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Social Drivers of Flood Vulnerability: Understanding Household Perspectives and Persistence of Living in Flood Zones of Metro Manila, Philippines

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Abstract: Urban populations, especially vulnerable communities, are facing increasing flood risks due to the rising frequency of floods caused by climate change and rapid growth. Effective mitigation requires moving beyond physical and environmental approaches to embrace social dimensions. This study examined the prevailing social drivers of floods in flood-prone communities in Metro Manila, Philippines using social data acquired through a door-to-door household survey. Responses were assessed using exploratory and combined qualitative and quantitative analyses. The findings of this study show that the decision to remain in flood-prone areas is influenced by attachment to homes and acclimatization to the environment, convenience of accessible amenities to fulfill basic needs, livelihood dependence, economic considerations, house ownership, and perceived safety from floods. When choosing a place to live, the complex tradeoffs of residents are reflected, wherein daily economic concerns outweigh the possible flood damage. By understanding the social drivers of residency, policymakers and community leaders can develop targeted interventions and formulate strategies to address the root causes of the problem, leading to effective interventions and enhancing the resilience of urban communities.

Keywords: social drivers; flood exposure; flood vulnerability; integrated flood risk management

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1. Introduction

Floods are the most prevalent and disastrous natural hazards globally. In 2022, most disasters recorded by the Centre for Research on the Epidemiology of Disasters (CRED) were related to floods, which affected 57.1 million people [1]. Floods are defined as temporary inundations of normally dry land [2,3]. In the context of this study, they were often due to the overflow of waterways caused by heavy rainfall, high tides, or lack of a proper drainage system.

In Metro Manila, the National Capital Region (NCR) of the Philippines, floods are recurring phenomena that have inflicted significant damage and have affected thousands of individuals over the years. Among notable events are the 2009 flood during Typhoon Ondoy, which affected 174,426 families and caused PhP570 million (USD10.1 million, based on 29 February 2024 exchange rate wherein PhP56.26 = USD1.00) in damages, and the 2020 flood during Typhoon Ulysses, which affected 13,132 families and resulted in PhP717 million (USD12.7 million) in damages, highlighting flood risks.

Despite experiencing devastating floods that regularly affect thousands and inflict millions of damages, the NCR has continued to experience urban expansion and population growth. Built-up areas doubled between 1972 and 2006, and flood-exposed settlements expanded by over 50% when compared with flood-safe areas between 1985 and 2015 [4,5]. Recent information from the National Mapping and Resources Information Authority (NAMRIA) and the Philippines Statistics Authority (PSA) reveals that 85% of the region is

classified as a built-up area, with a population increase of 1.3% from 2010 to 2020, leading to more people being at risk of flooding. As urban expansion and population growth continue to exacerbate the vulnerability of residents to flood hazards, there is a critical need to investigate the factors that influence the decisions of residents to reside in flood-prone areas and develop sustainable flood risk mitigation plans.

1.1. Flood Vulnerability and Social Drivers

Vulnerability is a complex and multidisciplinary factor in determining flood risk. Risk is a function of hazard and vulnerability; thus, the degree of risk depends not only on the type of hazard, but also on the level of vulnerability of the people who interact with the hazard [6]. Considering the diverse fields of research involved in vulnerability and risk assessment, such as disaster management [7], climate change [8], urban planning, and social sciences [9], there is consensus that there is yet to be a universal definition of vulnerability.

There are different types of vulnerabilities, including physical, social, and institutional. Among these, social vulnerability is the least considered because it involves complex societal conditions that are challenging to quantify [9,10] and the availability of acceptable data for analysis is low, especially in developing countries [11]. In this study, the definition of vulnerability was adopted from the field of flood risk management and the United Nations Office for Disaster Risk Reduction (UNDRR). In line with this, the term vulnerability in this study is linked to social vulnerability, and refers to the characteristics or conditions of people that influence their susceptibility and increase their likelihood of being harmed when exposed to floods [7,12]. These conditions encompass social structure, socioeconomic factors, and living conditions [11]. Owing to these conditions, vulnerability varies spatially and among social structures [13,14]. Notably, the poor and the disadvantaged are often identified as the most vulnerable, especially in urban settings in developing countries [15].

Early studies have focused on quantifying social vulnerability using a composite index based on demographic and socioeconomic indicators. Among the pioneering studies, Cutter et al. [9] used census data to quantify the relative social vulnerability of counties in the United States of America. Recent studies have also quantified social vulnerability using different frameworks [16,17]. Although the indicators vary according to each study, some of the commonly used indicators are age, sex, and socioeconomic level [6,11]. In the context of the Philippines and Metro Manila, previous studies have quantified social vulnerability using indicators commonly used in the literature and census data as input data [13,18,19]. Villordon [20] applied a different framework, but quantified social vulnerability using indices. The variables used to quantify the indicators describe the dependent population, such as children and the elderly, and those living in poor housing quality. Although valuable, these studies lack granular detail about social drivers, which are defined as the underlying factors influencing the vulnerability of residents directly affected by floods. Examining these drivers provides an in-depth understanding of local problems, considering the circumstances (social, economic, political, and environmental) in the area, paving the way for the development of targeted interventions.

1.2. Flood Risk Management Strategies

In flood management, the development of strategies has traditionally focused on hazard-based analysis, and flood countermeasures involve the construction of infrastructure and updating of technology [16]. This approach was implemented in Metro Manila to mitigate flood damage and losses. The national and local government agencies in the region, under the umbrella of the National Disaster Risk Reduction and Management Council (NDRRMC), have implemented various measures to address and mitigate damage and losses caused by floods in the NCR. The strategies include constructing dikes and floodwalls to confine floodwaters, establishing flood early warning systems, and providing online hazard maps through Project NOAH (Nationwide Operational Assessment of Hazards) for flood disaster preparedness and mitigation. However, these are based on hazard analyses and do not integrate the social dimension, particularly the vulnerability of affected populations.

Recognizing the limitations of a purely hazard-based approach, global initiatives advocate expanding risk assessment to encompass social exposure, susceptibility, and coping capacity [21]. Focusing on hazards alone overlooks the critical social dimension of flood risk management (FRM) [22]. Just as non-structural measures complement structural ones, understanding the social aspect of floods helps develop targeted policies and plans for effective FRM. By understanding the specific vulnerabilities of individuals, households, and communities, targeted interventions and policies that address their unique needs and enhance their overall resilience to flood risks can be developed. Therefore, acknowledging the importance of integrating social vulnerability assessments into flood risk management strategies is crucial.

To enhance the understanding of social vulnerability to floods and provide a reference for disaster decision-making, particularly in the context of Metro Manila, this study investigated the social drivers of flood vulnerability among households in the flood-prone areas of the region. These drivers are the underlying factors that influence the decisions of communities, consequently affecting their vulnerability and, in turn, their risk of flooding. Guided by the question, 'Why do inhabitants opt to reside and persist in flood-prone areas despite the dangers?', this study adopted a mixed-methods strategy that combined qualitative and quantitative analyses of household survey data.

It is crucial to employ household survey data because they reveal the prevailing and contemporary social factors that impact the responses of communities to floods, which are not typically available in census data, particularly in the Philippines.

The subsequent sections detail the study area, materials and methods used, the derived results, and a comprehensive discussion of the findings of the study.

2. Methods and Materials

2.1. Study Area and Sampling Sites

Metro Manila, located to the northwest of the country, has a population of 13.5 million according to the May 2020 census of PSA. As the capital region, it serves as the center for the majority of businesses and political activities, attracting locals and foreigners seeking employment and contributing to the number of people living in the area. Figure 1 illustrates the region of Metro Manila and its land cover. This highlights that the region is almost entirely built up, as indicated by the dark gray zones.

