

Article

Community-Based Risk Analysis: Assessing Multi-Hazard Vulnerabilities in Urban Kampung in Surabaya, Indonesia

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Abstract

Urban kampungs in Surabaya, Indonesia, face layered vulnerabilities due to overlapping environmental hazards, socioeconomic precarity, and limited infrastructural support. Despite being central to the city's cultural and spatial fabric, these communities are often excluded from formal risk governance frameworks and mischaracterized as homogenous informal settlements. This paper explores how multi-hazard risks, such as tidal flooding, electrical hazards, and social insecurity, manifest in three kampungs: Kampung Nelayan Kenjeran, Kampung Kue Rungkut, and Kampung Kota Ketandan-Kebangsren. Using qualitative methods including interviews, field observation, and participatory risk mapping, the study examines local adaptation strategies, collective resilience, and everyday practices that mitigate risk. The findings emphasize the value of a community-based risk analysis approach that centers on resident knowledge and social networks. Such bottom-up strategies not only complement existing urban policies but also offer contextually relevant insights for inclusive and adaptive resilience planning in rapidly urbanizing environments.

Keywords: community-based participatory risk analysis; multi-hazard vulnerabilities; Surabaya; urban kampungs

1. Introduction

Urban kampungs in Indonesia, particularly in large cities like Surabaya, represent a unique form of settlement where formal and informal practices intersect. While often broadly categorized as informal settlements or slums, kampungs differ significantly in their historical, cultural, and spatial development trajectories. They are not merely areas of poverty or illegality but are dynamic, adaptive communities characterized by strong social networks, localized governance, and a deep sense of place. However, in the context of rapid urbanization, environmental degradation, and climate change, kampungs are increasingly exposed to a range of multi-dimensional hazards that amplify their vulnerability. In Surabaya, kampungs face overlapping risks that span environmental, infrastructural and social domains. Tidal flooding in low-lying coastal areas, infrastructural hazards such as faulty electrical systems, and social insecurity driven by unemployment and weakened social protection systems are among the most pressing threats. Despite these challenges, kampung residents have developed diverse informal strategies for adaptation and resilience, rooted in collective action and everyday practices. These locally grounded responses, however, often remain underrecognized in top-down urban planning frameworks, which tend to treat risk management as a technocratic exercise, sidelining lived experiences and community agency.



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This paper relates to the paradigm of inclusivity in relation to addressing the vulnerabilities of urban citizens through community-based approaches to risk governance advocated by various scholars during the past few decades. As early as the 1960s, Lefebvre [1] suggested that city residents of all incomes and statuses have a right to be engaged in participatory processes that inform institutional initiatives in their context. Similarly, Pelling & Wisner [2] emphasize a community-led decision-making process where communities vulnerable to hazards are best placed to identify their context-specific risks and solutions to address them. Such an integration of local knowledge in urban policies and programs is suggested as essential to the positive development of the city by reducing the vulnerability of the people most at-risk. Even global frameworks such as the Sustainable Development Goals [3], Sendai Framework for Disaster Risk Reduction [4] and the New Urban Agenda [5], all call for an inclusive approach that links urban citizens to risk governance processes. Such an approach is widely espoused; however, it is yet to be mainstreamed within institutional policymaking in countries such as Indonesia. This study pursued a bottom-up process to generate knowledge that might be of value toward informing urban policy and practice.

This study thus adopted a community-based participatory risk analysis (CBPRA) framework to understand and evaluate multi-hazard vulnerabilities in kampung environments. Building on concepts of social vulnerability [6] and participatory governance [7], CBPRA emphasizes the need to integrate local knowledge, adaptive strategies, and community organization into urban risk governance. It challenges the prevailing technocratic approaches by reconceptualizing risk as socially produced and contextually experienced, thereby advocating for more inclusive and place-based strategies in disaster risk management and urban planning. There is a range of participatory methodologies exist [8], say for example Participatory Action Research (PAR) [9], and different community development organizations even develop their own toolkits customized to their programs by drawing from the wide palette of participatory methodologies and tools developed over the last few decades. The CBPRA toolkit, including the Risk Quadrant tool, was similarly developed by one of the authors through engagement with stakeholders in a ‘slum upgrading’ project in Bangladesh [10]; given the contextual similarities, the toolkit was adapted for application in Surabaya, as discussed in this paper.

The research focuses on selected kampungs in Surabaya: Kampung Nelayan Kenjeran, Kampung Kue Rungkut, and Kampung Kota Ketandan-Kebangsren, chosen to reflect a diversity of hazard exposures and socio-spatial conditions. By examining these cases, the study aims to identify and categorize the types of multi-hazard vulnerabilities present, analyze how these vulnerabilities are perceived and addressed by residents, and assess the potential contribution of community-based risk analysis to enhancing urban resilience at the kampung scale. The study is guided by three main research questions: (1) What types of multi-hazard vulnerabilities are present in urban kampungs of Surabaya, and how do they interact? (2) How do kampung residents perceive, experience, and respond to these risks in their daily lives? (3) What role can community-based risk analysis play in supporting more inclusive and context-sensitive urban risk governance? By addressing these questions, the research seeks to contribute to a deeper understanding of urban vulnerability and resilience in the specific context of Surabaya’s kampungs, with the aim of informing more grounded and effective urban resilience strategies.

1.1. Urban Kampungs and Informal Settlements in Surabaya

A key limitation in research on urban kampungs in Indonesia lies in the challenges of their conceptualization. This complexity is compounded by the diversity of kampungs, which range from thriving, community-driven areas to places grappling with poverty and

infrastructural inadequacies. Globally, kampungs are often oversimplified and categorized alongside informal settlements such as *favelas*, *villa miseria*, shanty towns and other slum typologies. However, such comparisons risk overlooking the localized adaptations, socio-cultural practices, and spatial dynamics that make kampungs a distinctive form of urban living. In the urban studies discourse, kampungs are frequently described as slums [11], but this characterization does not fully capture their embedded social structures, economic significance, or adaptive capacities.

According to UN-Habitat [12], informal settlements are defined by characteristics such as insecure land tenure, inadequate access to basic services, and housing that does not comply with formal regulations. While many kampungs in Surabaya exhibit these traits, they also demonstrate forms of resilience and solidarity that challenge deficit-based narratives. Communities within kampungs often engage in collective practices to improve their living environments, underscoring the need for more nuanced interpretations of informality that go beyond infrastructural deficiencies.

In recent years, the development of kampungs in Surabaya has received increased attention, partly due to the city's efforts to balance urban expansion with the preservation of local culture and social wellbeing. As a form of urban informality, kampungs are traditional settlements that resemble rural villages, yet are situated within urban contexts. Although the term "kampung" shares linguistic similarities with "kampong" used in other parts of Southeast Asia, its meaning in Indonesia is uniquely rooted in localized practices of self-help housing, community governance, and social cohesion [13]. The kampung is not merely a spatial typology but also represents a socio-cultural institution where communal relationships and informal governance systems are integral to everyday life.

Kampungs in Indonesia largely embody the principles of self-help housing, where construction and improvements occur incrementally based on the evolving needs and resources of residents. This bottom-up process often involves collaborative labor, flexible design adjustments, and community-organized initiatives to upgrade homes and neighborhood infrastructure. Kampungs provide affordable housing options for low-income groups while simultaneously fostering a sense of belonging and autonomy that is often absent in formal housing developments. They also contribute significantly to the local economy through informal businesses, supporting livelihoods, and enhancing neighborhood resilience [14]. The socio-economic functions and communal identity embedded in kampungs highlight their vital role in urban development beyond conventional planning paradigms.

In Surabaya, kampungs remain a core component of the city's social and spatial fabric. They serve not only as residential areas but also as centers of cultural preservation and local economic activity. Recognizing their potential, the Surabaya City Government initiated the Kampung Unggulan ("Prominent Kampung") program in 2010, aiming to transform kampungs into hubs for small and medium-sized industries. The program provides facilitation in legalizing micro-enterprises, obtaining trading licenses, and achieving *halal* certifications, thereby fostering entrepreneurship while preserving traditional community structures. Successful examples of this initiative include Kampung Kue (Cake Kampung), Kampung Kerupuk (Cracker Kampung), and Kampung Tas (Bag Kampung) [15]. These programs illustrate how kampungs can evolve into dynamic spaces of innovation and production, reinforcing their role as critical contributors to Surabaya's economic vitality and urban identity.

