Developing Disaster-Resilient Schools Through Disaster Education in High-Risk Areas: A Case Study of Padang City, Indonesia

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Abstract. Padang is one of the regions in Indonesia with a high risk of tsunamis and earthquakes, making disaster education a critical component of local environmental risk reduction strategies. This study develops a Disaster-Resilient School model that aligns disaster education activities with local socio-environmental conditions. A qualitative approach was applied using in-depth interviews with multi-level stakeholders, including the Regional Disaster Management Agency (BPBD), sub-district officials, school administrators, teachers, disaster preparedness community groups, and civil society actors. The findings show that although the Disaster Safe Education Unit (SPAB) program has been supported by regional policy frameworks and cross-sector collaboration, its implementation remains constrained by limited funding, insufficient teacher training, and the absence of systematic curriculum integration. However, the presence of local disaster preparedness networks, the recognition of tsunami-ready communities, and the role of local wisdom and cultural practices enhance community engagement potential. Strengthening institutional coordination, improving teacher competencies, and embedding disaster education into the formal curriculum are recommended to ensure the sustainability of environmentally-based disaster resilience efforts in schools. **Keywords:** Disaster-Resilient Schools, Disaster Education, Disaster Management, Public Policy

1 Introduction

Indonesia is located in the most disaster-prone part of the Pacific Ring of Fire, and coastal cities in West Sumatra, including Padang, are at the forefront of earthquake and tsunami risk [1]. The experience of the 2009 earthquake remains etched in the collective memory, while early warning systems, evacuation routes, and routine drills are not always uniformly

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implemented across schools. On the other hand, population mobility and urban densification add to the complexity of the risks faced by educational institutions, from evacuation access to the capacity of teachers to guide thousands of students in critical moments. This phenomenon underscores the need for disaster education that is not merely ceremonial, but rather integrated into the daily culture of schools [2].

In policy practice, Indonesia has promoted Disaster-Safe Education Units (SPAB). However, recent evaluations show that implementation in disaster-prone areas is often hampered by imbalances between policy and implementation, particularly in terms of financing, monitoring, and integration of materials into regular learning [3]. A 2024 study evaluating SPAB in volcano-prone areas found variations in implementation quality and real challenges in cross-actor coordination and program sustainability at the school level [4].

The phenomenon in Padang shows similar dynamics. Formal coordination between agencies (BPBD, Education Office, technical agencies, sub-districts) is generally running well, but is still hampered by budget constraints, limited human resources, especially teachers, and weak periodic evaluation mechanisms. At the same time, grassroots initiatives are actually growing, with disaster preparedness communities in neighborhoods, civil society organizations, and schools regularly conducting simulations. The gap between community enthusiasm and institutional support is the problem with implementation [5].

The traces of community-based strengthening are clearly evident in UNESCO's recognition of Lolong Belanti Village as a Tsunami Ready Community. This recognition did not come about suddenly, but was the result of fulfilling 12 indicators that required risk management, early warning communication, and evacuation preparedness at the community and school levels. This fact shows that collaboration between the local government, BMKG, local NGOs (KOGAMI), and KSB can produce international-standard preparedness, a valuable social asset for schools in the surrounding area.

From a scientific perspective, literature from the past three years confirms the central role of teachers and schools. Recent research shows that teachers function as agents of post-disaster resilience, not only as content providers who mediate psychosocial support and build students' sense of security [6]. Findings in the Indonesian context show the importance of institutional support so that teachers do not work alone. Mentoring structures, training, and spaces for reflection are key to transforming knowledge about disasters into trained action [7].

At the curriculum policy level, recent international and national studies emphasize that the integration of DRR/DRRE (disaster risk reduction education) into subjects is often partial, with material inserted as a cross-curricular theme without clear assessment, while local knowledge (local wisdom) has not been optimally utilized. The results of the 2023–2025 study highlight the importance of curriculum design that combines competency achievement, regular exercises, and context-based learning resources, so that learning does not stop at posters and socialization [8].

Other empirical evidence shows that preparedness-based school programs can improve student readiness, but the effects are highly dependent on the continuity of training, the quality of facilitators, and parental support [9]. A 2025 study on preparedness-based school programs in Indonesia found an increase in knowledge and skill indicators, but emphasized the need for repeated training and family involvement so that evacuation practices become ingrained as habits [10].

