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3 **Public Participatory on Urban Flood Risk**

4 **Management in 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 affecting economic growth of the city. With the technical effort for the city's drainage system, it is impossible to solve all the causes of the flooding; human factor is also an important link in the flooding problem and the contribution of flood reduction to the city. The study had observations and follows the reports on flooding situation from Ho Chi Minh City Steering Center of Urban Flooding Control in the rainy season (from May to November 2018); together the survey was conducted with about 820 households in flooding areas. It focused on awareness and behavior of public garbage disposal of households living in flooded areas. The survey has open content to create conditions for people to contribute their ideas. Especially the issues related to management, technology and propaganda to solve the city's flooding problems. The study had 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.

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13 *Keywords: urban flooding, flood risk, Public participatory, public awareness*

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16 **1. INTRODUCTION**

17

18 Urban flooding has become a regular phenomenon in many towns and cities in the world

19 over the past years. In European, flood risk happened in cities of the Netherlands, Italian,

20 United Kingdom [1][2][3]. In United State, the worst flood risk is clustered around the Central

21 and Southern U.S., along the Missouri and Mississippi rivers recently. Some of the hardest -

22 hit states include the Dakotas, Nebraska, Minnesota, Wisconsin, Iowa, Illinois, and Missouri

23 [4]. Specialy, flood occured in many asia cities in Indonesia, Thailand, Phillipin,

24 Vietnam...[5]

25 Urban floods cause inundation of streets, basements, ground level floors of buildings etc. in

26 urban areas. Flooding affects many aspects of society such as public health, economy,

27 transportation and the environment.

28 Most of these floods are originated from waterway system like cannal catchment, riverine or
29 coastal area[6], but a number of urban floods also are combined with the inadequate
30 capacity of the drainage system; changing in land use may that cause less filtration and
31 increase in urban floods; The population settlement in a risked area also increases the
32 frequency of floods.

33 Ho Chi Minh City is identified as one of the vulnerable cities to climate change, the possible
34 causes include[7]:

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

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 and also in the
46 central districts at spring tide twice a month for several days in a row and twice daily. The
47 main causes of flooding are high tide, heavy rain and combination with strong urbanization.
48 Beside, Land subsidence, increase of sea level rise and heavy rain due to climate change
49 contribute to an even more difficult situation[8].

50 Flooding in urban areas in Ho Chi Minh City poses serious challenges not only by affecting
51 large numbers of people and properties in urban areas but also directly affecting economic
52 growth. of the city[9]. Worldbank had mentioned the impacts of flooding on individuals and
53 households as follows: 67.5% of households believe that health is affected, 58% think that
54 work is affected, 50.0% of workers are discontinuity; 43.6% of freelance workers suffer from
55 income losses[10].

56 Several organizations, in recent years, have supported Ho Chi Minh City government to
57 construct and operate facilities relating to drainage, flood control and pollutants removal.
58 Some typical projects are effectively operating, including irrigation facilities along Sai Gon
59 River (AFD), Vietnam—HCMC environmental sanitation (Nhieu Loc-Thi Nghe Basin) , Tan
60 Hoa—Lo Gom Basin, urban development project (WB), and improving the quality of the
61 water in the Tau Hu-Ben Nghe-Doi Te Canal (JICA), and Integrated flood risk management
62 approach for HCMC, under support of the World Bank, was established to continually
63 improve drainage systems, flood control and environmental sanitation for the city, where a
64 focal point will be a catchment of Tham Luong-Ben Cat-Nuoc Len Canal [11].

65 However, with the technical effort for the city's drainage system, it is impossible to solve all
66 the causes of the flooding; from natural factors such as rising tide levels over the years
67 related to sea level rise, abnormal rainfall changes, ... to unreasonable urban planning,
68 crowded and destructive population, concentration works of waste water drainage, littering,
69 clogging drainage systems and canals,... Floods although had some improved in some area
70 but they are still severed in many other places of the city.

