



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

Pham Thi Anh^{1*} and Nguyen Thi Bao Ngoc¹

¹*Institute for Environmental and Transport Studies, Ho Chi Minh City University of Transport, Vietnam.*

Authors' contributions

This work was carried out in collaboration between both authors. Authors PTA and NTBN discussed and designed the study organized the data collection, carrying survey. Author PTA processed data analysis. Author NTBN processed diagrams and figures. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/SAJSSE/2019/v4i430133

Editor(s):

(1) Dr. Silviu Stanciu, Professor, Department of Technology Transfer and Training, "Dunarea de Jos" University of Galati, Romania.

(2) Dr. Velan Kunjuraman, Lecturer, Faculty of Hospitality, Tourism and Wellness, University Malaysia Kelantan (UMK), Kelantan, Malaysia.

Reviewers:

(1) Dr. P. R. Reddy, CSIR-NGRI, India.

(2) Dr. Shubham Pathak, Walailak University International College, Thailand.

Complete Peer review History: <http://www.sdiarticle3.com/review-history/50663>

Original Research Article

Received 29 June 2019
Accepted 02 September 2019
Published 09 September 2019

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 hindering the economic growth of the city. Despite the huge technical effort to improve the city's drainage system, which is necessitated by phenomenal growth of the city and the challenges of climate change and land subsidence, it is impossible to put an end to flooding. The human factor appears an important element in the flooding problem and the efforts of flood reduction. In this study the emphasis was laid on the issue of inappropriate garbage disposal which leads to obstruction of drainage systems. As a part of a well-planned strategy an interactive survey was conducted in about 820 households in flooding areas. The survey focused on awareness and behavior of public garbage disposal of households living in flooded areas. People have an understanding of the

*Corresponding author: Email: phamthianh@hcmutrans.edu.vn;

causes of flooding, and have a sense of environmental protection, they can contribute to reducing flooding. In addition to technological solutions, community awareness, solutions for management and sanctioning are necessary.

Keywords: Urban flooding; flood risk; public participatory role; public awareness.

ABBREVIATIONS

HCMC : Ho Chi Minh City.

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 the United Kingdom [1,2,3]. In the United States, 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]. In Asia floods occurred especially in cities in Indonesia, Philippines, Vietnam and Thailand [5,6].

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

Most of these floods originate from waterway systems like canal catchments and riverine or coastal areas [7]. A number of urban floods are combined with the inadequate capacity of the drainage system; changing in land use may reduce infiltration and increase the floods. The dense population settlements in risked areas also increase the frequency of floods.

Ho Chi Minh City, our study area, is situated close to sea level and 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 cities vulnerable to climate change. The possible causes include [8]:

- The city lies close to sea level, with 40% - 45% of Ho Chi Minh City's land area in the range of 0-1 m above sea level, 15% -20% in about 1-2 m, and very little area at altitudes above 4m;
- 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 increases vulnerability, for example by reducing water permeability and increasing local flooding;
- Climate and sea level are in a process of rapid change. More intense storms, surges and high tides may be expected.

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 occurs due to spring tide twice a month for several days in a row. Among the main causes of flooding the habit of many citizens to dump tons of garbage to the streets or water ways, which chokes the drain water outlets. Besides, land subsidence, sea level rising and heavy rain due to climate change contribute significantly to the 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 its negative impact on economic growth, in particular the transportation [10]. The Worldbank has 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 the 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 to improve the city's transport routes and drainage system, 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 extensive network of rivers and canals and is very diverse in terms of scale and functional use. The slope of most of these canals is very small and their bottom s is filled with deposition materials so that the drainage capacity is very poor. Because of this negative factor pollutants remain in the channel and are gradually accumulating.

An important issue is the dumping of solid wastes in the streets.

The city's drainage system has more than 69,000 stormwater inlets collecting water, but nearly half of them serve as a garbage dump., when it rains, overflowing water will sweep the rubbish left in the streets into the drainage system and clog it.

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 removal 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]. As indiscriminate disposal of garbage is one of the reasons contributing to the flooding in the city, the mitigation of floods has an important behavioral aspect. The aim of this study was to assess people's awareness on flooding and behavior of leaving garbage in street, and to consider the role of the community in contributing to the city's flood risk management.

2. METHODOLOGY

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. Besides, 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. To conduct its surveys the research group chose roads with flooding characteristics associated with the sanitation situation.

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 conditions conducive for people to contribute their ideas, without any restrictions. The survey included, especially the issues related to management, technology and public information campaigns 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 flooded roads due to rain and tide, of which 19 roads have been reconstructed in 2016 – 2017. 27 roads are expected to be reconstructed during 2018-2020 and 3 roads after 2020 [14].

