

Disaster Management and Landslide Risk Reduction Strategies in The Gebog Sub-District of Kudus Regency, Central Java, Indonesia

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Abstract

Historically, the Kudus Regency in Central Java Province, Indonesia, has been prone to landslides. This study was conducted in the Gebog Sub-District of Kudus Regency, Central Java, Indonesia. The objectives of this study are: (1) to analyze the level of landslide disaster risk in the Gebog Sub-District, (2) to assess the current community-based landslide risk management activities undertaken by the local population in the Gebog Sub-District and (3) to formulate community-based landslide risk reduction management strategies to mitigate landslide risk. Variables for the level of landslide disaster risk include landslide hazards/threats, vulnerability to landslide hazards and community capacity to deal with landslides. Variables related to the management of landslide risk studied encompass pre-disaster, during-disaster and post-disaster activities by the community.

Meanwhile, the variables for community-based landslide risk reduction management strategies include threat reduction, vulnerability reduction and enhancing community capacity before, during and after a landslide disaster. The research design is based on field surveys with 99 individuals as research subjects and 33 field units as samples. Data was collected through questionnaires and interviews and analysis was conducted using scoring and ranking. The research findings indicate that the current community-based landslide risk management activities are still low. From the research and focus group discussions, new strategies for community-based landslide risk reduction management were identified to reduce landslide risk.

Keywords: Landslide risk reduction management, Kudus, Central Java.

Introduction

Data from the BPBD of Kudus Regency in 2020³ provided details of landslides in Kambangan Hamlet, Menawan Village with 12 casualties and 7 houses were severely damaged (collapsed). In February 2019, a 12-meter-high cliff with a length of 10 meters fell on the road body, as a result of which the avalanche material as thick as 4 meters

blocked road access, resulting in 115 households being isolated for several days. In addition to this data, on March 1, 2020 at 13.00, there was an avalanche in Rahtawu Village that resulted in 9 houses being severely damaged. The data shows that the increase in landslide incidents is always followed by an increase in losses in the form of both casualties and property.

According to law no. 24 of 2007 on disaster management²³, a disaster is an event or series of events that threaten and disrupt the lives and livelihoods of communities. These events can be caused by natural factors, non-natural factors, or human factors, resulting in environmental damage, property loss and psychological impact.

Landslides are a process of mass movement of soil or rocks in a sloping direction, separating from the stable mass due to the influence of gravity. The movements can be rotational or translational²⁰. Landslides are mass movement involving soil or rocks, or a mixture of both, that move outward or downward on a slope due to destabilization of the composing soil or rocks⁹. There are potential mechanisms for mobilizing and spreading pollutants⁷. Landslides can occur in various locations with differing slopes, requiring significant government expenditure on investigation, design and implementation of mitigation and prevention measures to reduce the likelihood of loss of life and economic damage¹³.

Based on these definitions, landslides in this study are defined as a type of mass movement with either sliding or rotational motion. The moving material may consist of dislodged debris, soil and rocks driven by gravitational forces. They are distinguished from other groups by their movement and lower water content. Different types of landslide threats are influenced by various combinations of environmental and triggering factors⁵.

Disaster risk involves determining and managing three risk components. Efforts to minimize risk are made by (1) reducing the threat, (2) decreasing vulnerability and (3) increasing the capacity of the threatened area. The National Disaster Management Agency (BNPB) has created guidelines for disaster risk mitigation planning as set out in BNPB regulation no. 2 of 2012¹⁹.

The definitions for these terms are as follows: (1) Disaster threat refers to the geological, biological, hydrological,

climatological, geographical, social, cultural, political, economic and technological conditions or characteristics in a specific area over a set period that reduces the ability to prevent, mitigate, prepare for and respond to particular hazards; (2) Vulnerability is a condition within a community that leads to an inability to face disaster threats; (3) Capacity is the ability of an area and its community to take actions that reduce the level of threat and losses from disasters; (4) Risk is the potential for losses due to disasters in a particular area over a specific period which may include death, injuries, illness, threatened lives, loss of a sense of security, displacement, property damage and disruption of community activities¹⁵.

Management of Disaster Risk Reduction: Institutional reinforcement which involves the Government, communities and private sector, is a key factor in disaster risk management. Communities play a significant role in disaster prevention. According to law no. 24 of 2007, disaster prevention is a series of activities aimed at reducing or eliminating disaster risks, either by decreasing the threat or the vulnerability of the affected parties². Communities and Governments need to realize the importance of renewing disaster preparedness and improving their disaster management capabilities⁶. Appropriate measures in risk reduction are urgently needed to save more lives¹¹.

Disaster risk is related to the human capacity to face disasters. Effective disaster management can reduce or minimize risks, thus preventing significant losses due to disasters. Hence, the community's role in managing disaster risks in vulnerable areas must be studied for further risk reduction⁴.

Many studies focus on landslide hazards. However, most existing research primarily examines various factors causing landslides as an effort in landslide hazard mitigation^{12,24}. In landslide research, very few studies concentrate on community-led disaster risk reduction. Considering that communities are the most affected when disasters occur^{1,17}, this study aims to further explore community-led disaster management and risk reduction as a means to minimize losses due to landslides.

Material and Methods

This study was conducted in the Gebog Sub-district, Kudus Regency, Central Java Province. This place was chosen because landslides frequently occur there, particularly in Menawan and Rahtawu villages, triggering material and human loss. The materials used include soil (soil samples) and rocks analyzed in a soil laboratory. The equipment used in this study includes GPS, geological compass, clinometer, Abney level, RBI topographic maps, satellite images, slope maps, geological maps, population density maps, soil maps, plastic for samples, soil knives, analytical scales, a set of tools for soil texture testing and a set for soil consistency testing. The study design is analyzed descriptively and quantitatively, describing field conditions systematically

and factually and examining the relationships between the phenomena investigated¹⁶. The population for the study includes both the physical terrain and the human communities residing in disaster-prone areas in the Gebog subdistrict, Kudus Regency. Field samples were taken purposively, based on specific considerations or goals, such as residents living in areas that have previously experienced landslides or are at high risk of landslides. A total of 99 individuals from the community and 33 terrain units were sampled.

The risk variables for landslides consist of three main variables: (a) the threat/hazard of landslides, (b) the vulnerability of the terrain to landslides and (c) the community's capacity to deal with landslides. The threat/hazard value for landslides was obtained by evaluating parameters such as slope inclination, soil texture, rock weathering levels, rock layering structure, landslide history, slope cutting/excavation, slope water management/seepage, vegetation density, rainfall and the distance to objects at risk of landslides. The spatial threat to landslide disasters is presented in a threat/hazard map (Figure 1).

The vulnerability of the terrain to landslides is determined based on social, economic, physical and environmental vulnerabilities. Once calculated, the vulnerability to landslide disasters can be determined using a formula provided by the BNPB¹⁹.

