

# Early alert and community involvement: approach for disaster risk reduction in Rwanda

Lamek Nahayo<sup>1,2,3</sup> · Christophe Mupenzi<sup>1,2,3</sup> ·  
Alphonse Kayiranga<sup>1,2,3</sup> · Fidele Karamage<sup>1,2,3</sup> ·  
Felix Ndayisaba<sup>1,2,3</sup> · Enan Muhire Nyesheja<sup>1,2,3</sup> ·  
Lanhai Li<sup>1</sup>

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**Abstract** Natural disasters' socioeconomic and environmental losses are predicted to rise, unless early warning, full stakeholders and community involvement in the mitigation, adaptation and risk reduction are squarely engaged. The objective of this study is to assess the impact of early alert and community involvement in disaster risk reduction in Nyabihu District, Western Rwanda. A quota sampling method was employed to obtain a sample of 240 households from 12 sectors of Nyabihu District in 2015. A structured questionnaire was used, and the field data collected were computed by using SPSS16.0 for Windows. The results indicated that, as stated by respondents, the frequently experienced disasters are floods (51.25%) and landslides (42.08%). However, as asserted by 68% of informants, disaster-related information is communicated through radio channels after the occurrence, while 29% of them declared that disaster information is disseminated before occurrence, which implies the rising level of risk vulnerability and incidences to the community due to lack of early warning. A lower community participation in disaster risk preparedness and mitigation was noticed (6.2%) while 31.6% mentioned taking part in activities aimed at coping with the aftermath (adaptation). Moreover, disaster risk reduction government policies are preferentially implemented (42.9%) other than considering the community's knowledge (14.1%). To halt the gradual increase in disasters' associated risks and losses, it is suggested to introduce disaster-related training across the community, introduce disaster courses from elementary schools and integrate the community in decision-making process.

**Keywords** Community involvement · Disaster risk reduction · Early alert · Nyabihu District · Rwanda

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✉ Lanhai Li  
lilh@ms.xjb.ac.cn

<sup>1</sup> State Key Laboratory of Desert and Oasis Ecology, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, 818 South Beijing Road, Ürümqi 830011, Xinjiang, China

<sup>2</sup> University of Chinese Academy of Sciences, Beijing 100049, China

<sup>3</sup> University of Lay Adventists of Kigali (UNILAK), POB Box 6392, Kigali, Rwanda

## 1 Introduction

Under climate change, various disasters like floods, heatwaves, storms, droughts plus increasing atmospheric greenhouse gases have been reported. These disasters cause heavy human, socioeconomic and environmental losses, particularly on poor societies with limited mitigation and adaptation capabilities (Merkouris 2014; Doğulu et al. 2016; Kellenberg and Mobarak 2008). The most registered disasters are natural, with spread of diseases, infrastructure damage and human and livestock death. Significant disaster risk reduction mechanisms, such as increasing meteorological stations for regular updates, disaster monitoring and evaluation centers, rescue/relief services, have been built to achieve sustainable development and a resilient community to the changing weather and climate (Pearce 2003; Tompkins and Adger 2004). Natural disasters have generally hydrological, meteorological, climatic, geophysical or biological origin and/or causes. Natural disasters cause both short- and long-term effects on economic growth, development and poverty reduction. To enhance community's resilience to natural disasters, it has been reported to understand and assess the consequences and their implications along with considering their main signs, time and place of appearance (Mata-Lima et al. 2013; Benson and Clay 2004; Noy 2009).

However, mitigation is still prominent compared to adaptation and the community's low level of direct participation in decision making is among the leading causes of increasing disasters' gravity. The increasing rise of damages of disasters resulting from lack of appropriate and timely forecasting, early warning and evacuation procedures is heavily impacting on public health and sustainable development programs. Therefore, to reduce the incidences and vulnerability, there is need of community involvement approaches and rise of awareness particularly on the frequency and magnitude of the events for early preparedness, mitigation and adaptation (Satapathy and Walia 2007; Few 2003; Sättele et al. 2016; Haile 2005; Nkwunonwo et al. 2016; Mercer 2010).

