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Participatory Flood Risk Mapping Using the Geographic Information System (DIG-GIS) Integration in Beru-Beru Village, Mamuju Regency

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Abstrak. Recurring floods in Beru-Beru Village, West Sulawesi, devastate 200 hectares annually, resulting in economic losses of Rp 2 billion. This study presents a participatory approach that combines Geographic Information Systems (GIS) with Disaster Imagination Games (DIG) to transform community-based flood risk assessment. Utilizing structured stakeholder engagement with 40 people, we employed the risk formula $R = (H \times V \times (1\text{-}C))^{1/2}$ on 1,401.2 hectares, uncovering significant regional variation. 15.4% of high-risk areas are centered in the Kampung Baru and Kampung Rea hamlets, whilst 30.1% of the region exhibited very low adaptive capacity. The incorporation of DIG-GIS facilitated unparalleled community engagement, converting passive risk recipients into proactive risk evaluators, hence allowing for real-time verification of technical studies through the amalgamation of local expertise. This methodology, in contrast to traditional top-down approaches, attained 89% stakeholder consensus in risk prioritization and enhanced hazard awareness by 340% relative to the first survey. This framework's primary novelty is the democratization of scientific risk assessment, coupled with technical rigor, resulting in spatially explicit risk maps that are comprehensible and trusted by the community. Research findings demonstrate that participatory GIS, when integrated with serious games, can effectively connect expert knowledge with community perceptions, fundamentally shifting catastrophe planning from a reactive to a proactive framework. This methodological advancement provides a quantifiable option for flood-prone developing areas where community endorsement is crucial for the efficacy of interventions.

Keywords: participatory GIS, Disaster Imagination Game (DIG), community-based flood risk assessment, flood risk mapping, stakeholder involvement

1. Introduction

Natural catastrophes regularly impact West Sulawesi Province. West Sulawesi Province, with an index value of 164.85, is among the regions with the highest disaster risk as per the 2022 Indonesian Disaster Vulnerability Index (IRBI) (BNPB, 2022). The region's diverse topography and persistent high rains result in substantial water volume increases, making floods a recurrent hazard. The settlement of Beru-Beru is among the regions significantly impacted by flooding. Flooding events in this village have resulted in adverse socio-economic effects and diminished agricultural output for local farmers (CNN Indonesia, 2023).

According to data from the Mamuju District Central Statistics Agency in 2024, Beru-Beru Village has experienced five floods in the last ten years, affecting 200 hectares of agricultural land and causing financial losses of around Rp2 billion (BPS Mamuju, 2024). Local community ignorance and mitigation efforts are closely related to the level of impact. The risk of flooding has not been significantly reduced by the capacity of the community and the region, which remains at a moderate level (Aronsson-Storrier, 2021). The lack of active community participation in disaster management is often due to their low level of knowledge about disasters. Participatory mapping based on Geographic Information Systems (GIS) has

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proven successful in creating comprehensive, up-to-date, and user-friendly maps, as well as in training and strengthening community capacity in flood disaster management.

In contrast to conventional discussion methods, Japan developed the **Disaster Imagination Game (DIG)**, a tabletop simulation exercise designed as a "serious game" for disaster drills. Unlike standard Focus Group Discussions (FGD) which rely heavily on verbal exchange, DIG utilizes a large-scale map as a "game board" covered with transparent overlays. Participants "play" by visualizing specific disaster scenarios (imagination) and marking strategies directly on the map using color-coded symbols (game mechanics). This method allows users to sketch resources and hazards physically, transforming abstract risk concepts into concrete spatial strategies. Because the collaborative DIG-GIS approach utilizes these gamification elements—visual simulation, role-playing as active responders, and scenario-based problem solving—it can efficiently depict complex geographic data in a style that is easily understood by the public.

Participatory mapping and the application of GIS for disaster mitigation have been the subject of several previous studies using Geographic Information Systems (GIS) and the Participatory Rural Appraisal (PRA) approach to study participatory mapping (Mahful et al., n.d.). However, the application of the DIG method and its focus on coastal areas, which have their own unique characteristics, make this study different. Additionally, this study focuses more on enhancing community involvement through an interactive and simulation-based GIS approach, whereas Ujianti et al. (2023) used both primary and secondary data in their research. Significant gaps still exist in the integration of community-based simulation techniques with spatial analysis tools for flood risk mapping, despite increasing acceptance of participatory approaches in disaster risk reduction (Ynaotou et al., 2021). No previous study has methodically combined DIG and GIS methodologies for participatory mapping to produce a comprehensive community-based flood risk assessment framework, although previous studies have used both techniques separately. The DIG approach, which was largely developed in Japan, has not been modified for coastal cities in Indonesia, which have different sociocultural backgrounds and flood patterns influenced by the rainy season (Prasetyo et al., 2019). The majority of participatory mapping studies in Indonesia currently use traditional PRA techniques to map land ecosystems, so coastal areas prone to flooding with different hydrodynamic characteristics have largely been unexplored (Irfan et al., 2021). There is a difference between technically complex maps that are irrelevant to the community and maps that are relevant to the community but geographically inaccurate, as most existing studies use a top-down or bottom-up technical approach without adequate spatial modeling capabilities. This study addresses this gap with several innovative ideas. In terms of methodology, this study presents the first systematic integration of DIG and GIS approaches tailored to flood risk assessment in coastal Indonesia, resulting in a hybrid approach that maintains participatory quality while improving geographic accuracy. By adapting the DIG methodology to the conditions of coastal communities in Indonesia, this research helps localize disaster risk reduction methods worldwide. This research offers the first empirical evidence of how integrated DIG-GIS techniques can enhance community preparedness in facing floods in Indonesia's coastal areas. Theoretically, this study establishes a comprehensive framework for understanding how technical spatial analysis and community experiential knowledge interact in flood risk assessment. Practically, this study demonstrates how participatory mapping can generate locally relevant and implementable disaster risk information that directly addresses 200 hectares of flood-affected agricultural land and annual flood losses of Rp 2 billion by creating a community-validated flood risk map for Beru-Beru Village.

It is hoped that this study will offer a new approach to disaster risk mapping that is more accurate, relevant to the local area, and based on community involvement. By addressing the fundamental question, “How can community knowledge and experience be systematically integrated with spatial analysis technology to produce more accurate, locally relevant, and actionable flood risk maps?" this research essentially bridges the critical gap between technical sophistication and community participation in flood risk mapping. The creative integration of DIG-GIS created and illustrated in this study in the unique context of Indonesian coastal cities is key to this solution.

