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# Strengthening Community Disaster Preparedness through the Provision of Flood Emergency Response and Safety Equipment in Pematang Tengah and Paya Perupuk Villages, North Sumatra, Indonesia

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**Abstrak**

Bencana banjir telah meningkatkan kerentanan masyarakat di Desa Pematang Tengah dan Desa Paya Perupuk, Sumatera Utara, Indonesia, sehingga diperlukan penguatan sarana keselamatan dan kesiapsiagaan bencana. Kegiatan pengabdian kepada masyarakat ini bertujuan memberdayakan masyarakat terdampak banjir melalui penyediaan peralatan keselamatan dan tanggap darurat. Metode pelaksanaan menggunakan pendekatan partisipatif yang meliputi identifikasi kebutuhan, koordinasi dengan pemerintah desa, penyediaan peralatan tanggap darurat banjir, dan pelibatan masyarakat. Hasil kegiatan berupa penyediaan dan penyerahan peralatan keselamatan, meliputi perahu karet, pelampung, helm keselamatan, dan tali penyelamatan untuk mendukung respons darurat banjir berbasis masyarakat. Kolaborasi antara tim perguruan tinggi dan pemerintah desa mendukung pelaksanaan program serta memperkuat keterlibatan pemangku kepentingan lokal. Kegiatan ini menghasilkan dukungan sarana dasar kesiapsiagaan bencana dan menegaskan pentingnya kolaborasi kelembagaan serta partisipasi masyarakat sebagai fondasi penguatan ketangguhan masyarakat dalam menghadapi risiko banjir.

**Kata kunci:** ***Pemberdayaan masyarakat; Kesiapsiagaan bencana; Mitigasi banjir; Peralatan tanggap darurat; Ketangguhan masyarakat.***

***Abstract***

*Flood disasters have increased the vulnerability of communities in Pematang Tengah and Paya Perupuk Villages, North Sumatra, Indonesia, highlighting the need for improved safety facilities and disaster preparedness. This community service program aimed to empower flood-affected communities by strengthening their capacity for disaster preparedness through the provision of emergency response and safety equipment. The program employed a participatory approach involving needs assessment, coordination with village authorities, provision of flood emergency equipment, and community engagement. The activities resulted in the provision and handover of safety equipment, including inflatable boats, life jackets, safety helmets, and rescue ropes, to support community-based flood emergency response. Collaboration between the university team and village authorities facilitated the implementation of the program and reinforced local participation. The initiative established essential resources for community-based disaster preparedness,*



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*emphasizing the importance of institutional collaboration and community involvement in strengthening local flood resilience.*
***Keywords* : *Community empowerment; Disaster preparedness; Flood mitigation; Emergency response equipment; Community resilience.***

## Introduction

Flooding remains a persistent threat to residential safety and community welfare in North Sumatra, where repeated inundation disrupts housing conditions and essential public services. Nababan et al. (2024) reported 450 flood incidents across North Sumatra between 2002 and 2019, with 512 victims and 12,630 injuries recorded in the provincial data used in their study. Their investigation of 170 household heads in the Kwala Bekala watershed also identified preparedness among 104 respondents, suggesting that practical readiness cannot be assumed even in communities exposed to recurrent flooding. This regional concern became particularly relevant to Pematang Tengah and Paya Perupuk Villages in Tanjung Pura District following the severe flooding of late 2025. According to the local needs assessment documented by the community service team, floodwater reached approximately 30 centimeters to more than 100 centimeters in affected residential areas. Village records cited in the project report identified 1,078 households in Pematang Tengah and 978 households in Paya Perupuk. Flooding affected residential buildings and disrupted access to sanitation, drainage systems, and electricity, while several families sought refuge in temporary shelters and elevated buildings. These conditions created immediate demands for reliable emergency resources at the village level, particularly where households had limited access to protective equipment and where community response depended heavily on locally available personnel and facilities during the initial stages of an emergency particularly when formal assistance was delayed (Aji et al., 2025).

