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Article

THE BARRIERS TO LANDSLIDE RESPONSES OVER THE MT. ELGON IN BUDUDA DISTRICT, UGANDA

Marrion Namono[1,9], Isaac Mugume[2,10,‡], Radu Negru[3,‡], Godfrey Mujuni[4,‡], Sulin Tao[5,‡], Bob Nakileza[6,‡], Sylvain Racaud[7,‡], Shuichi Oyama[8,‡]

1 Faculty of Natural Resources and Environmental Science, Busitema University, P.O. Box 236 Tororo, Uganda; marrionnmn@gmail.com; M.N.
2 Department of Geography, Geo–informatics & Climatic Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda; imugume@caes.mak.ac.ug; I.M
3 Dimitrie Cantemir University, Targu Mures 3–5, Bodoni Sandor st, 540545 Romania; negrurg@yahoo.com; R.N.
4 Directorate of Applied Data and Climatic Services, Uganda National Meteorological Authority, P.O. Box 7025, Kampala, Uganda; grmujuni@gmail.com; G.M.
5 School of Applied Meteorology, Nanjing University of Information Science & Technology, Nanjing 210044, P.R.China; sulintao@foxmail.com; S.T.
6 Department of Environmental Management, Makerere University, P. O. Box 7062, Kampala, Uganda; nakilezabob@gmail.com; B.N.
7 Department of Geography, University of Bordeaux Montaigne; sylvain.racaud@u-bordeaux-montaigne.fr; S.R.
8 Center for African Area Studies, Kyoto University, 46 Shimo-Adachi Yoshida Sakyo Kyoto–City 606-8501, Japan; oyama.shuichi.3r@kyoto-u.ac.jp; S.O.
9 Department of Natural Resources, Bududa District Local Government; marrionnmn@gmail.com; M.N.
10 Hub for Environmental and Atmospheric Research, Kampala–Uganda; imugume@caes.mak.ac.ug; I.M.
* Correspondence: imugume@caes.mak.ac.ug; Tel.: +256779721 (I.M.)
‡ These authors contributed equally to this work.

Abstract: Landslides are natural disasters that normally cause misery over the Mount Elgon region, especially in Bududa district. A landslide early warning system was developed in collaboration with the community and this study investigated it's effectiveness in disseminating warnings to the community. The data were collected from 82 respondents (mean age 43) and 4 focus group discussions (one per village). Majority of the respondents lost crops (35.9%); land (29.8%); lives and livestock (6.9%). The frequent occurrence of landslides is due to the changes in landuse patterns; settlement on steep slopes; and prolonged rainfall of low intensities. The study found that, 93.2% of respondents have ever received the warnings and alerts. 78.8% of those who received the warnings evacuated. The use of radios to disseminate warnings is the most efficient communication channel (44.4%) followed by using the clan members (19.5%). Only 40% of the women received the early warning through radios, an indicator that this channel puts women at a disadvantage. The main challenges regarding utilization of early warning system were: poor timing (29.9%); poor coordination (20.7%); and poor sensitization (18.4%). There is need to strengthen the community networks, and with continuous

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sensitization, the effectiveness of the landslides early warning will improve and this is expected to enhance the resilience of the community to landslides.

Keywords: Disasters; Rainfall; Early warning

1. Introduction

Landslides have traditionally caused injury, death and destruction of property in areas they occur. Over different areas, efforts have been made to improve their prediction and helping communities to cope, e.g. Albano & Sole[1]. In this paper, the term "*Landslide*" was considered a general term used to mean the sliding motion of all varieties of mass–transport deposits including "slides", "slumps", "topples", "debris avalanches" and "debrites" among others. This definition of "landslide" is adopted from Zhao *et al.*[2] and Hungr *et al.*[3] among others. Additionally, we adopt this definition because it is the one widely used by media and communities without differentiating the various types of slope movements.

