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Evaluating community-based disaster preparedness programs: a case study from Semeru area

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ABSTRACT

Background: Communities residing in high-risk volcanic zones continue to experience uneven disaster preparedness despite formal mitigation programs, highlighting the need for evaluation-oriented engagement. **Objective:** This program aimed to evaluate and strengthen community-based disaster preparedness in villages surrounding Mount Semeru through participatory and reflective approaches. **Method:** A participatory model was implemented involving evaluation activities, refresher training, and sustained mentoring with community members, local institutions, and disaster management stakeholders. **Results:** The program improved residents' preparedness knowledge, evacuation competence, and response confidence, while fostering collective practices such as local drills and peer learning, alongside improved institutional alignment through community-informed evacuation plans. **Implication:** These findings suggest that evaluation-driven and participatory approaches can enhance community ownership and effectiveness of disaster preparedness in high-risk areas. **Novelty:** The program introduces an evaluation-centered, trauma-sensitive model that integrates local knowledge with formal disaster governance as a transferable framework for disaster-prone contexts.

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1. INTRODUCTION

Communities living in high-risk volcanic zones face persistent and compounded vulnerabilities that demand sustained, evidence-based disaster preparedness interventions. Mount Semeru, Indonesia's most active volcano, recorded major eruptive events between 2021 and 2023 that affected more than 50,000 residents in Lumajang Regency, particularly in Candipuro and Pronojiwo districts. Despite the existence of formal preparedness initiatives such as Disaster-Resilient Villages (Desa Tangguh Bencana), post-disaster assessments reveal uneven levels of community readiness. Local rapid surveys indicate that approximately 50–60% of residents in KRB II–III areas remain unable to independently execute evacuation procedures without external instructions. This condition is exacerbated by livelihood dependency on agriculture, proximity to lahar and pyroclastic flow channels, and lingering disaster-related trauma. These realities underscore why this community service program is crucial: preparedness cannot rely solely on infrastructure and early warning systems but must be continuously evaluated and recalibrated through participatory, community-centered mechanisms grounded in lived experience.

Existing literature on community-based disaster risk reduction (CBDRR) emphasizes training, drills, and early warning dissemination as core components of preparedness programs. Studies in Indonesia and other volcanic regions have demonstrated that simulation-based training improves short-term knowledge and awareness among residents [1], [2], [3]. Similarly, community engagement initiatives implemented after major eruptions often focus on capacity-building workshops and evacuation rehearsals [4], [5], [6]. However,

most documented programs emphasize implementation rather than systematic post-program evaluation. Limited attention has been given to participatory evaluation that examines whether knowledge is retained, practices are internalized, and local knowledge is meaningfully integrated into formal disaster governance frameworks. Moreover, few community service studies address the psychosocial dimension of repeated disasters, particularly how trauma influences participation in preparedness activities [7], [8], [9]. These gaps highlight what has not yet been adequately addressed in prior initiatives and form the rationale for this community service program, which positions evaluation not as an endpoint but as a catalyst for adaptive learning and program refinement.

Against this backdrop, this community service program aims to evaluate and strengthen community-based disaster preparedness in high-risk villages surrounding Mount Semeru through a participatory and reflective approach. The primary objective is to identify gaps between existing preparedness programs and actual community knowledge, attitudes, and practices related to evacuation and mitigation. Specifically, this program seeks to answer the following questions: To what extent do residents understand and internalize evacuation standard operating procedures? How do previous disaster experiences shape current preparedness behaviors? What aspects of existing programs require adjustment to better align with local capacities and needs? By combining participatory evaluation tools—such as focus group discussions, community surveys, and preparedness checklists—with targeted refresher training, this community service program addresses preparedness as a dynamic process rather than a one-time intervention. In doing so, it directly responds to the community's expressed need for context-sensitive, evaluative engagement.

