



## **Landslide Risk Perceptions and Associated Factors Among Families Living in High Risk zones in Gasabo District, Rwanda**

**<sup>1\*</sup> Bienvenue Aliane Uwineza, <sup>2</sup>Dr Erigene Rutayisire, PhD**

**<sup>1</sup>School of Social Sciences, Mount Kenya University Rwanda**

**<sup>2</sup>College of Medicine and Health Sciences, University of Rwanda**

**\*Corresponding author e-mail: [bienane.bo@gmail.com](mailto:bienane.bo@gmail.com)**

### **Abstract:**

This study aimed to assess the perceptions of landslide risk and the associated socio-demographic and economic factors among families residing in landslide-prone areas in Gasabo District. Landslides have significant economic, environmental, and social impacts, with over 50% of reported landslides in Asia, Africa, and South America resulting in fatalities. The study adopted a cross-sectional design with a quantitative approach, targeting 4157 households in high-risk zones of Gasabo District. A random sample of 365 households was selected for data collection using a semi-structured questionnaire covering socio-demographic information and landslide risk perceptions. Key findings from the study indicated that 59.5% of respondents had landslide risk perceptions, while 40.5% did not. Socio-demographic factors, including family size and past experience, were significantly associated with landslide risk perceptions. Economic factors such as land ownership (heritage and purchase) and income level also played a role in shaping these perceptions. Despite a relatively high proportion of respondents perceiving landslide risks, the overall level of landslide risk perception was still low. This poses a potential public health problem, as inadequate risk perception could expose the populations of Gatsata and Jali in Gasabo District to landslide risks. The study underscores the importance of interventions to prevent and manage landslide risks while increasing awareness among communities about these risks.

***Keywords:* Landslide, Risk perceptions, Associated factors, Families, High risk zones, Rwanda**

## 1. Introduction

### 1.1 Background

Worldwide, landslides are ranked as the 7th largest killer compared to other natural disasters that consequently cause heavy economic losses in many countries (Herath & Wang 2012). It has been a fatal hazard to humans not only in urban settlements but also in rural industrial areas (Froude & Petley 2018). Moreover, as a consequence of landslides, billions of euros are available to repair lost and/or damaged infrastructure, which includes different assets such as railways, embankments, roads, pipelines, and buildings (Klose et al. 2015).

In Italy, studies show that nearly 40% of participants perceive landslides as a harmful and significant threat to their homes, and 60% consider landslides to be a significant life-threatening threat (Papa et al., 2013). Scolobig et al. (2012) mentioned economic, environmental, and social factors as factors underlying risk perceptions. In addition, between 1990 and 2013, approximately 90% of global disaster-related deaths caused by landslides occurred in low- and middle-income countries (Below & Wallemacq, 2017).

Regarding Africa, every year Africa loses dollars of resources (Igwe, 2017; McAllister, 2017). Natural and human factors have made the capital of Sierra Leone vulnerable to landslides that killed more than 400 people in a week (August 2017).

The same vulnerabilities were found in villages and towns in western, central, and eastern Africa, and researchers say the threat of landslides is exacerbating the planet. Landslides have hit different parts of Rwanda in the past, causing casualties, losing many homes, and making no living (MINEMA, 2015). The following statistics reported by MINEMA (2017) indicate the prevalence of cases in some areas in Rwanda in three successive years and also the general consequences of landslides.

In April 2015, in Ngororero District/West (13 deaths and 27 injuries, 4 classrooms destroyed), in May 2016 in Gakenke District/North (35 deaths and 26 injuries, 67 roads and 29 bridges), and in April 2017 in Muhanga District/South (6 deaths and 27 injuries, 55 houses destroyed). Despite the magnitude of landslides in Rwanda, little is known about risk perceptions and their associated factors among families living in landslide risk zones. In view of that, we have done this study to answer the question, "What are the landslide risk perceptions and their associated social demographic and economic factors among families living in high-risk zones in Gasabo District.

