Original Research Article

Public Participatory Role in Urban Flood Risk Management of Ho Chi Minh City - Vietnam: From Awareness to Action

ABSTRACT

Urban flooding has become a regular phenomenon in many towns and cities in the world over the past years. Flooding in urban areas in Ho Chi Minh City poses serious challenges not only by affecting large numbers of people and properties in urban areas but also directly affecting economic growth of the city. Due to the ongoing technical effort to strengthen the city's drainage system, which is necessitated by phenomenal growth of the city making the presently existing drainage system both inadequate and substandard, it has become impossible to solve all the causes of the flooding.This important facility in a growing city has made human factor an important link in the flooding problem and the contribution of flood reduction to the city. To start with, the flood risk management included close observation of the flooding dynamics and detailed study of the technical reports on flooding situation (available with Ho Chi Minh City Steering Center of Urban Flooding Control in the rainy season, from May to November 2018). As a part of well planned strategy, together, an interactive survey was conducted with the flood affected people residing in about 820 households in flooding areas. The survey focused on awareness and behavior of public garbage disposal of households living in flooded areas. The survey has been carried out, without any restrictions, as an open interaction. Care has been taken to ensure positive environment for people to freely contribute their ideas.The survey focused, especially on the issues related to management, technology and propaganda to solve the city's flooding problems. The study investigated people's awareness and behavior of littering in the area for flood reduction; assessed the effectiveness of the previous public awareness propaganda program for households living in districts of 04 canal basins (Nhieu Loc - Thi Nghe, Tau Hu - Ben Nghe) , Tan Hoa - Lo Gom, Tham Luong - Ben Cat), and considered the role of the community in contributing to the city's flood risk management.

Keywords: urban flooding, flood risk, Public participatory role, public awareness

1. INTRODUCTION

Urban flooding has become a regular phenomenon in many towns and cities in the world over the past years. In Europe, flood risk has been experienced in cities of the Netherlands, Italy and United Kingdom [1][2][3]. In United State, in recent times, the worst flood risk is clustered around the Central and Southern U.S., along the Missouri and Mississippi rivers.Some of the hardest -hit states include the Dakotas, Nebraska, Minnesota, Wisconsin,

Iowa, Illinois, and Missouri [4]. Specialy, flood occured in many Asian cities of Indonesia, Philippines, Vietnam, Thailand …[5][6].

Urban floods cause inundation of streets, basements and ground level floors of buildings, in urban areas. Flooding affects many aspects of society such as human and animal life, public health, economy, buildings, transportation and the environment.

Most of these floods are originated from waterway systems like cannal catchment, riverine or coastal area[7]. A number of urban floods also are combined with the inadequate capacity of the drainage system; changing in land use may cause less filtration and increase in urban floods. The dense population settlements in a risked area also increase the frequency of floods.

Ho Chi Minh City, study area, close to sea level is prone to intense monsoon and cyclonic rains leading to inundation of low lying areas due to flooding. It is identified as one of the vulnerable cities to climate change, the possible causes include[8]:

- The city is close to sea level, with 40% - 45% of Ho Chi Minh City's land area in the range of 0-1m above sea level, 15% -20% in about 1-2m, and very little area at altitudes above 4m;
- The proportion of the population in the city is very large and constantly increasing as the city has a dynamic economy that attracts immigrants throughout the country;
- Local urban development also increases vulnerability, for example reducing water permeability and increasing local flooding;
- Climate and hydrodynamics are already at an extreme level and are expected to increase in intensity, so there will be many storms, surges and high tides.

During the rainy season from May to November and during flood-tide between September and December, residents are confronted with flooding in the low-lying areas. In the central districts, even during non monsoon season, flooding adversely impacts due to spring tide twice a month for several days in a row. The main causes of flooding impact are high tide, heavy rain and high density of population in low lying areas, who add regularly tons of garbage to the street or water ways, choking the drain water outlets. Besides, land subsidence, increase of sea level rise and heavy rain due to climate change contribute significantly to already existing difficult situation[9].

Flooding in urban areas in Ho Chi Minh City poses serious challenges not only by affecting large numbers of people and properties but also directly affecting economic growth of the city[10]. Worldbank had mentioned the impacts of flooding on individuals and households as follows: 67.5% of households believe that health is affected, 58% think that work is affected, 50.0% of workers are unable to attend to respective works during floods due to transportation difficulties ; 43.6% of freelance workers suffer from income losses[11].