The anticipated implications of this community service program extend beyond individual knowledge gains toward collective and institutional transformation. At the individual level, increased comprehension of evacuation and mitigation procedures is expected to enhance residents' confidence and autonomy during emergencies. At the community level, the program fosters a culture of reflection and collective learning, enabling villagers to critically assess and improve their own preparedness practices. Institutionally, evidence-based recommendations generated through participatory evaluation provide local governments and disaster management bodies with actionable insights to strengthen existing programs such as Destana and FPRB. More broadly, this community service program contributes a replicable model of community-based preparedness evaluation that can be adapted to other disaster-prone regions. By embedding evaluation within community engagement, this program repositions preparedness as an iterative, learning-oriented process essential for long-term resilience.

2. METHOD

This community service program was planned using a participatory and context-sensitive approach involving disaster-prone villages in the Mount Semeru KRB II–III area. The planning stage focused on aligning program activities with the roles and capacities of key partners, including village governments, FPRB, Destana volunteers, and BPBD Lumajang. This stage ensured institutional legitimacy and community access while minimizing intervention fatigue. Table 1 presents the comprehensive activity framework developed during planning, detailing objectives, actors, timelines, and outputs. Prior community service studies emphasize that clearly structured planning matrices enhance accountability and implementation coherence in disaster-related engagement programs [10], [11], [12]. Thus, this planning stage established an operational foundation for systematic, evaluative, and adaptive intervention.

Table 1. Planning matrix

Phase	Activity	Stakeholders Involved	Timeframe	Expected Output
Planning	Stakeholder coordination	Village govt., FPRB, BPBD	Week 1	Role agreement
	Baseline needs assessment	Community reps, facilitators	Week 1–2	Needs map
Implementation	Participatory evaluation (FGD, survey)	Residents, facilitators	Week 3	Evaluation data
	Refresher training & simulation	Residents, Destana	Week 4	Improved skills
Evaluation	Monitoring & reporting	All partners	Week 5–6	Policy recommendations

The design of this community service program was guided by participatory action research principles, emphasizing co-planning with community partners. Needs mapping was conducted through preliminary discussions with village leaders and disaster volunteers to identify gaps between existing preparedness

programs and actual community practices. These findings informed the formulation of a flexible implementation strategy combining evaluation, training, and mentoring. Literature on community-based disaster risk reduction highlights that programs grounded in locally identified needs demonstrate higher relevance and sustainability. Accordingly, this planning stage translated contextual insights into a structured yet adaptive program design capable of responding to evolving community dynamics and disaster risks.

This community service program relied on multiple sources of information to ensure data triangulation and contextual accuracy. Primary sources included community participants (30–40 residents per village), local disaster volunteers, and village officials. Facilitators consisted of the community service team with expertise in disaster preparedness and participatory evaluation. Secondary sources included village contingency plans, Destana documentation, BPBD reports, and evacuation SOPs. Previous community engagement literature emphasizes the importance of combining experiential knowledge with formal documents to capture both procedural and lived dimensions of preparedness. This multi-source approach strengthened the analytical depth and credibility of this community service program [13], [14].

The implementation of this community service program followed sequential stages: socialization, participatory evaluation, refresher training, and mentoring. Participatory methods such as focus group discussions, structured surveys, and simulation-based learning were employed to encourage active community involvement. Mentoring was conducted over four to six weeks to support the refinement of local evacuation plans and reinforce learning outcomes. Evidence from disaster education studies suggests that iterative engagement and hands-on simulation are more effective than one-off training sessions. Consequently, this implementation process positioned community members not merely as beneficiaries but as co-actors in preparedness strengthening [15], [16].

Evaluation in this community service program was conducted through formative and summative stages to measure both process and outcome effectiveness. Pre- and post-assessments were used to quantify changes in knowledge and preparedness levels, while qualitative reflections from FGDs captured shifts in attitudes and confidence. Monitoring focused on the application of evacuation plans during simulations and routine community activities. Community service literature increasingly advocates mixed-method evaluation to capture complex behavioral change in disaster contexts. Therefore, this evaluation stage provided an evidence-based foundation for recommendations aimed at improving local preparedness programs and informing future community-based interventions [17], [18], [19].