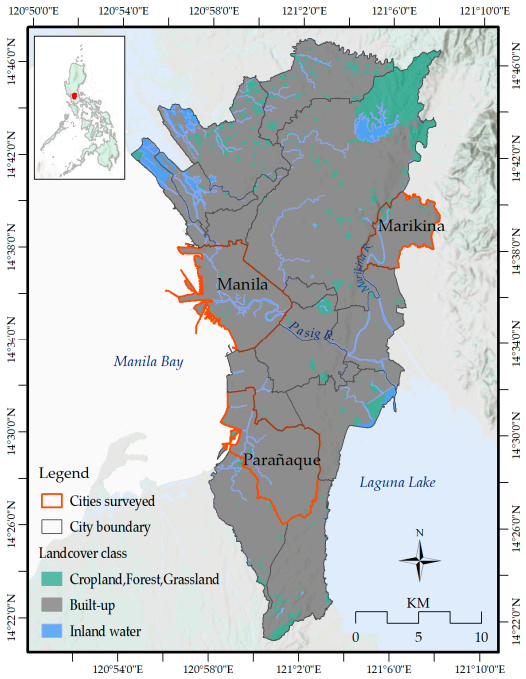
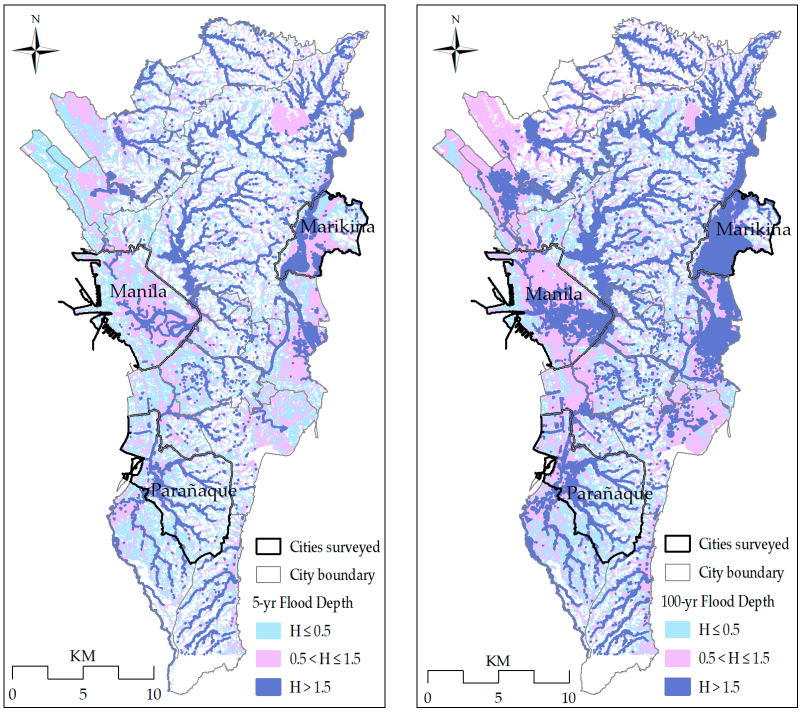


Figure 1. Study area location and land cover.

Floods in Metro Manila are associated with thunderstorms, monsoons, and typhoons [23]. The region experiences diverse flood types (pluvial, fluvial, tidal, and flash floods), owing to its geography, topography, and land cover. Pluvial floods often occur during heavy downpours, resulting in traffic disruptions and class suspensions. Fluvial and flash floods coincide with typhoons or monsoon-related downpours, posing risks to communities residing near rivers and creeks, notably along the Pasig–Marikina River and its primary tributaries. Tidal floods are associated with an increase in water levels in Manila Bay due to high tides. The high tidal level causes a backwater effect on adjacent rivers and canals, resulting in bank overflow and flooding of the adjacent areas.

Figure 2 displays the flood hazard maps provided by Project NOAH, indicating extensive exposure to 5-year and 100-year return period floods. The figure illustrates that even for a 5-year flood, almost all of the area is likely to be flooded.



(**a**) (**b**)

Figure 2. Probable flooding in Metro Manila: (**a**) 5-yr flood map; (**b**) 100-yr flood map. Maps generated using Project NOAH flood depth.

Considering the expansive area of Metro Manila and its limited resources, we strategically selected three target cities from 16 cities and one municipality in the region where the survey was conducted. To ensure a comprehensive reflection of the social drivers, the target cities were selected based on their ranking, applying the following criteria:

1. (C_1) the number of flood events per city from 2009 to 2020 based on 33 collected situation reports (SitReps) from the NDRRMC. SitReps contain information about hazard events, affected areas, number of affected individuals, casualties, and damages.
2. (C_2) the population density per city, noting that there could be no flood exposure if there were no communities within the study area.
3. (C_{31}–C_{32}) the proportion of the affected families during the extreme flood events in September 2009 during Typhoon Ondoy and in November 2020 during Typhoon Ulysses.
4. (C_{41}–C_{42}) the proportion of the city area affected by a 100-year flood with high flood depth and all flood depths.

These four main criteria were assigned equal weights (=0.25), and the weights of the sub-criteria were divided equally (=0.125). Before calculating the score for each city, each

criterion was normalized using the linear maximum method [17]. Next, the criteria scores were aggregated using the weighted-sum method. The cities were then ranked based on their scores. The highest- and lowest-ranking cities were selected to reflect the social drivers of the most and least flood-affected cities, respectively. Table 1 shows the result of this selection analysis, wherein Marikina is ranked first and Parañaque ranked last.

Table 1. Selecting cities to conduct the survey.

City/Municipality	Weighted Normalized Values						Sum	Rank
	C_1	C_2	C_{31}	C_{32}	C_{41}	C_{42}		
Caloocan	0.111	0.177	0.062	0.005	0.013	0.036	0.406	11
Las Piñas	0.139	0.105	0.018	0.002	0.015	0.068	0.347	13
Makati	0.102	0.143	0.002	0.002	0.012	0.071	0.332	15
Malabon	0.185	0.137	0.007	0.005	0.052	0.125	0.510	5
Mandaluyong	0.176	0.214	0.014	0.007	0.018	0.057	0.485	6
Manila	0.231	0.250	0.004	0.029	0.032	0.125	0.671	2
Marikina	0.176	0.113	0.125	0.125	0.125	0.112	0.776	1
Muntinlupa	0.167	0.079	0.008	0.038	0.009	0.042	0.342	14
Navotas	0.157	0.133	0.000	0.018	0.006	0.116	0.430	9
Parañaque	0.130	0.087	0.002	0.008	0.023	0.072	0.321	17
Pasay	0.167	0.140	0.006	0.002	0.014	0.093	0.422	10
Pasig	0.185	0.146	0.089	0.020	0.070	0.117	0.626	3
Pateros	0.102	0.230	0.023	0.003	0.004	0.108	0.470	8
Quezon City	0.250	0.104	0.079	0.021	0.033	0.053	0.540	4
San Juan	0.102	0.124	0.002	0.003	0.039	0.062	0.331	16
Taguig	0.148	0.141	0.093	0.018	0.010	0.071	0.482	7
Valenzuela	0.194	0.087	0.006	0.017	0.022	0.052	0.377	12

Manila was selected as the third city owing to its political, social, economic, and hydrological roles. Serving as the capital city of the Philippines, it has consequently become the center of administrative and economic activities. It is also the most densely populated city among the cities in the region, with 73,920 persons per km^2 as of 2020, according to PSA. Despite these significant characteristics, Manila is often plagued by floods. As indicated in Table 2, it ranked second, reflecting how often it was affected by such hazards.

Table 2. Summary of hydrological and topographic conditions of the three cities.

	Manila	Marikina	Parañaque
Types of floods experienced	Fluvial, pluvial, and tidal	Fluvial and pluvial	Same as Manila
Hydrological representation	• Downstream of PMLLB. • Pasig River flows across the city.	• Upstream of Pasig–Marikina River. • Marikina River flows across the city.	• Covered by a different sub-basin of PMLLB. Not directly connected to Pasig and Marikina rivers. • Several creeks flow across the city.
Topographic condition	Relatively flat, low-lying area	Hilly terrain, relatively high elevation	Hilly terrain, with low-lying areas

Hydrologically and topographically, these three cities represent different scenarios. Table 2 summarizes these characteristics, and Figure 3 shows the basins and topography of the study area. Manila is located downstream of the Pasig–Marikina–Laguna Lake Basin (PMLLB), which has a catchment area of 4522 km^2 [24]. The Pasig and Marikina Rivers are considered major rivers in the Philippines, with a catchment area of at least 40 km^2. Manila floods are attributed to fluvial, pluvial, and tidal floods owing to their hydrological spatial location and flat and low-elevation terrain. Marikina is located upstream of the Pasig–Marikina River and at the foot of a mountainous area to the northeast. It is often

affected by fluvial floods due to overflow from the Marikina River and its tributaries and its varying terrain. As a result of its hilly terrain, low-lying areas are affected by surface runoff from relatively high-elevation built-up areas because of the inadequate capacities of the drainage channel. On the other hand, Parañaque is not directly connected to the Pasig–Marikina River. It is marked by hilly and low-lying areas, with several creeks passing across the city. Residential areas near Manila Bay are often affected by tidal floods, whereas those adjacent to creeks are affected by fluvial floods because of the limited flow capacity of these waterways. High tides cause backwater effects in small canals running parallel to coastal areas, thereby affecting adjacent residential areas.

