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Enhancing Urban Resilience: Mapping School Community Preparedness for Tsunami Disasters in Coastal Banda Aceh

Muhammad Riza Rizky, Evalina Zuraidi*, Fahmi Aulia

Department of Architecture and Planning, Faculty of Engineering, Universitas Syiah Kuala, 23117, Banda Aceh, Indonesia

***Corresponding Author:** Evalina Zuraidi (evalinaz@usk.ac.id)

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Abstract

Urban resilience against tsunami risks requires robust preparedness within educational institutions, particularly in high-risk coastal regions. This study assesses the disaster preparedness levels of senior high schools in the coastal districts of Meuraxa and Kuta Raja, Banda Aceh, employing a comprehensive mapping approach (LIPI-UNESCO/ISDR) to evaluate knowledge, preparedness policy, emergency planning, warning systems, and resource mobilization. Data were collected through questionnaires targeting school administrators, teachers, and students. The findings reveal significant disparities in preparedness levels, with SMAN 6 Banda Aceh demonstrating higher readiness compared to SMAS Al-Misbah, which exhibited the lowest scores across all dimensions. The absence of standardized disaster management policies and inadequate institutional preparedness were identified as critical challenges. The study underscores the urgent need for integrated disaster education, routine evacuation drills, and well-coordinated emergency response strategies to enhance school and community resilience. Furthermore, it advocates for a collaborative approach involving local authorities, educators, and disaster management agencies to embed disaster preparedness into the urban resilience framework. By mapping preparedness levels, this research provides actionable insights for policymakers to develop targeted interventions and promote sustainable disaster resilience strategies. Future research should expand to other vulnerable coastal areas and assess the long-term impacts of preparedness initiatives to ensure effective risk reduction.

Keywords: Urban Resilience, Banda Aceh, Disaster Preparedness, LIPI-UNESCO/ISDR, Tsunami Risk, School Community

Introduction

Indonesia, as an archipelagic nation, is located at the convergence of several major tectonic plates, including the Indo-Australian plate to the south, the Eurasian plate to the north, and the Pacific plate to the east [1]. This geographic position exposes the country to various natural disasters, including earthquakes,

volcanic eruptions, and tsunamis. One of the most devastating events in Indonesia's history occurred on December 26, 2004, when a magnitude 9.1 earthquake struck off the coast of Sumatra, triggering a massive tsunami. This tsunami caused widespread destruction in Aceh, particularly in Banda Aceh, and led to the tragic loss of over 173,000 lives [2]. Beyond the loss of life, the disaster severely disrupted the education sector, with 1,488 school facilities damaged, affecting approximately 150,000 students [2]. The scale of the 2004 disaster underscored the urgent need to improve disaster preparedness, particularly in urban areas [3].

Urban resilience, which refers to the ability of cities to anticipate, absorb, adapt to, and recover from shocks, is essential for minimizing the impact of natural disasters and ensuring that cities can continue to function in the aftermath [4]. In the context of urban resilience, education plays a crucial role, as schools can serve as centers for building disaster awareness and preparedness. Strengthening the resilience of educational institutions is not only vital for the continuity of learning during crises but also for cultivating a culture of preparedness among future generations [5]. Urban resilience involves not only the capacity of cities to recover from disasters but also their ability to mitigate risks and adapt to changing conditions. Scholars such as Meerow et al. [6] and Pelling [7] emphasize that resilient cities are those that integrate disaster risk reduction, sustainable urban planning, and community-based approaches. The analysis conducted by Zuraidi et al. further supports this view, showing that resilience research has increasingly focused on the interplay between urban planning and disaster preparedness [8-11]. In the case of Banda Aceh, resilience-building efforts must focus on reducing the vulnerability of its urban areas to future tsunami and earthquake risks. According to the UNISDR, effective urban resilience strategies require a multi-stakeholder approach, involving local government, institutions, and communities to collectively enhance preparedness and response capabilities [12].