3. RESULTS

3.1. Planning: participatory mapping and program readiness

This section presents the planning outcomes of this community service program, focusing on participatory readiness assessment prior to implementation. This stage was designed to ensure contextual alignment between program objectives, community needs, and institutional capacities. As shown in Table 2, planning emphasized systematic stakeholder coordination, baseline mapping of community preparedness, and the development of evaluation instruments grounded in local realities. By combining administrative data, community surveys, and focus group discussions, this community service program established a robust evidence base to guide subsequent interventions. The planning results reveal not only the structural readiness of partners and communities but also critical gaps in knowledge continuity, local knowledge integration, and trauma-sensitive engagement. These findings provide a strategic foundation for adaptive implementation and outcome-oriented evaluation.

Table 2. Comprehensive planning outcomes

Dimension	Input/Data	Process	Output	Outcome	Note
Stakeholder	Partners	Meetings	5 inst.	Collaboration	Clarify roles
Coverage	Villages	Registry	2 (KRB II–III)	Relevance	High risk
Mapping	Participants	Records	86	Targeting	HH focus
Exposure	Training exp.	Survey	62%	Gap	Refresh needed
Knowledge	SOP awareness	Survey	48%	Low readiness	Eval needed
Local	Warning signs	FGD	Identified	Untapped	Integrate
Docs	Plans	Review	2 plans	Outdated	Update
Trauma	Drill reluctance	FGD	~30%	Fatigue	Adaptive
Instrument	Tools	Output	4 tools	Ready	Validated
Time	Schedule	Analysis	6 wks	Feasible	Sustainable

Table 2 demonstrates that this community service program engaged five key institutional partners, ensuring multi-level coordination from village to district authorities. A total of 86 potential participants were mapped across two high-risk villages, with 62% reporting prior exposure to disaster preparedness activities. However, only 48% demonstrated adequate understanding of evacuation standard operating procedures during baseline assessment. Document analysis identified two existing contingency plans, both requiring revision to reflect post-2021 eruption dynamics. Approximately 30% of residents expressed reluctance to participate in repeated drills, indicating psychosocial fatigue. Four evaluation instruments were developed and validated collaboratively, covering surveys, FGD guides, and preparedness checklists. The overall planning timeline of six weeks was assessed as feasible for staged implementation and mentoring. These quantitative indicators illustrate both readiness assets and structural gaps addressed by this community service program.

The planning results of this community service program underscore the importance of evaluation-oriented preparedness in disaster-prone communities. While institutional presence and prior training coverage appear substantial, the limited procedural comprehension among residents confirms findings in disaster risk reduction literature that exposure does not guarantee internalization. The identified gap between formal SOPs and locally practiced warning cues highlights a structural disconnect between technocratic preparedness systems and community knowledge ecosystems. Furthermore, the presence of disaster fatigue reinforces the need for trauma-informed and adaptive engagement strategies. From an applied perspective, these planning outcomes validate the decision to position evaluation as a central intervention rather than a post hoc activity. Theoretically, this planning phase operationalizes participatory action research by transforming communities from program recipients into evaluative actors [20], [21]. Consequently, this community service program establishes a scalable planning model that prioritizes readiness diagnosis as a prerequisite for sustainable disaster preparedness.

3.2. Implementation: participatory execution and capacity strengthening

This section presents the implementation outcomes of this community service program, emphasizing participatory execution and community capacity strengthening. This phase translated planning assumptions into concrete actions through structured evaluation, refresher training, and sustained mentoring. As shown in Table 3, implementation was intentionally designed to be iterative and adaptive, allowing facilitators to respond to community feedback, emotional dynamics, and contextual constraints. By embedding evaluation activities within training and simulation, this community service program ensured that learning processes were directly informed by empirical findings rather than generic preparedness models. The results demonstrate how participatory implementation not only enhanced individual competencies but also activated collective engagement, positioning communities as active agents in disaster preparedness rather than passive recipients of instruction.

