

MULTIDIMENSIONAL ANALYSIS OF COMMUNITY VULNERABILITY TO FLOOD RISKS IN WEST JAKARTA

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Abstract: This study aims to analyze the level and determinants of multidimensional community vulnerability to flooding in West Jakarta, an area with high exposure to flood risk due to natural and anthropogenic factors. The analysis is based on four main dimensions: social, economic, physical, and environmental, using a quantitative descriptive approach. The assessment method refers to BNPB Number 2 of 2012 through weighting and scoring techniques. Data was obtained from field observations, questionnaire surveys, in-depth interviews, and documentation studies from relevant agencies. The results of the study show that Tambora Subdistrict has the highest vulnerability score compared to other subdistricts. Social vulnerability is characterized by high population density and the dominance of vulnerable groups such as children and the elderly. The economic aspect reflects the community's dependence on the informal sector and the limited availability of productive assets. Physical vulnerability is evident in the presence of vital infrastructure in flood-prone zones. Meanwhile, the environmental aspect highlights a significant contribution to vulnerability due to the scarcity of green open spaces and the area's low absorption capacity. The findings of this study underscore the necessity of enhancing both structural and non-structural capacities via cross-sectoral collaboration in adaptive, contextual, and evidence-based planning for disaster risk reduction.

Keywords: Multidimensional Analysis, Flood Vulnerability, Disaster Mitigation, Risk Reduction

INTRODUCTION

Jakarta is geographically located on the northern coast of Java Island, dominated by low-lying sedimentary plains and traversed by 13 major rivers. These natural features, combined with rapid urban development and increasing land conversion, make Jakarta highly prone to flooding from both river overflows and rising sea levels. Climate change further exacerbates the city's vulnerability by contributing to more intense and frequent rainfall events and seawater intrusion. For instance, on January 1, 2020, Jakarta recorded an extreme rainfall of 377 mm/day, causing widespread floods (Jannah et al., n.d.).

The combination of sea level rise and extreme rainfall is especially threatening to coastal sub-districts. These environmental stresses are intensified by swift population increase, the spread of informal settlements, and

deficient urban planning, all of which impose further demands on limited infrastructure. The period from 2017 to 2019 saw a 13.86% expansion of slum zones in cities across Indonesia (Siti Zubaidah; Irvan Arif Kurniawan, n.d.).

Flooding in West Jakarta, in particular, poses a serious risk due to the convergence of natural hazards and socio-economic stressors. Urban density, informal housing, inadequate drainage, and lack of green open space all contribute to the region's heightened exposure and vulnerability. According to BNPB, from 2010 to 2020, Indonesia experienced 1,518 flood events, affecting over 4 million people and displacing more than 780,000. Within the framework of West Jakarta, these incidents adversely influence populations possessing limited adaptive capacity, notably those

characterized by substandard infrastructure and diminished socio-economic resilience. Vulnerability in this setting can be understood as a multidimensional condition including physical (e.g., damaged infrastructure), social (e.g., low education and awareness), economic (e.g., income instability), and environmental (e.g., pollution and limited vegetation) dimensions (Mantika et al., n.d.).

Despite the growing number of studies discussing flood vulnerability in Jakarta, there remains a limited amount of research that analyzes the issue with a multidimensional framework at the sub-city or district level, particularly in West Jakarta. Most existing literature tends to focus on Jakarta as a whole or on specific environmental or infrastructural aspects without integrating the physical, social, economic, and environmental dimensions holistically. Furthermore, many studies lack the use of standardized vulnerability frameworks, resulting in inconsistent comparisons across different areas. This leads to a lack of clarity regarding the manifestation of flood vulnerability at a more localized, administrative scale, especially in rapidly urbanizing districts like West Jakarta.

This study addresses that gap by applying a quantitative, index-based approach using the standardized framework of PERKA BNPB No. 2/2012. By operationalizing this national regulation into measurable indicators across eight sub-districts in West Jakarta, the study provides a more detailed and structured analysis than previous research. It identifies which areas are most vulnerable and explains how different aspects such as high population density, prevalence of informal housing, low economic resilience, and limited green open spaces interact and compound the risks. Unlike earlier studies that were often qualitative or focused on singular dimensions, this research offers an integrative vulnerability map that can directly inform local-scale mitigation and planning.

Moreover, the application of the PERKA BNPB framework in the context of West Jakarta presents novel insights. It showcases the adaptation of a nationally recognized standard to create locally applicable vulnerability assessments. Few studies have implemented the regulation at this level of spatial granularity, despite its widespread citation. The study finds that vulnerability is spatially differentiated. Tambora, Cengkareng, and Kembangan show the highest vulnerability scores, emphasizing the need for targeted policies to reduce disaster risk

rather than generalized city-wide strategies. This study enhances the academic discourse on urban flood vulnerability and offers a practical framework for reconciling national policy guidelines with local governance requirements.

LITERATURE REVIEW

Research on community vulnerability to flooding generally employs a multidimensional framework, incorporating physical, social, economic, and environmental components (Bencana, 2012). This approach aligns with the broader theoretical discourse that views vulnerability not merely as exposure to hazards but as the outcome of systemic conditions that weaken a community's capacity to respond and recover (Wisner et al., 2004). The concept of vulnerability has evolved from being hazard-centered to embracing a more holistic, socially constructed perspective, emphasizing factors such as access to resources, institutional support, and social equity.