Vulnerability to landslides

$$= (0.4 \times \text{Value of Social Vulnerability}) \\ + (0.25 \times \text{Value of Economic Vulnerability}) \\ + (0.25 \times \text{Value of Physical Vulnerability}) \\ + (0.1 \times \text{Value of Environmental Vulnerability})$$

The spatial vulnerability to landslide disasters is presented in a vulnerability map (Figure 2).

The community's capacity score is determined using the Hyogo framework for action, comprising five components: (a) disaster management rules and institutions, (b) early warning and disaster risk assessment, (3) disaster education, (4) reduction of basic risk factors and (5) preparedness development across all sectors. The assessment results for community capacity are spatially presented in a map showing community capacity levels for landslide disasters (Figure 3).

Once maps for the threat level, vulnerability level and community capacity level are obtained, a comprehensive risk map for landslide disasters can be created. The risk of landslide disasters is a combination of threat, vulnerability and community capacity, in accordance with the disaster risk formula used by the BNPB (BNPB regulation no. 2 of 2012).

$$R = H \times V / C$$

where R = Disaster Risk; H = Hazard (Threat); V = Vulnerability and C = Community Capacity. Subsequently, the assessment results of landslide disaster risk levels are presented spatially using a landslide disaster risk level map (Figure 4).

The variables for managing landslide disaster risk consist of three main categories, each with several indicators as follows:

- a. Pre-disaster risk management variables include (1) landslide prevention, (2) landslide preparedness, (3) early warning for landslides and (4) landslide mitigation.
- b. During-disaster risk management variables include (1) rescue and evacuation activities including relocation to safer zones, (2) search and rescue (SAR), (3) property preservation, (4) meeting basic needs of refugees, (5) emergency aid, (6) logistical capacity and facilities for aid delivery, (7) communication and information management and (8) survivor response and management.
- c. Post-disaster risk management variables include (1) recovery activities, (2) rehabilitation such as material support for victims and data re-inventory and (3) reconstruction.

For variables related to disaster risk reduction strategy, indicators will be formulated using data on (a) reducing landslide threats, (b) reducing vulnerability to landslides and (c) increasing community capacity against landslides. These are linked to (1) pre-disaster management, (2) management during the disaster and (3) post-disaster management.

Existing data on landslide disaster risk management are analyzed using scoring. In the instrument used to measure these variables, each question offers two answers: "yes" and "no." Respondents selecting "yes" will receive a score of 1 and those selecting "no" will receive a score of 0. The research instrument contains a total of 32 questions to measure landslide risk management. If a respondent answers "yes," they proceed to the next question. These subsequent answers will be used to describe landslide risk management in the research area. The scores are then summed and consulted with a pre-established criteria table to determine the level of landslide risk management in the

research area. The detailed steps used for analyzing landslide disaster risk management are as follows:

1. Determine the highest score:
= 32 x 1 = 32
2. Determine the lowest score:
= 32 x 0 = 0
3. Calculate the score range:
= highest score - lowest score
= 32 - 0 = 32
4. Define the criteria to be used:
In this study, 5 criteria are used (very low, low, moderate, high, very high).
5. Determine the range of criteria which is the score range divided by the number of criteria used.
= 32/5 = 6.4.

Create a table of criteria classes with score interval classes. The criteria used to determine the level of landslide risk management for each sub-variable can be seen in table 1. The analysis of Community-Based Landslide Disaster Risk Reduction Management Strategy is essentially an extension of existing strategies: This strategy development is analyzed using scoring and ranking or AHP analysis²¹. In the measurement instrument, each statement offers two choices: "agree" and "disagree." A score of 1 is given for "agree," and a score of 0 for "disagree." These scores are then summed up. The total scores from respondents are then ranked. Statements with the most "agree" scores are placed at the beginning of the draft strategy for landslide risk reduction management followed by statements with fewer scores.

These prioritized statements outline activities in the pre-disaster, during-disaster and post-disaster phases. These activities involve the Government, private sector and community. After the draft strategy was prepared, it was discussed in a Focus Group Discussion (FGD) attended by (a) 13 academic representatives from various fields, (b) the Regional Disaster Management Agency (BPBD, 5 people), (c) the Local Development Planning Agency (BAPPEDA, 3 people), (d) the Social Services Department (2 people), (e) Non-Governmental Organizations (NGOs, 3 people) and (f) Community representatives (3 people).

Table 1
Criteria for Determining Landslide Disaster Risk Management

S.N.	Criteria	Interval Class	Frequency (Number of respondents)	Amount in percent (%)
1	Very low	0 - < 6.4		
2	Low	6.4 - < 12.8		
3	Moderate	12.8 - < 19.2		
4	High	19.2 - < 25.6		
5	Very high	25.6 - < 32		

The discussion revised the draft to exclude less relevant activities. It included new ones to be carried out by the community, government and private sector during the pre-disaster, disaster and post-disaster phases. The outcome is a "Community-Based Landslide Disaster Risk Reduction Management Strategy," as presented in figure 5.

Results

Landslide disaster risk is determined by overlaying three maps: threat map, vulnerability map and community capacity map against landslides. The threat map is derived from scoring physical terrain parameters such as slope angle, soil texture, rock weathering level, rock layering, landslide history, slope excavation, water management, vegetation density, rainfall and distance to at-risk objects. The threat map is shown in figure 1.

The vulnerability map is calculated from the scores of social, economic, physical and environmental vulnerabilities. These values are summed to determine the total vulnerability score which is spatially presented in figure 2. The map of the level of community capacity against landslides is obtained from

the scoring and calculation of community capacity indicators with the Framework for Actions (Hyogo Framework for Actions), which consists of five components, namely (1) disaster management rules and institutions, (2) early warning and disaster risk assessment, (3) disaster education, (4) reduction of basic risk factors and (5) development of preparedness at all levels. After the value of community capacity is obtained, it can be spatially presented as a map of the level of community capacity against landslides as in figure 3.

The landslide risk level map is determined based on 3 sub-variables, namely the threat sub-variable in the form of a threat map, the vulnerability sub-variable in the form of a vulnerability map and the community capacity sub-variable in the form of a map of the level of community capacity towards landslides. After obtaining the landslide threat map, landslide vulnerability map and landslide community capacity map, the three maps are overlaid to determine the landslide risk level map. The distribution and extent of the risk level of landslides in Gebog District, Kudus Regency, are presented in table 2.