1.2. Multi-Hazard Urban Vulnerabilities

Urban areas are increasingly exposed to multi-hazard vulnerabilities that intersect environmental, economic, infrastructural and social domains. These vulnerabilities are not isolated but often interact, creating complex risk landscapes that disproportionately

affect marginalized populations. Daily risks such as economic instability and insufficient income generation [16] can compound broader systemic vulnerabilities, entrenching cycles of urban poverty and insecurity.

Natural hazards remain a critical threat to urban systems. Hazards such as earthquakes and floods place substantial pressure on infrastructure and social networks, with the frequency and severity of some of the hazards often exacerbated by climate change. Economic vulnerabilities, including high unemployment rates, income inequality and limited fiscal resilience further undermine urban stability. Inflationary pressures and economic downturns increase the susceptibility of urban communities to shocks, making recovery after disasters more difficult and prolonging disruption.

Environmental pressures, such as declining green space coverage, urban heat island effects, and pollution of air and water systems, also significantly impact urban resilience [17]. The lack of ecological buffers not only deteriorates living conditions but also amplifies the effects of natural hazards. Social vulnerabilities are deeply interconnected with these environmental and economic factors. Disruptions in healthcare, education, and public safety systems can cascade across sectors, disproportionately affecting low-income groups, migrants and single-income households [18].

Moreover, urban vulnerabilities are dynamic, not static, and are also related to human-induced hazards. Changing patterns of waste management, industrial emissions and effluents, and technological risks such as cyber-attacks or infrastructure failures represent evolving threats that require adaptive governance strategies. These dynamic challenges demand continuous monitoring and policy flexibility to maintain urban resilience in the face of shifting hazards.

Historic urban areas also present unique vulnerability profiles. Aging infrastructure, heritage conservation challenges, and limited retrofitting capabilities increase the physical vulnerability of historic districts. Simultaneously, the social vulnerability of residents, often exacerbated by limited access to resources and preparedness programs, further amplifies disaster risks in these areas [19]. The strength of local networks and community-based preparedness strategies becomes crucial in mitigating the impacts of hazards on both the built environment and social structures.

In highly exposed urban zones, vulnerability is further influenced by socio-economic status, social identities, and the quality of community support networks. Populations such as the elderly, disabled, and homeless are particularly susceptible due to constrained access to services and institutional support [20]. The compounding effect of multiple vulnerabilities highlights the need for integrated, multi-sectoral strategies to address urban risk comprehensively.

1.3. Community-Based Participatory Risk Analysis Approach

Enhancing urban resilience requires a shift from top-down disaster management models toward more integrated, participatory approaches that engage communities directly in risk assessment and mitigation. Community-based participatory risk analysis (CBPRA) [10] offers a critical framework for identifying, understanding, and addressing urban vulnerabilities through localized engagement, collective preparedness, and adaptive strategies. By involving residents in decision-making processes, risk management initiatives become more contextually grounded and responsive to the specific conditions and capacities of different communities.

Integrated community services play a vital role in facilitating this approach. Strengthening policy implementation, supporting participatory urban strategies, and investing in sustainable, long-term initiatives are essential to ensure that resilience efforts are not merely reactive but also preventive [21]. Early interventions, informed by community

input, can help mitigate emerging risks before they escalate into crises. CBPRA is most effective when supported by strong institutional frameworks that align with local urban resilience strategies, ensuring that community actions are systematically incorporated into broader governance systems.

Qualitative methods, including in-depth interviews, participatory mapping, and focus group discussions, are particularly valuable in CBPRA. These tools capture nuanced insights into the adaptive capacities of communities and reveal subgroup-specific vulnerabilities that are often invisible in conventional risk assessments [22]. Understanding the differentiated needs within communities, such as those of the elderly, migrants, or low-income groups, is essential for designing inclusive strategies that leave no population group behind.

Moreover, CBPRA emphasizes the importance of continuous learning and adaptation. Given the dynamic nature of urban risks, communities must be equipped with the knowledge and resources necessary to monitor hazards, reassess vulnerabilities, and adjust strategies over time. Building local capacities through training programs, workshops, and knowledge-sharing platforms not only strengthens immediate risk responses but also fosters long-term autonomy and resilience. By embedding capacity-building within community structures, CBPRA transforms resilience from a top-down policy objective into a community-driven process, enhancing both the effectiveness and sustainability of urban risk governance. Public perception of risk is crucial to understand in order to design effective, community-based adaptation strategies. The risk quadrant approach, which categorizes risks based on their frequency and impact, enables the identification of risk management priorities from the citizens' perspective [10].

2. Materials and Methods

This study adopts a Community-Based Participatory Risk Analysis (CBPRA) approach to investigate multi-hazard vulnerabilities in selected urban kampungs of Surabaya. CBPRA is rooted in the principle that communities should not merely be passive recipients of external interventions but can be active agents in identifying, assessing, and managing the risks they face. By emphasizing the lived experiences, local knowledge, and adaptive capacities of residents, CBPRA offers a pathway toward building resilience from within the community itself. In contrast to conventional top-down risk assessments, this approach foregrounds participatory engagement as essential to understanding the social construction of vulnerability and enhancing context-specific resilience.

The CBPRA framework employed in this study integrates qualitative methodologies, including participatory workshops, semi-structured interviews, field observations, and the use of the Risk Quadrant Tool to facilitate the prioritization of identified hazards. Through this participatory lens, resilience is conceptualized not simply as the capacity to recover from hazards but as the dynamic ability of communities to anticipate, adapt, and transform in the face of multi-hazard exposures.

The selection of the study areas was informed by preliminary disaster risk assessments conducted by the Center for Disaster Mitigation and Climate Change Studies at ITS (where most of the authors are based) in 2021, which mapped hazard exposure, vulnerabilities, and coping capacities across urban Surabaya in a monograph (unpublished). Kampungs exhibiting relatively lower resilience levels, as identified through the Layering Risk Assessment model, were prioritized to capture contexts where community-based strategies would be most critical. Three kampungs were selected: Kampung Nelayan Kenjeran, Kampung Kue Rungkut, and Kampung Kota Ketandan-Kebangsren (see Figures 1–3), each representing a distinct risk profile, namely tidal flooding, infrastructural hazards, and social

insecurity, thereby providing a comparative basis for understanding multi-dimensional vulnerabilities.

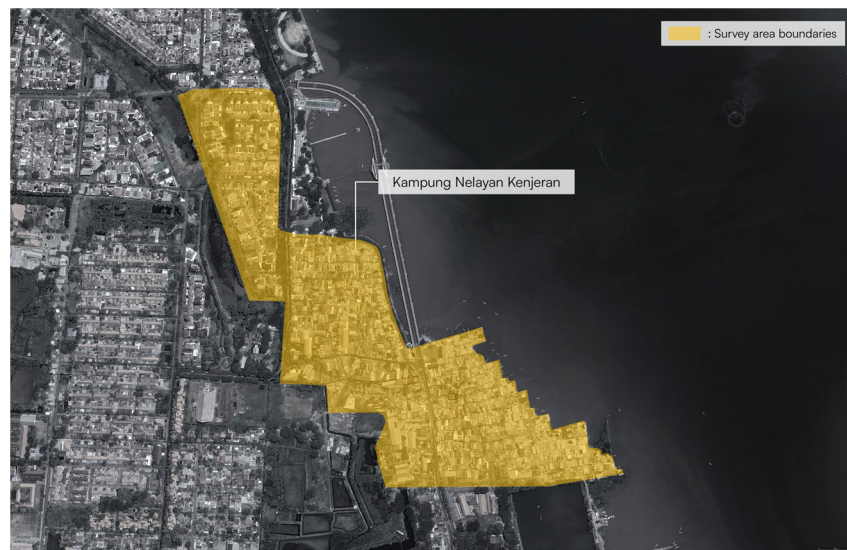


Figure 1. Site 1—Kampung Nelayan Kenjeran.



Figure 2. Site 2—Kampung Kue Rungkut.



Figure 3. Site 3—Kampung Kota Ketandan Kebangsren.

Primary data collection commenced with participatory workshops conducted within each kampung. These workshops engaged a diverse range of community members, including women, youth, elders and local leaders, ensuring an inclusive representation of perspectives. Participants collaboratively identified hazards affecting their communities, discussed their perceived impacts, and engaged in hazard prioritization exercises using the Risk Quadrant Tool. This tool guided participants in ranking hazards along two axes, perceived severity of impact and probability of occurrence, enabling a systematic yet accessible method for community-driven risk assessment (see Figure 4). The research team engaged with the research participants extensively to explain the tool and ensured that they understood it.