Numerous studies have adopted this multidimensional lens to assess flood vulnerability in urban contexts. For instance, Cutter et al. (2003) the Social risk Index (SoVI) was established, prompting numerous regional adaptations for the quantitative assessment of risk. In Indonesia, numerous scholars have concentrated on the flood hazards in Jakarta, emphasizing the impact of unregulated urban growth, informal housing, and climate-related precipitation extremes, which led to the development of the Social Vulnerability Index (SoVI), subsequently prompting diverse adaptations across regions for quantitative vulnerability assessment. In Indonesia, numerous scholars have concentrated on the flood hazards in Jakarta, emphasizing the impact of unregulated urban growth, informal housing, and climate-related precipitation extremes. (Hardianto et al., 2024). However, many of these studies concentrate on hazard exposure or infrastructure analysis, with limited integration of the social and economic dimensions.

Additionally, while existing research frequently affirms that flood vulnerability in Jakarta is influenced by factors such as high population density, the prevalence of vulnerable groups, dependence on the informal economy, and restricted access to green open spaces, it often generalizes findings at the city level, neglecting intra-urban disparities. This research reinforces those general patterns, showing that in West Jakarta, particularly in sub-districts like

Tambora, Cengkareng, and Kembangan, social and physical conditions significantly amplify flood risk. Tambora, for example, exhibits the highest levels of vulnerability due to the accumulation of socio-economic stressors and environmental degradation.

Despite the constant identification of primary factors affecting disaster susceptibility in past studies, notable methodological inconsistencies continue to exist in the evaluation of disaster risk. Existing research frequently employs qualitative approaches, locally adapted indicators, or disparate analytical frameworks, thereby limiting cross-regional comparability and reducing the reproducibility of research outcomes.

Moreover, the lack of standardized assessment protocols constrains the translation of scientific evidence into operational disaster risk management. This study addresses these limitations by implementing a standardized quantitative assessment framework derived from PERKA BNPB No. 2 of 2012, the official Indonesian guideline for disaster risk assessment. The framework integrates hazard, exposure, vulnerability, and capacity indicators within a unified analytical structure, enabling a systematic and transparent evaluation of disaster risk. By applying this nationally established methodology at the sub-district scale, the study not only improves methodological robustness and spatial comparability but also provides policy-relevant evidence to support evidence-based disaster risk reduction strategies and local resilience planning.

Moreover, certain aspects of this discourse remain insufficiently examined. For example, the interactions between different dimensions of vulnerability, how physical infrastructure deficits intensify social and economic hardships, or how environmental degradation undermines resilience are often not examined in an integrated way. Most studies do not assess how vulnerability patterns differ within urban zones or how policy frameworks like PERKA BNPB can be adapted for practical implementation at the local government level. This research tackles these deficiencies by creating a spatially explicit, multi-faceted flood vulnerability evaluation that combines national disaster risk models with local district attributes. The research integrates physical, social, economic, and environmental aspects into a spatial analytical framework, offering a more thorough depiction of flood susceptibility throughout West Jakarta.

Moreover, it addresses the methodological constraints and discrepancies recognized in earlier research by employing a comprehensive and spatially nuanced methodology. The results indicate that flood susceptibility is influenced by intricate interactions among various elements, underscoring the necessity for evidence-based and geographically informed mitigation approaches in swiftly urbanizing regions like West Jakarta.