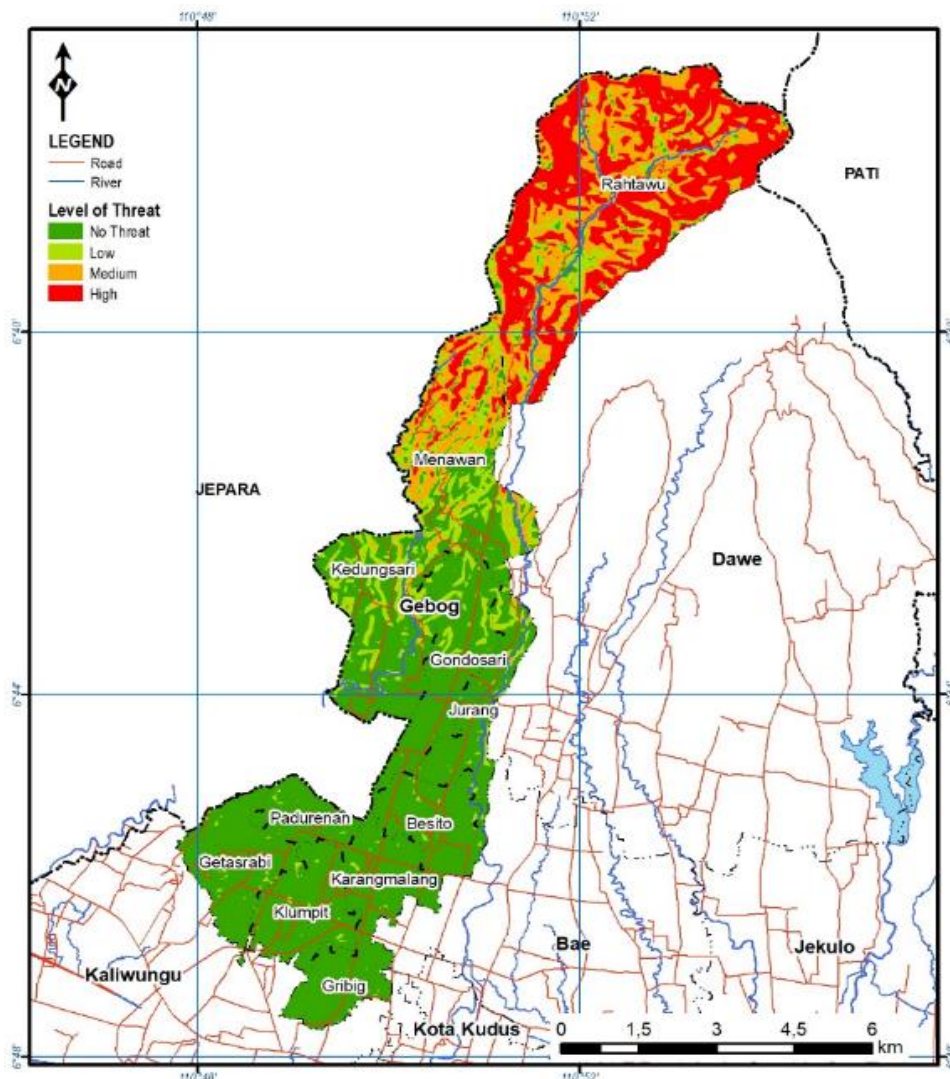


Figure 1: Landslide Threat/Hazard Map in Gebog Sub-District, Kudus Regency

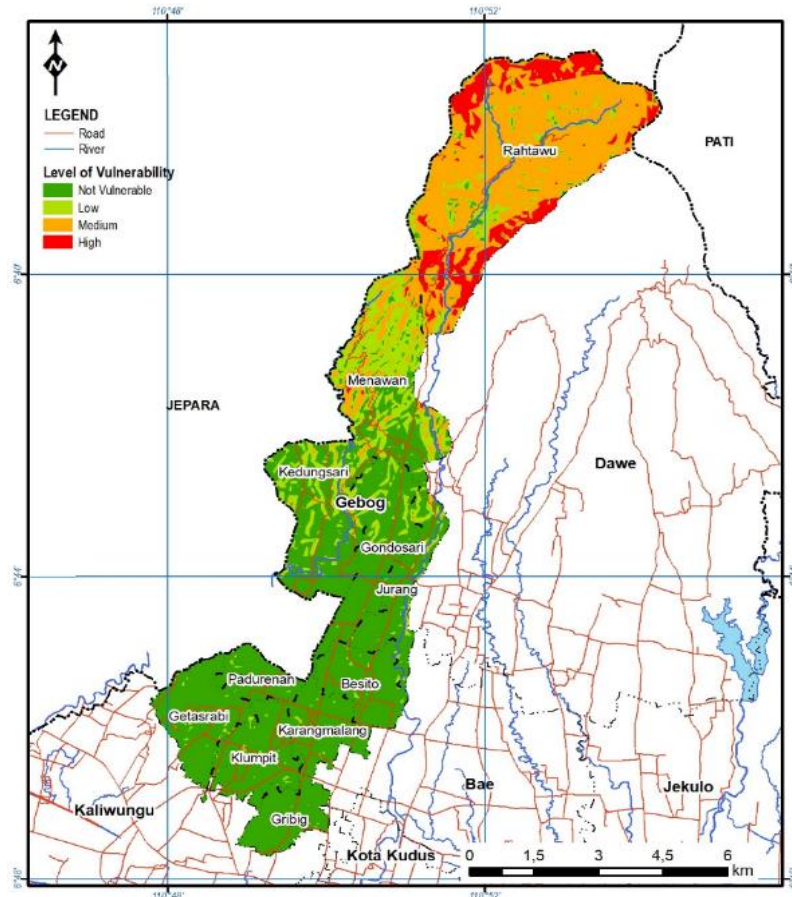


Figure 2: Vulnerability Map to Landslides in Gebog Sub-District, Kudus Regency

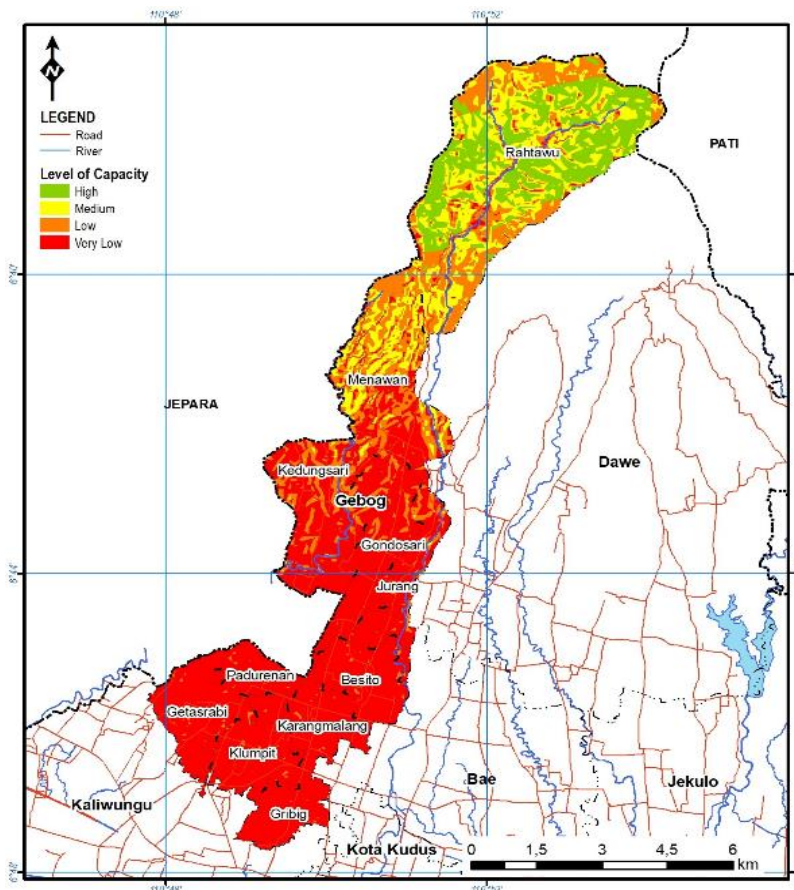


Figure 3: Community Capacity Level Map for Landslide Disaster in Gebog Subdistrict, Kudus Regency

According to table 2, it can be explained that the area of high landslide risk level in Gebog Subdistrict is 1125.99 ha (18.66% of the total administrative area of Gebog Subdistrict). Villages that have a high landslide risk area are

Rahtawu village (1055.51 ha) and Menawan village (70.48 ha). The area with a moderate landslide risk level is 897.27 ha (14.87% of the administrative area of Gebog subdistrict).

Table 2
Risk Level Distribution of Landslide Disaster in Gebog Subdistrict, Kudus Regency

S.N.	Village Name	No Landslide Risk		Low Landslide Risk		Medium Landslide Risk		Hard Landslide Risk	
		Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
1	Besito	304,07	9	5,60	1	0,00	0	0	0,00
2	Getasrabi	412,52	13	9,68	1	0,00	0	0	0,00
3	Gondosari	402,68	12	47,99	6	0,22	0	0	0,00
4	Gribig	242,56	7	0,74	0	0,00	0	0	0,00
5	Jurang	281,88	9	46,78	6	1,55	0	0	0,00
6	Karangmalang	283,42	9	2,85	0	0,00	0	0	0,00
7	Kedungsari	520,96	16	149,05	20	7,17	1	0	0,00
8	Klumpit	344,81	11	5,78	1	0,00	0	0	0,00
9	Menawan	247,68	8	283,60	37	233,65	26	70,48	6,26
10	Padurenan	144,84	4	1,73	0	0,00	0	0	0,00
11	Rahtawu	62,79	2	209,81	27	654,7	73	1055,51	93,74