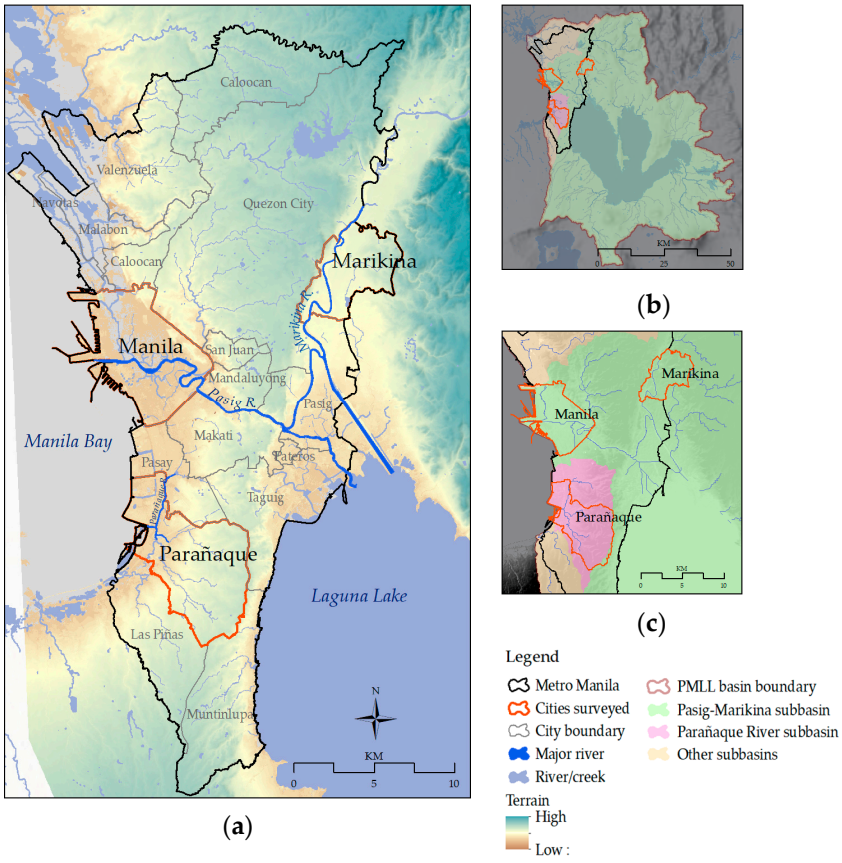


Figure 3. Topographic and hydrological map of: (**a**) the study area; (**b**) index map showing the PMLLB and its sub-basins with respect to Metro Manila; (**c**) index map showing sub-basins where the surveyed cities are located.

2.2. Instrument

A questionnaire in Filipino and English was prepared for the survey. During the preparation stage of the questionnaire, the wording of the questions was reviewed to avoid influencing the responses. Next, an online pilot test was conducted to obtain feedback on question comprehension, the flow of questions, the possible duration of the survey, and choices for multiple-choice questions. The questionnaire then underwent several translation checks, from English to Filipino and back. To guarantee translation quality, different sets of individuals proficient in both Filipino and English translated the questionnaire. The final questionnaire used in the survey was available in both English and Filipino to ensure that the participants could understand and choose their preferred language. It contains both closed- and open-ended questions covering flood experiences, length of residency, household conditions, housing conditions, socioeconomic status, reasons for staying, and choices of preferred places to live. Open-ended questions were used to ask about the reasons for staying to prevent premeditated responses.

2.3. Sampling Procedure and Sample Size

A door-to-door household survey was conducted in the urban areas of Marikina, Parañaque, and Manila from February to March 2023, adhering to local regulations and health guidelines, considering the presence of COVID-19. The survey aimed to gather firsthand data on flooding and the reasons for residing in flood-prone areas. Before the commencement of the survey, all requisite permissions were secured from the relevant local government authorities. The survey was specifically carried out in barangays or communities susceptible to flooding, which were identified in collaboration with local stakeholders such as municipal officers and volunteers. Within each community, participating households were selected at random, with the head chosen as the representative because of their comprehensive understanding of the household's circumstances. A door-to-door survey was conducted to ensure that all respondents answered the questions and to clarify any questions they had about the data and the questions being asked.

At the start of the interview, participants were informed about the purpose of the survey and research, the confidentiality of their personal information, and it was confirmed that the use of the collected information was for research purposes only. Despite our efforts to explain the purpose and nature of the study, our team encountered instances in which potential participants declined to be interviewed. In such cases, we respected their decisions and proceeded with the next candidate. We did not force anyone to participate because we aimed to ensure voluntary participation and consent. Our approach prioritized the autonomy and well-being of participants and ensured that the interview process was conducted in a manner that was both respectful and professional. A total of 1169 households voluntarily participated in this study, as shown in Table 3. This number is greater than the minimum sample size determined using Cochran's modified formula for finite populations, as shown below.

$$n_0 = \frac{z^2 p(1-p)}{e^2} \quad (1)$$

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad (2)$$

where n_0 = Cochran's ideal sample size, z = z-value, e = margin of error, p = population proportion, n = required sample size, and N = population size. For this study, a 95% confidence interval and p of 0.50 were applied.

Table 3. Number of participants (n) compared to the required minimum sample (n).

City	N [1]	n [2]		n	Remark
Manila	486,293	385	<	385	ok
Marikina	104,415	384	<	394	ok
Parañaque	182,216	384	<	390	ok
Total	772,924	1153	<	1169	ok

Notes: [1] Number of households from the May 2020 census by PSA. [2] Minimum population size calculated from Equations (1) and (2).

2.4. Data Analysis and Profile of Households Surveyed

This study performed a combined qualitative and quantitative analysis of the collected survey data to assess the social drivers of households living in flood-prone areas of Metro Manila.

Before conducting the analyses, survey data were sorted and transcribed to create a database. The datasets were arranged based on the flow of the questions, which were grouped according to their content: (1) participant information, (2) local flood experience and knowledge, (3) household condition, (4) considerations or criteria for choosing a place to live in, (5) residential conditions, (6) socioeconomic conditions, (7) perception of flood occurrence, (8) reasons for choosing to remain in the current address, and (9) willingness and measures taken concerning disaster preparedness. For the perception of flood occur-

rence, participants were asked to describe the frequency of flooding in their neighborhood using any of the following words: never, rarely, sometimes, often, and always. Open- and mixed-type questions were used for reasons and considerations, as listed in Table 4.

Table 4. Questions asked to identify social drivers.

Question	Type
1. Please state your reason(s) for choosing to stay at your current address even though it is sensitive to flood.	Open-ended
2. What are your top three considerations when choosing where to live?	Mixed

Assessment of the sorted survey datasets was divided into four stages. First, we profiled the households to provide a background and better understanding of their decisions in terms of residing in the area. At this stage, a descriptive analysis was used to summarize the basic profile of the households in terms of structure, housing conditions, socioeconomic conditions, and flood experiences.

The second and third stages covered the analysis of the residents' reasons for remaining in their current homes despite floods, and the priorities or considerations in choosing a place to live. At this stage, the responses were analyzed using a thematic approach in which the reasons were clustered based on their meaning and context. This method is a flexible research tool commonly used in qualitative analysis to identify and deduce the patterns or themes of a qualitative dataset [25,26]. Figure 4 shows the flow diagram of the thematic analysis. The first set of categories was based on common responses, which included similarities in the meanings of the responses and keywords used. If a participant had multiple reasons, multiple categories were created for each reason. This iteration of the analysis was repeated until the final participant was reached. The first set of categories was then grouped based on common contexts or themes. These responses were then cross-tabulated with the profiles of the households to gain an in-depth understanding of their reasons and considerations.

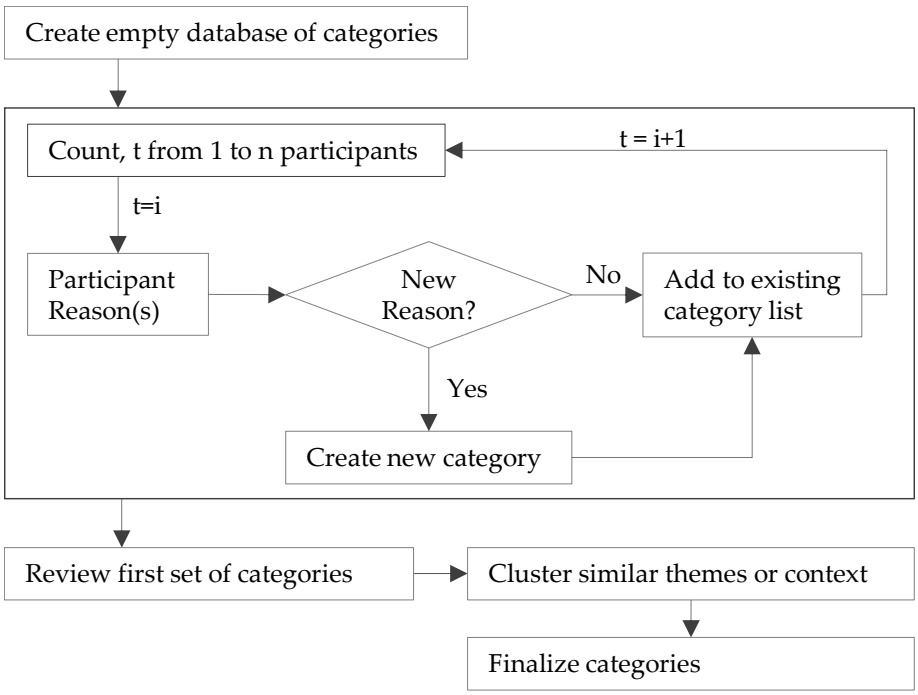


Figure 4. Schematic of the thought process of thematic analysis to categorize reasons.