Research on urban resilience also highlights the importance of schools as critical components of a city's resilience framework. Schools are not merely educational institutions, they are essential spaces where disaster preparedness knowledge can be disseminated, and where future leaders are equipped with the skills and awareness needed to respond to emergencies [13]. Several studies have underscored the role of schools in disaster risk reduction. Ikramullah et al. argue that schools provide an ideal environment for fostering a culture of preparedness, as they are trusted community institutions capable of reaching large numbers of people [14]. Schools can teach students about the risks of natural disasters, train them in emergency response protocols, and even serve as shelters during a disaster. The importance of disaster preparedness in schools, particularly in disaster-prone regions, is well-documented. Research by LIPI-UNESCO/ISDR identifies key elements of school preparedness, including knowledge of risks, emergency response plans, and physical safety measures [15]. In Banda Aceh, schools located in coastal areas, such as those in Meuraxa, Kuta Raja, and Syiah Kuala, are particularly vulnerable to tsunami risks. Despite

this, much of the research conducted so far has been limited to individual schools, leaving a significant gap in understanding the preparedness levels of schools across the broader coastal region.

Previous studies have pointed out that while some schools in Banda Aceh have implemented disaster preparedness programs, the extent of their effectiveness and the consistency of their practices across different schools remains unclear. Pujianingsih et al. note that effective preparedness must involve not only disaster education but also regular drills, the establishment of clear evacuation plans, and collaboration with local emergency services [16]. This study aims to fill the gap by mapping the preparedness levels of schools across a wider area, specifically within the coastal districts of Meuraxa, Kuta Raja, and Syiah Kuala, which are at the highest risk for tsunami and earthquake events. While there has been growing attention to disaster preparedness in schools, particularly in Indonesia's disaster-prone regions, existing studies are often limited in scope. Many studies focus on the preparedness of individual schools or small clusters of schools, which may not provide a comprehensive picture of the overall resilience of educational institutions within a larger geographical context. For instance, previous studies conducted in Banda Aceh typically assess preparedness within specific schools or isolated cases, without considering the broader network of schools across the entire coastal area. As a result, there is a notable gap in the research regarding the comprehensive assessment of school preparedness in a wider urban context, especially across multiple districts with varying levels of risk.

Additionally, much of the existing literature on disaster preparedness in schools tends to focus on either theoretical frameworks or the preparedness of schools in isolation, rather than taking a holistic approach that includes the surrounding communities and the role of urban resilience as a whole. In the context of urban resilience, schools are not standalone entities; they are integral components of a city's ability to withstand and recover from disasters. This gap in the literature underscores the importance of examining school preparedness not only as an isolated task but as part of a broader strategy for enhancing urban resilience.

This study aims to address these gaps by mapping the disaster preparedness levels of senior high schools in the coastal districts of Meuraxa, Kuta Raja, and Syiah Kuala in Banda Aceh. By conducting a comprehensive assessment across multiple schools, this research seeks to provide a more representative understanding of school preparedness in tsunami-prone urban areas. Specifically, this study will (1) evaluate the extent of disaster preparedness measures implemented in these schools, (2) identify key factors influencing preparedness levels, and (3) analyze the role of schools in enhancing overall urban resilience. Furthermore, this research will explore how senior high schools can serve as hubs for disseminating disaster risk reduction knowledge to the wider community, thereby strengthening collective preparedness efforts. Through this approach, the study contributes to a more integrated understanding of disaster risk reduction within urban resilience frameworks, offering insights that can

inform policy and practice for enhancing disaster preparedness in educational institutions and beyond.

Materials and Methods

Study Location

This research was conducted at five senior high schools located in the districts of Meuraxa and Kuta Raja, Banda Aceh (Figure 1). In Meuraxa District, the selected schools were SMA 1 Banda Aceh, SMA 6 Banda Aceh, and SMAS Al-Misbah. In Kuta Raja District, the schools included SMA 13 Banda Aceh and SMA 14 Banda Aceh. These schools were chosen based on criteria outlined in the guidelines for assessing community and school preparedness levels developed by the Indonesian Institute of Sciences (LIPI).