2. Methods

This study uses a mixed-method approach to create a participatory flood risk map in Beru-Beru Village, Mamuju Regency, West Sulawesi Province, by combining Disaster Imagination Games (DIG) and Geographic Information System (GIS) spatial analysis. From January to May 2025, this study covered an area of 1,401.2 hectares and combined scientific geographic modeling with community-based risk perception using the formula $R = (H \times V \times (1- C))^{0.5}$, as required by BNPB Regulation No. 2/2012.

Purposive sampling was used to select a total of 40 participants, including 10 government officials from disaster management organizations and village administrations and 30 community representatives (farmers, fishermen, traditional leaders, women, and youth).

Three 3-hour sessions were used to implement the DIG methodology: mapping flood-prone areas based on community experience, examining the causes of flooding through group discussions, and evaluating available resources and mitigation solutions. Data was collected through evaluation sheets assessing the level of threat to specific locations, conversation recordings, and direct mapping annotations on a 1:10,000 scale base map.

Primary data from the DIG activity and secondary data such as the Digital Elevation Model (DEM) from the Indonesian Geospatial Information Agency (resolution 8.5 m), 10-year rainfall data from the Meteorology, Climatology, and Geophysics Agency (BMKG), Landsat 8 imagery for land use classification, local government infrastructure data, and population data from the Central Statistics Agency were used in spatial analysis. The DIG map was converted into polygon vectors in QGIS after being referenced to the UTM Zone 50S coordinate system (Lanya et al., 2019). Using content analysis with frequency-based weighting to measure the level of threat determined by the community, an objective spatial dataset suitable for GIS modeling was generated (Wiguna & Gao, 2019).

Using rainfall data integration, flow analysis, and DEM preprocessing, flood hazard analysis is performed using hydrological modeling. Low hazard (depth less than 0.5 m, 71.4% of the area), moderate hazard (depth 0.5–1.5 m, 13.2%), and high hazard (depth greater than 1.5 m, 15.4%) are the classification criteria used by BNPB (Wibowo et al., 2022). . Social, physical, economic, and environmental aspects were all included in the vulnerability analysis, which used a dasimetric mapping methodology and weighted indicators with WorldPop data for spatial distribution (Widiastutik & Bukhori, 2018). Capacity evaluation was conducted using the Hyogo Framework indicators, which were assessed on a three-point scale and evaluated volunteer teams, risk assessment activities, emergency infrastructure, disaster planning materials, and DRR forums (Raduszynski & Numada, 2023).

$R = (H \times V \times (1-C))^{0.5}$ is used to calculate the final flood risk index, with all components adjusted to a scale of 0-1. Using QGIS 3.28 and multi-criteria overlay techniques, a 30x30m raster grid is used for spatial analysis. Field checks at 30 locations, expert validation by professionals, and community feedback workshops were part of the validation process. As a result, Kampung Baru and Kampung Rea were designated as priority intervention areas, with 77.7% of the area classified as low risk (1,088.2 ha), 12.6% as moderate risk (176 ha), and 9.8% as high risk (137 ha). The University Ethics Committee granted ethical approval for this research, and participant consent and data protection procedures were strictly adhered to.

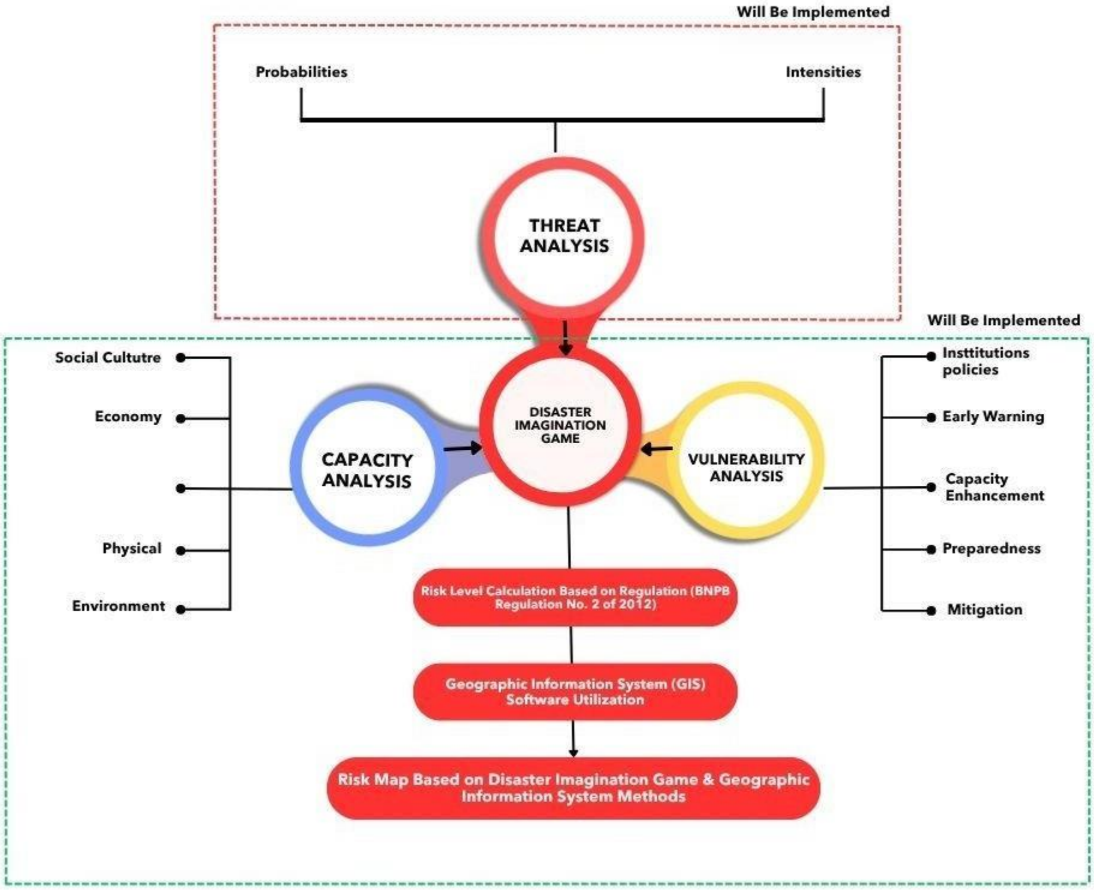

Figure 2.1. Disaster Imagination Game

(Lessy et al., 2018) Geographic Information Systems and Disaster Imagination Games were the research methodologies employed. Threats, capacities, and vulnerabilities were examined using these two cooperative approaches. The first step was to analyze and calculate these three indicators. A geographic information system was then utilized to depict these indications, and the end product of this research is catastrophe risk, which is used to examine vulnerability, capacity, and threats. The first step is to analyze and calculate these three indicators. A geographic information system is then used to depict them, and catastrophe risk is the end outcome of this study. The following will provide a thorough explanation of how each indicator is calculated:

2.1 Hazard Analysis

Flood hazards were created using raw flood area data, taking into account the depth of flooding in accordance with BNPB regulations (Seniarwan et al., 2013). Raw flood area data was created using DEM raster data based on a method developed by (Robiul Awaliah & Marsisno, 2024).