The final stage was to understand the level of preparedness of the residents, noting their persistence in staying in a flood-prone area. Five questions were used to quantify

the participants' willingness to prepare, as listed in Table 5. These questions represent residents' readiness to prepare for flood disasters and their willingness to collaborate with the local government. The total level of preparedness, PL_{TOT}, was calculated by adding the scores for each response, Pl*i*, where *i* ranged from 1 to 5. The preparedness indicators, that is, Pl*i*, were assigned equal weighting, resulting in a score range of 5 to 25, with the lowest score indicating the lowest level of preparedness.

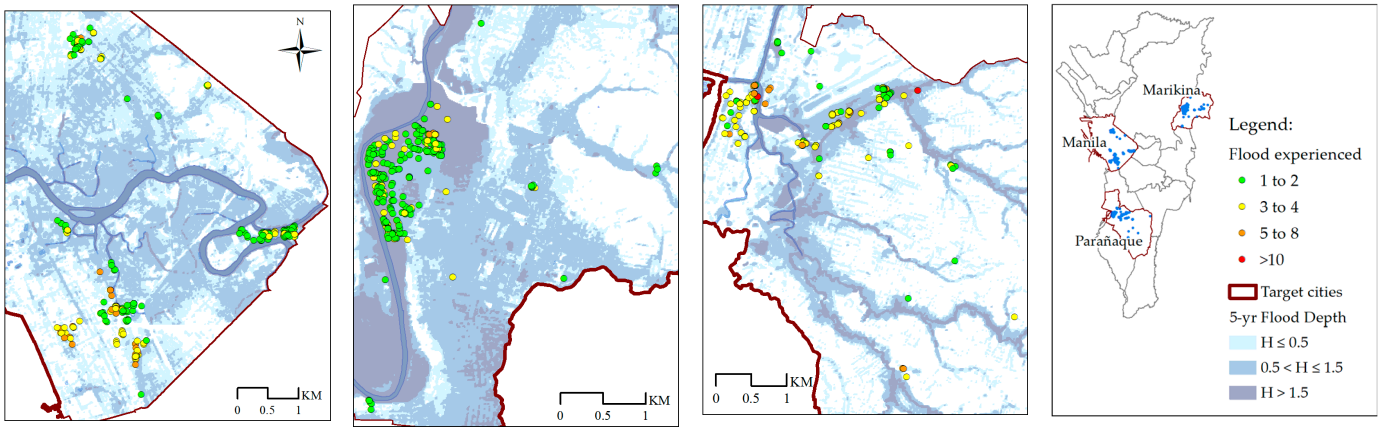
Table 5. Questions for assessing residents' preparedness.

Question	ID	Type/Response	Scoring
1. What is the likelihood that you will store food and/or water when you hear that a heavy rainfall or typhoon is coming?	PL_1	5-level Likert	1 to 5
2. What is the likelihood that you will wear protective gear or equipment when you must wade into the flood?	PL_2	5-level Likert	1 to 5
3. What is the likelihood that your household will evacuate (to the evacuation center) in case the LGU advises you to temporarily evacuate due to a dangerous flood?	PL_3	5-level Likert	1 to 5
4. Do you receive flood advisory or warning before a flood event?	PL_4	No-Maybe-Yes	1, 3, 5
5. Are you going to participate in evacuation drills or exercises in your community to help in preventing flood losses and injuries?	PL_5	No-Maybe-Yes	1, 3, 5

3. Results

3.1. Household Profiles and Flooding Condition

Table 6 presents a summary of the surveyed households and Figure 5 illustrates their locations. Of the total sample, 1125 (96%) responded that they experienced flooding in their area during their residency. Of these households, 89% had been residing in their current address for 10 years or more, 3% for 7 to 9 years, and 4% for both groups of residents who stayed for 1 to 3 years and 4 to 6 years. Overall, 73% of these households are house owners, with the bulk of the population representing poor, low-income, and lower-middle-income socioeconomic levels (SILs).



(**a**) (**b**) (**c**) (**d**)

Figure 5. Areas surveyed overlaying a 5-yr flood: (**a**) households in Manila showing floods experienced annually; (**b**) households in Marikina showing floods experienced annually; (**c**) households in Parañaque showing floods experienced annually; (**d**) index map.

Table 6. Summary of the characteristics of the surveyed households with flood experience.

Description	Metrics	Manila	%	Marikina	%	Parañaque	%	Overall	%
Flood experienced annually									
	Mean	2.7	-	1.9	-	3.1	-	2.5	-
	Median	2.0	-	2.0	-	3.0	-	2.0	-
	SD	1.7	-	1.0	-	2.1	-	1.7	-
Frequency of flooding									
Never	Count	6	1.6	1	0.3	1	0.3	8	0.7
Rarely	Count	119	32.5	194	50.3	178	47.7	491	43.6
Sometimes	Count	76	20.8	120	31.1	61	16.4	257	22.8
Often	Count	147	40.2	67	17.4	110	29.5	324	28.8
Always	Count	18	4.9	4	1.0	23	6.2	45	4.0
HH condition									
Size	Mean	5.1	-	6.3	-	4.8	-	5.4	-
Head: single	Count	75	20.5	102	26.4	79	21.2	256	23.0
Head: dual parent	Count	291	79.5	284	73.6	294.0	78.8	869	77.0
Head: employment	Full-time	169	46.2	238	55.2	184	52.4	591	51.0
	Part-time	180	49.2	180	41.8	152	43.3	512	45.0
	Unemployed	17	4.6	13	3.0	15	4.3	45	4.0
HH socio-economic income class [1]									
Poor	Count	203	55.5	190	49.2	196	52.5	589	52.4
Low income	Count	102	27.9	146	37.8	155	41.6	403	35.8
Lower middle income	Count	42	11.5	31	8.0	18	4.8	91	8.1
Middle middle income	Count	13	3.6	12	3.1	3	0.8	28	2.5
Upper middle income	Count	4	1.1	4	1.0	0	0.0	8	0.7
Upper income	Count	0	0.0	2	0.5	1	0.3	3	0.3
Rich	Count	2	0.5	1	0.3	0	0.0	3	0.3
Residential condition									
Years of residency	1–3 years	18	4.9	11	2.8	17	4.6	46	4.0
	4–6 years	13	3.6	8	2.1	23	6.2	44	4.0
	7–9 years	15	4.1	4	1.0	12	3.2	31	3.0
	>10 years	320	87.4	363	94.0	321	86.1	1004	89.0
House owners	Count	225	61.5	316	81.9	282	75.6	823	73.0

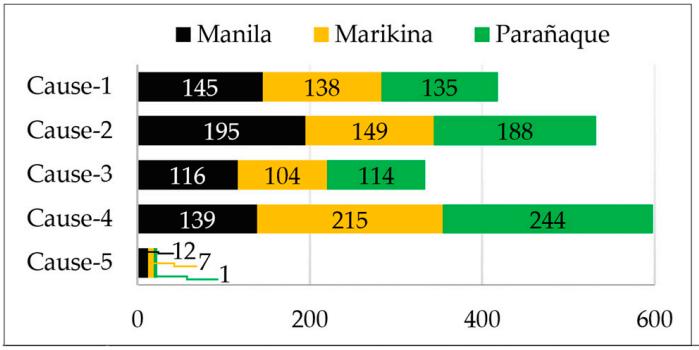
Note: [1] Socioeconomic income levels are based on the Profile and Determinants of the Middle-Income Class in the Philippines in 2018 by the Philippine Institute for Development Studies, with the indicative range updated by the PSA using the First Semester 2021 Poverty Statistics Press Release.