Natural disasters have been recorded over last years in Rwanda, like landslides, flooding, droughts, fires and famine which in turn took out people's life, washed hectares of crops, destroyed houses and misplaced people along with soil and water quality pollution and degradation (Kalinba 2011; Nduwayezu et al. 2014). In Rwanda, from 2000 to 2013, floods mainly occurring from September to December and April to May, where the frequency and intensity of rainfall are too high washed away 1446.4 ha of cropland and damaged 881 houses, caused 10 injuries and 24 deaths. Heavy rains and winds killed 28 people, causing 47 injuries, 3282 houses were damaged, and 1498 ha of cropland was taken away. Also, a total of 6 droughts killed 237 people, while 4156, 545 people were affected by its consequences (Asumadu-Sarkodie et al. 2015; Buruchara et al. 2002; Rugigana et al. 2014; Gebauer and Doevenspeck 2015). The government of Rwanda adopted several measures for disaster risk reduction, including but not limited to bench terraces and agroforestry on hills and mountains, financial aid for the loss recovery and people expropriation after disasters, increasing the number of meteorological stations for regular updates and awareness of community on disasters (Vunabandi et al. 2015; Musana and Mutuyeyezu 2011).

In spite of mitigation and adaptation measures adopted, Rwandan high elevation of northern and western parts exposes these regions to more landslide and floods, whereas the southern and eastern parts have been experiencing droughts events. These are associated with high demographic pressure under limited steep slope land, easily exposed to erosion, which in turn increases the flooding and landslides' incidences (REMA 2011; Thaxton

2009). Nyabihu District of the Western Province, in particular, has been greatly affected by natural disasters, and their related losses have been recorded, including 431 houses destroyed, and this led to 2300 people displaced and 210 ha of land destroyed (Zimmerman 2012). Landslides and floods have been among the major disasters in Rwanda with great impact on human development, properties, infrastructures and environment, which today is integrated in national development plans as crosscutting issues (Bizimana and Schilling 2009). However, unavailable detailed data and studies on natural disasters, limited meteorological stations for climate monitoring and update provision, lack of early warning, late and/or lack of information sharing and awareness at local levels and limited financial capabilities for adaptation are the main concerns in Rwanda (Zimmerman 2012; Bizimana and Sönmez 2015; Munyaneza et al. 2011). Therefore, more efforts for disaster risk reduction in Rwanda are paramount. The objectives of this study are therefore to (1) assess the impact of early alert and local community involvement in disaster risk reduction and (2) suggest the plausible course of action to be undertaken for disaster risk reduction in Rwanda.

## 2 Materials and methods

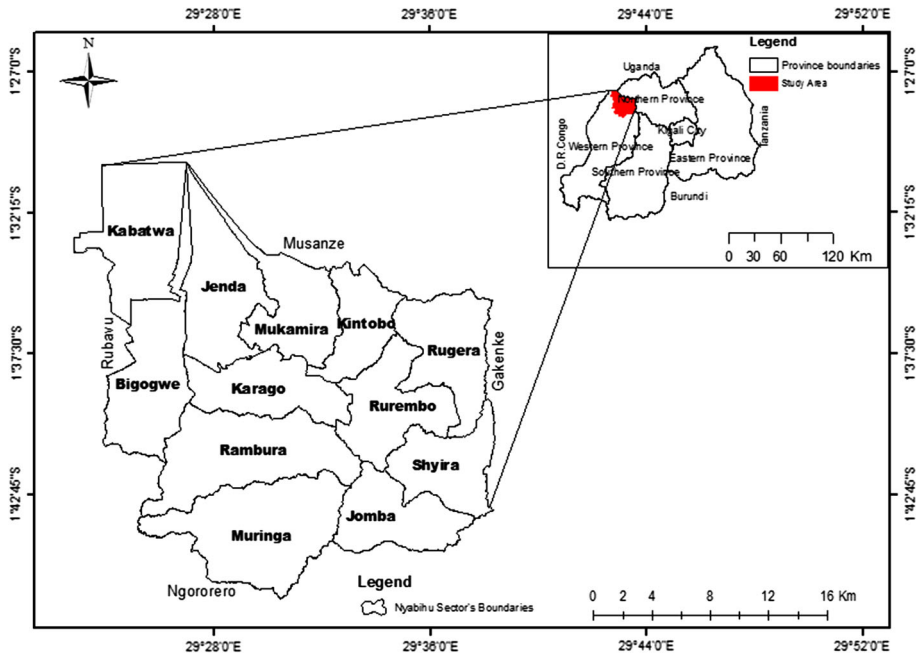
### 2.1 Description of the study area

This study assessed the impact of early alert and community involvement in disaster risk reduction, with the case of Nyabihu District, one of the seven districts of the Western Province of Rwanda. The district is composed by 12 sectors and borders in its north with Musanze District and Virunga National Park separating the district with the Democratic Republic of the Congo (DRC). Rutsiro and Ngororero districts are located in its south, Musanze and Gakenke districts are located in the East while Rubavu District is located at its west (Zimmerman 2012; Fig. 1).