Based on these recent phenomena and findings, this study offers an in-depth reading of the disaster education ecosystem in Padang through a qualitative analysis of interviews with stakeholders. It focuses on three highlights: the role of actors, key constraints, and the potential/innovation based on teacher capacity and local wisdom. This approach allows us to see the space between policy and practice where school resilience is actually shaped by collaboration, leadership, and appropriate incentives.

The ultimate goal is to formulate a down-to-earth Disaster Resilient School model, strengthen teacher competencies, organize cross-actor coordination, provide incentives to consistent schools, and link the curriculum with Minangkabau cultural practices so that preparedness is not just a project, but a school culture.

2 Research Method

This study uses a qualitative approach with a case study design in Padang City. Primary data were collected through in-depth interviews with key actors (Padang City BPBD, Regional Secretariat, Education Office, Environment Office, PUPR, sub-district government, community organizations such as KOGAMI, Tagana, Jemari Sakato, disaster preparedness communities/KSB, teachers, and school officials), supplemented by limited participatory observation of simulation and socialization activities in educational units. Secondary data included local policy documents related to SPAB, program reports, and training materials. The analysis was conducted thematically, with transcripts organized, coded, and then grouped into themes of actor roles, constraints, and innovation capacity, while linking field findings with the 2023–2025 literature for contextual and evidence-based interpretation. Validity is supported by source triangulation and policy tracing of key decisions and initiatives at the city-subdistrict-school levels.

3 Result and Discussion

3.1 The Role of Actors in the Disaster Education Ecosystem

The Padang City Disaster Management Agency (BPBD) plays a central role in driving SPAB by facilitating schools, initiating training, and establishing regular coordination with the Education Office. Educational expansion to communities is carried out through the strengthening of Disaster Resilient Neighborhoods (Kaltana), which has reached dozens of neighborhoods, connecting schools with their surrounding environments. However, monitoring and evaluation activities are often carried out personally by staff, indicating that individual resilience is more prominent than institutional systems. This pattern reflects the broader challenge identified in the Sendai Framework for Disaster Risk Reduction (Priority 1 and 2), which emphasizes the need to strengthen institutional capacity and coordination mechanisms rather than relying on individual initiatives.

Meanwhile, the regional secretary has positioned SPAB as a local government priority by supporting training, workshops, periodic simulations, and inter-school preparedness competitions as non-financial incentives. This pattern is important for maintaining public attention to disaster preparedness in schools, but without stable budgetary support, many initiatives remain annual events rather than embedded daily practices. This gap between recognition and operational sustainability illustrates the policy–implementation divide also noted in Indonesia’s National Disaster Management Plan (RPB) 2020–2024, which calls for mainstreaming disaster education into regular education funding and planning cycles.

The Education Office acts as the gatekeeper for the integration of disaster education into the curriculum and school culture. The formation of the SPAB Task Force through the Mayor's Decree (2023) signals institutional commitment, yet without adequate budget allocation and an integrated monitoring and evaluation system, it is difficult to ensure that policy instruments influence teaching behavior. This finding echoes the Sendai Framework’s Priority 3, which highlights the importance of investing in disaster risk reduction for resilience through education and training. It also aligns with Indonesia’s Merdeka

Curriculum, which encourages contextual and character-based learning, including local risk awareness and community engagement as part of holistic education reform [8].

Civil society organizations play a pioneering role and fill policy gaps. KOGAMI has promoted local content curricula since 2005 and remains active in assisting schools. Tagana continues its Tagana Goes to School program, although it has recently faced funding constraints. Jemari Sakato acts as a catalyst, developing modules and risk maps, advocating for regulations, and encouraging schools to allocate resources for disaster preparedness. Their contribution exemplifies multi-stakeholder collaboration, a principle central to both the Sendai Framework (Priority 4: "Enhancing disaster preparedness for effective response") and Indonesia's SPAB National Guideline, which emphasizes community partnerships in school-based disaster education.

Sub-district governments and KSBs implement disaster education closest to the community level. A notable example is KSB Lolong Belanti, which actively socializes evacuation procedures for students and promotes independent evacuation based on local wisdom, moving without waiting for official sirens during earthquakes. This self-initiated action embodies the Sendai Framework's call for community-based risk knowledge and preparedness and demonstrates how local wisdom (*kearifan lokal*) recognized in Indonesia's disaster education policy can enhance responsiveness and collective safety in schools.