Disaster preparedness involves more than recognizing hazards because households must also understand emergency procedures and have access to resources that make protective action possible. Hargono et al. (2023) examined disaster awareness and preparedness through an Indonesian online survey involving 400 respondents. Their analysis found that participants with lower disaster awareness were 1.49 times as likely to exhibit lower preparedness as those with higher awareness, with a prevalence ratio of 1.49 and a 95% confidence interval of 1.25–1.76. This association highlights the relevance of public understanding while leaving open the question of whether knowledge can be translated into effective action when safety equipment is unavailable. In flood-prone villages, emergency response may require buoyancy aids, protective helmets, rescue ropes, and inflatable boats for moving through inundated areas or assisting residents at risk. Yet equipment provision alone does not demonstrate that residents can operate these devices safely or coordinate their use under hazardous conditions. The community service needs assessment in Pematang Tengah and Paya Perupuk identified limited access to flood safety equipment alongside gaps in local disaster information and preparedness. Village authorities therefore faced the practical challenge of improving the availability of emergency resources while maintaining arrangements for their storage, oversight, and potential deployment. These operational concerns formed an important part of the intervention context. Such constraints also affect decisions about prioritizing vulnerable residents during sudden inundation events.

Community empowerment in disaster management requires attention to institutional relationships because local preparedness activities depend on how

residents and village authorities participate in decisions about risk reduction. Fathinnisa et al. (2026) examined adaptive capacity and participatory governance in flood preparedness and reported a positive association between adaptive capacity and structural preparedness ($\beta = 0.3930$; $p < 0.0001$). Their analysis also found that the governance dimension of participation was positively related to structural preparedness ($\beta = 0.2499$; $p = 0.0170$), indicating that organizational involvement deserves attention alongside technical interventions. These findings are relevant to community service initiatives that involve universities and village administrations in identifying needs and organizing disaster preparedness resources. In Pematang Tengah and Paya Perupuk, the 2026 community partnership program involved coordination with village officials and the provision of flood emergency response equipment following the late 2025 disaster. The initiative focused on addressing documented limitations in basic safety resources through the handover of equipment intended for community use. Its implementation brought together an academic service team and local government representatives in a process centered on needs identification, resource provision, and institutional coordination. Within this setting, the present article describes the implementation of equipment-based community empowerment and examines the role of local participation in supporting access to essential flood response resources, without presuming measurable changes in operational competence or disaster outcomes across the two villages.

## Implementation Method

### 1. Study Area and Community Needs Assessment

The community service program was conducted in Pematang Tengah and Paya Perupuk Villages, Tanjung Pura District, Langkat Regency, North Sumatra, Indonesia. Both villages are situated within a lowland settlement area influenced by river systems and coastal hydrological conditions. These geographical characteristics contribute to recurrent flooding, particularly during periods of intense rainfall and increased river discharge. The program targeted communities affected by the severe flooding of late 2025, which caused residential inundation and disrupted essential infrastructure. Preliminary information obtained from village authorities indicated that floodwater reached approximately 30 centimeters to more than 100 centimeters in affected settlements. The administrative records identified 1,078 households in Pematang Tengah and 978 households in Paya Perupuk. These conditions provided the geographical and social context for implementing community-based disaster preparedness activities. The initial implementation stage involved coordination with village authorities and identification of community needs through field observations and stakeholder discussions. Coordination activities were documented on May 8, 2026, and involved representatives of the university service team and local government. Discussions focused on flood exposure, existing emergency response resources, and practical limitations affecting community preparedness. Particular attention was given to the availability of personal protective equipment and basic rescue facilities at the village level. Information gathered during these activities was used to identify priority interventions and establish cooperation arrangements with local partners. The assessment emphasized the relationship between community vulnerability and the availability of equipment required for immediate flood response. The location and administrative boundaries of the participating villages are presented in Figure 1.

