

1 **Original Research Article**

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3 **Public Participatory Role in Urban Flood Risk**
4 **Management of Ho Chi Minh City - Vietnam:**
5 **From Awareness to Action**
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10 **ABSTRACT**
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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 and 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 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.

12
13 *Keywords: urban flooding, flood risk, Public participatory role, public awareness*
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15
16 **1. INTRODUCTION**
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18 Urban flooding has become a regular phenomenon in many towns and cities in the world
19 over the past years. In Europe, flood risk has been experienced in cities of the Netherlands,
20 Italy and the United Kingdom [1][2][3]. In the United States, in recent times, the worst flood
21 risk is clustered around the Central and Southern U.S. along the Missouri and Mississippi
22 rivers. Some of the hardest-hit states include the Dakotas, Nebraska, Minnesota, Wisconsin,
23 Iowa, Illinois, and Missouri [4]. In Asia floods occurred especially in cities in Indonesia,
24 Philippines, Vietnam and Thailand[5][6].

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

28 Most of these floods originate from waterway systems like canal catchments and riverine or
29 coastal areas[7]. A number of urban floods are combined with the inadequate capacity of the

30 drainage system; changing in land use may reduce infiltration and increase the floods. The
31 dense population settlements in risked areas also increase the frequency of floods.

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

- 35 • The city lies close to sea level, with 40% - 45% of Ho Chi Minh City's land area in
36 the range of 0-1m above sea level, 15% -20% in about 1-2m, and very little area at
37 altitudes above 4m;
- 38 • The population in the city is very large and constantly increasing as the city has a
39 dynamic economy that attracts immigrants throughout the country;
- 40 • Local urban development increases vulnerability, for example by reducing water
41 permeability and increasing local flooding;
- 42 • Climate and sea level are in a process of rapid change. More intense storms, surges
43 and high tides may be expected.

44 During the rainy season from May to November and during flood-tide between September
45 and December, residents are confronted with flooding in the low-lying areas. In the central
46 districts, even during non-monsoon season, flooding occurs due to spring tide twice a month
47 for several days in a row. Among the main causes of flooding the habit of many citizens to
48 dump tons of garbage to the streets or water ways, which chokes the drain water outlets.
49 Besides, land subsidence, sea level rising and heavy rain due to climate change contribute
50 significantly to the already existing difficult situation[9].

51 Flooding in urban areas in Ho Chi Minh City poses serious challenges not only by affecting
52 large numbers of people and properties but also its negative impact on economic growth, in
53 particular the transportation. [10]. The Worldbank has mentioned the impacts of flooding on
54 individuals and households as follows: 67.5% of households believe that health is affected,
55 58% think that work is affected, 50.0% of workers are unable to attend to respective works
56 during floods due to transportation difficulties ; 43.6% of freelance workers suffer from
57 income losses[11].

58 Several organizations, in recent years, have supported the Ho Chi Minh City government to
59 construct and operate facilities relating to drainage, flood control and pollutants removal.
60 Some typical projects are effectively operating, including irrigation facilities along Sai Gon
61 River (AFD), Vietnam—HCMC environmental sanitation (Nhieu Loc-Thi Nghe Basin) , Tan
62 Hoa—Lo Gom Basin, urban development project (WB), improving the quality of the water in
63 the Tau Hu-Ben Nghe-Doi Te Canal (JICA), integrated flood risk management approach for
64 HCMC, under support of the World Bank. Integrated flood risk management was established
65 to continually improve drainage systems, flood control and environmental sanitation for the
66 city, where a focal point will be a catchment of Tham Luong-Ben Cat-Nuoc Len Canal [12]. In
67 spite of concerted technical effort to improve the city's transport routes and drainage system,
68 floods are still severe in many low lying segments of the city.

69 Located in the downstream area of Dong Nai river system, Ho Chi Minh City has quite a
70 extensive network of rivers and canals and is very diverse in terms of scale and functional
71 use. The slope of most of these canals is very small and their bottom s is filled with
72 deposition materials so that the drainage capacity is very poor. . Because of this negative
73 factor pollutants remain in the channel and are gradually accumulating.