For its interactive survey with the community the research team has selected 21/49 regularly flooded roads in 11/12 urban districts. The surveys involved 820 respondents and were conducted from June 23 to August 25, 2018. Out of the 21 roads selected, 8 had been reconstructed and 13 were not yet improved and would be reconstructed in the future. The number of respondents living near reconstructed roads was 323. Among the 820 respondents, 56% were male and 44% were female.

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 per event has increased very much from 51mm in 2010 to 112mm in 2016. Accordingly, the number of flooding events decreases with time but they have a bigger impact [14].

In response to flooding challenges, a number of structural measures have been implemented and more have to be executed yet. The city has started several projects that focus on resolving flooding by the tide 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 drainage and storm sewer lines large projects have been approved under 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, the HCMC Steering Center of Urban Flooding Control in coordination with the People's Committees of the districts implement 64 projects to renovate and upgrade alleys and feeder roads. In 2017, 4 wastewater treatment stations were put into operation with total capacity of around 38,700 m³/day [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 rain events or high tides caused flooding in many areas of Ho Chi Minh City.

3.2 Results of the Survey on Public Perception on Flooding Risk Management

3.2.1 Public's perception

Regarding the time respondents had lived 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 the surveyed people resided for less than 1 year.

Regarding the situation in the surveyed area, only 23% of people living in the area are not often flooded; 77% of the remaining respondents 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 a poor sewer system, and the water was not drained. As compared to 5 years ago, 39% of surveyed people living in flooded areas (77%) 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 which means is worsening. The last category has not given clear information about the flooding frequency.

Table 1. Flooding events in HCMC in the rainy season in 2018 (courtesy: HCMC steering center of urban flooding control)

No	Recorded rains/tides	Number of flooding points	Rainfall measured at stations (mm)	Flooding depth (m)	Tide level (m)	Flooding duration (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	0.15 - 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

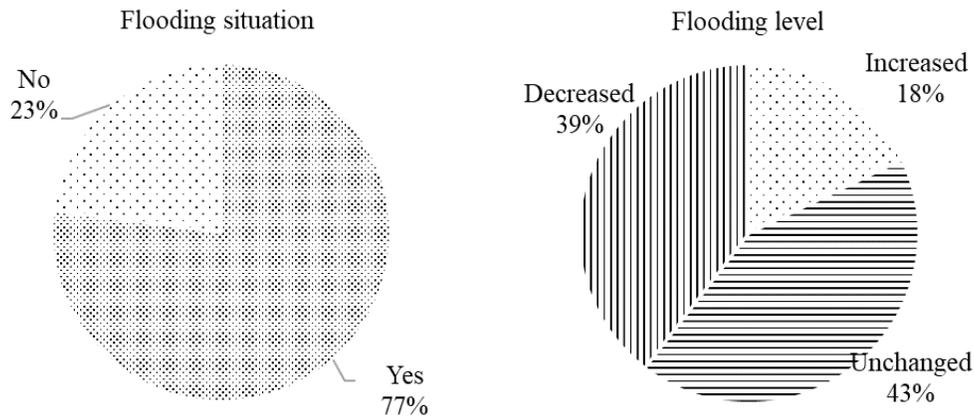


Fig. 1. Opinions of surveyed residents on flooding situation in HCMC

Residents in the impacted area of HCMC are 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.

As per available records, many flooded roads have been reconstructed in recent years for lessening the impact of flooding using better technology. For other roads reconstruction is being planned. Problems are multi-fold where old and poorly laid roads are in use, especially in low-lying areas. Respondents along both types of roads were asked about their experiences. Along roads that had been reconstructed 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 worsening (Fig. 2).

Flooding situation at roads that were not yet reconstructed respondents expressed the following views. They 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. As compared to the situation 5 years ago, 49% said that the flooding situation was the same and unchanged, 25% of the respondents said that the flooding situation was increasing and the remaining 26% of respondents expressed that flooding decreased (Fig. 3).

The above results show that in the perception of the respondents the reconstruction of the roads has produced a significant improvement in terms

of less flooding or less flooding depth. However, even along the roads that were not yet reconstructed there was about one quarter of the respondents (26%) that found that the situation had improved. On the other hand even along the reconstructed roads there is a small part of the respondents that says that their situation has worsened (7%). Probably these respondents referred more to the general flooding situation in the city than to the situation in their own dwelling area.

With regard to the 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 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.

Though several other factors may influence people's health along the roads the data indicate that flooding of roads is seen by many (50%) as a factor that impacts their health. This could mean that not improving the flooding situation would lead to increase and serious dissatisfaction among a significant part of the citizens as health is a crucial factor in the perception of well-being.