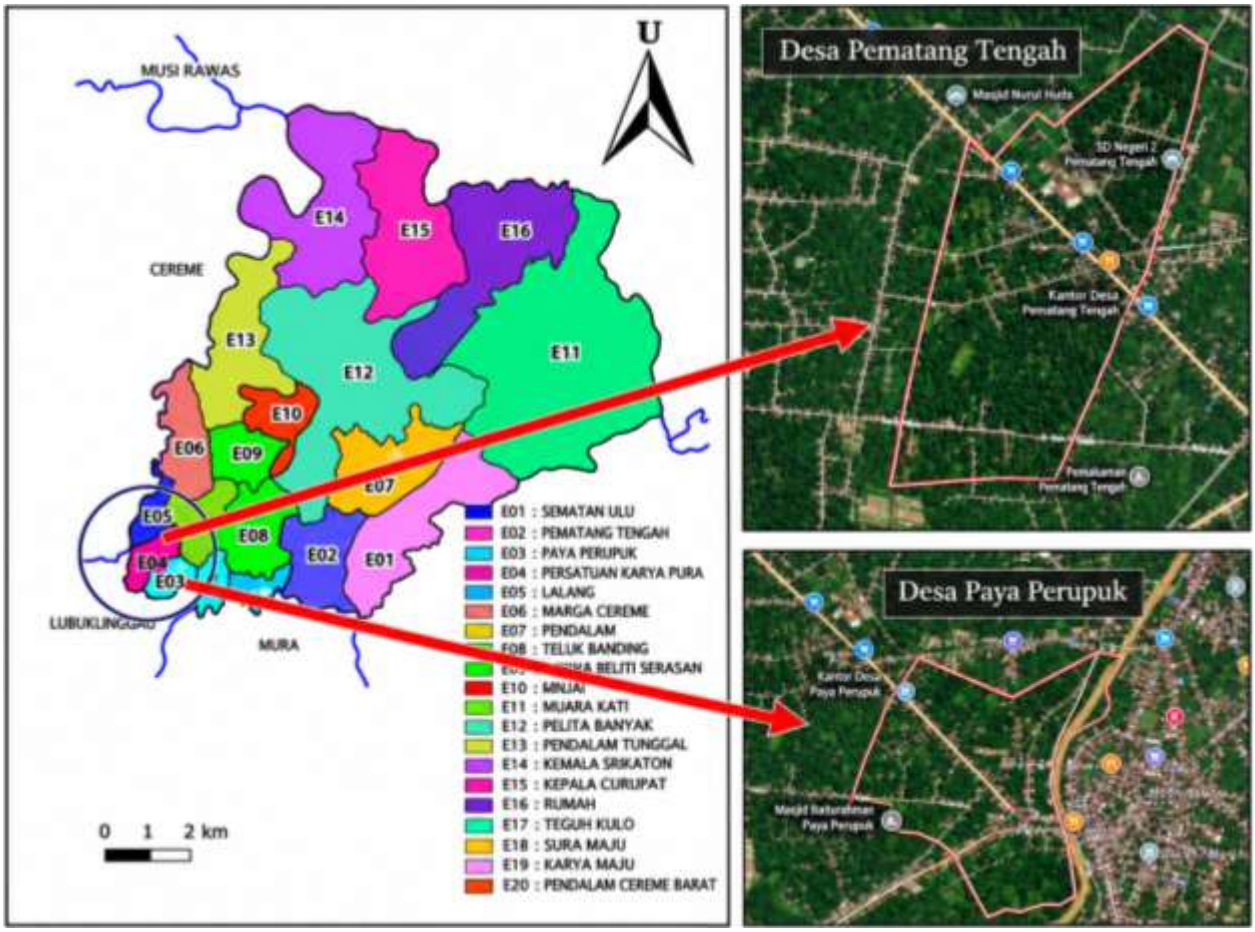



Figure 1. Study Location of Pematang Tengah and Paya Perupuk Villages, North Sumatra

