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INTEGRATING DISASTER MITIGATION INTO URBAN PLANNING FOR RESILIENT DEVELOPMENT IN SABANG

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ABSTRACT

This study explores public perceptions regarding the integration of disaster mitigation into urban planning in Sabang, a coastal city in Indonesia highly vulnerable to natural hazards such as tsunamis and earthquakes. Employing a structured survey administered to 26 stakeholders including local officials, community leaders, and tourists. The research identifies strong consensus on the importance of embedding disaster risk reduction (DRR) into development strategies. Findings show that all respondents agreed, with 80.8% strongly agreeing, that disaster mitigation should be a key component of Sabang's planning processes. The most critical elements identified were development location, urban spatial planning, support infrastructure, building design, and regulatory frameworks. Despite this broad support, only 38.5% of participants believed that current tourism management adequately incorporates disaster risk analysis, revealing a significant gap between perceived necessity and actual implementation. These results highlight the need for coordinated, cross-sectoral planning efforts that align policy with public expectations. The study contributes to resilience discourse by emphasizing the role of stakeholder perspectives in advancing inclusive, risk informed urban development in disaster-prone tourist destinations.

Keywords: Disaster Mitigation; Urban Planning; Resilience; Stakeholder Perceptions; Tourism Management.

INTRODUCTION

Disasters have emerged as a critical global challenge, significantly endangering human lives, infrastructure, and economic stability (Ghaffarian et al., 2023). The community's capacity to respond has been exceeded (Ghaffarian et al., 2023). Urban planning that incorporates disaster risk reduction is widely recognized as essential for resilient city development. (Armaya et al., 2025) note that **"**Integrating Disaster Mitigation into Urban Planning for Resilient Development in Sabang". In particular, integrating hazard mitigation into development plans (through land-use controls, infrastructure design, zoning and policies) can significantly reduce disaster impacts on communities (Mujahid et al., 2025)(Prana et al., 2024)(Sintong et al., 2025). The growing trend in nature-based tourism has resulted in increased tourist activity in coastal regions, including areas with high disaster risk and a history of tsunami exposure (Rahmafitria et al., 2024).

Sabang City is a coastal tourist city that was hard hit by the 2004 tsunami(Jihad et al., 2023). Its low-lying and rugged terrain makes it vulnerable to earthquakes, tsunamis, and other hazards (Kantamaneni et al., 2022). In this context, local authorities have emphasized the need to integrate tsunami risk assessments into urban development strategies to enhance resilience (Akmal et al., 2024). Urban environments are shaped by diverse systems, and planning goals may conflict with disaster risk reduction (Asian Development Bank, 2016).

Effective DRR requires coordinated cross-sectoral action that integrates urban planning, environmental management, infrastructure development, and community engagement (March et al., 2017). This collaborative approach ensures that risk reduction strategies are context specific, inclusive, and sustainable, ultimately enhancing the resilience of vulnerable urban populations to future disasters (Amil, 2025). However, There is limited empirical understanding of how the general public (including officials, residents and tourists) perceives the inclusion of disaster mitigation in Sabang's urban planning (Wardana et al., 2025) (Rindrasih et al., 2024). This study analyzes survey data on public perceptions of disaster mitigation within Sabang's development planning, aiming to reveal key themes in attitudes and awareness.

RESEARCH METHODS

The data source was a structured questionnaire administered to 26 stakeholders in Sabang. Respondents included local officials, community leaders, and tourists (Table 1). Key items were:

- Demographics: Gender, age, education, and affiliation.
- Question 1 (Q1): "Do you agree that disaster mitigation needs to become part of Sabang's development planning?" (2-point Likert: Strongly agree; Agree).
- Question 2 (Q2): "Which aspect is most important in Sabang's development planning related to disaster mitigation?" (open-ended, multiple aspects could be listed).
- Question 3 (Q3): "Do you think tourism management in Sabang already considers disaster risk analysis?" (responses: Yes; No; Don't know).