Several organizations, in recent years, have supported Ho Chi Minh City government to construct and operate facilities relating to drainage, flood control and pollutants removal. Some typical projects are effectively operating, including irrigation facilities along Sai Gon River (AFD), Vietnam—HCMC environmental sanitation (Nhieu Loc-Thi Nghe Basin) , Tan Hoa—Lo Gom Basin, urban development project (WB), improving the quality of the water in the Tau Hu-Ben Nghe-Doi Te Canal (JICA), integrated flood risk management approach for HCMC, under support of the World Bank. Integrated flood risk management was established to continually improve drainage systems, flood control and environmental sanitation for the city, where a focal point will be a catchment of Tham Luong-Ben Cat-Nuoc Len Canal [12].

In spite of concerted technical effort for the city's drainage system, it is impossible to solve all the causes of the flooding; from natural factors such as rising tide levels over the years related to sea level rise, abnormal rainfall changes, unreasonable urban planning, crowded and destructive population, concentration of overlapping works of waste water drainage,

littering, clogging drainage systems and canals. It is noticed that recent technical efforts have improved drainage systems, to reduce adverse impact of floods, in some segments of the city. Yet, floods are still severe in many low lying segments of the city.

Located in the downstream area of Dong Nai river system, Ho Chi Minh City has quite a network of rivers and canals and is very diverse in terms of scale and functional use. Major and important rivers in Ho Chi Minh City include Dong Nai River, Saigon River, Nha Be River - Soai Rap River, Long Tau River and Thi Vai River and 4 main canals with a total length of more than 100 km. The 4 main canals are Nhieu Loc - Thi Nghe, Tan Hoa - Lo Gom, Tau Hu - ben Nghe - Kenh Doi - Kenh Te, , and Tham Luong - Ben Cat - Vam Thuat. The slope of most of these canals is very small, the bottom of the canal is filled with deposition materials so the drainage capacity is very poor. City canal system is strongly influenced by tides, some channels are affected by many flows. Because of this negative factor pollutants remain in the channel and are gradually accumulating.

The city's drainage system has more than 69,000 manholes collecting water, but nearly half become a garbage dump; in addition, the rubbish left on the street surface, when it rains, overflowing water will sweep this waste and clog the drainage system.

According to data from the Department of Natural Resources and Environment in Ho Chi Minh City, every year, the city spends tens of billions of dong(Vietnam currency) on garbage and water hyacinth projects along canal basins. In 2018, the city used about 6.3 billion VND to collect garbage along Nhieu Loc - Thi Nghe canal, 1.1 billion VND for Tan Hoa - Lo Gom canal and 14.4 billion VND for Tau Hu - Ben Nghe - Đoi Te canal with a volume of about 31 - 46 tons / day, peaking at about 68-85 tons/day [13]. Indiscriminate disposal of garbage is also one of the reasons contributing to the flooding in the city.Thus, human factor is also an important link in the flooding problem and the contribution of flood reduction to the city.

This study aims to investigate people's awareness on flooding and behavior of littering in the area for flood reduction; to assess the effectiveness of the previous public awareness propaganda program for households living in districts of 04 canal basins (Nhieu Loc - Thi Nghe, Tau Hu - Ben Nghe) , Tan Hoa - Lo Gom, Tham Luong - Ben Cat), and to consider the role of the community in contributing to the city's flood risk management.

2. MATERIAL AND METHODS

This study involves several steps.

Firstly, on the basis of information of specialized units on flood management, the research team collected information on natural/ environmental details followed by socio-economic conditions, information on flooded roads and low lying segments of the city and characteristics of flooding in the period of 2017 – 2018. Beside, the team also recorded basic observations and followed the reports on flooding situation from HCMC Steering Center of Urban Flooding Control in the rainy season (from May to November 2018).

As a Second step, the research team made an actual survey of the characteristics of the roads, the situation of littering in public places, the operation status of the drainage system. The survey team/ research group chose routes with flooding characteristics associated with the sanitation situation to conduct surveys.

The survey focused on awareness and behavior of public garbage disposal of households living in flooded areas. The survey has been carried out as an open interactive exercise to create conducive conditions for people to contribute their ideas, without any restrictions. The survey included, especially the issues related to management, technology and propaganda to solve the city's flooding problems.

