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Community Landslide Preparedness for the Risk Reduction in Rwanda

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Abstract

Landslide occurrence impacts on livelihoods, hence, community involvement is crucial to ensure preparedness and adaptation as well. This study aimed to assess the extent of landslide preparedness for the risk reduction among residents of Gakenke district, northern Rwanda. A sample of 99 households was calculated from 11,271 households. The structured questionnaire was used to collect data which were analyzed by using the Statistical Package for Social Sciences (SPSS). The results, as mentioned by 49.5% of respondents, revealed that sometimes landslide information is listened on radio and television compared to 75.5% who never received alert on their mobile phones. This expresses that the information is not reaching all people as mobiles phones are not used while owners recorded gradual record in recent years. In addition, the delivered information merely bases on recent events and omits meteorological information like rainfall which could raise awareness as rainfall leads the majority of landslide occurrence in Rwanda. Moreover, the indigenous knowledge is not integrated in planning and execution landslide preparedness schedule. The study suggests improved use of short messages and meteorological information. Accordingly, provision of local trainings and starting disaster courses at early age would develop the awareness (preparedness) and contribute to response at large.

Keywords

Gakenke District, Landslide, Preparedness, Risk Reduction, Rwanda

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1. Introduction

Landslide risk and their consequences have been intensified in recent years, particularly rainfall-triggered landslides which affect several countries across the globe especially in the tropics [1, 2]. Landslide risk reduction requires identification of the processes that control slope stability and information sharing from local scale in order to allow appropriate risk reduction measures to be identified and their effectiveness to be evaluated [3].

In Rwanda, flood and landslide are the major disasters recorded due their severe losses and rainfall is registered as the key driving factor. This is associated with the geographic aspects of the country and population pressure on land which complicate the risk reduction efforts [4, 5]. Disaster risk reduction in Rwanda, as recently reported [6, 7], is still complicated mainly in the north-western parts of Rwanda namely Burera, Musanze, Rulindo, Nyabihu, Gakenke, Ngororero and Rubavu districts highly prone to floods and landslides. The above studies suggested that efforts should merely consider the involvement of the local communities which suffers the most damages.

The Gakenke district is one of landslide highly prone district in the northern Rwanda [8]. The report of the Ministry of Disaster Management and Refugees [9] indicated that in this area, in the last five years, landslide killed 34 people and injured 19. Approximately 6,031 people became homeless due to 1,500 houses destroyed. Also, 632 hectares of

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cropland and 777 livestock were damaged. However, there is still gap in analyzing how the residents are prepared and respond to landslide which could help to minimize such losses and damages [8, 9]. Therefore, the objective of this study was to assess the level of community landslide preparedness for its risk reduction with the case of Gakenke district in the Northern Rwanda.

2. Materials and Methods

2.1. Study Area Description

This study was conducted in Gakenke district, one of five districts forming the northern province of Rwanda. The district borders with Burera and Musanze districts at its eastern part, Nyabihu district in western, and Kamonyi and Muhanga districts at its southern part. The district is formed by 19 sectors namely: Busengo, Coko, Cyabingo, Gakenke, Gashenyi, Mugunga, Janja, Kamubuga, Karambo, Kivuruga, Mataba, Minazi, Muhondo, Muyongwe, Muzo, Nemba, Ruli, Rusasa and Rushashi [8]. The district is inhabited by 354,469 residents at and area of 704.1 Km² [8].

The authors considered the fact that it would be hard to easily cover the whole district then randomly chose two sectors of the district (Figure 1). These sectors (Busengo and Gakenke) were chosen due to recent report which indicated that previous landslide events were largely recorded within both sectors and chose to assess residents' preparedness to landslide across these sectors of Gakenke district.