Furthermore, other technical agencies contribute in complementary ways. The Environmental Agency (DLH) promotes environmentally conscious behavior (Adiwiyata/PHBS), which indirectly strengthens orderly evacuation culture. Meanwhile, the Public Works and Housing Office (PUPR) plays a crucial role in spatial planning and licensing for disaster-safe schools, though enforcement remains inconsistent. These findings reaffirm that achieving resilient education systems requires cross-sectoral integration, consistent with the Sendai Framework's systems approach and Indonesia's National Strategy for Disaster Resilient Schools (2022–2027).

At the school level, good practices are evident at SMPN 25 Padang, which regularly collaborates with BPBD to conduct simulations, train teachers, and ensure SOP compliance (e.g., unlocked shelters, clear evacuation routes, and visible assembly points). The involvement of NGOs and local values mutual assistance and discipline make these drills meaningful for students. This practice aligns with the Sendai Framework's emphasis on school-based learning and drills as part of risk-informed education, and with Indonesia's policy to embed disaster preparedness in school accreditation standards [10].

Overall, these findings illustrate that while Padang City has developed promising cross-sectoral collaboration, further institutionalization is needed to translate community enthusiasm into sustainable governance structures. Strengthening these linkages not only supports the Sendai Framework's goal of resilient communities through education but also operationalizes Indonesia's vision for a disaster-prepared generation *(Generasi Tangguh Bencana)* under the Ministry of Education's current policy direction.

Table 1. Roles and collaboration of key actors in the disaster education ecosystem of Padang City.

Actor/ Institution	**Main Roles/ Contributions**	**Challenges or Limitations**	**Notable Practices/ Innovations**
BPBD Padang	Coordinates SPAB implementation, provides training, links schools with community preparedness programs	Limited budget, relies on personal initiative	Regular simulations, Kaltana neighborhood networks
Regional Secretariat	Supports training/workshops and provides non-financial incentives	Lack of sustained funding	Preparedness competitions among schools
Education Office	Integrates disaster topics into curriculum, established SPAB task force	Limited monitoring & evaluation, funding constraints	Mayor's Decree 2023 on SPAB implementation
Civil Society (KOGAMI, Tagana, Jemari Sakato)	Develop local modules, risk maps, advocacy	Depend on external funding	"Tagana Goes to School", curriculum innovation
Sub-district Gov't & KSB	Implement school-community simulations, promote local evacuation customs	Uneven community involvement	Lolong Belanti's "Tsunami Ready" initiative
Technical Agencies (DLH, PUPR)	Promote environmental culture, ensure safe infrastructure	Weak enforcement, zoning issues	Adiwiyata integration
Schools	Conduct regular simulations, maintain SOPs	Dependence on external facilitation	SMPN 25 Padang as best practice

3.2 Main Obstacles

Budgeting remains a persistent structural challenge. Many facilitations, mentoring, and monitoring and evaluation activities are conducted voluntarily by facilitators or inter-agency staff. As a result, program continuity relies heavily on individual commitment rather than institutional systems. This condition reflects the Sendai Framework's Priority 2, which calls for strengthening governance to manage disaster risk through stable institutional and financial mechanisms. Similarly, Indonesia's National Action Plan for Disaster Risk Reduction (RAN-PRB) emphasizes the need for sustained funding and the integration of disaster education into formal budget structures at both national and regional levels to ensure program continuity and equity across schools. An external evaluation of SPAB also noted that limited funding and coordination barriers have led to uneven implementation quality among schools.

Another major obstacle lies in the uneven capacity of teachers. In several schools, SPAB implementation has been reduced to a formality rather than a competency-building process in evacuation management, risk communication, and psychosocial support. This finding underlines the Sendai Framework's Priority 3, which promotes investment in disaster risk reduction through education and training. Within Indonesia's policy context, it echoes the Merdeka Curriculum and the SPAB National Guideline (2020) that position teachers as key agents of disaster resilience who require continuous professional development, mentoring, and reflective learning to sustain preparedness culture in schools.