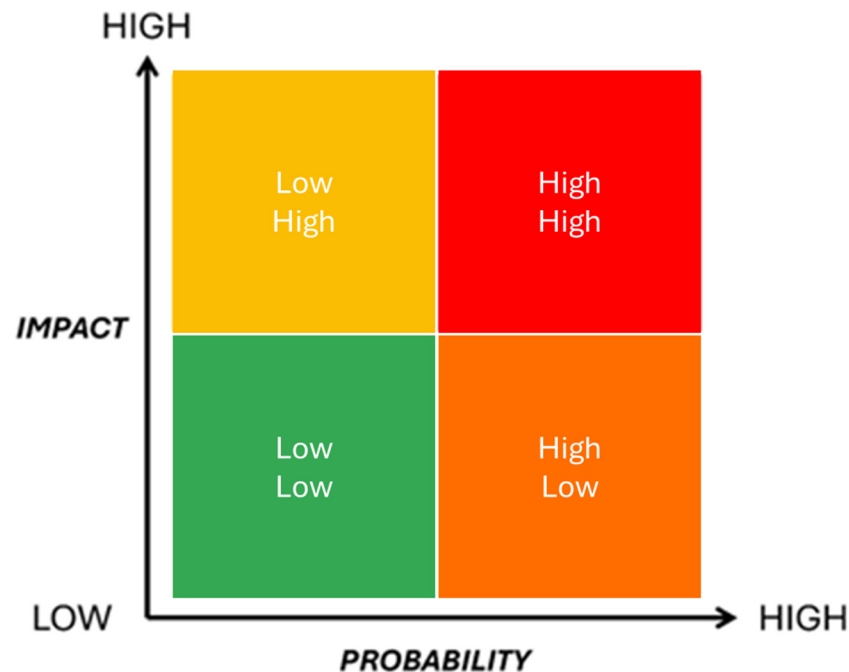


Figure 4. The Risk Quadrant Tool.

To ensure that the data collected were statistically reliable, the minimum number of respondents required in each kampung was determined using Slovin's formula, as outlined in Table 1. Slovin's formula was chosen because it fits the needs of quantitative research that requires an objectively measurable sample size. Representativeness is maintained by adjusting the sample distribution proportionally through stratification and randomization. Using Slovin's formula ensures that the data collected accurately represents the population of the kampung. From the monograph data, the population (per kampung) and the area of each kampung were obtained, which allowed the calculation of Population Density (per km²). Subsequently, the Population Density was multiplied by the Kampung Area to determine the Kampung Population (N). The units for each category were defined as follows: Population (per kampung), Population Density (per km²), Area of Sub-District (km²), Kampung Area (km²), and Kampung Population (N).

In parallel, semi-structured interviews were carried out with key informants, including long-term residents, community organizers, and representatives from local government institutions. These interviews explored historical experiences with hazards, existing coping mechanisms, and perceptions of institutional support or gaps. Field observations were conducted concurrently to document physical vulnerabilities observable in the built environment, such as the condition of drainage systems, housing structures, public spaces, and critical infrastructures. To complement primary data, a review of secondary sources

was undertaken, encompassing urban planning documents, disaster risk reduction strategies, demographic profiles, and prior vulnerability assessments. This secondary data provided a broader contextual background and enabled triangulation of findings from community-based activities.

Table 1. Numbers of research respondents.

Total	Kampung Nelayan Kenjeran	Kampung Kue Rungkut	Kampung Kota Ketandan-Kebangsren
Population (per sub-district)	10,422	22,926	8394
Population Density (per km ²)	4512	15,812	15,262
Area of Sub-district (km ²)	2.309840426	1.44991146	0.5499934478
Kampung Area (km ²)	0.06805531	0.00756168	0.0992835
Kampung Population (N)	307	120	1515
Margin of Error	0.1	0.1	0.1
Minimum Number of Respondents (Slovin)	75	54	94

Data analysis proceeded through identifying recurring patterns related to risk perception, vulnerability-drivers, coping strategies, and collective action. Thematic coding was conducted manually because understanding how to map respondents' answers to the hazard types under investigation was crucial. In this context, qualitative coding involved mapping hazards from the perspectives of respondents whose answers did not fit into the pre-existing hazard categories from previous related research [10] and were thus context specific. In addition, hazard prioritization outputs from the risk quadrant exercises were synthesized into localized risk maps, providing a spatial visualization of key vulnerabilities. Comparative analysis across the kampungs allowed for the identification of common themes as well as kampung-specific dynamics in vulnerability and resilience-building processes.

As part of an ethical research process, the consent of the workshop and interview participants was obtained after explaining the study and its objectives to them, and that their identity would be kept anonymous beyond the research team and in all publications resulting from the research. The participants were also informed that they could choose not to participate, and also that they could withdraw their participation at any stage without having to provide a reason. Even though there were no direct benefits to the participants, they were informed that the findings of this study may have potential to inform institutional resilience-building policies and initiatives for their communities.

3. Key Findings and Results of the Research Investigations

The participatory risk quadrant mapping exercises revealed distinct patterns of hazard prioritization across the case study kampungs, highlighting how localized environmental conditions, infrastructural capacities, and socio-economic dynamics shape residents' perceptions of risk severity and likelihood. While certain hazards, such as flooding and waterlogging, appeared across all sites, the dominant concerns varied significantly, reflecting the spatial and social diversity of vulnerability landscapes within Surabaya.

This differentiated prioritization provides a critical foundation for understanding the complex layering of vulnerabilities in urban kampungs, and it signals the necessity for risk governance approaches that are both place-specific and hazard-integrated. The following two Sections 3.1 and 3.2 discuss the differentiation of vulnerability, and broadly, the hazards typologies in the three case study kampungs and related community perceptions.

3.1. Differentiated Vulnerability Across Community Groups

Beyond the differences observed between kampungs, the study also revealed important variations in vulnerability perceptions across different community groups within each kampung. Risk is not experienced uniformly even within the same spatial context; instead, it is filtered through the lenses of age, gender, social role, and livelihood position, producing stratified patterns of perceived exposure and capacity to adapt. Among women and elderly participants, infrastructural and environmental hazards were consistently ranked as the most significant threats. Issues such as poor drainage, deteriorating house conditions, and heightened risks of disease transmission from stagnant water were particularly emphasized. These groups often framed vulnerability through the lens of daily life disruptions and personal safety concerns, highlighting how limited physical mobility and caregiving responsibilities intensified their exposure to both environmental and infrastructural risks. In contrast, youth participants expressed greater concern over social hazards, particularly theft, gang activities, and the erosion of communal safety. In discussions, youth groups pointed to the changing social fabric of the kampungs, where economic pressures and demographic shifts have weakened traditional community ties, leading to heightened perceptions of insecurity and distrust in public spaces.

Community leaders, both formal (RT/RW heads, i.e., community leaders) and informal (religious and market leaders), tended to frame risk in more systemic terms. They identified gaps in governance structures, lack of institutional support for infrastructure maintenance, and limited community preparedness for disaster response as key contributors to ongoing vulnerabilities. Rather than isolating individual hazards, leaders often pointed to their interconnectedness, emphasizing how environmental degradation, infrastructural failures, and social disintegration compounded each other to produce complex and persistent vulnerabilities. During data collection, respondent representation was ensured by allocating proportional participation for each category: youth, adults, and elderly. However, during the quantitative data analysis, all categories were treated as a single unified group of kampung residents.

These differentiated perceptions across social groups reveal that vulnerability is both socially constructed and relational. What constitutes a major risk for one group may be considered secondary by another, depending on daily practices, social status, and access to coping resources. Understanding these layered vulnerabilities is crucial for designing inclusive risk reduction strategies that respond not only to the physical characteristics of hazards but also to the lived realities of diverse community members. The next section synthesizes these findings into a broader typology of hazards and vulnerabilities, illustrating how multiple dimensions of risk converge within urban kampungs, and outlining the emerging multi-hazard landscapes experienced in the kampungs.

3.2. Typologies of Hazards and Their Perceived Risks

Synthesizing the findings from the kampung-level hazard prioritization and the differentiated perceptions among community groups, three broad typologies of hazards and vulnerabilities emerged across the studied sites: environmental hazards, infrastructural hazards and social vulnerabilities. These categories are not mutually exclusive; they often overlap and interact, producing complex multi-hazard landscapes that challenge simplistic or sectoral approaches to risk management.