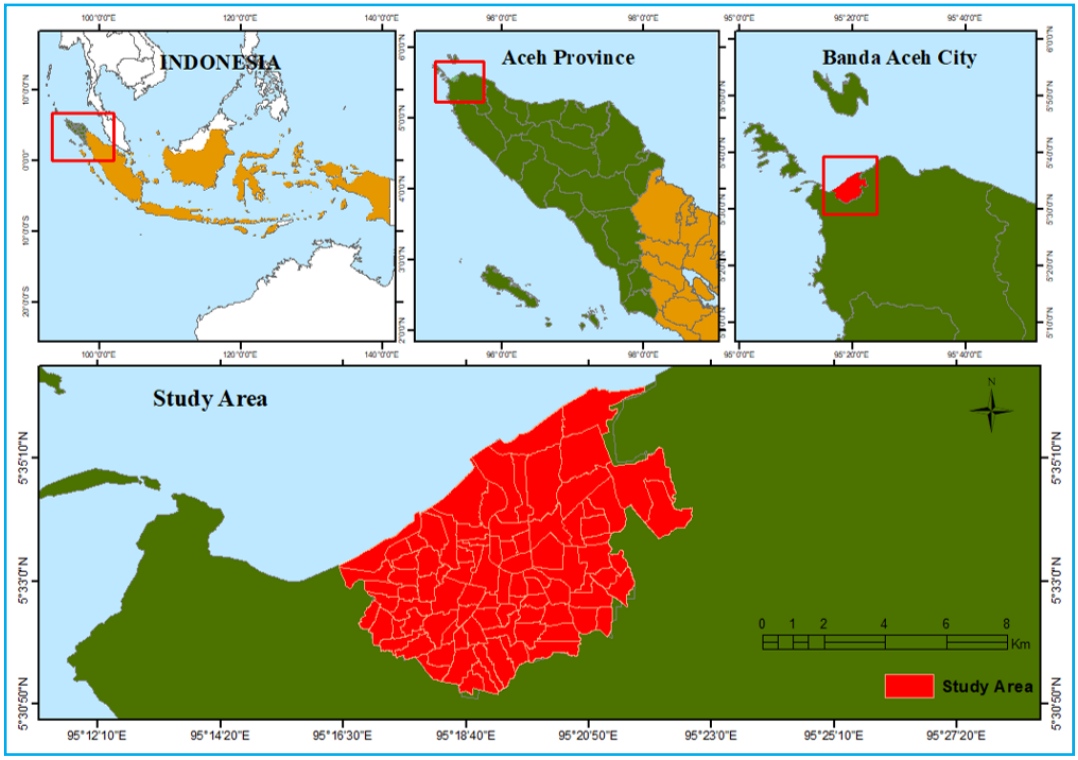

Figure 1. Studi location

Sample Selection

The total population across all research locations comprised 1,873 individuals. From this population, a sample of 75 respondents was selected according to predetermined criteria. The sample distribution in each school consisted of one principal, ten teachers, and two student representatives from each grade level. This stratified sampling approach ensured that the perspectives of all key stakeholders within the school community were represented.

Data Analysis Method

Data analysis was conducted using the index analysis method. Preparedness evaluation was carried out by employing indices as measurement tools,

representing the ratio between one value and another. To facilitate interpretation, the resulting ratios were multiplied by 100. The index assessment process involved several stages, beginning with the calculation of the index for each parameter. This was followed by the calculation of a combined index across all parameters. The index value ranged from 0 to 100, with higher scores indicating a greater level of preparedness. The analytical approach adopted was based on the guidelines of Hidayati et al. [17], which provide a framework for assessing school community preparedness. The resulting preparedness index scores illustrate the extent of school community readiness to respond to potential risks and disasters. The classification of disaster preparedness levels is outlined in Table 1.

Table 1. Disaster preparedness index classification

No	Index Value	Category
1	80–100	Very Prepared
2	65–79	Prepared
3	55–64	Nearly Prepared
4	40–54	Less Prepared
5	0–39	Not Prepared

Index Calculation Procedure

In this study, data processing including index calculations for each parameter (school, teacher, and student) was conducted using a composite index approach without applying weighting factors. All questions within each parameter were considered to contribute equally to the overall index value. The index calculation was performed using Equation (1).

$$\text{Index} = \left(\frac{\text{Total Real Score of Parameter}}{\text{Maximum Score of Parameter}} \right) \times 100 \quad (1)$$

The maximum parameter score was determined by the total number of questions within the indexed parameter, with each question assigned a value of one. If a question included sub-questions (e.g., a, b, c, and d), each sub-question was assigned a score of 1/Number of Sub-questions. The total real score of the parameter was obtained by summing the scores of all questions within the relevant parameter.

Results

Hazard Exposure and School Locations

All five schools are situated in tsunami-prone coastal zones, emphasizing the need for robust preparedness strategies. The hazard maps in Figure 2 illustrate the tsunami risks associated with each school's location.

