

ENHANCING DISASTER RESILIENCE INDICATORS TOWARDS APPROPRIATED MITIGATING STRATEGIES: SYSTEMATIC LITERATURE REVIEW APPROACH

Asti Istiqomah^{1,*}, Akhmad Fauzi¹, Sri Mulatsih¹, Nuva¹, Pini Wijayanti¹

¹ Faculty Economics and Management, IPB University, Jawa Barat, Indonesia
Corresponding author email: asti.istiqomah@apps.ipb.ac.id

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Abstract

Developing a regional resilience index for natural disasters is essential for systematically monitoring resilience performance and supporting evidence-based policymaking. Strengthening regional resilience is particularly critical for West Java Province, given its high exposure and vulnerability to multiple hazards. This study aims to construct a comprehensive framework of regional disaster resilience indicators and to assess the level of resilience across the province. The research employs a Systematic Literature Review (SLR) and the PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) for multi-criteria analysis. Secondary data were obtained from Statistics of West Java Province, while the SLR was conducted using the Scopus database complemented by manual searches. A total of 77 selected articles yielded 22 principal indicators of regional disaster resilience, classified into five dimensions: economic, social, ecological, infrastructure, and institutional. The assessment reveals that several indicators—particularly within the ecological, infrastructure, and institutional dimensions—demonstrate relatively low performance across districts and cities. Based on 17 equally weighted indicators, the ranking results identify Cimahi City, Bandung City, and Cirebon City as the three most resilient regions in the province. Meanwhile, Tasikmalaya City, Cianjur City, and Indramayu City ranked lowest in terms of disaster resilience. These findings provide an empirical basis for stakeholders and policymakers to evaluate regional resilience capacity and formulate integrated action plans and targeted mitigation strategies to support sustainable and adaptive regional development.

Keywords: Disaster, Promethee, Resilience, SLR, West Java.



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INTRODUCTION

The frequency and impact of disasters, both socially and economically, have been on the rise. Data from EM-DAT (2024) reveal that Asia persists as a high-risk disaster region, while Indonesia remains especially vulnerable to risks dominated by hydrometeorological hazards (CRED, 2024). Climate change affects many facets of the Earth and has intensified markedly since the Industrial Revolution (IPCC AR, 2013). At the same time, rapid population growth, rising prosperity in high-risk regions, unregulated resource exploitation, and inadequate land-use planning have increased the vulnerability of ecosystems to natural hazards (IPCC, 2014).

Natural disasters have generated substantial economic losses worldwide. Floods (41.42%), storms (28.16%), and landslides (10.68%) represent the three most frequently occurring disaster types, while the remaining proportion consists of other natural hazards. Based on EM-DAT 2024, global disasters affected approximately 167 million people and resulted in 16,753 fatalities (CRED, 2025). Furthermore, the Global Assessment Report on Disaster Risk Reduction (UNDRR, 2025) estimates that direct economic losses reach around USD 202 billion annually. When indirect impacts, such as ecosystem degradation, are considered, total losses increase significantly to an estimated USD 2.3 trillion per year. EM-DAT (2024) also reports that the highest economic losses were attributed to storms (USD 172.8 billion), followed by floods (USD 32.8 billion) and earthquakes (USD 18.1 billion).

In Indonesia, disaster-related economic losses are estimated at approximately IDR 22.8 trillion per year (Sudarno, 2025), encompassing both direct and indirect costs. Direct losses primarily involve physical damage to infrastructure, including buildings, transportation networks, energy systems, agricultural land, and other productive assets. Indirect losses include employment disruptions, interruptions to supply chains, declines in tourism revenue, and other secondary economic impacts. Collectively, these losses pose significant risks to regional development, highlighting the critical importance of strengthening regional resilience.

In 2022, West Java Province emerged as the region in Indonesia experiencing the most natural disasters (Annur, 2022). Beyond topographical factors, climate change-related global environmental alterations have escalated the frequency and magnitude of numerous natural hazards (CRED, 2024; Meng et al., 2015). In West Java, the occurrence of disasters fluctuates but generally shows an upward trend. The most frequent disasters in the province are landslides, tornadoes, and floods (BPS, 2023). In 2022, tornadoes accounted for the highest number of incidents (85), followed by landslides (74), and floods (38). During that year, 1,167 villages experienced landslides, and 1,005 villages were affected by floods. The human toll included 64 fatalities, 146 injuries, and a total of 294,265 people impacted, displaced, or affected by these disasters (Statistics of West Java Province, 2023). According to the West Java Provincial Disaster Management Agency (BPBD), material damages from natural hazards in West Java from January to November 2016 totaled approximately IDR 63.5 billion (Sudrajat, 2016).

These disasters can undo development efforts that have been difficult to achieve. Emergency response and recovery expenses often reduce budgets that could otherwise be used for regional development and poverty reduction. During disasters, the poor tend to be the most severely affected, as they constitute the majority of victims and suffer most from the resulting impoverishment. This impact is especially pronounced for populations residing in vulnerable areas, who often lack the resources needed to adapt or recover swiftly from such shocks (Aldrich and Meyer, 2015; Kamal et al., 2018). Given these challenges, West Java Province warrants focused attention. Building resilience in regional development is crucial for the province's sustainable growth. Therefore, developing a resilience index for natural disasters is essential for monitoring resilience levels and is a critical step in formulating effective policies.

Previous studies have established a robust theoretical foundation and strategic orientation for resilient regional development. Nevertheless, several critical research gaps remain. From a methodological perspective, many existing index-based evaluation frameworks continue to emphasize a single dimension—such as economic or ecological aspects—thereby limiting the advancement of comprehensive, multidimensional resilience assessments. Consequently, further empirical investigations are urgently required, particularly those aimed at systematically identifying relevant indicators to measure regional resilience levels and enabling comparative analyses across regions.