Globally, landslides are on the rise [4–6]. They normally occur over hilly terrain [4,7] and over coastal areas [7,8] and are usually triggered by rainfall [2,9], earthquake [5], floods [9,10], landscape grading [5,10,11] among others. These result into failure of the layer between the debris and bedrock, hence landslides [12,13]. They have far reaching impacts including destruction of crops [7], land degradation [12], destruction of property e.g. buildings [13] and loss of lives [4,5,13] among others. Over most hilly terrain, efforts are in place to use terraces as an adaptation to reduce the landslide risk [12]. In Bududa, eastern Uganda, sustainable land management approaches are being promoted as a control measure for soil erosion, landslides and increasing soil productivity for crops [14].

The skillful prediction of landslide occurrences and magnitude is a challenge over many places, including Bududa district[4,15]. This is attributed to the changes in landuse (e.g. landscape grading, crop cultivation)[5,16]; changing rainfall patterns and intensity over the region [5,17,18]. In spite of the challenge, it is important to understand the landslide risk exposure for people living in such hilly areas [17,19,20], because, this helps them in planning and increases their preparedness. It is also necessary to raise awareness in order to reduce the adverse impacts to lives (e.g. injury and death) and property among others, should the landslide occur. In Uganda, it is done using the "*Landslide Early Warning System* and the dissemination is carried out using smart phones, mega–phones, motorcycles, bicycles, short message systems (SMS) and FM radios [21].

The occurrence of landslides is also known to trigger food shortage and misery especially the lives lost, and has been recognized as a problem of concerned over Uganda, especially the Mount Elgon region [5,17,22]. Neema *et al.*[4] and Nyakaisiki *et al.*[23], among others, attribute the occurrence

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to changing climate, that has made rainfall patterns erratic and unpredictable. Additionally, prolonged rainfall of low intensities is found a major driver of landslides over Bududa [5,17]. According to Masaba *et al.*[6] and Wanasolo[5], the increasing population which is putting pressure on land resources is an additional driver of landslides in Bududa landslide prone areas.

The Mount Elgon region has witnessed increasing manifestation of landslides since 2000. Studies by Odlum[24], Neema *et al.*[4] and Wanasolo[5] put the total number of lives lost due to landslides at 759 since 2000 (Table 1). Fortunately, there is presently growing capacities to improve landslide prediction over the Mount Elgon region including integrating the indigenous knowledge systems [17]. Additionally, the government of Uganda with support from partner agencies like Red Cross have intensified response efforts including relocation policies. The communities are also planting trees [5,6] and improved farming technologies e.g. sustainable land management [5,25] to reduce the chances of landslide occurrences.

Table 1. *Some reported cases of Landslides over the Mt. Elgon region*

Date/Period	Comments	Reference
October 2018	Over 50 death reported and over 850 people displaced in Bududa	Odlum[24]
August 2013	Heavy rainstorm triggered mudslides that killed a 4 year old child and injured 17 people	Odlum[24]
June 2012	Landslide killed 8 people	UNESCO[26]; Odlum[24]
March 2011	Landslide in Bukalasi sub county killed over 300 people. Only 92 bodies were recovered	Odlum[24]
March 2010	Very devastating landslide that killed over 400 people and displaced about 5,000 people	Neema *et al.*[4]; Wanasolo[5]
1997–1999	Killed 48 people and displaced about 10,000; destroyed farmlands, roads and bridges	Kitutu *et al.*[17]
1989	Landslide in Bubiita subcounty killed 11 people	Wanasolo[5]
1970	Over 60 people at a circumcision ceremony buried alive	UNESCO[26]

This study was carried out to examine the barriers to the effective utilization of the landslide early warning information by the vulnerable communities. The landslide early warning system was presented to the Parliament of Uganda by Onek[21] in 2018. Masaba *et al.*[6] recommended a detailed study of the "*effectiveness of the landslide early warning system*", which is presented in this study. The data and the methods used are presented in Section 2 and Section 3 discusses the results while Section 4 presents the summary and important conclusions along with recommendations.