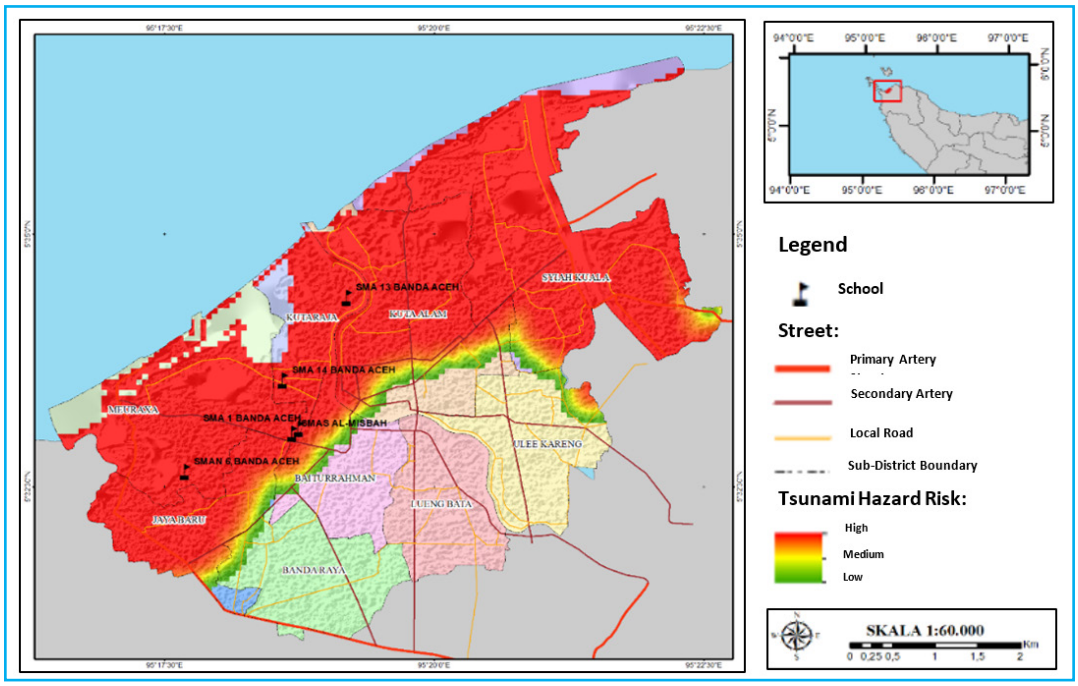

Figure 2. The Tsunami Risks Associated with Each School's Location. Adapted from Tsunami Hazard Map of Banda Aceh (BNPB, 2024)

The analysis confirms that SMAN 13 Banda Aceh, SMAN 14 Banda Aceh, SMAN 1 Banda Aceh, SMAN 6 Banda Aceh, and SMAS Al-Misbah are in high-risk zones. The proximity of these schools to coastal areas underscores the urgency of improving their preparedness strategies.

Preparedness Index

Knowledge and attitude (KAP)

Table 2 presents the Knowledge, Attitude, and Practice (KAP) Parameter Index for tsunami preparedness among the school community, including schools (S1), teachers (S2), students (S3), and the overall school community (KS) across five senior high schools in Banda Aceh. All schools scored 0 for School (S1), indicating no institutional-level preparedness. In the Teacher (S2) category, SMAN 6 Banda Aceh scored the highest (54.4), while SMAS Al-Misbah had the lowest (36.7). For Student (S3), the highest index was observed at SMAN 13 Banda Aceh (63.5), and the lowest at SMAS Al-Misbah (51.3). Regarding School Community (KS), SMAN 6 Banda Aceh recorded the highest index (28.17), whereas SMAS Al-Misbah had the lowest (21.28). Overall, SMAN 6 Banda Aceh showed the highest preparedness, while SMAS Al-Misbah consistently scored the lowest across all categories.

Preparedness strategy (PS)

Table 3 presents the PS Parameter Index for five schools in Banda Aceh, focusing on four categories: School (S1), Teacher (S2), Student (S3), and School Community (KS). Among the schools, SMAN 1 Banda Aceh has the highest index for the School category (S1) at 28.1, followed closely by SMAN 6 Banda Aceh

with a score of 27.8. SMAS Al-Misbah and SMAN 13 Banda Aceh also show relatively high indices, at 26.1 and 23.4, respectively, while SMAN 14 Banda Aceh records the lowest S1 index of 11.4. For the Teacher (S2) and Student (S3) categories, all schools show an index of 0, indicating no measurable parameter within these groups. In terms of the School Community (KS) index, SMAN 1 Banda Aceh again leads with a score of 2.81, with SMAN 6 Banda Aceh closely behind at 2.78. SMAS Al-Misbah records a KS index of 2.61, while SMAN 13 Banda Aceh and SMAN 14 Banda Aceh show lower scores of 2.34 and 1.14, respectively.