Furthermore, monitoring and evaluation remain unsystematic. Many programs end once activities are completed, without a feedback loop to update standard operating procedures

(SOPs), revise risk maps, or recalibrate evacuation routes. This weakness illustrates a gap in implementing the Sendai Framework's Priority 4, enhancing preparedness for effective response and "building back better." The curriculum literature also warns that without assessment and ongoing evaluation, disaster risk reduction education risks becoming an "incidental theme" rather than an embedded part of learning practice. Therefore, institutionalizing a continuous monitoring and evaluation framework, supported by education policy and local government oversight, is essential to transform temporary activities into a sustainable culture of preparedness.

Table 2. Main obstacles in implementing disaster education (SPAB) in Padang City.

Type of Obstacle	**Description**	**Impact on SPAB Implementation**
Funding	Limited and inconsistent budget for training, facilitation, and logistics.	Activities depend on external projects; low program continuity.
Teacher Capacity	Uneven understanding of SPAB principles; limited follow-up training.	Disaster education often reduced to symbolic activities.
Monitoring & Evaluation	No structured M&E framework or feedback loop.	Lack of measurable outcomes and sustainability.
Incentives	Non-financial or symbolic incentives only.	Low motivation among schools and teachers.
Infrastructure	Several schools located in disaster-prone areas with limited mitigation measures.	Ongoing exposure to physical risks.
Family & Community Involvement	Weak coordination between schools and parents.	Limited behavioral reinforcement outside school.

Incentives for active schools and communities remain minimal. Appreciation is often symbolic, while financial or performance-based recognition is rare. This lack of structured incentives weakens long-term motivation, particularly for communities that independently sustain disaster education activities despite limited external support. This condition contradicts the Sendai Framework's Priority 4, which calls for recognizing and strengthening community-led initiatives as essential drivers of resilience. Within the Indonesian context, it also diverges from the SPAB Guideline (Permendikbud No. 33/2019) and the National Strategy for Disaster-Resilient Schools (2022–2027), which emphasize institutionalizing reward systems and measurable performance indicators such as the number of trained teachers, drill frequency, and school safety scores to sustain engagement across education units.

Spatial compliance and infrastructure constraints further weaken the structural layer of disaster mitigation. Schools located in hazard-prone zones are not easily relocated, and enforcement of zoning regulations for new construction remains inconsistent. This situation highlights the gap between national spatial planning policies and actual school infrastructure management at the local level. The Sendai Framework's Priority 2 explicitly underlines the importance of integrating disaster risk information into urban planning and critical facilities, including schools. Similarly, Indonesia's Safe School Initiative (Sekolah Aman Bencana) requires physical infrastructure, evacuation routes, and safety signage as part of the minimum standards for disaster-resilient schools. Without adequate infrastructure such as visible signage, clear evacuation pathways, and accessible shelters even well-trained teachers and students cannot fully implement effective evacuation protocols.

The involvement of parents and families in school disaster education remains limited. Yet, recent studies stress that continuity between home and school is crucial to developing sustained safe behavior, especially among younger students. This gap reflects the Sendai Framework's emphasis on inclusive, whole-of-society approaches and the Merdeka Curriculum's directive to involve parents and communities in character-based and contextual learning. The absence of structured risk communication to households and its exclusion from school assessment systems reduce the reinforcement of preparedness behaviors beyond the classroom. Strengthening parent engagement programs and incorporating family participation into SPAB performance indicators could enhance the cultural sustainability of disaster education practices [11].

3.3 Teacher Capacity, Local Wisdom, and Innovation

Teachers are the anchors of resilience in school-based disaster education. Recent evidence from Indonesia shows that teachers play dual roles as educators and as facilitators of psychosocial recovery during and after emergencies. When regular drills are complemented by peer support systems and clear school policies, teachers become more capable of managing classrooms under stress. This aligns with the Sendai Framework's Priority 1, which emphasizes understanding disaster risk through education and training. It also supports Indonesia's Teacher Professional Development (PPG) program, which increasingly integrates disaster risk reduction (DRR) competencies as part of lifelong learning for educators.

Repeated and structured training is critical. Schools that implement continuous simulation programs show measurable improvements in student evacuation performance. A 2025 intervention study confirms that school-based preparedness initiatives are most effective when training occurs in scheduled cycles and includes reflective feedback mechanisms. Thus, teachers should receive cyclical professional development, similar to continuous PPG programs, where modules integrate theory, simulation, and evaluation indicators. This approach operationalizes the SPAB (Safe School) framework, which mandates sustainable capacity building rather than one-off activities.

