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Impact of Flood on Community Livelihoods in Rwanda

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Abstract

The geographical features and climatic profile of Rwanda make the country, mainly its north-western parts, highly prone to disasters, especially landslides and floods, and this severely impacts on its citizens' livelihoods. The current study assessed the impact of flood on community livelihoods in Nyabihu district of western Rwanda. The authors adopted a descriptive research design with a sample of 139 respondents from the households, and the collected data contained qualitative and in-depth information. The communities confirmed that they record flood occurrences and some lives were lost along with severe damages. The study also revealed that flooding primarily results from frequent and heavy rains, topography, and poor drainage of rainwater. It was indicated that flood occurrence in this area leads to water-borne diseases and sicknesses. Also, roads and bridges are damaged by flood occurrences which limits transport. However, it was noted that if more people are educated, the awareness would be increased hence reducing flood effects. This study can be useful to policymakers to better understand relevant sustainable preventive measures to mitigate the negative effects inflicted by the flooding.

Keywords

Flood, Disaster Management, Mitigation, Preparedness, Rwanda

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1. Introduction

Flooding causes loss of human life, damages infrastructure such as roads, bridges, and buildings, and hurts agricultural productivity resulting from crop loss and soil erosion. Flood disaster relief often requires enormous funding [13]. Flooding can be classified into several types. Out of those, riverine floods and urban floods are the most common [17]. The majority of losses attributed to flood are evaluated probably in millions of dollars with an exponential increase with time [16].

Due to its geographical features and climatic profile, Rwanda is one of the Sub-Sahara African countries prone to disasters and especially landslides and floods [3]. The occurrence of flood in Rwanda has huge impact on the community's livelihood since it impacts on natural resources on which people's daily living conditions depend on. In Rwanda, the number of cases of flood occurrence keeps on increasing over time. For example, between December 2010 and September 2011, Rwanda registered 43 losses of lives and 73 people injured. Besides, 1,854 houses were destroyed and 2,989.9 Ha of croplands were damaged and one hundred (100) classrooms were seriously destroyed [7]. As a result, the cost of the intervention activities in terms of disaster responses and recovery to assist the victims was more than 515,520,000 Rwandan francs [7].

Nyabihu district of western Rwanda is among districts at high risk of environmental and natural resources degradation that require special attention in environment protection. The district began rehabilitating Gishwati forest devastated by the

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population in 1995 with the aim of getting arable land. And 1,405 hectares of forest have already been planted out of 1,948 hectares [11]. The district has a record on occurrence of floods and landslides which impact on seeds, harvest, tea and roads. For example, in 2013, a total of 210 hectares were destroyed, 431 houses were totally destroyed and 2,300 people became homeless [11].

Regardless the fact that flooding has been a pressing problem afflicting both human securities at the same time hindering sustainable development, most of documents about flooding events are reports of MIDIMAR and others are press releases. This calls for a scientific paper which can help to document flood occurrence and its impact on community's livelihood and identifying existing practices to prevent, mitigate and cope with floods. Therefore, this study considered Nyabihu district to analyze the impact of flood on community livelihoods.

2. Methods and Materials

2.1. Study Area

This study was conducted in Nyabihu district composed by twelve sectors: Bigogwe, Jenda, Jomba, Kabatwa, Karago, Kintobo, Mukamira, Mulinga, Rambura, Rugera, Rurembo, and Shyira. The district shares borders with Musanze district in the north and the Virunga National Park, which separates it with the Democratic Republic of Congo (DRC). In the South, there are Ngororero and Rutsiro districts, and in the East, there are Gakenke and Musanze districts, and Rubavu district is located in western side of Nyabihu district [11].