Overall, the data suggests that the School (S1) category is the most significant contributor to the PS Parameter Index across all schools, while no contributions are observed from Teachers (S2) and Students (S3). Additionally, SMAN 1 Banda Aceh demonstrates the highest overall preparedness within the School Community (KS) category. The preparedness strategy index was uniformly low across all schools, highlighting the lack of structured disaster policies and emergency action plans.

Table 2. KAP Parameter Index

School Name	School (S1)	Teacher (S2)	Student (S3)	School Community (KS)
SMAN 13 Banda Aceh	0	48.3	63.5	27.18
SMAN 14 Banda Aceh	0	46.6	59.8	25.94
SMAN 1 Banda Aceh	0	46.6	57.3	25.44
SMAN 6 Banda Aceh	0	54.4	59.3	28.17
SMAS Al-Misbah	0	36.7	51.3	21.28

Table 3. PS Parameter Index

School Name	School (S1)	Teacher (S2)	Student (S3)	School Community (KS)
SMAN 13 Banda Aceh	23.4	0	0	2.34
SMAN 14 Banda Aceh	11.4	0	0	1.14
SMAN 1 Banda Aceh	28.1	0	0	2.81
SMAN 6 Banda Aceh	27.8	0	0	2.78
SMAS Al-Misbah	26.1	0	0	2.61

Emergency planning (EP)

Table 4 presents the EP Parameter Index for five schools in Banda Aceh, detailing the preparedness levels of each school component, including School (S1), Teacher (S2), Student (S3), and the overall School Community (KS). SMAN 13 Banda Aceh shows low indices across all categories, with values of 1.3 for School, 12.5 for Teacher, 7.0 for Student, and 1.2 for School Community. In comparison, SMAN 14 Banda Aceh also demonstrates low preparedness, recording indices of 1.3 for School, 8.5 for Teacher, 4.6 for Student, and 0.86 for School Community. SMAN 1 Banda Aceh displays relatively higher indices, particularly for School (11.7) and School Community (2.43), while its Teacher and Student indices are 9.9 and 5.2, respectively. SMAN 6 Banda Aceh exhibits

the highest School index (12.4) and a School Community index of 2.47, with moderate indices for Teacher (8.5) and Student (7.1). Meanwhile, SMAS Al-Misbah reports indices of 10.3 for School, 7.0 for Teacher, 6.0 for Student, and 2.05 for School Community, indicating a relatively balanced but moderate level of preparedness across all components. Overall, the data suggests significant variation in disaster preparedness levels among the schools, with SMAN 6 Banda Aceh and SMAN 1 Banda Aceh showing relatively better preparedness compared to the others.

Table 4. EP Parameter Index

School Name	School (S1)	Teacher (S2)	Student (S3)	School Community (KS)
SMAN 13 Banda Aceh	1.3	12.5	7.0	1.2
SMAN 14 Banda Aceh	1.3	8.5	4.6	0.86
SMAN 1 Banda Aceh	11.7	9.9	5.2	2.43
SMAN 6 Banda Aceh	12.4	8.5	7.1	2.47
SMAS Al-Misbah	10.3	7.0	6.0	2.05

Warning system (WS)

