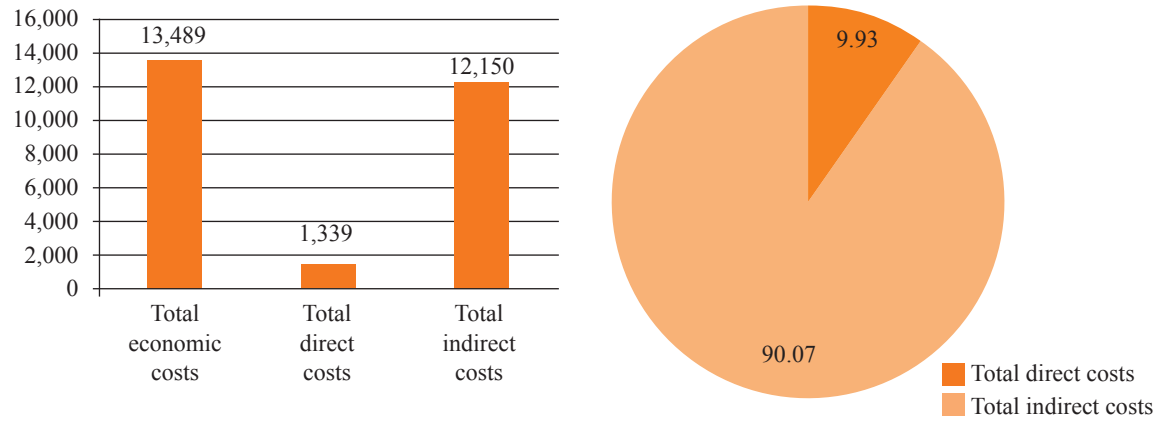


The total annual economic losses caused by flooding was VN$ 13,489,000 (approximately US$ 642) per household. With a mean annual income of VN$ 121,638,000 (approximately US$ 5792), the percentage of economic losses due to flooding in a household's income was approximately 11 per cent per year. Most of these were indirect costs with 90 per cent of total economic losses. Additionally, nearly 95 per cent of economic costs were variable costs. Table 15 and Figure 7 show the cost components of total economic losses and the comparison of total direct costs and total indirect costs in the total annual economic losses per household.

Table 15. Proportion of economic losses classified as direct and indirect costs

	Per event (1000 VN$)			**Per year (1000 VN$)**		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost**	**Fixed cost**	**Variable cost**
Total economic costs, in which:	2622	*506*	*2116*	*13,489*	*793*	*12,696*
Total direct costs	*597*	*506*	*91*	*1339*	*793*	*546*
Total indirect costs	*2025*	*0*	*2025*	*12,150*	*0*	*12,150*
Indirect costs/total costs (%)				90.1		
Total variable costs/total economic losses (%)				94.1		
Income per year				121,638		
Economic losses/income per year (%)				11.1		

Figure 7. Comparison of direct and indirect costs



a. Monetary value (1,000 VN$) b. Proportion (%)

Second, in a different mode of analysis, cost calculations in the before-during-after framework were investigated further. Cost components for each stage of flood period were identified, calculated and arranged by categories of direct costs and indirect costs. Table 16 presents economic losses in the before-flood period. Total annual before-flood costs were VN$ 1,006,000 (approximately US$ 48), of which direct costs were VN$ 601,000 (approximately US$ 29) and indirect costs were VN$ 405,000 (approximately US$ 19). All direct costs were actual costs and included investments such as elevating the base of the house and other improvements that people made before the floods. Seventy two per cent of direct costs were fixed costs.

Table 16. Total economic costs due to urban flooding: before flooding

	Per event (1000 VN$)			**Per year (1000 VN$)**		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost**	**Fixed cost**	**Variable cost**
1. Direct costs						
Fixed assets (depreciation @ 20 years)	375	375	0	375	375	0
Durable assets (depreciation @ 5 years)	59	59	0	59	59	0
Materials	28	0	28	167	0	167
Subtotal	*462*	*434*	*28*	*601*	*434*	*167*
2. Indirect costs						
Own labour: moving assets to safer places	26	0	26	153	0	153
Own labour: outside repairs	3	0	3	18	0	18
Own labour: installing sandbags	9	0	9	54	0	54
Own labour: cleaning sewage discharge system	2	0	2	9	0	9
Own labour: other	29	0	29	171	0	171
Subtotal	*68*	*0*	*68*	*405*	*0*	*405*
Total before-flood costs	*529*	*434*	*95*	*1006*	*434*	*572*

Meanwhile, the monetary value all of indirect costs were derived from the amount of time spent preparing for the flood, such as moving assets or furniture to higher places. All of the indirect costs in this period of flood were variable costs.