According to the data that had been provided by HCMC Steering Center of Urban Flooding Control, Ho Chi Minh City has 49 flooding routes due to rain and tide, of which 19 routes have been made accessible in 2016 – 2017. 27 routes are expected to be made accessible/ useful during 2018-2020 and 03 routes after 2020[14].

Based on characteristics on causes of flooding, the expected results of flood control program will be implemented. From the total number of flooded roads in each district; the research team had selected 21/49 routes of 11/12 urban districts to conduct interactive survey with the community. The surveys on 21 selected routes were conducted from June 23 to August 25, 2018 with 820 respondents.

3. RESULTS AND DISCUSSION

3.1 Situation of flooding in Ho Chi Minh City

Ho Chi Minh City is prone to face , on a regular basis, the huge risk of flooding, from normal climate events and extreme climate events such as thunderstorms and tropical storms[8]. The number of rainy spells has shown a decreasing trend from 2010 to 2016,namely, from 214 down to 51.But, the average rainfall has increased very high from 51mm in 2010 to 112mm in 2016. This shows that the extreme weather is getting more and more intense, which is probably the reason for 52 floods due to rain in 2010 , decreased significantly to 26 floods in 2015[14].

In response to flooding challenges, a number of structural measures have been planned and implemented. The city has started several projects that focus on resolving flooding by tide in Ho Chi Minh City considering climate change factor, such as construction of Tidal control gates, Dikes along the river and drainage systems in vulnerable locations.

To prioritize investment in construction and renovation of sewer lines under projects approved by the overall drainage planning: Various types of 37 sewer systems with a total length of 104.2 km have been completed and put into operation. 69.4 km of rivers and 211 lines of canals have been dredged ,enhancing the drainage capacity of the system. Besides, a number of projects to improve axial canals are in the preparation phase of investment.

In addition, HCMC Steering Center of Urban Flooding Control coordinated with the People's Committees of the districts to implement 64 projects to renovate and upgrade allays and feeder roads. As a part of 64 projects dredging of canals in the area is planned to ensure synchronous and clear flow of 91 routes.

In 2017, 04 wastewater treatment stations were put into operation with total capacity of around 38700 m3/day. Through implementation of flood controlling initiative, in 2016 and 2017, 15 main roads that were flooded due to rain were properly renovated. In addition in 2018 , 7 more flooded roads were repaired and upgraded [14].

The records from the observations and reports from HCMC Steering Center of Urban Flooding Control have shown that in the 2018 rainy season, from May to November, 14 heavy rains or high tides caused flooding in many areas of Ho Chi Minh City.

Table 1. The records of flooding situations in HCMC in the rainy season in year 2018 (Courtesy: HCMC Steering Center of Urban Flooding Control**)**

No	Recorded rains/tides	Number of flooding	Rainfall at measured	Flooding depth (m)	Tide level (m)	Flooding duration

		points	stations (mm)			(minutes)
1	7/5/2018	5	16.0 - 63.7	0.15 - 0.3		20 - 45
2	8/5/2018	13	19.4 - 62.6	0.2 - 0.25		30 - 180
3	19/5/2018	32	36.9 - 119.3	0.1 - 0.25	1.23	30 - 180
4	20/5/2018	5	15 - 55	0.15 - 0.22		10 - 180
5	1/6/2018	29	13.5 - 139.5	0.15 - 0.4		10 - 180
6	2/6/2018	5	10.7 - 90.6	0.1 - 0.25		10 - 20
7	3/9/2018	10	10 - 57.2	015 - 0.25		10 - 20
8	8/9/2018	18	28 - 127.8	0.1 - 0.25	1.19	10 - 30
9	2/10/2018	12	26.1 - 57.7	0.1 - 0.25		10 - 20
10	3/10/2018	9	21.2 - 88.9	0.2 - 0.25		10 - 20
11	7/10/2018	3	0	0.1 - 0.2	1.63 - 1.64	60
12	8/10/2018	5	0	0.1 - 0.2	1.59 - 1.6	60
13	25/11/2018	102	138.3 - 401	0.1 - 0.7	1.29	500 - 600
14	26/11/2018	31	0	0.1 - 0.4	1.5	60