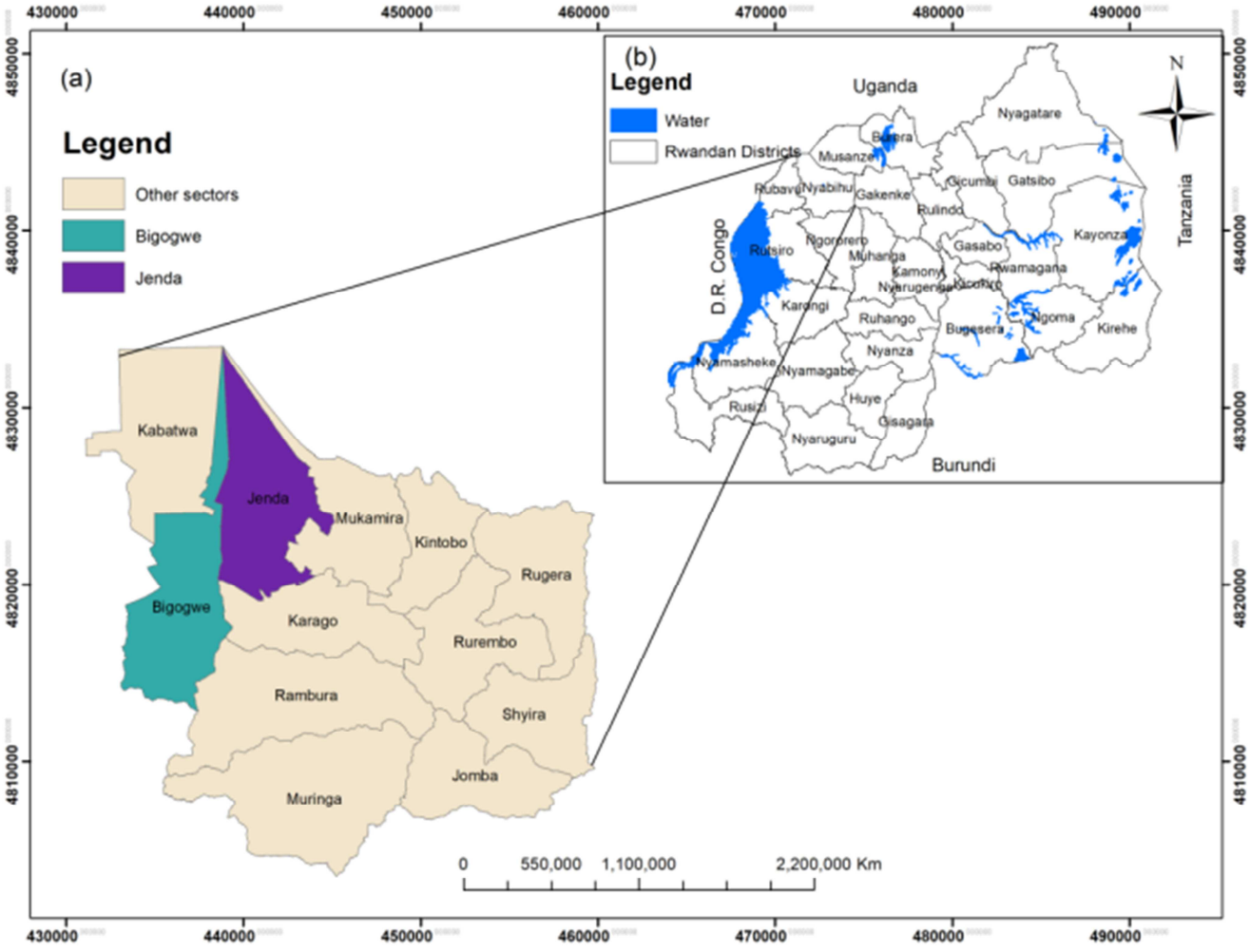

Figure 1. Location of study areas (Jenda and Bigogwe sectors) in Nyabihu district and its bordering districts of Rwanda.

Nyabihu distrct geographical relief is characterized by 90% of rugged mountains with a slope of more than 55% creating a high risk of erosion [11]. The characteristic of the soil is sandy and clay, laterite and volcanic, what makes it very fertile. The precipitation is almost uniformly over every month and close to 1,400 mm per year. The district has a temperate climate with an average temperature of 15°C favorable for the growth of the agro-pastoral products throughout the year with less risk of development of bacteria and diseases [11]. In terms of fauna and flora, there is

Gishwati Natural Forest and Volcanoes National Parks; home of diverse animal and plant species.