Respondents reported experiencing two to three floods annually, aligning with the average annual flood events that occurred in the region based on forty-seven NDRMC reports from 2009 to 2020. Manila and Marikina had the same median number of two, whereas Parañaque had three. The higher number of floods in Parañaque was due to tidal floods that affected residents living near Manila Bay or the river. Thus, whenever there is high tide, these residents experience flooding in their neighborhoods.

Meanwhile, from the perspective of households, regarding flood frequency, most participants described their experiences as rarely or often flooded. In Manila, 40% described themselves as often flooded, whereas in Marikina and Parañaque, almost half of the residents (i.e., 50% and 48%, respectively) described themselves as rarely flooded.

Figure 6 illustrates the causes of flooding observed by the residents. These floods were attributed to three main factors: blockage of drainage canals by garbage or debris impeding the natural flow, overflow of nearby creeks and rivers, and the habitation of residents in low-lying areas. In Manila, almost one-third of the responses linked floods to overflow drainage canals because garbage and debris obstructed floodwater flow, resulting in pluvial floods. Manila residents expressed frustration about the garbage clogging the canals and creeks, while others complained about debris from construction materials used for ongoing infrastructure projects that blocked the culverts. On the other hand, in both

Marikina and Parañaque, more than one-third of the participants associated floods with the inadequate capacity of rivers and creeks, resulting in fluvial flooding.



Total	% of Total
418	22
532	28
334	18
598	31
20	1
1902	100

ID	Description
Cause-1	I live in a low-lying area compared to surrounding area.
Cause-2	Overflowing of canals due to garbage/debris blocking the pathway of water
Cause-3	Overflowing of canals due to their lack of capacity / Lack of drainage facilities
Cause-4	Overflowing of nearby creek or river due to inadequate capacity
Cause-5	Others

Figure 6. Causes of floods based on resident observation.

3.2. Reasons for Residing in Flood-Prone Area

Despite the potential exposure to floods, residential structures exist in flood-prone areas, and families choose to remain. Six categories were derived from the thematic analysis of reasons for staying. They are as follows:

1. (R1) Access to and proximity to livelihoods;
2. (R2) Accessibility of basic needs and public facilities;
3. (R3) Limited financial resources;
4. (R4) Perceived safety from floods;
5. (R5) Stable housing or property ownership;
6. (R6) Place attachment and acclimatization to the local environment.

In R1, the reasons included translate to being near the workplace ("*malapit sa trabaho*", "*nandito ang trabaho*"), this is where my livelihood is ("*nandito ang kabuhayan*"), or this is where business is ("*malapit sa negosyo*", "*namumuhunan kami dito*"). Some participants used the reason that their residence is close to everything, including their work ("*malapit sa lahat*"). Thus, in the first category, residents decided to stay because they live close to their jobs or where their livelihoods are located. One participant testified "*Pwede makadiskarte dito*", this response translates to it is easier to find ways to make a living at their current address; connotating a comparison between accessible livelihood in the city and in a rural or provincial area.

In R2, almost all participants phrased their responses similarly, starting with "*malapit sa lahat*", which means close to everything, and expounded by specifying which amenities "everything" refers to, such as the hospital, clinic, school, or transportation ("*malapit sa ospital, palengke at* school", "*malapit sa trasportasyon*, LRT" or "*malapit sa centro o parang*"). Families opt to stay in their current location because it provides them with easy access to food and supplies from a nearby supermarket, a public market, or a mall, schools for their children, hospitals for their sick or elderly family members, and easy access to public transportation. Parents with children particularly value the proximity of schools and markets, whereas families with elderly members or special needs emphasize the availability of nearby hospitals or health centers. One participant stressed that they live in the capital city, wherein institutions are near and access to transportation is available ("*Ang lokasyon ng tirahan ay nasa Maynila at napakalapit sa mga institusyon tulad ng eskwelahan, ospital, palengke at transportasyon*"). A similar response highlighted the availability of facilities

and transportation in the city ("*andito na lahat ng kailangan mo,* clinics, *malapit sa lahat*"). Another cited that it is close to everything even though it is sometimes flooded ("*malapit sa lahat kahit minsan binabaha*"), highlighting their preference for R2 over safety from possible flood disasters.

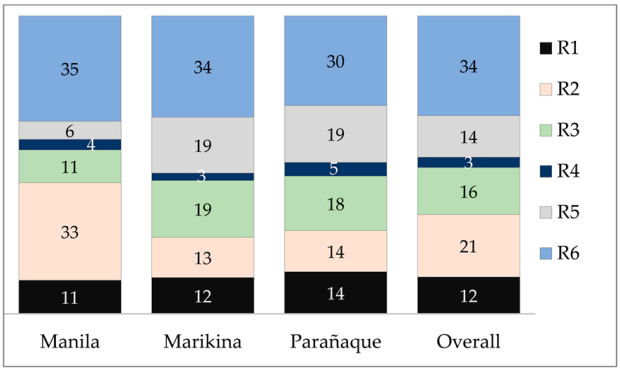
In R3, the participants stated that they do not have the financial capacity to move to a less risky area, leaving them "no choice" but to stay. The reasons included in this category are low rent ("*mababa ang renta*"), no means to pay rent ("*walang pambayad ng upa*"), no rent ("*walang upa*"), and no other place to live ("*walang* choice *na lilipatan*"). These reasons reflect the financial constraints of residents in deciding on a less flood-exposed place to live. In this category, low rent or no rent was highlighted as the reason. By contrast, others do not have to pay rent because they live in a house with their relatives. One participant stressed that they have to endure their current living conditions because it is what they can afford, due to poverty ("*Kahirapan. Yun ang kayang tirhan. Pagtiyagahan mo na lang*").

In R4, the participants decided to stay because their area was "not often" or "sometimes" flooded ("*bihira naman ang baha*" or "*minsan lang naman binabaha ang lugar*"). One respondent emphasized that flooding is not a daily problem because the area is not flooded every day ("*hindi naman araw-araw ang baha*"). Other responses in this category include: their house has a second floor where they can temporarily stay during high floods ("*may second floor ang bahay*"), they live on relatively high ground or are renting a unit located above the first floor ("*mataas na lugar*" or "*nasa taas ng bahay ang aking inuupahan*"), or they are far from the river ("*mejo malayo naman sa ilog*").

In R5, residents who inherited their houses prefer to live in their ancestral homes, whereas long-time residents, who have invested their earnings in their own house and lot, are reluctant to move or relocate. The responses in this category included the following: they own the house ("*sarili na ang bahay*"), they inherited the house ("*mana po itong bahay sa kanunuhan ko*"), and they used their investments to buy the house ("*dito na nakapagpundar lahat*"). Thus, most of the residents in this category were homeowners.

Finally, in R6, residents decided to remain in their homes and communities because they had an emotional attachment to the area and were accustomed to flooding conditions. A common response in this category is that they grew up there and it is their birthplace ("*dito na lumaki*", "*dito na ako pinanganak*"), they do not want to leave their home ("*ayaw iwan ang bahay*"), and they built their families and established their homes there ("*dito na nagkapamilya*", "*. . .dito ang pamilya*"), which created a sense of familiarity and comfort. Most participants had been residents of their respective neighborhoods for a long time. Consequently, they had become accustomed to flooding conditions in the area ("*nasanay na sa tagal ng pagtira sa lugar*", "*matagal na sa lugar*", "*sanay na*"), which further reinforced their decision to remain. Furthermore, some residents stressed the peace and order in their neighborhood, which led them to have a sense of safety and comfort ("peaceful, *walang gulo*"), contributing to their reluctance to leave. One participant decided to remain because they felt safe (from criminal acts) in their neighborhood, even though it was prone to floods ("*Dahil* safe *pa sa amin kahit binabaha*").

Figure 7a summarizes the overall and city-specific distributions of these responses. Despite the inherent flood risk, the three most frequently cited reasons for remaining in flood-prone areas were emotional attachment to homes and familiarity with the environment (R6 = 34%), access to essential amenities and infrastructure (R2 = 21%), and economic constraints limiting relocation options (R3 = 16%). Notably, while all three cities shared the same primary reason for staying, the second and third most influential factors varied. Marikina and Parañaque residents exhibited similar motivations in the top three: emotional attachment, access to basic needs, and proximity to public services (R5). By contrast, Manila residents prioritized emotional attachment, economic limitations, and access to amenities.



(**a**)

Rank	Manila	Marikina	Parañaque	Overall
1st	R6	R6	R6	R6
2nd	R2	R3	R5	R2
3rd	R3	R5	R3	R3
4th	R1	R2	R1	R5
5th	R5	R1	R2	R1
6th	R4	R4	R4	R4

(**b**)

Figure 7. (**a**) Percentage distribution of reasons for remaining in flood-prone areas; (**b**) ranking of reasons for staying.