### 1.2 Statement of the Problem

Rwanda faces significant challenges related to landslides, with reports of major disasters that negatively impact development, infrastructure, and the environment. Several districts and sectors in Rwanda, particularly the northern, southern, and western provinces, have been exposed to landslides due to high slopes, rainfall, and poor land management. Notably, districts like Nyamagabe, Ngororero, Rutsiro, Nyabihu, and Kamonyi are at high risk, affecting over 1.7 million residents, mainly those in vulnerable conditions. Even in Kigali City, 44.4% of the population is exposed to landslide risks. However, the perception of landslide risk among affected individuals is not well understood. Studies have shown that risk perception plays a crucial role in motivating people to take preventive measures.

Unfortunately, only a small percentage of unaffected people believe they are likely to be affected by landslides, highlighting the need to investigate factors influencing risk perceptions. Despite some prior studies on landslides in Rwanda, there is limited information on the factors affecting risk perceptions and attitudes toward landslides. This study aims to fill this knowledge gap by examining landslide risk perceptions and associated factors among families living in landslide-prone areas in Gasabo District.

## **2.0 Literature Review**

### **2.1.1 Landslide Overview**

According to Highland and Johnson (2004), the term "landslide" describes many processes that lead to downward movement and carry out of the materials that form the slope, including rock, soil, and man-made fill or a combination of them. Landslides can be falls, slips, or rapid flows. Landslides are mainly caused by earthquakes, rainfall, volcanic eruptions, and human activities (Wang & Sassa, 2005). Wang and Sassa (2005) also revealed that the devastating consequences of landslides include injuries and deaths.

Others include also great economic loss, specifically to families and society in general, through the distraction of very important infrastructure such as buildings, roads, lifelines, and others because of the gravitational mass movement of the earth's that results in earth-system risk. The landslides go beyond the above negative consequences and also cause irreparable damage to our culture and natural heritage (Wang & Sassa, 2005).

### **2.1.2 Landslide Risk Perception**

The meaning of risk differs for different things and for different observers (people) (Brun, 1994). Risk perceptions can be considered a subjective, personal assessment of the probability that a specified type of incident can happen and the consequences that would be attributed to that incident. During the 1940s, Gilbert White from the United States was the first researcher to introduce the concept of risk perceptions when he was studying adaptation to floods in the United States of America (Qasim et al. 2018). After 20 years, the concept of risk perceptions started to be used to understand how people view nuclear technology, which was increasingly emerging. Therefore, risk can be quantified objectively by measuring probabilities and outcomes (Raaijmakers et al. 2008). Individual awareness of risk is very important to be able to reactively adapt to natural disasters. A person's perception of risks is influenced by knowledge of past events and environmental conditions, personal beliefs, and experience (Ludy & Kondolf, 2012).

Community resilience means that people who are at high risk of disasters, imminent crises, and already existing vulnerabilities can proactively predict, mitigate, and manage the effects of shock and stress without compromising their long-term outlook or ability to recover from them (Antronico et al. 2020). According to Eidsvig et al. (2014), some conditions people experience, like social ones, can have negative effects on vulnerability factors and, in turn, provoke hazards that further lead to disaster. However, in regards to level of income, the more people are economically stable, the more they feel worried about the negative effects of landslides on their lives and safety (Qasimetal, 2018).

### **2.1.3 Landslide Risk Factors**

Hernández-Moreno (2016) in Mexico outlined the factors associated with landslide risk perceptions, which included gender, culture, individual perceptions, experience with landslides, awareness level, preparedness, exposure, responsibility or accountability, response level, trust in official sources, and knowledge of measures. Rwanda's national disaster risk management policy and contingency plan for floods and landslides in Rwanda (MINEMA, 2014) also helped to quantify landslide hazards in Rwanda. Nahayo et al. (2017) revealed that landslide risk perceptions are influenced by the fact that people are familiar with climate change, but some variables such as landslide risk perceptions, gender, culture, individual perception, experience with landslides, awareness level, preparedness, exposure, responsibility/accountability, response level, trust in official sources, and knowledge of measures were not clearly studied and documented in Rwanda.

## **2.2 Empirical Literature**

### **2.2.1 Landslides Risk Perceptions**

Antronico et al. (2020) designed and conducted a study that dealt with awareness of landslide risks, social vulnerability, and community resilience, especially in the case of Maierato in Calabria, southern Italy. The purpose of the study was to address not only the conceptualization of social vulnerability but also community resilience in the context of landslide risk regulation and risk awareness. The structured questionnaire was a mixture and had a minimum sample size of 200 adults interviewed. A qualitative approach was used to find the results, and descriptive statistics were used to support the qualitative results. As a result, 71% of respondents rated the risk of landslides as high. The percentage of high awareness is 57% for earthquakes, 54% for floods, and 41% for pollution. This contribution survey did not mention the factors associated with the high perceptions found, especially the social, demographic, and economic factors.