Total area(Ha)		3248,21		763,61		897,27		1125,99	6035,08
Total area (%)		53,82		12,65		14,87		18,66	100

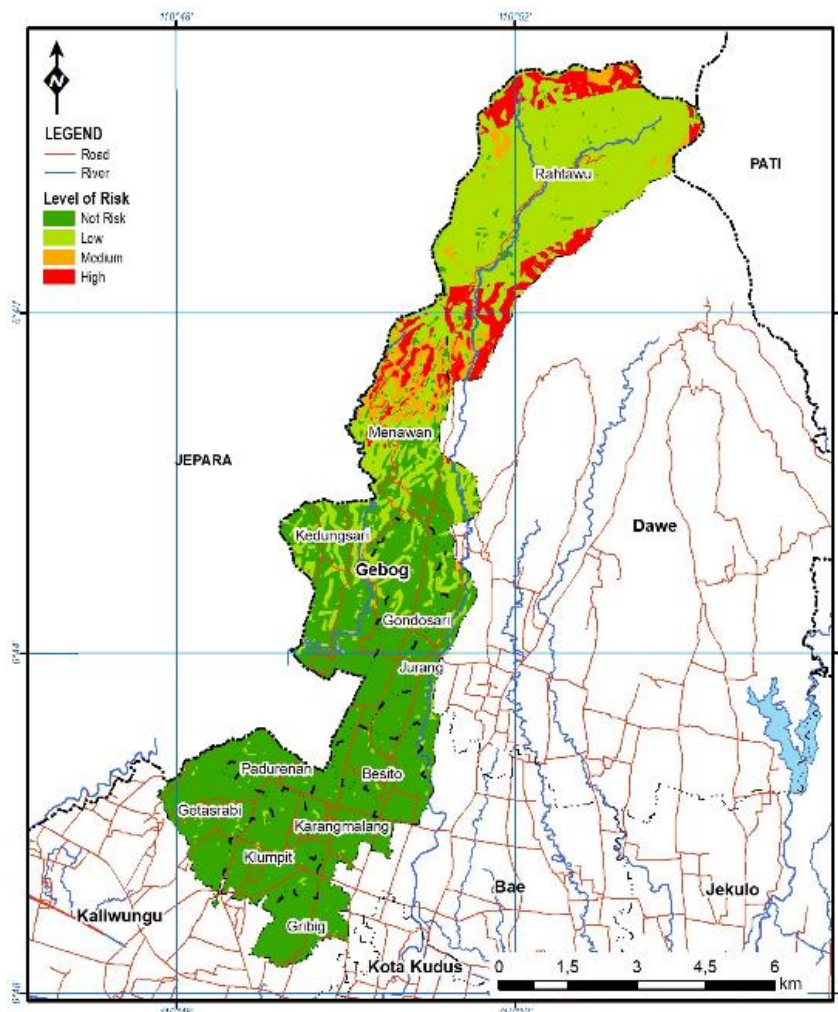


Figure 4: Landslide Disaster Risk Level Map in Gebog Sub-district, Kudus Regency

The area with a low category of landslide risk is 763.61 hectares (12.65% of the administrative area of Gebog Subdistrict) while the area that is not at risk of landslides is 3248.21 Ha (53.82% of the administrative area of Gebog subdistrict). Furthermore, the spatial extent of landslide disaster risk level in 11 villages in Gebog sub-district is presented in figure 4 as Landslide Disaster Risk Level Map in Gebog sub-district, Kudus Regency.

In this study, the existing landslide disaster risk management is evaluated through sub-variables of pre-disaster, during-disaster and post-disaster management. The evaluation is tailored to the research needs and local conditions using 99 samples. The majority of existing risk management in Gebog sub-district, Kudus Regency, shows low (35.35%) and very low (25.25%) criteria. The data is presented in table 3. The results of the landslide disaster risk management instrument for each indicator are described as follows:

Landslide Disaster Risk Management at the Pre-Disaster Stage: Pre-disaster risk management indicators are examined using a questionnaire divided into four topics:

prevention, preparedness, early warning and mitigation. The majority of respondents indicate very low (56.56%) and low (33.33%) criteria. This data is displayed in table 4.