RESEARCH METHOD

This research incorporates both qualitative and quantitative methods. Qualitative research was used to identify indicators of regional disaster resilience using the SLR approach. Quantitative research was used to assess the level of regional disaster resilience using the PROMETHEE method. This study utilizes the SLR approach to identify indicators of regional resilience to natural disasters to be implemented in assessing the disaster resilience index in West Java. SLR is a research methodology designed to systematically collect, evaluate, and synthesize studies related to a specific topic. SLR has been demonstrated to be an effective approach for providing insights into research trends, assessing the effectiveness of existing studies, and mapping the scope of research within a particular field (Borret et al., 2018).

This paper identifies indicators of regional resilience to disasters using SLR. The identified indicators are then further filtered based on several criteria, namely being Specific, Observable,

Measurable, Available, and Relevant. It involves organized, transparent, and iterative processes at each stage, ensuring a comprehensive review.

This study hypothesizes that regional disaster resilience in West Java Province exhibits variation across economic, social, ecological, infrastructure, and institutional dimensions. While many regions display strong economic and social resilience, improvements are needed in environmental, infrastructure, and institutional resilience. This study collected data through systematic searches in the leading journal database Scopus, complemented by manual searches. The collected materials were subsequently refined through three stages: identification, screening, and eligibility (Salleh et al., 2023). The initial search used the keywords "regional resilience" OR "rural resilience" OR "village resilience" OR "urban resilience" OR "city resilience" AND "indicator". Thus, from this stage, a total of 621 articles were obtained.

Next, filters were applied based on subject areas: "social science," "environmental science," "earth and planetary science," "energy," "economics," "econometrics," and "finance," and year range is 2010-2023, resulting in 305 papers. Further criteria included document type "article", publication stage "final" and language "English", narrowing the selection to 225 papers. During screening, 78 papers were excluded for being non-open access, 85 for being irrelevant, leaving 62 relevant papers. Additionally, manual searches using Google identified 15 relevant journals, bringing the total eligible papers to 77 for review. The process flow of the SLR is illustrated in Figure 1.

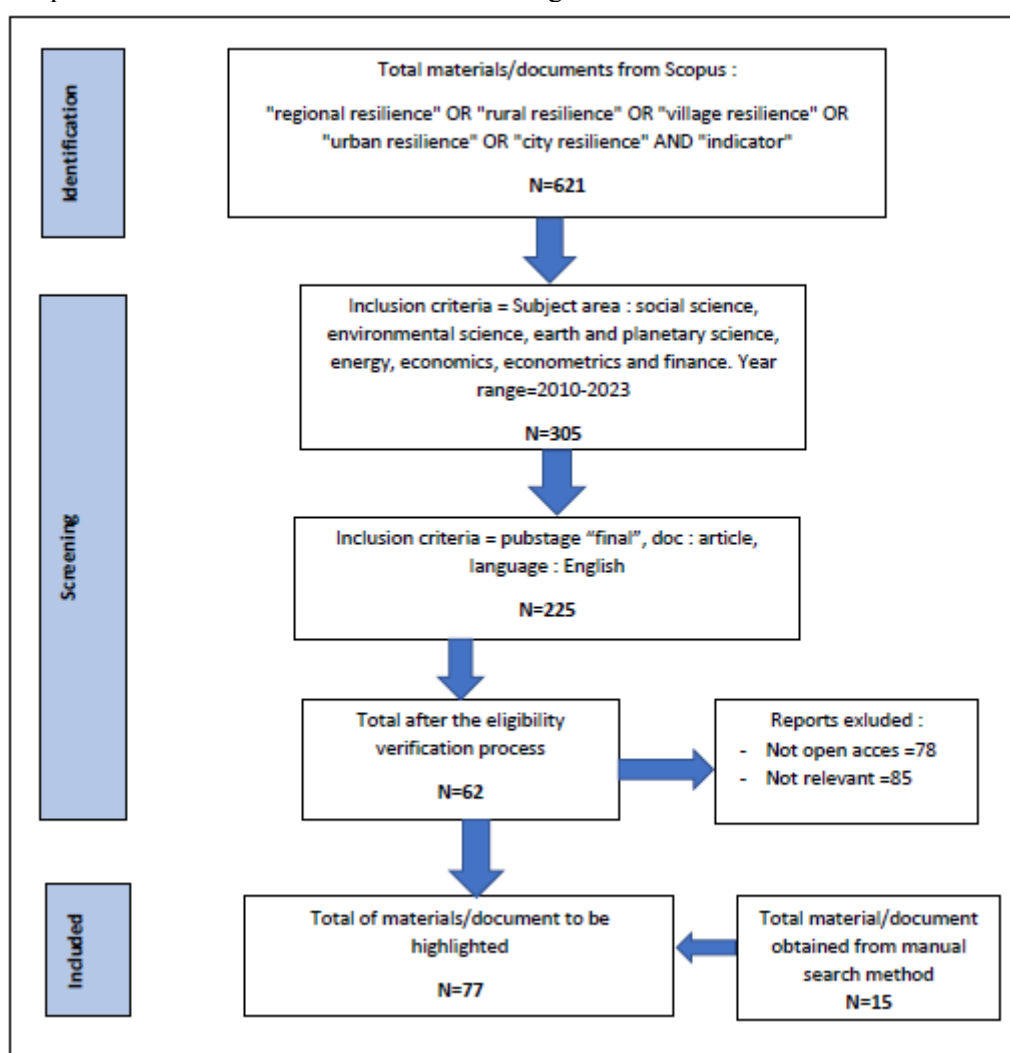


Figure 1. SLR Stages of Regional Resilience Indicators

Meanwhile, a quantitative descriptive analysis was employed to describe the indicators of regional resilience to natural disasters, with selection based on the SLR results. The study covers 27 regions (18 districts and 9 cities) within West Java Province, focusing on data from 2022. We do not use regional samples but analyze all regions in West Java Province. The data used are secondary, obtained from various sources including the Statistics of West Java Province. The study utilizes secondary data

derived from official publications of the Statistics of West Java Province (BPS). Data on the disaster risk index were obtained from the West Java Provincial Disaster Management Agency (BPBD), while forest cover data were sourced from the Ministry of Environment and Forestry. The collected data were initially examined through descriptive analysis, and selected key indicators were spatially visualized using ArcGIS. Subsequently, the dataset was processed using PROMETHEE software to evaluate the level of regional disaster resilience. Regional disaster resilience was ranked using available indicator data, which included 17 indicators from 27 districts and cities in 2022. The analysis employed PROMETHEE software, a multi-criteria decision-making method that assesses and prioritizes alternatives based on defined criteria. This method facilitates the decision-making process by evaluating alternatives and ranking them according to their relative preferences.