Pedoth et al. (2014) also conducted a cross-sectional study and were interested in outlining the crucial contribution of risk awareness and community collaboration and networks in preparing and implementing control measures for landslides: a case study of dolomites. The authors selected another case study of Badia's municipality, which is an area located in the province of Bolzano in the country of Italy. The contributing study concerned the landslides that incidentally hit the region of Badia in December 2012. Two communities were compared, including a geographic community and a supportive community. Quantitative and qualitative methods were used in the study. As a result, the case study shows that the residents of Badia are more risk-conscious because they know they live in risky areas.

However, prior to 2012, we did not anticipate and prepare for the actual event to occur. In fact, for 50% of the people surveyed, the potential for such an event was unimaginable. This contributing survey did not mention the factors associated with the high risk perceptions found, especially the social, demographic, and economic factors.

Chaturvedi and Dutt (2015) conducted a survey to assess public awareness of landslide risk in the town of Mandy in the Himalayas. The main purpose of the research paper was to highlight the already existing gap that was found between specialized judgment and how the public perceives landslide risks. The results of this survey showed that most respondents felt that they live in a place that is safe and free from landslide risk when they answered the question regarding whether, in the future they expect dangerous landslides to take place in the current area. In addition, 66% said that they would prefer to leave their houses if they got information that threatening landslides could happen nearby, and 22% said they did not want to leave their home but rather face the danger. This contribution survey did not mention the factors associated with the high perceptions found, especially the social, demographic, and economic factors.

### **2.2.2 Social Demographic Factors Associated with Landslide Risk Perceptions**

Chaturvedi and Dutt (2015) conducted a survey with a minimum sample size of 23 participants from the Color area of Mandy City. 57% of respondents were men; approximately 87% of respondents are undergraduates or have university degrees in various disciplines. Approximately 48% of respondents had an average household size of 3–6, and 26% had more than 6 members in their family. About 65% of them owned their own homes, and 26% lived in rental apartments. About 48% of the people surveyed have lived in their high-risk place of residence for over 15 years. On the other hand, 26% lived in areas between the ages of 5 and 15. About 56% of respondents earned more than \$4,800 a year. The risks of a landslide can vary from place to place, so location can also be important when looking at landslide risk perceptions. No other independent variables of interest in this study have been investigated or mentioned.

Calvalho de Assis Dias et al. (2018), conducted in Brazil (2018), estimate that the majority of the population exposed to landslides and floods in Brazil at the city center level was surveyed in central Rio de Janeiro, Brazil. The sample population was 825,834. The study had a cross-sectional design. The results showed that 49.3%, 42.2%, and 8.5% of landslide events were found in Novafriburgo, Petropolis, and Telezopolis, respectively. This study showed that landslide epidemics can vary from place to place, and it is important to know the risk perceptions of landslides. No other independent variables of interest in this study have been investigated or mentioned.

Landslides also occur in different locations in Rwanda. A survey conducted by Nsengiyumva (2019) under the Ministry of Emergency and Management in Rwanda conducted a cross-sectional survey of floods and landslides in the affected areas. Residential landslide vulnerabilities are highest in Nyabihu, Burera, and Ngororero, with very high slope vulnerabilities, and in the Gasabo District area, with high and moderate slope vulnerabilities. In addition, the southern and northern provinces experienced 29 and 24 landslide events during 2011, with the highest rates of landslides. This brings up the idea that some locations

are landslide-high-risk areas while other locations are not, which may influence the population's perceptions of landslide risks. No other independent variables of interest in this study have been investigated or mentioned.