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

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

78 According to data from the Department of Natural Resources and Environment in Ho Chi
79 Minh City, every year, the city spends tens of billions of dong (Vietnam currency) on garbage
80 and water hyacinth removal projects along canal basins. In 2018, the city used about 6.3
81 billion VND to collect garbage along Nhieu Loc - Thi Nghe canal, 1.1 billion VND for Tan Hoa
82 - Lo Gom canal and 14.4 billion VND for Tau Hu - Ben Nghe - Đoi Te canal with a volume of
83 about 31 - 46 tons/day, peaking at about 68-85 tons/day [13]. As indiscriminate disposal of
84 garbage is one of the reasons contributing to the flooding in the city, the mitigation of floods
85 has an important behavioral aspect. The aim of this study was to assess people's awareness
86 on flooding and behavior of leaving garbage in street, and to consider the role of the
87 community in contributing to the city's flood risk management.

88

89 2. METHODOLOGY

90

91 This study involves several steps.

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

98 As a second step, the research team made an actual survey of the characteristics of the
99 roads, the situation of littering in public places, the operation status of the drainage system.
100 To conduct its surveys the research group chose roads with flooding characteristics
101 associated with the sanitation situation.

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

107 According to the data that had been provided by HCMC Steering Center of Urban Flooding
108 Control, Ho Chi Minh City has 49 flooded roads due to rain and tide, of which 19 roads have
109 been reconstructed in 2016 – 2017. 27 roads are expected to be reconstructed during 2018-
110 2020 and 3 roads after 2020[14].

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

117

118 3. RESULTS AND DISCUSSION

119

120 3.1 Situation of flooding in Ho Chi Minh City

121

122 Ho Chi Minh City is prone to face , on a regular basis, the huge risk of flooding, from normal
123 climate events and extreme climate events such as thunderstorms and tropical storms[8].
124 The number of rainy spells has shown a decreasing trend from 2010 to 2016, namely, from
125 214 down to 51. But, the average rainfall per event has increased very much from 51mm in

126 2010 to 112mm in 2016. Accordingly, the number of flooding events decreases with time but
 127 they have a bigger impact. [14].

128 In response to flooding challenges, a number of structural measures have been
 129 implemented and more have to be executed yet. The city has started several projects that
 130 focus on resolving flooding by the tide such as construction of tidal control gates, dikes along
 131 the river and drainage systems in vulnerable locations.

132 To prioritize investment in construction and renovation of drainage and storm sewer lines
 133 large projects have been approved under the overall drainage planning Various types of 37
 134 sewer systems with a total length of 104.2 km have been completed and put into operation.
 135 69.4 km of rivers and 211 lines of canals have been dredged, enhancing the drainage
 136 capacity of the system. Besides, a number of projects to improve axial canals are in the
 137 preparation phase of investment.

138 In addition, the HCMC Steering Center of Urban Flooding Control in coordination with the
 139 People's Committees of the districts implement 64 projects to renovate and upgrade alleys
 140 and feeder roads. In 2017, 4 wastewater treatment stations were put into operation with total
 141 capacity of around 38,700 m3/day. [14].

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

145 **Table 1. Flooding events in HCMC in the rainy season in 2018 (Courtesy: HCMC**
 146 **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

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148 3.2. Results of the survey on public perception on flooding risk management

149 3.2.1. Public's perception

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

153 Regarding the situation in the surveyed area, only 23% of people living in the area are not
 154 often flooded; 77% of the remaining respondents in the area have often faced flooding. They
 155 said that the time of frequent flooding often occurs when it rains (99.5%) and during high tide

156 (13.9%). Some people expressed that flooding was caused by a poor sewer system, and the
 157 water was not drained. As compared to 5 years ago, 39% of surveyed people living in
 158 flooded areas (77%) said the level of inundation decreased, 43% of surveyed people felt that
 159 the flooding situation was the same and unchanged and the remaining 18% said the flooding
 160 situation is increasing which means is worsening. The last category has not given clear
 161 information about the flooding frequency.