Figure 7b further illustrates the substantial influence of R6, as evidenced by its consistency, as the primary reason for all types of spatial coverage. Many residents expressed familiarity with their surroundings, using the phrase "*sanay na*", which means "used to (it)", to signify their ingrained sense of belonging and acceptance of the flood risk.

Access to convenient amenities and public services (R2) also emerged as a key factor contributing to residents' reluctance to relocate. The proximity and ease of access to schools, hospitals, and workplaces were frequently cited as compelling reasons to remain. Conversely, economic limitations (R3) presented a significant barrier to other households seeking to move to safer locations. Residents facing financial constraints or lacking alternative housing options expressed feelings of having "no choice" but to stay.

Notably, homeowner status further solidified the attachment of residents to their existing locations. With high homeowner rates in all three cities (Marikina, 82%; Parañaque, 76%; Manila, 62%, as shown in Table 6) and the majority of the population consisting of long-term residents (over 85%), this combination of prolonged residence and financial investment in housing ownership contributed to residents' resistance to relocation to areas with lower flood exposure.

Figure 8 shows the reasons given by the households with respect to their socioeconomic income level (SIL). In terms of SIL, the respondents in the upper-middle income to rich categories were very limited or absent; thus, the reasons for these groups may not reflect the population. Nevertheless, when comparing the different classes, most of the poor to low-income levels in Manila choose to remain due to R6, followed by R2, while the middle-income and rich remain mainly due to R2, followed by R6. Similarly, in Marikina, most of the poor to lower-middle income levels choose to stay because of R6, followed by R3 and R5, while the upper levels stay because of R1, R2, R3, and R4. In Parañaque, almost all levels chose to stay because of R6, followed by R5. Overall, the primary reasons across the lower socioeconomic income group (i.e., poor to lower-middle income) did not vary within and across the city. Apart from the primary reason (R6), most residents chose to stay because of R5 and R2.

In terms of flood experience, some households testified to experiencing more than three floods annually (Figure 5) but still decided to remain in their current homes. Except for Manila, the primary reason for participants in Marikina, Parañaque, and the overall coverage was R6, while the second reason varied among R2, R3, and R5 (Figure 9). In Manila, the primary reason is R2, indicating that the accessibility of basic needs and primary amenities for the family outweighs the possible flood risk. The second reason for the other two cities, R3 in Marikina and R5 in Parañaque, further underscores the roles of financial constraints and stable housing as barriers to relocating to less exposed areas.

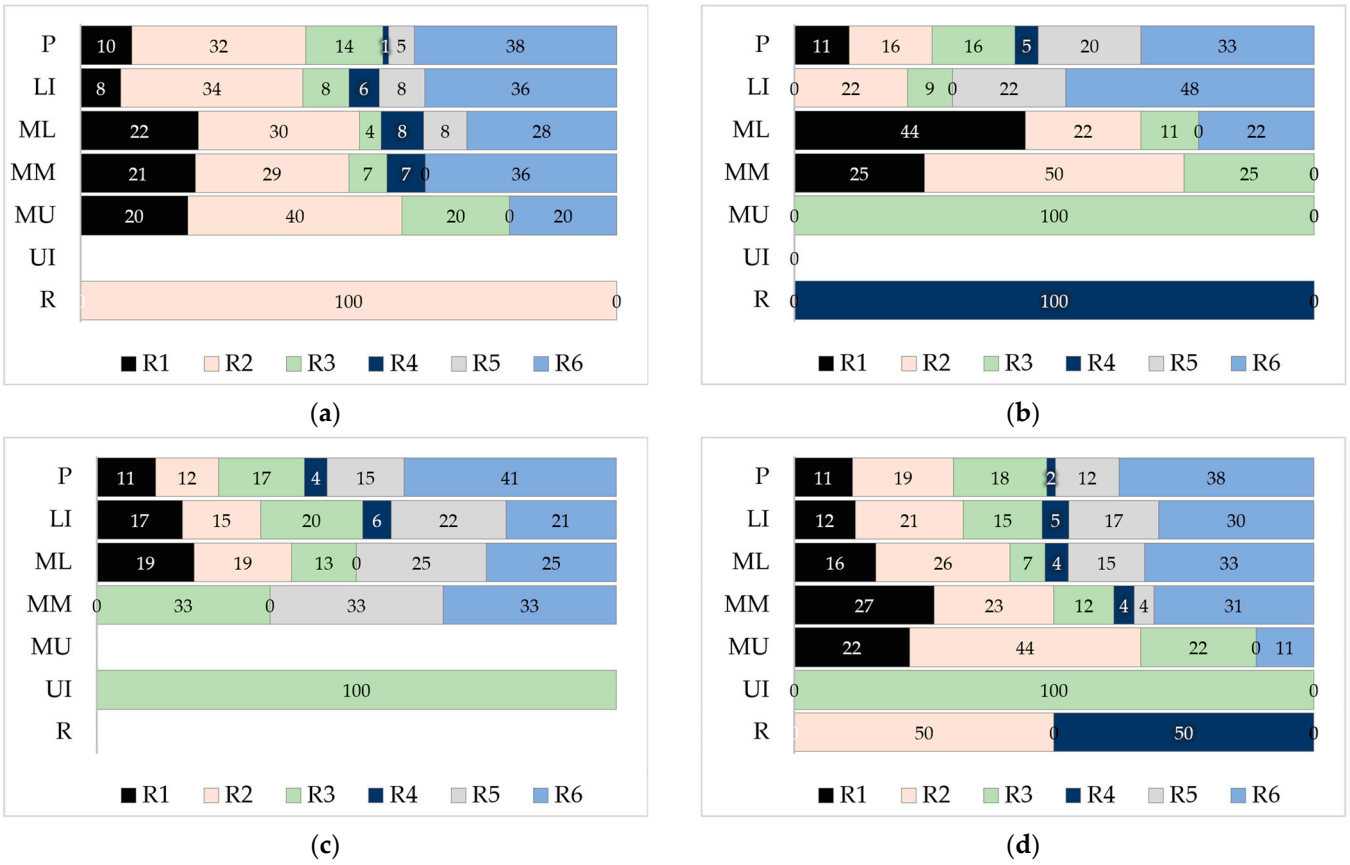
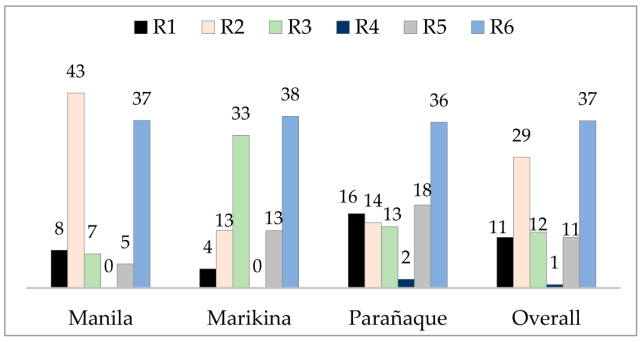


Figure 8. Percentage of responses per SIL in (**a**) Manila, (**b**) Marikina, (**c**) Parañaque, and (**d**) overall or combined responses.



(**a**)

	Manila		Marikina		Parañaque		Overall	
Reason	Count	%	Count	%	Count	%	Count	%
R1	11	8	1	4	17	16	29	11
R2	57	43	3	13	15	14	75	29
R3	10	7	8	33	14	13	32	12
R4	0	0	0	0	2	2	2	1
R5	7	5	3	13	19	18	29	11
R6	49	37	9	38	38	36	96	37
Total	134	100	24	100	105	100	263	100

(**b**)

Figure 9. Distribution of reasons for households who experience more than three floods annually: (**a**) percentage of counts according to spatial coverage; (**b**) frequency of reasons according to spatial coverage.

3.3. Conditions in Choosing a Place of Residence

To explore residential preferences that can indirectly affect their vulnerability, participants were asked to enumerate the top three criteria for choosing a place to live. While we emphasized the requirement of providing three choices, some participants were unable to do so. Consequently, only the sets of responses that fulfilled this condition were considered, comprising 999 of the 1125 participants (89%). The conditions set by the respondents are summarized as follows:

1. (C1) Live in the ancestral or existing house;
2. (C2) Affordable rent;
3. (C3) Rent-free accommodation;

4. (C4) Near my workplace;
5. (C5) Convenient access to public transportation;
6. (C6) Not easily flooded or high-ground area;
7. (C7) Live with family or relatives;
8. (C8) Near hospital;
9. (C9) Near commercial center (mall, public market);
10. (C10) Near a school;
11. (C11) Peace and order in the neighborhood;
12. (C12) Far from river or creek.