Pedoth et al. (2014) also mentioned factors associated with landslide risk perceptions in the municipality of Badia, Italy, and noted that age and past experience are determinants of landslides. The authors positively correlate risk awareness with respondents' age; they are more aware that older people live in high-risk areas, and risk awareness and concerns about future landslide events are independent variables. We found that it was relatively evenly distributed in all age groups. Pedoth and his colleagues said that the events they survived in 2012 had a major negative impact, particularly on public perceptions of risk. As a result, we estimated that those who are currently directly affected have a significantly higher probability of future landslides than those who are not. 30.6% of those affected believe that landslides are very likely to cause re-injury, but only 13.8% of those who do not

### **2.2.3 Economic Factors Associated With Landslide Risk Perceptions**

In the above-discussed study conducted by Qasim et al. (2018) on socio-economic risk factors of landslide risk perceptions in the area of Murree Hills of the nation of Pakistan, the results of this study were collected from 200 populations as the minimum sample size. The level of income was also discussed as an independent variable. The results on this particular variable revealed that the more people are economically stable, the more they fear the negative effects of landslide risks. The level of income at the household level was statistically associated with landslide risk perceptions. Another study entitled "Social Vulnerability Assessment for Landslide Hazards in Malaysia: A Systematic Review Study" was reviewed along with this proposal. Income indicators and social vulnerability were analyzed after reviewing eight selected studies and 14 indicators. In terms of income, being in a low-income group with less than 40% of Malaysia's income has proven to be extremely vulnerable to disasters. However, the results of the author's research show that there is less emphasis on income indicators and social capital.

In Rwanda, a study was conducted on landslides. It was conducted by Nsengiyumva (2019) on flood- and landslide-prone areas, purposefully focusing on identifying areas in Rwanda that are prone to landslides. It was a cross-sectional study design. The survey was conducted mainly based on the awareness of danger among local governments and local residents. In respect to the quality standards of the research, key informant interviews and structured questionnaires were administered in order to collect the needed data. In this study, the author found that the population of the Southern Province is highly exposed to landslides, and factors associated with landslides include steep slopes, low drainage systems, and ground instability. Unfortunately, this study does not consider landslide risk perceptions or factors associated with landslide risk perceptions.

### 3.0 Methodology

A number of 4157 households living in high risk zones of Gasabo District was a target population. A minimum sample size of 365 households living in high risk zones was randomly selected by using a simple random sampling method. For data collection, a semi structured questionnaire asked questions on socio-demographic information and questions related to landslide risk perceptions and their associated factors were used. Data entry and statistical analysis were performed using Open Data Kits (ODK) and Statistical package for social sciences (SPSS) respectively. Frequency and percentage were performed to measure landslide risk perceptions among families living in high risk zones. In addition, Chi-square test was used to determine the factors associated with landslide risk perceptions and p value less than 0.05 were considered to be significant.

### 4.0 Findings

The study aimed to assess landslide risk perceptions among families residing in high-risk areas of Gasabo District. Results indicated that 59.5% of participants had perceptions of landslide risk, while 40.5% did not. This contrasted with a similar study in Italy where 71% perceived the risk as "high." Comparatively, Gasabo District had a higher percentage of residents perceiving landslides as not harmful. Past experience with landslides, family size, and income level were found to be associated with landslide risk perceptions. Education was also associated, but not as significantly as the other factors. These findings align with previous studies that highlighted the influence of personal experience and economic variables on landslide risk perception.

#### 4.0.1 Socio-Demographic Characteristics of Respondents

Socio-demographic characteristics of respondents include gender, age category, marital status, education of husband and wife, occupation, religion and level of income.

**Table 1: Socio-Demographic Characteristics of Respondents**

Variable	Frequency	Percent
<b>Gender</b>		
Female	143	39
Male	222	61
<b>Age category</b>		
20-29	57	15.6
30-39	140	38.4
40-49	89	24.4

50-59	53	14.5
60 and above	26	7.1
<b>Marital status</b>		
Single	52	14.2
Married	292	80.0
Divorced/widowed	21	5.8
<b>Education level</b>		
Primary and no schooling	40	11.0
Secondary	205	56.2
University	120	32.9
<b>Occupation</b>		
Agriculture	18	4.9
Salaried	94	25.8
Business/trader	248	67.9
No Occupation	5	1.4
<b>Religion</b>		
Catholic	111	30.4
Protestant	218	59.7
Muslim	31	8.5
Other	5	1.4
<b>Ubudehe category</b>		
Category 1	1	0.3
Category 2	226	61.9
Category 3&4	138	37.8