Table 17 presents economic losses in the during-flood period. Total annual during-flood costs were VN$ 9,663,000 (approximately US$ 460), of which direct costs were VN$ 393,000 (approximately US$ 19) and indirect costs were VN$ 9,270,000 (approximately US$ 441). All of the direct costs were actual costs, consisting of materials and repairs to damaged facilities and vehicles.

Table 17. Total economic costs due to urban flooding: during flooding

	Per event (1000 VN$)			**Per year (1000 VN$)**		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost**	**Fixed cost**	**Variable cost**
1. Direct costs						
Durable assets (depreciation @ 5 years)	14	14	0	14	14	0
Vehicle damage	9	0	9	56	0	56
Materials	32	0	32	191	0	191
Other	22	0	22	132	0	132
Subtotal	*77*	*14*	*63*	*393*	*14*	*379*
2. Indirect costs						
Missed work	180	0	180	1080	0	1080
Revenue loss	472	0	472	2830	0	2830
Other losses	468	0	468	2808	0	2808
Health cost	362	0	362	2174	0	2174
Own labour: pumping water	42	0	42	252	0	252
Own labour: moving assets to safer places	6	0	6	36	0	36
Own labour: outside repairs	8	0	8	45	0	45
Own labour: installing sandbags	2	0	2	9	0	9
Own labour: other	6	0	6	36	0	36
Subtotal	*1545*	*0*	*1545*	*9270*	*0*	*9270*
Total during-flood costs	*1622*	*14*	*1608*	*9663*	*14*	*9649*

Almost all direct costs were variable costs. Indirect costs consisted of labour costs, lost income and health costs etc. While labour costs were only at 4 per cent, a large proportion of indirect costs were due to lost income or earnings. Besides this, all of the indirect costs in this period of flooding were variable costs.

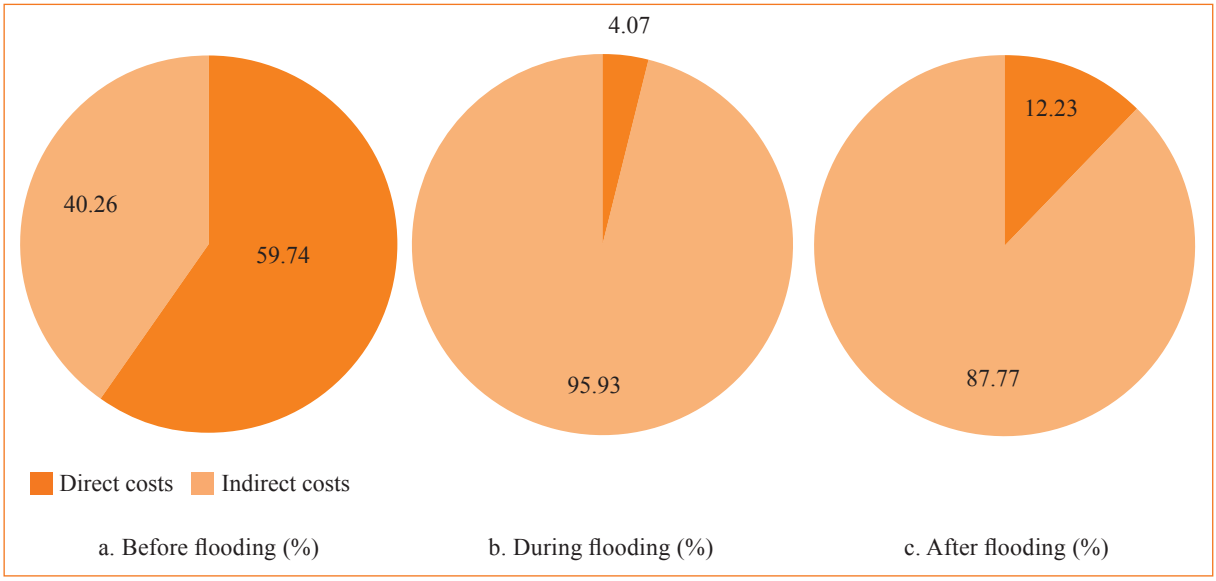
Table 18 presents economic losses in the after-flood period. Total annual after-flood costs were VN$ 2,820,000 (approximately US$ 134), of which direct costs were VN$ 345,000 (approximately US$ 16) and indirect costs were VN$ 2,475,000 (approximately US$ 118). Direct costs were actual costs, consisting of cleaning costs. Indirect costs consisted of labour costs. All the direct and indirect costs were variable costs.