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2. Data and study methods

2.1. Study area

This study considered Bududa district. The district is found in Eastern Uganda (Figure 1). This area was considered because, Bududa is one of the districts prone to landslides over the Mount Elgon region and recent studies e.g. Masaba *et al.* [6], Kitute *et al.*[17] and Onek[21], among others, have observed that landslides over this region are on the rise. The district is bound by latitude $1^o04'N$ and $1^o00'N$, longitude $34^o15'E$ and $34^o26'E$ with altitudes in the range: $1250 - 2850$ meters above mean sea level [14,17].

Bududa district normally receives average rainfall of about 1,500 mm [5,17] which peaks around May and October [5,14]. Due to the hilly terrain of Bududa [4,17], most areas are prone to landslides [5,6]. Such exposure with prolonged low intensity rainfall increases the risk of landslide occurrence [17,22]. This is because the prolonged low intensity rainfall soaks the ground, rendering it vulnerable to moving downslope [17]. On the other hand, heavy rainfall along slopes normally trigger run–off that has a potential of razing down buildings and property.

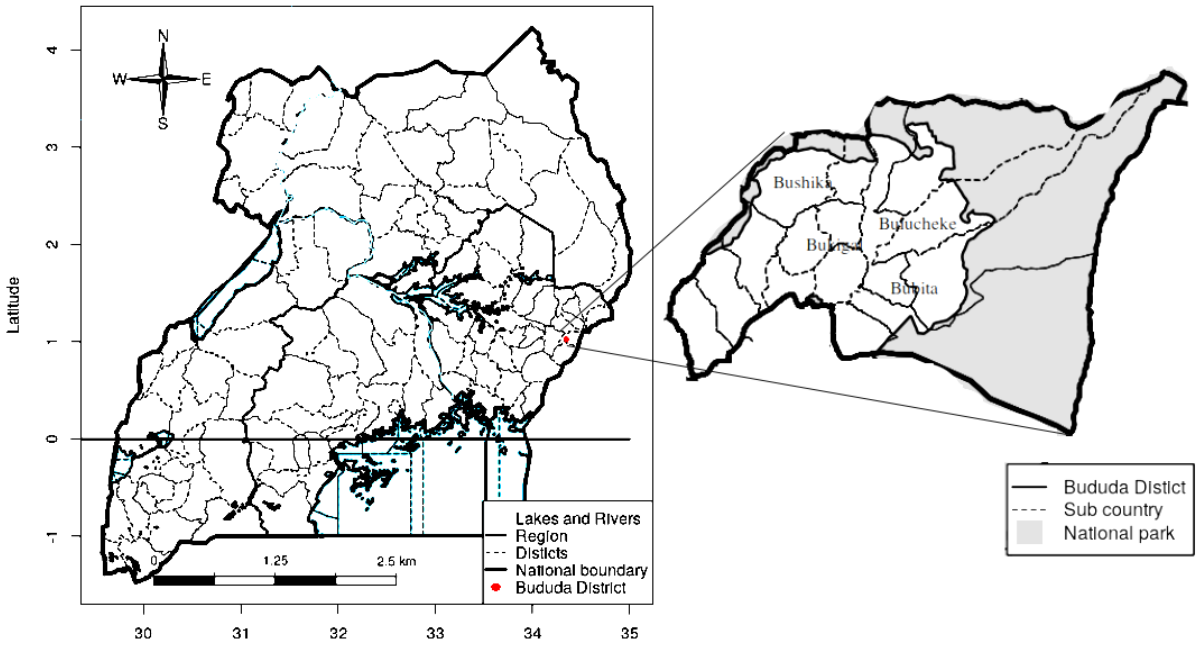

Figure 1. *Shows the map of Uganda and Bududa, the study area*

Bududa is one of the districts having the highest population growth [4,27]. Bududa's population has been growing at a rate of about 4% (i.e. 79,218 in 1991; 123,103 in 2002 and 210,173 in 2014) [27,28]. The district is estimated to have a population density of over 950 persons per square kilometre [17,27] and the main economic activities of most local people is crop growing [5,17]. The increasing population of the district is putting pressure on land resources and forcing people to encroach on the hill slopes

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including protected areas. This observation was also made by Wansolo[5] and presented as one of the drivers of the frequent occurrences of landslides over Bududa.