## 2. Community Engagement and Provision of Flood Emergency Response Equipment

The implementation stage focused on community empowerment through collaboration between the university service team and the village governments of Pematang Tengah and Paya Perupuk. The program adopted a participatory approach in which local authorities contributed information about community conditions and supported the identification of priority equipment needs. Village representatives facilitated communication with local stakeholders and coordinated arrangements for implementing the activities. The intervention was designed to address limited access to basic safety facilities and emergency response resources in flood-prone settlements. Equipment provision was integrated into the broader community partnership program that included disaster mitigation education and activities related to residential environmental management. The principal intervention involved procuring and handing over flood emergency response equipment to the participating village authorities. The documented equipment included inflatable boats, life jackets, protective helmets, rescue ropes, and supporting safety supplies. These resources were selected to address practical requirements associated with emergency movement, personal protection, and initial assistance during flooding. The equipment handover was conducted through direct coordination between the implementation team and village representatives. Photographic documentation was collected to establish a record of the resources provided and the participation of local stakeholders. The activity emphasized strengthening the availability of village-level emergency response facilities rather than demonstrating technical proficiency in equipment

operation. Community involvement was reflected primarily through local institutional participation and the coordination of equipment provision. Practical training and technical assistance concerning equipment operation and maintenance were identified as subsequent program components requiring separate implementation records and evaluation evidence to establish their actual completion and effectiveness (Prayogo et al., 2022; Ersa et al., 2026).

### 3. Program Monitoring and Evaluation Framework

The monitoring and evaluation framework was designed to assess the implementation of community empowerment activities and the availability of flood emergency response equipment in both villages. The evaluation distinguished between immediate program outputs and potential improvements in disaster preparedness. Output assessment focused on documenting equipment provision, identifying participating institutions, and examining the alignment between supplied resources and previously identified community needs. The principal documentary sources comprised coordination records, photographic evidence, equipment handover documentation, and available administrative reports. These materials were intended to establish implementation traceability and provide supporting evidence for describing the activities undertaken through the community partnership program. A descriptive evaluation approach was considered appropriate because the available documentation primarily concerned resource provision rather than experimentally measured changes in preparedness. Equipment delivery could be assessed using the Equipment Provision Achievement Rate (EPAR) in Equation (1), comparing delivered units with approved planned equipment quantities. Additional monitoring indicators included the presence of designated equipment custodians, storage arrangements, maintenance procedures, and opportunities for community access during emergencies. These indicators would require field verification before being reported as achieved outcomes. The broader program also planned technical assistance and evaluation of community capability in operating emergency equipment. However, competency improvements should only be assessed when training records and standardized observations become available. Any future assessment could employ practical demonstrations using predefined performance criteria to examine correct equipment operation and adherence to safety procedures.

$$EPAR = \frac{N_d}{N_p}\ x\ 100\% \quad (1)$$

Equation notation: $N_d$ represents the number of equipment units delivered, whereas $N_p$ represents the number of equipment units planned for delivery. EPAR expresses the percentage of planned equipment provision achieved.

## Result and Discussion

### 1. Implementation of Community-Based Flood Disaster Preparedness Activities

The community service program was implemented in Pematang Tengah and Paya Perupuk Villages through institutional coordination and direct engagement with local government representatives. The initial activities involved identifying community needs following the severe flooding experienced in late 2025. Field observations and discussions with village authorities revealed limitations in the availability of emergency response equipment, particularly resources required for personal protection and evacuation assistance. These findings informed the selection of safety equipment and the arrangements for its distribution. The intervention was incorporated into the

broader 2026 community partnership program, which also included educational activities concerning flood-adaptive housing and environmental management. The program documentation recorded two educational sessions involving 30 participants per session, although these participation records cannot establish the number of individuals directly involved in equipment handover activities. The equipment handover activities were conducted through cooperation between the university implementation team and representatives of the two participating villages.