Table 7 shows the ranking of the choices according to spatial coverage. Overall, the top three criteria for residents living in flood-prone areas in Metro Manila are C3 (19.7%), C5 (16.7%), and C4 (16.6%). These responses give insight into the priorities of the residents, which are related to affordable housing and economic sustainability, such as living near the workplace and having easy access to public transport for daily commuting. These factors are of greater concern than the problem of being at risk of flooding, such that C4 and C12 are in the fourth and twelfth place within the rank, respectively.

Table 7. Ranks of each criterion for choosing a place to live.

Rank	Manila		Marikina		Parañaque		Overall	
	Criteria	%	Criteria	%	Criteria	%	Criteria	%
1st	C5	21.4	C6	22.2	C3	26.7	C3	19.7
2nd	C3	19.2	C4	17.2	C6	16.7	C5	16.7
3rd	C4	19.2	C5	16.2	C7	15.1	C4	16.6
4th	C1	17.0	C7	16.2	C4	13.5	C6	14.9
5th	C6	5.5	C3	12.5	C5	13.1	C7	12.3
6th	C8	5.5	C8	5.9	C1	7.9	C1	10.1
7th	C7	5.1	C1	5.7	C8	4.4	C8	5.2
8th	C9	3.4	C9	3.1	C9	1.9	C9	2.7
9th	C2	2.7	C2	0.4	C2	0.6	C2	1.2
10th	C10	0.6	C11	0.3	C10	0.1	C10	0.3
11th	C11	0.3	C10	0.2	C11	0.0	C11	0.2
12th	C12	0.1	C12	0.1	C12	0.0	C12	0.1

Note: The choices ranked 4th and below are grayed out to emphasize the top three choices in each city and overall coverage.

Similarly, the top three criteria for Manila residents were C5 (21.4%), C3, and C4 (19.2% each). Access to public transportation is highlighted in this city. Located at a relatively low elevation and downstream of the Pasig–Marikina River basin, the streets and low-lying areas of Manila are easily flooded during sudden downpours and long rainfalls. To get to work, many rely on public transportation, especially trains and jeepneys, which brave the flood to attract passengers.

In Marikina, the top three criteria were C6 (22.2%), C4 (17.2%), and a tie between C5 and C7 (16.2%). Prioritizing a flood-safe area in Marikina may have been influenced by the damage experienced during the previous extreme flood events. According to NDRRMC reports, Marikina has a relatively high proportion of flood-affected families. Even during the extreme flood in November 2020, it had the highest number of affected persons among the cities in Metro Manila. C7 is explained by the reliance of residents on their relatives and neighbors during evacuation and recovery.

For respondents in Parañaque, the top choices were C3 (26.7%), C6 (16.7%), and C7 (15.1%), which is similar to Marikina's, with the exception of C3. Residents in this city also chose to stay in rent-free accommodation, either by living with relatives or living along the creeks and rivers in informal settlements. While Marikina is often devastated by extreme floods, the low-lying areas of Parañaque often experience floods during high tide, owing to their proximity to Manila Bay and the low capacity of the canals, resulting in bank overflow.

The top three criteria for choosing a place to live coincide with the reasons for staying, such that C3 falls under R3, C5 to R2, and C4 to R1, highlighting economic constraints and accessibility of public facilities as critical factors that indirectly affect the vulnerability of the people to floods.

3.4. Preparedness of Residents against Flood Disaster

To mitigate potential disasters caused by flooding, it is crucial for residents living in flood-prone areas to be well-prepared, especially if they continue to live in areas prone to floods. In this study, five indicators were used to assess the level of preparedness: (1) willingness to prepare basic needs such as food and water beforehand, (2) willingness to wear protective equipment, (3) willingness to evacuate, (4) effort made to be updated on and informed of disasters, and (5) coordination with the local government to be educated in disaster preparedness.

Figure 10 summarizes the responses of the residents from each city. In terms of PL_1 (Figure 10a), almost one-third of the residents from each city were willing to prepare food and water when they heard news of typhoons and heavy rainfall which might cause floods, whereas only 10% to 16% would "definitely" prepare them.

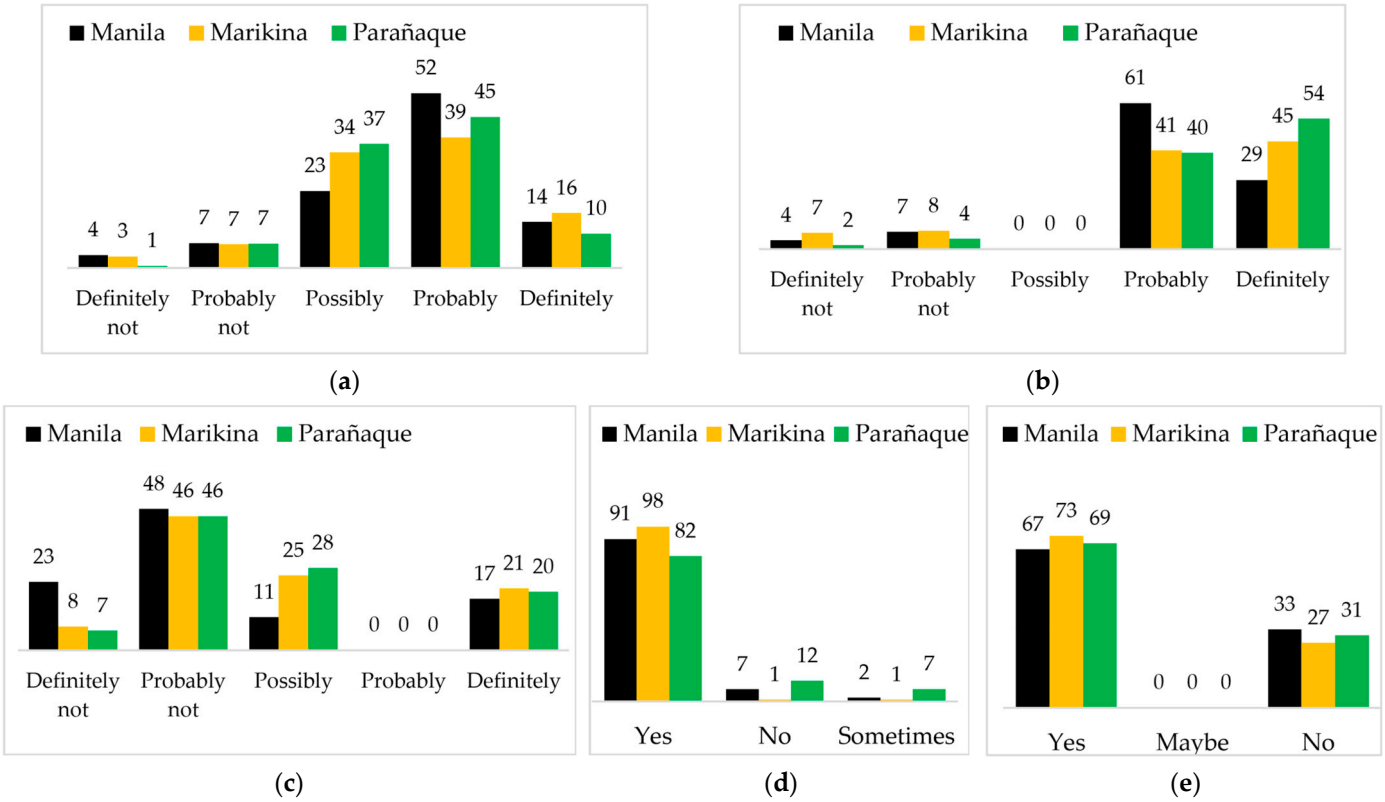


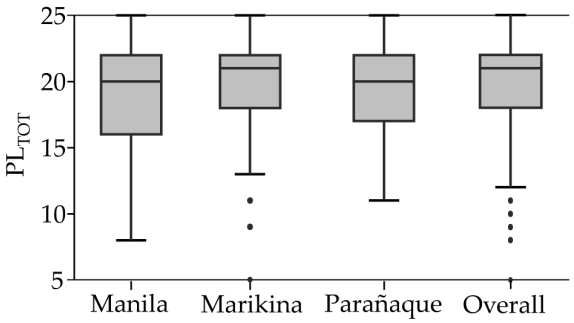
Figure 10. (**a**) Willingness of residents of each city to prepare food and water in case of flood in percent; (**b**) willingness of residents of each city to wear protective gear or use equipment in percent; (**c**) willingness of residents of each city to evacuate in percent; (**d**) effort to access warnings and information in percent; (**e**) willingness to participate in evacuation drills in percent.