3.2. Results of the survey on public perception on flooding risk management

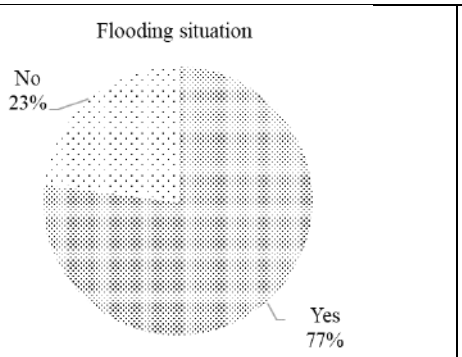
3.2.1. Public's perception

Observations from HCMC Steering Center of Urban Flooding Control in recent years indicate that Ho Chi Minh City has 49 flooding routes due to rain and tide. The research team had selected 21/49 routes of 11/12 urban districts to conduct survey with the community. The surveys were conducted from June 23 to August 25, 2018 with 820 respondents. Among 820 respondents, 56% were male and 44% were female.

Regarding the time of residing in the area, more than 60% of the respondents said they had stayed in the area for more than 10 years, 30% of the people resided in the area for 3 - 10 years and only 10% of surveyed people resided for less than 1 year.

Regarding the situation in the living area, only 23% of people living in the area are not flooded. 77% of the remaining respondents living in the area have often faced flooding.They said that the time of frequent flooding often occurs when it rains (99.5%) and during high tide (13.9%). Some people expressed that flooding was caused by poor sewer system, and the water was not drained. Compared to 5 years ago, 39% of surveyed people living in flooded areas said the level of inundation decreased, 43% of surveyed people felt that the flooding situation was the same and unchanged and the remaining 18% said the flooding situation is increasing. The last category have not given clearly about the flooding frequency.

Residents in the impacted area of HCMC are local and well aware of flooding situation. These residents have a medium and low socio-economic position. And as such, they are vulnerable to various types of flooding risks.



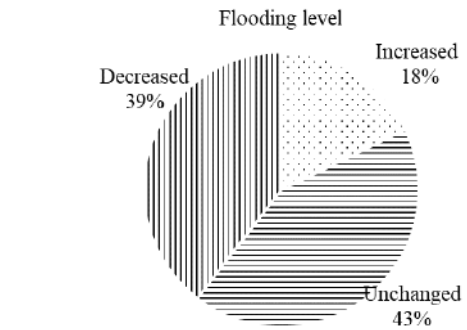


Fig.1. Opinions of surveyed residents on flooding situation in HCMC

As per available records, many flooded roads have been re-laid in recent years using better technology. Rest of the roads are being planned properly for lessening the impact of flooding.Problems are multi-fold where old and poorly laid roads are in use, especially in low lying areas. Along roads that have been flooded and re-laid respondents expressed the following views. 60% of people said the level of inundation decreased, 33% said that the flooding situation was the same, unchanged and the remaining 7% said that the flooding situation was increasing (Fig-2).

Flooding situation at roads that are being planned for overcoming flooding related problems, especially transportation, respondents expressed the following views. People said that they are living in flooded areas, due to socio-economic limitations, even though they are aware that the residing area is flooded mainly due to rains. Compared to the previous 5 years, 49% said that the flooding situation was the same and unchanged , 25% of the respondents remain said that the flooding situation was increasing and remaining 26% of respondents expressed that flooding decreased (Fig-3)

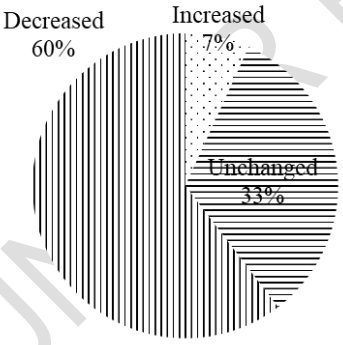


Fig.2 Flooding situation at roads that have been flooded and resolved

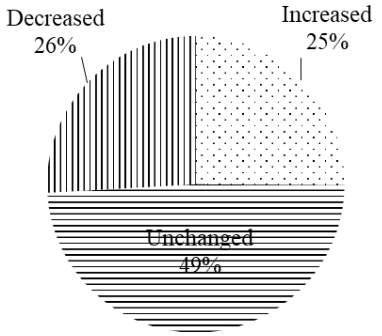


Fig.3. Flooding situation at roads that are being planned for flooding resolves

For assessing the degree of influence of flooding on the health of the family, 50% of surveyed people think that it is not affected, 28% of people think that flooding affects the health of the family but is not serious, 21% of people rate the impact as serious and only 1% of the remaining assesses the level of influence is very serious.