Nyabihu District covers a geographical coordinates of  $1^{\circ}27' - 1^{\circ}42'45''$  south and  $29^{\circ}28' - 29^{\circ} - 52'$  east. Its geographical relief is of 90% mountains with more than 55% highly exposed to erosion, landslides and other climate change-generated harms. The precipitation is around 1400 mm per year and an average temperature of  $15^{\circ}\text{C}$ . The total population of Nyabihu District is 295,580 with a density of 556 inhabitants per kilometer square; agriculture is the main source of income employing 74% of its total population, as by 2013 (District 2013).

### 2.2 Data collection and analysis

The primary data were obtained through a field visit by using a questionnaire in October 2015. This study adopted the quota sampling method (Altun et al. 2005; Morrow et al. 2007) due to its advantage in easy sampling and good results while considering a sample from a large population. This method was applied to the case study to select 240 households within 12 sectors (20 households in each sector of the district). However, depending on the number of the cells per sector, it arrived where we could take more or less than 20 households per sector, being sure that the household is located in the target sector until the whole district estimated number of sampled household (240) was obtained. The household questionnaire was answered by the head of the family or his/her substitute. Table 1



**Fig. 1** Map indicating the study area (Nyabihu District)

**Table 1** Description of respondents

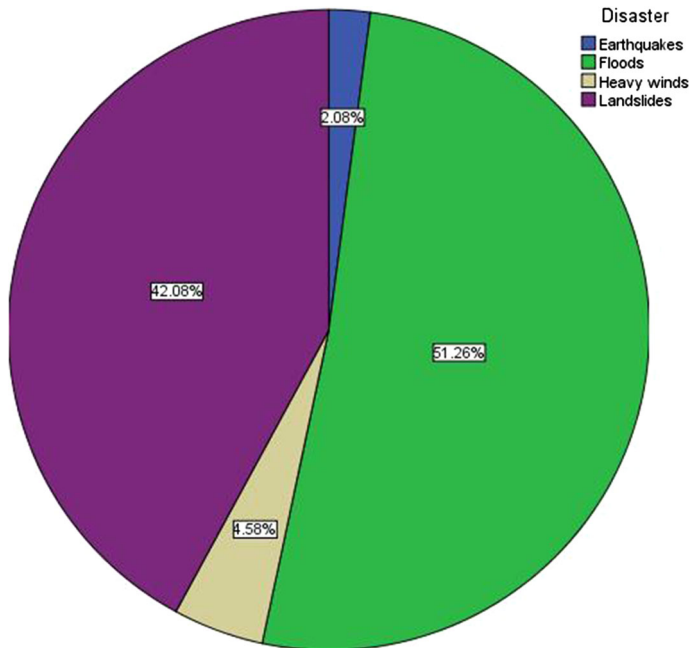
	Gender			Education						
	M.	F.	T.	Illiterate		Primary		Secondary		
				M.	F.	M.	F.	M.	F.	T.
Frequency	134	106	240	32	27	69	78	18	16	240
Percentage	55.83	44.1	100	13.33	11.2	28.75	32.5	7.5	6.66	100

*M.* male, *F.* female, *T.* total

illustrates that a majority of informants are male (55.8%), and female (11.2%) is less illiterate than male (13.33%) and attended primary schools at high level than male.

The use of questionnaire was adopted in this study due to its advantages in collecting information in a large number of people, like this case study of 240 informants. The Questionnaire is practical, reliable and valid, and enables respondents to feel free in providing their feedback and provides openness and honest (Bowling 2005; Kelley et al. 2003).