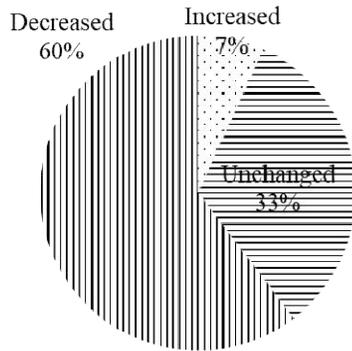


Fig. 2. Flooding situation at reconstructed roads

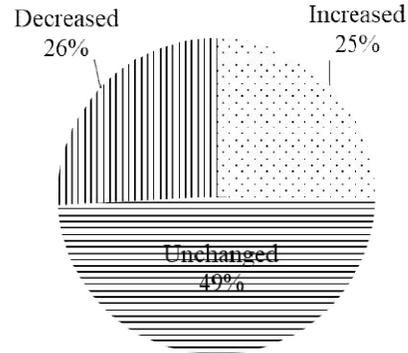


Fig. 3. Flooding situation at roads that are not yet reconstructed

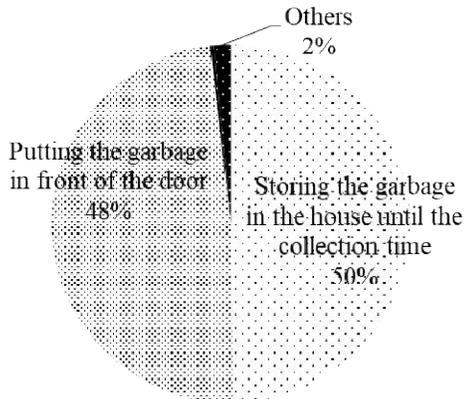


Fig. 4. Behavior of residents along the roads that have been reconstructed

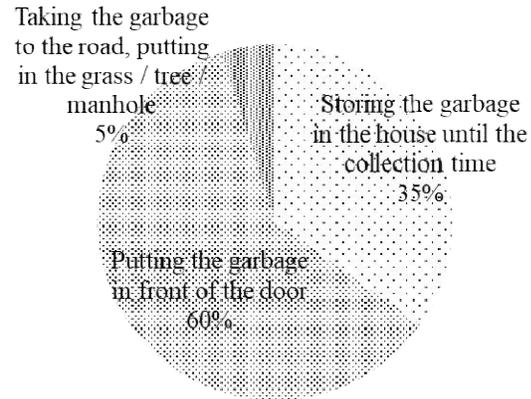


Fig. 5. Behaviors of residents along roads that are not yet reconstructed

According to the surveyed participants, the increasing flooding has seriously affected the lives and activities of families, especially difficulty in travelling. Compared to the study from Worldbank in 2014 (11) that we had mentioned above, most impacts of floodings to the residents are also on health, works, and transportation; although the percentage of respondents on these impacts are lower in this survey with improved flooding situation comparing to 2014.

Regarding domestic solid waste collection, 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. With respect to the deliverance of garbage for collection, 55% of the respondents choose to take the waste out of the house before the

collection time, 41% of the surveyed store it in the house and give it at collection time to the garbage collectors to take it out for disposal, 4% of the surveyed take their garbage to the front of their house, put it in the grass / tree / storm sewer inlet or bring it to the garbage collection place.

Along reconstructed roads, 48% of the surveyed choose to take the waste to the street irrespective of the garbage collection time, 50% of the surveyed store in the house until the collection time and then hand it over to the garbage collectors (Fig. 4). Particularly along the roads that still have to, be reconstructed to solve flooding, 60% of the surveyed choose to put the waste at any time in the street, 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 and put it in the grass / tree / storm sewer inlets (Fig. 5).

Regarding questions whether people were familiar with the local cleaning up program of the city only 34% of survey respondents answered that they knew of this program. This local cleaning up means often: scraping walls, cleaning neighborhoods, sorting garbage, collecting bottles, spraying flies and mosquitoes, distributing leaflets for public information and participating in the green summer campaign.

In the case that the neighborhood does not participate in this official cleaning up, 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. In the central districts, the study found that the participation in this local cleaning up program (42%) is higher than in the urban districts surveyed (33%).

Regarding the current status of garbage disposal at the storm sewer inlets, 53% of respondents often see residents involved in this activity (Fig. 6) In particular, passersby are most often seen disposing garbage (43%), followed by the local people (37%). The local traders account for 17% and 3% are street vendors (Fig. 7).