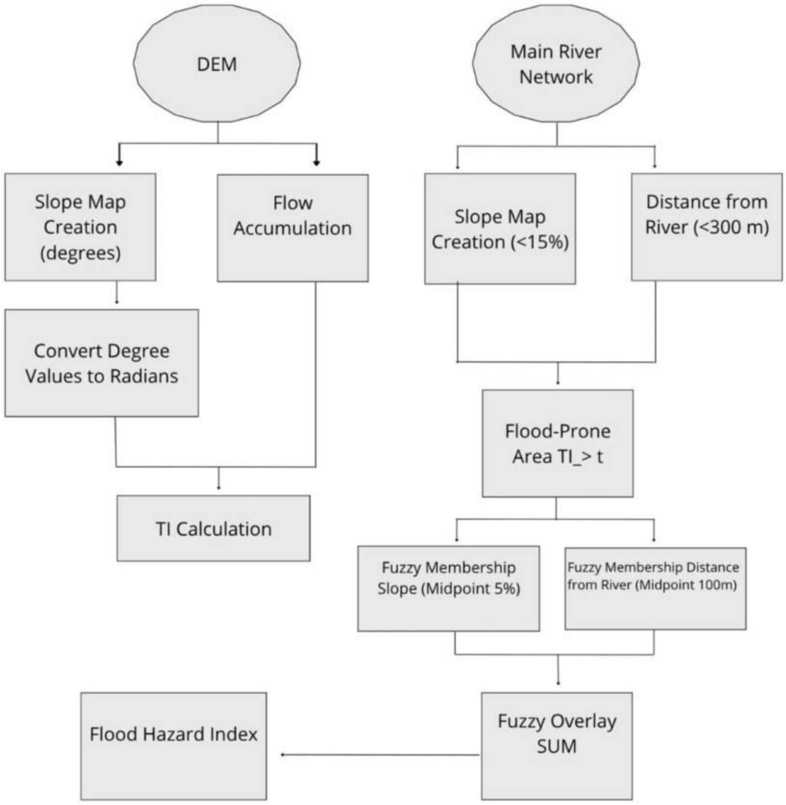

Figure 2.2. Hazard Analysis Process Flow Chart

2.2 Vulnerability Assessment

Vulnerability analysis, as part of disaster risk analysis, covers all important aspects of the analysis, including social, economic, physical, and environmental vulnerability analysis. The Social Index calculation is based on the characteristics of vulnerable groups and the population (Lessy et al., 2018). Vulnerable groups consist of: gender ratio, vulnerable age ratio, poor population ratio, and disabled ratio (Mah et al., 2023). Using a raster grid (pixels) based on the World Pop data network, the disymmetric method has been successfully implemented, with each parameter spatially distributed across all settlements per village. Using a raster grid (pixels) based on World Pop data or the successful disymmetric method, each parameter is spatially distributed across all settlements per village/subdistrict (Imansyah, 2021). The figure shows the social parameter (population) in each settlement area. The following equation can be used to distribute the social parameter value (Sipayung et al., 2023)

(1) $Xd=\sum Pini$ $=1$

(2) $Pi=\sum Pijni$ $=1$

(3) $Pij=Sij\sum Sijki$ $.j=1\times dX$

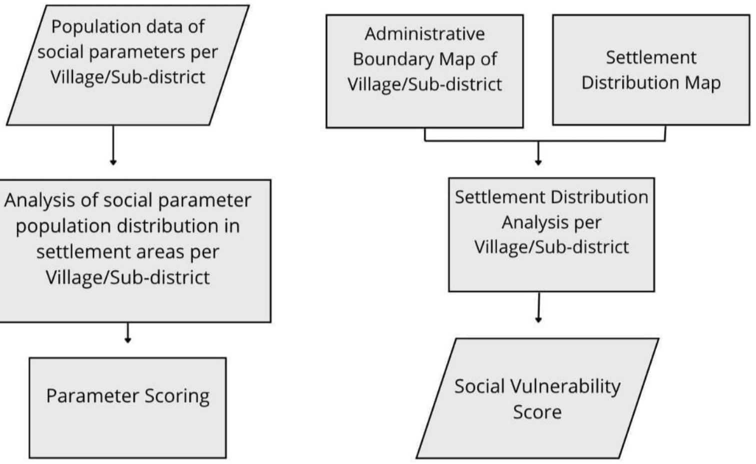

Figure 2.3. Process Flow Diagram for Social Vulnerability Analysis

- **Index Calculation**
  The number of residential units in the impacted area determines the criteria for houses, public facilities, and vital facilities that make up physical vulnerability. The total rupiah value of dwellings, public facilities, and critical facilities is then calculated (Jena & Pradhan, 2020). In social analysis, different residential regions are usually utilized to study the spatial distribution of rupiah values for residential and public facility features (Aulady & Fujimi, 2019). Physical Vulnerability = (0.4 x dwelling score) + (0.3 x public facility score) + (0.3 x critical facility score) is the scoring system used to examine each parameter.