Table 18. Total economic costs due to urban flooding: after flooding

	Per event (1000 VN$)			Per year (1000 VN$)		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost**	**Fixed cost**	**Variable cost**
1. Direct costs						
Cleaning costs	58	0	58	345	0	345
Subtotal	*58*	*0*	*58*	*345*	*0*	*345*
2. Indirect costs						0
Own labour: outside repairs	338	0	338	2025	0	2025
Own labour: cleaning sewage discharge system	75	0	75	450	0	450
Subtotal	*413*	*0*	*413*	*2475*	*0*	*2475*
Total after-flood costs	*470*	*0*	*470*	*2820*	*0*	*2820*

In summary, there were differences in cost structure at different stages of flooding. The direct costs which were usually actual costs that people had to spend in monetary terms occupied a large proportion of the before-flood period, whereas indirect costs which were economic costs – a concept of opportunity costs in economic analysis – dominated in during-flood and after-flood periods. Figure 8 shows the comparison of cost structures in three stages of urban flooding.

Figure 8. Comparison of cost structures in the before-during-after framework

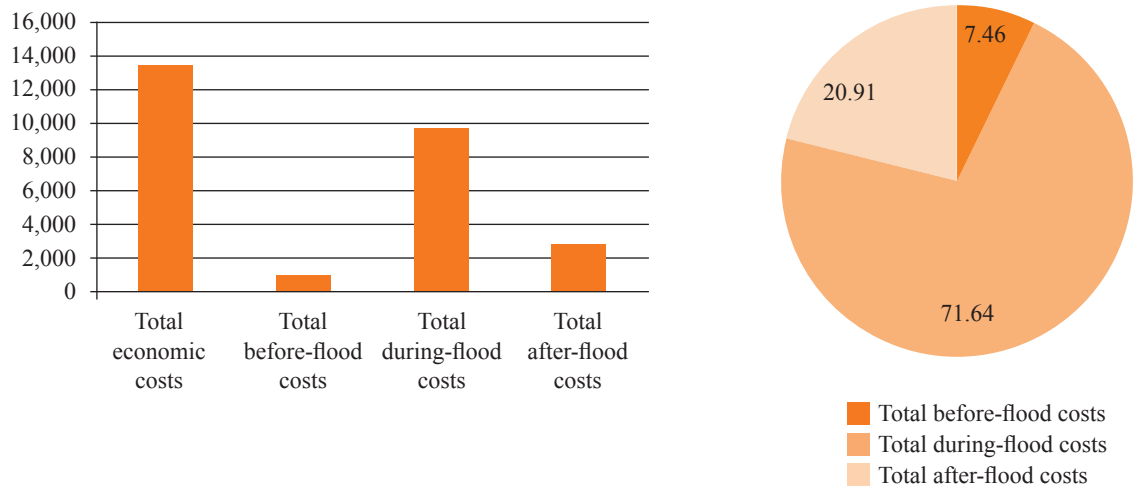


The total average annual economic loss due to flooding was VN$ 13,490,000 (approximately US$ 642) per household and the percentage of economic loss to households' income due to flooding was approximately 11 per cent per year. Losses were incurred mostly in the during-flood period, accounting for over 70 per cent of total economic losses. Losses also were higher in the after-flood period than the before-flood period, which again suggests that taking more preventive and adaptive measures before flooding would have beneficial effects in reducing after-flood losses to a certain extent. Table 19 and Figure 9 show the comparison of economic losses in the before-flood, during-flood and after-flood periods.