Source: Primary Data (2023)



Table 1 above indicates the socio-demographic characteristics of respondents, and it was found that participants were composed of 143 (39%) females and 222 (61%) males. The majority of respondents, 140 (38.4%) are between 30 and 39 years old, while 89 (24.4%) are between 40 and 49 years old. However, 57 (15.6%), 53 (14.5%), and 26 (7.1%) of respondents were between 20 and 29 years old, 50 and 59 years old, and 60 and older, respectively. The predominant number of respondents had married: 292 (80%), whereas 52 (14.2%) were single and 21 (5.8%) were divorced or widowed. The education level was also described. 205 (56.2%) of respondents had secondary education, 120 (32.9%) had university level, and 40 (11%) had primary and no schooling. Regarding occupation, 248 (67.9%) of the participants in this study were businesswomen or men/traders, 94 (25.8%) were salaried, 18 (4.9%) were farmers, and those who didn't have an occupation were 5 (1.4%). The religions of respondents were also described, and 218 (59.7%), 111 (30.4%), 31 (8.5%), and 5 (14%) were protestants, Catholics, Muslims, and others, respectively. Finally, 1 (0.3%) and 226 (61.9%) of respondents were in Ubudehe categories one and two, while 138 (37.8%) were in categories 3 and 4 of Ubudehe.

## **4.2 Presentation of Findings**

The findings of the study presented in this section are landslide risk perceptions among families living in high-risk zones in Gasabo District and their associated social, demographic, and economic factors among families living in high-risk zones in Gasabo District.

### **4.2.1 Landslides Risk Perceptions among Families Living in High-Risk Zones**

The contents of this section include landslide risk perceptions among families living in high-risk zones and the proportion of landslide risk perceptions by score.

#### **4.2.1.1 Landslides Risk Perceptions by Questions**

This section outlines the four questions asked and the corresponding proportion of respondents to each and every question before scoring in order to show the level of landslide perception. Table 2 below shows that 75.6% of respondents said that their lives in Gasabo District were designated as landslide-risk areas, while 89.6% of participants thought that landslides could be a threat to their families. In addition, 57.5% had ever thought about living in their area because they lived in a high-risk zone. Moreover, only 39.7% perceived the risk of landslides as a danger.

**Table 2 Landslides Risk Perceptions among Families Living in High Risk Zones by Questions**

Variable	Category	Frequency	%
Is your area designated as landslides risk area?	Yes	276	75.6
	No	89	24.4
Do you think landslides can be a threat to your family?	Yes	327	89.6
	No	38	10.4
Have you ever thought about leaving his area because it is landslides high risk zone?	Yes	210	57.5
	No	155	42.5
To what extent do you perceive the Risk of landslides?	Danger	145	39.7
	No danger	220	60.3
<i>Yes =1score , Danger=1 score</i>		<i>No= 0 score , No Danger=0 score</i>	

Source: Primary Data (2023)

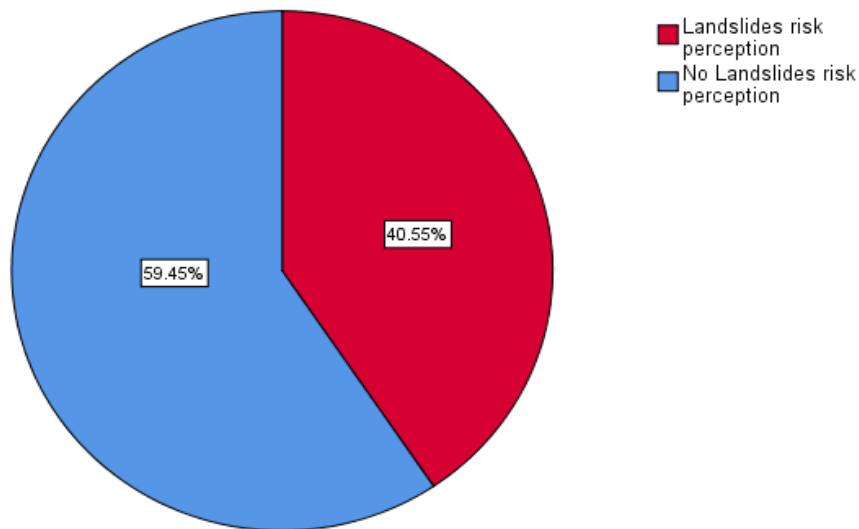
#### 4.2.1.2 Proportion of Landslides Risk Perceptions by Score

