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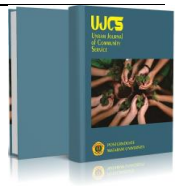

Disaster Mitigation Management to Reduce Social, Economic, and Health Risks and to Strengthen Community Resilience in Sibalanga Village, North Tapanuli Regency, North Sumatera

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Abstract: Sibalanga Village in Adiankoting District, North Tapanuli Regency, was among the areas most severely affected by a series of floods and landslides in late November 2025, which damaged settlements, agricultural land, and basic infrastructure while disrupting local economic activities. Most residents rely on cocoa, petai, and durian as their main commodities; therefore, plantation damage and post-disaster distribution disruptions significantly reduced household income and increased socio-economic and health vulnerabilities. This community engagement program, conducted under the *Program Mahasiswa Berdampak*, aimed to implement community-based disaster mitigation to reduce social, economic, and health risks while strengthening community resilience. A participatory approach was employed through environmental clean-up activities, tree planting, production of solid organic fertilizer, children's trauma healing, cocoa processing training under the "TapaRes Kakao (Tapanuli Cocoa Resilience)" initiative, and the provision of appropriate technology tools to local partners, including LDPH and the PKK of Sibalanga Village. The program improved community understanding of flood and landslide mitigation, encouraged small-scale cocoa processing initiatives, strengthened local institutional networks, and fostered social recovery and resilience after the disaster. These findings indicate that integrating disaster mitigation, environmental management, and cocoa-based agro-industry innovation can serve as a model for empowering disaster-prone rural communities while supporting the achievement of SDG 8 and SDG 12.

Keywords: Appropriate Technology, Cocoa, Community Resilience, Disaster Mitigation, Sibalanga Village.

Introduction

Sibalanga Village, located in Adiankoting District, North Tapanuli Regency, North Sumatera, was among the areas most severely affected by a series of floods and landslides in late November 2025. The disaster caused significant damage to residential areas, agricultural land, and basic infrastructure such as bridges and main road access, thereby disrupting community mobility and economic activities. Most residents of Sibalanga Village rely on the agricultural sector, particularly cocoa, petai, and durian commodities. Consequently, plantation damage and disrupted distribution channels following the disaster directly reduced household income, increased socio-economic vulnerability, and threatened the stability of local food security (Djalante et al., 2020).

From a geomorphological perspective, North Tapanuli Regency, particularly Adiankoting District, is characterized by hilly terrain with steep slopes and a history of recurrent landslides. This condition places Sibalanga Village in a high landslide-risk area. A regional hazard assessment indicates a substantial proportion of land classified as "very high risk,"

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influenced by hilly topography, high rainfall intensity, and relatively uncontrolled land-use patterns. According to Sianturi (2023), a landslide vulnerability assessment in North Tapanuli Regency shows that the region faces significant risk: approximately 77.78% (±2,950.75 km²) is categorized as moderately vulnerable, 5.05% (±191.58 km²) as highly vulnerable, and only 17.17% (±651.38 km²) as non-vulnerable, out of a total area of approximately ±3,800.31 km² (3,793.71 km² of land and 6.60 km² of the waters of Lake Toba). These conditions highlight the importance of designing recovery and community empowerment initiatives in Sibalanga Village as part of a long-term disaster mitigation strategy rather than merely short-term emergency assistance (Djalante et al., 2020).

On the other hand, the community of Sibalanga Village possesses significant potential in agricultural commodities such as cocoa, petai, and durian, supported by a strong cultivation tradition. However, post-harvest management remains largely limited to the sale of raw products without value-added processing, resulting in weak bargaining power for farmers within the value chain. Regional disaster data indicate that both before and after the disaster, university interventions in the area were relatively limited and mostly focused on logistical assistance and general awareness programs. Capacity-building initiatives related to appropriate technology and economic diversification based on local commodities have not yet been implemented optimally or documented as sustainable empowerment models. As a result, the economic recovery of local residents has progressed slowly and remains dependent on short-term aid.