2.2. The history of landslides

Historically, the Mount Elgon region has traditionally experienced landslides during rainy seasons and Bududa district is the most prone area in the region [4]. The historical occurrences of landslides and their associated impact to the communities are presented using Table 1. The landslides over the Mount Elgon region are attributed to the changing landuse patterns [5,6], steepness of the slopes [5,17], water flow from the ground and concavities [17]. Prolonged rainfall of low intensities normally have high chances of infiltrating and soaking the soil thus increasing the chances of landslides over steep slopes [5,6,17].

2.3. Data collection

The study used 82 respondents randomly selected from Bulucheke sub county and from the villages of Bunakasala, Mayenze, Bumarakha and Bumamulembwa. During the data collection exercise, the participants focused on whether the respondent's household was affected by the previous landslide of October 2018 [24] and the efficiency of the landslide early warning in helping the respondents to mitigate the impacts of the landslides.

The study administered semi–structured questions to the 82 respondents and an in–depth interview to four focus group discussions(FGD) with each village being represented by one FGD. A pilot study was first conducted to test the validity and reliability of the questions that were administered. Separate follow–up interviews were arranged to two key informants to further validate the information obtained from the administered questionnaires.

Simple random sampling was employed to recruit the respondents and the sampling framework was obtained from the local council chairpersons of the respective villages. Emphasis was put on households settling in hilly areas, i.e. facing a high exposure to landslides.

2.4. Data analysis

The data collected using questionnaires from household surveys were analyzed using descriptive statistics to draw conclusions about the communities' perception regarding the barriers to the effective utilization of the landslide early warning system. The data collected using focus group discussions were in local language (i.e. Lugisu) and were first translated to English language. Lugisu was used because it is the main language used in the area [28] and care was taken not to alter the meaning.

The content was then analysed using content analysis approach as suggested by Neema *et al.*[4] and Lavaei *et al.*[29], among others. This study particularly used the *Conceptual analysis* [30,31] to

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determine the presence and frequency of concepts from the views of the respondents. Where necessary, *Relationship analysis* [29,32] was employed to further examine the relationship among the views of the respondents.

The data as transcribed were read and re–read by the authors to ensure accuracy and then coded. The coded data enabled categorization which gave the themes as presented in the results. The results are presented using both graphical and tabular formats.

2.5. Ethical matters

The study was carried out in line with the basic ethical consideration e.g. informed consent [33]. The permission to carry out the study was obtained right away from the district authorities through the different local governing levels to the village. Additionally, the consent of each respondent was first thought before administering the questionaires and the responses from the respondents made annonymous.

The objectives and benefits of the study were explained to the respondents and the respondents were made aware that they were not obliged to respond to all or any of the questions should they feel uncomfortable with any question at anytime during the interview. Additionally, all the data collected were strictly kept confidential and for the purpose of this study.

3. Results and Discussion

3.1. Demographic characteristics

The study used 82 respondents (Males: 58% and Females: 42%) and 4 focus group discussions (FGD) with each FGD representing a village. The age distribution of the respondents is presented by Figure 2. We noted that majority of the respondents were older than 35 (i.e. 70% of the respondents) who had a thorough understanding of the landslides occurrences in their respective areas of residence. Generally the mean age of the respondents was 43.