A context-based curriculum that integrates Disaster Risk Reduction Education (DRRE) is most effective when it uses local realities actual evacuation routes, community hazard maps, and local case studies of earthquakes and tsunamis. Studies from 2023–2025 highlight that DRRE should not be a one-time topic but assessed through performance-based learning, projects, and competency rubrics, in line with the Merdeka Curriculum's competency-based assessment. Local wisdom also plays a crucial role. In Padang, practices such as independent evacuation, the use of tabuah as a traditional siren, and the culture of gotong royong (mutual cooperation) give authentic meaning to school drills. Embedding these cultural practices into school SOPs aligns with the Sendai Framework's Priority 3 on strengthening disaster risk governance at local levels and reinforces cultural continuity during emergencies. The success of Lolong Belanti's Tsunami Ready community exemplifies how local knowledge combined with international frameworks can yield demonstrable preparedness outcomes.

Cross-actor collaboration also strengthens system resilience. NGOs like KOGAMI, volunteer groups such as Tagana, and community networks (KSB) bridge the gap between schools and external resources, often moving faster than bureaucratic processes. Establishing target-based partnerships for example, the number of drills per semester, the ratio of trained teachers, or average evacuation time ensures that collaboration translates into measurable outcomes. This collaborative governance model reflects the Sendai Framework's Priority 2 (strengthening disaster risk governance) and supports Indonesia's multi-sectoral education approach under the National Action Plan for School Safety.

 https://doi.org/10.1051/e3sconf/202567101001

Moreover, establishing repositories and open learning resources is essential for sustainability. Research in 2025 recommends developing a national DRR education repository that compiles local teaching modules, evacuation maps, SOP templates, and assessment rubrics. For Padang, this would allow replication of best practices across schools and reduce redundancy in program design [12]. Such repositories align with the Merdeka Curriculum's open education principle and the Ministry of Education's digital learning roadmap.

Finally, incentives and recognition schemes based on indicators can motivate continued innovation. Adopting the spirit of UNESCO's Tsunami Ready indicators, city governments can classify schools into basic, advanced, and resilient categories based on quantifiable performance such as simulation frequency, teacher certification rates, average evacuation time, and parental involvement. Incentives could take the form of equipment support, priority access to infrastructure improvement, or teacher training scholarships. This approach not only reflects the Sendai Framework's call for measurable progress but also aligns with Indonesia's SPAB policy, which encourages both symbolic and material recognition to sustain resilience-building at the school level.

4 Conclusion

This study concludes that disaster education in Padang represents a convergence of policy achievement and community vitality. Three main pillars underpin the development of disaster-resilient schools. First, teacher preparedness is strengthened through continuous, practice-oriented training that enables educators to integrate disaster risk reduction into everyday learning. Second, community collaboration particularly among BPBD, the Education Office, and local groups such as KSB ensures that preparedness activities remain sustainable even with limited resources. Third, the integration of local wisdom, such as independent evacuation practices and the culture of mutual cooperation (gotong royong), contextualizes disaster education and enhances its cultural relevance.

From a policy perspective, the establishment of clear indicators, systematic monitoring and evaluation, and incentive-based recognition can institutionalize these practices within the education system. Aligning local initiatives with the Sendai Framework and Indonesia's SPAB policy reinforces the importance of multilevel governance in building disaster-resilient schools. Looking forward, this integrated model of teacher capacity, community collaboration, and cultural adaptation can be scaled up to other disaster-prone regions in Indonesia, positioning Padang as a laboratory for evidence-based and locally grounded disaster education,

5 Limitation

This study relies on interviews and limited observations, making it highly dependent on the openness of informants and the timing of activities. Perceptual bias and recall bias may have influenced the chronological details as well as the emphasis of the narratives. The scope of the study focuses on Padang City; thus, generalization to other contexts must take into account differences in risk geography, governance, and community culture. Further research in other coastal cities in Indonesia would help to map variations in SPAB implementation and to test the replication of innovations based on local wisdom. Finally, this study has not included quantitative measurements (such as average evacuation time, percentage of certified teachers, or changes in students' knowledge scores). Going forward, a mixed-methods approach with clearly defined performance indicators will strengthen policy recommendations and training design.

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