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Disaster Safety Awareness as a Pathway to School Resilience in Merapi Volcano Hazard Zones

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Abstract
Indonesia is among the countries with a high risk of disasters. This situation necessitates raising disaster safety awareness from an early age, particularly within school environments, which serve as places for both learning and play for children. This community service initiative aims to enhance schools' emergency response capabilities by establishing emergency response teams and procedures, developing pocket guides, building the capacity and knowledge of the school community through training and disaster simulations, improving safety facilities, and educational innovations regarding disaster preparedness. Implementation methods include interactive training sessions for students, staff, and teachers. A participatory approach is also employed in the development of educational materials, response procedures, disaster response teams, evacuation routes, and simulation scenarios to ensure the initiative's relevance and sustainability. Results indicate an improvement in students' understanding of disaster mitigation: a 40.8% increase for 3rd-grade students and a 5% increase for 4th-grade students. This initiative supports the achievement of Asta Cita 4 and the Sustainable Development Goals, specifically Goal 3 (Good Health and Well-being) and Goal 11 (Sustainable Cities and Communities) by serving as an effective and practical model for disaster mitigation education in schools.

Keywords: *disaster safety awareness*, capacity, school, Merapi zone

INTRODUCTION

Magelang Regency is characterized by a vast hilly landscape (Badan Pusat Statistik Kabupaten Magelang, 2025). Topographically, many villages fall into the slope or ridge category, reflecting a landscape dominated by steep terrain and significant elevation differences. From a geomorphological perspective, these conditions heighten susceptibility to landslides, particularly during periods of high-intensity rainfall (Iskahar et al., 2020; Singha et al., 2025). In addition, several villages are also located in the vicinity of the forest area (Badan Pusat Statistik Kabupaten Magelang, 2025). The presence of forest areas on slopes of a certain steepness can constitute an additional risk factor for landslides in the event of vegetation degradation or extreme rainfall (Putra et al., 2025; Ramadanti, 2025).

For instance, regarding climate and rainfall data for Bandongan District in 2024, the highest rainfall occurred in December (512 mm) and February (480 mm), with 28 and 26 days of rain, respectively (Badan Pusat Statistik Kabupaten Magelang, 2025). High rainfall during that period has the potential to trigger: 1) flooding caused by the overflowing of drainage systems and small rivers; 2) landslides in sloping areas (Iskahar et al., 2020); 3) extreme weather in the form of heavy rain accompanied by strong winds. Based on the Magelang Regency Disaster Risk Assessment, the dominant types of disasters with the potential to occur—and which frequently do occur, such as in the Bandongan area—include floods, landslides, and extreme weather (Peraturan Bupati Magelang Nomor

46 Tahun 2018 Tentang Kajian Risiko Bencana Kabupaten Magelang Tahun 2017-2021, 2018). The natural conditions of Bandongan and Dukun Districts in Magelang Regency are quite similar, as both are situated in highland areas and on mountain slopes, and both are influenced by volcanic activity from Mount Merapi. However, the extent of this influence differs, as Dukun District faces a higher level of hazard potential than Bandongan District. Schools, as educational institutions, serve as a crucial focal point in efforts to reduce disaster risk (Horton et al., 2023; Widowati et al., 2018; Widowati, Sutomo, et al., 2021). Given the large population and the prevalence of hillside terrain, these schools are potentially at risk of being directly affected by hydrometeorological disasters. Children constitute a vulnerable group due to their limited physical capabilities and decision-making abilities during emergencies (Mimaki & Shaw, 2007; Widowati, Istiono, et al., 2021).