Data were entered into a spreadsheet and analyzed with Python and pandas. For the Likert-type Q1 item, responses were treated as ordinal data, so results are summarized by frequency and percentage (rather than means). Q2 responses (free-text lists) were coded into the following categories based on content: development location, urban spatial planning, support infrastructure, building design, and policy and regulation. We counted the number of respondents mentioning each aspect. Q3 (yes, no, don't know) was also summarized by counts and percentages. Where appropriate, cross-tabulations were inspected (e.g. gender vs Q3 response) to explore patterns. No inferential tests were conducted du e to the small sample size. All analyses rely on descriptive statistics.

Table 1. Respondent characteristics (N = 26)

Characteristic	Category	Count	Percent
Gender	Male	14	53.8%
	Female	12	46.2%
Education	Bachelor's degree	16	61.5%
	Master's degree	5	19.2%
	High school	5	19.2%

The mean age was 39.7 years (SD ≈ 7.35, range 25–55). Respondent roles included local government staff (Tourism Department, Public Works, Planning/Bappeda, Fisheries, Local Disaster Management/BPBD), community leaders, and both local and foreign tourists (each category had 3–4 respondents).

The dataset captures opinions of a heterogeneous group: government officials from tourism, planning and disaster agencies; community leaders; and tourists visiting Sabang. Table 2 and Table 3 present the coded survey responses. Overall, respondents uniformly support integrating disaster mitigation into planning (Q1), but views vary on what aspects are most crucial related disaster mitigation planning (Q2) and whether current tourism management is risk-aware (Q3).

Table 2. Responses to Q1. Agreement that disaster mitigation should be part of Sabang's development planning (N = 26).

Response	Count	Percent
Strongly agree	21	80.8%
Agree	5	19.2%

Table 3. Top aspects identified in Q2 (N = 26 respondents, multiple aspects allowed).

Aspect	Count	Percent of Respondents
Development location	21	80.8%
Urban spatial planning	19	73.1%
Support infrastructure	18	69.2%
Building design	13	50.0%
Policy and Regulation	13	50.0%

Table 4. Responses to Q3: "Does current tourism management consider disaster risk analysis?" (N = 26)

Response	Count	Percent
Yes	10	38.5%
No	6	23.1%
Do Not Know	10	38.5%

The survey data reveal a very strong consensus on Q1: *all* respondents agree (80.8% "strongly agree," 19.2% "agree") that disaster mitigation should be part of Sabang's development planning (Table 2). For Q2, the most frequently cited aspect was development location, mentioned by 21 of 26 respondents (80.8%). Close behind were urban spatial planning with 19 mentions (73.1%) and support infrastructure with 18 (69.2%). Half of respondents (13) identified building designand the same number identified policy and regulation as important (each 50.0%). These categories were not mutually exclusive as respondents could list multiple aspects; Table 3 reports the count of respondents who mentioned each category.

For Q3 on whether tourism management already incorporates risk analysis, responses were mixed Table 4. Only 10 respondents (38.5%) answered "Yes". Six (23.1%) said "No", and another 10 (38.5%) said "Don't know". Thus a majority (61.5%) either doubt or are uncertain about whether current policies in tourism account for disaster risk. A closer look at subgroups suggests possible patterns: for example, local tourist respondents were especially likely to answer "Don't know" as were foreign tourists, whereas many officials in planning or disaster agencies answered "Yes" though sample sizes are small, see Section "Discussion".

Exploratory associations were used due to small sample size, formal statistical tests are limited. A cross-tabulation of gender by Q3 response (not shown) indicates that among males (n=14), 6 said "Yes", 5 "No", and 3 "Don't know"; whereas among females (n=12), 4 said "Yes", 1 "No", and 7 "Don't know". Thus female respondents were more often uncertain, but the numbers are too small for reliable inference. Education level and affiliation were similarly reviewed; for example, all three foreign tourists answered "Don't know". No inferential correlations (e.g. x^2 tests or regressions) were applied

due to data sparsity. In summary, the key analytical result is descriptive: unanimous support for mitigation (Q1), clearly prioritized aspects (Table 3), and a divided view on current risk consideration in tourism (Q3).