3.2. The experience of the community with the 2018 landslide

Table 2 shows the responses regarding the experiences of the respondents with the landslides that occurred in 2018. The results (Table 2) show that majority of the respondents were concerned with the crops destroyed when the landslides occurred (35.9%). The degradation of land (Table 2, 29.8%) is also reported by Kitutu *et al.*[17] and they also reported destruction of infrastructure as a major concern to the farmers over Bududa. On the other hand, only 6.9% lost livestock and human lives. This probably means that some respondents settled in areas less steep (or prone to landslides) or had capacity to evacuate on receipt of the landslide early warning information. The importance of early warning in

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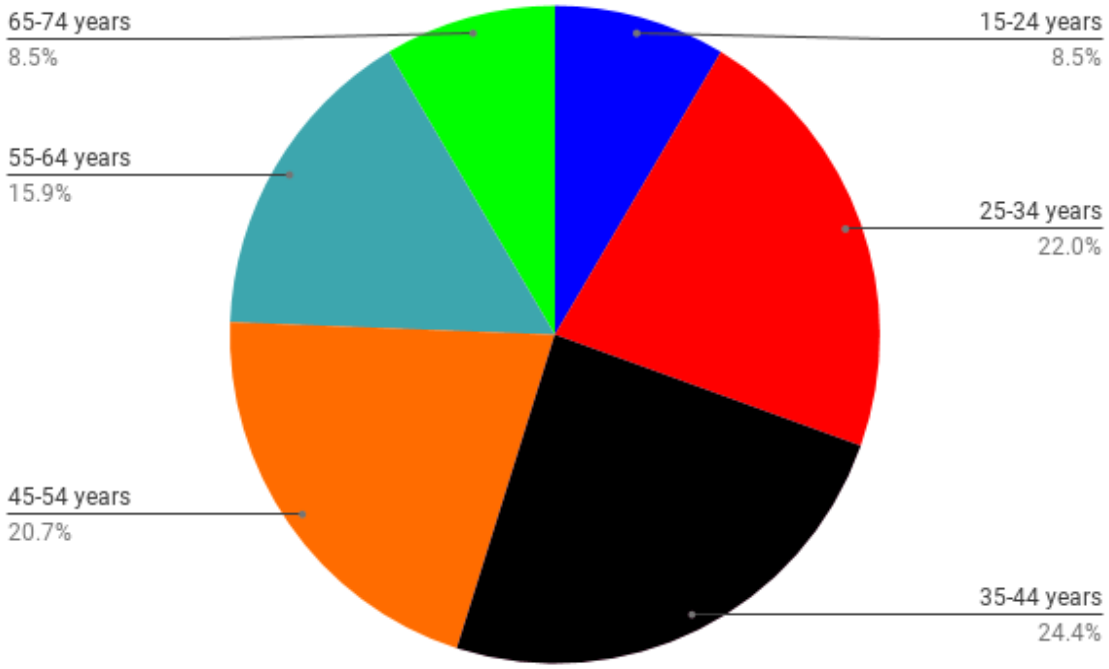

Figure 2. *Shows the distribution of the age of respondents used during the study*

eminent risk of landslide occurrence was expounded by Mirus *et al.*[34] and they showed how the early warning help to reduce fatalities over the landslide prone areas between Everett and Seattle, Washington, USA.

Table 2. *Reported damages of landslides*

Effect/Damage	Responses*	Frequency (%)
Destruction of crops	47	35.9
Degraded land	39	29.8
Destroying houses/buildings/infrastructure	19	14.5
Killing livestock	9	6.9
Killing people	9	6.9
Uprooting trees/bananas/coffee	8	6.1
Total	131	100

* More than one response was allowed

Thus, a possible explanation of the decreased fatalities on occurrences of landslide could be the utilization and uptake of the warnings issued through the landslide early warning. This must have made the community members exposed to high landslide risk, i.e. living in hilly areas, to evacuate. This observation was further expounded by Mr. Charles Khatiya, one of the key informants, a primary teacher and elder as:

"*Household members respond to warnings and evacuate immediately*"