Figure 2. Handover of Flood Emergency Response and Safety Equipment to Village Representatives: (a) Pematang Tengah Village and (b) Paya Perupuk Village

As illustrated in Figure 2, the activities involved direct interaction with local stakeholders and the presentation of emergency response equipment intended for village-level preparedness. This institutional arrangement provided an opportunity to align the provision of resources with locally identified needs. The participation of village representatives was particularly relevant because emergency equipment requires organizational responsibility beyond its initial distribution. Local authorities can contribute to determining equipment storage locations, identifying responsible personnel, and coordinating access during emergencies. However, the available documentation primarily demonstrates institutional engagement and the physical handover of equipment rather than the establishment of fully operational response procedures. The implementation represents a resource-oriented approach to community empowerment in which material support complements existing disaster education activities. Unlike interventions focused exclusively on transferring knowledge, this program addressed the practical limitations associated with insufficient safety equipment. Nevertheless, the provision of emergency resources should be interpreted as an initial preparedness output. Evidence of sustained

community participation, equipment accessibility, and operational readiness would require subsequent monitoring of how the provided resources are managed and used within the participating villages.

## 2. Provision of Safety Equipment and Its Contribution to Village-Level Emergency Response Capacity

The principal tangible output of the community service program was the provision of flood emergency response and safety equipment to Pematang Tengah and Paya Perupuk Villages. The documented resources included inflatable boats, life jackets, protective helmets, rescue ropes, and supporting safety supplies, as presented in Figure 3. These equipment categories serve different functions within emergency response operations and address several practical requirements associated with flooding. Inflatable boats can support controlled transportation across inundated areas when operated by trained personnel under appropriate conditions. Life jackets provide personal flotation support, while protective helmets are intended to reduce exposure to certain head injuries. Rescue ropes may support assisted evacuation activities when deployed with suitable equipment and established rescue procedures. The provision of these resources addressed an equipment-related vulnerability identified during the preliminary needs assessment. Before the intervention, the program documentation described limited access to emergency safety facilities in both villages. The distribution activities subsequently established the presence of several categories of response equipment within the participating village institutions.

As illustrated in Figure 3(b), protective helmets were also equipped with village-specific identification labels distinguishing equipment associated with Pematang Tengah and Paya Perupuk. This identification provides a practical means of recognizing the intended institutional allocation of equipment. Nevertheless, the number of individual units provided, their technical specifications, and their allocation between the villages require confirmation through detailed inventory and handover records. From an operational perspective, the availability of emergency equipment can support the development of local preparedness arrangements by providing physical resources for future response activities. However, equipment availability does not independently establish rescue capability. The effectiveness of these resources depends on appropriate storage, routine inspection, trained operators, and coordination with authorized emergency personnel.




Figure 3. Flood Emergency Response Equipment Provided To Support Community Disaster Preparedness: (a) Inflatable Boat, Life Jackets, Safety Helmets, and Rescue Equipment; (b) Designated Safety Helmets for Pematang Tengah and Paya Perupuk Villages

Inflatable boat operations and rope-assisted rescues are particularly dependent on competent personnel and hazard assessment because inappropriate use during flooding may expose both responders and residents to additional risks. The findings

therefore demonstrate progress in the provision of material preparedness resources rather than verified improvements in operational performance. Their longer-term contribution will depend on whether local institutions establish reliable systems for maintaining equipment functionality and ensuring its safe deployment during future flood emergencies.