According to the 2012 Census on Population and Housing, the population of Nyabihu district is estimated at 295,580 inhabitants with 1% population growth with a population density estimated at 556 inhabitants per square km [11]. For this study, the authors considered two sectors of the district. These two sectors (Figure 1) were mainly considered due to the fact that recent flood events at large extent, took place across both sectors compared to the remaining sectors of Nyabihu district.

2.2. Methodology

For this study, the authors employed the descriptive or survey research design within the study cases, attempting to provide a more complete picture of the occurrence of flood in the selected sectors. The data gathered mostly contained qualitative and in-depth information for each of the two sectors about flooding by using questionnaires and group discussions. Both purposive sampling and simple random sampling techniques were employed in the process of selecting the study respondents. As long as all 66,305 residents of Jenda and Bigogwe sectors could not be easily reached, the authors selected key respondents from both sectors.

The authors considered the victims of floods in 2018 who were most affected by flooding. They all made a total of 212 households in both sectors Bigogwe and Jenda. Thereafter, the authors estimated a sample from these 212 households by using the following formula of Yamane [15].

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

Where n is the sample size, N is the population size, and e is the level of precision. Therefore, the sample size was calculated as follows:

$$n = \frac{212}{1+212\,(0.05)^2} = 138.56 \asymp 139 \quad (2)$$

The sample size for this study was one hundred and thirty-nine (139) respondents who were selected from two sectors as the case studies. The authors selected community representatives composed of village leaders, youth and women representatives, and agriculture promoters as key informants. The above 139 informants represented the total of 212 flood victims within two sectors under study. Thus, the information provided by these respondents is representing the remaining population.

2.3. Data Analysis

For this study, the collected data were coded, categorized, and entered in computer to be presented by using Microsoft Office Excel and to be analyzed by using the Statistical Package for Social Sciences (SPSS). Calculations were made of total and average frequencies. In addition, the frequencies were converted into percentages enabling the analysis and the interpretation of results.

3. Results and Discussion

The results of the study (Table 1) showed that most of the households have between five and ten members and these households with more family members are more affected because flood cause poverty and hunger which likely affect big size households than small size ones especially when the income of sources are the same. Moreover, the results indicated that farming is the major source of income of respondents. It is reported that flood effects on farming are very high. Therefore, the communities' livelihood of both Jenda and Bigogwe sectors are likely victims as they merely rely on agriculture as a source of income and main occupation as shown by Table 2 with 79% of the total respondents of the study.

3.1. Description of Respondents

Table 1. Description of respondents by gender, age, marital status, education and household size.

GENDER			
Gender	**Male**	**Female**	**Total**
Frequency	83	56	139
Percentage	60	40	100

AGE				
Age	**<35**	**35 to 50**	**>50**	**Total**
Frequency	27	63	49	139
Percentage	19	45	35	100

MARITAL STATUS					
Marital Status	**Single**	**Married**	**Divorced**	**Widow(er)**	**Total**
Frequency	2	107	5	25	139
Percentage	1	77	4	18	100

EDUCATION					
Education	**Illiterate**	**Primary**	**Secondary**	**University**	**Total**
Frequency	20	97	19	3	139
Percentage	14	70	14	2	100

HOUSEHOLD SIZE					
Household size	**Below 3**	**3-5**	**5-10**	**More than 10**	**Total**
Frequency	24	33	72	10	139
Percentage	17	24	52	7	100

The majority of respondents in this study were males representing 60% while women were 40% (Table 1). According to the results in Table 1, the youth with age less than 35 years old represented 19% of respondents, middle-aged people (35-50 years old) represented 45% and they participate more in the agriculture activities and the remaining group composed by old people (>50 years old) represented 30.9% of the total respondents under study. The

same Table 1 showed many households (52%) with 5- 10 members and followed by a group of 3-5 people with 24% of the respondents. Furthermore, the results of the study about marital status revealed that 107 of the respondents were married followed by widowed group (25%).