Mr. Charles Khatiya's assertion was further reinforced by a focus group interview carried out consisting of religious leaders. They had the following to say:

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"The people respond immediately and lives have been saved especially they have not lost lives ever since the system [landslide early warning] was put in place, in 2018"

3.3. The landslide warnings

Our study found that a landslide early warning system[21], is in place to warn and alert the community potentially the occurrence of landslide. The findings show that 93.2% of the respondents received the landslide early warning alerts while only 6.8% didn't. We also noted that, of those who received the warnings, 60% were males and 40% females. The results further showed that of those who received the landslide early warning, 78.8% evacuated which probably explains the small percentage, i.e. 6.9% of the respondents who have lost their relatives due to the landslides that occurred in October 2018.

A couple of channels are used to disseminate the warnings as presented in Table 3 and these are also presented by Onek[21]. Additionally, Table 3 shows the effectiveness of the different channels of transmitting the landslide early warnings messages. The results show that of the eight channels of delivering the early warning messages (Table 3), the method of using radios (44.4%) is the most effective followed by using the community especially the clan members (19.5%). However, these channels seems to be disadvantaging the receipt of the warnings by female gender, since only 40% of those who received the information were female. This view is also supported by the findings of Balikoowa *et al.*[16]. Fortunately, in the event of a disaster occurring, the affected often work together irrespective of gender segregation to reduce the impact of the disaster [35].

Table 3. *Landslides warning received. "Channel" is how the warning was received*

Channel	Responses*	Frequency (%)
Radio	59	44.4
Clan members/family/community	26	19.5
Local leaders / Local Councils	19	14.3
Redcross	10	7.5
Drums / Alarms / Outdoor speakers	7	5.3
News paper Television	5	3.8
Church / Mosque	4	3.0
Telephone call / short message	3	2.3
Total	133	100

* More than one response was allowed

The religious institutions seems to be less effective probably because, the times of happening of the landslide disasters do not match the time of congregating or the people rarely visit the religious places. Additionally, the use of telephone call / short messages is least effective probably because, the people are not affording to buy the telephones or not having the credit (i.e. air time) to communicate. The ineffective use of telephones to communicate during landslides is contrary to the

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recommendations of Odlum[24] who had suggested the use of smartphones in communication with the disaster management officials.

3.4. The challenges in disseminating landslide warning information

Although the landslide early warning was well received by the community (85% of the respondents reported that they were generally satisfied with the landslide early warning system) and this position was further emphasized by Ms. Robinah Nabutale in one of the focus groups, thus:

> *"... yes, it [landslide early warning] was a community initiative ..."*

and further confirmed by Mr. Dison Wanasolo in another separate focus group interview, thus:

> *".. yes, [community] participated in the development of the early warning system [landslide early warning system]"*

it has faced many challenges arising from the perception of the community members it is intended to serve. Table 4 presents the perception of the communities exposed to landslides in the uptake of the disseminated landslide warning information.

Table 4. *The perception of the community members when landslide warning is issued*

Perception	Responses*	Frequency (%)
Poor timing	26	29.9
Poor coordination	18	20.7
Poor sensitization	16	18.4
Radio signal problem / power	9	10.3
Negligence	9	10.3
Unclear information	8	9.2
Not understanding information	1	1.1
Total	87	100

* More than one response was allowed

The results present: poor timing (29.9%) of issuing the warnings; poor coordination (20.7%); and poor sensitization (18.4%) as the major challenges affecting the uptake and utilization of the landslide early warning. Poor timing seems to be a global problem because, as explained by Koizumi *et al.*[36], relying on rainfall alone cannot give information about slope characteristics and soil moisture. Locally, poor coordination is probably one of the underlying factors that lead to the heavy fatalities suffered when landslides occur. It must be this reason why Odlum[24] recommended improved coordination between government, the disaster management teams and humanitarian agencies in order to adequately support the landslide victims and escape duplication. Generally, these challenges affect the preparedness and resilience of Bududa people negatively as observed by Juventine[37].