In this context, the *Program Mahasiswa Berdampak* implemented by the Management Study Program, Faculty of Economics, Universitas Sisingamangaraja XII Tapanuli, was designed to address the urgent need for post-disaster recovery while also strengthening long-term community resilience. Research by Aldrich and Meyer (2019) in Gunung Nago, Padang demonstrates that integrating psychosocial recovery with post-flood legal assistance effectively enhances community understanding, awareness of legal rights, self-confidence, social resilience, and empowerment. These findings emphasize the importance of holistic post-disaster management. Accordingly, the *Program Mahasiswa Berdampak* integrates disaster mitigation management, environmental restoration, psychosocial recovery, and economic empowerment through the development of appropriate technology for cocoa processing known as "TapaRes Kakao (Tapanuli Cocoa Resilience)." This approach aligns with the objectives of United Nations Sustainable Development Goals, particularly SDG 8 and SDG 12, while also supporting the development agenda of disaster-resilient villages and strengthening commodity-based local economies.

This article aims to comprehensively describe the implementation of the *Program Mahasiswa Berdampak* in Sibalanga Village, including the disaster context, program design, field implementation, achieved outcomes, and its implications for strengthening the resilience of communities in disaster-prone rural areas.

Method

This community engagement activity employed a participatory and qualitative descriptive approach. The program was conducted in Sibalanga Village, Adiankoting District, North Tapanuli Regency, targeting disaster-affected residents, cocoa farmer groups, the Village Forest Management Institution (LDPH), and the PKK women's organization of Sibalanga Village. The program was implemented over a period of 23 days, followed by the distribution of appropriate technology equipment on the 24th day.

Data were collected through several techniques. First, participatory observation was conducted as students were directly involved in community activities such as environmental clean-up, tree planting, and assistance in cocoa production processes. Second, informal interviews and small-group discussions were carried out with village officials, LDPH administrators, PKK members, and affected residents to explore disaster experiences and community recovery needs. Third, documentation was gathered in the form of activity photographs, field notes, and secondary data obtained from village administration records and regional disaster reports.

The program design was structured into three main clusters: (1) strengthening disaster mitigation and environmental management, (2) psychosocial recovery for children, and (3) economic empowerment through the application of appropriate technology in cocoa processing.

Data analysis was conducted using descriptive qualitative analysis by synthesizing field findings into several key themes, including changes in community mitigation behavior, strengthening of local economic capacity, and the dynamics of social resilience.

Result and Discussion

Strengthening Disaster Mitigation and Environmental Management

The initial activities focused on environmental recovery and raising awareness of disaster mitigation. Students and local residents worked together in community clean-up activities (gotong royong) to restore the surrounding environment, including cleaning residential areas, drainage

channels, and locations identified as landslide-prone points. These activities were combined with basic educational sessions emphasizing the importance of maintaining slope-supporting vegetation and proper waste management to reduce the risk of floods and landslides.

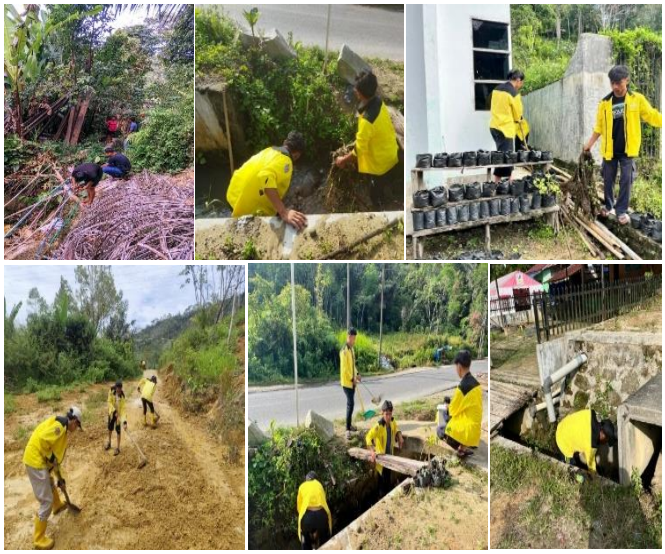

Figure 1. Community Clean-Up Activities Conducted by Students and Residents, Including the Cleaning of Residential Areas, Drainage Channels, and Landslide-Prone Locations in Sibalanga Village

Figure 2. Educational Session for Students of SMP Negeri 2 Adiankoting on the Importance of Maintaining Slope-Supporting Vegetation and Proper Waste Management to Reduce the Risk of Floods and Landslides

In addition, tree planting activities were carried out on community land and areas that potentially function as slope buffer zones. The planted species included durian, cocoa, and cinnamon trees. The selection of these commodities combines ecological functions such as land rehabilitation and erosion control with medium and long-term economic benefits for farming households.