For PL_2 (Figure 10b), the majority of the residents will "probably" and "definitely" wear protective gear when wading through floods. Residents cited that they were afraid of contracting leptospirosis, a disease frequently associated with floods and one of the major causes of death based on NDRRMC records during Typhoon Ondoy in 2009. However, almost 50% of the residents were unwilling to evacuate to the evacuation center (Figure 10c). Their hesitation was mostly associated with their fear of getting sick (e.g., COVID-19, the common cold, flu) and the possible looting of their house. In the case of a high flood,

they preferred to go to the highest level of their house or to a neighbor's or relative's house which was tall or located on high ground. One of the participants in favor of not evacuating stressed that their house has a second floor and expressed the possibility of facing difficulties at the evacuation center, such as getting sick ("*Meron kaming* second floor. *Baka mas mahirap sa* evacuation center. *Baka lalo magkasakit ka doon*").

For the other variables, more than 80% of the residents were able to obtain information or warnings from radio, television, social media, or their neighbors (Figure 10d), indicating their efforts to be updated and able to prepare for possible disasters. Meanwhile, at least 67% of the residents were willing to join evacuation drills, which aim primarily to reduce the number of affected persons by educating them about safety.

Aggregating the above sublevels, the PL_{TOT} shows that each city has a moderate to high total level of preparedness (Figure 11), wherein the median of each city is either 20 or 21.



(**a**)

	PL_{TOT}			
	Manila	Marikina	Parañaque	Overall
Valid	366.0	386.0	373.0	1125.0
Median	20.0	21.0	20.0	21.0
Mean	19.2	20.0	19.6	19.6
Std. Deviation	3.5	3.0	3.0	3.2
Minimum	8.0	5.0	11.0	5.0
Maximum	25.0	25.0	25.0	25.0

(**b**)

Figure 11. Level of preparedness: (**a**) box plot of PL_{TOT} per spatial coverage; (**b**) descriptive statistics of PL_{TOT}.

4. Discussion

This study examined the social drivers of floods in the context of households living in flood-prone areas of Metro Manila based on their reasons for staying in the area despite the risks, and their top choices when choosing a place of residence, to better understand the indirect factors that contribute to the vulnerability of people to floods and, consequently, the level of risk. The results show complex tradeoffs and combinations of factors that motivate residents to stay, such that the reasons provided by residents are combined with other considerations.

The findings indicate that the primary driving force for residents to continue living in flood-prone areas despite flood risks is their emotional connection to their homes and their familiarity with the area. The majority of the residents in this area grew up in their current residence; thus, it holds great sentimental value, as it is their birthplace and the location of their family members and ancestors. Long-term residents have developed relationships with their neighbors and have adapted to the flooding situation in their community. Furthermore, these residents are attached because they feel safe from risks other than flooding. Balachandran [27] underscores that people will continue to stay after making several tradeoffs based on their situation and until they no longer feel "safe". Attachment to a place is a complex social driver in terms of risk mitigation, because it is linked to the emotional judgment of people who are at risk. Place attachment is also a factor in both developed and developing countries [28,29], but its impact on an individual's vulnerability and risk can be either negative (e.g., decreasing risk perception and motivation to mitigate risk) or positive (e.g., increasing awareness) [30].

The second social driver emphasizes the importance of convenient access to essential services that support and educate family members. This includes supermarkets or public markets and commercial establishments or malls where food, medicine, and other necessities can be easily obtained, as well as schools for children and hospitals or health

centers for emergencies and illnesses. The convenience of having these amenities nearby influences people's decision to stay in the area despite the risk of flooding. This also indicates inadequate urban or land-use planning in the region, considering the accessibility of essential facilities within the flood-prone area.

Economic considerations also play a crucial role in the decision making of these residents. Residents who lacked financial capacity were unable to move to safer zones. Moreover, proximity to work and more livelihood opportunities influence the decisions of residents to stay, outweighing the potential risks of flooding.

Another social factor that influences the decision of families to stay is having stable housing by owning a house through inheritance or investment. These residents highly valued their ancestral home and wanted to preserve it, while others who invested in or were still paying for their house felt a sense of fulfillment for having a house of their own and preferred to stay despite the flood risk.

Finally, another indirect factor affecting the flood vulnerability of residents living in the flood zones of Metro Manila is the perceived safety from floods. This includes residents who live on relatively high ground, have a two-story or higher house, reside above the first floor of a residential building, and live far from rivers or creeks. These residents feel that they are safe from floods because they are relatively less flooded, or they have easy access to a place to evacuate in case of a high flood.

The results also reveal that despite the moderate to high total level of preparedness, the majority of the households, for various reasons, are less willing to evacuate, and instead would stay on the highest level of their house or go to a neighbor's or relative's place. The concerns raised by residents include discomfort in staying in crowded places, lack of hygiene, and possible sickness of family members, especially considering the recent pandemic. Unfortunately, these are common problems at evacuation centers [31,32] and underscore the facility and planning gaps in disaster risk reduction management in the area.

Deeply attached to their homes and familiar surroundings, residents in flood-prone areas often display limited interest in relocation. This highlights the importance of developing and promoting self-coping and adaptive strategies to empower residents to manage flood disasters, rather than relying solely on relocation efforts or emergency assistance from the government. Notably, a recent study showed that a stronger desire to remain coincides with increased engagement in mitigation measures, which suggests the potential for community-driven solutions to reduce flood impacts [14]. In disaster risk management, the participatory approach is a beneficial tool in disaster management because it incorporates not only the opinion of experts but also the inputs of flood-affected individuals, households, and communities by engaging them in the decision-making process. This approach also encourages the sharing of knowledge and perspectives from different fields involved in decision-making to achieve effective risk management plans [33]. By integrating local knowledge of flood-related problems and what the residents need to address them, a comprehensive and sustainable plan is more likely to be developed [34]. Furthermore, the participatory approach increases trust among stakeholders and encourages and educates residents about their significant role in mitigating disasters, thus increasing the likelihood of implementing flood mitigation strategies [35]. In line with this, planners and policymakers should promote a participatory approach that encourages the involvement of residents in decision-making to develop community-based disaster preparedness programs that incorporate the needs of residents and their local knowledge.

Residents facing economic barriers or relying on local work opportunities require a multifaceted approach, beyond simply providing financial assistance and relocation sites. As relocation involves complex risk trade-offs (e.g., hazard risks and health and livelihood concerns) [27], programs in the relocation action plan (RAP) must address community needs and incentivize movement. For instance, developing livelihood programs and providing essential public facilities (such as schools, clinics, markets, and transportation) near relocation sites can address economic concerns and ensure continued access to livelihoods and daily necessities. This necessitates thorough urban planning, ensuring vibrant and

functional communities that mitigate the concerns of residents, and encouraging them to consider relocation as a viable long-term solution.

While this study offers valuable insights into the social aspects of flood management, its applicability to the upper (SIL) group remains unclear due to limited data from this stratum. Despite efforts to involve residents from diverse backgrounds, participation from the upper SIL remained low. This potentially limits the generalizability of the findings to the entire population. To address this limitation and to gain a more nuanced understanding of social drivers across all socioeconomic strata, we recommend expanding the scope of participants in future research to include more individuals from the upper socioeconomic spectrum. This broader representation could provide richer insights into the diverse perspectives and experiences within the community, ultimately leading to more comprehensive and applicable findings.

5. Conclusions

This study investigated the social factors that indirectly contribute to household vulnerability to floods in Metro Manila. A household survey was conducted in Marikina, Parañaque, and Manila, chosen based on historical flood events, affected families, population density, and estimated flooded area during a 100-year flood. To ensure statistical validity, participants were randomly chosen from each city, resulting in 1169 households. By applying a control measure stipulating that all participating households must have experienced flooding, the analysis focused on 1125 households.

This study identified several key social drivers that influence flood vulnerability. Place attachment and acclimatization to the local environment are the primary factors that influence decisions to remain in flood-prone areas despite the risks. Moreover, the convenience of accessible public services and amenities in the area plays a significant role, particularly for families with dependents. Economic considerations, housing stability, livelihood dependence, and perceived safety from floods further contribute to decisions, as residents and households weigh the benefits and losses between flood risks and immediate needs. The study further highlights the complex trade-offs that the majority of households undertake when choosing housing, where the prioritization of daily economic concerns outweighs the perceived threat of flooding.

Given the importance of comprehending the perspectives of residents in the successful implementation of effective and targeted interventions, this study recommends a two-pronged approach. The first involves adopting a participatory approach to flood risk management. This approach emphasizes the active participation of all relevant stakeholders, including policymakers, planners, local officials, and affected residents, to ensure that interventions are specifically tailored to meet the unique needs and priorities of each community. The second recommendation is to develop a comprehensive RAP that integrates appropriate urban planning strategies and the economic and environmental needs of affected families to encourage relocation.

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Conflicts of Interest: The authors declare no conflict of interest.

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