RESEARCH METHODS

Research Approach and Research Design

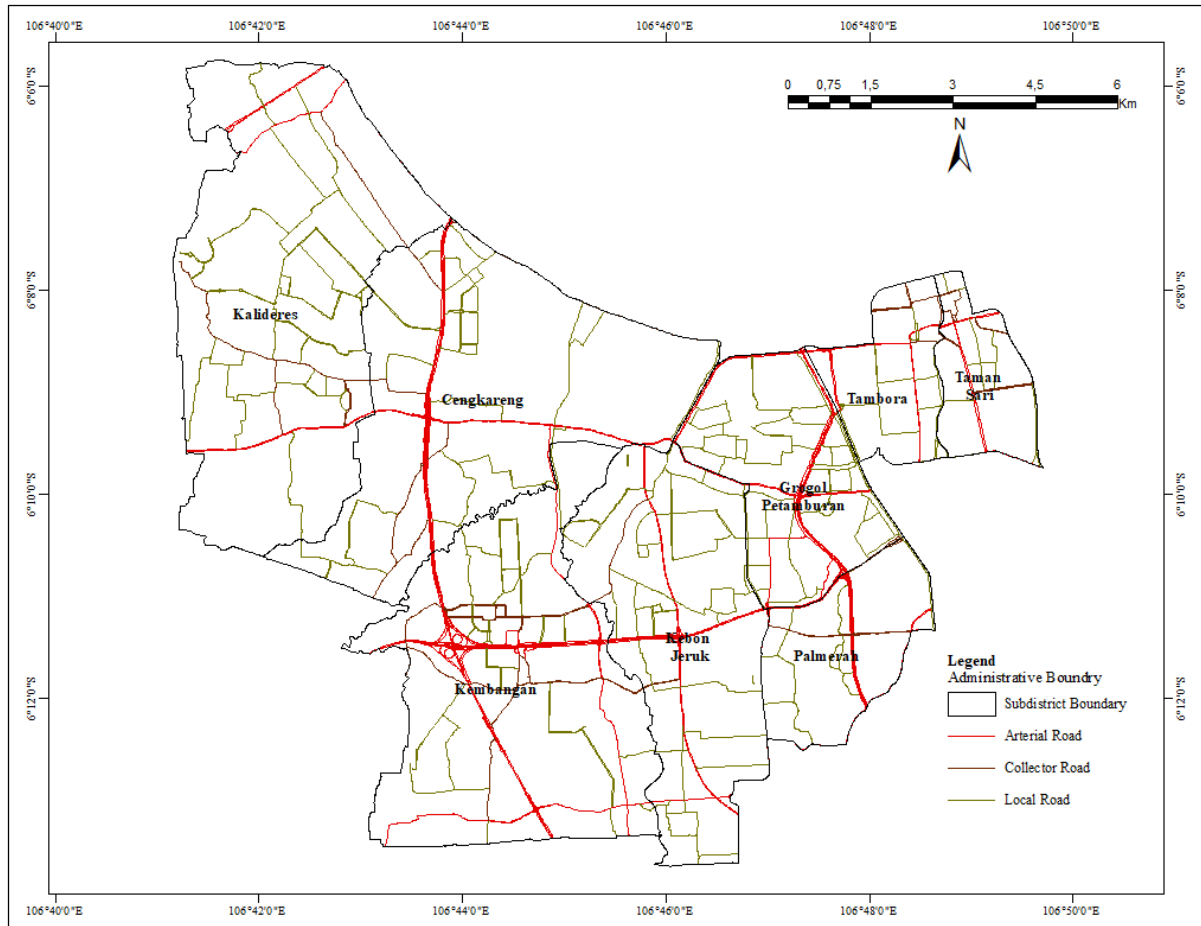
This research utilized a quantitative descriptive methodology to methodically evaluate community susceptibility to flooding in West Jakarta. Original data were gathered via structured survey instruments and examined utilizing descriptive statistical methods, without the evaluation of pre-established hypotheses. The results were displayed in tabular and graphical formats to offer a thorough summary of community awareness concerning flood hazards and the implemented mitigation measures.

This method enables an impartial and methodical assessment of community readiness and the efficacy of current flood prevention strategies. Moreover, the descriptive quantitative framework facilitates an evidence-driven evaluation of existing field circumstances, thereby establishing a solid basis for formulating informed policies and plans to enhance flood catastrophe risk management.

Research Location

The study was conducted in West Jakarta Administrative City, one of the five administrative municipalities of the Special Capital Region (DKI) of Jakarta, Indonesia. Geographically, the study area is located between 106°22'42" and 106°58'18" E longitude and 5°19'12" and 6°23'54" N latitude. West Jakarta covers a total area of 129.54 km², representing approximately 19.56% of the total land area of the Special Capital Region of Jakarta.

West Jakarta is administratively organized into eight subdistricts (kecamatan): Cengkareng, Grogol Petamburan, Taman Sari, Tambora, Kebon Jeruk, Kalideres, Palmerah, and Kembangan. These subdistricts encompass a total of 56 urban villages (kelurahan), forming the municipality's lowest administrative level.

Picture 1. Research Location

Course : Suku Dinas Cipta Karya Jakarta Barat, 2025

Research Population and Sample

This study employs a quantitative descriptive approach to assess the level of community vulnerability to flooding in West Jakarta. The goal is to provide a systematic and objective picture of what is really going on in the field without testing any specific ideas. This method is particularly suitable for identifying patterns and distributions of vulnerability across multiple dimensions and for supporting the development of data-informed strategies for reducing disaster risk.

Structured questionnaires were used to gather data from 15 people living in a randomly chosen sub-district of West Jakarta. The selection of the sub-district was conducted using a simple random sampling technique to ensure impartiality and to avoid selection bias. Within the chosen sub-district, respondents were also selected randomly to capture a representative range of community perspectives and conditions. The questionnaire was designed based on the BNPB Regulation No. 2 of 2012, covering four dimensions of vulnerability: physical, social, economic, and environmental.

Indicators under each dimension were translated into measurable questions, enabling a consistent and reliable assessment of community exposure, sensitivity, and adaptive capacity in relation to flood risk.

The collected data were systematically processed and analyzed using descriptive statistical techniques and subsequently presented in the form of tables, graphs, and composite vulnerability indices to facilitate a comprehensive interpretation of the findings. The construction of composite indices enabled the identification of the relative severity of flood-related vulnerabilities across multiple dimensions, thereby providing a robust basis for assessing patterns, trends, and spatial disparities. Furthermore, this analytical approach supports comparisons with previous empirical studies while generating context-specific evidence that reflects the socioeconomic and environmental characteristics of the study area.

By integrating quantitative measurements into a comprehensive vulnerability assessment framework, this study aims to strengthen

evidence-based flood risk management and support informed decision-making. The analysis identifies the most critical factors contributing to household vulnerability in flood-prone communities, thereby highlighting priority areas for intervention. The findings are expected to provide valuable scientific evidence for local governments, disaster management authorities, and other stakeholders in formulating targeted mitigation strategies, optimizing resource allocation, and enhancing community resilience through more adaptive and sustainable flood risk reduction policies.