Table 5 presents the WS Parameter Index for five senior high schools in Banda Aceh, assessing different components: the school (S1), teachers (S2), students (S3), and the overall school community (KS). Among the schools, SMAN 1 Banda Aceh, SMAN 6 Banda Aceh, and SMAS Al-Misbah exhibit the highest S1 scores, each at 11.8, indicating a relatively strong institutional preparedness. SMAN 13 Banda Aceh follows closely with an S1 score of 10.6, while SMAN 14 Banda Aceh records the lowest at 1.2, suggesting a significant gap in school-level preparedness. For teacher preparedness (S2), SMAN 1 Banda Aceh ranks the highest at 3.5, followed by SMAN 13 Banda Aceh (3.0), SMAN 6 Banda Aceh (2.8), SMAN 14 Banda Aceh (2.0), and SMAS Al-Misbah (1.7), indicating variations in teacher readiness across institutions. In terms of student preparedness (S3), SMAS Al-Misbah shows the highest score of 3.0, slightly ahead of SMAN 13 Banda Aceh (2.8) and SMAN 6 Banda Aceh (2.5). SMAN 1 Banda Aceh and SMAN 14 Banda Aceh report lower scores at 1.9 and 1.6, respectively, reflecting differences in student awareness and preparedness. Regarding the overall school community preparedness (KS), SMAN 1 Banda Aceh has the highest score at 0.56, closely followed by SMAN 6 Banda Aceh (0.55), SMAS Al-Misbah (0.54), and SMAN 13 Banda Aceh (0.51). SMAN 14 Banda Aceh has the lowest score of 0.10, highlighting a critical need for improvement in community-wide disaster preparedness efforts.

Overall, the data suggests that while some schools demonstrate relatively high preparedness levels, significant disparities exist, particularly for SMAN 14 Banda Aceh, which consistently reports the lowest scores across all parameters. This indicates an urgent need for targeted interventions to enhance preparedness at both the institutional and community levels.

Table 5. WS Parameter Index

School Name	School (S1)	Teacher (S2)	Student (S3)	School Community (KS)
SMAN 13 Banda Aceh	10.6	3.0	2.8	0.51
SMAN 14 Banda Aceh	1.2	2.0	1.6	0.10
SMAN 1 Banda Aceh	11.8	3.5	1.9	0.56
SMAN 6 Banda Aceh	11.8	2.8	2.5	0.55
SMAS Al-Misbah	11.8	1.7	3.0	0.54

Resource mobilization capacity (RMC)

Table 6 presents the RMC Parameter Index for five schools in Banda Aceh, categorized into four components: School (S1), Teacher (S2), Student (S3), and School Community (KS). Among the schools, SMAS Al-Misbah has the highest index for the School component (S1) at 16.4, indicating a strong institutional capacity. This is followed by SMAN 6 Banda Aceh (11.1), SMAN 1 Banda Aceh (10.5), and SMAN 13 Banda Aceh (10.1). Meanwhile, SMAN 14 Banda Aceh has the lowest score in this category (3.4), suggesting relatively lower school-level preparedness. For the Teacher component (S2), SMAN 13 Banda Aceh shows the highest index (5.0), suggesting better preparedness among teachers compared to other schools. SMAN 1 Banda Aceh and SMAN 6 Banda Aceh follow closely with indices of 4.6 and 4.3, respectively. In contrast, SMAS Al-Misbah records the lowest score (3.4). Regarding the Student component (S3), SMAN 6 Banda Aceh exhibits the highest preparedness level with an index of 3.7. Conversely, SMAN 1 Banda Aceh has the lowest student preparedness index (2.4). In the School Community (KS) category, SMAS Al-Misbah scores the highest (1.11), indicating relatively better community engagement in disaster preparedness. This is followed by SMAN 6 Banda Aceh (0.83) and both SMAN 13 Banda Aceh and SMAN 1 Banda Aceh (0.79). SMAN 14 Banda Aceh records the lowest index (0.33), highlighting a need for enhanced community involvement in disaster risk management.

Overall, the results indicate varying levels of preparedness across different components and schools, emphasizing the importance of targeted interventions to strengthen urban resilience through school community engagement.

Table 6. RMC Parameter Index

School Name	School (S1)	Teacher (S2)	Student (S3)	School Community (KS)
SMAN 13 Banda Aceh	10.1	5.0	3.1	0.79
SMAN 14 Banda Aceh	3.4	3.2	3.5	0.33
SMAN 1 Banda Aceh	10.5	4.6	2.4	0.79
SMAN 6 Banda Aceh	11.1	4.3	3.7	0.83
SMAS Al-Misbah	16.4	3.4	2.7	1.11

