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Landslide Disasters and Their Socio-Economic Impacts in Gakenke District, Rwanda

Aimee Muhumuza[1]; Dr. Jean Baptiste NSENGIYUMVA.[1,2]

1. Department of Environmental Economics and Natural Resource Management, University of Lay Adventists of Kigali (UNILAK), Kigali, Rwanda, Street KK 508 ST, P.O Box 6392 Kigali- Rwanda.

2. WaterAid UK, Rwanda Country Programme
Plot 701 KG 622 St, P.O Box 2194, Kigali-Rwanda.

Abstract

Landslides, as hazardous natural events, have significantly affected various pillars of Rwanda's national reform agenda. This study aimed to assess the impact of landslide disasters on the socio-economic development of communities in Gakenke District, Rwanda. A descriptive research design employing both qualitative and quantitative approaches was used. The study population included 105,487 household heads across all 15 sectors of the Gakenke District. A purposive sample of 392 households and three key informants was selected for detailed investigation. Data were collected using questionnaires, interviews, observation, and document reviews, drawing on primary and secondary sources. Descriptive statistics were analyzed using Microsoft Excel, while inferential statistics were processed using SPSS version 16.0. Additionally, GIS and remote sensing tools (ArcGIS 10.8) were used to map the study area. The findings revealed a strong positive correlation (r = 0.953) between landslide occurrence and socio-economic impacts. Specifically, landslides were found to contribute to fatalities, injuries, mental health disorders, destruction of homes and schools, reduced school attendance, loss of crops, trees, and livestock, land degradation, increased poverty, and food insecurity. Based on these findings, the study recommends coordinated efforts among local authorities, NGOs, and the Government of Rwanda to contain the potential landslide risks. Suggested interventions include the relocation of residents from high-risk zones to planned settlements, construction of terraces and drainage systems, promotion of agroforestry, reforestation, provision of water harvesting infrastructure, support to affected households, and enforcement against illegal mining and quarrying activities.

Key Words: Community, Disaster, Landslide, Socio-economic-Development.

1. Introduction

Landslides are widespread natural hazards that can occur anywhere in the world, particularly in mountainous areas (Kishor, 2011). According to the World Health Organization (WHO), landslides killed over 18,000 people and injured approximately 4.8 million globally between 1998 and 2017 (WHO, 2018). Countries most frequently affected include India, China, Nepal, Indonesia, and the Philippines (Kirschbaum et al., 2021). In Indonesia, for instance, landslides frequently result in both human casualties and significant damage to homes and public infrastructure (UNISDR, 2021).

The economic effects of landslides are also profound. Rehabilitation needs and asset losses influence household consumption (Bui et al., 2014), while disruptions in planned investments increase disaster-related expenditures (Klomp & Valckx, 2021). These disturbances ultimately affect core components of GDP such as government spending, private consumption, and investment (Prathama & Manurung, 2018).

In Southern Africa, landslides pose a growing threat, damaging infrastructure and reducing productivity (Van Niekerk et al., 2019; Noy, 2019). Recent events in South Africa highlight their impact on mining communities, ecosystems, and GDP per capita (Díaz et al., 2020; Felbermayr & Groschl, 2023). Sub-Saharan Africa is particularly vulnerable due to climate change, especially in Eastern Africa's rangelands, the Great Lakes region, and arid southern zones (Stern, 2020). Between 2020 and 2022, East Africa lost an estimated USD 208.76 million due to landslides, while the Sahel lost USD 123.9 million due to climate-related issues (World Bank, 2022).

East Africa, including Rwanda, has recently experienced severe landslides that destroyed infrastructure, farmland, and claimed lives. Contributing factors include deforestation, overgrazing, poor farming practices, earthquakes, and heavy rainfall. In Rwanda, a mountainous country averaging 1,700 meters in elevation, landslides are particularly common in the northern, western, and southern highlands (REMA, 2023; MIDIMAR, 2024). The country loses around 15 million tons of fertile soil annually to erosion, much of it carried into major river basins (Hussein & Osman, 2021).

Despite this, the specific socio-economic impacts of landslides in Gakenke District remain poorly understood. The identification of vulnerable areas and effective mitigation strategies is still limited. This study aims to assess the impact of landslide disasters on the socio-economic development of communities in Gakenke District, Rwanda.