Table 1. Research Sample

No	District	Population	Sample
1	Kembangan	311.262	15
2	Kebon Jeruk	362.641	15
3	Palmerah	225.845	15
4	Grogol Petamburan	230.173	15
5	Tambora	258.061	15

No	District	Population	Sample
6	Taman sari	122.909	15
7	Cengkareng	581.788	15
8	Kalideres	464.076	15
	Total	2.611.515	120

Source: Results of the author's research, West Jakarta 2025

Research Variables

Variables and parameters used in flood vulnerability analysis represent the fundamental components for systematically assessing the susceptibility of a given area to flood hazards. These variables provide a structured framework for quantifying the physical, environmental, socio-economic, and infrastructural conditions that influence flood vulnerability. To ensure a comprehensive and robust assessment, the variables are typically organized into several major categories, each representing a distinct dimension of vulnerability and contributing to the overall evaluation of flood risk.

Table 2. Research Variables.

Variable	Sub-Variable	Indicator
Flood Disaster Vulnerability Source: PERKA BNPB Number 2 of 2012	Social Vulnerability	Population Density
		Percentage of Women
		Percentage of Vulnerable Age Groups
		Level of Education
		Percentage of Age Groups with Disabilities
	Economic Vulnerability	Percentage of Poor Population
		Number of Economic Facilities
		Income per Household
	Physical Vulnerability	Building Density
		Public Facilities
		Critical Facilities
	Environmental Vulnerability	Protected Forests
		Natural Forests
		Mangrove Forests
		Scrubland
		Swamps

Source : PERKA BNPB Number 2 of 2012

Data and Data Sources

The study employed a combination of primary and secondary data sources to support a comprehensive analysis. Primary data were collected through structured interviews, questionnaire-based surveys, and direct field

observations conducted within the study area. Secondary data were compiled from official statistical reports, government publications, institutional documents, and other relevant literature. The use of multiple data sources facilitated methodological triangulation, thereby improving the credibility, consistency, and reliability of the findings.

Table 3. Data and Data Sources

Sub-Variable	Indicator	Data and Data Sources
Social Vulnerability	Population Density	Data from BPS
	Percentage of Women	Data from BPS
	Percentage of Vulnerable Age Groups	Data from BPS
	Level of Education	Data from BPS
	Percentage of Age Groups with Disabilities	Data from BPS
Economic Vulnerability	Percentage of Poor Population	Questionnaires, economic statistics data
	Number of Economic Facilities	Questionnaires, economic statistics data
	Income per Household	Questionnaires, economic statistics data
Economic Vulnerability	Building Density	Data from BPS, field observations
	Public Facilities	Data from BPS, field observations
	Critical Facilities	Data from BPS, field observations
Environmental Vulnerability	Protected Forests	Data from field observations, BPS, data from Dinas Lingkungan Hidup Dki Jakarta (LH)
	Natural Forests	Data from field observations, BPS, Data from Dinas Lingkungan Hidup Dki Jakarta (LH)
	Mangrove Forests	Data from field observations, BPS, Data from Dinas Lingkungan Hidup Dki Jakarta (LH)
	Scrubland	Data from field observations, BPS, Data from Dinas Lingkungan Hidup Dki Jakarta (LH)
	Swamps	Data from field observations, BPS, Data from Dinas Lingkungan Hidup Dki Jakarta (LH)

Source: PERKA BNPB Number 2 of 2012

Data Collection Techniques

This study uses a quantitative descriptive approach to examine the vulnerability of communities to flooding in West Jakarta. Data was collected from two types of sources, namely primary and secondary sources. Primary data was obtained through semi-structured interviews, field observations, and questionnaires. Interviews were conducted with five key informants from the Disaster Management Agency (BPBD), district and sub-district governments, the Environmental Agency, and community leaders to explore the social, physical, economic, and environmental aspects of flood risk. Observations were aimed at mapping physical conditions in the field, such as houses and public facilities vulnerable to flooding. Meanwhile, questionnaires were

distributed to residents from various sub-districts to assess their understanding and preparedness.

Secondary data was obtained from agencies such as the Cipta Karya Sub-Department, BPBD, BPS, and the Housing Agency. The types of data included administrative maps, road networks, rainfall, demographics, and economic and population data. This data was used as the basis for spatial and social analysis in assessing the vulnerability of the area.