During the field visit, authors considered (1) both male and female along with their education level (Table 1); (2) community’s understanding on natural disasters, as shown in Fig. 2 where respondents enumerated the frequently experienced natural disasters; (3) the channels used for communication and information sharing like radio, television and community meetings (Fig. 3), in here, respondents answered if the channel provides



**Fig. 2** Community’s knowledge on frequency of natural disasters in Nyabihu District

disaster-related information before or after occurrence; (4) the mitigation and adaptation measures adopted (Fig. 4), respondents were given alternatives basing on the common practices for disaster risk reduction in Rwanda (bench terraces, agroforestry, financial aid for the loss recovery, expropriation and early warning) and were asked to pick the most applied in their respective area; finally, (5) the way and level at which both government and local community participate in disaster risk reduction options like involving local community in mitigation, adaptation, considering local traditional knowledge, only implementing government policies and provision of training sessions for community awareness and preparedness to disasters were provided (Fig. 5) and respondents chose the most executed for disaster risk reduction in Nyabihu District. After all, primary data were edited and coded for easy interpretation and then were computed with the use of SPSS16.0 for Windows. This study also adopted the literature methodology to facilitate the analysis and discussion of primary data obtained from field visit.

### 3 Results

#### 3.1 Community’s experience with natural disasters in Nyabihu District

Flood and landslides are the main frequently experienced disasters in Nyabihu District (Fig. 2) as highlighted by 51.25% and 42.08% of respondents, respectively, compared to heavy winds (4.58%) along with earthquakes (2.08%).

Bearing in mind that natural disasters are associated with consequences particularly on natural resources, human health and its properties, the impacts of these prominent disasters