Table 3 below indicates the level of landslides risk perception where landslides risk perceptions have two values of landslides risk perceptions which are 3 to 4 score and 0 to 2 score. A 3 to 4 score indicated landslides risk perception while 0 to 2 score indicated participant had no landslides risk perception. More precisely, to determine the level of landslides risk perceptions, the answers from respondents upon the four questions that were asked to scale the level of landslides risk perceptions were scored. Each and every “yes” as answer to one of the first three questions was equivalent to 1 score while each and every “No” to one of the first three questions was equivalence to 0 score. The answer to the last question which was “To what extent do you perceive the Risk of landslides?” was also scored. Danger was scored “1” and No danger was scored “0”. Then, all scores were added to determine the level of landslides risk perceptions. A total score between “3 to 4 score” was considered if participant answer “yes” to the first three questions, or if participant answer “yes” to two questions and “danger” to last question. Otherwise, other answers were scored “0 to 2 score “living in high risk zones.

**Table 3 Proportion of Landslides Risk Perceptions by Score**

Landslides risk perception	Frequency	Percent
3 to 4 Score (Yes)	217	59.5
0 to 2 Score (No)	148	40.5

Source: Primary Data (2023)



Source: Primary Data (2023)

**Figure 1 Proportion of Landslides Risk Perceptions by Score**

Graph 1 outlines the proportion of landslides risk perceptions and the results revealed that 59.5% (n=217) had landslides risk perceptions while 40.5 % (n=148) had no landslides risk perceptions.

**Table 4. 4Social Demographic Factors Associated with Landslide Risk Perception**

Variable	Landslides risk perception		$\chi^2$	<i>p-value</i>
	Yes	No		
<b>Age category</b>			10.384	<b>0.034</b>
20-29	40(70.2)	17(29.8)		
30-39	91(65)	49(35)		
40-49	48(53.9)	41(46.1)		
50-59	24(45.3)	29(54.7)		
60 and above	14(53.8)	12(46.2)		
<b>Level of education</b>			28.375	<b>0.001</b>
Primary & No education	24(65)	14(35)		
Secondary	143(69.8)	62(30.2)		
University	48(40)	72(60)		
<b>Family size</b>			18.303	<b>0.001</b>
<=3 members	78(77.2)	23(22.8)		
4 and above	139(52.7)	125(47.3)		
<b>Religion</b>			5.868	0.053
Catholic	76(68.5)	35(31.5)		
Protestant	122(54.7)	101(45.3)		
Muslim	19(61.3)	12(38.7)		
<b>Past experience</b>			70.941	<b>0.001</b>
Yes	89(96.7)	3(3.3)		
No	128(46.9)	145(53.1)		

**Source: Primary Data (2023)**

Table 4 shows the results from the estimation of the association between socio-demographic factors and landslide risk perceptions using the chi-square test statistic. The chi-square test revealed that age category ( $\chi^2 = 10.384$ ,  $p = 0.034$ ), level of education ( $\chi^2 = 28.375$ ,  $p = 0.001$ ), family size ( $\chi^2 = 18.303$ ,  $p = 0.001$ ), and past experience ( $\chi^2 = 70.941$ ,  $p = 0.001$ ) on landslide risks are statistically associated with landslide risk perception. However, the Chi-square test showed religions ( $\chi^2 = 5.868$ ,  $p = 0.053$ ) had no statistical association with landslide risk perceptions.

### 4.2.3 Economic Factors Associated with Landslide Risk Perception

Economic factors that was discussed in this study include, level of income, home ownership, living means and occupation.