Data Analysis Techniques

The data analysis techniques used in this study employ a descriptive quantitative approach through scoring and weighting methods for each research variable. Data processing for vulnerability in this study refers to the guidelines set forth in BNPB Regulation No. 2 of 2012. The

analysis process is conducted through scoring and weighting of the four main dimensions of disaster vulnerability, namely physical, economic, social, and environmental vulnerability. Each dimension has specific indicators used to calculate vulnerability values quantitatively. The final value of each parameter will be calculated using the following formula:

Vulnerability Index $= (0.4 \times \text{Social Vulnerability Index}) + (0.25 \times \text{Physical Vulnerability Index}) + (0.25 \times \text{Economic Vulnerability Index}) + (0.1 \times \text{Environmental Vulnerability Index})$ <i>Source: PERKA BNPB No 2 of 2012</i>
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Table. 4 Social Vulnerability Indicators

Indicator	Weight (%)	Class		
		Low	Medium	High
Population Density	60%	< 500 People/km ²	500 – 1000 people/km ²	>1000 people/km ²
Sex Ratio	10%	<20%	20 – 40%	>40%
Poverty Ratio	10%	<20%	20–40%	>40%
Disability Ratio	10%	<20%	20–40%	>40%
Age Group Ratio	10%	<20%	20–40%	>40%

$$\text{Social Vulnerability} = (0.6 \times \text{Population Density Score}) + (0.1 \times \text{Gender Ratio Score}) + (0.1 \times \text{Poverty Ratio}) + (0.1 \times \text{Disability Ratio}) + (0.1 \times \text{Age Group Ratio})$$

Source : PERKA BNPB No. 2 of 2012

Table 5. Physical Vulnerability Indicators

Indicator	Weight (%)	Class		
		Low	Medium	High
Housing	40%	< 400 million	Rp. 400 million – 800 million	>800 million
Public Facilities	30%	< 500 million	Rp 500 million – 1 billion	>1 billion
Critical Facilities	30%	< 500 million	Rp. 500 million – 1 billion	>1 billion

$$\text{Physical Vulnerability} = (0.4 \times \text{House Score}) + (0.3 \times \text{Public Facility Score}) + (0.3 \times \text{Critical Facility Score})$$

Source: PERKA BNPB No. 2 of 2012

Table 6. Environmental Vulnerability Indicators

Indicator	Weight (%)	Class		
		Low	Medium	High
Protected Forest	30%	< 20 Ha	20 – 50 ha	> 50 ha
Natural Forest	30%	< 25 Ha	25 – 75 ha	> 75 ha
Mangrove Forest	10%	< 10 Ha	10 – 30 ha	> 30 ha
Scrubland	10%	< 20 Ha	10 – 30 ha	> 30 ha
Swamp	20%	< 5 Ha	5 – 20 ha	> 20 ha

$$\text{Environmental Vulnerability} = (0.3 \times \text{Protected Forest Score}) + (0.3 \times \text{Natural Forest Score}) + (0.1 \times \text{Mangrove Forest Score}) + (0.1 \times \text{Scrubland Score}) + (0.2 \times \text{Swamp Score})$$

Source: PERKA BNPB No. 2 of 2012

Table 7. Economic Vulnerability Indicators

Indicator	Weight (%)	Class		
		Low	Medium	High
Productive Land Area	60%	< Rp. 50 Million	Rp. 50 Million – 200 Million	>Rp. 200 Million
Contribution of GRDP by Sector	40%	< Rp. 100 Million	Rp. 100 Million – 300 Million	>Rp. 300 Million

$$\text{Economic Vulnerability} = (0.6 \times \text{Productive Land Area}) + (0.4 \times \text{Contribution of GRDP by Sector})$$

Source: PERKA BNPB No. 2 of 2012

Vulnerability Level Classification:
Vulnerability levels are divided into three categories: low, medium, and high. Each category is based on a vulnerability index value ranging from 0.33 to 1. The intervals for each class are determined using an arithmetic formula, resulting in a proportional and systematic class division. The formula for calculating the vulnerability level class interval is as follows: Class Interval Value

$$\frac{\text{Highest Value} - \text{Lowest Value}}{\text{Number of Classes}}$$

Table 8. Vulnerability Class Interval Values

Interval Class of Flood Vulnerability	
Class	Interval Value
Low	0,33 - 0,553
Medium	0,554 – 0,777
High	0,778 - 1

Source: PERKA BNPB No. 2 of 2012

RESULTS AND DISCUSSION

The evaluation of social susceptibility to flood risks in West Jakarta utilized a weighted indicator methodology that incorporates essential demographic and socioeconomic factors, such as population density, gender ratio, poverty levels, the percentage of individuals with disabilities, and the share of at-risk age demographics. These factors were chosen to illustrate the varying vulnerability of communities to flood effects. To measure total social vulnerability, each indication was allocated a relative weight according to its impact on community vulnerability, thereby enabling a methodical and geographically precise assessment of vulnerability throughout the study region.

Social Vulnerability Level

The evaluation of social vulnerability in West Jakarta was conducted utilizing five principal indicators: population density, gender ratio, poverty rate, disability rate, and the percentage of at-risk age demographics. Every indicator underwent a normalization procedure to achieve standardization and was allocated a weight reflecting its proportional impact on social resilience and vulnerability to flood risks. The resultant composite social vulnerability score demonstrated regional discrepancies throughout the research region. Three sub-districts, Cengkareng (0.4305), Kembangan (0.8508), and Kebon Jeruk (0.8245), were identified as demonstrating elevated degrees of social vulnerability.

These sub-districts exhibit significant population density, a higher percentage of individuals in at-risk age demographics, and comparatively high rates of poverty and disability. Demographic and socioeconomic traits diminish the adaptive potential of local populations and heighten their vulnerability to negative flood effects, underscoring the necessity for focused risk mitigation and resilience enhancement efforts. Meanwhile, five other sub-districts - Palmerah (0.7595), Grogol Petamburan (0.76), Tambora (0.7455), and Taman Sari (0.7723) - fall into the medium social vulnerability category. Although these areas also have a large working-age population, they show more moderate values in terms of poverty and disability ratios, so their vulnerability scores are slightly lower compared to the high vulnerability group. These findings highlight the importance of targeted interventions in subdistricts with high social vulnerability.