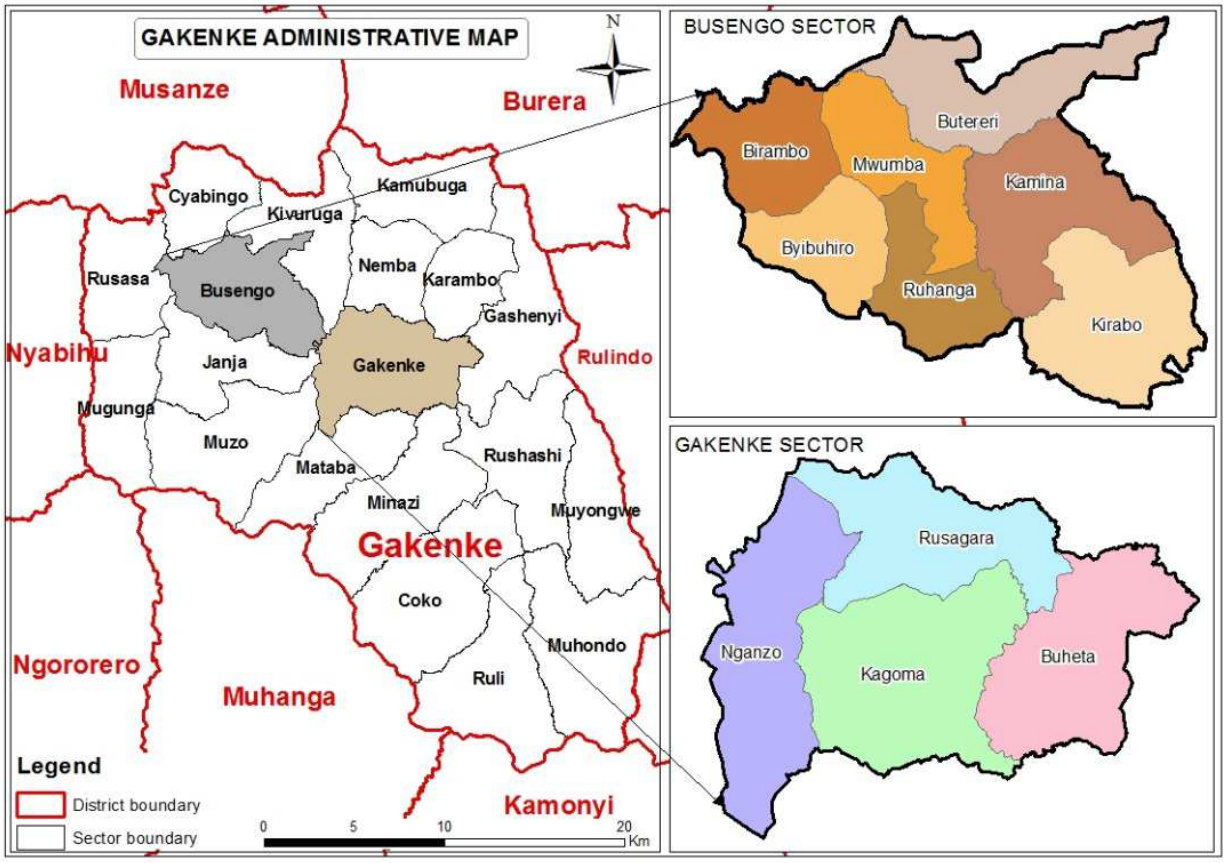

Figure 1. Location of study area.

2.2. Data Collection and Analysis

For this study, the primary data were collected by employing a structured questionnaire between June and August 2019. The study adopted a quota and qualitative methodologies [10]. Both methods allowed the authors to consider a small sample from a large number of people and permitted the interviewees to express their opinions. The total households of both Busengo and Gakenke sectors are 11,271. The sample was calculated from these households by adopting the formula expressed as follows:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where n is the sample size, N is the population size, and e is the level of precision. To minimize the risk that the sample size will not represent the true population, the margin error was fixed at 10%. The authors adopted the above formula due to its application in several descriptive studies for estimating the sample from large population [11, 12]. Hence, the sample size was estimated as follows:

$$n=\frac{11,272}{1+11,272(0.1)^2}=99 \quad (2)$$

Thereafter, the study employed a structured questionnaire to collect data and the followings were considered. (1) both male and female respondents along with their education level and sex, (2) the extent to which people are prepared to landslide and here, questions like frequency and causes of landslide occurrence, delivery of courses/training in regard to landslide, types of early warning systems used (radio, television, local meeting, mobile phones, etc.), were asked and (3) respondents were asked to rank their participation in planning and execution of landslide preparedness schedule, and its indigenous knowledge valuing. After all, the collected data were analyzed by using SPSS software.