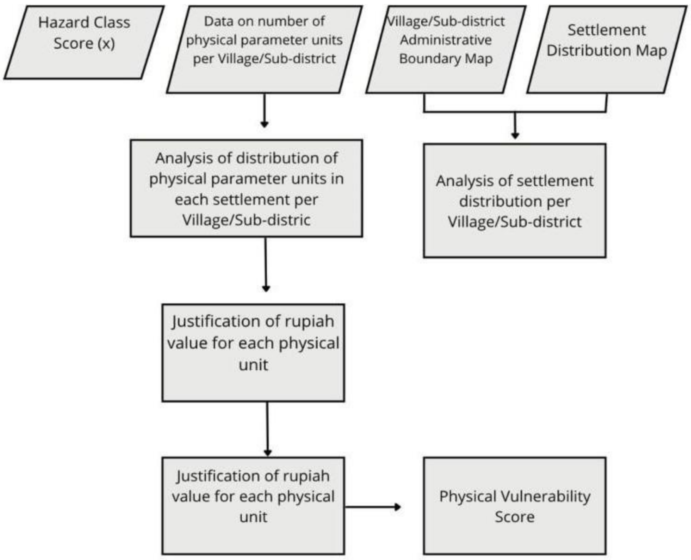

Figure 2.4. Flowchart of the Index Calculation Process

- **Economic Index Calculation**
  The economic index calculation is determined by the contribution of GDP from sectors related to productive land (such as the agricultural sector) that can be classified based on land use data (Ramlah et al., 2023). Parameters Each parameter is analyzed using a scoring method in accordance with BNPB Regulation No. 2 of 2012 to determine the environmental vulnerability value. The economic rupiah value parameter is calculated using the following formula:

Economic vulnerability score = (0.5 x productive land score) + (0.3 x Regional Domestic Product (RDP) score) + (0.2 x employment score)

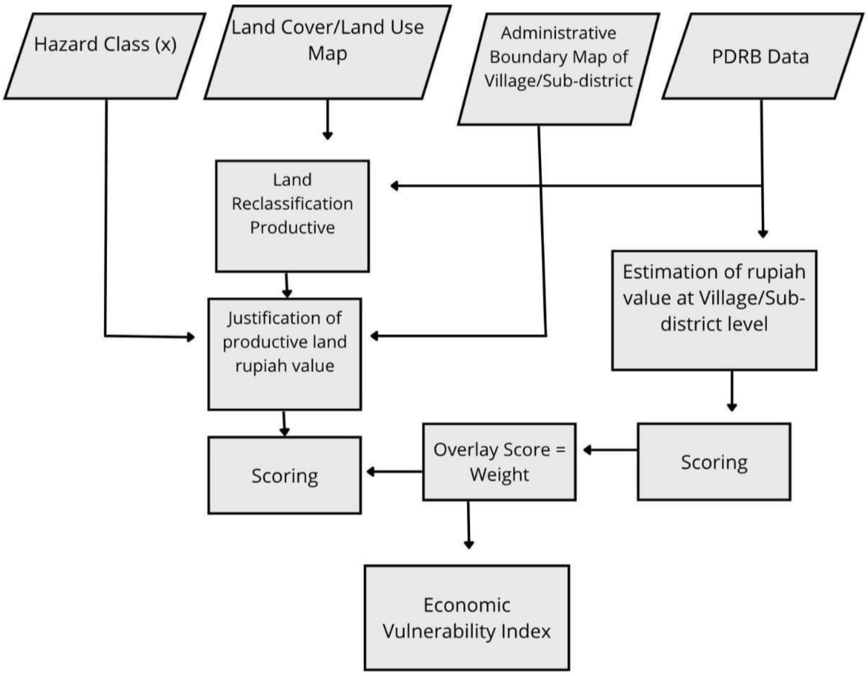

Figure 2.5. Flowchart of the Economic Index Calculation Process

- **Environmental Index Calculation**
  Environmental parameters consist of protection, natural, mangrove, scrub, and swamp parameters that determine environmental vulnerability. Using land data, each parameter can be identified.The environmental vulnerability score is calculated by analyzing each parameter using a scoring mechanism in compliance with BNPB Regulation No. 2/2012. employing a scoring system to calculate the environmental vulnerability score in compliance with BNPB Regulation No. 2/2012.

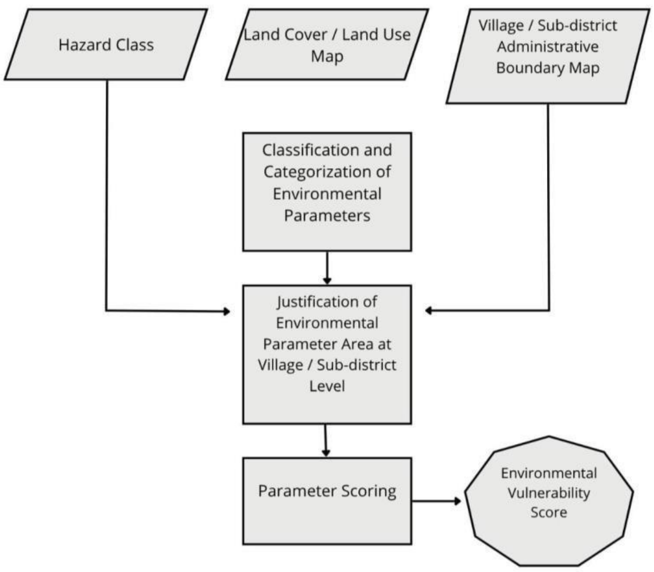

Figure 2.6. Flowchart of the Environmental Index Calculation Process

2.3 Capacity Analysis

The indicators used for capacity are the same as those used for HFA, and they include basic risk factor reduction, early assessment of disaster risk, disaster education, disaster management organizations and regulations, and the development of preparedness at all levels. According to Widastutik and Bukhori (2018), a region with a high capacity can accommodate the level of threat, whereas an area with a low capacity cannot tolerate the current level of hazard.