Management of Landslide Disaster Risk at the Emergency Response Stage (Emergency Response and Emergency Assistance for Landslide Disasters): Management during a landslide disaster is also studied using a questionnaire. Most respondents fall under the low criterion (58.58%), indicating that community efforts during a landslide need to be improved. This data is available in table 5.

The average score for risk management during a landslide is moderate (3.26). The community indicators include (a) efforts to evacuate family members or landslide victims to safer places (b) presence of assistance during the evacuation process (c) data collection on the number of casualties and material losses due to the landslide (d) external aid during the landslide (e) community awareness of the required aid during a disaster and (f) community participation in reporting when a landslide occurs.

Table 3
Frequency Data of Respondents and Criteria for Landslide Disaster Risk Management in Gebog Sub-District, Kudus Regency

S.N.	Value Interval	Criteria	Frequency	Percentage (%)
1	0 - < 6,4	Very low	25	25,25
2	6,4 - < 12,8	Low	35	35,35
3	12,8 - < 19,2	Moderate	21	21,21
4	19,2 - < 25,6	High	12	12,12
5	25,6 - 32	Very high	6	6,06
Total			99	100,00

Table 4
Frequency Data of Respondents in Terrain Units and Criteria for Pre-Disaster Landslide Risk Management in Gebog Sub-District, Kudus Regency

S.N.	Value Interval	Criteria	Frequency	Percentage (%)
1	0 - < 4,2	Very low	56	56,56
2	4,2 - < 8,4	Low	33	33,33
3	8,4 - < 12,6	Moderate	10	10,10
4	12,6 - < 16,8	High	0	0,00
5	16,8 - < 21	Very high	0	0,00
Total			99	100,00

Table 5
Frequency of Respondents in Terrain Units and Criteria for Risk Management During Landslide Disasters

S.N.	Value Interval	Criteria	Frequency	Percentage (%)
1	0 - < 1,6	Very low	0	0
2	1,6 - < 3,2	Low	58	58,58
3	3,2 - < 4,8	Moderate	36	36,36
4	4,8 - < 6,4	High	5	5,05
5	6,4 - < 8	Very high	0	0
Total			99	100,00

In practice, community involvement during disasters does exist but is still relatively limited.

Risk Management of Landslide Disasters in the Post-Disaster Phase: Post-disaster risk management is examined using a questionnaire. Most of the respondents fall under the low criterion (73.3%). The average score for risk management in the post-disaster phase is moderate (1.24). Community indicators include recovery activities, Government assistance and reconstruction efforts. This data is shown in table 6.

The indicators possessed by the community are: (a) There are recovery activities for landslide disaster victims (b) There is Government assistance for the post-disaster recovery process and (c) There are reconstruction activities for landslide disaster victims.

Strategies for Community-Based Landslide Disaster Risk Reduction Management in Gebog Sub-District, Kudus Regency: The strategy for reducing landslide risk is based on data from interviews, questionnaires and focus group discussions (FGD) conducted by the Regional

Disaster Management Agency (BPBD). This strategy extends existing disaster management frameworks from BNPB, BAPPENAS, UNDP, UNISDR and the 2007 Disaster Management Law (Law No. 24 of 2007). The researchers combined relevant components and specifically added actions to reduce landslide risks such as threat reduction, vulnerability reduction and enhancing community capacity to face landslides. Implementers of these activities include the community, Government and private sector. The community's involvement in each activity aims to increase their awareness of being both the subject and object of disasters.

The risk-reduction strategy starts with pre-disaster conditions and includes threat reduction, vulnerability mitigation and capacity building. If a disaster occurs, it transits to emergency response activities like quick response and evacuation. Post-disaster, rehabilitation and reconstruction activities take place. All activities involve the community, the community with the Government and the community with the private sector. Detailed activities conducted by these groups can be seen from table 7 to table 13. The community-based landslide risk reduction strategy is presented in figure 5.

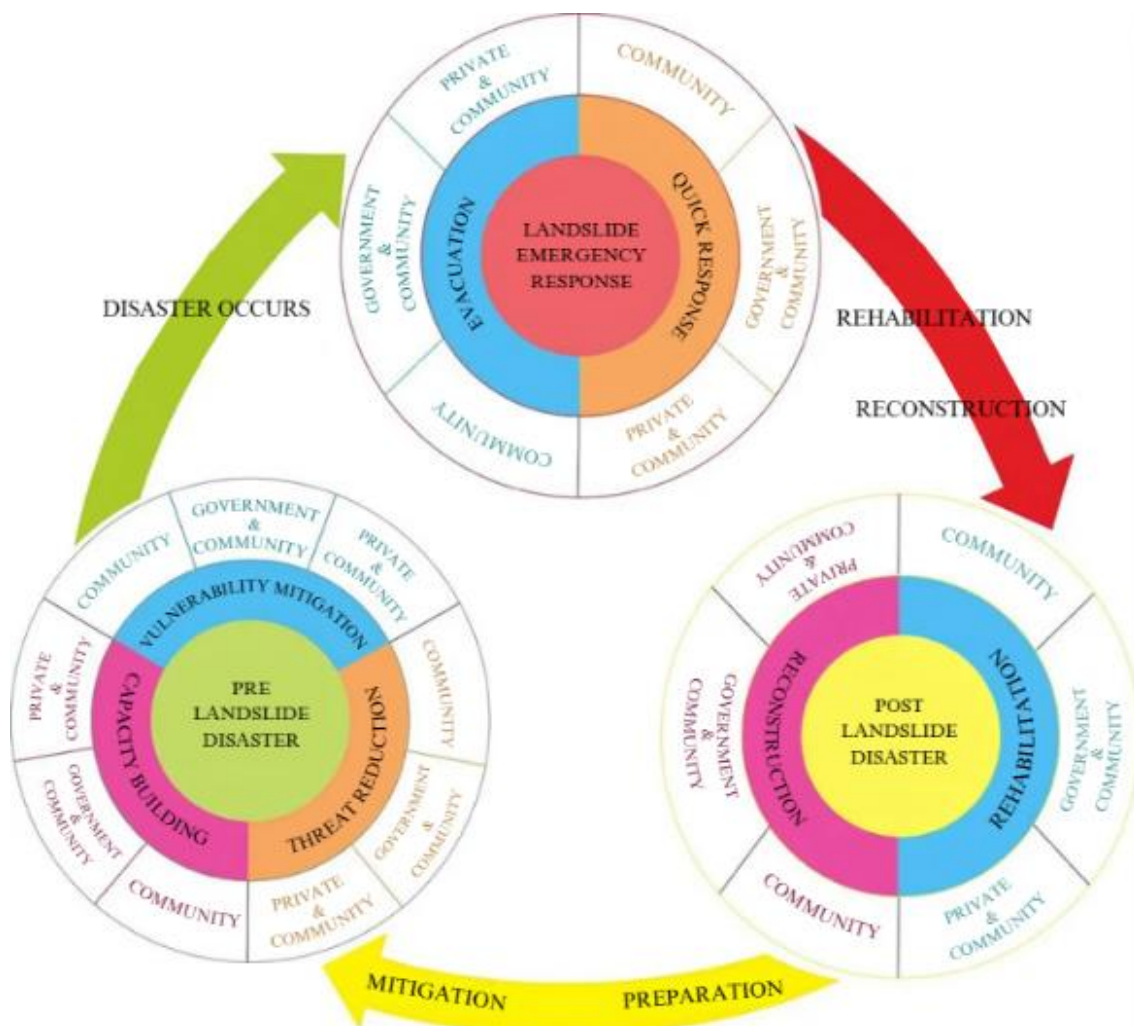


Figure 5: Community-Based Landslide Disaster Risk Reduction (DRR/PPRB) Management Strategy