Figure 3. Tree Planting of Durian, Cocoa, and Cinnamon on Community Land and Potential Slope Buffer Areas as Part of Environmental Rehabilitation and Disaster Mitigation Efforts

Students also trained residents to produce solid organic fertilizer (SOF) using locally available materials. This initiative not only supports soil fertility but also reduces farmers' dependence on chemical fertilizers while encouraging environmentally sustainable agricultural practices.

Psychosocial Recovery for Children

Disasters not only damage physical infrastructure but also affect the psychological well-being of residents, particularly children. Therefore, the program included trauma healing activities for children from early childhood education centers and elementary schools in Sibalanga Village. Through educational games, creative activities, and warm interpersonal interactions, students aimed to restore children's sense of safety and enthusiasm for learning.

Small gifts in the form of notebooks and pens were distributed to the children as symbols of encouragement to continue their education. Parents perceived this activity as an important form of moral support during the difficult post-disaster situation.

Figure 4. Distribution of Notebooks and Pens to Children as Part of the Trauma Healing Program to Motivate Learning After The Disaster

These activities highlight that comprehensive disaster mitigation efforts should incorporate psychosocial dimensions, particularly for vulnerable groups, in order to strengthen long-term community resilience.

Economic Empowerment through "TapaRes Kakao"

The core innovation of the program lies in the development of appropriate technology for cocoa processing and the strengthening of the village-scale agro-industrial value chain. Through a series of training sessions, community members were introduced to the process of transforming raw cocoa beans into value-added products, specifically chocolate bars marketed under the brand "TapaRes Kakao (Tapanuli Cocoa Resilience)" (Marshner et al., 2025).

To ensure program sustainability, the team, in collaboration with the Ministry of Higher Education, Science, and Technology through the BIMA scheme, provided appropriate technology equipment consisting of a cocoa peeling machine, roasting machine, and cocoa grinding machine.

These tools were officially handed over to two local institutional partners: the Village Forest Management Institution (LDPH) of Sibalanga Village, chaired by Pernando Aritonang, and the PKK organization of Sibalanga Village, chaired by Maria A.S. Lumbantobing. The handover ceremony was witnessed by the Village Secretary, Daniel Hutabarat, on March 2, 2026.

Figure 5. Handover of Appropriate Technology Equipment for Cocoa Processing Including Cocoa Peeling, Roasting, and Grinding Machines to Local Institutional Partners, Namely The Village Forest Management Institution (Ldph) of Sibalanga Village and The Pkk of Sibalanga Village, Witnessed by Village Officials and The Program Implementation Team

Strengthening local institutions is crucial to ensure that cocoa processing initiatives are not carried out individually but are organized within village-level institutions that have the potential to develop into cooperatives or joint business units. In this way, appropriate technology not only improves production efficiency and product quality but also functions as an instrument for mitigating economic risks, as farmers are no longer entirely dependent on the sale of raw cocoa beans.

Furthermore, the "TapaRes Kakao" innovation aligns with the principles of sustainable production and consumption by encouraging the utilization of cocoa pod waste as organic compost and opening opportunities for the future adoption of renewable energy in the processing stages.

Conclusion

The *Program Mahasiswa Berdampak* titled "Disaster Mitigation Management to Reduce Social, Economic, and Health Risks and Strengthen Community Resilience in Sibalanga Village" demonstrates that integrating environmental mitigation activities, psychosocial recovery, and economic innovation based on appropriate technology can effectively strengthen the resilience of communities in disaster-prone villages. Community clean-up activities, tree planting, and the production of organic fertilizer increased public awareness of environmental management as an important component of flood and landslide mitigation. Trauma healing activities for children and simple educational support also contributed to the psychosocial recovery of affected families. Meanwhile, the development of the "TapaRes Kakao" initiative and the handover of cocoa processing equipment to the Village Forest Management Institution (LDPH) and the PKK of Sibalanga Village have created opportunities for establishing a village-scale cocoa agro-industry that enhances product value, household income, and local economic resilience.

In the future, continued assistance will be necessary to strengthen institutional capacity, expand marketing networks, and integrate this program into village development planning documents and regional policies on disaster-resilient villages. This model has the potential to be replicated in other disaster-prone villages that possess similar local commodity advantages.

Acknowledgments

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