### 3. Development of Community Guidelines for the Safe Use of Flood Emergency Equipment

In addition to providing physical resources, the program developed an illustrated guideline intended to support community understanding of basic safety requirements associated with flood emergency response equipment. The educational material was prepared as a visual infographic presenting six instructional components, as illustrated in Figure 4. These components addressed equipment inspection, correct use of life jackets, helmet fastening, inflatable boat safety, rescue rope precautions, and general emergency response procedures. The material also emphasized the importance of prioritizing vulnerable residents and maintaining accessible equipment storage arrangements. The guidelines were designed to translate technical safety considerations into accessible visual information for village communities. The development of this material responded to the need for understandable instructions that could accompany the provision of emergency equipment. Visual communication can help organize essential safety messages and provide a reference for community members with different educational backgrounds. In this program, the infographic incorporated illustrations of equipment similar to the resources supplied to the participating villages. The inclusion of identifiable safety helmets and inflatable boats established a direct connection between the educational material and the physical outputs of the community service activities. This contextual relationship may facilitate recognition of the equipment discussed in the guidelines, although the extent of community understanding has not yet been assessed.

The infographic represents an additional educational output rather than evidence of completed operational training, particularly for residents with limited experience. Its instructional content provides introductory information about safe equipment handling but cannot substitute for supervised practical exercises or competency assessment during potentially hazardous flood conditions. Activities involving inflatable boats and rescue ropes require particular caution because operational decisions depend on water conditions, equipment limitations, the skills of trained personnel, and changing environmental hazard levels. Accordingly, the educational material should be positioned as a supplementary resource for preparedness communication rather than a standalone operational rescue manual during actual flood response operations. The development of village-oriented safety guidance also creates opportunities for further engagement between community members and local emergency management stakeholders through locally coordinated follow-up activities. Future dissemination and practical training could be evaluated using measures such as guideline distribution coverage, participant comprehension, correct identification of safety procedures, and demonstrated equipment-handling competency using standardized instruments across both villages. This process may also help village authorities identify practical barriers to equipment access during future flood emergencies.




Figure 4. Community Guidelines for the Safe Use of Flood Emergency Response and Safety Equipment in Pematang Tengah and Paya Perupuk Villages

## 4. Comparative Assessment of Community Empowerment Outcomes and Implications for Disaster Preparedness

The outcomes of the present community service program can be examined in relation to previous interventions addressing flood preparedness and community

disaster resilience. Table 1 summarizes ten community-based studies reporting activities such as disaster preparedness counseling, evacuation simulation, disaster equipment education, and technology-assisted learning. These studies employed different approaches to strengthening disaster-related knowledge and skills, with several reporting quantitative changes between pre-intervention and post-intervention assessments. The comparison provides an opportunity to distinguish the physical resource outputs of the present program from the educational outcomes commonly measured in previous community service activities. For example, Solikhah et al. (2022) reported an increase in preparedness scores from 50 to 84 among 27 participants, representing an absolute increase of 34 points. Addiarto et al. (2025) documented improvements in disaster literacy scores from 56 to 66 among 50 adolescents, together with an increase in preparedness skills from 54 to 63. Similarly, Purnamasari et al. (2026) reported an increase in understanding from 26.67% to 87.50% following augmented reality-based flood mitigation education, representing a difference of 60.83 percentage points. These findings illustrate the emphasis placed on knowledge acquisition and behavioral preparedness indicators within community-based disaster education programs. However, variations in instruments, scoring systems, and participant characteristics prevent the numerical differences from being interpreted as directly comparable measures of intervention effectiveness.

Table 1. Quantitative Comparison of Flood Disaster Preparedness and Community Empowerment Programs

| Study and intervention | Participants (n) | Pre-intervention score | Post-intervention score | Absolute change | Additional measurable outcomes | References |
|---|---|---|---|---|---|---|
| **Flood safety equipment provision in Pematang Tengah and Paya Perupuk** | 30 per educational session | 55 | 93 | +38 | 2 villages; ≥4 equipment categories documented | Present community service program (2026) |
| **Flood preparedness counseling in Telukan Village** | 27 | 50 | 84 | +34 | Preparedness questionnaire assessment | Solikhah et al. (2022) |
| **TITEER-based community disaster preparedness in Teratak Village** | 20 | NR* | NR* | NR* | 12 youth involved in IoT-based evacuation technology demonstration | Deswinda et al. (2025) |
| **Flood emergency and water rescue training in Marang** | 26 | NR | NR | NR | Wilcoxon test: $p < 0.001$ | Sadek et al. (2024) |
| **Animated video education** | 59 | 13.14 | 14.58 | +1.44 | Wilcoxon test: $p < 0.05$ | Haristiani et al. (2023) |