The choice of options “x” and “y” can meet the outranking criteria if option “x” is at least equal to option “y” (or vice versa) relative to a number of criteria. This “outranking relation” is called the preference index or $\pi(x,y)$. In the preference index, if option “x” dominates option “y”, then $\pi(x,y)=0$, but $\pi(x,y)$ is not necessarily equal to 1. The preference index between option x relative to y is interpreted as a weighted average of the preference functions for different types of criteria. Mathematically, it can be written as the following equation (Fauzi 2014):

$$\pi(x, y) = \frac{\sum_i^k P_i(x, y)}{\sum_t w_t} \tag{1}$$

$P_i(x, y)$ is the preference function for option x and option y for the i-th criterion. This preference function has a value between 0 and 1. A value of 0 indicates no difference between x and y (indifferent), while a value of 1 indicates a significant difference between options x and y (strict preference).

RESULTS AND DISCUSSION

The SLR finds 22 indicators of resilience against natural disasters (see Figure 2). From the reviewed literature, the indicators were categorized into five dimensions i.e., economic, social, ecological, infrastructural, and institutional. Overall, the ecological and economic dimensions are the most frequently discussed aspects in studies on resilience related to natural disasters. Additionally, social and infrastructure dimensions are also commonly addressed. In contrast, the institutional dimension is mentioned in relatively few papers. These indicators can be employed to calculate the regional resilience index to natural disasters.

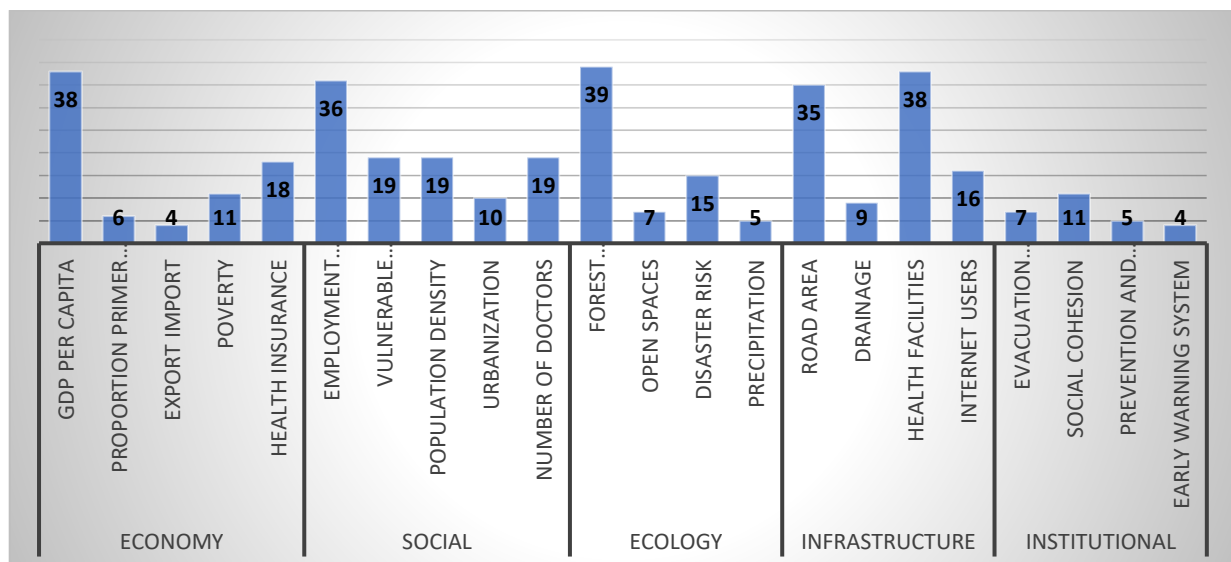


Figure 2. Regional resilience indicators for natural disasters

There are five key indicators within the economic dimension: GDP per capita, the contribution of the agricultural sector to GDP, exports and imports, the % age of individuals in poverty and the population with access to health insurance. GDP per capita reflects a region's level of economic development; higher levels indicate greater capacity for mitigation, recovery, and adaptation strategies. Regions with robust economic resources tend to recover faster and exhibit higher resilience (Feofilovs

and Francesco, 2021; Zhou et al., 2022; Zhang et al., 2023). The agricultural sector’s contribution to GDP indicates its role in driving economic growth and increasing resilience (Giannakis and Bruggeman, 2020; Ge et al., 2022; Yang et al., 2022), as the added value of agriculture reflects the internal driving forces and risk resilience of rural areas. Total exports and imports demonstrate trade structure and bolster the ability to withstand financial crises, thereby enhancing resilience (Shi et al., 2023). The proportion of residents living under the poverty threshold serves as an indicator of poverty levels higher poverty correlates with reduced capacity to mitigate, recover, and adapt, while communities above the poverty line generally recover more swiftly after hazards (Cardoni et al., 2021; Barton et al., 2021). The number of insured individuals reflects the level of health protection; greater insurance coverage facilitates faster recovery (Ghasemzadeh et al., 2021; Gaber et al., 2022).