In the past 1 year, 25% of families had health problems, of which 56% of people suffer from skin diseases, 29% of people with respiratory problems, 10% of people with dengue fever, 4% number of people suffering from digestive issues and 1% suffer from other diseases. According to the surveyed participants, the increasing flooding has seriously affected the lives and activities of families, especially difficulty in travelling.

Regarding solid waste treatment, 99% of respondents said that household waste is collected at home by local public/private service, 1% of the remaining people bring garbage to garbage collection or self-treatment places for burial. In general the solid waste is used for composting and as fertilizer and rest is burnt. In case the garbage generated improperly at the time of the collection time, 55% of the respondents choose to take the waste out of the house beforehand, 41% of the surveyed store it in the house until the collection time and given to the garbage collectors to take it out for disposal, 4% of the surveyed took their garbage to the front of the road, put it in the grass / tree / manhole or brought it to the garbage collection place.

Along roads that have been flooded and re-laid, 48% of the surveyed choose to remove the waste beforehand in case the garbage cannot be disposed during the collection time, 50% of the surveyed store in the house until the collection time and then handed over to the garbage collectors. Particularly along the roads that are being planned to solve flood, 60% of the surveyed choose to take the waste in advance from the house in case the garbage disposal is not possible at the time of collection, 35% of the surveyed will store In the house and hand over to the garbage collectors at the collection time for disposal and 5% of the people choose to take the garbage to the street front, put it in the grass / tree / manhole.

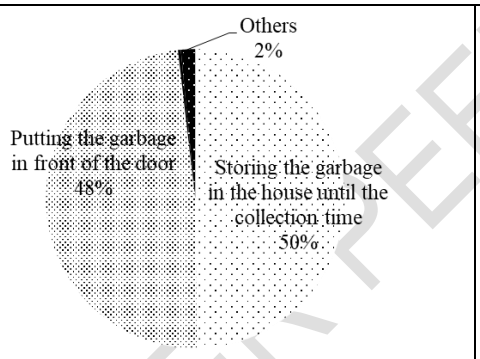


Fig.4. Bihaviors of residents along the roads that have been flooded and resolved

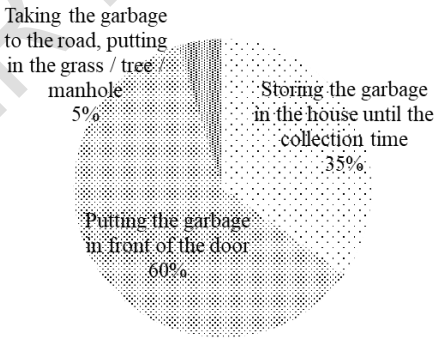


Fig.5. Bihaviors of residents along roads that are being planned for flooding

For the urban districts surveyed (Districts 2, 6, 7, 8, 11, Tan Binh, Go Vap, Binh Tan, Tan Phu), behavior of respondents has been detailed as : 48% of the surveyed chose to remove rubbish from the house and put in front of the house. In case the garbage generated improperly at the collection time, 50% of the surveyed will store it in the house until the next collection time and dispose through garbage collectors. 2% of the respondents, who choose to take the garbage to the road front, put it in the carpet grass / stump / manhole (Fig-4). In the central districts (District 1 and Binh Thanh District) this ratio is 60%, 35% and 5%, respectively (Fig-5)

Regarding questions related to launching the movement for people to participate in cleaning up local sanitation companaign, only 34% of survey respondents answered yes. Launching movements were often: scraping walls, cleaning neighborhoods, sorting garbage, collecting bottles, spraying flies and mosquitoes, distributing leaflets during propaganda and

participating in the green summer campaign (with the highest weekly rate of 1 week / time, the average of 3-6 months / time and the lowest of 1 time / year).

In the case that the neighborhood does not launch the movement, people will keep the general hygiene, dispose of garbage at the prescribed place or clean up themselves to maintain environmental hygiene in the living area. The rate of movements was launched for people to participate in cleaning up the sanitation in the central districts (42%) is found to be higher than the urban districts surveyed (33%).