The integration of disaster mitigation into urban planning in Sabang has garnered unanimous public support, with all respondents affirming its importance and a substantial majority (80.8%) strongly agreeing. This consensus underscores a shared recognition of the need to embed safety measures within the city's development strategies. Key planning priorities identified by respondents include the location of development, urban spatial planning, and supporting infrastructure. highlighting both physical and governance dimensions as central to effective risk reduction. However, a significant implementation gap emerges, as only 38.5% believe that current tourism management adequately incorporates disaster risk considerations, indicating a disconnect between public expectations and perceived policy execution. Furthermore, stakeholder perspectives vary, with government and disaster agency officials expressing greater confidence in current efforts than community members and tourists, suggesting disparities in awareness and information access across groups. These findings indicate strong public backing for risk-informed planning, with particular emphasis on locational and infrastructural aspects, but with doubts about current implementation.

RESULTS AND DISCUSSION

The results align with broader research emphasizing inclusive, risk-aware urban planning (CNAWP et al., 2025)(Rezvani et al., 2023)(Nahid et al., 2024)(Mehryar & Surminski, 2021). The unanimous support for including disaster mitigation mirrors the literature. A recent review underlines that integrating risk assessments into planning is crucial for resilience (Ventura et al., 2025)(Tagarev et al., 2021)(Obike et al., 2025). Our respondents' prioritization of *where* to build and how to design infrastructure is sensible for Sabang's context. Sabang's rugged terrain and limited safe land (nearly half the city lies in high-risk zones) likely make "disaster mitigation development location" salient. Indeed, (Armaya et al., 2025) found that Sabang needs strategic interventions like relocating settlements away from tsunami zones. The emphasis on urban spatial planning and infrastructure suggests awareness that citywide plans and support systems are critical (Wamsler, 2004)(GODSCHALK et al., 2003)(Desouza & Flanery, 2013)(Alexander, 2015)(Karashima & Ohgai, 2019)(Khailani & Perera, 2013). Governments should strengthen tourists' disaster preparedness by implementing comprehensive guidelines, educational initiatives, and community based engagement programs (Rahmafitria et al., 2025). These priorities reflect a *multidisciplinary approach* to risk reduction (GmbH, 2024) (Dwirahmadi et al., 2023). Combining land use planning, building standards, and regulations as identified in global DRR frameworks (King et al., 2016).

The split in Q3 responses (only ~39% saying "Yes") points to a perceived shortfall in practice. Many respondents doubt that the tourism sector has fully internalized risk analysis. This is noTable given Sabang's role as a tourist destination: the management of tourism development may lack transparent risk criteria. Such a gap is exactly what (Armaya et al., 2025) warn against they stress the "urgent need for integrating tsunami risk assessments into urban development strategies" to enhance resilience. Our data suggest locals recognize the need but see it as not yet fully realized. Citizens and stakeholders strongly endorse risk reduction in planning, but are uncertain about current implementation in Sabang's tourism development.

This study has several constraints. The sample is small (N=26) and not a random population survey. It over-represents local officials, community Tables, and visiting tourists; the everyday resident population may have different views. Questions were self-reported and potentially subject to social desirability (especially Q1). The Q2 open-ended format may have missed some aspects if respondents did not recall or list them. Because respondents were primarily adults engaged with tourism and government, the findings may not generalize to all Sabang citizens (e.g. informal workers or children). Finally, analysis was limited to descriptive summaries; with so few observations, any formal statistical tests would be underpowered.