Finally, respondents' education is likely to influence their level of understanding about flooding in the area of the study and the level of impact that can flood have on them. According to the results in Table 1, the larger proportion of respondents (97) has attained primary school. The results indicated that 20 respondents are illiterate, 19 respondents have secondary education and only 3 respondents attended higher education.

Table 2. Income source of respondents.

Income type	Frequency	Percentage
Agriculture	110	79%
Business	18	13%
Service	4	3%
Other	7	5%
Total	139	100%

3.2. Flood Occurrence and Its Causes

According to the results of the study in Figure 2, the community of Bigogwe and Jenda sectors experiences flooding events frequently. Even if the respondents were principally the flood victims complemented by community representatives, the frequency of flooding is evident as 56% of respondents proved to experience floods for an average of 5 years. The reasons behind this frequency of flooding include heavy rains, topography, unplanned settlements, lack of /inadequate water drainage, and poor land use. These findings are similar to what was revealed by Abhas K Jha & Robin Bloch that causes of flooding include heavy rains, land use changes, urbanization and increase in surface runoff [1].

The respondents explained that their volcanic soil does not have good retention capacity of the rainwater and this makes rain water flow to the down grounds. They also indicated the existence of such down ground which doesn't have water drainage and which are likely to create permanent water bodies. Among the above-mentioned causes of flooding heavy rains and topography dominate as indicated by Figure 2.

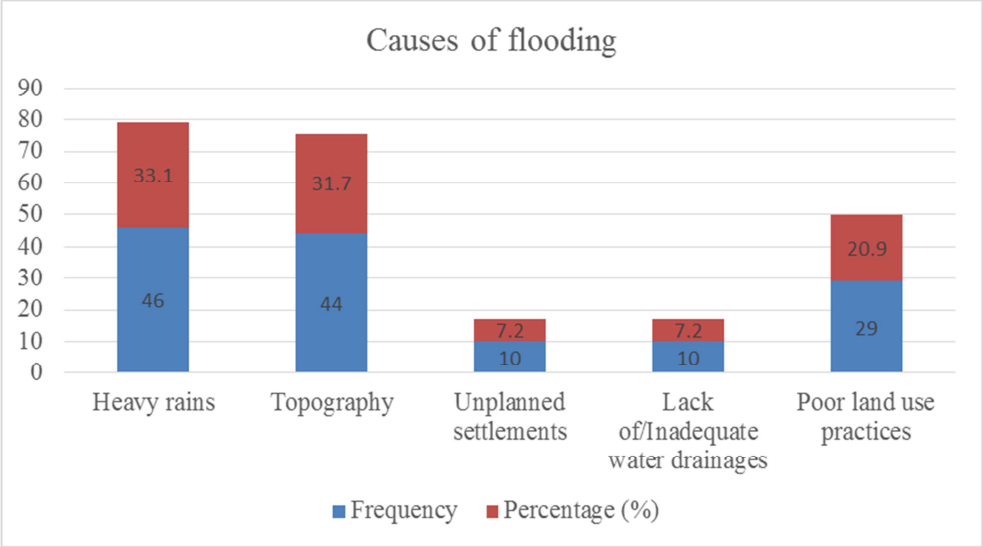

Figure 2. Major causes of flooding in Bigogwe and Jenda sectors.

3.3. Impact of Flood on Community Livelihoods

According to the results in Figure 3, 42.2% of respondents confirmed to temporally or permanently relocate from their homes, 24.5% reported having mental disorder as the major health effect, 18.7 percent reported suffering from other sicknesses due to flood. Also, 12.2 percent responded to have injuries and 2.2 responded death to be the major health effect due to flood. The displacement of flood victims requires them to find an amount of money either to build new shelters or to rehabilitate the existing ones.

Sometimes the affected communities are supported by their neighbors, civil societies, or the government through local authorities to recover from flood damages. Most common diseases resulting from flooding events as reported by respondents include diarrhea and intestinal worms and they are more prevalent in children than elder people. Diseases are also linked to the fact that flood destroys sanitation facilities like toilets and solid waste dumping. Figure 3 indicated major flood health effects revealed by the study.