2. Problem Statement

Due to the hilly and mountainous topography of Rwanda, heavy rainfalls cause larger and more catastrophic mudslides and landslides. The influence of landslide disasters on local economic growth in Rwanda, namely in the Gakenke District, was the issue this study aimed to investigate. Rwanda's hilly terrain, tropical climate, agricultural livelihoods, vulnerable communities, and fast population increase make landslides a serious problem. Natural disasters, such as landslides, have been more frequent and intense during the past ten years, with dire repercussions (Vuguziga, 2022). Disasters interrupt livelihoods, cause fatalities, damage property and infrastructure, and have a major effect on economic development. The expected yearly cost of these damages in Rwanda is USD 9.8 million (Ministry in charge of Emergency Management, MINEMA, 2022). Increased habitation of marginal land and altered weather patterns associated with climate change are predicted to make the issue worse (Ingabire et al., 2020). Although disasters in Rwanda cause a considerable amount of money in absolute terms, the number of fatalities and relative damage as a percentage of GDP are especially high (National Bank of Rwanda, 2023; MINECOFIN, 2023).

When triggering events like seismic activity or heavy or protracted rainfall take place in an area that is prone to landslides, landslides occur. In Rwanda, the lithology, topography, soil composition, and land cover all influence a region's susceptibility to landslides. The landslide risk is usually increased by the steep slopes of Gakenke and other areas in the southwest of the country, the presence of water accumulation zones, and soils with an impermeable layer. Large-scale soil degradation in Rwanda has resulted in the loss of infrastructure, assets, and human life (Nkurunziza, 2022).

In response to the landslide catastrophes brought on by torrential rains on the evening of May 2-3, 2023, which caused considerable damage and fatalities in Gakenke District, the Rwandan government has taken action. In addition to causing billions of Rwandan francs in damage to homes, crops, land, and public infrastructure, the tragedy killed 131 people and injured numerous others (Republic of Rwanda, 2023). With 21 confirmed deaths in the last three years, the impact in the Gakenke District has been especially severe. Along with damaging land and natural resources like vegetation, landslides have also destroyed infrastructure, including highways, bridges, and schools. Furthermore, rivers have been obstructed by landslide debris, raising the possibility of flooding in several Gakenke District areas (Relief Web,2023).

Given the aforementioned evidence and the fact that numerous studies have assessed the economic impact of landslides in developed nations by estimating direct infrastructure damage or lost revenue for particular industries, these approaches fall short of capturing the extent of landslide impacts on local people's social and economic development in Rwanda and the Gakenke District. Therefore, further research is required to determine the true cause of landslides and to determine why this hazard continues to affect social socioeconomic development of the local community, particularly in the Gakenke District and throughout Rwanda, and to propose robust mitigation measures based on the actual situation on the ground to inform decision and policy makers. This study aimed to explore the impact of landslide disasters on the household income of the local community in Gakeneke District, determine the effect of landslide disasters on school

attendance of the local community in the District, and analyse the influence of landslide disasters on the life expectancy of the local community.

3. Literature review

This section presents the key theory used to explain the study variables, It presents the empirical review in accordance with the study objectives.

3.1. Theoretical framework

This study was guided by the Resource curse theory, the resource curse concept was coined in mid mid-1990s to explain the perspective of an inverse relationship between resource abundance and socio-economic growth in the affected countries. The resource curse, it was argued, befalls a country when it continues to experience negative growth as a result of overdependence on mineral resource extraction and external market forces such as fluctuations in the price of primary commodities (Shoko and Mwita, 2015). However, several academics have contested the idea that countries focused on natural resources will inevitably face slower development. The fundamental issue of causation is the basis of the first difficulty. According to Torvik (2009), there is no proof that slow growth is a result of resource plenty. Finding the differences between resource-rich blessed and resource-rich cursed states is the second step. The recognition that certain resource-rich nations saw growth made this significant. Ville and Wicken (2013) contend that by repeatedly diversifying into new resource-based industries and products, Australia and Norway have avoided the resource curse and reached modern levels of development as resource-based economies.
The debate narrows down to the conclusion that the resource curse affects states that are highly dependent on a particular resource that is held in abundance at the expense of other economic sectors and a general absence of efficiency enhancing reforms, checks and balances in the constitution and enabling laws.