Environmental hazards such as tidal flooding, waterlogging, heavy rainfall, and storm impacts were most pronounced in coastal and low-lying areas like Kampung Nelayan Kenjeran. These hazards are primarily linked to natural processes, but their severity is compounded by anthropogenic factors such as inadequate drainage systems and coastal

reclamation activities. Environmental vulnerabilities tend to be manifested as direct physical risks to property, health, and mobility, especially during seasonal peak events.

Infrastructural hazards were a dominant concern in Kampung Kue Rungkut, where risks related to electrical hazards, drainage failures, and deteriorating housing stock were prioritized. These hazards reflect the cumulative effects of informal urbanization, aging infrastructure, and insufficient maintenance regimes. Unlike environmental hazards, infrastructural vulnerabilities are embedded within everyday routines, making them persistent, normalized, and often less visible to external observers.

Social vulnerabilities, including theft, insecurity, and the pressures of gentrification, were most acutely observed in Kampung Kota Ketandan Kebangsren. As urban redevelopment processes intensify, traditional social networks are eroded, and long-term residents face increasing displacement pressures. These social risks represent a shift in the urban kampung risk landscape, where socio-economic transformations create new forms of exposure and marginalization that are not captured by traditional disaster risk assessments.

Overall, the convergence of these hazard typologies underscores the evolving complexity of urban kampung vulnerability. No single kampung faces risks from only one source; rather, residents navigate overlapping and intersecting hazards that are shaped by their physical environment, infrastructural context, and socio-economic conditions. Recognizing this multi-dimensionality is crucial for moving beyond hazard-specific interventions toward integrated and adaptive risk reduction strategies that align with the realities of kampung life.

3.3. *Kampung-Specific Results*

The research investigation was carried out through the distribution of questionnaires and structured interviews with initial respondents across the three kampung locations. The resulting dataset was used to conduct a preliminary mapping of the types of hazards faced by the communities, classified into four categories within the Risk Quadrant diagram (see Figure 4): high impact with high probability, high impact with low probability, low impact with high probability, and low impact with low probability. The following section presents an overview, analysis, and explanation of the results of the investigations in the three case study kampungs.

3.3.1. *Kampung Nelayan Kenjeran*

Fisherfolk settlements in Indonesia's coastal areas face various environmental risks that affect social, economic, and public health aspects. High building density, poor infrastructure quality, and exposure to climate change contribute to increased vulnerability to coastal hazards and environmental degradation [23]. Residents who work in the fishing industry are usually highly dependent on the natural environment in which they live [24]. To identify and understand the potential hazards faced by the coastal community in Kenjeran fisherfolk kampung (see Figure 5), a field survey was conducted and analyzed using the Risk Quadrant approach. This approach mapped the likelihood and impact of each potential risk present in the area. The survey results showing the potential hazards in Kampung Nelayan Kenjeran based on the Risk Quadrant are presented in Table 2 and Figure 6.

The field study conducted in Kampung Nelayan Kenjeran revealed that out of 77 respondents, the hazards categorized as High Impact High Probability (HIHP) were predominantly flooding, storm, heavy rain, and waterlogging. A total of 14.2% to 19.48% of the respondents selected floods, storms, heavy rain, and waterlogging as primary hazards. These hazards are interrelated: waterlogging is a direct consequence of heavy rain and storms. These three HIHP risks also contribute to other vulnerabilities such as poor health

conditions and polluted water. In addition to these interrelated hazards, other vulnerabilities identified by residents include poor housing conditions and inadequate sanitation facilities. Specifically, in this fisherfolk kampung, there is a different hazard not common in other urban kampungs: tidal flooding. This was mentioned by six respondents (7.79%), along with theft, which was identified by eight respondents (10.38%). The issue of theft is important to note—such crime is usually committed by people who are outsiders and do not belong to the kampung; the community within a kampung is generally cohesive and does not commit crime against their own community members.

Table 2. Hazard risk mapping datasets of Kampung Nelayan Kenjeran.

Hazard	High Impact High Probability (%)	Low Impact Low Probability (%)	High Impact Low Probability (%)	Low Impact High Probability (%)	SUM
Waterlogging	3.90	66.23	11.69	18.18	77
Flood	14.29	50.65	25.97	9.09	77
Storm	19.48	28.57	46.75	5.19	77
Heavy rain	16.88	44.16	25.97	12.99	77
Inadequate drainage	3.90	72.73	14.29	9.09	77
Bad house condition	7.79	51.95	31.17	9.09	77
Poor health condition	16.88	41.56	38.96	2.60	77
Polluted water	10.39	74.03	7.79	7.79	77
Fire	1.30	79.22	19.48	0.00	77
Poor latrine	6.49	72.73	6.49	14.29	77
Inadequate waste disposal	10.39	72.73	9.09	7.79	77
Social problems	12.99	62.34	14.29	10.39	77
Electric hazard	5.19	74.03	14.29	6.49	77
Hazards based on community perceptions					
Tidal flood	7.79	85.71	1.30	5.19	77
Reclamation	1.30	98.70	0.00	0.00	77
Heavy construction activity	0.00	97.40	2.60	0.00	77
Insect	2.60	96.10	0.00	1.30	77
Shell waste pollution	1.30	98.70	0.00	0.00	77
Youth risk behavior	0.00	98.70	0.00	1.30	77
Theft	10.39	84.42	3.90	1.30	77
Community leadership gap	0.00	98.70	1.30	0.00	77
Illegal fishing	0.00	98.70	0.00	1.30	77
Tsunami	0.00	98.70	1.30	0.00	77
Earthquake	3.90	96.10	0.00	0.00	77
Stray animals	1.30	98.70	0.00	0.00	77
Heatwave	0.00	98.70	1.30	0.00	77
Poor nutrition quality	1.30	98.70	0.00	0.00	77
Littering in the sea	3.90	94.81	0.00	1.30	77

Table 2. Cont.

Hazard	High Impact High Probability (%)	Low Impact Low Probability (%)	High Impact Low Probability (%)	Low Impact High Probability (%)	SUM
Pests	0.00	98.70	0.00	1.30	77
Drugs	2.60	97.40	0.00	0.00	77



Figure 5. A view from Kampung Nelayan Kenjeran showing its coastal location (photo credit: Author Iftekhar Ahmed).

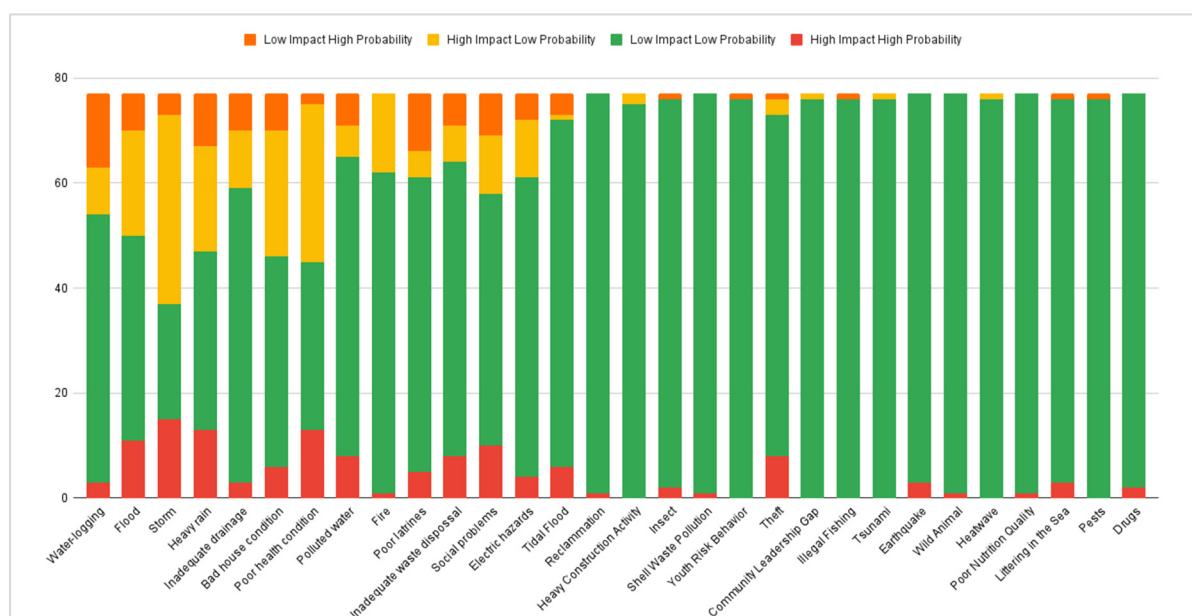


Figure 6. Stacked column chart derived from Risk Quadrant findings (Kampung Nelayan Kenjeran).