The results in Figure 4, as mentioned by 56.8% of respondents, confirmed that during and after a flood, streets are inundated. Also, 22% of respondents confirmed that after flood, roads cannot be used. The affected roods include even the international road like Kigali-Rubavu as it crosses the two sectors of the study area.

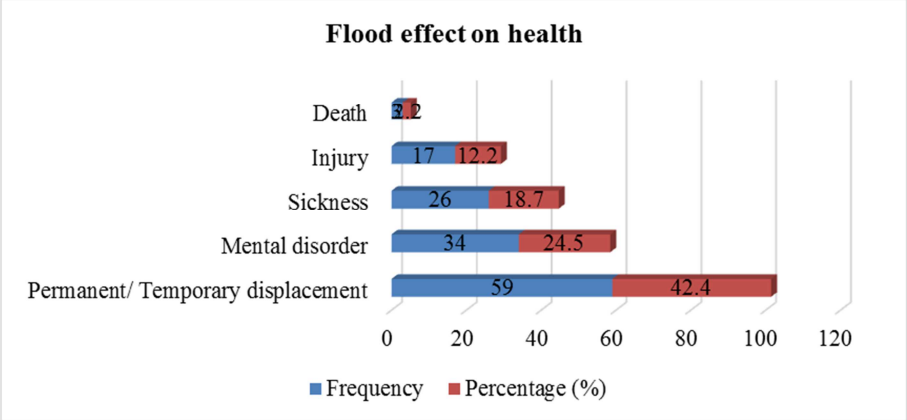

Figure 3. Major flood effects on health.

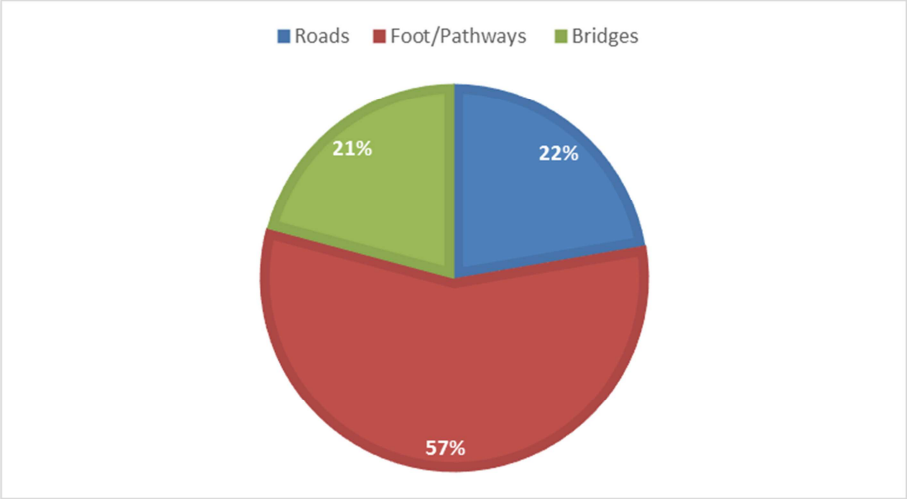

Figure 4. Transportation means hindered by floods.

The results in Figure 5, as highlighted by 23% of respondents, indicated that school infrastructures such as school premises were highly damaged due to flood in one and/or another way. Also, 64% said that children experience school attendance disruption. The disruption was attributed to various reasons such as road being impassable (28.1%) and school being submerged and closed 2.9% as well.