Table 3. Implementation outcomes

Dimension	Input/Data	Process	Output	Outcome	Note
Participation	Attendance	Socialization/FGD	68	Engagement	Balanced
Completion	Sessions	Program log	100%	Fidelity	Consistent
Evaluation	FGDs	Participatory	4	Data	Rich
Response	Survey	Questionnaire	91%	Reliability	Minimal gap
Knowledge	Test score	Pre–post	+28%	Cognitive	Clear
Skills	SOP demo	Simulation	74%	Skill	Confident
Local	Warning signs	Training	Integrated	Relevance	High
Mentoring	Duration	Monitoring	5 wks	Practice	Reinforced
Initiative	Local drills	Observation	2	Ownership	Emerging
Adaptation	Method change	Reflection	6	Inclusion	Sensitive

Table 3 shows that this community service program engaged 68 participants across two villages, exceeding the minimum target of 60 residents. All planned sessions were successfully implemented, resulting in full program completion. Four focus group discussions generated comprehensive qualitative insights, while survey instruments achieved a 91% response rate, indicating strong participant commitment. Quantitative assessment revealed an average 28% increase in preparedness knowledge scores between pre- and post-tests. During evacuation simulations, 74% of participants were able to correctly demonstrate standard operating procedures, compared to less than half at baseline. Mentoring activities were conducted continuously over five weeks, reinforcing procedural learning. Notably, two resident-initiated informal drills emerged during implementation, signaling early signs of autonomous preparedness behavior fostered by this community service program.

The implementation results of this community service program highlight the effectiveness of participatory and adaptive engagement in strengthening disaster preparedness. The substantial increase in knowledge and procedural competence supports experiential learning theory, which emphasizes learning through reflection and practice rather than instruction alone. The integration of local warning signs into formal SOP training reduced cognitive distance between institutional frameworks and community experience, enhancing relevance and acceptance. Furthermore, the emergence of resident-led drills reflects a shift from compliance-based participation toward ownership-driven preparedness. From a theoretical standpoint, this implementation phase operationalizes community-based disaster risk reduction by embedding agency within practice. Applied implications suggest that sustained mentoring and trauma-sensitive facilitation are critical in post-disaster contexts [19], [22]. Consequently, this community service program demonstrates that effective implementation depends not only on technical content but also on relational and contextual responsiveness.

3.3. Monitoring and evaluation: measuring impact and program effectiveness

This section presents the monitoring and evaluation outcomes of this community service program, focusing on measurable changes in community preparedness and program effectiveness. Monitoring was conducted continuously throughout implementation, while evaluation was carried out using mixed quantitative and qualitative methods at the end of the program cycle. This phase aimed to assess whether planned interventions translated into meaningful improvements in knowledge, skills, confidence, and collective practices. By integrating pre–post measurements, observational data, and reflective feedback, this community service program positioned evaluation as an integral learning mechanism rather than a procedural requirement. As shown in Table 4, the results offer empirical evidence of impact at individual, community, and institutional levels, providing a solid basis for reflection, accountability, and future program refinement.

Table 4. Monitoring and evaluation outcomes

Dimension	Input/Data	Process	Output	Outcome	Note
Knowledge	Test score	Pre–post	52→80	+28%	Strong gain
Skills	SOP demo	Simulation	46→76%	+30%	Ready
Awareness	Hazard ID	Survey	58→83%	+25%	Improved
Literacy	Info source	Survey	61→85%	+24%	Reduced bias
Confidence	Self-report	Likert	2.9→4.1	+1.2	Prepared
Continuity	Attendance	Log	—→88%	Sustained	Stable
Practice	Local drills	Observation	0–1→2–3	↑	Routine
Institution	Evac plan	Review	Old→Revised	Updated	Linked
Feedback	Inputs	Reflection	—→12	Adopted	Responsive
Scalability	Transfer	Expert	—→High	Ready	Scalable