**Table 5 Economic Factors Associated with Landslide Risk Perception**

Variable	Landslides risk perception		$\chi^2$	<i>p-value</i>
	Yes	No		
<b>Level of income</b>			62.793	<b>0.001</b>
Category 1&2	171(75.3)	56(24.7)		
Category 3&4	46(33.3)	92(66.7)		
<b>Home ownership</b>			93.648	<b>0.001</b>
Purchase	28(25)	84(75)		
Heritage	27(51.9)	25(48.1)		
Rent	162(80.6)	39(19.4)		
<b>Living means</b>			81.306	<b>0.001</b>
Homeowner	56(33.9)	109(66.1)		
Rent	161(80.5)	39(19.5)		
<b>Occupation</b>			14.620	<b>0.002</b>
Agriculture	14(77.2)	4(22.8)		
Salaried	69(73.4)	25(26.6)		
Business/trader	131(52.8)	117(47.2)		
No Occupation	3(60)	2(40)		

Source: Primary Data (2023)

Table 5 also tests the possible statistical association between economic factors and landslide risk perceptions using the chi-square test. All economic factors tested were statistically associated with landslide risk perceptions. The chi-square test revealed that the level of income measured by the Ubudehe category in this study was statistically associated with landslide risk perceptions ( $\chi^2 = 62.793$ ,  $p = 0.001$ ). Moreover, the chi-square test showed that home ownership ( $\chi^2 = 93.648$ ,  $p = 0.001$ ) and living means ( $\chi^2 = 81.306$ ,  $p = 0.001$ ) were also statistically associated with landslide risk perception. In addition, occupation was also shown by the Chi-square test as a factor associated with landslide risk perceptions ( $\chi^2 = 14.620$ ,  $p = 0.002$ ).

### Discussion

The study aimed to assess landslide risk perceptions and associated factors among families living in high-risk zones in Gasabo District. The findings indicated that 59.5% of participants had landslide risk perceptions, while 40.5% did not. This contrasted with a study in Italy by Antronico et al. (2020), where 71% of respondents perceived the risk of landslides as "high." However, Gasabo District's percentage of those without landslide risk perceptions (40.5%) was higher than in Italy (29%). This study's findings align with Chaturvedi and Dutt (2015), who found that some people may not consider landslide risks as dangerous, especially when they are frequently exposed to similar risks.

In terms of socio-demographic characteristics, family size was statistically associated with landslide risk perception, which was also supported by Qasim et al. (2018) in Pakistan. Past experience with landslides was another significant determinant of landslide risk perception in Gasabo District, consistent with the findings of Qasim et al. (2018). However, the level of education was associated with landslide risk perceptions in Gasabo District but did not emerge as a significant predictor. This differs from the results of Qasim et al. (2018), where higher education was associated with increased landslide risk perception.

Regarding economic factors, level of income, home ownership, and occupation were all associated with landslide risk perception. The study findings were consistent with the idea that economic variables influence decisions related to landslide risk perception, as noted by Scolobig et al. (2012). Additionally, the study referenced Hernández-Moreno (2016), who found a significant correlation between personal experience with landslides and increased anxiety in a Mexican population, further highlighting the importance of past experience as a factor in risk perception.

## 6.0 Conclusions

This study was guided by two main questions that need to scientifically respond in order to assess landslide risk perceptions and its related socio-demographic and economic factors among families living in high risk area in Gasabo District. So all questions were responded and on the first questions revealed that 40.5% without landslides risk perceptions constitutes a very important public health problem that need to address. Based on this study, family size, past experience, and land purchase, heritage and level of income are determinants of landslides risk perceptions among population of Gatsata and Jali sectors of Gasabo District. even though more than half of respondents from Gatsata and Jali perceive landslides risks, landslide risk perception level is still low and may be considered as public health problems that need to be addressed because if it not improved could consequently expose Gatsata and Jali population to landslides risks.

## 7.0 Recommendations

Based on the results, these are the recommendations:

1. The study recommends that community members use this knowledge to inform landslide risk perception.
2. The study also recommends that the City of Kigali and both sectors raise awareness of landslide risk among families in the Gatsata and Jali sectors. The City of Kigali and both sectors should also initiate projects aimed at increasing the income levels of families in the Gatsata and Jali sectors, resettling heritage, and acquiring land for families living in landslide-prone areas.