3.2.2 From awareness to actions

When asked about the situation when they are outside of the house and they see any garbage,

what option will they choose? 92% of people choose to find a public trash bin to dispose of garbage, 6% would choose to take it home and put it in their own trash bin and 2% would not care or choose to dispose of garbage on the spot as littering.

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

When asked about the environmental impacts of waste disposal near the storm sewer inlets 49% of respondents living along roads that still have to be reconstructed 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)

At roads that have been reconstructed in the framework of flooding control, the same question gave the following result, 64% of people think that garbage disposal 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).

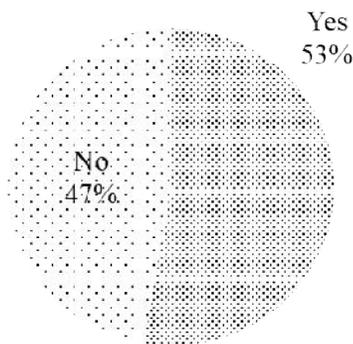


Fig. 6. Surveyors saw people leaving garbage at the stormwater inlets

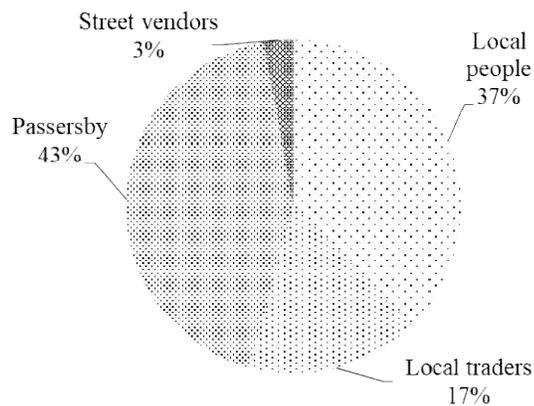


Fig. 7. Different groups disposed garbage at the stormwater inlets

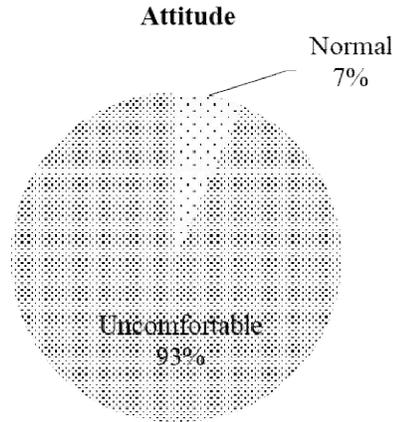


Fig. 8. Attitude of citizens when they see people throwing garbage in a stormwater inlets

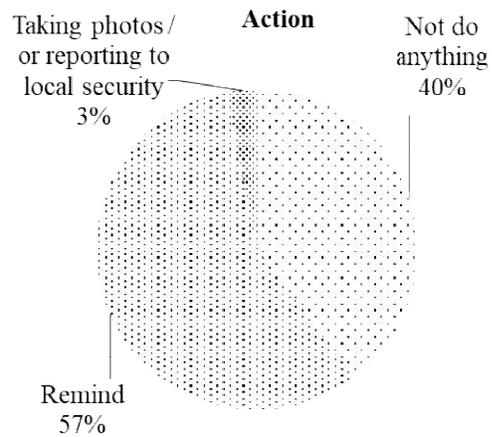


Fig. 9. Action of citizens when they see people throwing garbage in stormwater inlets

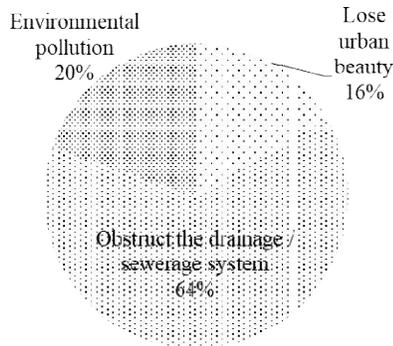


Fig. 10. Opinions of people living along the roads that have been reconstructed about impacts of waste disposal near storm-water inlets

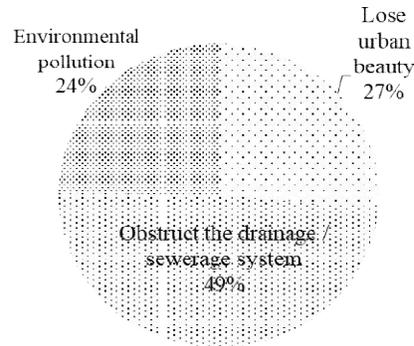


Fig. 11. Opinions of people living along roads that are not yet reconstructed about impacts of waste disposal near the storm-water inlets

For the question regarding access to sanctioning regulations for illegal garbage disposal, issued by the State, 57% of respondents said to have access to this information. 43% of respondents did not know/could not access. Among those who have access to information 6% of respondents said the information had reached them through banners, street signs, 18% of people got 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 where roads had been reconstructed to overcome flooding and in the area where such reconstruction still had to take place with respect to awareness, attitudes and participation in environmental protection and flood risk management. People in the first type of areas understand on causes and effects of the flooding. They have a sense of environmental protection, of storing garbage in the house instead of leaving it in their front door or on the street, and seem ready to remind others. These rates are higher in the unresolved area of the population. We also noted the impact of the public information campaigns on flooding.