Table 6

Frequency of Respondents in Field Units and Risk Management Criteria in the Post-Disaster Phase of Landslide

S.N.	Value Interval	Criteria	Frequency	Percentage (%)
1	0 - < 0,6	Very low	0	0
2	0,6 - < 1,2	Low	73	73,3
3	1,2 - < 1,8	Moderate	21	21,7
4	1,8 - < 2,4	High	0	0
5	2,4 - < 3	Very high	5	5,05
		Total	99	100,00

Table 7

Activities that can be carried out by the community, Government and private sector to reduce threats at the pre-landslide disaster stage

Private and Community	Government and Community	Community
<ol style="list-style-type: none"> 1. Observation of landslide phenomena. 2. Analysis of the results of landslide observation. 3. To prevent landslides on sloping land, heavy construction should be minimized because heavy construction increases the soil's load, making it more prone to landslides. 4. Land grading on steeply sloped land is necessary if residential areas are to be built. 5. Planting sturdy, deep-rooted trees (such as mahogany, teak, rosewood and others) in landslide-prone areas. 6. Increasing commitment to landslide disaster mitigation. 7. Spatial planning and environmental management. 8. Implementation and enforcement of spatial planning. 9. Implementation of spatial planning based on landslide disaster risk analysis. 10. Creating brochures/leaflets/posters on landslide disasters. 11. Widespread dissemination of information about landslide disaster warnings. 12. Disaster education and training. 13. Organization, installation and testing of early warning systems. 14. Provision and preparation of essential supply items. 15. Provision and preparation of materials, goods and equipment for infrastructure recovery. 	<ol style="list-style-type: none"> 1. Constructing embankments to prevent landslides on sloping land. 2. Strengthening the physical structures in landslide-prone areas. 3. Managing water channels to prevent water from infiltrating the soil in hilly and landslide-prone areas. 4. Developing landslide hazard maps for villages or regions with landslide potential. 5. Observing cracks or signs of landslide disasters. 6. Selecting landslide risk reduction measures. 7. Developing landslide risk reduction action plans. 8. Analyzing the results of landslide disaster observations. 9. Spatial planning for disaster-prone areas and environmental management. 1. Enhancement of regulations for safety and comfort in landslide-prone areas. 2. Introduction and assessment of landslide disaster threats. 3. Analysis of potential landslide disaster impacts. 4. Determination of readiness mechanisms and disaster impact mitigation for landslides. 5. Development of landslide disaster mitigation plans coordinated with (BNPB, BPBD and local governments). 6. Participatory disaster mitigation planning for landslides. 7. Precise identification and recognition of landslide disaster threat sources. 8. Organization, installation and testing of early warning systems for landslides. 9. Control over the management and control of landslide disaster sources. 	<ol style="list-style-type: none"> 1. People should inspect cracks in the ground and muddy water flow on slopes as initial signs of impending landslide disasters. 2. To prevent landslides on hilly terrain, it is advised not to create ponds or water bodies in the area, as these can accelerate soil saturation and increase the soil's weight, making it more prone to landslides. 3. Avoid tree-cutting on hilly slopes to prevent landslides. 4. To prevent landslides on steep land, people are prohibited from cutting into the slope. 5. Strengthening community social resilience (establishing Disaster Preparedness Groups) to deal with landslide disasters. 6. Implementation of community-led spatial planning for disaster-prone areas. 7. Education and training in landslide disaster management. 8. Observation of landslide disaster symptoms. 9. Identification of the results of landslide disaster symptom observations. 10. Dissemination of information on landslide disaster warnings. 11. Initiation of early actions by the community. 12. Implementation and supervision of spatial planning based on landslide disaster risk analysis.

Table 8

Activities that can be carried out by the community, Government and private sector to enhance community capacity at the pre-landslide disaster stage

Community	Government and Community	Private and Community
<ol style="list-style-type: none"> 1. Instilling a culture of disaster awareness and emergency response in the community. 2. Educating the community about human actions that can lead to landslides, such as deforestation, slope cutting and building settlements in landslide-prone areas. 3. Ensuring that the community is aware of the landslide-prone areas in their vicinity through the distribution of maps. 4. Conducting awareness campaigns for residents on landslide mitigation. 5. Providing educational programs on landslide disasters in landslide-prone areas. 6. Offering training sessions to residents in landslide-prone areas (e.g., disaster preparedness training, shelter management). 7. Strengthening the establishment of community organizations (e.g., youth groups) in the field of landslide disaster management. 8. Self-training and training family members on what to do in the event of a landslide disaster. 9. Preparing a disaster preparedness bag containing essential supplies such as food, drinking water, a small box with necessary medications and more. 	<ol style="list-style-type: none"> 1. Establishment of landslide disaster management institutions at the local level (sub-districts/villages). 2. Implementation of an early warning system that is easily recognizable by the community (e.g., using different tones for gongs or sirens) in landslide disaster management. 3. Enforcement of laws and provision of incentives for environmental preservation in landslide-prone areas. 4. Enhancement of regulatory and institutional capacities for landslide disaster management. 5. Enhancement of community knowledge about landslide disasters through local content in the school curriculum. 6. Vigilant monitoring of the implementation of landslide disaster regulations <ol style="list-style-type: none"> 1. Create a Landslide Hazard Map. 2. Develop a Disaster Management Program (Training, education, drills and standard operating procedures). 3. Allocate a budget for Disaster Management in the local government's budget (APBD). 4. Compile data on the potential roles of Community Security (Hansip) or Public Order Officers (Linmas). 5. Prepare paramedic data and facilitate First Aid (P3K) supplies. 6. Prepare Community Security (Hansip) or Public Order Officers (Linmas) for disaster response. 7. Conduct guidance and outreach programs for Community Security (Hansip), Public Order Officers (Linmas) and the community. 8. Coordinate with the community in preparing disaster response equipment and facilities. 9. Carry out disaster readiness guidance and drills. 10. Identify evacuation locations and alternative routes for evacuations. 11. Establish a Disaster Response Team (TIM) to ensure unified command during disaster response. 12. Enhance monitoring through early warning efforts. 13. Consider landslide disaster insurance 	<ol style="list-style-type: none"> 1. Management of landslide disaster education at the individual level. 2. Enhancing preparedness among the community, village officials and personnel in agencies involved in landslide disaster management. 3. Enhancing the capacity and abilities of individuals, families and communities to adapt to landslide-prone areas. 4. Individual-level socialization of landslide disaster mitigation. 5. Conducting training simulations for landslide disaster scenarios. 6. Enhancing the practice of landslide disaster response simulations. 7. Providing landslide disaster simulation training at the individual level. 8. Improving programs that encourage individuals or institutions to actively engage in landslide disaster mitigation actions. 9. Considering landslide disaster insurance.