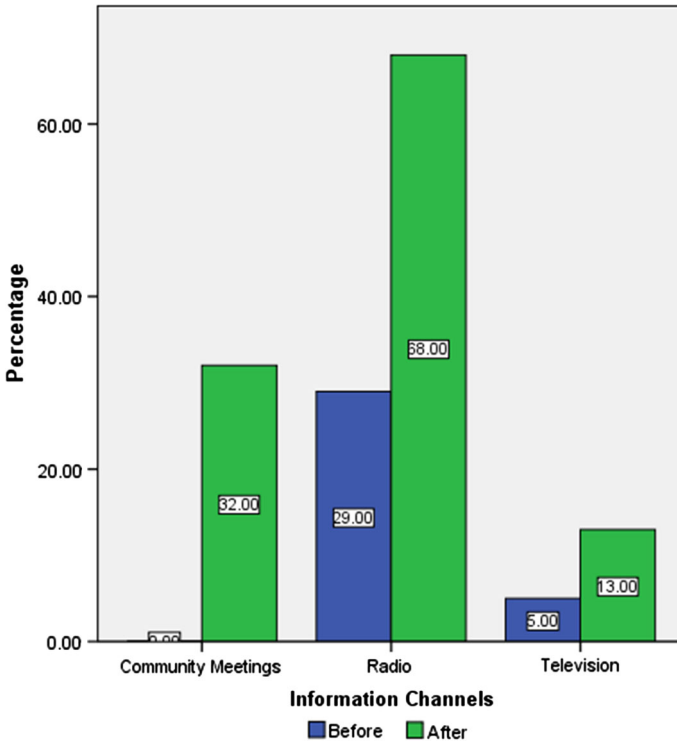


Fig. 3 Information-sharing channels

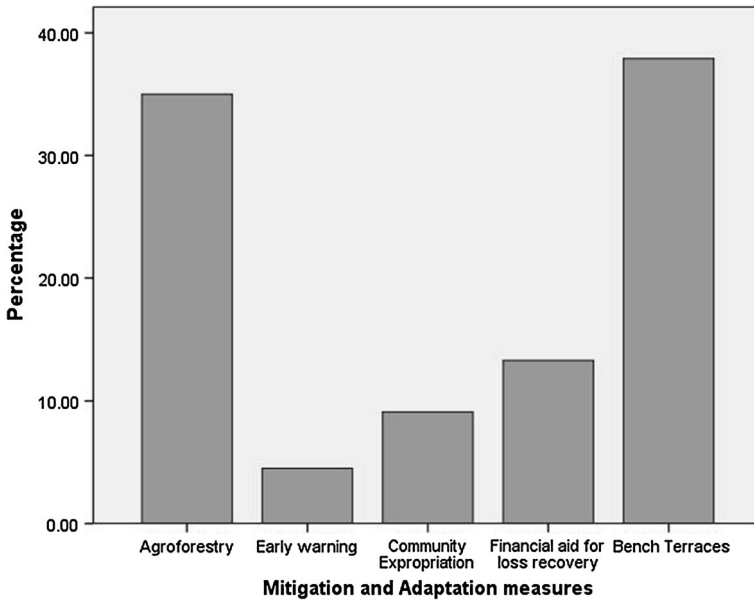
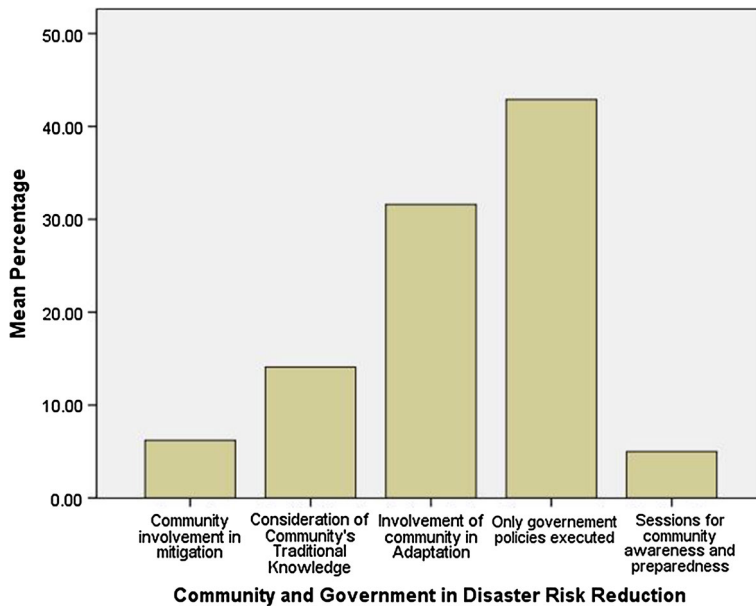


Fig. 4 Natural disasters mitigation and adaptation measures



**Fig. 5** Proportion of community and government involvement in disaster risk reduction indicates a low community participation compared to government policies execution, which raises local community vulnerability, since it is beneficiary not participant

need accurate and appropriate mitigation measures to restore community welfare and natural resources sustainability (Kiedrzyńska et al. 2015; Schipper and Pelling 2006). Disasters such as these constitute a monumental challenge to sustainable development and economic growth in the area since they are often associated with losses in human lives, killing of livestock, cropland ravages, infrastructure and natural resource degradation.

### 3.2 Natural disasters mitigation and adaptation measures

Respondents provided information on the channels through which they get information, either before or after disaster occurrence, the mitigation and adaptation measures adopted and the extent to which community participates in disaster risk reduction in Nyabihu District.

#### 3.2.1 Channels and time of information sharing on disasters

Communication greatly impacts on improving community disasters’ resilience through learning from previous events and enhances the community’s awareness and preparedness to the coming disasters. In this regard, local radio and television channels along with regular weather stations for updates provision are used in many places to reduce the community’s vulnerability to natural disasters (Kelman et al. 2016; Sims and Vogelmann 2002).

As illustrated in Fig. 3, respondents asserted that the information regarding disasters in Nyabihu District is mostly provided by radio channels after occurrence (68%) than before (29%). This late or lack of disaster alert increases community’s vulnerability, while it

normally could be provided before the incidence happens for the community readiness in assets deployment, moving from disaster-prone area and envisaging appropriate adaptation measures in advance.

The use of radio has been found to be the most common channel for disseminating disaster-related information due to the following reasons: firstly, most communities have access on radio in a sense that they are relatively affordable, handy and require no other extra spending; secondly, televisions require electricity which has not been yet distributed the whole community; and lastly, the information is provided in Kinyarwanda language to enable all listeners to understand and get the information disseminated. However, as there are fixed hours of news broadcasts, urgent disaster-related news may be delayed to conform with the schedule, which, in turn, may jeopardize the ability of households to access timely information. We therefore suggest to promptly spread out the news relating to disasters' occurrence as soon as the signs are detected without waiting for the time of formal news broadcasts either on radios or televisions. This will enhance community's preparedness and resilience to disasters as well.