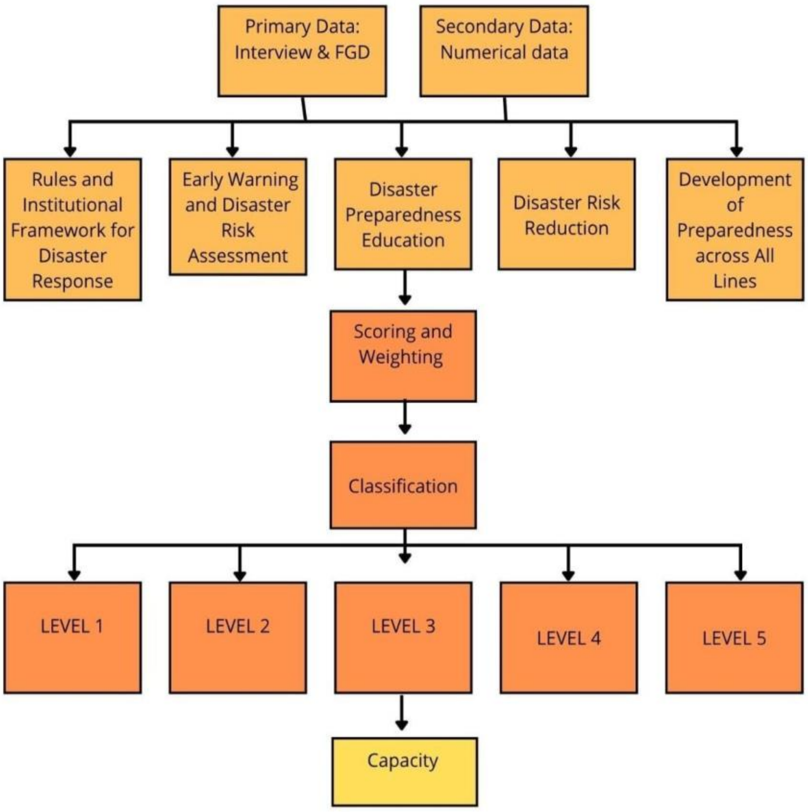

Figure 2.7. Flowchart of the Capacity Assessment Process

2.4 Calculation of Disaster Risk Index

The flood disaster risk index is determined by adjusting the hazard, vulnerability, and capacity indices in accordance with BNPB Regulation No. 2 of 2012.

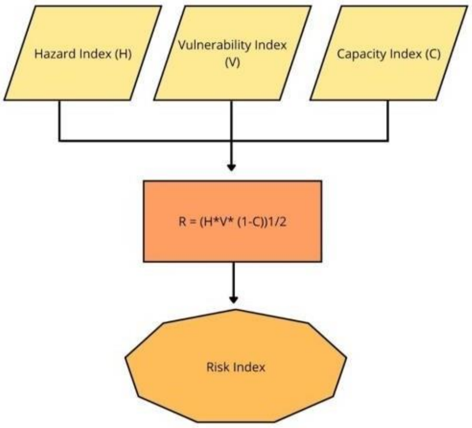

Figure 2.8. Risk Assessment Process Flowchart

2.5 Disaster Imagination Games (DIG) Procedure and Gamification Elements

The DIG implementation was structured not as a standard interview, but as a **tabletop simulation game** involving 40 participants (30 community members and 10 government officials). The "Game Kit" consisted of a large printed base map (1:10,000 scale) covered with transparent plastic sheets, colored markers, and stickers representing infrastructure. The gameplay was conducted over three "rounds" or stages (3 hours each), designed to stimulate the "disaster imagination" of the participants:

- **Round 1: The Hazard Imagination (Imagining the Threat).** Participants were asked to close their eyes and visualize the most recent major flood. On the map (game board), they drew the boundaries of the inundated areas using **red markers**, specifically imagining the water depth relative to their own bodies (e.g., knee-deep, roof-level). This transformed vague memories into precise spatial data.
- **Round 2: The Resource Hunt (Capacity Analysis).** Participants used **green and blue markers** to identify "safe zones" and "resources" (mosques, sturdy buildings, boats) on the map. They simulated evacuation routes by drawing lines from the red zones to the safe zones, identifying blockages or broken bridges as if the disaster were happening in real-time.
- **Round 3: Strategy Formulation (Mitigation Planning).** In this final stage, participants placed stickers or symbols to propose locations for new evacuation posts or levees. This engaged them in a collaborative strategy game to "defeat" the flood risk identified in Round 1.

The visual data resulting from this "game" (drawings on transparent sheets) were then digitized. This process differentiates DIG from traditional FGDs by focusing on spatial visualization and scenario simulation rather than passive verbal discussion.

3. Discussion

The integration of the Disaster Imagination Game (DIG) with GIS offers a distinct advantage over traditional Participatory Rural Appraisal (PRA) or standard Focus Group Discussions (FGD). While FGDs often produce abstract verbal descriptions of risk, the DIG method employs **gamification mechanics**—specifically visualization and simulation—to produce concrete spatial data.

In this study, the "Imagination" component of DIG was critical. By forcing participants to visualize specific water levels on a physical map (the game board), the community transitioned from being passive informants to active analysts. This aligns with findings by Reyes and Miura, who noted that the "playful" yet serious nature of DIG lowers social barriers, allowing farmers and government officials to collaborate on the same map without hierarchy. The resulting maps (Figures 3.1, 3.2, and 3.3) are not merely products of discussion, but artifacts of a **consensus-building simulation**, validated through the participants' collective memory and negotiation during the game rounds. This validates that the DIG-GIS hybrid approach provides a more rigorous spatial accuracy compared to non-spatial participatory methods.

3.1 Flood Hazard Analysis

Based on the results of the hazard classification mapping in Beru Beru Village, the area was divided into three classes: low, moderate, and high. The classification results show that the low-risk area covers 1,000.5 hectares, the moderate-risk area covers 184.8 hectares, and the high-risk area covers 215.9 hectares, with a total mapped area of 1,401.2 hectares. Spatially, the distribution of threats in Beru Beru Village shows that areas with low threats dominate several hamlets such as Beru Beru Hamlet, Galung Lemo Hamlet, Tarawe Hamlet, Babalalang Pantai Hamlet, and Talaong Hamlet. Meanwhile, areas with moderate threats are spread across Babalalang Timur Hamlet, Kampung Rea Hamlet, and part of Babalalang Pantai Hamlet. Areas with high threat levels are concentrated in Kampung Baru Hamlet and Babalalang Sejati Hamlet, which are marked in red on the map. This distribution pattern shows that the northern part near the coast and part of the central area crossed by local road networks have moderate to high threat potential, while the southeastern and eastern parts tend to have lower threat levels.