Strengthening community-based strategies for reducing disaster risk, especially for poor households, people with disabilities, and the elderly, is crucial for enhancing social resilience.

The differences in scores also show that social vulnerability is not just based on demographics; it is also closely related to inequality and access to resources in each sub-district.

Table 9. Social Vulnerability Level

Sub-district	Population Density	Sex Ratio	Poverty Ratio	Disability Ratio	Age Group Ratio	Final Score	Description
Kembangan	0,97	0,553	0,51	0,54	1	0,8508	High
Kebon Jeruk	0,93	0,52	0,505	0,53	1	0,8245	High
Palmerah	0,835	0,545	0,33	0,51	1	0,7595	Medium
Grogol Petamburan	0,86	0,33	0,48	0,52	1	0,76	Medium
Tambora	0,8	0,535	0,525	0,5	1	0,7455	Medium
Taman Sari	0,84	0,51	0,553	0,553	1	0,7723	Medium
Cengkareng	1	0,53	0,495	0,51	1	0,853	High
Kalideres	0,96	0,54	0,485	0,5	1	0,8425	High

Source: Author's Research Results, 2025

The Level of Economic Vulnerability

Economic vulnerability in West Jakarta was assessed using three key indicators: the density of residential areas, the contribution of the Gross Regional Domestic Product (GRDP), and the distribution of public service and critical facilities located in flood-prone zones. These parameters were scored based on the guidelines from PERKA BNPB No. 2 Tahun 2012, allowing a structured evaluation of how economically at risk each subdistrict is in the face of potential flood disasters.

The analytical findings indicate that five subdistricts Kembangan, Kebon Jeruk, Tambora, Cengkareng, and Kalideres are classified as exhibiting significant economic susceptibility. These regions have peak or almost peak ratings across all metrics, indicating a significant density of housing and vital infrastructure, including educational institutions,

marketplaces, healthcare facilities, and transit systems, in zones often subjected to flooding. The financial repercussions of flooding in these areas could be significant, posing considerable threats to property loss, disruptions in commerce, and prolonged economic decline. These findings cast doubt on the initial assumption that most areas in West Jakarta may demonstrate low economic vulnerability. Instead, they reveal that a significant portion of the city's economic assets are located in flood-exposed areas, especially in subdistricts with high population density and strategic facilities. Consequently, there is an urgent need for proactive flood mitigation efforts and economic resilience planning, particularly in high-vulnerability zones, to minimize future disruptions, ensure service continuity, and protect local livelihoods and economic development.

Table 10. Level of Economic Vulnerability

Subdistrict	Interval Value Land Area	GRDP Interval Value	Economic Vulnerability	Interval Value	Description
Kembangan	1	1	1	3	High
Kebon Jeruk	1	1	1	3	High
Palmerah	0,33	1	0,598	2	Medium

Subdistrict	Interval Value Land Area	GRDP Interval Value	Economic Vulnerability	Interval Value	Description
Grogol Petamburan	0,33	1	0,598	2	Medium
Tambora	1	1	1	3	High
Taman Sari	0,33	1	0,598	2	Medium
Cengkareng	1	1	1	3	High
Kalideres	0,665	1	0,799	3	High

Source: Author's Research Results, 2025

Physical Vulnerability

Physical vulnerability to flooding in West Jakarta was assessed using three primary indicators: the distribution of residential housing, the availability of public facilities (such as schools and health centers), and the presence of critical facilities (such as government offices and transportation nodes) within flood-prone areas. These physical components are crucial in understanding how infrastructure and human settlements might be impacted by flood events, particularly in terms of structural damage and disruption of essential services.

Based on the weighted scoring results, the analysis indicates that the majority of subdistricts, Kembangan, Kebon Jeruk, Grogol Petamburan, Taman Sari, Cengkareng, and Kalideres, fall into the low physical vulnerability category. This suggests that while these areas are exposed to flood risks, the physical assets, particularly critical infrastructure and housing, are relatively less concentrated in high-hazard

zones, reducing the overall susceptibility to physical damage during flood events.

In contrast, Palmerah and Tambora are categorized as having moderate physical vulnerability, with Tambora recording the highest vulnerability score (0.6985) among all subdistricts. These findings are primarily due to the higher density of residential areas and critical infrastructure located within flood-prone zones, which significantly increases their exposure and potential for physical losses. The presence of essential services in hazard-prone areas further amplifies the risk of disruption during disaster events. While West Jakarta generally exhibits low physical vulnerability, certain pockets, particularly in Palmerah and Tambora, necessitate heightened attention. Strategic urban planning, improved zoning regulations, and targeted flood mitigation infrastructure are needed in these areas to protect physical assets and enhance the overall resilience of the built environment against flood hazards.