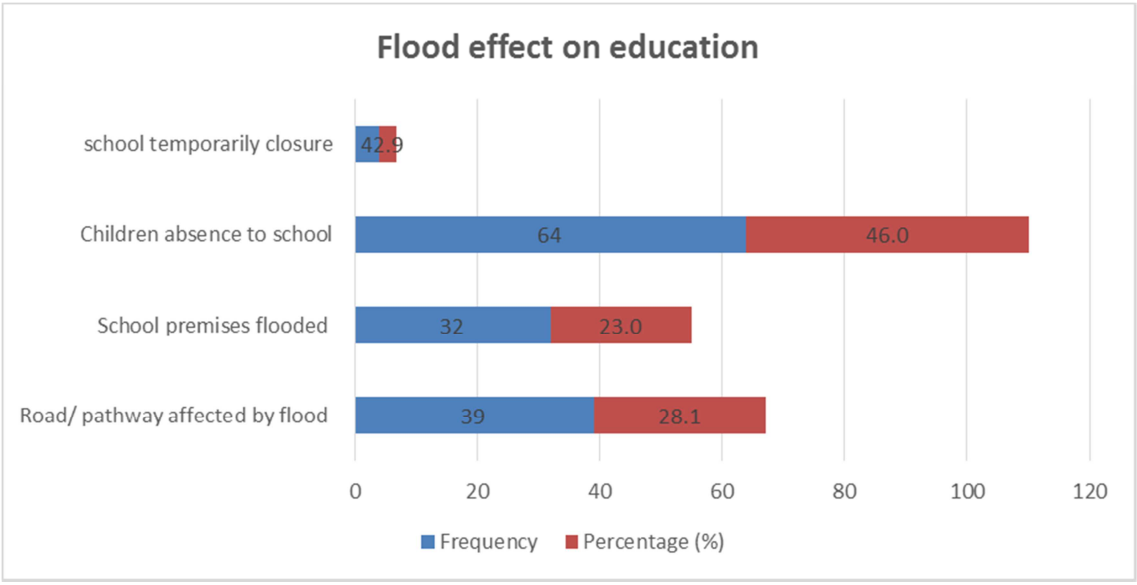

Figure 5. School activities affected by floods.

3.4. Flood Management Practices in Place

The results in Figure 6 on flood prevention measures indicated that 29.5% of respondents mentioned afforestation and reforestation, 22.3% mentioned education and 17.3% mentioned respecting building codes. In addition, in the same Figure 6, 15.8% believed in the provision of proper maintenance of adequate drains. Finally, 12.9% and 5.6% of respondents mentioned appropriate land use practices and rainwater harvesting at household, respectively. This revealed that the most commonly practiced flood management is afforestation and/ or reforestation.

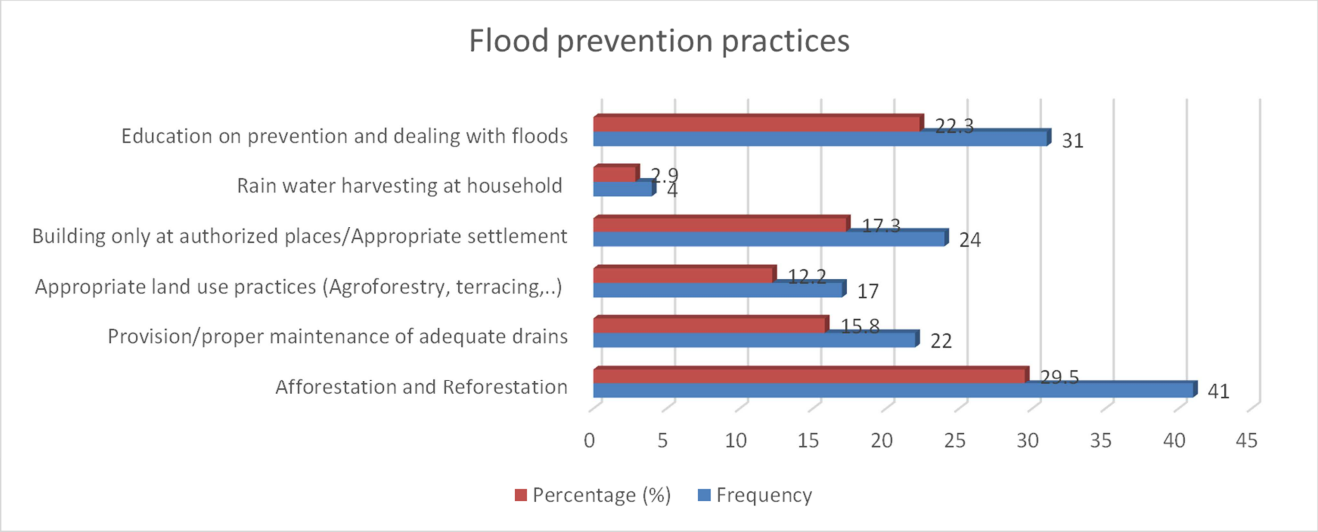

Figure 6. Flood prevention practices.