Table 19. Proportion of economic losses as classified in the before-during-after flooding framework

	Per event (1000 VN$)			Per year (1000 VN$)		
	Total cost	**Fixed cost**	**Variable cost**	**Total cost**	**Fixed cost**	**Variable cost**
Total costs, in which:	*2622*	*448*	*2174*	*13,490*	*448*	*13,042*
Total before-flood costs	*529*	*434*	*95*	*1006*	*434*	*572*
Total during-flood costs	*1622*	*14*	*1608*	*9663*	*14*	*9649*
Total after-flood costs	*470*	*0*	*470*	*2820*	*0*	*2820*
Total variable costs/total economic losses (%)	82.9			96.7		
Income per year				121,638		
Loss/income per year (%)				11.1		
Before-flood cost/total economic losses (%)				20		
During-flood cost/total economic losses (%)				62		
After-flood cost/total economic losses (%)				18		

Figure 9. Comparison of before-during-after costs



a. Monetary value (1,000 VN$)

b. Proportion (%)

To assess the factors affecting household economic losses, a regression model was used in the study, as explained in the methodology. Table 20 presents the OLS results of the model.

Table 20. Regression results of economic losses due to urban flooding

Variable	Coefficient
Constant	2.1154*** (3.7687)
Flood information exchange with neighbours (Yes = 1, No = 0)	0.1934ns (0.2435)
Level of concern re. flooding (Concerned = 1, Not concerned = 0)	–0.4678** (–1.7874)
Gender (Male = 1, Female = 0)	–0.3165ns (–0.4452)
Education level (Schooling year)	–0.0858*** (–2.4351)
Age (Year)	0.0076ns (0.1454)
Income (1000 VN$)	–8.54E-07ns (–0.6783)
Uncertainty (Relocating to another place within next 5 years = 1, Not relocating = 0)	0.4558*** (2.9865)
Location (Main street = 1, Blind alley = 0)	0.3574*** (2.8977)
Log (Cost of before flooding)	–0.102*** (–2.3740)
R^2 = 0.226	

Dependent variable: Log(Flood_During_Cost)

*, **, *** significant level at 10%, 5% and 1% respectively

ns not statistically significant

Numbers in parenthesis are t-value.

Results show that public awareness or levels of concern regarding urban flooding, respondent's education status, each household's location and the probability of relocating to another place to avoid the floods were factors statistically significant to the economic losses incurred due to the floods. The more concerned about and aware of urban flooding people were, the lower their economic losses were. The higher the education level the respondent had, the lower the economic losses were. In contrast, those who had a plan to relocate their home to another place incurred higher losses than those who chose to remain in their existing homes. Those living along a main street incurred higher losses than those who lived in a blind alley or in residential clusters. Of particular importance, the regression results revealed that if people spent money on preparedness activities before the flood event, the costs incurred during the flood would be reduced, as the statistically negative coefficient to costs during flooding in Table 20 shows.

5 Conclusions and recommendations

5.1 Conclusion

Urban floods in Can Tho City have become more serious in recent decades. In addition to damages to the city's infrastructure, they also affect residents' livelihoods. Floods occur in the city for a number of reasons: the Mekong River upstream flooding coinciding with a high tide regime in the East Sea; the timing and scale of rains; the poor flood-prevention infrastructure system in the city; and urbanisation. Each has reduced the natural adjustment of the surface, increasing surface runoff and decreasing the natural reservoir inside the city, causing a partial flood. This study sought to assess what the costs borne by local residents were when faced with these floods.

The results of this survey show that during flooding, nearly half of respondents' houses were inundated heavily at 20–50 cm. More than three-quarters of respondents thought that urban flooding had become a very serious issue over the last five years, and half of respondents thought it would continue to be so for the next ten years. Many households had plans to prepare for urban floods before they occurred. Using Chi squared (χ^2) testing there was statistical evidence to show the relationship between inundation status, concern levels about the floods and plans for coping with the flood. The more serious the flood was forecast to be and the more concerned people were about the flood, the higher the probability of preparedness was. Similarly, there was statistical evidence to show the relationship between education level and concern level regarding urban flooding in this study. The higher their education level, the more concerned a respondent was.

People's knowledge of floods came from several sources, either from their own past experience or the media. Exchanging flood-warning information early on also gave residents more time to prepare.