Under the High Impact Low Probability (HILP) category, which includes hazards of severe impact, but low frequency, storm, poor health conditions, and poor housing conditions remain the most frequently chosen, which as mentioned above, reflect the lack of institutional support. Flooding and heavy rain are also among the top responses; between 20 and 36 people selected these hazards. For drainage problems and social issues, 11 respondents selected each, while fire was chosen by 15 respondents. When combining responses from those who mentioned storm, flood, and heavy rain as high-impact risks, a significant percentage emerges, approximately 40.25% to 53.24% of the total respondents in this kampung, which indicates that hydrometeorological hazards are predominant in this context.

In the Low Impact High Probability (LIHP) category, residents reported hazards that occur frequently but are perceived to have a relatively low impact. These included water logging (14 respondents), heavy rain (10 respondents), and flooding (7 respondents). Additionally, poor housing conditions and inadequate drainage were selected by around 6–7 respondents. From the field survey, between 31 to 41 people (40.25% to 53.24%) identified these five hazards, and even though some respondents categorized them as high impact with low probability, they remained among the main concerns, despite their perceived low impact.

The final category, Low Impact Low Probability (LILP), includes hazards that are rarely experienced and perceived as having minor impact. Waterlogging, inadequate drainage, polluted water, fire, and electrical hazards were still the most frequently selected by the community.

Several other issues also emerged based on community input or perception, such as tidal flood, reclamation, heavy construction activity, insects, safety threats (e.g., gangsters), waste pollution, youth risk behavior, theft, community leadership gap, illegal fishing, tsunami, and earthquake. Although these hazards were mentioned, they were not considered major concerns by most of the community, possibly due to their low frequency or perceived minimal impact, and they appear to have become normalized over time.

3.3.2. Kampung Kue Rungkut

Kampung Kue Rungkut is a residential area in Surabaya that has unique characteristics and its own set of challenges in facing hazards and environmental issues. Like many other densely populated kampungs, Kampung Kue Rungkut has a high residential density, with diverse building structures and infrastructure conditions that are not yet fully adequate. In Kampung Kue Rungkut, the main challenges include flooding, heavy rainfall, and fire risks caused by intensive use of household electrical appliances, a specific urban risk. Other domestic risks, such as poor drainage (see Figure 7) and electrical hazards, also consistently appear in residents' perceptions. The field study conducted with 78 respondents in Kampung Kue Rungkut presents the findings shown in Table 3.

Table 3. Hazard risk mapping datasets of Kampung Kue Rungkut.

Hazards	High Impact High Probability (%)	Low Impact Low Probability (%)	High Impact Low Probability (%)	Low Impact High Probability (%)	SUM
Waterlogging	2.56	58.97	3.85	34.62	78
Flood	5.13	65.38	17.95	11.54	78
Storm	2.56	56.41	28.21	12.82	78
Heavy rain	10.26	29.49	28.21	32.05	78

Table 3. Cont.

Hazards	High Impact High Probability (%)	Low Impact Low Probability (%)	High Impact Low Probability (%)	Low Impact High Probability (%)	SUM
Inadequate drainage	8.97	73.08	10.26	7.69	78
Bad house condition	8.97	73.08	12.82	5.13	78
Poor health condition	6.41	56.41	34.62	2.56	78
Polluted water	5.13	69.23	17.95	7.69	78
Fire	1.28	64.10	23.08	11.54	78
Poor latrines	2.56	79.49	10.26	7.69	78
Inadequate waste disposal	29.49	51.28	11.54	7.69	78
Social problems	10.26	69.23	12.82	7.69	78
Electric hazards	8.97	67.95	19.23	3.85	78
Stray animals	6.41	88.46	0.00	5.13	78
Large number of flies	0.00	98.72	0.00	1.28	78
Strong wind	0.00	97.44	0.00	2.56	78
DBD (dengue fever)	0.00	92.31	7.69	0.00	78
Drought	2.56	97.44	0.00	0.00	78
Lack of fuel	0.00	97.44	2.56	0.00	78
Lack of electricity	2.56	97.44	0.00	0.00	78
Theft	1.28	92.31	1.28	5.13	78
Pests	1.28	98.72	0.00	0.00	78
Youth risk behavior	6.41	93.59	0.00	0.00	78

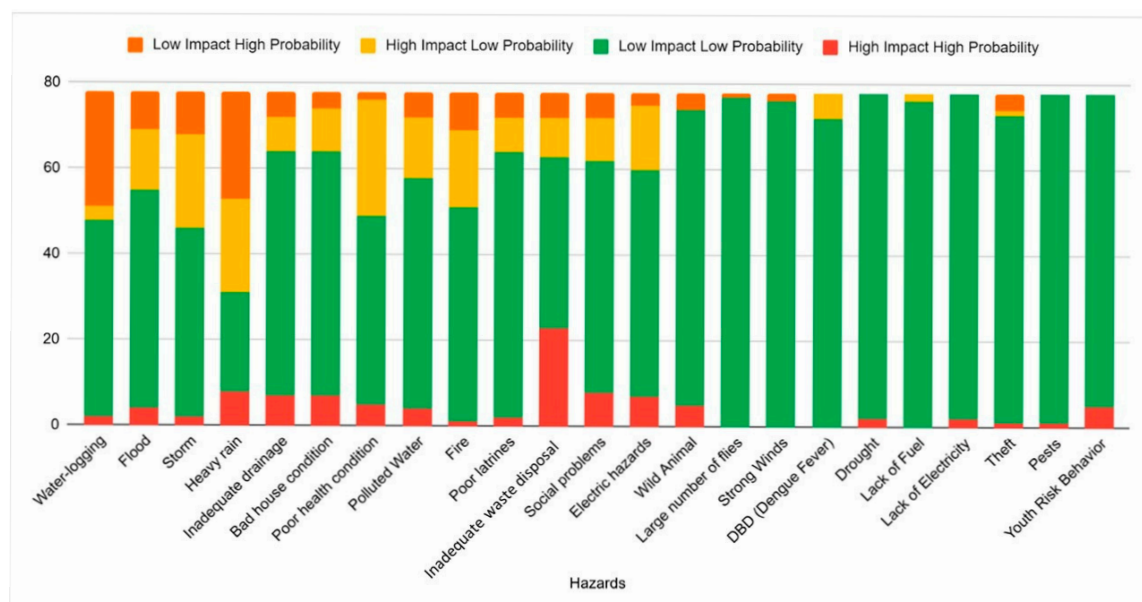


Figure 7. Stacked column chart derived from the Risk Quadrant findings (Kampung Kue Rungkut).

The survey provides further insights. In the HIHP category, the most prominent hazard identified was inadequate waste disposal, cited by 29.49% respondents as both high impact and high probability. Other significant hazards included heavy rain, bad house

conditions, inadequate drainage (see Figure 8), and electric hazards, each cited by 7 to 8 respondents. These findings reinforce that residents are acutely aware of recurring threats that significantly affect their daily lives and overall well-being.



Figure 8. A view from Kampung Kue Rungkut showing its inadequate drainage conditions (photo credit: Author Iftekhar Ahmed).

In the High Impact Low Probability (HILP) category, hazards with potentially severe consequences were included despite their infrequent occurrence. Health risks such as dengue fever (DBD) and polluted water were also included in this category, cited by 6 to 14 respondents. Additionally, social problems and electric hazards were mentioned with slightly lower but still notable numbers. These findings indicate that while such hazards may occur less frequently, their impact could be highly detrimental if they do happen.

In the Low Impact High Probability (LIHP) category, residents identified hazards that they frequently experience but perceive to have a relatively minor impact. Waterlogging was the most dominant issue in this category, with 27 respondents reporting frequent experiences, followed by heavy rain (25 respondents) and flood (9 respondents). Inadequate drainage and poor sanitation, such as improper toilets and poor waste management, were also common issues, each reported by 4 to 6 respondents, which are related to the hazards above including waterlogging and flood. Bad house conditions and theft were among the frequently occurring hazards as well, mentioned by one to four respondents. The high frequency of these hazards indicates the need for continuous intervention to improve

infrastructure and enhance the community's quality of life, and to build capacity for community policing.