71 Located in the downstream area of Dong Nai river system, Ho Chi Minh City has quite a
72 network of rivers and canals and is very diverse in terms of scale and functional use. Major
73 and important rivers in Ho Chi Minh City include Dong Nai River, Saigon River, Nha Be River
74 - Soai Rap River, Long Tau River and Thi Vai River and 4 main canals with a total length of
75 more than 100 km. The 4 main canals are Nhieu Loc - Thi Nghe, Tan Hoa - Lo Gom, Tau Hu
76 - ben Nghe - Kenh Doi - Kenh Te, , and Tham Luong - Ben Cat - Vam Thuat. The slope of

77 most of these canals is very small, the bottom of the canal is filled with deposition materials
78 so the drainage capacity is very poor. City canal system is strongly influenced by tides, some
79 channels are affected by many flows, it results that pollutants remain in the channel and are
80 gradually accumulating.

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

84 According to data from the Department of Natural Resources and Environment in Ho Chi
85 Minh City, every year, the city spends tens of billions of dong on garbage and water hyacinth
86 projects along canal basins. Estimately in 2018, the city used about 6.3 billion VND to collect
87 garbage along Nhieu Loc - Thi Nghe canal, 1.1 billion VND for Tan Hoa - Lo Gom canal and
88 14.4 billion VND for Tau Hu - Ben Nghe - Đoi Te canal with a volume of about 31 - 46 tons /
89 day, peaking at about 68-85 tons/day [12]. Indiscriminate disposal of garbage is also one of
90 the reasons contributing to the flooding in the city.

91 Thus, human factor is also an important link in the flooding problem and the contribution of
92 flood reduction to the city. This study aims to investigate people's awareness on flooding and
93 behavior of littering in the area for flood reduction; to assess the effectiveness of the
94 previous public awareness propaganda program for households living in districts of 04 canal
95 basins (Nhieu Loc - Thi Nghe, Tau Hu - Ben Nghe) , Tan Hoa - Lo Gom, Tham Luong - Ben
96 Cat), and to consider the role of the community in contributing to the city's flood risk
97 management.

98

99 **2. MATERIAL AND METHODS**

100

101 This study involves several steps, firstly, the research team collected information on natural,
102 socio-economic conditions, information on flooded roads, characteristics of flooding in the
103 period of 2017 - 2018, and on the basis of information of specialized units on flood
104 management. Beside, we also keep observations and follows the reports on flooding
105 situation from HCMC Steering Center of Urban Flooding Control in the rainy season (from
106 May to November 2018).

107 Second, the research team made an actual survey of the characteristics of the roads, the
108 situation of littering in public places, the operation status of the drainage system, the group
109 chose routes with flooding characteristics associated with the sanitation situation to conduct
110 surveys.

111 The survey focused on awareness and behavior of public garbage disposal of households
112 living in flooded areas. The survey has open content to create conditions for people to
113 contribute their ideas. Especially the issues related to management, technology and
114 propaganda to solve the city's flooding problems.

115 According to the data that had been provided by HCMC Steering Center of Urban Flooding
116 Control, Ho Chi Minh City has 49 flooding routes due to rain and tide, of which 19 routes
117 have been solved in 2016 - 2017, 27 routes are expected to be solved in the period 2018-
118 2020 and 03 routes are expected to be resolved after 2020[13].

119 Based on characteristics on causes of flooding, the expected results of flood control program
120 that have been and will be implemented, the total number of flooded roads in each district;
121 the research team had selected 21/49 routes of 11/12 urban districts to conduct survey with
122 the community. The surveys on 21 selected routes were conducted from June 23 to August
123 25, 2018 with 820 votes.

124

125 **3. RESULTS AND DISCUSSION**

126

127 **3.1 Situation of flooding in Ho Chi Minh City**

128

129 Ho Chi Minh City has a huge risk of flooding, from normal climate events and extreme
130 climate events such as thunderstorms and tropical storms[7]. The number of rains is
131 showing signs of decreasing from 2010 to 2016, 214 matches down to 51 matches, but the
132 average rainfall increases very high from 51mm match in 2010 to 112mm / match in 2016.
133 That shows the extreme weather is getting more and more intense, which is probably the
134 reason that from 52 flooding due to rain in 2010, has decreased significantly to 26 times in
135 2015[13].