Results show that public awareness or concern levels regarding urban flooding, education levels, household location, and probability of relocating homes to avoid floods in future were factors statistically affecting the economic losses incurred due to floods. Public awareness and education levels affected negatively economic loss (meaning that losses were lower) while the probability of relocating to another place had a positive effect on the value of economic losses (i.e. losses were higher). Those living on a main street would incur higher losses than those living in a blind alley or residential cluster – according to cost calculations this is because people living on a main street incurred more business damage or revenue losses.

In calculating economic costs or losses due to flooding, both direct and indirect costs were defined within a timeframe of before-during-after the flood. Both direct and indirect costs were also classified into fixed costs and variable costs in calculations. Calculation results show that total annual household's economic losses were $US 642 which accounted for 11 per cent of annual household income. A large proportion of economic losses were indirect costs. Measuring the indirect costs was based on a concept of opportunity costs in economic analysis. These costs included the use of their own labour, missed work and lost revenue or earnings etc. The indirect costs accounted for 90 per cent of total economic losses and dominated mainly the during-flood and after-flood periods. Table 21 summarises the economic losses by cost classification.

Table 21: Summary of economic losses by cost classifications

Cost item	Cost (US$)	%
I. Classification by direct and indirect costs		
1. Total annual direct costs, in which:	64	10.0
Before-flooding costs	29	4.5
During-flooding cost	19	3.0
After-flooding cost	16	2.5
2. Total annual indirect costs, in which:	578	90.0
Before-flooding costs	20	3.1
During-flooding cost	440	68.5
After-flooding cost	118	18.4
Total economic losses	642	100.0
II. Classification by before-during-after costs		
1. Before-flooding costs, in which:	48	7.5
Direct costs	29	4.5
Indirect costs	19	3.0
2. Before-flooding costs, in which:	460	71.7
Direct costs	20	3.1
Indirect costs	440	68.5
3. Before-flooding costs, in which:	134	20.9
Direct costs	16	2.5
Indirect costs	118	18.4
Total economic losses	642	100.0

The results of the regression analysis also provide evidence that if each household paid more attention and spent more on preparation for floods before they happened, damages and losses would be reduced. This implies that if appropriate adaptation measures were implemented in the before-flood period, the costs of coping and recovering in the during- and after-flood periods would be decreased. Therefore, investing in adaptation measures would help to enhance the capacity of households' resilience to urban flooding, for example by providing households with access to information and training on the most effective adaptation measures, and how they could be implemented using their own labour at the household level.

5.2 Recommendations

To reduce losses due to flooding, the following measures are recommended:

First, the city should prepare a shoft-term coping strategy and also a longer-term plan for adapting to urban flooding in order to minimise the impacts on individual households. In the short term, partial flood-prevention systems in flood-prone areas such as central areas and main streets should be temporarily established, as these areas tend to be the most severely affected. In the long term, the city's flood prevention needs to be integrated into the master plan for upgrading the infrastructure of this young, central-administrative city in the middle of the Mekong Delta. In the process of urbanisation, when building new residential clusters, sewage discharge systems needs to be connected with the city's main discharge systems. An efficient flood-prevention system in the long term is extremely necessary for the development of the city.

Second, the city needs to build an early-warning system. This system should provide residents with timely and effective flood information before the floods. Results of this study's regression analyses show that if preparedness is ensured at the beginning of a flood event, losses caused by urban flooding are reduced. Many of these preparedness actions are permanent measures, such as elevating houses or surrounding them with concrete walls, which could be regarded as an investment for future flood events as well, and thus a form of climate adaptation. Other strategies, such as moving furniture or cleaning drains can also be considered a coping strategy. However, if the local government was to upgrade or regularly clear drains, this could be a form of adaptation, by increasing drainage capacity to cope with heavier rainfall.

Third, the city should establish an urban flooding-mitigation unit, which could launch permanent activities to enhance public awareness about urban flooding. Once residents' awareness and understanding about floods is improved, they could invest in protecting their houses from damage. Results of the regression analyses also show that losses could be reduced if people were more concerned about floods, which would come from awareness-raising.