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

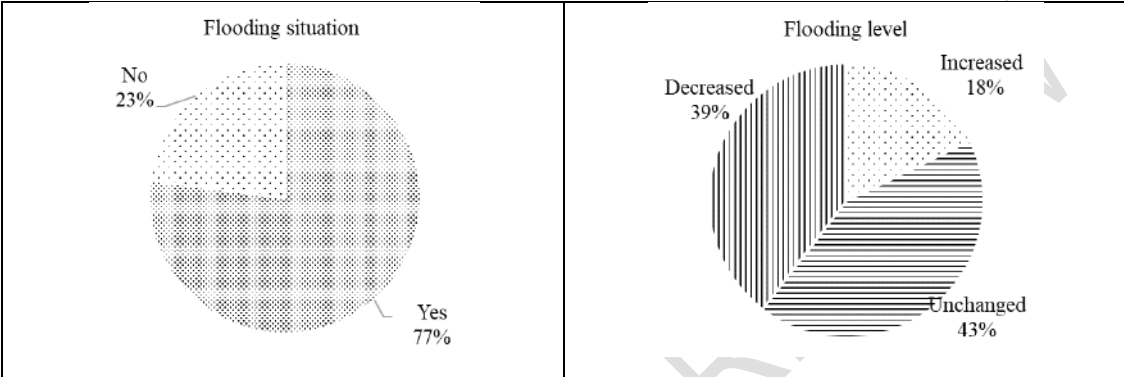


Fig.1. Opinions of surveyed residents on flooding situation in HCMC

165
 166 As per available records, many flooded roads have been reconstructed in recent years for
 167 lessening the impact of flooding using better technology. For other roads reconstruction is
 168 being planned. Problems are multi-fold where old and poorly laid roads are in use, especially
 169 in low-lying areas. Respondents along both types of roads were asked about their
 170 experiences. Along roads that had been reconstructed respondents expressed the following
 171 views. 60% of people said the level of inundation decreased, 33% said that the flooding
 172 situation was the same, unchanged and the remaining 7% said that the flooding situation
 173 was worsening (Fig-2).

174 Flooding situation at roads that were not yet reconstructed respondents expressed the
 175 following views. They said that they are living in flooded areas, due to socio-economic
 176 limitations, even though they are aware that the residing area is flooded mainly due to rains.
 177 As compared to the situation 5 years ago, 49% said that the flooding situation was the same
 178 and unchanged, 25% of the respondents said that the flooding situation was increasing and
 179 the remaining 26% of respondents expressed that flooding decreased (Fig-3).

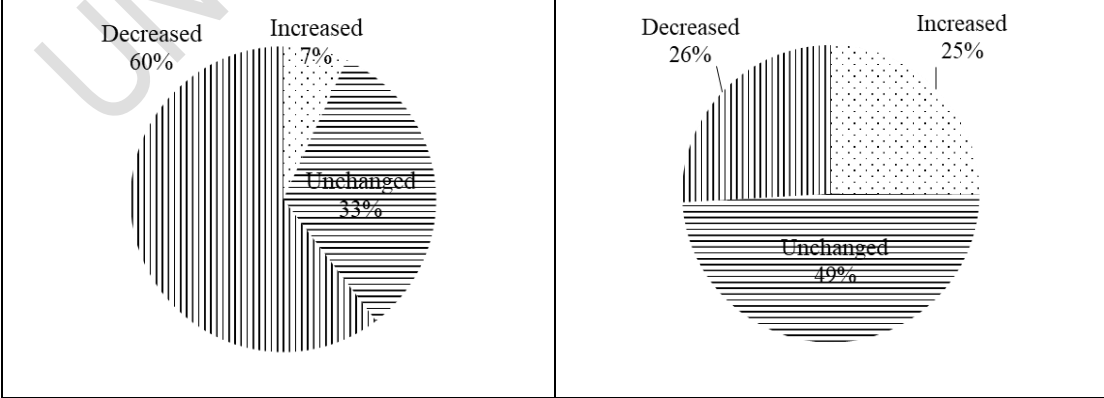


Fig.2 Flooding situation at reconstructed roads

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

180

181 The above results show that in the perception of the respondents the reconstruction of the
182 roads has produced a significant improvement in terms of less flooding or less flooding
183 depth. However, even along the roads that were not yet reconstructed there was about one
184 quarter of the respondents (26%) that found that the situation had improved. On the other
185 hand even along the reconstructed roads there is a small part of the respondents that says
186 that their situation has worsened (7%). Probably these respondents referred more to the
187 general flooding situation in the city than to the situation in their own dwelling area.

188 *With regard to the influence of flooding on the health of the family*, 50% of surveyed people
189 think that it is not affected, 28% of people think that flooding affects the health of the family
190 but is not serious, 21% of people rate the impact as serious and only 1% of the remaining
191 assesses the level of influence is very serious.