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

140 To prioritize investment in construction and renovation of sewer lines under projects
141 approved by the overall drainage planning: 37 sewer system with a total length of 104.2 km
142 of various types have been completed and put into operation; 69.4 km of rivers, canals and
143 canals have been dredged (211 lines), contributing to enhancing the drainage capacity of the
144 system. Besides, a number of projects to improve axial canals are in the preparation phase
145 of investment.

146 In addition, HCMC Steering Center of Urban Flooding Control coordinated with the People's
147 Committees of the districts to implement projects to renovate and upgrade alleys and feeder
148 roads with 64 projects; dredging canals in the area to ensure synchronous and clear flow of
149 91 routes.

150 In 2017, 04 wastewater treatment stations were put into operation with total capacity around
151 38700 m3/day. Through implementation, in 2016 and 2017, 15 main roads were flooded due
152 to rain were resolved; and in 2018 for other 7 flooded road were resolved[13].

153 The records from the observations and reports from HCMC Steering Center of Urban
154 Flooding Control in the rainy season in 2018, from May to November shown that there were
155 about 13 heavy rains or high tide that caused flooding in many areas of Ho Chi Minh City.

156

157 **Table 1. The records of flooding situations in HCMC in the rainy season in year 2018**

158

No	Recorded rains/tides	Number of flooding points	Rainfall at measured 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

159

160 3.2. Results of the survey on public perception on flooding risk management

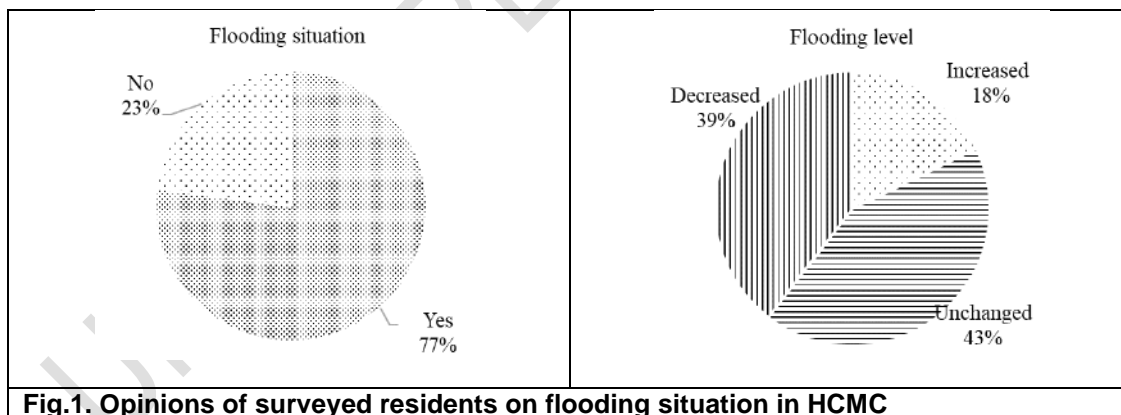
161 3.2.1. Public's perception

162 Via observations from HCMC Steering Center of Urban Flooding Control in recent years, Ho
 163 Chi Minh City has 49 flooding routes due to rain and tide. The research team had selected
 164 21/49 routes of 11/12 urban districts to conduct survey with the community. The surveys
 165 were conducted from June 23 to August 25, 2018 with 820 respondents. Among 820
 166 respondents, 56% were male and 44% were female.

167 Regarding the time of living in the area, more than 60% of the respondents said they had
 168 stayed in the area for more than 10 years, 30% of the people lived in the area in the period
 169 of 3 - 10 years and only 10% of surveyed people live less than 1 year.

170 Regarding the situation in the living area, only 23% of people living in the area are not
 171 flooded. 77% of the remaining respondents living in the area are often flooded, they said that
 172 the time of frequent flooding often occurs when it rains (99.5%) and during high tide (13.9%).
 173 Some people thought that flooding was caused by a poor sewer system, and the water was
 174 not drained. Compared to 5 years ago, 39% of surveyed people living in flooded areas said
 175 the level of inundation decreased, 43% of surveyed people felt that the flooding situation was
 176 the same, unchanged and other 18% said the flooding situation is increasing but not given
 177 clearly about the flooding frequency.