In 2022, the average GRDP per capita across West Java's regencies and cities was IDR 31 million. Nineteen regions reported values below this average, with Cianjur and Tasikmalaya having the lowest at IDR 14 million (Figure 3). The low GRDP per capita in these areas is primarily due to their continued reliance on agriculture and traditional trade sectors, which have low productivity and added value. For instance, in Tasikmalaya Regency, the sectors of large-scale manufacturing and trade contribute most to GRDP, but their growth remains relatively slow compared to major industrial regions like Karawang or Bekasi. Moreover, the predominantly hilly and mountainous terrain in Tasikmalaya hampers infrastructure development and regional connectivity. This geographic limitation complicates investment and the distribution of goods and services, thereby slowing economic growth locally.

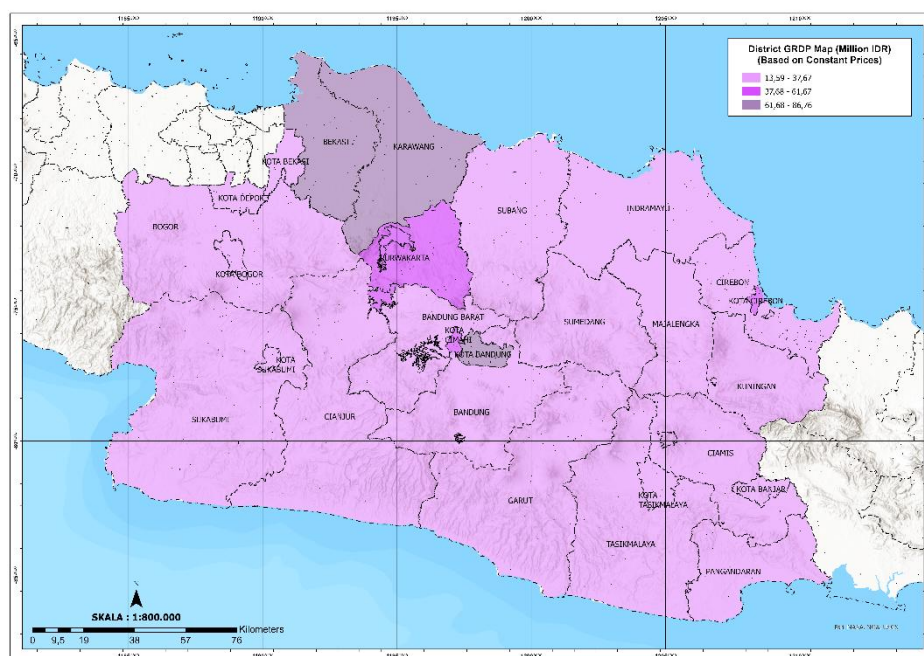


Figure 3. Mapping of GDRP per capita in West Java Province

In West Java, the average poverty rate across the region is approximately 9 % . The districts with the highest poverty levels are Indramayu and Tasikmalaya City, each at 13 % , while Depok City has the lowest at 3 % . In 2022, Indramayu Regency recorded the highest poverty rate in West Java, reaching 12.77%, which corresponds to roughly 225,040 individuals out of a population of around 1.8 million. This elevated poverty level is largely attributed to the region’s dependence on agriculture and fisheries sectors that are highly vulnerable to climate variability and unstable commodity prices. Additionally, these sectors generally have lower productivity. The region also has a relatively low average years of schooling, which limits residents' skills and access to better employment opportunities.

Regarding community participation in health insurance, the average participation rate in West Java stands at 39 % . Fourteen regions fall below this average. Cirebon City has the highest participation, at 77 % , while Pangandaran has the lowest, at 17 % . Low engagement is often driven by economic hardships that make premium payments difficult, as well as a lack of awareness and information about health insurance benefits. Insufficient socialization and outreach, particularly in rural and remote areas, contribute to this low participation rate.

In the social dimension, five indicators are used: the number of employed individuals, the proportion of vulnerable age populations, population density, population growth rate, and the count of medical staff. Employment figures serve as an indicator of regional stability; a higher employment rate suggests lower vulnerability and greater resilience (Datola et al., 2021; Qiao and Pei, 2022; Huang et al., 2022). The proportion of vulnerable age populations reflects susceptibility, with a higher % age of residents over 65 implying reduced resilience (Rezende et al., 2019; Feofilovs and Francesco, 2021; Li et al., 2023). Population density measures how crowded an area is; higher density correlates with increased disaster vulnerability (Huang et al., 2018; Zheng et al., 2018; Su et al., 2022; Li et al., 2022; Botezat et al., 2022). The number of health workers signifies investment in healthcare capacity; more health personnel enable a more effective emergency response (Cardoni et al., 2021; Zhou et al., 2022; Wang and Shuangshuang, 2022; Ye et al., 2022).

In West Java, the average employment rate is 47%, with 13 regions below this average. Pangandaran has the highest employment rate at 59%, while Kuningan has the lowest at 40% (Figure 4). This disparity may stem from Kuningan's limited manufacturing sector, which restricts job opportunities and workforce absorption, as many residents rely on agriculture and MSMEs with limited capacity for new graduates and productive workers. Additionally, urbanization and labor migration contribute, as limited local jobs drive young people to industrial centers like Bekasi, Karawang, or Jakarta.