### 3.2.2 Mitigation and adaptation measures

Mitigation and adaptation measures are the mechanisms used to alert on the upcoming events, for the readiness and management of its associated consequences, while for the mitigation of natural disasters, early warning is the first and most important strategy to adopt (Klein et al. 2005). Early warning is reported to be among the major tools for disaster risk reduction, since it provides information on disaster before occurrence and can help in saving people's health and properties (Flanagan 2001).

However, the situation appears contrary in Nyabihu District (Fig. 4), as asserted by respondents, early warning is at low level (4.5%) compared to agroforestry (35%) and bench terraces (37.9%), mainly applied for land protection from landslides and floods, which can be named adaptation and not mitigation measures. Moreover, the expropriation (9.1%) and financial aid for loss recovery (13.3%) are low. This indicates that the community is at high risk and its health and socioeconomic development can be disrupted, due to lack of stability, resulting from inappropriate and late warning on the frequency of disasters' occurrence and intensity. This is clear with high percentage of agroforestry and bench terraces against that of early warning. Agriculture being the most predominant economic activity in the district, agroforestry and bench terraces are used to minimize the soil sediments and nutrients runoff, protecting the soil against erosion, tending to supplant early warning, as a mitigation policy that should be put in place before the disasters' occurrence to enhance the community's resilience and preparedness. Furthermore, this expresses that adaptation measures are more refereed to compared to mitigation and implies the increasing disaster risk to the community, its belongings and infrastructure in Nyabihu District and calls for appropriate measures in terms of early warning.

### 3.3 Level of community and government participation in disaster risk reduction

Natural disasters' mitigation and adaptation require an active and participative local community as the most affected by the consequences of disasters and detain much experience/knowledge in managing and/or resolving the problem (Apronti et al. 2015). As illustrated in Fig. 5, local community is largely involved in adaptation (31.6%) than in mitigation (6.2%). Additionally, government policy is implemented (42.9%) with little



consideration of the community's traditional knowledge (14.1%) together with low level of disaster's awareness and preparedness sessions (5%). This expresses that local community stands as the beneficiary and not the participant in the disaster risk reduction activities, which in turn affects its welfare, as only the governmental strategies are preferentially considered, other than community's, who might have its own way of adaptation according to the realities specific to its local living milieu.

## 4 Discussion

### 4.1 Community's knowledge on natural disaster and information sharing

Community's traditional knowledge should be taken into consideration while setting out a development activity, from which the community will benefit due to its key role in community wellbeing. Nevertheless, it needs to be associated with scientific and technological education to enable the community to adapting to the changing world, weather and climate (Boyko and Cooper 2013; Conard 2013). With regard to the results of this study in terms of education (Table 1), female attended primary schools at high level than male and this is an advantage in case of countries like Rwanda, whose majority of population are female and are the most in charge of household activities (Cohen et al. 2005). Also as indicated in Fig. 2, the local community is aware of the most experienced natural disasters in their district. This expresses that, as local community can already detect and differentiate its common natural disasters, it also can be easy to reach the community through education and sensitization and can facilitate thorough dissemination of information on disaster risk reduction, taking the higher level of female literacy as leverage (Table 1).

The consequences of climate change and natural disasters are being experienced in Rwanda, and the government adopted some measures for disaster risk reduction, such as the use of bench terraces and agroforestry on hills and mountains, financial aid for the loss recovery and people expropriation after disasters, increasing the number of meteorological stations for regular updates and awareness of community on disasters (Vunabandi et al. 2015; Musana and Mutuyeyezu 2011). However, as illustrated in Fig. 3, there is still a gap for the disaster risk reduction in Nyabihu District, where the most information for community preparedness and awareness comes after the disasters take place, even the warning that should be provided before the disaster occurrence is at low level compared to its role in rescuing people's life and properties. This late or lack of information sharing leads to more risk, while early update helps both local community and government to increase the prediction and resistance as well (Liu et al. 2015). Bench terraces and agroforestry are the main natural disasters adaptation mechanism adopted in Nyabihu District (Fig. 4), due to Rwandan soil topography (steep slope) easily exposed to erosion, floods and landslides incidences (Kagabo et al. 2013). Nonetheless, earlier warning and expropriation which should be prioritized to help people moving from high risk to safe zones before disasters are not yet highly put into action compared to bench terraces and agroforestry (Figs. 2, 4), despite their role in protecting land and water resources.