The Low Impact Low Probability (LILP) category includes hazards that are rarely encountered and that are perceived to have minimal impact by the community. Feral or stray animals, a large number of flies, strong winds, drought, and shortage of electricity or fuel fall into this group. Stray animals were not seen as a threat by 69 respondents; flies and strong winds were dismissed by 77 and 76 respondents, respectively. Drought and electricity shortages were also considered low impact and rare by 76 respondents. Although these hazards were listed, they were not viewed as major concerns by residents, likely due to their low frequency or negligible impact. Additionally, emerging risks such as youth risk behavior were also placed in this category, with five respondents mentioning it.

Overall, the situation in Kampung Kue illustrates a complex vulnerability landscape, where physical, social and environmental hazards intersect. Poor waste management, fire hazards, and lack of proper waste disposal are the primary hazards that require immediate attention. Meanwhile, frequent events such as waterlogging, heavy rain, and flooding, though seen as of lower impact, continue to disrupt residents' activities and health, signaling the need for sustained focus, especially in improving the drainage system. Social issues, including conflict, youth risk behavior, and insecurity, should not be overlooked, as over time they may further exacerbate the vulnerability of this kampung.

3.3.3. Kampung Kota Ketandan-Kebangsren

Kampung Kota Ketandan-Kebangsren is a densely populated residential area located in the heart of Surabaya. Its strategic location in the city center makes it highly vulnerable to rapid urbanization and gentrification (see Figure 9), including environmental, social, and economic pressures. Most of the houses in this kampung were self-built by residents, often without adherence to disaster-resilient construction standards. The research findings from Kampung Ketandan Kebangsren are presented in Table 4 and Figure 10.



Figure 9. A view from Kampung Kota Ketandan Kebangsten indicating its central city location (photo credit: Author Iftekhar Ahmed).

Table 4. Hazard risk mapping datasets of Kampung Kota Ketandan Kebangsren.

Hazards	High Impact High Probability (%)	Low Impact Low Probability (%)	High Impact Low Probability (%)	Low Impact High Probability (%)	SUM
Waterlogging	0.78	75.78	3.12	20.31	128
Flood	2.34	85.16	5.47	7.03	128
Storm	0.00	86.72	5.47	7.81	128
Heavy rain	4.69	65.63	0.78	28.91	128
Inadequate drainage	1.56	88.28	3.91	6.25	128
Bad house condition	4.69	69.53	4.69	21.09	128
Poor health condition	4.69	85.16	3.12	7.03	128
Polluted Water	8.59	74.22	5.47	11.72	128
Fire	6.25	80.47	10.16	3.12	128
Poor latrines	3.91	88.28	0.00	7.81	128
Inadequate waste disposal	3.91	85.94	0.78	9.38	128
Social problems	12.50	67.19	7.03	13.28	128
Electric hazards	2.34	80.47	14.84	2.34	128
High-rise building development	1.56	92.97	3.91	1.56	128
Gentrification	1.56	96.09	1.56	0.78	128
Theft	10.16	85.16	3.91	0.78	128
Lightning	0.00	98.44	1.56	0.00	128
Earthquake	0.00	96.88	3.12	0.00	128
Extreme Heat and Climate	0.00	96.88	0.00	3.12	128
Stray Animals	0.00	98.44	1.56	0.00	128
Vacant House	0.00	99.22	0.78	0.00	128
Vacant House	1.56	92.97	3.91	1.56	128
Fallen Tree	1.56	96.09	1.56	0.78	128

Based on a survey involving 127 respondents from the local community, various types of hazards were identified and classified according to their level of impact and probability of occurrence. In the High Impact High Probability (HIHP) category, several major hazards emerged as the most significant and recurring threats in the residents' daily lives. Social problems such as interpersonal conflicts, insecurity and community disturbances ranked the highest with 16 respondents identifying them as high-impact and highly probable. Theft was also a serious concern, noted by 13 respondents. Bad house conditions and poor health conditions were each considered highly dangerous and frequently experienced, with six respondents selecting each. Fire was also significant in this category, expressed by eight respondents, and electric hazards were identified by three respondents. These findings reflect that both physical and social threats were acknowledged by residents and must be addressed together to reduce overall community risk.

The High Impact Low Probability (HILP) category refers to hazards that are infrequent but have the potential for severe consequences. Within this category, fire again received a high level of concern with 13 respondents, followed by electric hazards with 19 respondents. Natural hazards such as flood and storm were each cited by seven respondents, indicating

concerns over environmental risks despite their less frequent occurrence. Polluted water and social problems were also included in this category, mentioned by seven and nine respondents, respectively.

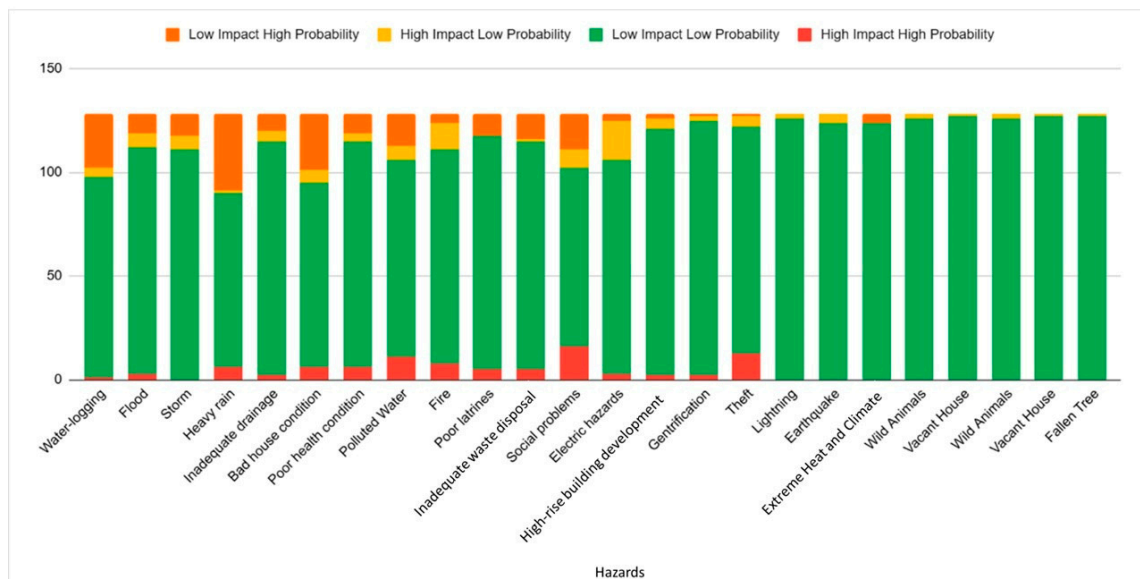


Figure 10. Stacked column chart derived from Risk Quadrant findings (Kampung Kota Ketandan-Kebangsren).

In the Low Impact High Probability (LIHP) category, the hazards identified are those that occur frequently but are perceived to have relatively low impact. Heavy rain was the most frequently experienced, with 37 respondents stating it as a routine event. Waterlogging was also common, mentioned by 26 respondents, and bad house condition was reported by 27 respondents. Inadequate drainage and poor latrines were each identified by eight and ten respondents, respectively. Inadequate waste disposal remains a consistent issue, with 12 respondents selecting it. Although the immediate impacts of these hazards are relatively minor, their high frequency leads to chronic issues that degrade living conditions and increase exposure to environment-related diseases such as gastro-intestinal infections and other health problems.

The Low Impact Low Probability (LILP) category includes hazards perceived as both low in impact and low in likelihood. These include stray animals, lightning, earthquakes, extreme heat and climate, vacant houses and fallen trees. Most respondents considered these hazards to have minimal relevance to their daily lives, as reflected in the very low response rates in this category. This indicates that these hazards are perceived as less significant, likely due to their rare occurrence, low intensity, or a general lack of direct experience with them.

Overall, the findings suggest that Kampung Kota Ketandan-Kebangsren faces a complex and interconnected set of multi-hazard vulnerabilities. Physical risks such as fire, poor sanitation (e.g., poor latrines, inadequate drainage, and inadequate waste disposal), and bad house condition are closely linked with social and economic risks such as social problems, theft, and gentrification. The imbalance between hazard frequency and impact poses a challenge in disaster risk reduction planning. Frequent but low-impact hazards like waterlogging and poor sanitation require sustained, long-term interventions to improve community well-being, while high-impact but less frequent hazards like fire and electric hazards demand significant preparedness and technical measures to prevent losses.