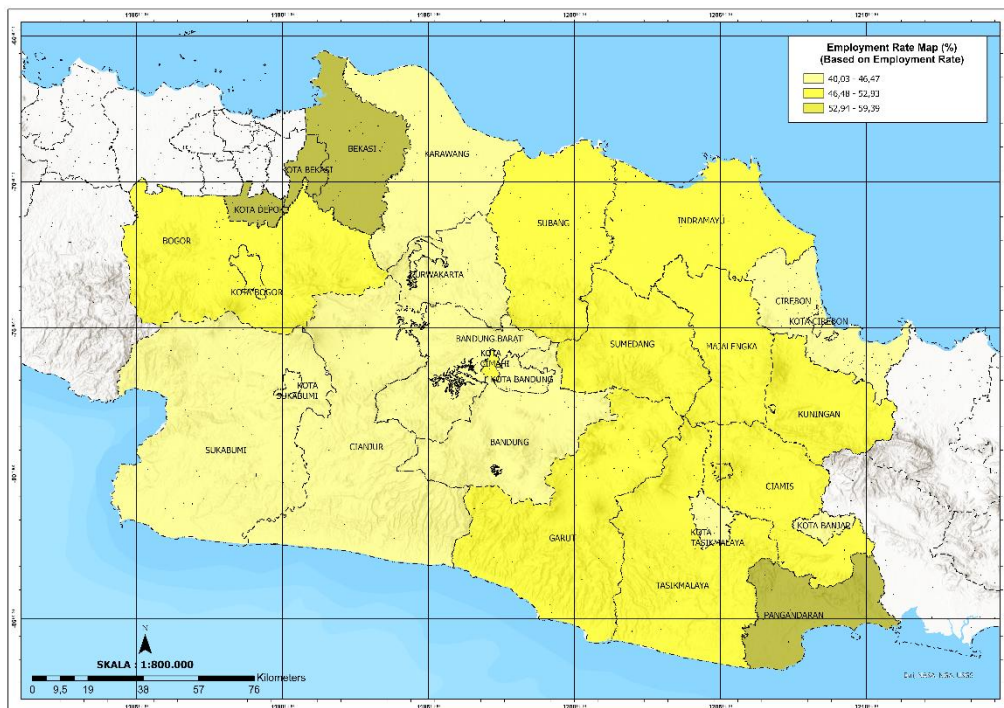


Figure 4. Mapping of employment rate in West Java Province

Regarding vulnerable age populations, West Java's average is 7%, with 14 regions exceeding this value. Ciamis has the highest proportion at 11%, while Bogor and Bekasi have the lowest at 4%. The average population growth rate is 1.3%, with Bekasi and West Bandung experiencing the highest growth at 1.86%, and Cimahi City the lowest at 0.4%. Concerning health workforce ratios, West Java's average is 44 health workers per 10,000 residents; 16 regions fall below this average. Bandung City has the highest ratio at 157, while Tasikmalaya has the lowest at 10. A higher number of health workers enhances the capacity for rapid emergency response, such as triage, medical evacuation, and treatment during disasters.

In the ecological dimension, four indicators are considered: forest cover area, green open space, natural disaster risk, and annual rainfall. Forest cover area reflects ecosystem health and water retention capacity, which bolster resilience (Yang et al., 2021; Liu et al., 2021; Nagy and Szep, 2023). Green open spaces indicate ecological quality; more vegetation reduces runoff, lowering flood and landslide risks (Sajjad et al., 2021; Sandu et al., 2021; Parizi et al., 2022; Oliveira and Fath, 2023). Natural disaster risk assesses both the likelihood and potential impact of disasters; higher risk threatens resilience (Xu et al.,

2021; Feng et al., 2021; Li et al., 2022; Xie, 2023). Annual rainfall indicates the region’s precipitation levels; increased rainfall heightens the chances of flooding and landslides (Cao et al., 2023).

The average forest cover in West Java is 12%, with 16 regions falling below this level. Kuningan has the highest forest coverage at 35% (Figure 5). Conversely, six areas—Sukabumi City, Bandung City, Cirebon City, Bekasi City, Depok City, and Cimahi City—have no forest cover. The regional disaster risk index averages 132, with 15 areas scoring below this average. Cianjur faces the highest disaster risk at 208, while Bogor City has the lowest at 71. Regarding rainfall, the average in West Java is 263 mm/month, with 16 regions experiencing below-average rainfall. Sukabumi receives the most rain at 430 mm/month, and Cirebon the least at 121 mm/month. Extreme rainfall can trigger hydrometeorological disasters such as floods, landslides, and flash floods. While high rainfall itself does not directly weaken resilience, without proper adaptive infrastructure, regional planning based on risk, community education, and preparedness, areas become more vulnerable and recovery slower.