Fourth, at the household level people should make their investment in the before-flood period rather than subsequent periods of the flood. This study shows that the during-flood period incurred the largest portion of economic losses. If investment was made prior to the floods, losses and costs incurred as a result of flooding could be prevented or minimised. As households would incur fewer damages or losses, this could be regarded as a contribution to their longer-term resilience to climate change, as they would be able to recover more easily from flooding events.

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Appendix 1. Survey on economic losses due to urban flooding

Can Tho University is conducting a household survey to identify possible measures to prevent future urban flooding damage. Your participation in this survey will be greatly appreciated.

Before we get started, we want to assure you that the answers you give will be kept confidential. Your name will not be associated with your answers and your answers will be combined with those we get from everyone else. This interview is voluntary and you are entirely free not to participate or not to answer any of the questions you choose. If you accept to join the interview, it will take you about 35–45 minutes to answer. You are also free to terminate the interview at any time. Are you willing to participate in this survey?

Name of interviewee:

Address of interviewee:

Mobile (optional):

Name of interviewer:

Interview date:

Interview number:

SECTION A: KNOWLEDGE OF AND ATTITUDE TOWARDS URBAN FLOODING

Q.1. Is your area usually flooded?

Yes ☐ No ☐

(If no => stopped)

Q.2. In which month(s) and how often was your residence flooded last year?

1	2	3	4	5	6	7	8	9	10	11	12
…	…	…	…	…	…	…	…	…	…	…	…

Q.3. Do you think flooding in your area has become really serious in the last five years?

Yes ☐ No ☐

Q.4. How serious do you think urban flooding will become in the next ten years (circle one)?

(1: Not very serious; 5: Very serious)

1	2	3	4	5

Q.5. Do you have any strategies to cope with floods and/or to mitigate the after-effects?

Yes ☐ No ☐

Q.6. If yes, what are they?

Q.7. How severely do you think your area is affected by flooding relative to other areas?

More ☐ Less ☐ Same ☐ Don't know ☐

Q.8. How concerned are you personally about urban floodinging (circle one)?

(1: Very unconcerned; 5: Very concerned)

1	2	3	4	5

Q.9. What factors do you think possibly cause flooding in your area?

SECTION B: ASSESSMENT OF FLOOD WARNING SYSTEMS

Q.10. During the floods, had your home ever been flooded before?

Yes ☐ No ☐

Q.11. If yes, what warnings did you receive about the floods and which warningwas the first?

Warned by:

Message:

Q.12. In response to the first flood warning, what did you do?

Q.13. How seriously did you take this first flood warning (circle one)?

(1: Not seriously; 5: Very seriously)

1	2	3	4	5

Q.14. Besides the first flood warning, did you receive a **different warning later on** indicating that flooding was possible?

Yes ☐ No ☐

Q.15. If yes, what was the warning and from where/whom you receive it?

Message:

Whom/where:

Q.16. In response to the second flood warning, what did you do?

Q.17. How seriously did you take this second flood warning (circle one)?

(1: Not seriously; 5: Very seriously)

1	2	3	4	5

Q.18. After receiving the second warning, did you receive any later warnings which caused you to take further action?

Yes ☐ No ☐ Not sure ☐

Q.19. Please describe the later warning(s):

Q.20. What additional action, if any, did you take as a result?

Q.21. Do you have any suggestions or ways to improve current flooding information systems?

Q.22. Do you regularly exchange information about floods with your neighbours?

Yes ☐ No ☐

Q. 23. Does anyone else in your home receive any communications about possible flooding?

Yes ☐ No ☐

Q.24. Who would you most trust to provide you with information about urban floodinging in your area?

First preference:

Second preference:

Q.25. What measures/actions, if any, have you taken to minimise the impact of urban flooding?

Q.26. Do you think anything can be done to minimise the after-effects of urban flooding?

By government:

By community:

SECTION C: ASSESSMENT OF COSTS AND DAMAGES

Q.27. During the floods last year, did any member of your household have to leave to avoid the flood temporally?

Yes ☐ No ☐

I. Before the floods

Q.28. Before the floods, what action(s) did you take to cope with them?

Q.29. How many days did you spend preparing for coping with or preventing potential damage caused the coming floods?

Q.30. How much money did you spend to prepare for coping with or preventing potential damage caused the coming flood?

II. During the flood

Q.31. How many days did you spend in preparing to protect your house from the floods?