Regarding the current status of garbage disposal at the manholes, 53% of respondents often see this activity being followed by residents. In particular, passersby are most often seen disposing garbage (43%), followed by the local people 37%. The local traders account for 17% and other 3% are street vendors (Fig-7).

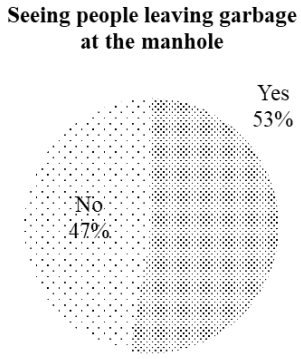


Fig.6. Surveyors saw people leaving garbage at the manholes

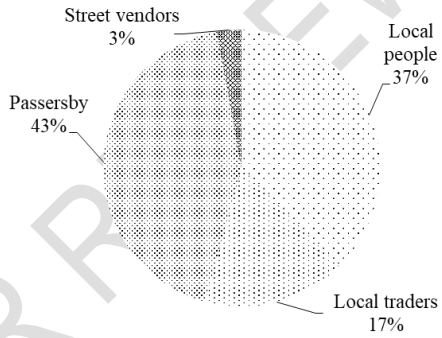


Fig.7. Different groups disposed garbage at the manholes

Particularly for roads that are being planned for flooding control, 53% of respondents regularly see people leaving garbage at the manhole (they include the local people 40%,the local traders account for 11% and other 2% are street vendors). Where as 47% of passers-by are often seen not leaving garbage(Fig-6).

3.2.2. From awareness to actions

When asked about the situation when they are outside, if there is any garbage, what option will they choose? 92% of people choose to find public trash to dispose of garbage, 6% of those who choose to take it home and put it in their own trash and 2% of the rest do not care or choose to dispose of garbage on the spot.

Regarding the attitude of community when they see people throwing garbage in the manhole, 93% of the respondents said that they felt uncomfortable and only 7% of the rest (mostly men) found it normal (Fig-8). In order to prevent littering, 57% of respondents choose to remind these littering men about the ills of littering, 3% choose to take photos and bring to the notice of administration and media / or report to local security and 40% choose not to do anything(Fig-9).

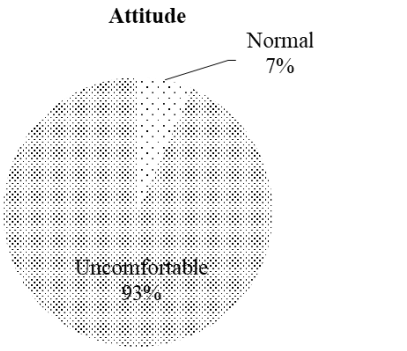


Fig.8. Attitude of community when they see people throwing garbage in the manhole

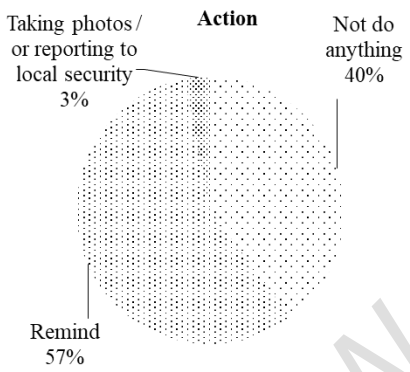


Fig.9. Action of community when they see people throwing garbage in the manhole

When asked about the environmental impacts of waste disposal near the manhole correspondents living along roads that are being planned, 49% of people said that it would obstruct the drainage / sewerage system, 27% expressed that urban beauty is lost and 24% people think that it will cause environmental pollution(Fig-11)

For roads that have been flooded and resolved, when asked about the environmental impacts of sewage disposal, 64% of people think that it will block the drainage system, 16% of those choose "losing Urban beauty", 20% of people think that it will cause environmental pollution. People consider the importance of drainage systems (Fig-10).