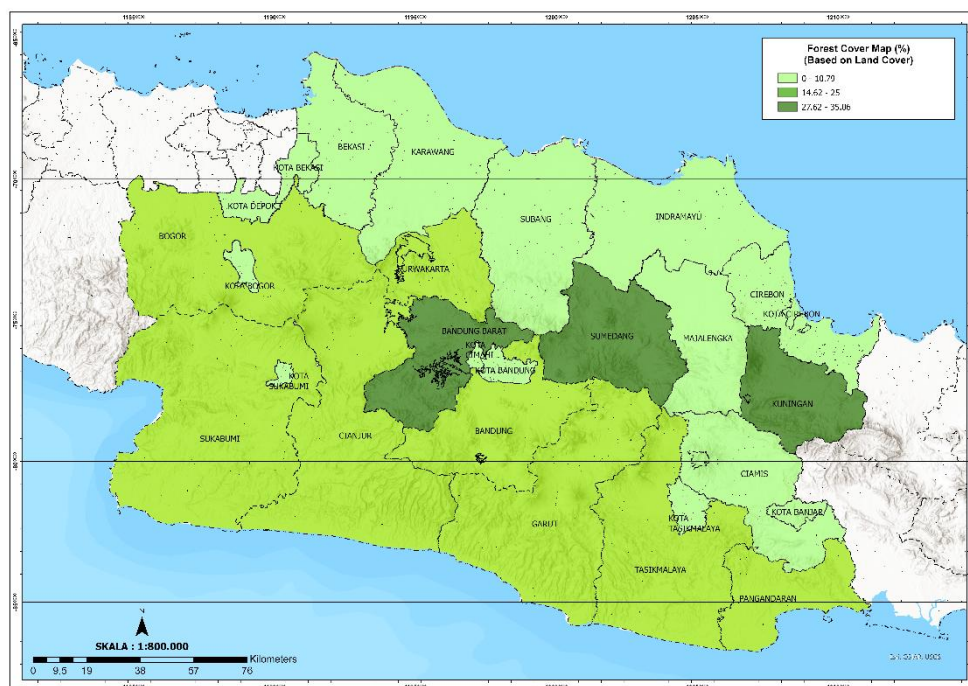


Figure 5. Mapping of forest cover in West Java Province

Meanwhile, the indicators for the infrastructure dimension include the length of paved roads, evacuation route signs, the number of health facilities, and internet access. The length of paved roads indicates transportation capacity; higher quality transportation services enhance resilience (Zhang et al., 2020; Alberico et al., 2020; Dehghani et al., 2023; Li et al., 2023). Evacuation signs and routes represent disaster mitigation efforts, as their presence can minimize losses of assets and lives, thereby boosting resilience (Carvalhoes et al., 2021). The number of health facilities signifies the health security capacity; a greater number of hospitals suggests higher resilience (Qiao and Pei, 2022; Al Jawari et al, 2022; Lu et al., 2023). Internet access reflects communication efficiency; more advanced communication infrastructure enables quicker information flow.

The average ratio of road length to area in West Java is 206, with 19 regions falling below this average. Depok City has the highest road length ratio in the province, while Garut has the lowest. The presence of evacuation signs and routes in West Java remains limited, with an average coverage of only 11 % ; 15 regions have values below this average. Pangandaran and Cimahi City lead with evacuation sign and route coverage at 33 % , whereas Indramayu and Tasikmalaya City have the lowest at just 1 % (Figure 6). Adequate evacuation signs and routes are crucial for regional resilience to natural disasters, as they directly contribute to saving lives and minimizing casualties during emergencies. These features are integral to disaster simulations and educational efforts, helping communities become more familiar with their surroundings and enabling them to make swift decisions in the event of a disaster. Regions that routinely conduct evacuation drills tend to have higher levels of preparedness.

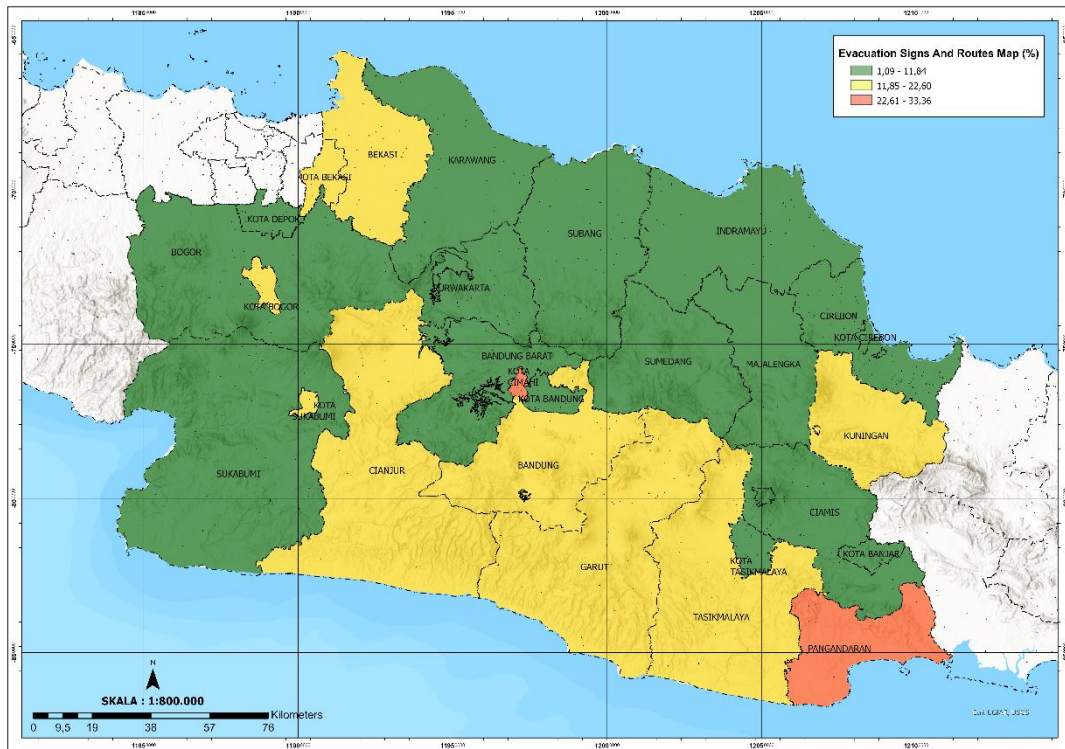


Figure 6. Mapping of evacuation signs and routes in West Java Province

The ratio of health facilities to the population varies across regions, with Cirebon City having the highest and Bekasi City and Depok City the lowest. The availability of health facilities is closely related to the number of medical personnel; areas with more complete facilities such as hospitals, health centers, and clinics are better equipped to respond swiftly to emergencies and facilitate recovery following a disaster. Next, the institutional dimension indicators include Evacuation Planning and Emergency Management, Social Cohesion, Prevention and Mitigation Actions, and Early Warning Systems. Effective evacuation and emergency management indicate that local governments have implemented mitigation measures to enhance resilience. Rapid government response plays a crucial role in addressing dangers more efficiently (Liang et al., 2020; Xun and Yongbo, 2020). Social cohesion, exemplified by habits of mutual cooperation, reflects community solidarity, which bolsters resilience (Abedini et al, 2022; Rahimi et al., 2023; Ulloa et al., 2023). Prevention and mitigation actions demonstrate ongoing efforts to reduce disaster risks and build regional resilience (Zhang et al., 2020; Park et al., 2021). Additionally, early warning systems facilitate timely communication and rescue efforts, further strengthening regional resilience through proactive hazard alerts (Narieswari et al., 2022; Kim et al., 2023).