4. Discussion and the Way Forward

The following discussion addresses the specific issues that occur most frequently and have the greatest impact on the community in each kampung, along with potential mitigation strategies.

4.1. Tidal and Localized Floods, and Social Problems in Kampung Nelayan Kenjeran

As is well known, flooding in coastal areas can be caused by heavy rain or tidal floods. Tidal flooding is an increasingly common hazard in coastal regions. Coastal settlements are most vulnerable to tidal floods, with communities affected economically, socially and health-wise. Tidal flooding is caused by seawater rising and inundating low-lying land areas, especially settlements adjacent to the coast. This phenomenon results from a combination of sea level rise, land subsidence and climate change [25]. In Indonesia, coastal cities such as Semarang, North Jakarta, and Demak are clear examples of areas severely affected by tidal floods. In recent years, tidal flooding has begun to occur in the Kampung Nelayan Kenjeran area and its surroundings, disrupting the daily activities of the community. According to the perceptions of residents, the flooding was caused by rising sea levels.

From the research conducted, flooding, whether caused by tidal flooding or localized flooding due to heavy rain, has resulted in a decline in the community's quality of life. This condition impacts the lives and activities of residents, including social problems arising from decreased economic activity. Flooding hampers business activities, reduces productivity due to damaged homes, disrupts daily routines, and causes health issues such as skin diseases and diarrhea due to unhygienic conditions created by persistent waterlogging. This reflects the wider issue of lack of provision of adequate drainage by the city government and consequent mistrust of the government.

To address these issues, several mitigation strategies can be implemented through structural and non-structural approaches. The Kenjeran community and Surabaya City Government have already undertaken some adaptation measures for the tidal flooding problem. Structurally, tidal flooding can be managed by building seawalls, polders and adequate drainage systems. However, in Kenjeran, these measures have not been fully implemented. A dike constructed alongside the Surabaya Bridge, built around 2015, has somewhat helped mitigate tidal flooding in some directly affected areas. However, the majority of the area remains vulnerable. Additionally, the bridge itself creates access difficulties for local fishers, affecting their boat movements to and from the sea, an issue not covered in this paper.

Non-structurally, efforts to reduce impact need to focus on educating the community. For example, constructing houses that meet coastal area standards, planting mangroves, maintaining cleanliness to prevent litter, and ensuring that drainage channels remain free of trash. Despite these efforts, house construction that meets standards is sometimes hindered by residents' financial constraints and builders' knowledge. Moreover, mangrove planting is currently not feasible in Kampung Nelayan Kenjeran due to geographic conditions, and further study is needed regarding this concept.

From the above explanation, it is clear that this fishing kampung faces a very high potential for multi-hazard pressure. This multi-hazard pressure results from a combination of hazards that simultaneously influence the occurrence of other consequences. Flooding caused by heavy rain or tidal flooding disrupts community activities. This situation is worsened by poor infrastructure conditions, such as inadequate drainage, poor housing, and mismanaged waste. Poor waste management clogs drainage channels, and many residents still dispose of waste improperly, which exacerbates flooding during rain. This is again a reflection of the inadequacy of institutional support to address these risks.

In addition, residents also complain about security disturbances caused by safety threats (gangsters), shell waste pollution, youth risk behavior, theft, and community leadership gaps. All of these issues stem from social shifts within the community. According to in-depth interviews, this phenomenon began after the construction of the Surabaya Bridge, which caused social changes. Previously, the area was more homogeneous, mainly inhabited by the Madurese ethnic group, whose livelihoods centered around fishing and marine-related activities. Currently, the area is increasingly influenced by other activities, such as marine tourism, with the bridge serving as an iconic tourist landmark. Additionally, to boost local incomes, the Surabaya City Government developed the Bulak Fish Center, located in the same district as Kampung Nelayan Kenjeran, attracting many tourists. Around the Fish Center, parks and the Suroboyo Monument (an icon of Surabaya) have also been built.

Economic growth has naturally attracted outsiders, who have started settling near the fisherfolk kampung. The mingling of various cultures and customs has weakened social bonds in the community. Reduced social cohesion has consequently lowered residents' care and concern for their neighbors, environment, and each other.

Deviant youth behavior and the influx of external cultures have altered the social fabric. Youths growing up without adequate guidance, coupled with limited support from family, schools, and community leaders, have formed anti-social informal groups such as gangs. If left unchecked, these groups can disrupt public order. Their desire for identity and recognition makes them counterproductive to community harmony. In the long term, the degradation of social cohesion might lead to community fragmentation, inter-neighborhood conflicts, and weakened resilience to external challenges. This is indicative of an urban anomaly and a form of socio-spatial inequality that can emerge and grow in large cities like Surabaya.

These findings point to the need for kampung officials, community leaders, and religious figures to strengthen social cohesion to effectively counter threats from both internal and external sources.

4.2. Inadequate Waste Disposal in Kampung Kue Rungkut

Kampung Kue Rungkut is a densely populated residential area in Surabaya known not only as a place to live but also as a center for small-scale economic activity, specifically the production of traditional cakes. This home-based industry serves as the main source of income for most residents and is an important part of the local identity and culture. However, the intensive cake production activities also bring certain challenges, particularly related to inadequate waste management. This issue has the potential to cause serious impacts on the environment, public health, and the sustainability of local businesses.

Based on a survey involving 78 respondents, inadequate waste disposal emerged as one of the main issues with high impact and probability. A total of 23 respondents categorized this problem under High Impact High Probability (HIHP), making it the most frequently identified serious and recurring threat. Additionally, nine respondents placed it in the High Impact Low Probability (HILP) category, six respondents in Low Impact High Probability (LIHP), and the remaining 40 respondents in Low Impact Low Probability (LILP). These data show that although residents' perceptions vary, the majority recognize the significant potential danger of a suboptimal waste management system.

The main underlying problem causing inadequate waste management in Kampung Kue Rungkut is the lack of infrastructure, such as waste segregation systems and organized disposal routes. Waste from cake production, including leftover food materials, plastic packaging, and domestic wastewater, is often dumped directly without treatment. This leads to pollution and creates an unhealthy environment for residents. In the long term,

this can affect public health and the local economy's sustainability, as Kampung Kue's product reputation may be impacted by the environmental image.

To address this problem, coordinated intervention is needed involving the city government, environmental agencies, and local communities. Concrete steps such as providing integrated waste management facilities are essential. In addition, training home industry operators on more environmentally friendly production methods can help reduce waste volume and raise collective awareness about the importance of environmental sanitation. A community-based approach involving local leaders and cake producers can facilitate socialization and the implementation of solutions.

With active involvement from all parties, Kampung Kue Rungkut can achieve a cleaner, healthier environment that supports sustainable economic growth. This effort will not only solve waste problems but also strengthen the overall socio-economic resilience of the community.

4.3. Security Concerns and the Threat of Social Hazards in Kampung Ketandan Kebangsren

Kampung Kota Ketandan-Kebangsren is a densely populated residential area that faces not only environmental and physical risks but also various social challenges that significantly impact the safety and comfort of its residents. Based on data obtained from the survey, social problems rank high in terms of impact and probability, with 16 respondents rating social problems as a risk with High Impact High Probability (HIHP). Additionally, 86 respondents categorized social problems as Low Impact Low Probability (LILP), and nine respondents assessed the probability as high despite the impact being low, indicating that social issues are frequent and complex problems in this community.

The range of social problems faced by Kampung Kota Ketandan-Kebangsren includes social conflicts and criminal acts such as theft. Theft also received significant attention in the survey data, with five respondents categorizing it as High Impact Low Probability (HILP) and 109 respondents placing it in the Low Impact Low Probability (LILP) category. This indicates that although theft does not occur frequently, its impact on victims is severe, causing both material and psychological harm. This social insecurity poses a major challenge affecting residents' quality of life and community stability in Kampung Kota Ketandan-Kebangsren. Socio-spatial inequality leading to such social issues and crime is specific to this kampung because of its inner-city location and being surrounded by relative affluence, causing conditions of disparity.

Moreover, such social dynamics are influenced by urban changes such as gentrification and the development of high-rise buildings entering the area. While these changes are considered to have a low probability of occurring in the near term, their potential impact is very large and could drastically alter the community's social and physical structure. The data also show that social risks are closely related to poor public health conditions and sanitation, which indirectly exacerbate social tensions. When basic needs such as health and sanitation are inadequately met, frustration and dissatisfaction may increase, contributing to potentially significant social problems.