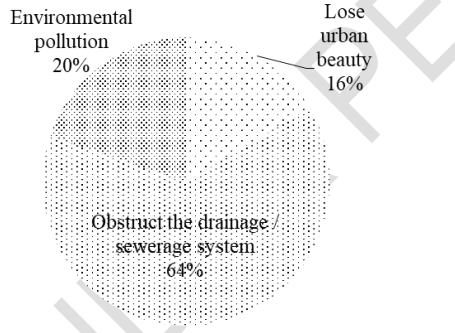


Fig.10. Opinions of people living along the roads that have been flooded and resolved about impacts of waste disposal near the manhole

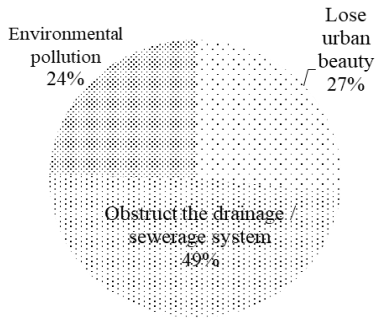


Fig.11. Opinions of people living along roads that are being planned for flooding resolves about impacts of waste disposal near the manhole

For the question regarding access to sanctioning regulations for illegal garbage disposal, issued by the State, 57% of respondents have access to this information.43% of respondents did not know / could not access. Among those who have access to information, 6% of respondents reach through banners, street signs, 18% of people access via local channels (message boards, leaflets, meetings, etc.). , 36% via television, radio and 40% are self-learn / see online / listen to others. 61% of the surveyed respondents in the inner districts of the city responded that they had access to sanctions regulations for illegal dumping, which was higher than respondents in other districts.

There are differences in the surveyed groups in the area that have been flooded and resolved, and in the area being planned for flooding control in awareness, attitudes and participation in environmental protection and flood risk management. People in the area have been flooded and resolved understand on causes and effects of the flooding. They have a sense of environmental protection, storing garbage in the house instead of leaving in their front door or on the street, leaving the garbage in the right place, and ready to remind others. These rates are higher in the unresolved area of the population. We also noted the impact of the propaganda on flood. Similarly, this is also true for surveyed people in central districts and other districts.

The complex interaction of social, ecological and physical processes in flooding poses significant challenges for understanding, modelling and managing floods[15]. Therefore, both the drivers of increased flood risk and the implications of flooding touch on a wide range of sectors. Efforts to plan for and manage floods confront complex and uncertain factors. So as to make the efforts successful and long lasting it is essential to balance and mediate among multiple sectors and competing interests. The integrated and participatory risk-based management approach is becoming institutionalized at different levels [16][17], [18],[19] and various facets of these important factors should be monitored regularly, involving all the stake holders participation from planning stage on wards until success is ensured to mitigate the problems of a large number of middle and lower income groups.

4. CONCLUSION

The flooding problem in Ho Chi Minh City is complicated by many reasons, of which nature`s role is significant, as it cannot be controlled by man. Dense population residing at low lying segments of Ho Chi Minh City add to the misery introduced by the nature, especially changes in rainfall pattern and magnitude of tides over the years. The city's drainage system, including sewers and canals, is obscured and degraded; so in areas where drainage systems have been upgraded, flooding is reduced.

There is a difference in people's understanding of the causes of flooding, the impact of flooding and the sense of environmental protection as well as flood risk management among the residents in the area that has been flooded. Timely introduction of technically superior strategy in lessening the flood impact can resolve many problems , including health, hygiene, transportation and security. Since these basic needs are essential to make Ho Chi Minh city, a world renowned city from various aspects, efforts are to be made on war footing to plan and execute flooding control.

Propaganda solutions in various forms to the people are effective to raise people's awareness and understanding in environmental protection in general and drainage system in particular to contribute to flood risk management.

In addition to technological solutions, community awareness, solutions for management and sanctioning are also necessary. This is recommended to enhance quality of all the residents.

Further research should investigate how, and under what conditions, participatory and collaborative governance contributes to the success of effective and legitimate efforts to confront flood hazards, reduce exposure and vulnerability of communities, and thereby foster sustainable flood risk management.

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COMPETING INTERESTS

no competing interests exist

AUTHORS' CONTRIBUTIONS

Author 1 and 2 discussed and designed the study, organized the data collection, carrying survey; author 1 processed data analysis and author 2 processed diagrams and Figures; All authors read and approved the final manuscript."

CONSENT (WHERE EVER APPLICABLE)

"All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal."

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

DEFINITIONS, ACRONYMS, ABBREVIATIONS

HCMC: Ho Chi Minh City

APPENDIX