Building on this work, future studies could employ larger, representative surveys to validate these findings. Longitudinal research would assess whether perceptions change as policies evolve. Perception can be defined as an individual's subjective response or evaluation toward an object, event, or information received through the senses, which is then cognitively processed and results in a specific attitude, opinion, or behavior (Liani et al., 2022). Qualitative interviews or focus groups could explore *why* residents feel risk is not adequately considered, or how they envision improvements. Comparative studies in other Indonesian tourist cities could reveal whether the

patterns in Sabang are unique or widespread. Pairing perception surveys with actual policy analysis (e.g. reviewing Sabang's zoning ordinances or disaster management plans) would clarify the gap between intention and practice.

CONCLUSIONS

This analysis of Sabang's survey data shows clear public support for embedding disaster mitigation in urban planning, with respondents prioritizing location, planning, infrastructure, design, and regulation as key factors. However, only a minority feel that current tourism management fully incorporates risk analysis. These findings are consistent with disaster resilience research: urban planning must be inclusive and risk-focused, yet implementation challenges often remain. In Sabang, stakeholders appear aware of hazards and of the need for safer development, but perceive a shortfall in actual policy integration. Policymakers and planners should take note of this gap efforts to involve the community and to transparently incorporate risk assessments (as recommended by recent studies) may improve both resilience and public confidence. While limited by sample size, this study highlights that creating safer, more resilient cities begins with the public's mindset. Future efforts should monitor whether the strong public mandate for mitigation (Q1) translates into concrete planning measures on the ground.

BIBLIOGRAPHY

Akmal, M. N., Risma, S., & Ishak, S. F. (2024). Analysis Of Disaster Knowledge , Preparedness , And Perceptions On Mitigation Strategies In Kota Sabang Urban Development Planning As A Disaster-Prone. *Sumatra Journal of Disaster, Geography and Geography Education*, *8*(2), 13–18. https://doi.org/https://doi.org/10.24036/sjdgge.v8i2.618

Alexander, D. E. (2015). Disaster and Emergency Planning for Preparedness, Response, and Recovery. *Oxford Research Encyclopedia of Natural Hazard Science*, *November*, 1–20. https://doi.org/10.1093/acrefore/9780199389407.013.12

Amil, A. C. (2025). Collaborative Governance Mechanisms in Disaster Risk Reduction and Management in the Philippines: A Systematic Review. *Proceedings of the 1st International Conference on Public Administration and Social Science (ICoPASS 2024) Universitas Sultan Ageng Tirtayasa Theme: Innovation and Adaption Policy: Climate Action Collaborative*, *ICoPASS 2024*, 149–173. http://creativecommons.org/licenses/by-nc/4.0/

Armaya, H. G., Aulia, F., Syamsidik., Dadek, T. A., Sufirmansyah., Suppasri, A., Reza, M. I., & Khalis, M. I. (2025). *Building Distribution and Spatial Constraints from Perspectives of Tsunami Inundation at a Small Island Context : A Study Case of Sabang-Aceh , 20 Years after the 2004 Aceh Tsunami*. *11*(26), 275–284. https://doi.org/10.22146/jcef.18868

Asian Development Bank. (2016). *Reducing Disaster Risk by Managing Urban Land Use : Guidance Notes for Planners*.

CNAWP, R. P., Basir, B., Yusda, D. D., & Nofirman, N. (2025). Risk Management in Community Service: An Integrated Approach to Addressing Social Challenges in Communities. *Journal Of Human And Education (JAHE)*, *5*(2), 448–457. https://doi.org/10.31004/jh.v5i2.2441

Desouza, K. C., & Flanery, T. H. (2013). Designing, planning, and managing resilient cities: A conceptual framework. *Cities*, *35*, 89–99. https://doi.org/https://doi.org/10.1016/j.cities.2013.06.003

Dwirahmadi, F., Barnes, P., Wibowo, A., Amri, A., & Chu, C. (2023). Linking Disaster Risk Reduction and Climate Change Adaptation through Collaborative Governance: Experience from Urban Flooding in Jakarta. In *Geosciences* (Vol. 13, Issue 11). https://doi.org/10.3390/geosciences13110353