### 4.2 Community participation in disaster risk reduction

Natural disasters are considered as crosscutting issue to community's socioeconomic development. However, suggestions in prevention, mitigation, preparedness and relief are

given for its achievement, and most importantly, these suggestions have been pointing out the full integration of the local community (Edwards and Mercer 2013; Berke 1995; Proust et al. 2012), which is appearing contrary to the case of Nyabihu District (Fig. 5), where government policies were highly considered at the expense of the community's traditional knowledge, which also means that community is not fully integrated in the disaster risk reduction activities (only beneficiaries instead of participants).

Moreover, the level of community involvement in mitigation is low than in adaptation, together with few training sessions to increase the community's awareness and preparedness to disasters (Fig. 5). This is in congruency with previous studies (Mathbor 2007; Pearce 2003; Stajura et al. 2012) that highlight how lack of community involvement (participant against beneficiary) is the leading cause of its increasing vulnerability and poverty. While its active integration in decision making and implementation should be prioritized, it will identify its own problems and the solutions thought to be helpful from which the development interventions can start or base on. This expresses how much community involvement can be among the solutions for disaster risk reduction in Nyabihu District.

### 4.3 Natural disasters and sustainable development

Sustainable development encompasses meeting the needs of the present generation without compromising the future ones to meet theirs (Sneddon et al. 2006). However, climate change and its damages along with natural disaster are increasingly revealing diverse expectations, and much effort is required in particularly pointing out solutions of the community's most experienced challenges (Little and Green 2009; Læssø e 2010). Lack of interaction and institutional overlap among communities and government are challenges in achieving sustainable development (Schipper and Pelling 2006). It has been discovered that natural disasters destroy natural resources, which the pro-poor depend on for their survival. Moreover, as development depends on natural resources, it is good to consider their sustainable management particularly in Rwanda, where natural resources support agriculture, one of the main sources of national GDP along with industry and services, and employs almost 80% of the total population (Ansoms and Rostagno 2012). Although the sector plays a key role in national development, it can be noted that floods and landslides (Fig. 2) will lead to grave impact on soil and water resources as the main supports of agriculture and other development activities, unless intervention and sustainable measures are regarded.

The government of Rwanda is committed to increase the number of school attendance after considering its role in sustainable development, as embedded in its Vision 2020 program. Additionally, the government made good steps in mitigating and adapting to climate change, like expanding the area under forests and bench terraces along with agroforestry for soil and water management and conducting an Environmental Impact Assessment for each development activity to be started (Ansoms and Rostagno 2012; REMA 2011). However, natural disasters are appearing to be among the challenges to sustainable development in Rwanda, and the government policies of mitigation and adaptation are highly implemented with low community's participation (Fig. 5), which increases its vulnerability as a result of not fully being integrated in the process. For sustainable development and disaster risk reduction, much is still needed in Rwanda, to increase community's resilience and reduce the amount of money paid for the loss recovery cost, which in turn enhances community welfare and national socioeconomic development as well.

## 5 Conclusions

This study assesses the impact of early alert and community involvement in disaster risk reduction in Nyabihu District, Western Province of Rwanda. The results showed that floods and landslides are the commonly experienced disasters. However, it has been found that the disaster-related information is mostly provided after and not before disaster occurrence, which can be associated with the risks and vulnerability. Also, it has been noted that mitigation and adaptation measures consisted of largely applying government policies rather than integrating and considering community's traditional knowledge, meaning that local community is not fully integrated in the process and this can decrease its resilience to natural disasters. From the findings and for the disaster risk reduction in Rwanda, we suggest to (1) fully integrate local communities in disaster risk mitigation and adaptation processes, consider its traditional knowledge and evacuate it from high risk to safe zones before the disaster occurrence, (2) invest more in science and technology research and provide disaster risk reduction education and training sessions for enhancing the community's awareness and preparedness, (3) spread out sufficient meteorological stations for regular weather updates and warnings and finally (4) future studies on the community's perception about their participation in decision making and execution could be helpful to provide more of understanding on what should be done to assure sustainable development in Rwanda.

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