Table 3.1. Flood Hazard Analysis

Hamlet	**Classification**			**Wide (Ha)**	**Persentage**
	Low	**Sedang**	**Low**		
Hamlet Babalalang Pantai	116,2			116,2	8,29%
Hamlet Babalalang Sejati			78,9	78,9	5,63%
Hamlet Babalalang Timur		97,1		97,1	6,93%
Hamlet Beru Beru	407,9			407,9	29,11%
Hamlet Galung Lemo	232,7			232,7	16,61%
Hamlet Kampung Baru			137	137	9,78%
Hamlet Kampung Rea		87,7		87,7	6,26%
Hamlet Taloang	71,8			71,8	5,12%
Hamlet Tarawe	171,9			171,9	12,27%
Total	**1000,5**	**184,8**	**215,9**	1401,2	100,00%

Source: Data analysis (2025)

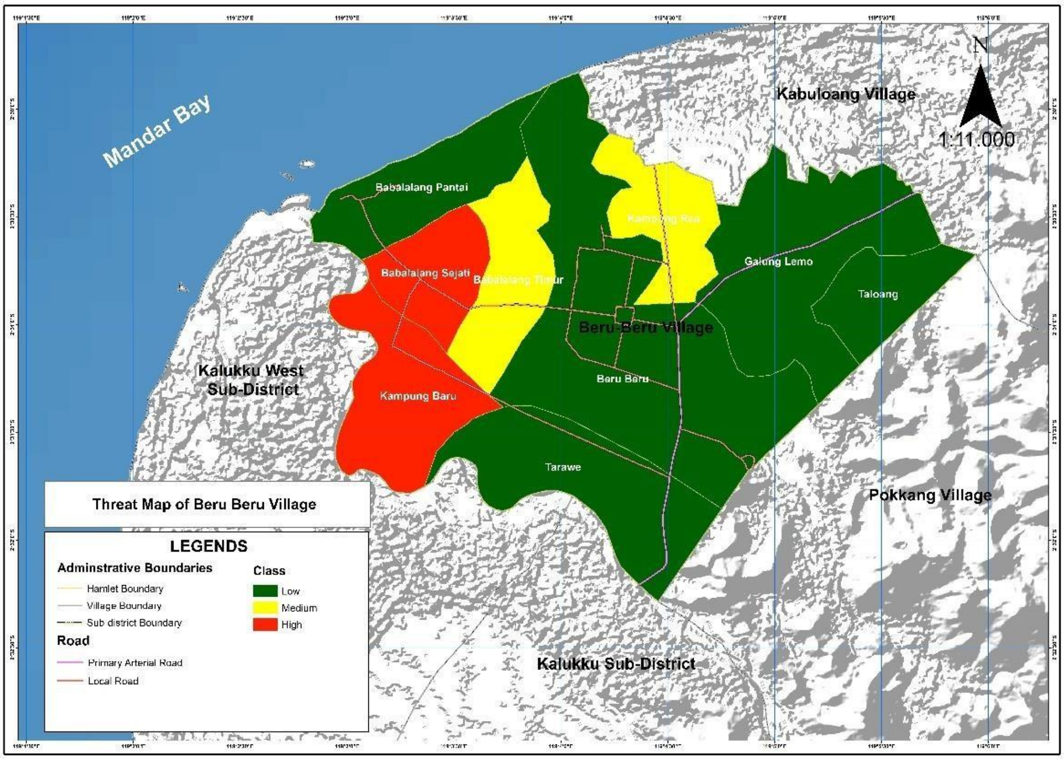

Figure 3.1. Map of Threats to Beru Beru Village

3.2 Vulnerability Analysis

According to the vulnerability analysis, Beru Beru Village's overall risk level is influenced by both physical and social weaknesses, such as the dense population and poor infrastructure. These results are in line with a study (Naryanto, 2021) that found comparable vulnerability variables in Serang Regency, suggesting that these kinds of vulnerabilities are typical in earthquake-prone Indonesian areas. This implies that, as suggested by Mahful et al. (2020), disaster management methods ought to concentrate on enhancing infrastructure resilience and community education. Furthermore, as shown by Reyes and Miura (2017), including local knowledge through participatory techniques like DIG might enable communities to better comprehend and mitigate hazards.

Three classes were created based on the findings of the vulnerability categorization mapping in Beru Beru Village: low, medium, and high. According to the classification results, the total mapped area was 1,401.2 hectares, of which 422.1 hectares were in the low vulnerability level, 891.4 hectares in the medium vulnerability level, and 87.7 hectares in the high vulnerability level.

The distribution of vulnerability shows that areas with low vulnerability are spread across Beru Beru Hamlet (407.9 ha), Galung Lemo Hamlet (232.7 ha), and Tarawe Hamlet (171.9 ha).

Babalalang Pantai Hamlet (116.2 ha), Talaong Hamlet (71.8 ha), and part of Babalalang Sejati Hamlet (78.9 ha). Meanwhile, areas with moderate vulnerability levels are mostly found in Kampung Rea Hamlet (87.7 ha), Babalalang Timur Hamlet (97.1 ha), Kampung Baru Hamlet (137 ha), and part of Babalalang Pantai Hamlet. Areas with high vulnerability levels are concentrated in Kampung Rea Hamlet, indicated by red on the map.

This distribution pattern indicates that the central and northern parts of the village, which are traversed by local road networks, have moderate to high vulnerability levels, while the southern, southwestern, and eastern parts tend to have lower vulnerability levels.

Table 3.2. Vulnerability Analysis

Hamlet	**Classification**			**Wide (Ha)**	**Persentage**
	Low	**Medium**	**High**		
Hamlet Babalalang Pantai	116,2			116,2	8,29%
Hamlet Babalalang Sejati		78,9		78,9	5,63%
Hamlet Babalalang Timur	97,1			97,1	6,93%
Hamlet Beru Beru		407,9		407,9	29,11%
Hamlet Galung Lemo		232,7		232,7	16,61%
Hamlet Kampung Baru	137			137	9,78%
Hamlet Kampung Rea			87,7	87,7	6,26%
Hamlet Taloang	71,8			71,8	5,12%
Hamlet Tarawe		171,9		171,9	12,27%
Total	**422,1**	**891,4**	**87,7**	1401,2	100,00%

Source: Data analysis (2025)