Ghaffarian, S., Taghikhah, F. R., & Maier, H. R. (2023). Explainable artificial intelligence in disaster risk management: Achievements and prospective futures. *International Journal of Disaster Risk Reduction*, *98*(April), 104123. https://doi.org/10.1016/j.ijdrr.2023.104123

GmbH, D. G. für I. Z. (GIZ). (2024, June). Enhancing disaster risk management through a multi-sectoral approach : recommendations for local governments by local governments Success factors for urban disaster risk reduction strategies DRM in African cities. *FLOW Communications GIZ/RIA*, 1–3.

GODSCHALK, D. R., BRODY, S., & BURBY, R. (2003). Public Participation in Natural Hazard Mitigation Policy Formation: Challenges for Comprehensive Planning. *Journal of Environmental Planning and Management*, *46*(5), 733–754. https://doi.org/10.1080/0964056032000138463

Jihad, A., Atas, Z., Banyunegoro, V., Anugrahningrum, H., Ginting, R., Putra, K., Rusdin, A., Ardiyansyah, T., & Yatimantoro, T. (2023). Reconstruction of the Indian Ocean Tsunami in 2004 in Sabang Based on the Current Land Cover for Tsunami Evacuation Sites Recommendations. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, *13*, 174–189. https://doi.org/10.26740/jpfa.v13n2.p174-189

Kantamaneni, K., Christie, D., Lyddon, C., Huang, P., Nizar, M., K., B., Ravichandran, V., Kumar, A., Pushparaj, R. R. B., Robins, P., & Panneer, S. (2022). A Comprehensive Assessment of Climate Change and Coastal Inundation through Satellite-Derived Datasets: A Case Study of Sabang Island, Indonesia. *Remote Sensing*.

Karashima, K., & Ohgai, A. (2019). Implementation issues of the planning support tool in Japan: Focusing on urban disaster mitigation. *Frontiers of Architectural Research*, *8*(4), 483–497. https://doi.org/https://doi.org/10.1016/j.foar.2019.07.002

Khailani, D. K., & Perera, R. (2013). Mainstreaming disaster resilience attributes in local development plans for the adaptation to climate change induced flooding: A study based on the local plan of Shah Alam City, Malaysia. *Land Use Policy*, *30*(1), 615–627. https://doi.org/https://doi.org/10.1016/j.landusepol.2012.05.003

King, D., Gurtner, Y., Firdaus, A., Harwood, S., & Cottrell, A. (2016). Land use planning for disaster risk reduction and climate change adaptation: Operationalizing policy and legislation at local levels. *International Journal of Disaster Resilience in the Built Environment*, *7*, 158–172. https://doi.org/10.1108/IJDRBE-03-2015-0009

Liani, F. M., Azhar, A. A., & Rozi, F. (2022). Persepsi Mahasiswa Ilmu Komunikasi Uin Sumut Terhadap Konten Skincare Review Di Akun Tiktok. *Algebra : Jurnal Pendidikan, Sosial Dan Sains*, *2*(4). https://doi.org/10.58432/algebra.v2i4.654

March, A., Kornakova, M., & Leon, J. (2017). Chapter 1 - Integration and Collective Action: Studies of Urban Planning and Recovery After Disasters. In A. March & M. B. T.-U. P. for D. R. Kornakova (Eds.), *Urban Planning for Disaster Recovery* (pp. 1–12). Butterworth-Heinemann. https://doi.org/https://doi.org/10.1016/B978-0-12-804276-2.00001-3

Mehryar, S., & Surminski, S. (2021). National laws for enhancing flood resilience in the context of climate change: potential and shortcomings. *Climate Policy*, *21*(2), 133–151. https://doi.org/10.1080/14693062.2020.1808439

Mujahid, T., Sufni, N., & Syafiq, Z. Z. (2025). Education and Socialization of Disaster Preparedness To Children in Mis Al-Wasliyah Village Timbang Lawan. *Algebra : Jurnal Pendidikan, Sosial Dan Sains*, *5*(2), 41–46. https://doi.org/10.58432/algebra.v5i2.1249