Table 9
Activities that can be undertaken by the community, Government and private sector to reduce vulnerability at the pre-landslide disaster stage

Community	Private and Community	Government and Community
<ol style="list-style-type: none"> 1. Communities should create strong building foundations while keeping the upper parts of the buildings lightweight to reduce the risk of landslides. 2. Avoid constructing homes in steeply sloped areas to protect people from landslide disasters. 3. Enhance the diversity of community assets and resources in landslide-prone areas. 4. Before a disaster occurs, communities should identify and select several locations for potential shelters in case of a disaster. 5. Discuss with all family members the designated meeting place after a disaster. 6. With government support, communities should develop various new public facilities in landslide-prone areas. 7. Create a landslide buffer zone or establish a minimum distance (at least 15 meters) between residential buildings and the edge of cliffs that have previously experienced landslides or have the potential for landslides. 8. Communities need to form organizations capable of ensuring the safety of vulnerable individuals (the elderly, pregnant women and people with disabilities) in the event of landslides. 9. Train oneself and family members on what to do in the event of a landslide disaster. 10. Prepare disaster preparedness kits containing necessary items such as food, drinking water, a small box with essential medications, etc. 	<ol style="list-style-type: none"> 1. Training on landslide disaster evacuation and first aid (P3K) for each vulnerable community group. 2. Mapping or providing visual information on the level of landslide disaster vulnerability in a particular region as input to the community and the district government to serve as the basic data for regional development that mitigates disaster risk. 3. Studying the causes and impacts of a disaster to use in disaster mitigation planning and regional development plans. 4. Form an early warning team consisting of local government representatives, local organizations or NGOs, local community leaders and volunteers. 5. Allocate responsibilities within the team based on their designated roles and responsibilities in the early warning system for disaster anticipation. 6. Conduct training for all team members in accordance with their assigned tasks and roles. This training should be led by trained personnel to ensure effective and smooth implementation of activities in the field 	<ol style="list-style-type: none"> 1. The use of areas or land with landslide potential should be clearly regulated (restricted) by law. 2. Relocating settlements prone to landslide disasters to safer locations. 3. Establishing observation posts in landslide-prone zones. 4. Appoint one member of the local leadership or relevant agency personnel (preferably from the Regional Disaster Management Agency or BPBD) as responsible for the team's performance and early warning system activities. The selection of these personnel should be known and approved by the local authorities. 5. Designate one individual with knowledge of disaster management and trust to take command of evacuation. This person is accountable to local authorities and reports any field conditions developments. 6. Conduct investigations during and after a disaster to determine the causes and methods of mitigation. 7. Monitor areas prone to disasters, especially those of economic and service significance, to assess danger levels early and inform users and local residents. 8. Provide information and awareness to provincial, district, or municipal governments and the general public regarding landslide disasters and their consequences. This can be achieved through various means, such as distributing posters, booklets and leaflets or directly engaging with communities and government officials.

Table 10
Activities that can be carried out by the community, Government and private sector for a rapid response during the emergency phase of landslides.

Private and Community	Government and Community	Community
<ol style="list-style-type: none"> 1. Immediately report landslide disaster incidents to the nearest government authorities or disaster relief organizations. 2. Deploy volunteers to the landslide disaster site. 3. Prepare evacuation locations and routes. 4. Establish evacuation base camps promptly. 	<ol style="list-style-type: none"> 1. Quickly coordinate the provision of assistance to landslide disaster victims. 2. Hold coordination/consolidation meetings promptly with relevant disaster-related agencies. 3. Immediately establish evacuation base camps. 4. Determine the landslide disaster status. 5. Examine injured victims and those trapped in landslides without entering the landslide area directly. 	<ol style="list-style-type: none"> 1. Immediately evacuate the landslide area or debris flow to a more stable area. 2. If escaping is not possible, curl up tightly and protect your head. This position provides the best protection for your body. 3. Evacuate to a safer place promptly to save lives. 4. Stay away from landslide-prone slopes during heavy rain.

Table 11

Activities that can be carried out by the community, Government and private sector for Evacuation during the emergency response phase of a landslide disaster

Community	Government and Community	Private and Community
<ol style="list-style-type: none"> 1. Save yourself and your family. 2. Save valuable possessions and documents that can be rescued (land certificates, diplomas, valuable papers). 3. Report the landslide disaster incident to the nearest government authorities or private disaster relief agencies. 4. Evacuate to a safe location. 5. Search and rescue landslide disaster victims. 6. Provide emergency care for injured individuals. 7. Avoid landslide-affected areas, as secondary landslides may occur. 8. Assist in guiding search and rescue teams to the landslide location. 9. Help neighbors who require assistance, particularly children, the elderly and individuals with disabilities. 10. Listen to local radio or television broadcasts for the latest updates. 11. Be vigilant for the possibility of flooding or debris flow following the landslide. 	<ol style="list-style-type: none"> 1. Send a Search and Rescue (SAR) team or Rapid Response Team (RRT) to dispatch disaster management task forces. 2. Provide first aid to victims. 3. Evacuate victims and offer them support and motivation. 4. Set up a communal kitchen. 5. Prepare temporary shelters for displaced individuals. 6. Secure the location or area. 7. Provide infrastructure support (shelter, healthcare services, clothing and food). 8. Offer counselling and motivation to victims. 9. Receive aid and promptly distribute it. 10. Report to the Subdistrict Head/Mayor/Governor. 11. Report to the Ministry of Home Affairs and the National Disaster Management Agency 	<ol style="list-style-type: none"> 1. Provide first aid to the victims. 2. Evacuate the victims and offer them motivation. 3. Establish a communal kitchen. 4. Prepare clean water and quality sanitation, nutrition and disaster medicine services. 5. Set up a temporary shelter. 6. Receive assistance and promptly distribute it.