Total Preparedness Index

Table 7 presents the Total Preparedness Index for five senior high schools in Banda Aceh: SMAN 13, SMAN 14, SMAN 1, SMAN 6, and SMAS Al-Misbah. The index is calculated based on five key parameters: Knowledge and Attitude (KAP), Preparedness Policy (PS), Emergency Response Plan (EP), Disaster Warning (WS), and Resource Mobilization (RMC). Among the schools, SMAN 6 Banda Aceh achieved the highest Total Score of 34.80, indicating the most comprehensive preparedness. This is largely attributed to its highest scores in Knowledge and Attitude (28.17) and Resource Mobilization (0.83). In contrast, SMAS Al-Misbah had the lowest Total Score of 27.59, mainly due to its lower scores in Knowledge and Attitude (21.28) and Disaster Warning (0.54). SMAN 13 and SMAN 1 Banda Aceh displayed similar Total Scores of 32.02 and 32.03, respectively. Both schools showed balanced preparedness across most parameters, with particularly strong performances in Knowledge and Attitude. SMAN 14 Banda Aceh recorded the second lowest Total Score of 28.37, impacted by its minimal scores in Disaster Warning (0.10) and Resource Mobilization (0.33).

Table 7. RMC Parameter Index

Parameters/ School	SMAN 13 Banda Aceh	SMAN 14 Banda Aceh	SMAN 1 Banda Aceh	SMAN 6 Banda Aceh	SMAS Al-Misbah
Knowledge and Attitude (KAP)	27.18	25.94	25.44	28.17	21.28
Preparedness Policy (PS)	2.34	1.14	2.81	2.78	2.61
Emergency Response Plan (EP)	1.20	0.86	2.43	2.47	2.05
Disaster Warning (WS)	0.51	0.10	0.56	0.55	0.54
Resource Mobilization (RMC)	0.79	0.33	0.79	0.83	1.11
Total Score	32.02	28.37	32.03	34.80	27.59

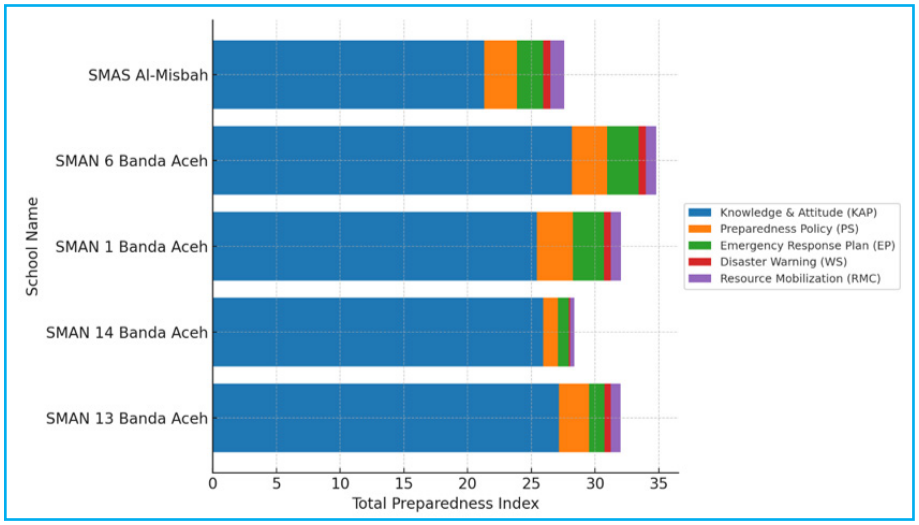

Figure 3. Disaster Preparedness Index by School

Figure 3 graphically represents the Disaster Preparedness Index for each school, illustrating the comparative performance across the five parameters. The graph highlights SMAN 6's leading position and SMAS Al-Misbah's relatively lower preparedness. The visual comparison underscores the variation in disaster preparedness levels among the schools, emphasizing the need for targeted interventions to enhance resilience.

Discussion

The findings of this study highlight significant gaps in school community preparedness for tsunami disasters, reflecting broader urban resilience challenges in coastal cities. The concept of urban resilience emphasizes the ability of communities, institutions, and infrastructure to absorb, recover from, and adapt to shocks such as natural disasters [6]. This study aligns with resilience theory, which posits that disaster preparedness is a crucial factor in reducing vulnerability and ensuring a community's ability to recover swiftly [18]. However, our findings suggest that despite the theoretical emphasis on preparedness as a key component of resilience, Banda Aceh's school communities remain inadequately prepared.

The low Knowledge and Attitude (KAP) index indicates that school communities lack fundamental disaster awareness. Previous studies suggest that disaster knowledge significantly influences preparedness behaviors [19]. In contrast to research conducted in Japan, where high school students undergo regular disaster preparedness drills and education [20], our findings reveal that Banda Aceh's school curricula lack sufficient integration of disaster education. This absence of knowledge leads to confusion and improper responses during emergencies, reducing the overall resilience of the community.