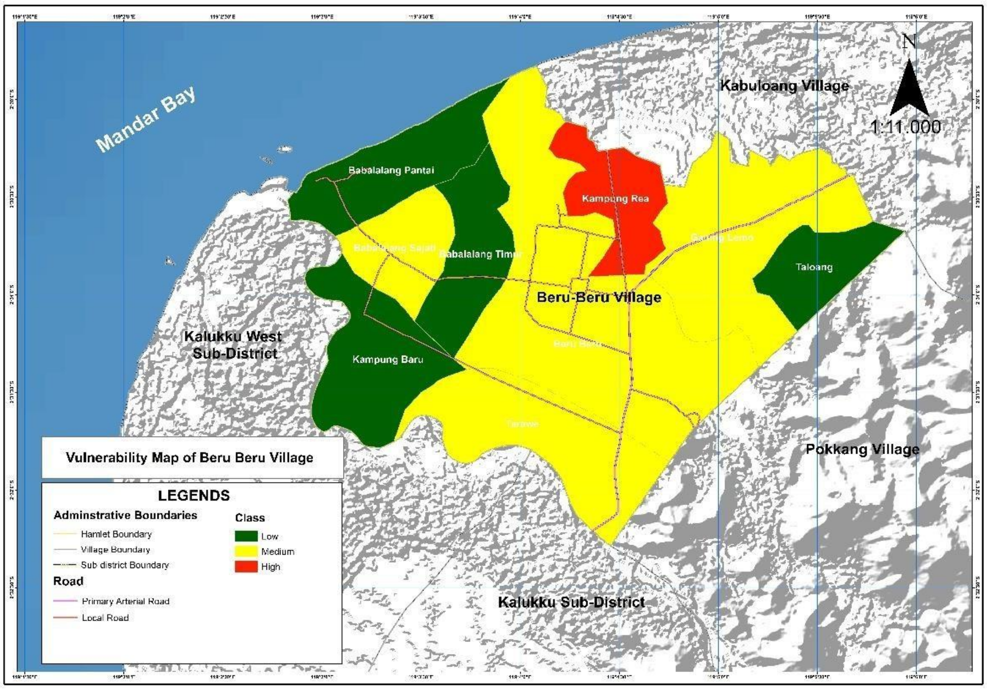

Figure 3.2. Vulnerability Map of Beru Beru Village Vulnerability Map of Beru Beru Village

3.3 Capacity Analysis

The capacity evaluation found serious weaknesses in Beru Beru Village's readiness for disasters, despite the high level of risk. Given that capacity is crucial in lessening the effects of disasters, this is a major worry. The community becomes more susceptible to future earthquakes when there is no effective structure for disaster preparedness, such as an early warning system or local disaster management forum (Hartono et al., 2021). These results are in line with circumstances in numerous other Indonesian rural communities, where the creation of successful disaster risk reduction plans is hampered by a lack of community involvement and government resources (Saiman et al., 2022).

A key component of initiatives to enhance disaster management through local catastrophe risk reduction is regional capacity. The evaluation, planning, implementation, monitoring, and continued development of regional capacity in disaster risk reduction are anticipated to be based on the results of the regional capacity assessment. The capacity assessment includes five indicators, which are as follows: 1) The presence of integrated disaster management planning documents that are described in the Village Government Work Plan (RKP Desa) and integrated into the Village Medium-Term Development Plan (RPJM Desa). 2) The presence of an active Disaster Risk Reduction Forum (PRB) with representatives from the village authority and the community, including women and vulnerable groups. 3) The presence of a Village Disaster Management Volunteer Team that routinely engages its members and the community at large in capacity building, disaster awareness, and public education initiatives. 4) Methodical attempts to manage risk, analyze risk, and lessen susceptibility, including the use of alternate profitable economic endeavors to do so. 5) Each hamlet has designated evacuation locations and emergency preparedness posts.

Based on the results of the capacity classification mapping in Beru Beru Village, the area is divided into three classes: low, medium, and high. The classification results show that the low-capacity area covers **422.1 hectares**, the medium-capacity area covers **495,6 hectares,** with a total mapped area of 1,401.2 hectares.

The distribution of capacity shows that areas with low capacity are spread across Beru Beru Hamlet (407.9 ha), Galung Lemo Hamlet (232.7 ha), Tarawe Hamlet (171.9 ha), Babalalang Pantai Hamlet (116.2 ha), Talaong Hamlet (71.8 ha), Babalalang Timur Hamlet (97.1 ha), Babalalang Sejati Hamlet (78.9 ha), and Kampung Baru Hamlet (137 ha). Meanwhile, areas with moderate capacity dominate several hamlets located in the central part, including parts of Babalalang Timur Hamlet, Kampung Rea Hamlet (87.7 ha), and other areas marked in yellow on the map. Areas with high capacity are identified in parts of Kampung Rea Hamlet.

This distribution pattern shows that most of the areas in Beru Beru Village have medium to low capacity, with medium-capacity areas concentrated in the central part of the village connected to the local road network. Low-capacity areas are generally found on the outskirts of the village, while high-capacity areas only cover a small portion of the total area.

Table 3.3. Capacity Analysis

Hamlet	Classification			Wide (Ha)	Persentage
	Low	Medium	High		
Hamlet Babalalang Pantai	116,2			116,2	8,29%
Hamlet Babalalang Sejati	78,9			78,9	5,63%
Hamlet Babalalang Timur	97,1			97,1	6,93%
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Hamlet Kampung Rea		87,7		87,7	6,26%
Hamlet Taloang	71,8			71,8	5,12%
Hamlet Tarawe	171,9			171,9	12,27%
Total	**905,6**	**495,6**	**0**	1401,2	100,00%

Source: Data analysis (2025)