Table 12

Activities that can be undertaken by the community, Government and private sector for Rehabilitation in the post-landslide disaster phase

Private and Community	Government and Community	Community
<ol style="list-style-type: none"> 1. Receiving and distributing aid 2. Counselling for adults, spiritual support and information management in the field of education 3. Debris clearing 4. Participation and roles of community organizations, businesses and the public 5. Providing assistance for repairing community houses 6. Supplying basic needs such as water and sanitation, food, clothing, shelter, health services and counselling. 	<ol style="list-style-type: none"> 1. Inventory of the number of victims report the count of victims, the extent of damage and rehabilitation needs 2. Place victims in safe temporary shelters 3. Refer victims to health centers or hospitals 4. Light rehabilitation or reconstruction of public facilities 5. Receive and distribute aid 6. Report to the sub-district head/mayor/regent 7. Facilitate the establishment of conditions for smooth governance and development 8. Swift and accurate assessment of location, damage and losses 9. Strengthening the capacity of central and regional governments for coordination 10. Revitalization of the functions of village, sub-district, regency and provincial city governments 11. Restoration of public services, government support facilities, capacity building, planning and funding 12. Enhancement of social, economic and cultural conditions. 	<ol style="list-style-type: none"> 1. Environmental improvement in landslide-prone areas 2. Psychological and social recovery for landslide disaster victims 3. Debris cleanup due to landslide disasters

Table 13
Activities that can be undertaken by the community, Government and private sector for Reconstruction in the post-landslide disaster phase

Community	Government and Community	Private and Community
1. Report damage to public facilities to the relevant authorities.	1. Rapid assessment of damage and needs.	1. Help direct search and rescue teams to the landslide location.
2. Inspect the foundation, house condition and the surrounding land in the landslide-affected area.	2. Implementation of proper construction and the use of better and disaster-resistant equipment for infrastructure and facility reconstruction.	2. Handling of emergency patients (Emergency Medical Services - EMS).
3. Replant the area affected by landslides or its vicinity to prevent erosion that has damaged the topsoil layer, which can lead to flooding.	3. Reconstruction of community social facilities.	3. Implementation of appropriate construction and the use of better and disaster-resistant equipment for infrastructure and facility reconstruction.
4. Seek advice or guidance from individuals knowledgeable about landslides to evaluate the threats and techniques for reducing landslide risks.	4. Reestablishment of the social and cultural life of the community.	4. Reconstruction of community social facilities.
5. Repair and reconstruct damaged houses.	5. Enhancement of public service functions or	5. Reviving the social and cultural life of the community.
6. Repair public infrastructure and amenities.	6. Improvement of essential services within the community.	6. Enhancement of public service functions.
		7. Improvement of essential services within the community.

Discussion

Landslide disaster risk management in the study area has an average of low criteria. The results of data analysis from various questions about landslide disaster risk management consisting of pre-disaster risk management during disasters and post-disaster landslide risk management, there are variations in answers from respondents with an average included in the low criteria.

The results of the study are in accordance with the statement of Lassa Jonathan et al¹⁴ that the reality in the field of community participation in disaster management tends to be low. This means that disaster risk management activities carried out by the community are only a few or only a small part of the many activities that should be carried out.

Paripurno et al¹⁸ stated that in disaster risk management, the community is the first party to directly deal with threats and disasters. Therefore, community readiness and community involvement determine the size of the disaster impact in the community. In community-based disaster risk management, a good community is a community that can organize itself both before a disaster, during a disaster and after a disaster by using the resources they have as much as possible to prevent, reduce, avoid and recover from the impact of disasters.

In line with the results of research on disaster risk management that is still low, Handayani⁸ explained that so far disaster risk management is still considered not a priority and only comes at any time, even though we live in areas vulnerable to disaster threats. Therefore, an understanding of disaster management needs to be understood and mastered by the community, Government and the private sector, so that we can better manage disasters around us together. According to Jones et al¹⁰, a case study in Nepal shows that

Government policies in disaster risk reduction (DRR) have a significant impact on the community. This is because the Government can actively institutionalize disaster risk reduction and tends to pay attention to its management. Community-supported Government involvement is crucial in managing landslide disaster risks minimizing property damage and loss of life. In disaster risk reduction, disaster risk maps play a very important role. Landslide risk maps are thought to play an important role in landslide disasters, landslide mitigation and management²².

The community-based landslide disaster risk reduction strategy covers pre-disaster, during-disaster/emergency response and post-disaster conditions. In the pre-disaster phase, activities include: (1) reducing landslide threats carried out by the Government and community, private sector and community, as well as by the community alone (2) minimizing landslide vulnerability conducted by the government and community, private sector and community and solely by the community and (3) enhancing community capacity to face landslides, led by the Government and community, private sector and community and the community itself.

During disaster conditions, activities that can be carried out by the community, Government and the private sector are rapid response at the emergency response stage and evacuation at the emergency response stage of the landslide disaster. During post-disaster conditions, activities that can be carried out by the community, Government and the private sector are to carry out rehabilitation in the post-disaster stage and reconstruction in the post-disaster landslide stage. If the activities detailed in the strategy are well implemented by the Government, the private sector and the community, disaster risk reduction will be minimized.

Conclusion

According to the research results, it can be concluded that the level of landslide risk in the research area includes (a) high landslide risk, (b) moderate landslide risk, (c) low landslide risk and (d) areas that are not at risk of landslides. The landslide risk level is evenly distributed in the study area. The area with a high landslide risk level in Gebog subdistrict is 1125.99 hectares. The area with a medium landslide risk level is 897.27 hectares. The area with a low level of landslide risk category is 763.61 ha. Meanwhile, the area that is not at risk of landslides is 3248.21 hectares. Villages with high landslide risk areas are Rahtawu village (1055.51 ha) and Menawan village (70.48 ha).

Pre-landslide risk management includes prevention, preparedness, early warning and mitigation activities which are carried out by the community, mostly showing very low (56.56%) and low (33.33%) criteria. The management of landslide disaster risk in the event of a landslide disaster is mostly in the low criteria (58.58%). This shows that the management of landslide disaster risk carried out by the community during a landslide disaster is still low. Disaster risk management by the community in the post-landslide disaster stage is mostly in the low criteria (73.3%). Realities are: (a) There are recovery activities for landslide victims, (b) There is assistance from the Government for the post-disaster recovery process and (c) There are reconstruction activities for landslide victims, but they are still low or in small intensity.

The landslide disaster risk reduction management strategy resulting from the research is a new discovery about disaster risk reduction strategies specific to landslide disasters which is a development of disaster risk management strategies in general. Existing activities need to be carried out jointly by the community, Government and the private sector to reduce disaster losses.

According to the results of the study, it is recommended that: (a) Areas with high landslide risk should get serious attention in order to reduce losses as small as possible in the event of a landslide, (b) Management of landslide disaster risk in the research area must be improved both in pre-disaster, during disaster and in post-landslide disaster, (c) The landslide disaster risk reduction management strategy is very important to implement. The Government must work together with the community and the private sector to implement landslide disaster risk reduction strategies to minimize losses in the event of a landslide disaster.

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