| Study and intervention | Participants (n) | Pre-intervention score | Post-intervention score | Absolute change | Additional measurable outcomes | References |
|---|---|---|---|---|---|---|
| **and evacuation simulation in Jember** | | | | | | |
| **Disaster Kit training for adolescents** | 50 | 56 | 66 | +10 | Preparedness skills: 54 → 63 (+9) | Addiarto et al. (2025) |
| **Augmented reality-based flood mitigation education** | 30 | 26.67% | 87.50% | +60.83 pp | 95% favorable responses to AR learning | Purnamasari et al. (2026) |
| **Coastal community disaster mitigation training in Loto** | 50 | 14% | 62% | +48 pp | 1 community disaster preparedness group established | Sadik and Somadayo (2026) |
| **PREPARE-BANJIR chatbot education** | 150 | 7.79 | 9.93 | +2.14 | 79.3% module completion; 5 response groups established | Fawzi et al. (2026) |
| **Flood mitigation education for early childhood institutions** | 80 | 56.2 | 84.7 | +28.5 | 35% increase in reported child understanding; 42% increase in teacher confidence | Rachmawaty et al. (2025) |
| **E-book-supported flood preparedness training in Sentani [10]** | 26 | NR | 83.81 | NR | Normalized gain = 0.60; positive perception response = 88% | Wijaya et al. (2026) |

In contrast, the present program emphasized the availability of flood response equipment across two vulnerable villages. Its documented outputs included at least four principal categories of safety and emergency response resources, accompanied by institutional coordination and the development of illustrated safety guidance. The educational components of the broader partnership program involved 30 participants per session, but the available evaluation records do not establish a verified numerical improvement in disaster preparedness attributable to equipment provision. Accordingly, the pre-intervention and post-intervention values should not be used to support claims of effectiveness unless the underlying participant assessment data can be verified. The comparison identifies an important distinction between knowledge-oriented interventions and resource-oriented disaster preparedness activities.

Educational interventions may demonstrate measurable changes in understanding, whereas equipment provision establishes the physical resources required for potential emergency operations. The present program contributes to the latter dimension through the distribution of safety facilities and cooperation with village authorities. Subsequent assessments involving equipment inventory verification, operational training, and practical competency evaluation would allow these material outputs to be examined alongside the preparedness outcomes reported in previous community-based studies.

## Conclusion

The community service program conducted in Pematang Tengah and Paya Perupuk Villages, North Sumatra, Indonesia, addressed the limited availability of flood emergency response resources through the provision of safety equipment and collaboration with local village authorities. The program successfully facilitated the handover of essential equipment, including inflatable boats, life jackets, safety helmets, and rescue ropes, to support community-based flood disaster preparedness. The development of illustrated safety guidelines complemented these activities by providing accessible information on basic equipment handling and emergency safety procedures. Institutional cooperation between the university implementation team and village representatives supported the identification of community needs and the distribution of preparedness resources. The principal contribution of this initiative lies in integrating equipment provision with community-oriented safety education and local institutional engagement. Nevertheless, the available evidence primarily demonstrates the implementation of planned activities and the availability of emergency equipment rather than measurable improvements in operational preparedness. Further monitoring should assess equipment functionality, maintenance arrangements, community accessibility, and practical competencies through structured training and evaluation. Sustained collaboration between academic institutions and village authorities remains important for supporting the effective utilization of emergency resources and strengthening community resilience against recurrent flood.

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