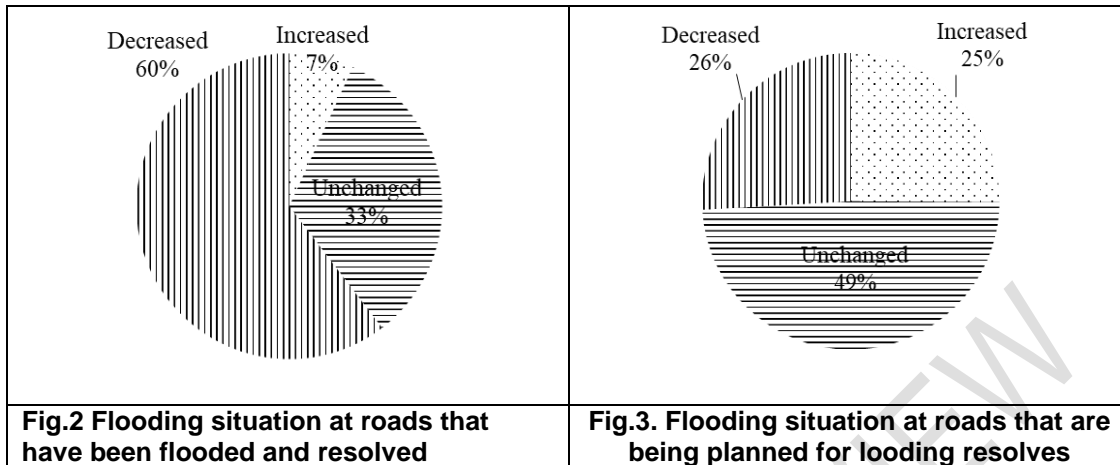
178 Thus, households living in the impacted area of HCMC are local residents. These residents
 179 have a medium and low socio-economic position, with this characteristic being vulnerable to
 180 flooding risks.



181

182 For roads that have been flooded and resolved, 73% of people said the area is still flooded,
 183 mainly due to rain (94%). Compared to 5 years ago, 60% of people said the level of
 184 inundation decreased, 33% said that the flooding situation was the same, unchanged and
 185 7% of the remain said that the flooding situation was increasing.

186 Particularly for roads that are being planned for flooding resolves, 80% of people said they
 187 are living in flooded areas, mainly due to rain (84%). Compared to the previous 5 years, 49%
 188 said that the flooding situation was the same, unchanged and 25% of the remain said that
 189 the flooding situation was increasing.