Table 11. Physical Vulnerability Level

Subdistrict	House	Public Facilities	Critical Facilities	Total Value	Class	Description
Cengkareng	0,33	0,665	0,33	0,4305	1	Low
Grogol Petamburan	0,33	0,33	1	0,531	1	Low
Kalideres	0,665	0,33	0,665	0,5645	2	Medium
Kebon Jeruk	0,33	0,33	1	0,531	1	Low
Kembangan	1	0,33	0,665	0,6985	2	Medium
Palmerah	0,33	0,33	0,33	0,33	1	Low
Taman Sari	0,33	0,665	0,33	0,4305	1	Low
Tambora	0,33	0,665	0,33	0,4305	1	Low

Source: Author's Research Results, 2025

Environmental vulnerability

The environmental vulnerability assessment was conducted using indicators representing ecologically important land-cover components, namely protected forests, natural forests, mangrove ecosystems, shrublands, and wetlands. The results reveal that all sub-districts

in West Jakarta Kembangan, Kebon Jeruk, Palmerah, Grogol Petamburan, Tambora, Taman Sari, Cengkareng, and Kalideres share an identical environmental vulnerability index of 0.33, placing them within the low vulnerability category. The absence of spatial variation in environmental vulnerability indicates that these

ecological indicators have a relatively homogeneous distribution across the study area. Consequently, environmental factors play a limited role in differentiating flood vulnerability among sub-districts, suggesting that variations in overall flood vulnerability are more likely influenced by other dimensions, such as physical, social, or infrastructural characteristics. This low score does not mean

that the environmental conditions are satisfactory but rather reflects the lack of natural vegetation cover that functions as a flood buffer. In other words, the carrying capacity of the environment to absorb and retain water is very limited. This condition indicates the need to increase green open space and restore ecological functions in the West Jakarta area as part of long-term flood mitigation efforts.

Table 12. Environmental Vulnerability Level

SubDistrict	Protected Forest	Natural Forest	Mangrove Forest	Scrubland	Swamp	Total Score	Class	Description
Kembangan	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Kebon Jeruk	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Palmerah	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Grogol Petamburan	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Tambora	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Taman Sari	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Cengkareng	0,099	0,099	0,033	0,033	0,066	0,33	1	Low
Kalideres	0,099	0,099	0,033	0,033	0,066	0,33	1	Low

Source: Author's Research Results, 2025

An analysis of the four aspects of physical, economic, social, and environmental vulnerability shows that West Jakarta faces a high flood risk with multidimensional characteristics. Physical vulnerability is most prominent in areas such as Cengkareng, Tambora, and Kembangan, triggered by settlement density and inadequate drainage infrastructure. On the economic aspect, the majority of sub-districts are classified as low to moderate, but areas such as Tambora and Palmerah remain at risk due to the high concentration of economic activity in vulnerable zones. Social vulnerability is strong in Cengkareng, Tambora, and Taman Sari, where vulnerable groups dominate the population. Meanwhile, all sub-districts show low environmental vulnerability due to the lack of green areas, reflecting the low ecological carrying capacity.

The results indicate that physical and social susceptibility are the primary factors influencing overall flood vulnerability in the examined region. This underscores the necessity for a holistic and cohesive flood risk management approach that transcends just structural solutions to include community empowerment, institutional governance, sustainable land-use planning, ecosystem restoration, and socio-economic resilience. Through the amalgamation

of these synergistic strategies, decision-makers can enhance regional adaptive capability, mitigate disaster risk, and foster enduring resilience to the escalating frequency and severity of flood occurrences linked to climatic and environmental alterations.

The vulnerability level is determined based on the BNPB analysis conducted in 2012.

An analysis of the community's vulnerability to flooding in West Jakarta was conducted based on four main aspects outlined in BNPB Regulation No. 2 of 2012, namely physical, economic, social, and environmental vulnerability. The results of the study in eight subdistricts indicate that the level of flood vulnerability in this area is complex and multidimensional, with variations reflecting the characteristics of each region. In terms of physical vulnerability, most sub-districts, such as Kembangan, Kalideres, Cengkareng, Kebon Jeruk, Grogol Petamburan, and Taman Sari, are classified as low. This indicates that these areas have relatively low building density or limited critical facilities in flood-prone zones.

Meanwhile, Palmerah and Tambora subdistricts are classified as moderately vulnerable due to residential density, inadequate building quality, and vital infrastructure that is not yet fully flood-resistant. The result indicates

the need to strengthen the drainage system and redevelop densely populated areas to reduce potential physical risks.