The results in Tables 3 and 4 showed the results from the chi-square test for the variables gender and health effects of flood management. For this analysis, a p-value smaller than 0.05 indicates a statistically significant association (at the 5% level) in the test while a p-value larger than 0.05 reveals no statistically significant association between two variables. Since the p-value in this example is 0.184, ($\chi2 = 6.206$, df = 4, $p>0.05$), it can be concluded that the health effects of flood and gender are not associated with one another at a statistically significant level (Table 2).

Table 3. Chi-Square Tests health effects of floods and gender.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.206[a]	4	.184
Likelihood Ratio	7.203	4	.126
Linear-by-Linear Association	.582	1	.445
N of Valid Cases	139		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 1.21.

The Chi-Square statistical results (Table 4) showed that highly educated people are less affected by floods. The reason behind is that educated people have more knowledge about how to prevent a flood. Based on the fact that the majority of respondents were farmers and attended primary school, this basic education can facilitate the training of farmers and the adoption of flood prevention practices which enhance their land-use system and household welfare. The analysis in Table 4 indicated a significant difference ($\chi2 = 290.022$ df = 12, $p<0.05$) in the educational backgrounds and flood health on respondents from Bigogwe and Jenda sectors (Table 4).

Table 4. Chi-Square Tests in education background and flood health effects.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	290.022[a]	12	.000
Likelihood Ratio	156.316	12	.000
Linear-by-Linear Association	82.137	1	.000
N of Valid Cases	139		

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is .06.

The study examined flooding prevention practices being practiced in Bigogwe and Jenda sectors. The statistical significance showed that 29.5% of respondents believed that afforestation and reforestation is the first prevention practice to retain water from hills. This is similar to what was revealed by the Food and Agriculture Organization (FAO) that the forests are necessary to regulate stream flow and reduce runoff. However, forests tend to be rather extravagant users of water, which is contradictory to earlier thinking [5]. But also this finding differs from what studies in the Himalayas indicated that the increase in infiltration capacity of forested lands over non-forested lands is insufficient to influence major downstream flooding events [6]. The analysis in Table 5 indicated a significant difference ($\chi2 = 142.618$ df = 15, $p<0.05$) in the education status and the

prevention practices. This proves that the more the population is educated, the more flood prevention strategies can be applied.

Table 5. Flood prevention and education status.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	142.618[a]	15	.000
Likelihood Ratio	134.290	15	.000
Linear-by-Linear Association	70.625	1	.000
N of Valid Cases	139		

a. 17 cells (70.8%) have expected count less than 5. The minimum expected count is .09.

The results of the study showed that 107 out of 139 respondents were married. However, it is reported that flood effects like permanent/temporal displacement, injury, mental diseases, illnesses, and absence to school are largely recorded by couples compared to singles. This is because most families have kids and women who are the most venerable in the society. The relationship analysis in Table 6 indicated significantly difference between marital status and flood prevention.

Table 6. Flood prevention and marital status.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	137.568[a]	15	.000
Likelihood Ratio	140.136	15	.000
Linear-by-Linear Association	82.122	1	.000
N of Valid Cases	139		

a. 17 cells (70.8%) have expected count less than 5. The minimum expected count is .06.

4. Conclusion

This study evaluated the flood occurrence and its impact on community's livelihoods and identified existing practices to prevent, mitigate and cope with flood in Bigogwe and Jenda sectors. The descriptive and quantitative data provided by the study confirmed that the communities of Bigogwe and Jenda sectors have been facing flood events. This was particularly shown by the frequency of the flooding in both sectors, which caused inhabitants to loose lives, economic properties and to struggle for recovery from the events. The study also revealed that flooding mainly results from heavy rains, topography and poor drainage of rainwater. The results indicated that the more people are educated, the high disaster awareness and low risk. Thus, more training and education are suggested to ensure future resilient society.

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