3. Results

3.1. Description of Respondents

The results in Table 1 showed that the majority of respondents (60.6%) were aged above 35 years old. It was noted that 30.3 percent of respondents were aged between 31 and 35 years old. Thus, the considered informants had enough experience and knowledge on landslide and could give the required information. In addition, it was noted that 67.7 percent of respondents were male against 32.3% of female informants (Table 1). Regarding respondents' description by sex, the results in Table 1 showed that 70.7 percent of the informants have attended primary schools followed by 17.2 percent who attended primary schools whereas only 4 percent attended university.

Table 1. Description of respondents by age, gender and education.

	Age				
	20-25	**25-31**	**31-35**	**Above 35**	**Total**
Frequency	4	5	30	60	100
Percentage	4	5	30.3	60.6	100

	Gender		
	Female	**Male**	**Total**
Frequency	67	32	100
Percentage	67.7	32.3	100

	Education				
	Illiterate	**Primary**	**Secondary**	**University**	**Total**
Frequency	9	70	17	4	100
Percentage	9.1	70.7	17.2	4	100

3.2. Landslide Preparedness

For this section, the authors considered several factors which likely can decrease/increase community's preparedness to landslide. The related questions were asked to respondents and their answers are provided in the following tables.

Table 2. Community landslide awareness.

Assertions	**Scales**	**Freq.**	**%**	**Mean**	**St.dev**	**Description**
	Never	3	3.0			
	Rarely	10	10.1			
Experiencing landslide	Sometimes	32	32.3	3.57	1.011	High
	Very often	35	35.4			
	Always	19	19.2			
	Never	47	47.5			
	Rarely	29	29.3			
Received local landslide training programs	Sometimes	16	16.2	1.86	1.03	Low
	Very often	4	4.0			
	Always	3	3.0			
	Never	63	63.6			
	Rarely	23	23.2			
Received courses on landslide at school	Sometimes	11	11.1	1.51	.77	Very low
	Very often	2	2.0			
	Always	0	0			
General Mean				2.73	0.97	Moderate

The results in Table 2 indicated that 37.4 and 35.5 percent of respondents sometimes and very often experience the occurrence of landslide in their areas, respectively. With regard to the delivery of training at community level, it was found that 47.5 percent of respondents never obtained such training compared to 29.3 percent who rarely attended the trainings.

Table 3. Landslide early warning systems.

Assertions	Scales	Freq.	%	Mean	St.dev	Description
Use of radio and television	Never	3	3.0	3.43	.810	High
	Rarely	3	3.0			
	Sometimes	49	49.5			
	Very often	36	36.4			
	Always	8	8.1			
Use of mobile phones	Never	75	75.8	1.35	.760	Very low
	Rarely	17	17.2			
	Sometimes	5	5.1			
	Very often	0	0			
	Always	2	2.0			
Local meetings and other method of warning	Never	4	4.0	4.25	.907	Very high
	Rarely	0	0			
	Sometimes	7	7.1			
	Very often	44	44.4			
	Always	44	44.4			
General mean				2.75	0.84	Moderate

The results in Table 3, as asserted by 49.5 percent, indicated that radio and television channels are sometimes used and mobile phones are never used as asserted by 75.8 percent. This expresses poor usage of mobile phones in early warning.

Table 4. Reference used to share information on landslide.