Q.32. During the floods, what action(s) did you take to cope with them?

Q.33. How much money did you spend?

Q.34. What did you lose during the floods?

Appliances (and respective costs):

Furniture (and respective costs):

Vehicles (and respective costs):

Other (please verify) (and respective costs):

Q.35. Did any members of your household lose any income because of the floods (e.g. could not get to work, or their place of work was closed etc.)?

Yes ☐ No ☐

Q.36. If yes, please indicate for each person where they work, their normal wage rate and how many days they could not work because of the flood.

Family member	Type of work: 1: worker; 2: wage earner; 3: business owner; 4: other (verify)	Normal income	Unit: 1: per day; 2: per week; 3: per month; 4: other (verify)	Number of days not working due to floods	Total losses (VN$)
Person 1					
Person 2					
Person 3					
Total losses					

Q.37. Was there any structural damage to your home?

Yes ☐ No ☐

Q.38. If yes, what was the cost of the structural damage to your home?

Q.39. Did any members of your household contract any diseases associated with the after-effects of flooding?

Yes ☐ No ☐

Q.40. If yes, how many household members were affected and how much did the family spend on medical treatment in total?

Disease	Number of family members affected	Did you receive any treatment?	Total cost to treat the family (doctor's fees, medicine, transport etc.) in VN$

III. After the flood

Q.41. How many days did you need to repair or clean up your home after the floods?

Q.42. What was the monetary cost to you for labour and supplies to clean up the structure and contents of your house **after** the flood?

Q.43. How many total unpaid hours did you and other family members spend on cleaning up the structure and contents of your house **after** the flood?

Q.44. How many person hours did it take to put back or (re)arrange the contents of your house?

Q.45. How high (in centimetres) did the water come to relative to the front entryway of your house?

Q.46. Can you break down your total real estate damages into the following categories?

Area of damage	**Before the flood**				**During the flood**				**After the flood**			
	Unit (VN$)	Days to repair or install, in addition to money spent	Was action taken to prevent damage? (tick for yes)	Value of damage prevented in VN$	Unit (VN$)	Days to repair or install, in addition to money spent	Was action taken to prevent damage? (tick for yes)	Value of damage prevented in VN$	Unit (VN$)	Days to repair or install, in addition to money spent	Was action taken to prevent damage? (tick for yes)	Value of damage prevented in VN$
1. Built-in shelves and appliances												
2. Electrical items												
3. Water pumps												
4. Exterior and internal walls, windows and doors												
5. Moving or storing furniture and belongings												
6. Outbuildings												
7. Setting sandbags outside house												
8. Septic, sewer and water systems												
9. Flood-related medical problems												
10. Other (please specify)												
Total												

SECTION D: HOUSEHOLD BACKGROUND INFORMATION

Q.47. What is the longest time in years and months that a member of your household has lived in this residence?

Q.48. What type of location do you live in?

Avenue ☐ Main street ☐ Blind alley ☐ Other (specify) ☐

Q.49. Do you own, rent or lease this residence?

Owned ☐ Rented or leased ☐ Other (specify) ☐

Q.50. Please describe your house:

Total area of land: …… m^2

Number of floors: ……..

Year built: ……

Q.51. How much is your house worth now (VN$)?

Q.52. How many people live in your house?

Below 15 years old:

Between 15 and 60 years old:

Above 60 years old:

Q.53. What is your total annual household income (VN$)?

Q.54. Are you the head of your household?

Yes ☐ No ☐

Q.55. If yes, please tell us about yourself.

Gender: Male ☐ Female ☐

Age:

Educational level:

Occupation:

Q.56. If no, who is the head of your household?

Name:

Gender: Male ☐ Female ☐

Age:

Educational level:

Occupation:

Q.57. Does your family plan to move to another location due to flooding within the next five years?

Yes ☐ No ☐

THANK YOU

Household economic losses of urban flooding: case study of Can Tho City, Vietnam

Asian Cities Climate Resilience Working Paper Series

This working paper series aims to present research outputs around the common theme of urban climate resilience in Asia. It serves as a forum for dialogue and to encourage strong intellectual debate over concepts relating to urban resilience, results from the ground, and future directions. The series is also intended to encourage the development of local research capacity and to ensure local ownership of outputs.

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