Schools, as educational institutions, serve as a crucial focal point for disaster mitigation efforts, given that children are among the groups most vulnerable to the risks posed by disaster events (Amri et al., 2017; Saputri & Sari, 2022; Widowati et al., 2020). A lack of awareness, preparedness, and emergency response systems within the school environment can exacerbate the negative impact of a disaster (Widowati et al., 2020). Limited evacuation facilities and safe routes, combined with a lack of practical knowledge regarding mitigation, make it crucial to establish educational activities and disaster mitigation systems in schools within this disaster-prone region (Widowati et al., 2023). Therefore, strengthening school-based disaster mitigation systems has become an urgent necessity to minimize the risk of loss of life and material damage (Ronggowulan et al., 2024). The proposed community service program focuses on strengthening school-based disaster mitigation systems in a structured and sustainable manner (Hidayah et al., 2021; Saputri & Sari, 2022). The activity began with a school risk assessment to identify potential threats such as floods, landslides, eruptions, and extreme weather and to evaluate the physical and non-physical vulnerabilities of the school community (Widowati et al., 2023). The results of this analysis will serve as the basis for developing the school's risk map and preparedness profile.

The community service program encompasses educational activities, the formation of school emergency response teams, the establishment of emergency response procedures, the creation of pocket guides, the planning of evacuation routes and assembly points, conduct of training and evacuation drills. These measures aim to enhance the capacity of teachers and students to respond swiftly and in a coordinated manner to emergencies or disasters. Mitigation materials were developed in the form of pocket guides designed to foster a culture of disaster awareness within the school environment (Peden et al., 2023). The community service program aims to produce an operational school-based disaster mitigation system, enhance the preparedness of the school community, and support sustainable disaster risk reduction (Noviana et al., 2023).

MI Muhammadiyah Sumber, located in Sumber Village, Dukun District, Magelang Regency, is situated in an area prone to natural disasters. Due to its location on slopes and hills, the school is at risk of hydrometeorological disasters such as landslides, tornadoes, and fires as well as tectonic events like earthquakes, and impacts from Mount Merapi's volcanic activity. Potential consequences of such disasters include physical damage to buildings, operational disruptions, and even loss of life. To minimize the risk of casualties, the school needs to implement disaster mitigation measures; however, it currently lacks the adequate capacity to carry out a disaster response program. The issues identified at the partner institution include: 1) Students' level of knowledge regarding disaster mitigation remains very limited; 2) Teacher capacity remains very limited; 3) Support from the school committee has not been optimal; 4) Does not yet have a school emergency response team; 5) There are no adequate disaster mitigation procedures in place yet; 6) Has not conducted adequate periodic emergency evacuation drills; 6) Inadequate minimum safety facilities; 7) Highly limited media and tools for disaster mitigation education. In regions frequently affected by various disasters, it is crucial for the school community to understand how to implement adequate disaster mitigation measures. This community service initiative aims to enhance the school's capacity for emergency response by establishing an emergency response team, developing response procedures, creating educational materials, conducting training and drills to boost the community's knowledge and capabilities, and upgrading school safety facilities.

METHOD

The partner for this community service activity is MI Muhammadiyah Sumber in Sumber Village, Magelang Regency, where the school principal, teachers, and students are involved in the activity's implementation. The implementation method for this community service activity consists of

two approaches: 1) Training methods. Providing education, understanding, and knowledge to the school community regarding the importance of disaster safety awareness in the face of disaster threats. The training is conducted through lectures and practical disaster response simulations; 2) Participatory Method**.** A participatory approach was employed during team formation, the drafting of standard procedures, the determination of evacuation routes and assembly points, the development of simulation plans, and the conduct of training to enhance the capacity of the school community. These activities included hazard identification and the collaborative development of an action plan involving both the outreach team and school stakeholders; this ensured that the resulting program was relevant and feasible for implementation at the school level, particularly regarding safety awareness and disaster mitigation capabilities.