Another key issue identified is the lack of a structured Preparedness Strategy (PS). The urban resilience framework suggests that institutional preparedness and governance play a crucial role in disaster mitigation [21].Our study finds that schools in Banda Aceh lack well-established policies and guidelines for disaster response. Unlike studies from New Zealand, where school disaster policies are standardized and reinforced through governmental frameworks [22], Banda Aceh schools exhibit a fragmented and inconsistent approach. This lack of institutionalized preparedness increases the risk of disorganized responses when disasters strike.

Emergency Planning (EP) is another critical aspect where Banda Aceh schools are found lacking. Research indicates that the existence of a formal emergency plan significantly enhances disaster response efficiency [23]. However, our findings show that none of the surveyed schools have clear evacuation routes, first aid training programs, or routine disaster simulations. This contrasts with best practices observed in countries such as the United States, where FEMA mandates regular school-based drills [24]. The absence of such protocols in Banda Aceh results in an uncoordinated approach to disaster response.

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The lack of an effective Warning System (WS) further exacerbates vulnerability. Urban resilience studies emphasize the importance of early warning systems in minimizing disaster impacts [25]. In contrast to places like Chile, where tsunami warning sirens are strategically positioned and regularly tested [26], Banda Aceh schools lack dedicated warning systems. The reliance on external government warnings without localized response mechanisms delays evacuation efforts, putting students and staff at risk.

Resource Mobilization Capacity (RMC) is also a major shortfall in Banda Aceh's school preparedness. Effective disaster response requires sufficient resources, trained personnel, and financial investment [27]. However, our research indicates a lack of basic emergency supplies, limited disaster response training, and inadequate government funding for school preparedness initiatives. In contrast, cities with established disaster management frameworks, such as Tokyo, have dedicated school response teams trained to handle emergency scenarios [20]. Banda Aceh's schools must adopt similar approaches to enhance their resilience.

The findings of this research differ from existing literature by emphasizing the compounded impact of these deficiencies within the context of a post-disaster city that has already experienced a catastrophic event. While previous studies on urban resilience discuss long-term adaptive capacity [28], our study underscores the immediate gaps in school preparedness, demonstrating that past disaster experience does not necessarily translate into improved readiness. In short, addressing these gaps requires a multi-faceted approach incorporating disaster education, institutional policy reforms, resource allocation, and localized warning systems. By adopting a more structured and proactive disaster preparedness framework, Banda Aceh's schools can significantly enhance their resilience, ultimately contributing to broader urban resilience efforts in coastal Indonesia.

Conclusion

This study highlights critical disparities in tsunami preparedness among senior high schools in the coastal districts of Meuraxa and Kuta Raja, Banda Aceh, revealing gaps in knowledge, preparedness strategies, emergency planning, and warning systems. While SMAN 6 Banda Aceh demonstrated relatively higher preparedness, SMAS Al-Misbah had the lowest scores, underscoring the need for targeted interventions. The findings indicate that institutional preparedness remains insufficient, and the absence of standardized policies hinders effective disaster response. Schools, as key community hubs, must adopt integrated disaster education, regular drills, and coordinated emergency plans to enhance resilience. Strengthening urban resilience in Banda Aceh requires a collaborative approach involving local authorities, educators, and disaster management agencies. Embedding disaster preparedness into the broader urban resilience framework can ensure schools play a proactive role in community safety. This study contributes to urban resilience discourse by mapping school preparedness

and offering insights for policy and practice. Future research should expand to additional coastal areas and assess the long-term impact of preparedness initiatives to develop sustainable disaster resilience strategies.

Acknowledgement

We sincerely thank the school communities in Meuraxa, Kuta Raja, and Syiah Kuala, Banda Aceh, for their participation in this study. Their insights and cooperation were invaluable in enhancing our understanding of tsunami risk preparedness.

Conflicts of Interest

The authors declare no conflicts of interest

Author Contributions

Muhammad Riza Rizky: conceptualization, methodology, software, data curation, writing-original draft preparation. **Evalina Zuraidi:** conceptualization, methodology, supervision, writing-reviewing and editing. **Fahmi Aulia:** methodology, software, supervision.

Data Availability Statement

The data used to support the findings of this study are included within the article.

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