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We also consider that with proper sensitization, the negligence (Table 4, 10.3%); the view that the information issued is not clear (Table 4, 9.2%); and the community not understanding the information (Table 4, 1.1%) will definitely improve since the landslide early warning was a community initiative and the community fully participated in its development.

In order to address some of the above challenges, one focus group discussion suggested, thus:

> *"... they [community members] need more trainings; motivate the community–based disaster risk reduction members; enhance supervision and monitoring by redcross; develop capacity of the subcounty team; and lobby for more partners to support the system [landslide early warning system]"*

We find the above suggestions in line with the recommendations of Misanya *et al.*[38], thus, to strengthen the community networks and communication channels. This is because, on the happening of most of the landslides, a section of people in the community is usually aware [5].

4. Conclusion

Bududa district is one of the districts prone to landslides and these are occurring due to the changing rainfall patterns, landuse and the steepness of the terrain. Prolonged rainfall of low intensities exacerbate the chances of landslides. In order to manage landslides and enhance preparedness, a landslide early warning system was developed in collaboration with the community in 2018. However, the effectiveness of this landslide early warning system is not well documented. This study set out to study the effectiveness of that landslide early warning system by critically investigating the barriers to sharing and managing landslides information and warnings.

This study obtained data from 82 respondents over Bududa (considered 4 villages) and also conducted 4 focus group discussions (one per village per village). 70% (mean age 43) of the respondents were older than 35 and it was presumed that they had a thorough understanding of the landslides in their respective areas of residence. The study observed that Bududa is heavily populated (population density of 950 persons per square kilometre) and this high population is one of the factors fueling landslides, because the people are encroaching on the hill slopes including the protected areas.

The study also observed that the people of Mount Elgon have historically been affected by landslides. This study found that majority of the respondents were concerned with the destruction of crops destroyed (35.9%); land degradation (29.8%); loss of lives and livestock (6.9%) on the occurrence of landslides. We theorize that a possible explanation of the decreased fatalities (6.9%) when landslides have occurred, is the utilization and uptake of the warnings issued through the landslide early warning and the people taking precaution including evacuation. Additionally, we attribute the

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frequent occurrence of landslides to the changing landuse patterns; settlement on steep slopes; water flowing from the ground and concavities; and prolonged rainfall of low intensities that infiltrate and soak the soil thus increasing the chances of landslides occurrences.

Whereas we found that the landslide early warning system was in place since 2018, 93.2% of the respondents have ever received the warnings and alerts, while 6.8% have never. We also found that of those who received the early warning, 78.8% of the respondents evacuated and we believe it could probably be the reason for the small fatalities (6.9%) after the occurrence of the October 2018 landslide. The study also observed that the landslide early warning messages are disseminated through different channels and out of these channels, the method of using radios (44.4%) was the most effective followed by using the community, especially the clan members (19.5%). However, only 40% of the women received the early warning from radios which probably means that this channel puts women at a disadvantage. The study further noted that the religious institutions are less effective and equally is the use of the telephone call / short messages.

This study also noted that poor timing (29.9%) regarding the issuing of the warnings; poor coordination (20.7%); and poor sensitization (18.4%) were the major challenges affecting the uptake and utilization of the landslide early warnings. We suggest that with proper sensitization, the negligence (10.3%); the view that the information issued is not clear (9.2%); and the community not understanding the information (1.1%) will improve since, the early warning system was a community initiative with full community participation. Generally, to enhance the effectiveness of the landslide early warning system, it is necessary to strengthen the community networks and communication channels since, whenever landslides occur, a section of people in the community is usually aware.

Author Contributions: This study was conceptualized by M.N. and supervised by I.M. Additionally, M.N. and G.M collected the data; R.N., S.T., B.N., S.R. and S.O. discussed the results. M.N. and I.M. authored the remaining parts of the manuscript.

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