Evacuation planning and emergency management are reflected in the efforts of local governments to prepare safety equipment. On average, 23% of villages in each district or city have equipped themselves with safety tools, though 16 districts or cities fall below this average. Pangandaran stands out with the highest % age of villages properly prepared, at 57%, whereas Tasikmalaya City has the lowest % age. In West Java, a significant 86% of villages engage in mutual cooperation, indicating strong social cohesion. This practice is most prevalent in Pangandaran, Cirebon City, and Banjar City, while Karawang exhibits the lowest level of mutual cooperation. Such communal cooperation is closely linked to regional disaster resilience, as it enhances social solidarity, boosts community participation in disaster mitigation and response, and speeds up post-disaster recovery. Additionally, mutual cooperation facilitates the optimal use of local resources and reinforces social bonds among residents, thereby strengthening overall community resilience to disasters.

River normalization activities serve as a key prevention and mitigation measure. On average, 49 % of villages along rivers in each district or city implement such activities. The Bandung area has the highest number of villages conducting river normalization, whereas West Bandung has only about 20 %. In 2022, the Bandung Regency Government undertook river normalization efforts, particularly on the Cidawolong and Cipadaulun Rivers, to address flooding issues. This initiative involved multiple stakeholders including government agencies, business entities, and the community through a

collaborative program known as the pentahelix. The primary goal of river normalization was to enhance the rivers' capacity to handle and drain rainwater, thereby reducing flooding risks.

Furthermore, Only 14% of areas in West Java are equipped with a natural disaster warning system. Cimahi City demonstrates the most extensive coverage, whereas Tasikmalaya City has the least (Figure 7). This disparity suggests that disaster mitigation efforts throughout West Java remain insufficient. Natural disaster warning systems play a critical role in enhancing regional resilience by providing early alerts that enable communities to implement preventive measures, evacuate, and prepare efficiently. These systems are essential for reducing the impacts of disasters and strengthening the region's recovery capacity.

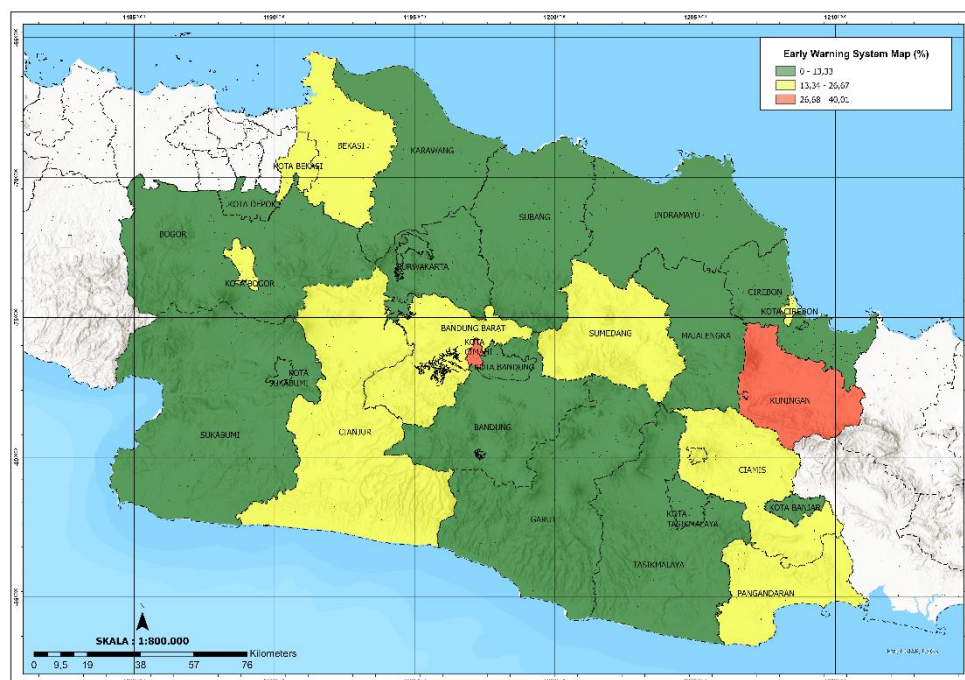


Figure 7. Mapping of early warning system in West Java

The preceding SLR results provide limited insights; therefore, an MCDA analysis using PROMETHEE software is required to rank each district or city according to its level of regional disaster resilience. Of the 17 resilience indicators presented in Table 1, five are negative indicators, in which lower values correspond to improved resilience outcomes. The remaining 12 indicators are positive, with higher values indicating greater regional disaster resilience. The details are outlined in table 1.

Table 1. Criteria and effects on resilience

No	Dimension	Criteria	Unit	Effects on resilience
1	Economic	GDP per capita	Million IDR	+
		Poverty	%	-
		Health insurance	%	+
		Employment rate	%	-
2	Social	Vulnerable people	%	-
		Growth rate of population	%	-
		Health worker	Ratio	+
		Forest area	%	+
3	Ecology	Disaster risk	Index	-
		Precipitation	Mm	-
4	Infrastructure	Road area	Km/km2	+
		Sign and evacuation routes	% Ratio	+

No	Dimension	Criteria	Unit	Effects on resilience
5	Institutional	Health facilities		
		Safety equipment	%	+
		Social cohesion	%	+
		River normalization	%	+
		Early warning system	%	+

Notes : + means the indicator contributes positively to resilience; therefore, its value should be optimized toward higher values. - means the indicator contributes negatively to resilience; therefore, its value should be reduced to the lowest possible level

Based on 17 indicators of regional resilience to disasters and using the same weighting, the PROMETHEE results show that Cimahi City is ranked as the most resilience city (Table 2). This can be seen from the Phi (Φ) or Net Flow value. Phi (Φ) shows the net value of the alternative ranking results used to determine the priority order or final ranking in PROMETHEE. Phi is the difference between the Leaving Flow/Phi + (Φ^+) and Entering Flow/Phi - (Φ^-) values, which represent the strengths (advantages) and weaknesses of each alternative being compared. Cimahi City has the largest phi value, at 0.4796. Its strengths (advantages) score is 0.7104, while its weaknesses score is 0.2308. Cimahi City is ranked as the most resilience city because Cimahi City has low rainfall and disaster risk. Furthermore, Cimahi City excels in the number of villages with natural disaster warning systems and river normalization programs.