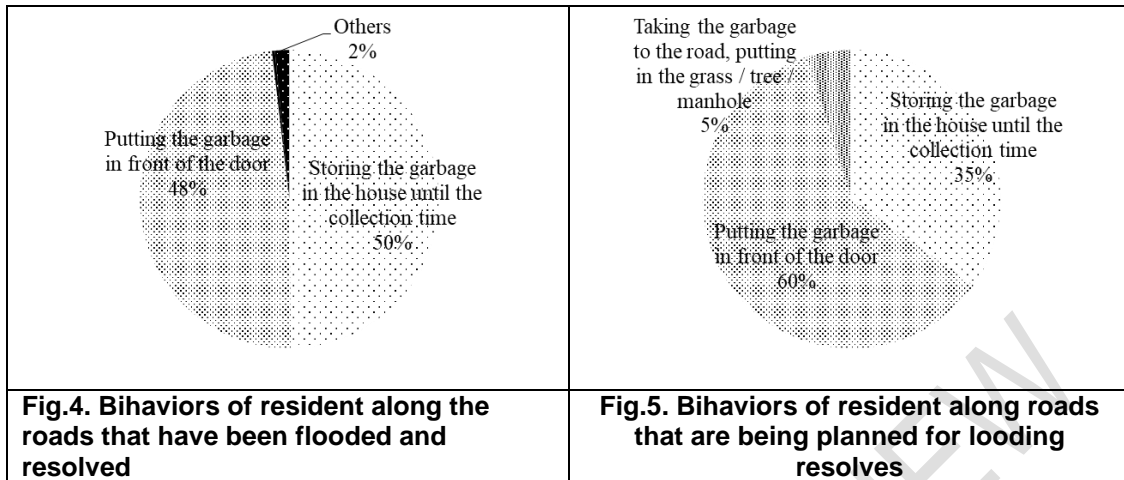
191

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

196 In the past 1 year, 25% of families had health problems, of which 56% of people suffer from
 197 skin diseases, 29% of people with respiratory problems, 10% of people with dengue fever,
 198 4% number of people suffering from digestive issues and 1% suffer from other diseases.
 199 According to the surveyed participants, the increasing flooding has seriously affected to lives
 200 and activities of families. Specifically, difficulty in traveling, time consuming for slapping,
 201 arranging furniture to avoid wet and cleaning up after sprinting, the cost of fixing fences,
 202 floors and household items...

203 Regarding to solid waste treatment, 99% of respondents said that household waste is
 204 collected at home by local public/private service, 1% of the remaining people will bring
 205 garbage to garbage collection or self-treatment places by burial, composting for fertilizer and
 206 burning, ... In case the garbage generated improperly in the collection time, 55% of the
 207 surveyors choose to take the waste out of the house beforehand, 41% of the surveyors will
 208 store it in the house until the collection time is taken out, 4% of the surveyors took their
 209 garbage to the front of the road, put it in the grass / tree / manhole or brought it to the
 210 garbage collection place.

211 Along roads that have been flooded and resolved, 48% of the surveyors choose the solution
 212 to remove the waste beforehand in case the garbage arises not in the collection time, 50% of
 213 the surveyors will store in the house until the collection time is taken out. Particularly along
 214 the roads that are being planned to solve flood, 60% of the surveyors choose to take the
 215 waste solution in advance of the house in case the garbage arises not in the collection time,
 216 35% of the surveyors will store In the house, the collection time will be taken out and 5% of
 217 the people choose to take the garbage to the street front, put it in the grass / tree / manhole.

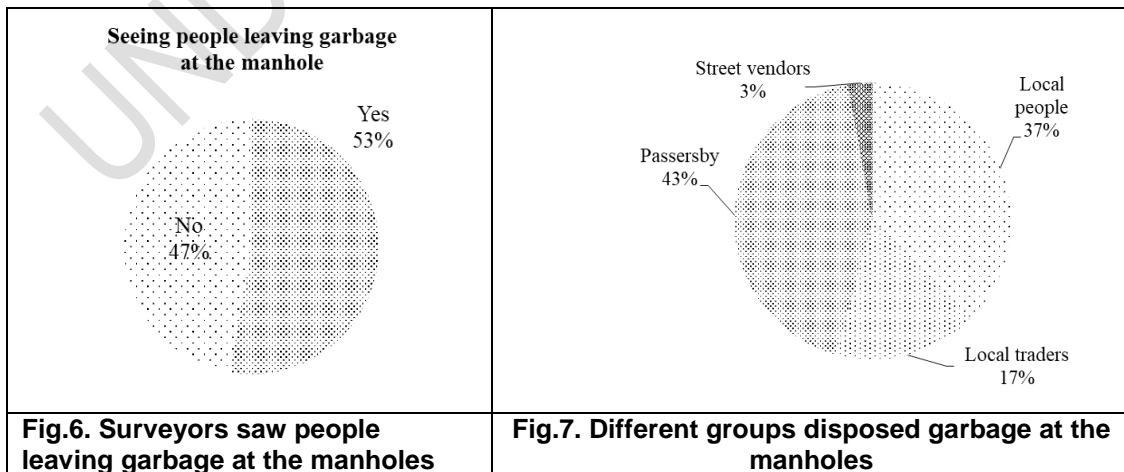


218 For the urban districts surveyed (Districts 2, 6, 7, 8, 11, Tan Binh, Go Vap, Binh Tan, Tan
 219 Phu), 58% of the surveyors chose the solution to remove rubbish in the house. In case the
 220 garbage generated improperly in the collection time, 39% of the surveyors will store it in the
 221 house until the collection time is taken out and 3% of the people who choose to take the
 222 garbage to the road front, put it in the carpet grass / stump / manhole. In the central districts
 223 (District 1 and Binh Thanh District) this ratio is 54%, 44% and 2% respectively.