Nahid, O. F., Rahmatullah, R., Al-Arafat, M., Kabir, M. E., & Dasgupta, A. (2024). Risk Mitigation Strategies in Large Scale Infrastructure Project:a Project Management Perspective. *Non Human Journal*, *1*(01), 21–37. https://doi.org/10.70008/jeser.v1i01.38

Obike, O., Soetanto, R., & Sohail, M. (2025). A risk management model for integrating resilience into renewable energy projects. *Construction Management and Economics*, *43*(7), 537–555. https://doi.org/10.1080/01446193.2025.2477695

Prana, M. A., Curl, A., Dionisio, M. R., Gomez, C., Hart, D., Apriyanto, H., & Prasetya, H. (2024). Urban planning approaches to support community-based flood adaptation in North Jakarta Kampungs. *Disaster Prevention and Management*, *33*(4), 383–405. https://doi.org/10.1108/DPM-05-2023-0114

Rahmafitria, F., Setiyorini, H. P. D., Hindayani, P., Oktadiana, H., & Ramadhan, A. (2025). How do Tourists Perceive Risk and Develop Travel Preparedness? Influence of Destination Attributes and Knowledge. *Jurnal Manajemen Hutan Tropika*, *31*(2 SE-Articles), 171. https://doi.org/10.7226/jtfm.31.2.171

Rahmafitria, F., Setiyorini, H. P. D., Hindayani, P., & Ramadhan, A. (2024). the Role of Destination Image and Risk Perception on Interest in Revisiting Disaster-Prone Coastal Destinations. *Journal of Environmental Science and Sustainable Development*, *7*(1), 480–495. https://doi.org/10.7454/jessd.v7i1.1227

Rezvani, S. M. H. S., Falcão, M. J., Komljenovic, D., & de Almeida, N. M. (2023). A Systematic Literature Review on Urban Resilience Enabled with Asset and Disaster Risk Management Approaches and GIS-Based Decision Support Tools. *Applied Sciences (Switzerland)*, *13*(4). https://doi.org/10.3390/app13042223

Rindrasih, E., Ratminto., Effendi, K. C., & Silviani, D. (2024). Expert perspectives on disaster risk reduction strategies in the tourist area of Borobudur-Yogyakarta-Prambanan in Indonesia.

Progress in Disaster Science, *24*, 100379. https://doi.org/https://doi.org/10.1016/j.pdisas.2024.100379

Sintong, M., Nurwihastuti, D. W., Putra, M., & Hidayat, S. (2025). Mapping of Tsunami Vulnerability Potential in Sabang City, Aceh Province. *ICIESC 2024*. https://doi.org/10.4108/eai.17-9-2024.2353092

Tagarev, T., Papadopoulos, G., Hagenlocher, M., Sliuzas, R., Ishiwatari, M., & Gallego, E. (2021). *Integrating the Risk Management Cycle*.

Ventura, N., Suárez, A., Lopez, J., & González, G. (2025). Integrating Risk Management into Territorial Planning: An Approach to Community Resilience. *Centro Sur*, *9*, 43–61. https://doi.org/10.37955/cs.v9i3.388

Wamsler, C. (2004). Managing Urban Risk: Perceptions of Housing and Planning as a Tool for Reducing Disaster Risk. *Global Built Enviroment Review*, *4*(2), 11–28.

Wardana, W. W., Haryanto, T., Jamil, I. R., Ismail, N. A., Heriqbaldi, U., Correa, E., Rohmah, W. N., & Ajija, S. R. (2025). Does improved accessibility translate into tourism growth? A difference-in-differences analysis of bridge infrastructure in Indonesia. *Annals of Tourism Research Empirical Insights*, *6*(2), 100189. https://doi.org/https://doi.org/10.1016/j.annale.2025.100189