Table 2. PROMETHEE flow table

Rank	Districts/cities	Phi	Phi+	Phi-
1	Cimahi City	0.4796	0.7104	0.2308
2	Bandung City	0.3959	0.6900	0.2941
3	Cirebon City	0.3643	0.6493	0.2851
4	Bogor City	0.2964	0.6131	0.3190
5	Bekasi City	0.2964	0.6154	0.3190
6	Bekasi	0.2195	0.5837	0.3643
7	Pangandaran	0.2149	0.5769	0.3620
8	Bandung	0.1380	0.5317	0.3937
9	Kuningan	0.1380	0.5385	0.4005
10	Ciamis	0.1041	0.5181	0.4140
11	Depok City	0.0973	0.5181	0.4208
12	Bogor	0.0950	0.5090	0.4140
13	Sumedang	-0.0452	0.4389	0.4842
14	Subang	-0.0611	0.4344	0.4955
15	Karawang	-0.0928	0.4321	0.5158
16	Garut	-0.1018	0.4118	0.5136
17	Majalengka	-0.1312	0.4005	0.5317
18	Banjar City	-0.1425	0.3959	0.5385
19	Sukabumi City	-0.1561	0.3982	0.5543
20	Sukabumi	-0.1652	0.3959	0.5611
21	Purwakarta	-0.1742	0.3846	0.5588
22	Cirebon	-0.1787	0.3733	0.5520
23	Tasikmalaya	-0.2783	0.3258	0.6041
24	Bandung Barat	-0.2873	0.3258	0.6131
25	Indramayu	-0.3213	0.3054	0.6267
26	Cianjur	-0.3258	0.3122	0.6380
27	Tasikmalaya City	-0.3778	0.2783	0.6561

Bandung City ranks second. Bandung City records the second-highest phi value, amounting to 0.3959. It demonstrates a strengths (positive flow) score of 0.6900 and a weaknesses (negative flow) score of 0.2941. Bandung City had the highest GRDP per capita (at constant prices) in West Java Province in

2022, reaching approximately IDR 85,820,000 per capita (Statistics of West Java Province, 2023). Several factors contributing to Bandung City's high GRDP per capita include the concentration of the service sector and the creative industry. Bandung City is known as a center of education, tourism, and the creative industry, which contribute significantly to the city's economy. These sectors create jobs and drive local economic growth. Furthermore, Bandung City has relatively good infrastructure and high accessibility, attracting investment and encouraging intensive economic activity.

As outlined in the earlier discussion, the analysis underscores that institutional and infrastructure elements play a critical role in reinforcing resilience. Although prior research has mainly emphasized economic, social, and ecological dimensions, the inclusion of institutional and infrastructure aspects is also imperative for enhancing resilience against natural disasters. This study offers two principal contributions to the assessment of regional disaster resilience. First, it is grounded in a systematic review of 77 peer-reviewed journal articles using the Systematic Literature Review (SLR) approach. Through this process, relevant and measurable indicators of regional disaster resilience were identified based on both conceptual relevance and data availability. In contrast to the resilience assessment framework currently applied by the Regional Disaster Management Agency (BPBD), which primarily emphasizes regional disaster management capacity and relies substantially on qualitative scoring that may be prone to subjectivity, this study prioritizes the use of more objective and data-driven indicators to enhance analytical rigor. Second, the study adopts a multidimensional framework that extends beyond the conventional economic, social, and ecological dimensions by incorporating infrastructure and institutional aspects. These additional dimensions are considered critical, as they substantially influence regional resilience, particularly in strengthening prevention, mitigation, preparedness, planning, and post-disaster recovery processes. In the Indonesian context, it is necessary to include the Asta Gatra dimensions covering geographic, demographic, natural resource, ideological, political, economic, socio-cultural, and defense and security aspects to provide a more comprehensive representation of regional disaster resilience.

CONCLUSION

This study identifies 22 key indicators of regional disaster resilience, categorized into five dimensions i.e., economic, social, ecological, infrastructure, and institutional. These indicators offer a structured approach to evaluating regional resilience levels. The highest level of regional resilience to disasters in West Java Province is Cimahi City and Bandung City. Although the framework was developed for West Java Province, it can be adapted to other regions, depending on local disaster profiles and contextual conditions. A more comprehensive assessment in Indonesia would necessitate the inclusion of the Asta Gatra framework; however, data constraints—particularly in the political and ideological dimensions—limited its full implementation. Furthermore, the use of equal indicator weights constitutes a methodological limitation. Future studies should therefore construct a composite index with differentiated weights to better reflect variations in resilience across districts and cities. This framework provides an initial reference for policymakers to identify strategic priorities and enhance regional disaster resilience.

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AUTHOR CONTRIBUTIONS

Asti Istiqomah: conceptualisation, investigation, data curation, formal analysis, methodology, and writing- original draft. Akhmad Fauzi: resources, supervision, methodology, writing–review and editing, and validation. Sri Mulatsih: resources, supervision, writing–review and editing, and validation. Nuva: resources, supervision, writing–review and editing, and validation. Pini Wijayanti: supervision, writing–review and editing, and validation. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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