224 Regarding questions related to launching the movement for people to participate in cleaning
 225 up local sanitation campaign, only 34% of survey respondents answered yes, launching
 226 movements were often: scraping walls, cleaning neighborhoods, sorting garbage, collecting
 227 bottles, spraying flies and mosquitoes, distributing leaflets propaganda and activities under
 228 the green summer campaign with the highest weekly rate of 1 week / time, the average of 3-
 229 6 months / time and the lowest of 1 time / year.

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

235 Regarding the current status of garbage disposal at the manholes, 53% of respondents often
 236 see this image. In particular, passersby are most often seen (43%), followed by the local
 237 people 37%, the local traders account for 17% and other 3% is a street vendors.



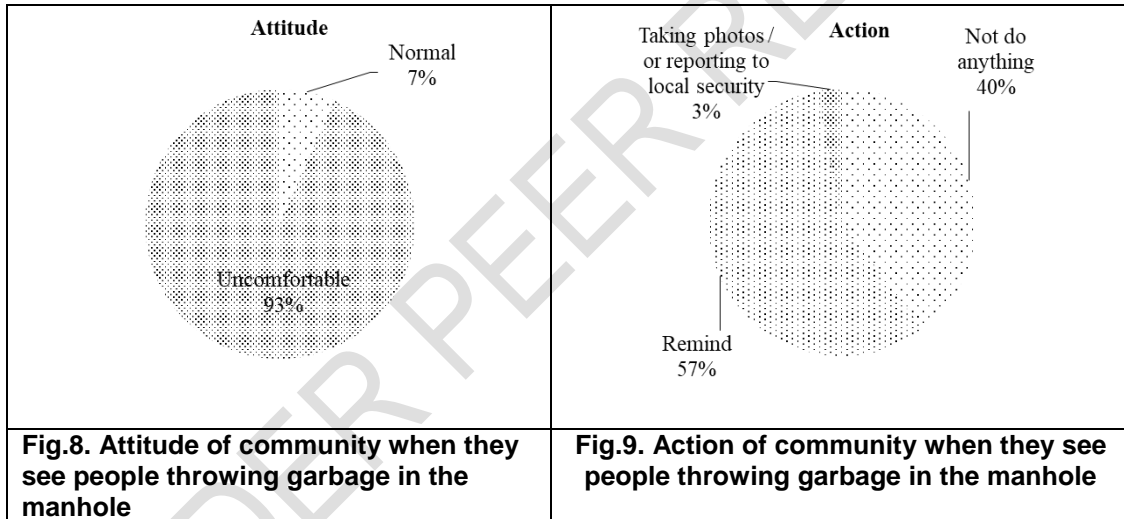
238 For roads that have been flooded and resolved, 43% of respondents often see people
 239 leaving garbage at the manhole. In particular, passersby are most often seen (34%),
 240 followed by the local people 32%, the local traders account for 30% and other 4% is a street
 241 vendors.

242 Particularly for roads that are being planned for flooding control, 59% of respondents
 243 regularly see people leaving garbage at the manhole. In particular, passers-by are often
 244 seen (47%), followed by the local people 40%, the local traders account for 11% and other
 245 2% is a street vendor.

246 **3.2.2. From awareness to actions**

247 When asked about the situation that when they are outside, if there is any garbage, what
 248 option will they choose? 92% of people choose to find public trash to dispose of garbage,
 249 6% of those who choose to take it home and put it in their own trash and 2% of the rest do
 250 not care or choose to dispose of garbage on the spot.