Addressing security issues and social hazards in Kampung Kota Ketandan-Kebangsren requires a comprehensive approach involving multiple stakeholders, including the government, security forces, and the local community itself. A community-based approach is crucial to building trust and facilitating dialogue among residents to resolve conflicts peacefully. Social welfare programs, including improvements in health and sanitation infrastructure, should also be integrated to reduce social problems. Strengthening local security institutions and increasing patrols and surveillance within the residential area can help reduce crime rates, particularly theft, which remains a concern for residents.

Overall, addressing social hazards in Kampung Kota Ketandan-Kebangsren must be an integral part of broader resilience-building strategies, as social factors greatly influence community preparedness and response to various threats.

4.4. Unveiling Risk Landscapes: A Comparative Analysis of the Three Kampung

Kampungs in Indonesia face diverse and complex risks, often compounded by a lack of planning, weak infrastructure, and socio-economic pressures. Understanding the unique ‘risk landscape’ of each kampung is essential for formulating inclusive and resilient urban development strategies.

From the discussion above, the three kampungs studied have different hazard vulnerabilities according to their landscape conditions. These three kampungs represent different natural settings and landscape challenges. The first kampung is a fishing kampung located on the coast, with a strong dependence on the coastal landscape. The livelihoods of the residents are related to the sea—whether as fisherfolk or through home-based businesses for processing marine products—making the sea their main source of livelihood. The issues faced by this coastal community are closely tied to its landscape and livelihoods. Periodic tidal flooding, localized floods, and storms disrupt daily activities, affecting both domestic life and income-generating work.

The second kampung is a home-based production kampung, primarily known for producing traditional cakes. Most households in this kampung produce cakes that are distributed daily throughout Surabaya. The processing of raw materials into ready-to-eat products also generates a large amount of waste, both organic and non-organic. The significant volume of waste and inadequate waste management make waste a critical problem in this cake kampung. Additionally, the relatively high electricity uses to support their businesses sometimes leads to electrical short circuits, increasing the risk of fires.

The third kampung is in a densely populated urban area. The influx of newcomers and the conversion of houses into boarding houses or rental homes have weakened social bonds among the residents. Although many original residents still live there, this situation has led to a decline in community care for the environment. The occurrence of theft and other social problems indicates that social cohesion is deteriorating. These are the main issues faced by this kampung.

Based on the discussion above a comparative risk landscape is presented in Table 5.

Table 5. Comparative risk landscape.

Aspects	Kampung Nelayan Kenjeran (Fishing Kampung)	Kampung Kue Rungkut (Production Kampung)	Kampung Kota Ketandan-Kebangsren (City Kampung)
Type of Risk	Tidal and localized flooding, storms	Waste management issues	Social problems, area security
Main Causes	Land subsidence, high tides, global warming	Poor waste management	Overcrowding, lack of supervision
Social Impact	Health problems, evacuation for treatment	Source of diseases	Sense of insecurity, social conflict
Local Responses	Stilt houses, embankments, mangrove planting	Periodic community clean-up efforts	Neighborhood watch, surveillance cameras
Common Challenges	Lack of technical assistance, high costs	Low awareness of environmental cleanliness	Weak community institutions, poor social cohesion

The emerging risk landscapes can be understood as a manifestation of housing inequality in urban areas that depend on the position or location of the landscape. The

different landscape settings of the three kampungs cause them to face varying disaster risks. However, the root problems tend to be similar—weak infrastructure, unequal access to public services, the low socio-economic conditions of the community, and the lack of proper planning during development and expansion. This condition aligns with findings by UN-Habitat [26], which states that non-inclusive planning leads to high disaster risks in areas that do not receive equitable development access.

One effort to reduce the impact of disaster risk characteristics of these landscapes can be done through technical planning that relies on community participation to engage in disaster risk reduction and to formulate people-centered policies. Communities can be encouraged to secure and prepare themselves for potential disasters in their areas due to the factors revealed by the unveiling of risk landscapes.

Flood and tidal flooding risks can be managed by maintaining clean and well-functioning drainage systems to prevent blockages caused by accumulated waste, building proper and adequate infrastructure so that residents can continue their activities during floods or tidal flooding, installing water gates, and creating barriers to reduce water intrusion into homes during floods or tidal flooding.

For Kampung Kue Rungkut, where waste management and fire caused by electrical short circuits are the main problems, residents can be provided with knowledge and training on the importance of cleanliness and proper waste management, the health hazards involved, and awareness of fire risks due to electrical faults. They should also be educated on safe electrical wiring practices and the use of safe electrical equipment and components designed to handle high electricity loads.

Meanwhile, for Kampung Kota Ketandan-Kebangsten, efforts can be made to restore community cohesion and concern for the surrounding environment through informal community organizations such as regular religious study groups (*pengajian*—reading Qur'an group), women's groups, youth organizations (*karang taruna*), mutual work activities (*gotong royong*), sports, and other social community events.

Despite these vulnerabilities, resilience also exists across Surabaya kampungs, which has its roots in longstanding community cohesiveness and social capital. Most kampungs include strong social networks through neighborhood associations (such as RT/RW), religious affiliations (e.g., different communities praying at a common mosque), community savings groups, and communal public spaces that make it possible to mobilize emergency response activities during disasters. The Kampung Improvement Program (KIP) initiated in the late 1960s has a strong legacy, and together with other initiatives such as waste management and 'green' kampung competitions, has encouraged kampung dwellers to take up shared environmental practices ranging from community gardens to waste sorting. These initiatives, supported by local knowledge and collective action, contribute to resilience systems that run across all kampungs, including the three kampungs in this study, thereby strengthening a culture of adaptive problem-solving and mutual support throughout the city, which can be harnessed to address the hazards discussed in this paper.

4.5. Key Integrative Aspects

Community-based risk analysis as conducted in this study can be a valuable resource for the municipal urban planning system. It can provide evidence on the actual nature of the risks faced by kampung communities, what the most significant hazards are and where they are located, and how they affect the wellbeing of residents. This can enable more effective risk governance and assist the city authorities to prioritize the allocation of resources, formulate risk reduction strategies, and develop targeted interventions. However, there would be a need to build capacity at the institutional level on conducting CBPRA through specific training programs for municipal urban planning personnel.

Policy innovations to upscale CBPRA in Indonesia's urban governance should focus on institutionalizing and mainstreaming community engagement and participation within planning processes and local regulations. Such innovations can include expansion of budgeting to support participatory risk analysis activities and establishing multi-stakeholder networks that incorporate local and community knowledge into urban policymaking. Again, capacity-building initiatives for municipal authorities and community facilitators would be important; together with establishing accessible data platforms, such programs would assist in conducting consistent and transparent risk analyses. Importantly, incentive strategies such as performance-based grants and reward/recognition schemes can motivate cities to espouse and nurture participatory models, thereby ensuring that community knowledge can shape urban resilience policies and programs.

The CBPRA method developed in another Global South country, Bangladesh, and then adapted in Indonesia demonstrates the potential for sharing lessons between countries with similar informal settlements. The method has been extended and further developed in this study, and offers lessons for other Global South countries, where it could again be adapted and contextualized for the local context and conditions.

5. Conclusions

Kampungs in major cities of Indonesia, such as Surabaya, face various multidimensional and contextual risks. From the three kampung case studies, different hazard risks were identified: The coastal kampung faces ecological pressures (storms, floods, and tidal flooding) and the production kampung faces environmental risks (waste management and fire hazards), while the dense urban kampung faces social risks (theft and criminal acts).

These differences confirm that resilience strategies cannot be generalized but must consider the specific local context. However, the root causes are very similar, so community-based approaches, improving the quality and quantity of infrastructure as a foundation, and strengthening local institutions are key to reducing risks in densely populated kampungs. In conclusion, a cross-sectoral and community-based approach is essential to create resilient and safe kampungs for their residents.

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Institutional Review Board Statement: There is no university Ethics Committee in Indonesia. Usually, the Directorate Office at the university provides approval for studies involving non-sensitive human data. A formal approval letter from the Directorate of Research and Community Services, Institut Teknologi Sepuluh Nopember (ITS), Surabaya, Indonesia, was provided to confirm the academic nature of the research and the ethical standards followed. Authors confirm that the study was conducted in accordance with the ethical principles of the Declaration of Helsinki (1975, revised in 2013), and remain committed to upholding the highest standards of research ethics.

Informed Consent Statement: Informed consent was received from all the research participants.

Data Availability Statement: Research data from this study can be made available on request for confidentiality, attribution of intellectual property, and permission for reproduction.

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

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