The implementation process comprised three stages: a) Preparation phase. At this stage, coordination is carried out with the school, MI Muhammadiyah Sumber in Sumber Village, Magelang Regency regarding the detailed implementation plan, covering the schedule, venue, and necessary facilities. Meanwhile, internal coordination among the community service team is conducted to prepare the materials, media, instruments, visual aids, and supplies required for the mentoring, training, and simulation activities; b) Implementation phase: This stage involves mentoring and discussions regarding team formation, the development of standard procedures, the creation of simulation scenarios, the determination of evacuation routes and assembly points, and the preparation of educational materials. It also includes disaster response training and simulations designed to enhance the school community's capacity to face disaster threats. Furthermore, the team is equipped with the skills to identify safety hazards—including necessary emergency preparedness measures—enabling them to assess potential risks within the school environment and understand appropriate prevention and response methods. c) Evaluation phase: The evaluation for this activity involved discussions, pre- and post-tests, and Q&A sessions with the school principal, teachers, and students regarding the mentoring and training provided; the aim was to assess the level of enthusiasm and understanding among the school community, as well as the benefits of establishing a school safety system particularly for handling emergencies and disaster threats. This activity has received ethical approval from the Research Ethics Commission of the Institute for Research and Community Service, Universitas Negeri Semarang, under number B/5906/UN37.3.1/KEP.00/2026.

RESULTS AND DISCUSSION

The results of this PMKI community service initiative are evident in three key areas; human resource (HR) capacity, safety management, and disaster preparedness, which are detailed as follows. The results of this community service activity demonstrate an increase in knowledge among not only the students but also the school management (principals) and teachers. The improvement in the principals' and teachers' knowledge was evident during the discussion sessions. Meanwhile, the increase in student knowledge was reflected in the pre-test results which measured their baseline understanding of disaster preparedness showing an average score of 46.25 for Grade 3 and 63.50 for Grade 4. Table 1 lists two pre-test scores as zero because the students in question did not take the pre-test; they arrived late to class after the session had already begun and proceeded directly to the intervention session—specifically, the disaster mitigation training. Following the pre-test, the team implemented an intervention consisting of training on disaster mitigation, pre-simulation preparation for the students and simulation. The training concluded with the students completing a post-test. The post-test results showed that the average class scores rose to 65.14 (Grade 3) and 66.56 (Grade 4). This represents an increase from pre-test to post-test of 40.8% for Grade 3 and 5% for Grade 4, indicating an improvement in the students' understanding of disaster mitigation. class 3 showed a greater score improvement than class 4, as class 4 started with a higher baseline level of knowledge compared to class 3. Consequently, the rate of improvement in class 3 (the smaller class) was more significant than that observed in class 4 (the larger class). Detailed results are presented in Table 1.

Table 1. Pre-test and Post-test Results

Code	Class	Pre-test	Post-test	Code	Class	Pre-test	Post-test
1	3	40	75	1	4	60	65
2	3	50	75	2	4	65	70
3	3	70	85	3	4	60	65
4	3	40	77	4	4	65	65
5	3	40	75	5	4	60	65
6	3	50	70	6	4	65	67
7	3	70	75	7	4	65	67
8	3	40	50	8	4	60	65
9	3	65	70	9	4	60	65
10	3	40	70	10	4	70	65
11	3	30	80	11	4	65	70
12	3	0	55	12	4	68	68
13	3	20	55	13	4	70	65
14	3	0	0	14	4	65	68
Average:		**46,25**	**65,14**	15	4	55	65
				16	4	60	65
				17	4	65	68
				18	4	65	70
				Average:		**63,50**	**66,56**

School-based disaster education contributes significantly to enhancing student preparedness. This improvement in preparedness is inextricably linked to strengthening human resource capacity a key component in building disaster-resilient schools. Schools serve not only as places of learning but also as hubs for knowledge, communication, and coordinated action that contribute to disaster management. Furthermore, schools possess resources such as trained personnel, structured curricula, and communication networks that can be leveraged to support disaster risk reduction efforts (Dwitarachmi et al., 2026; Marzban et al., 2026). Previous research indicates that students are the group most vulnerable to the impacts of disasters; therefore, they need to be empowered through disaster education that enhances the knowledge and skills required to protect both themselves and others. Furthermore, the effectiveness of disaster education is maximized when supported by the involvement of all school components and various stakeholders through the implementation of integrated programs (Mutanda & Ngcamu, 2026; Pambudi et al., 2025)

Initially, the school lacked adequate evacuation procedures, a proper organizational structure, and a disaster response team; it also lacked sufficient safety-related educational materials, safety guidelines, and mitigation handbooks, while possessing only minimal facilities for emergency response. However, following the community service activities, the school is now equipped with evacuation procedures, disaster mitigation guidelines, mitigation handbooks, fully stocked emergency first aid kits, traffic cones and flags for crowd control during evacuations and at assembly points, designated evacuation routes, signage for evacuation paths and assembly points, fire extinguishers, and safety-related educational materials. The safety handbooks and guidelines that were developed are presented in Figure 1.