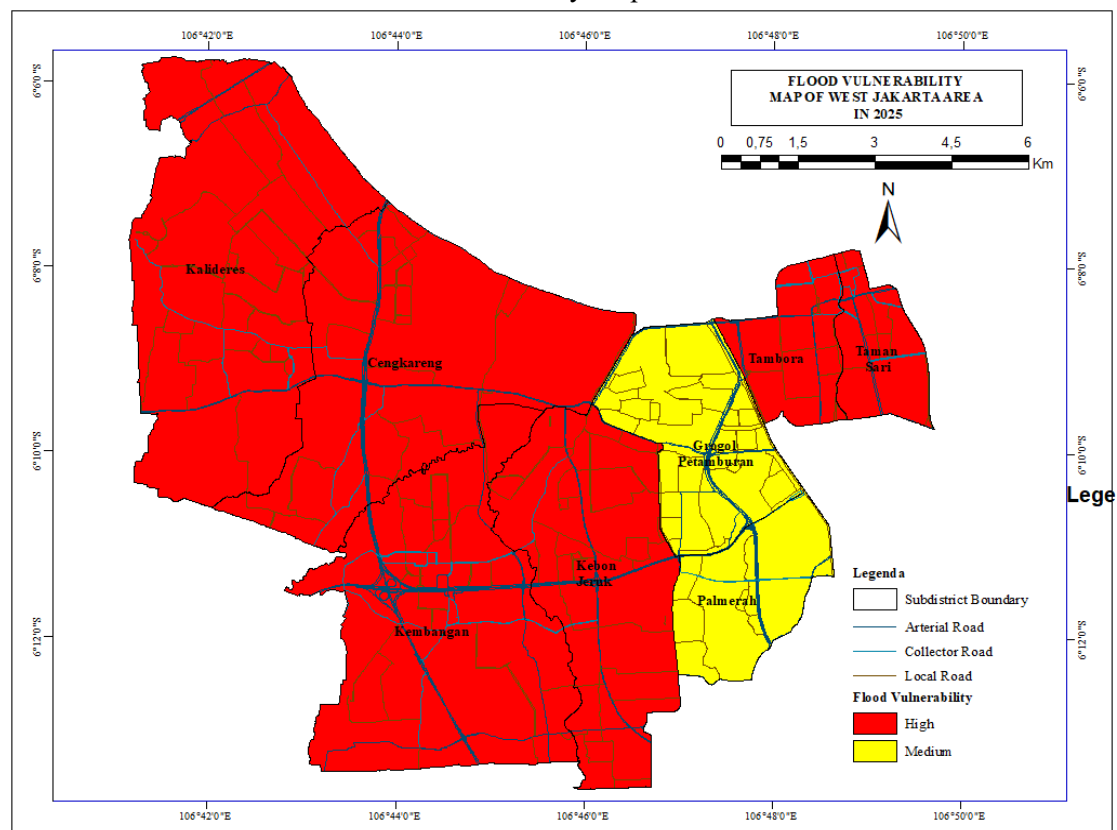
From an economic vulnerability perspective, the analytical results indicate that most areas, such as Kembangan, Tambora, Kalideres, Cengkareng, and Kebon Jeruk, are classified as significantly vulnerable. This circumstance is closely associated with the significant number of destitute individuals and dependence on the informal economy, which is especially vulnerable to disruptions from flooding. Districts such as Palmerah, Grogol Petamburan, and Taman Sari demonstrate a moderate level of economic vulnerability, requiring risk-focused economic strategies to bolster community resilience.

The social vulnerability aspect shows that different communities adapt to disasters in different ways. The subdistricts of Cengkareng, Kalideres, Kembangan, and Kebon Jeruk are classified as highly vulnerable, mainly due to the dominance of vulnerable groups such as the elderly, people with disabilities, and poor families. Meanwhile, Palmerah, Tambora, and Taman Sari are in the moderate category, with a social composition that still requires attention. This situation illustrates the value of enhancing community capacity through community-based

disaster training, inclusive early warning systems, and equitable access to basic services. Meanwhile, in terms of environmental vulnerability, all subdistricts in West Jakarta are numerically classified as low-risk. However, this low score does not reflect the strength of the ecosystem but rather indicates an ecological crisis due to the lack of natural vegetation cover, such as forests, swamps, and shrublands that function as natural flood buffers. In other words, the low environmental vulnerability reflects the absence of important ecological elements in the urban structure. The analysis indicates that flood susceptibility in West Jakarta is extensive and interdependent across various dimensions.

The main influences on populations are physical and social sensitivity, although economic and environmental aspects have secondary consequences that amplify situations during flooding. As a result, mitigation initiatives should be carried out in a coordinated and evidence-based fashion, prioritizing upgrades to physical infrastructure, enhancing community socio-economic resilience, revitalizing urban biodiversity, and using risk-informed spatial design. This comprehensive methodology is vital for developing West Jakarta into a more durable and flexible locality able to endure flood resilience in the future.

Picture 2. Flood Vulnerability Map of West Jakarta Area



Source: Research Results Author, Flood Vulnerability in West Jakarta, 2025

CONCLUSION

Social and economic aspects are the main contributors to high vulnerability, especially in areas with concentrations of vulnerable populations, low incomes, and dense economic activities. Meanwhile, environmental aspects, although relatively low in numerical index values, reflect a lack of natural vegetation cover and green open space, thereby exacerbating the flood risk. Physical vulnerability is generally low to moderate but remains significant in dense subdistricts such as Tambora and Palmerah. Overall, the results show that Tambora Sub-district has the highest overall vulnerability score, followed by Palmerah. This is because of the combined effects of physical, social, and economic risk factors. Conversely, Kembangan and Taman Sari tend to have the lowest vulnerability levels across dimensions.

These results show how important it is to take an integrated and data-driven approach to reducing the risk of flooding. The main goals should be to improve physical infrastructure, protect vulnerable social groups, and restore damaged environments. The application of BNPB's quantitative indicators provides a strong empirical foundation for designing adaptive and sustainable flood mitigation policies tailored to the specific needs of each sub-district.

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