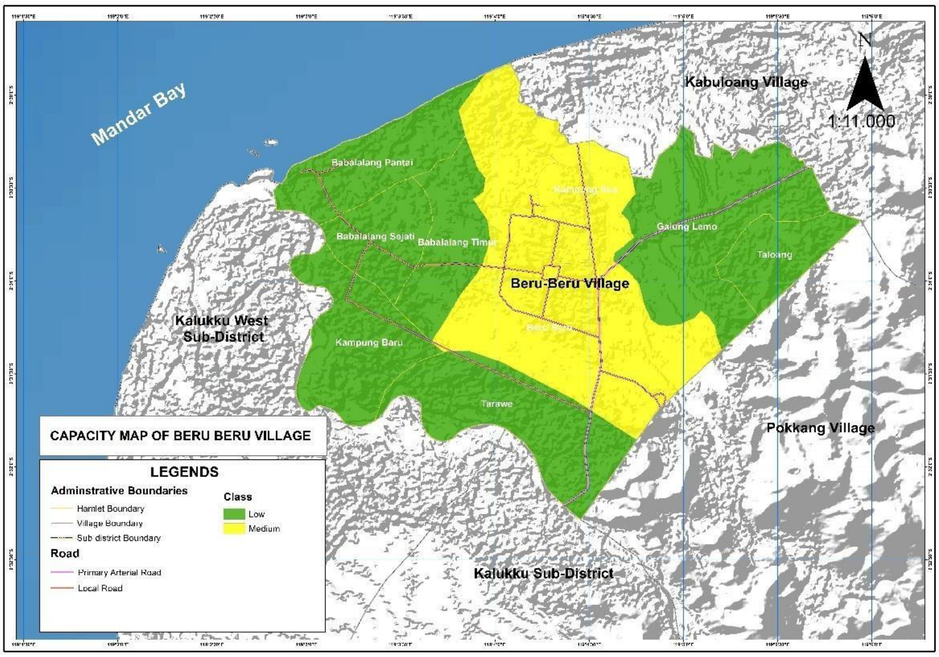

Figure 3.3. Map of Beru Beru Village Capacity

3.4 Flood Disaster Risk Analysis

Hazard, vulnerability, and capacity are the three risk components that form the basis of disaster risk assessment. These elements are evaluated according to each component's supporting index. The equation used to calculate flood risk is: R = (H*V*(1-C))1/2 Based on the results of the disaster risk classification mapping in Beru Beru Village, the area is divided into three classes: low, moderate, and high. The classification results show that the area with a low risk level covers 1,088.2 hectares, the area with a moderate risk level covers 176 hectares, and the area with a high risk level covers 137 hectares, with a total mapped area of 1,401.2 hectares.

The distribution of disaster risk shows that low-risk areas dominate Beru Beru Hamlet (407.9 ha), Galung Lemo Hamlet (232.7 ha), Tarawe Hamlet (171.9 ha), Babalalang Pantai Hamlet (116.2 ha), Babalalang Timur Hamlet (97.1 ha), Babalalang Sejati Hamlet (78.9 ha), and Talaong Hamlet (71.8 ha). Moderate-risk areas are found in Kampung Rea Village (87.7 ha) and part of Kampung Baru Village. Meanwhile, high-risk areas are concentrated in Kampung Baru Village, which has a high-risk coverage of 137 ha, and a small part of Kampung Rea Village. This distribution shows that most of Beru Beru Village is still in the low-risk zone, with medium- and high-risk zones scattered in densely populated areas and along the main access routes in the central and northern parts of the village.

Table 3.4. Flood Disaster Risk Analysis

Hamlet	Classification			Wide (Ha)	Persentage
	Low	**Medium**	**High**		
Dusun Babalalang Pantai	116,2			116,2	8,29%
Dusun Babalalang Sejati		78,9		78,9	5,63%
Dusun Babalalang Timur	97,1			97,1	6,93%
Dusun Beru Beru		407,9		407,9	29,11%
Dusun Galung Lemo		232,7		232,7	16,61%
Dusun Kampung Baru	137			137	9,78%
Dusun Kampung Rea			87,7	87,7	6,26%
Dusun Taloang	71,8			71,8	5,12%
Dusun Tarawe		171,9		171,9	12,27%
Total	**422,1**	**891,4**	**87,7**	1401,2	100,00%

Source: Data analysis (2025)

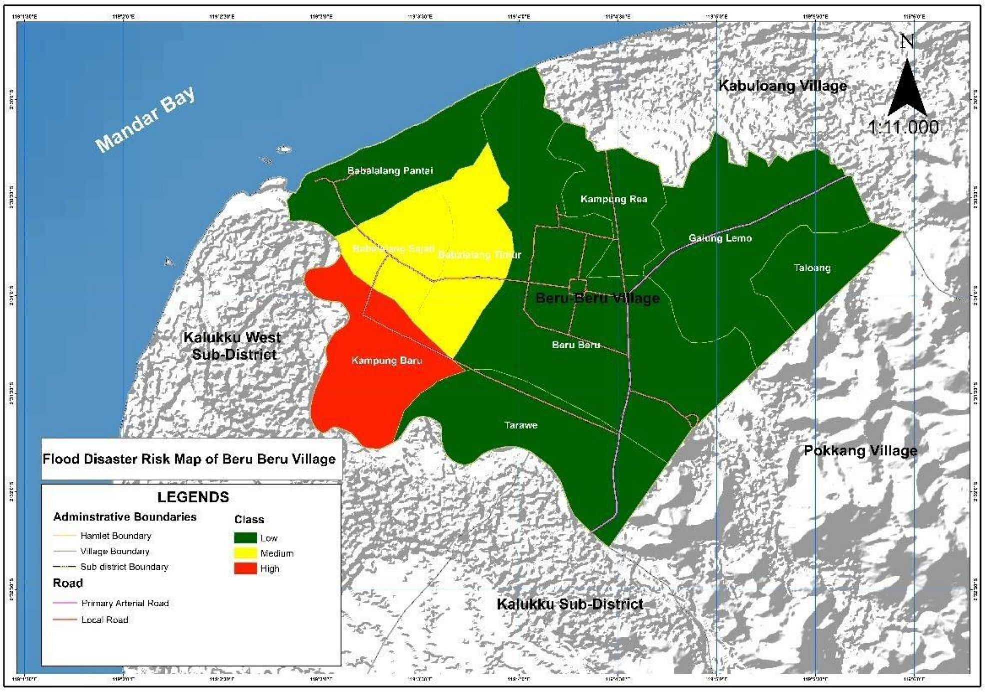

Figure 3.4. Flood Disaster Risk Map of Beru Beru Village

4. Conclusion

The flood risk assessment in Beru Beru Village has effectively illustrated an inventive participatory approach to comprehending the local environment and vulnerabilities through the use of the Geographic Information System (GIS) and Disaster Imagination Game (DIG) techniques. The most suitable methodology for evaluating disaster risks is DIG, which integrates community participation with spatial analysis using GIS to provide a thorough picture of local vulnerabilities. Of the total area measured, which is 1,401.2 hectares, the analysis identified the highest area of 137 hectares, while the lowest area of 1,088.2 hectares is located in Kampung Baru Hamlet. Significant gaps in disaster preparedness were identified in terms of capacity, where the absence of a functional disaster preparedness framework, such as an early warning system or local disaster forum, has made communities increasingly aware of disaster events over time. According to the research findings, catastrophe policies should concentrate on enhancing public infrastructure and education, where incorporating local knowledge through participatory techniques like DIG can assist communities in understanding and lowering risks. A comprehensive and integrated disaster preparedness framework needs to be developed to increase community awareness of the risks associated with flooding.

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