Figure 1. School safety handbook and guide

Disaster-resilient schools require the implementation of an integrated safety management system based on the three pillars of comprehensive school safety: safe school facilities, school disaster management, and disaster risk reduction education. The implementation of these pillars is supported by 23 key indicators, including commitment, policies and regulations, planning, risk assessment, teamwork, coordination, standard operating procedures, safety infrastructure, information systems, assembly points, safe zones, curriculum integration, training, and the presence of trained teachers. These components serve as the foundation for building a safety management system capable of enhancing preparedness and creating a school environment that is safe from various disaster threats (Widowati et al., 2023).

Beyond the provision of safety facilities and procedures, the effectiveness of safety management also depends on the school's ability to implement these procedures through regular training and evacuation drills. Clear evacuation instructions, the competence of teachers and staff in guiding the evacuation process, and the conduct of training and simulations contribute to enhanced emergency response effectiveness by accelerating the evacuation process and improving student safety (Bahmani et al., 2023). Initially, it was evident that students, staff, teachers, and school principals lacked a comprehensive understanding of evacuation procedures and the ideal actions to take during an evacuation. However, following the training and simulation exercises, the school community's preparedness improved; the first student reached the assembly point in under two minutes. This demonstrates a commendable level of responsiveness and an efficient evacuation process.

Training that includes simulation exercises can enhance the disaster preparedness of the school community (Pe et al., 2026). Evacuation drills provide guidance on the actions to be taken during a disaster and foster discipline and rapid response among students during the evacuation process (Rachman et al., 2024). Training that incorporates simulation exercises is an effective method for enhancing preparedness. This preparedness is characterized by strengthened knowledge and skills in disaster response; the ability to implement emergency plans; critical thinking and accurate decision-making; improved emergency communication, coordination, teamwork; and confidence in facing emergency situations (Quinn et al., 2024; Waring et al., 2024).

CONCLUSION

This community service initiative successfully enhanced disaster safety knowledge among the school community by strengthening human resource capacity, safety management, and preparedness in schools located in disaster-prone areas. Capacity building was evidenced by increased knowledge among students, teachers, and principals regarding disaster risk reduction and the implementation of evacuation procedures. Safety management was bolstered through the provision of evacuation protocols, disaster response teams, mitigation guidelines, evacuation routes, assembly points, portable fire extinguishers, disaster preparedness kits (including first aid supplies), and safety-related educational materials. Furthermore, training and evacuation drills improved the school community's preparedness, demonstrated by the students' ability to reach assembly points quickly and efficiently. These results indicate that an educational approach combined with strengthened safety systems and drills is effective in building schools that are better prepared and more resilient against disaster threats. Schools need to regularly conduct disaster education, training, and evacuation drills in partnership with potential collaborators such as universities, NGOs focused on disaster mitigation, government bodies, and village-level disaster risk reduction forums to enhance the preparedness of the entire school community, particularly given the dynamic nature of the student population, with new students enrolling and others graduating each year. Safety management systems including evacuation procedures, disaster response teams, and safety infrastructure must be routinely evaluated and updated based on local disaster risks. Furthermore, collaboration with the Regional Disaster Management Agency (BPBD), relevant government agencies (such as the education, social affairs, and health departments), and healthcare facilities needs to be strengthened to ensure the sustainability of school-based disaster risk reduction programs. Implementing similar programs in other schools located in disaster-prone areas is also recommended to foster a culture of safety and build school resilience.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

CONFLICTING INTEREST STATEMENT

The authors states that there is no conflict of interest in the publication of this article.

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