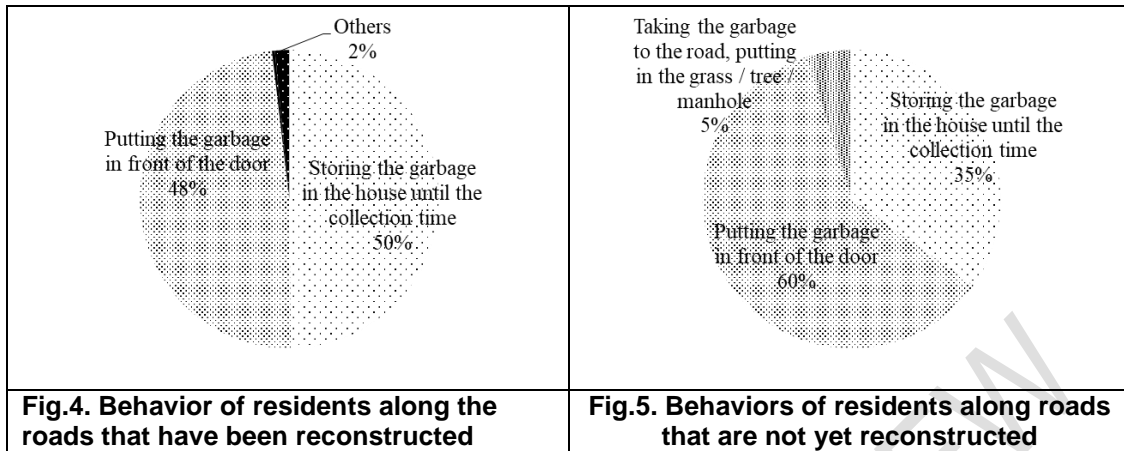
192 In the past year, 25% of families had health problems, of which 56% of people suffer from
193 skin diseases, 29% of people with respiratory problems, 10% of people with dengue fever,
194 4% number of people suffering from digestive issues and 1% suffer from other diseases.

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

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

206 Regarding **domestic solid waste collection**, 99% of respondents said that household waste is
207 collected at home by local public/private service, 1% of the remaining people bring garbage
208 to garbage collection or self-treatment places for burial. **With respect to the deliverance of**
209 **garbage for collection**, 55% of the respondents choose to take the waste out of the house
210 **before the collection time**, 41% of the surveyed store it in the house and give **it at collection**
211 **time** to the garbage collectors to take it out for disposal, 4% of the surveyed **take** their
212 garbage to the front **of their house**, put it in the grass / tree / **storm sewer inlet** or **bring** it
213 to the garbage collection place.

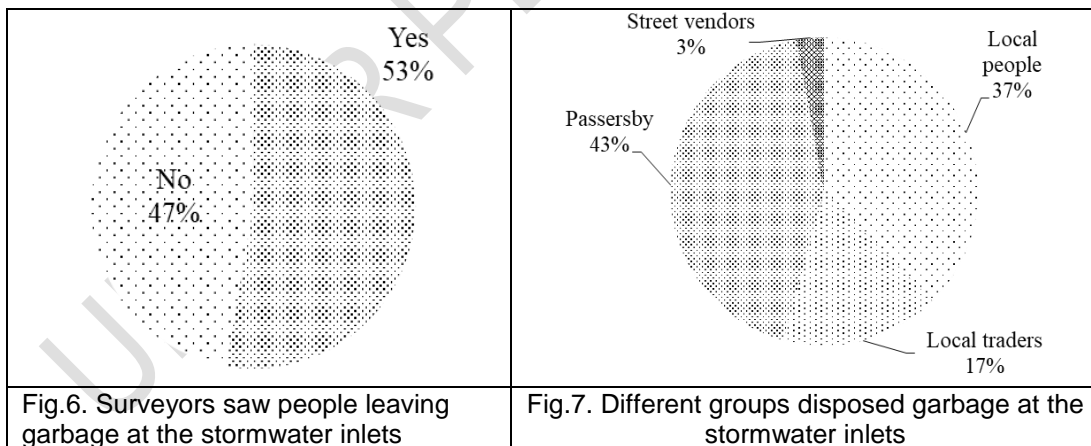
214 Along **reconstructed** roads, 48% of the surveyed choose to **take** the waste **to the street**
215 **irrespective of the** garbage collection time, 50% of the surveyed store in the house until the
216 collection time and then hand **it** over to the garbage collectors (fig-4). Particularly along the
217 roads that **still have to,be reconstructed** to solve flooding, 60% of the surveyed choose to put
218 the waste **at any time in the street**, 35% of the surveyed will store in the house and hand
219 over to the garbage collectors at the collection time for disposal and 5% of the people
220 choose to take the garbage to the street front and put it in the grass / tree / **storm sewer**
221 **inlets (fig 5).**