Table 4 figures out that this community service program achieved a significant increase in preparedness knowledge, with average test scores rising from 52 to 80 out of 100. Procedural competence during evacuation simulations improved from 46% to 76%, reflecting a 30% gain in operational readiness. Risk awareness related to hazard zones increased by 25%, while understanding of formal warning systems rose by 24%. Participants' self-reported confidence in evacuation improved from an average of 2.9 to 4.1 on a five-point scale. Attendance consistency reached 88% across activities, indicating sustained engagement. Community-level practices also evolved, with local drills increasing from sporadic occurrences to two or three routine practices within the monitoring period. Institutional documents were revised, aligning local plans with current risk conditions.

The monitoring and evaluation results of this community service program demonstrate that preparedness improvements are most effective when evaluation is embedded within participatory practice. The marked gains in knowledge and procedural competence affirm constructivist and experiential learning theories, which emphasize learning through active engagement and repetition. Increased confidence and routine drills indicate a transition from reactive preparedness toward anticipatory behavior, a key objective in community-based disaster risk reduction. The integration of community feedback into revised evacuation plans highlights the value of reflective governance, where local knowledge informs institutional frameworks. From an applied perspective, these results suggest that continuous monitoring and trauma-sensitive facilitation are essential in sustaining engagement in post-disaster contexts [23], [24], [25]. Consequently, this community service program offers a validated evaluative model that strengthens preparedness while generating transferable insights for disaster-prone communities elsewhere.

4. DISCUSSION

This community service program demonstrates significant practical and social implications for disaster preparedness in volcanic risk zones, particularly in strengthening community autonomy and responsiveness. One notable achievement lies in the increased capacity of residents to understand and enact evacuation procedures independently, reducing reliance on external authorities during emergencies. Socially, this shift enhances collective confidence and mitigates panic-driven behavior that often characterizes disaster response in high-risk rural communities. At the same time, the program revealed functional limitations, including uneven baseline knowledge and lingering disaster fatigue among certain groups. These findings underscore that preparedness is not merely a technical matter but a socially embedded process shaped by memory, trauma, and trust. The practical implication is clear: preparedness initiatives that foreground community reflection and evaluation can recalibrate existing programs to better align with lived realities [5], [15]. Thus, this community service program functions both as a capacity-building intervention and as a corrective mechanism for standardized preparedness models.

The underlying mechanisms shaping these outcomes can be traced to the structural design of this community service program, which positioned evaluation as a central rather than peripheral activity. By initiating engagement through participatory diagnosis, the program disrupted the conventional top-down flow of disaster education. This structure allowed facilitators and community members to jointly identify discrepancies between formal procedures and actual practices, fostering mutual accountability. Literature on community-based disaster risk reduction emphasizes that ownership emerges when communities are involved in defining problems rather than merely receiving solutions. Additionally, the program's flexible pacing and trauma-sensitive facilitation mitigated resistance rooted in prior disaster experiences. These mechanisms explain why engagement levels remained high despite initial reluctance among some residents [6], [12]. In this sense, the structural coherence between planning, evaluation, and action enabled this community service program to convert procedural compliance into reflective preparedness.

Beyond individual learning outcomes, this community service program generated broader social implications by reinforcing collective learning and informal governance practices at the village level. The emergence of resident-initiated drills and peer-to-peer knowledge sharing indicates a shift toward self-organized preparedness. Such practices contribute to social cohesion by redefining disaster response as a shared responsibility rather than an externally imposed obligation. However, the program also surfaced disfunctions, including disparities in participation across age and gender groups, suggesting that social inclusion remains an ongoing challenge. These mixed outcomes highlight that community empowerment is inherently uneven and requires continuous negotiation. Practically, the program demonstrates that preparedness interventions can serve as platforms for rebuilding trust and solidarity in post-disaster contexts [1], [7]. Consequently, this community service program extends its impact beyond technical readiness, embedding preparedness within everyday social relations.