## **Acknowledgement**

This research thesis was possible with the support of many people. I particularly express my gratitude to Dr. Erigene Rutayisire, my supervisor, who tersely labored to guide me; his attention, time, encouragement, and guidance made me successfully complete with time. I fully acknowledge the patience and understanding of my family members, especially Mrs. Dorothée Mukarugina. I also express my love and gratitude to my classmates and friends for their encouragement, tolerance, love, and moral support throughout the research. Their support cannot be quantified. My God blesses and pays each of them abundantly. Above everyone else, immeasurable thanks to the Almighty God for giving me life and good health.

Thank you all.

© GSJ

## REFERENCES

- [1] Antronico, L., Pascale, F., Coscarelli, R., Gullà, G. (2020). Landslide risk perception, social vulnerability and community resilience: The case study of Maierato. Calabria, southern Italy. *Reduction, Volume, June 2020, 101529*
- [2] Calvalho de Assis Dias, M.C., Saito, S.M., Alvala, R.C.D., Stenner, C., Pinho, G., Correa, C.O. (2018). Estimation of exposed population to landslides and floods risk areas in Brazil, on an intra-urban scale. *International Journal of Disaster Risk Reduction*.
- [3] Chaturvedi, P., & Dutt, V. (2015). (2015). Evaluating the Public Perceptions of Landslide Risks in the Himalayan Mandi Town. *Journal indexing and metrics*. <https://doi.org/10.1177/1541931215591323>
- [4] Eidsvig, U.M, McLean A, Vangelsten, B.V. (2014). Assessment of socioeconomic vulnerability to landslides using an indicator-based approach: methodology and case studies. *Bull Eng Geol Environ* 73: 307–324.
- [5] Froude MJ, Petley DN (2018) *Global fatal landslide occurrence from 2004 to 2016*. *Nat Hazards Earth Syst Sci* 18:2161–2181. <https://doi.org/10.5194/nhess-18-2161-2018>
- [6] Herath S, Wang Y (2012) Case studies and national experiences. In: *Landslides–disaster risk reduction*. Springer, Berlin, Heidelberg, pp 475–497
- [7] Hernández-Moreno and Alcántara-Ayala. (2016). Landslide risk perception in Mexico: a research gate into public awareness and knowledge. Mexico. *Springer-Verlag Berlin Heidelberg*. DOI 10.1007/s10346-016-0683.
- [8] Ludy, J., Kondolf, G.M. (2012). Flood risk perception in lands “protected” by 100-year levees. *Nat Hazards* 61: 829–842.
- [9] MINEMA, (2014). Landslides Hazard Mapping
- [10] MINEMA, (2015). *The National Risk Atlas of Rwanda*



- [11] MINEMA, (2017). *Disasters' Reports*
- [12] MINEMA, (2018). *Landslides Hazard Mapping*
- [13] Nahayo, L., Mupenzi, C., Habiyaremyef,G., Kalisa, E., UDAHOGORAD, M.&LI,L.(2017).Landslides Hazard Mapping in Rwanda using Bivariate Statistical Index Method.*College of Science and Technology, Kigali, Rwanda*
- [14] Nsengiyumva, J.B. (2019). *Disaster high risk zones on floods and landslides*. Kigali. Rwanda. Ministry of disaster management and refugee affairs.
- [15] Pedoth, L., Jülich, S., Taylor, R., Kofler, C., Matin, N., Forrester, J. and Schneiderbauer,S. (2014). The role of risk perception and community networks in preparing for and responding to landslides: a Dolomite case study. *Italy. EmBRACE deliverable 5.4*
- [16] Qasim, S.; Qasim, M.; Shrestha, R.P.; Khan, N. Socioeconomic determinants of landslide risk perception in Murree hills of Pakistan.*Aims Environ. Sci.* 2018, 5, 305–314. [CrossRef]
- [17] Raaijmakers, R., Krywkow, J., van der Veen, A. (2008). Flood risk perceptions and spatial multi-criteria analysis: an exploratory research for hazard mitigation. *Nat Hazards* 46: 307–322
- [18] Scolobig, A., De Marchi, B., and Borga, M. (2012). The missing link between flood **risk** awareness and preparedness: findings from case studies in an Alpine. *Natural Hazards*, 63, 499–520. Doi: 10.1007/s11069-012-0161-1
- [19] Wang HB, Sassa K (2005). Comparative evaluation of landslide susceptibility in Minamata area, Japan.*Environ. Geol.* 47: 956–966