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

227 In the case that the neighborhood does not participate in this official cleaning up, people will
 228 keep the general hygiene, dispose of garbage at the prescribed place or clean up
 229 themselves to maintain environmental hygiene in the living area. In the central districts, the
 230 study found that the participation in this local cleaning up program (42%) is higher than in the
 231 urban districts surveyed (33%).

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

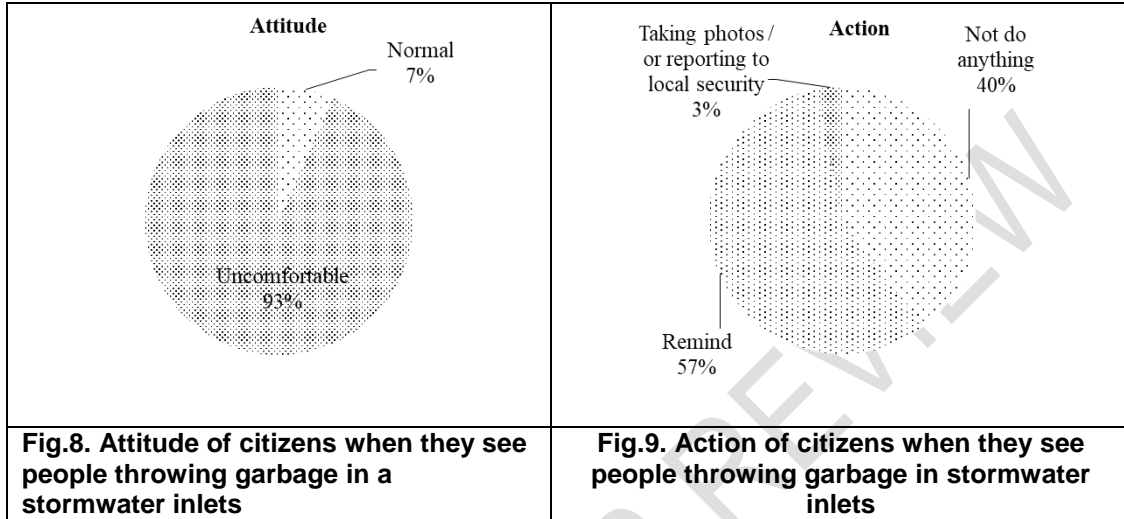


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237 **3.2.2. From awareness to actions**

238 When asked about the situation when they are outside of the house and they see any
 239 garbage, what option will they choose? 92% of people choose to find a public trash bin to
 240 dispose of garbage, 6% would choose to take it home and put it in their own trash bin and
 241 2% would not care or choose to dispose of garbage on the spot as littering.

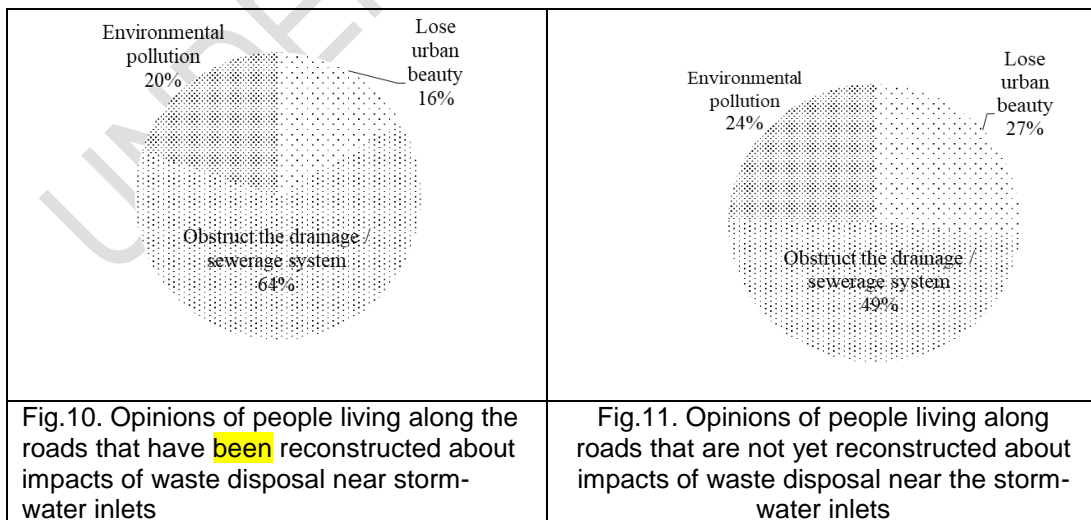
242 Regarding the attitude of citizens when they see people throwing garbage in a storm sewer
 243 inlet, 93% of the respondents said that they would feel uncomfortable and only 7% of the
 244 rest (mostly men) found it normal (Fig-8). In order to prevent littering, 57% of respondents
 245 would choose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