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 in technology, management and public awareness 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, but cannot be controlled at the level of the society. Dense population residing at low lying segments of Ho Chi Minh City adds 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 degraded; so in areas where drainage systems have been upgraded, flooding is reduced. The wrong garbage disposal of the people is also important to the flooding problem.

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.

CONSENT

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.

ACKNOWLEDGEMENTS

This research was financially supported by The Steering Center of the Urban Flood Control Program of Ho Chi Minh City and Ho Chi Minh City University of Transport. We would like to thank these organizations and people for their supports in finance and data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Edelenbos J, Van Buuren A, Roth D, Winnubst M. Stakeholder initiatives in flood risk management: Exploring the role and impact of bottom-up initiatives in three 'Room for the River' projects in the Netherlands. *J. Environ. Plan. Manag.* 2017;60(1):47–66.
2. Wehn U, Rusca M, Evers J, Lanfranchi V. Participation in flood risk management and the potential of citizen observatories: A governance analysis. *Environ. Sci. Policy.* 2015;48:225–236.
3. Charalambous K, Bruggeman A, Giannakis E, Zoumides C. Improving public participation processes for the Floods directive and flood awareness: Evidence from Cyprus. *Water (Switzerland)*. 2018;10(7).

4. Ula Chrobak. Disastrous spring floods loom for half of the United States. Available:<https://www.popsoci.com/spring-flooding-forecast#>.
5. Padawangi R, Douglass M. Water, water everywhere: Toward participatory solutions to chronic urban flooding in Jakarta. *Pac. Aff.* 2015;88(3):517–550.
6. Pathak S, Ahmad MM. Flood recovery capacities of the manufacturing SMEs from floods: A case study in Pathumthani province, Thailand. *Int. J. Disaster Risk Reduct.* 2016;18:197–205.
7. Murase M, Tyagi AC, Saalmueller J, Nagata T. Organizing community participation for flood management a tool for integrated flood management. *Management. Organizing*, no. 2008;1–10.
8. ADB, Ho Chi Minh City adapts to Climate change. Philippines: Asian Development Bank; 2014.
9. Pham Thi Anh. Public awareness and participation in canal environmental protection: Case studies in Ho Chi Minh City, Vietnam. *J. Shipp. Ocean Eng.* 2017; 7(3):121–126.
10. Bangalore M, Smith A, Veldkamp T. Exposure to floods, climate change, and poverty in Vietnam. *Nat. Hazards Earth Syst. Sci. Discuss.* 2017;1–28.
11. World Bank and Australian AID. Where are we during flooding? A Qualitative Assessment of Poverty and Social Impacts of Flooding in Selected Neighborhoods of HCMC; 2014.
12. EXP. ESIA for Ho Chi Minh City Flood Risk Mngement Project; 2016.
13. DONRE. Annual report on solid waste management program in Ho Chi Minh City. Ho Chi Minh city - Vietnam; 2018.
14. TTCN. Cong Thong Tin Trung Tam Chong Ngap Tp.HCM - General News. [Online]. Available:<http://www.ttcn.hochiminhcity.gov.vn/web/english/urban-flooding-news>. [Accessed: 03-Jul-2019]
15. Wheater HS. Progress in and prospects for fluvial flood modelling. *Philos. Trans. R. Soc. A.* 2002;360:1409-1431.
16. IRGC. An introducti on to the IRGC risk governance framework. International Risk Governance Council: Lausanne; 2012.
17. WMO. Integrated flood management: Concept paper. Geneva: World Meteorological Organization; 2009.
18. Renn O. White paper on risk governance: Toward an integrative framework. In Renn O, Walker KD. (Eds.), *Global risk governance: Concept and practice using the IRGC framework*. Netherlands: Springer. 2008;3-73.
19. Challies E, Newig J, Thaler T, Kochska E. Environmental science & policy participatory and collaborative governance for sustainable flood risk management: An emerging research agenda. *Repo. Uni-Hannover. De*, no. October 2007; 2015.

© 2019 Anh and Ngoc; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle3.com/review-history/50663>