The patterns underlying these collective outcomes are closely linked to the relational mechanisms embedded in this community service program. Sustained mentoring and repeated interaction created spaces for dialogue that transcended formal training sessions. This relational intensity enabled facilitators to adapt methods in response to community feedback, reinforcing relevance and emotional safety. The integration of local warning signs and experiential narratives into training content further bridged the gap between institutional knowledge and community memory. Empirical studies in disaster education suggest that such hybrid knowledge systems enhance retention and legitimacy. At the same time, the reliance on community volunteers as intermediaries strengthened horizontal communication networks [3], [9]. These structural features explain why collective practices persisted beyond scheduled activities, indicating that this community service program activated social infrastructure as much as technical capacity.

At the institutional level, this community service program produced meaningful implications for local disaster governance by generating evidence-based recommendations grounded in community evaluation. Revised evacuation plans and updated preparedness documents reflect a closer alignment between policy instruments and actual risk conditions. Socially, this alignment enhances the legitimacy of local institutions in the eyes of residents, potentially improving compliance during future emergencies. Nevertheless, the program also exposed institutional constraints, including limited resources for continuous training and dependence on project-based initiatives. These tensions illustrate the dual function of the program as both an enabler and a diagnostic tool [10], [13]. Practically, this community service program demonstrates how community engagement can inform adaptive governance, ensuring that preparedness policies evolve alongside environmental and social change.

The mechanisms driving institutional change within this community service program are rooted in its evaluative orientation and multi-actor collaboration. By systematically documenting community feedback and behavioral change, the program translated experiential knowledge into actionable policy insights. This process aligns with theories of reflexive governance, which emphasize learning through iterative feedback loops. The involvement of multiple stakeholders—from village authorities to disaster agencies—facilitated

cross-scale knowledge transfer and shared responsibility. However, sustaining these mechanisms requires institutional commitment beyond the program lifecycle. The findings suggest that when evaluation is embedded within community engagement, it can function as a governance innovation rather than a bureaucratic obligation [3], [5]. Therefore, this community service program offers a transferable model for integrating community evaluation into disaster preparedness systems, reinforcing resilience through learning-oriented practice rather than episodic intervention.

5. CONCLUSION

This community service program demonstrates that disaster preparedness in high-risk volcanic areas is most effective when evaluation is positioned as a core intervention rather than a post-activity requirement. The key lesson emerging from this program is that community preparedness improves not merely through repeated training, but through reflective, participatory diagnosis that aligns formal procedures with lived experience. The strengths of this program lie in its integration of participatory evaluation, trauma-sensitive facilitation, and sustained mentoring, which collectively enhanced knowledge retention, procedural competence, and community ownership. By embedding learning within practice, this community service program contributes an updated model of community engagement that reframes preparedness as an iterative and socially embedded process, advancing both the practice and methodology of community-based disaster empowerment.

Despite these achievements, this community service program faced several limitations. The intervention was constrained by a relatively short implementation period and limited coverage across demographic subgroups, particularly older residents and those experiencing prolonged disaster fatigue. Additionally, institutional capacity for long-term follow-up remains uneven, potentially affecting sustainability. These limitations indicate the need for continued engagement through longitudinal mentoring, integration with routine village governance, and expanded inclusion strategies. Future community service initiatives should prioritize multi-cycle evaluation, intergenerational participation, and stronger institutional embedding to ensure that preparedness gains are maintained and adapted over time.

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AUTHOR CONTRIBUTIONS STATEMENT

Wafiqotul Jamilah: conceptualization (lead), community evaluation (lead), field investigation (lead), writing – original draft (lead), writing – review and editing (lead).

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This manuscript related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

DATA AVAILABILITY

Data availability is not applicable to this article as no new data were created or analyzed in this study.

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