248 When asked about the environmental impacts of waste disposal near the storm sewer inlets
 249 49% of respondents living along roads that still have to be reconstructed said that it would
 250 obstruct the drainage / sewerage system, 27% expressed that urban beauty is lost and 24%
 251 people think that it will cause environmental pollution(Fig-11)

252 At roads that have been reconstructed in the framework of flooding control, the same
 253 question gave the following result, 64% of people think that garbage disposal will block the
 254 drainage system, 16% of those choose "losing Urban beauty", 20% of people think that it
 255 will cause environmental pollution. People consider the importance of drainage systems
 256 (Fig-10).

257



258 For the question regarding access to sanctioning regulations for illegal garbage disposal,
259 issued by the State, 57% of respondents **said to** have access to this information. 43% of
260 respondents did not know/could not access. Among those who have access to information
261 6% of respondents **said the information had reached them** through banners, street signs,
262 18% of people **got** access via local channels (message boards, leaflets, meetings, etc.), 36%
263 via television, radio and 40% are self-learn/see online/listen to others. 61% of the surveyed
264 respondents in the inner districts of the city responded that they had access to sanctions
265 regulations for illegal dumping, which was higher than respondents in other districts.

266 There are differences in the surveyed groups in the area **where roads had been**
267 **reconstructed to overcome flooding** and in the area **where such reconstruction still had to**
268 **take place with respect to** awareness, attitudes and participation in environmental protection
269 and flood risk management. People in the **first type of areas** understand on causes and
270 effects of the flooding. They have a sense of environmental protection, **of** storing garbage in
271 the house instead of leaving it in their front door or on the street, and **seem** ready to remind
272 others. These rates are higher in the unresolved area of the population. We also noted the
273 impact of the **public information campaigns** on flooding

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

285

286 **4. CONCLUSION**

287

288 The flooding problem in Ho Chi Minh City is complicated by many reasons, **but cannot be**
289 **controlled at the level of the society**. Dense population residing at low lying segments of Ho
290 Chi Minh City adds to the misery introduced by the nature, especially changes in rainfall
291 pattern and magnitude of tides over the years. The city's drainage system, including sewers
292 and canals, is degraded; so in areas where drainage systems have been upgraded, flooding
293 is reduced. **The wrong garbage disposal of the people is also important to the flooding**
294 **problem.**

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

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

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

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

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364

365 **COMPETING INTERESTS**

366
367 no competing interests exist
368

369 **AUTHORS’ CONTRIBUTIONS**

370
371 Author 1 and 2 discussed and designed the study, organized the data collection, carrying
372 survey; author 1 processed data analysis and author 2 processed diagrams and Figures; All
373 authors read and approved the final manuscript.”
374

375 **CONSENT (WHERE EVER APPLICABLE)**

376
377 “All authors declare that ‘written informed consent was obtained from the patient (or other
378 approved parties) for publication of this case report and accompanying images. A copy of
379 the written consent is available for review by the Editorial office/Chief Editor/Editorial Board
380 members of this journal.”
381

382 **ETHICAL APPROVAL (WHERE EVER APPLICABLE)**

383
384
385
386 NA
387

388 **DEFINITIONS, ACRONYMS, ABBREVIATIONS**

389
390
391 HCMC: Ho Chi Minh City
392

393 **APPENDIX**