Assertions	Scales	Frequency	%	Mean	St.dev	Description
Identifying past landslide movement is a vital sign of future occurrence	Never	6	6.1	3.45	1.13	High
	Rarely	9	9.1			
	Sometimes	41	41.4			
	Very often	20	20.2			
	Always	23	23.2			
Base on meteorological information	Never	53	53.5	1.72	.92	Very low
	Rarely	25	25.3			
	Sometimes	17	17.2			
	Very often	3	3.0			
	Always	1	1.0			
Use of aerial photographs	Never	75	75.8	1.38	.82	Very low
	Rarely	16	16.2			
	Sometimes	3	3.0			
	Very often	4	4.0			
	Always	1	1.0			
Average mean				2.18	0.96	Low level

The results in Table 4 indicated that 23.3 percent of respondents always received such information followed by 20.2 and 41.4 percent who sometimes and very often received the information of recent landslide movement, respectively (Table 4). However, the majority of respondents (53.5%) asserted that they never received meteorological information and 75.8% reported that aerial photographs are never used. This expresses that landslide preparedness is still at low pace since the reference made while sharing its information to the local community does not cover all possible reference to provide sufficient information.

Table 5. Participation in landslide response schedule.

Assertions	Scales	Frequency	%	Mean	St.dev	Description
Only local community participates in response planning and execution	Never	31	31.3	2.12	.97	Low
	Rarely	35	35.4			
	Sometimes	23	23.2			
	Very often	10	10.1			
	Always	0	0			
Only leaders participate in response planning and execution	Never	30	30.3	2.6	1.50	Moderate
	Rarely	25	25.3			
	Sometimes	10	10.1			
	Very often	16	16.2			
	Always	18	18.2			
Response plans are organized at local level and community's indigenous knowledge is valued and considered	Never	36	36.4	2.02	1.01	Low
	Rarely	37	37.4			
	Sometimes	15	15.2			
	Very often	10	10.1			

Assertions	Scales	Frequency	%	Mean	St.dev	Description
	Always	1	1.0			
Average mean				2.13	1.12	Low

The results in Table 5 indicated that local community rarely participated in the evacuation plans as mentioned by 35.4 percent of informants. This was associated with the fact that 37.4 percent of informants rarely took part in the organization of response plans and their indigenous knowledge was not considered. Also, it was noted that the local leaders very often (16.2%) and always (18.2%) participated in the response planning and execution (Table 5).

4. Discussion

The results of this study (Table 2) showed that the awareness on landslide which could help to improve the community's preparedness is at low level among the community. This is due to reason that 63.6 and 47.5 percent of respondents have never been given education or training on landslide (Table 2). This was pointed out by the study conducted in Slovenia [13] that through delivery of landslide related trainings, the community members were involved in landslide monitoring which helped them to better understand landslide occurrence, causes and ways of adaptation or risk reduction among them.

The use local communication channels have been suggested to help in minimizing disaster risk at community levels. Such channels include radio, television, mobile phones and local meetings [14]. For this study, it was noted that people at large extent, receive information on landslide through radio, television and local meetings (Table 3). Moreover, for disaster risk reduction schedule, it is reported that both local community and leaders should plan and work together [15, 16]. However, the study previously conducted in Nyabihu district, western Rwanda [4] indicated that the local community is not participating in disaster risk reduction activities. This is similar to the findings of this study (Table 5), as highlighted by 36.4 percent of informants that their indigenous knowledge is never considered while planning and executing landslide response plan which in turn leads to raising the risk and exposure among people (Table 5).

Furthermore, the results in Table 4 indicated that the use of meteorological information and aerial photograph is still at low level (Table 4). However, in Rwanda, the majority of landslide occurrence is rainfall-induced [17]. This expresses that sharing meteorological information with people would reveal areas with high landslide occurrence likelihood, which in turn enhances the preparedness and response as well. This was recently reported in Italy [18] that using all possible landslide monitoring systems helped policy makers and local community to obtain all possible information and ensure that all relevant landslide preparedness and response measures are integrated.

5. Conclusion

This study aimed to assess the extent to which landslide preparedness measures are provided to residents in order to reduce its risk. The study used a sample of 99 respondents selected from households of two sectors of Gakenke district. The results indicated low level of delivering landslide related courses and trainings. The local community is not involved in planning and executing landslide response activities and its indigenous knowledge is not considered. This likely increases people's exposure to landslide and is associated with the way information on landslide is provided where only recent events are highly are considered than meteorological information. For enhancing disaster awareness and preparedness, it is suggested to approach the community and start education at early age and provide local trainings. Finally, sharing meteorological information would save people's lives since landslide occurrence in Rwanda is largely rainfall-induced.

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