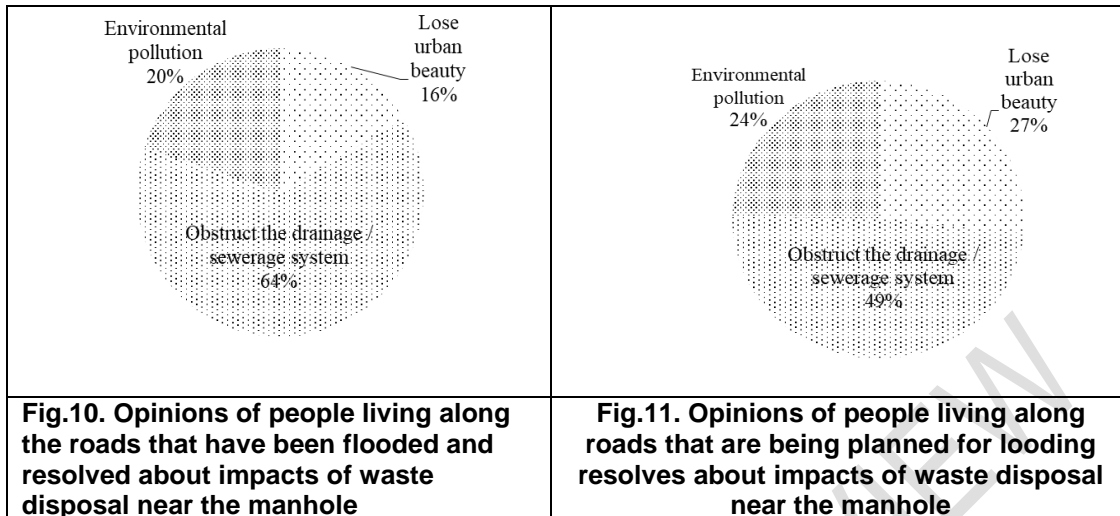
251 Regarding the attitude of community when they see people throwing garbage in the
 252 manhole, 93% of the respondents said that they felt uncomfortable and only 7% of the rest
 253 (mostly men) found it normal. In order to prevent littering, 57% of respondents choose to
 254 remind these littering men, 3% choose to take photos / or report to local security and 40%
 255 will not do anything.



256 When asked about the environmental impacts of waste disposal near the manhole, 54% of
 257 people said that it would obstruct the drainage / sewerage system, 23% of those who chose
 258 to lose urban beauty, 23% people think that will cause environmental pollution

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

263 Particularly for roads that are being planned for flooding control, these number are 49%,
 264 27% and 24% sequentially.



265 For the question regarding access to sanctioning regulations for illegal garbage disposal,
 266 issued by the State, 57% of respondents have access to this information, meanwhile 43% of
 267 respondents did not know / could not access. Among those who have access to information,
 268 6% of respondents reach through banners, street signs, 18% of people access via local
 269 channels (message boards, leaflets, meetings, etc.). , 36% via television, radio and 40% are
 270 self-learn / see online / listen to others. 61% of the surveyed respondents in the inner
 271 districts of the city responded that they had access to sanctions regulations for illegal
 272 dumping, which was higher than respondents in other districts.

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

282 The complex interaction of social, ecological and physical processes in flooding poses
 283 significant challenges for understanding, modelling and managing floods[14]. Therefore both
 284 the drivers of increased flood risk and the implications of flooding touch on a wide range of
 285 sectors, and efforts to plan for and manage floods confront considerable complexity and
 286 uncertainty, and must balance and mediate among multiple sectors and competing interests.
 287 The integrated and participatory risk-based management approach is becoming
 288 institutionalized at different levels [15][16], [17],[18].

289
 290
 291

4. CONCLUSION

292 The flooding problem in Ho Chi Minh City is complicated by many reasons, of which nature
 293 is due to changes in rainfall and tide over the years. The city's drainage system, including
 294 sewers and canals, is obscured and degraded; so in areas where drainage systems have
 295 been upgraded, flooding is reduced.

296 There is a difference in people's understanding of the causes of flooding, the impact of
 297 flooding and the sense of environmental protection as well as flood risk management among

298 the residents in the area that have been flooded and resolved, and in the area are being
299 planned for flooding control.

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

303 In addition to technological solutions, community awareness, solutions for management and
304 sanctioning are also necessary, which is recommended by the resident to increase.

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

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- 359

360 **COMPETING INTERESTS**

361

362 no competing interests exist

363

364 **AUTHORS' CONTRIBUTIONS**

365

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

369

370 **CONSENT (WHERE EVER APPLICABLE)**

371

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

376

377

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

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384 **DEFINITIONS, ACRONYMS, ABBREVIATIONS**

385

386 HCMC: Ho Chi Minh City

387

388 **APPENDIX**