Rwanda is not entirely dependent on agriculture, transport, and commerce. The resource curse theory does not, therefore, provide a firm theoretical base for the current study. It is, however, possible that the enabling laws and policy do not provide sufficient checks and balances in the mining sector. The study will rely on the resource curse theory only to the extent it provided light in the search of explanations on the intervening role of policy on the impact of landslides on socio-economic development of local community in Gakenke District because local community' life conditions in Gakenke District depend on agriculture, transport and commerce, when roads, bridges and markers are damaged by landslides, social economic development of local community reduces and when the lands destroy through soil unstable geology, the local community living conditions change destroyed. This current study will rely on the Resource Curse Theory.

3.2. Empirical review

3.2.1. Effect of landslide disasters on household income levels

Landslide disasters also directly affect household wealth. Most farming households rely on agricultural production for income; however, landslide disasters may destroy crops and cause significant losses to farming households (Huang et al., 2022). Additionally, landslide disasters may destroy houses and the means of production (Jia et al., 2018), causing direct wealth losses to households. Landslide disasters also cause panic and price increases, which increase household expenditures. Increased economic losses and expenditures, in turn, hinder rural households' wealth accumulation.
Landslides may, for example, decrease the access to markets by cutting off roads or they may cause floods and excessive sediment deposition by temporarily damming rivers, thereby indirectly affecting household income (Claessens et al. 2017 and Meyer et al. 2013). While critical infrastructure is limited in our study area, the indirect effects of landslides can still potentially decrease the income of the households at an aggregated geographical level (e.g. at the village level) and can be controlled for by including village fixed effects in the analysis.

Regardless of the actual occurrence of a landslide, the mere presence of its risk can affect income by influencing the behaviour of the household (Cameron & Shah 2015; Gloede et al. 2015). When attempting to estimate the direct impact of landslides on household income, it is therefore necessary to control for geographical variables that determine landslide susceptibility, which can be used as a proxy for landslide risk. This is even more relevant if one considers that poor households very often live in the most susceptible areas, thereby possibly exaggerating the measured impact of landslides (Wisner 2001).

When directly affecting a household's house or plots, landslides often destroy crops and productive assets, essentially soil quality and livestock, and thereby cause a shock. We hypothesize that income from agriculture will be reduced and, in case insufficient alternative income sources are found, also total income will be affected. The extent to which income from agriculture is reduced depends on the size and type of the landslide, while the extent to which total income is affected also depends on the capacity of the household to find alternative income sources. This capacity, strongly related to coping capacity, depends on the access to human, social, physical, and financial capital, as well as the livelihood strategies and services available in the region (Cutter et al. 201 and Thanapackiam et al. 2012).

Most landslides are relatively small and local, causing idiosyncratic shocks that only affect a few plots at the same time (Glade, 2013). The household coping capacity for idiosyncratic shocks can be high if sufficient alternative livelihood strategies and/or adequate risk-sharing mechanisms are present and accessible for all within a community (Dercon 2016; Sen 2011). Finding a significant income shock due to landslides would suggest that improving access to either income sources outside agriculture or local risk-sharing mechanisms could be a way to improve local resilience against landslides. Several studies have investigated the impact of Landslide disasters on household income (Bayudan-Dacuycuy and Lim, 2013; Bui et al., 2014; Arouri et al., 2015). Arouri et al. (2015) found that landslide disasters can dampen household income growth. However, other studies revealed that natural disasters do not affect the population's income, which may be because government transfers to the affected areas compensate for the population's income loss (Tatyana, 2017). Household wealth is a more comprehensive reflection of a household's economic situation (Pollack et al., 2007).

Qualitative case studies suggest that landslides in East Africa significantly affect smallholder farmers' income through the loss of houses, crops, and soil fertility (Kitutu et al. 2011; Msilimba 2009; Mugagga et al. 2010). Therefore, examining the impact of landslide disasters on household wealth can provide a more comprehensive understanding of landslide disasters on households' economic status. Existing literature that examines landslide disasters on the household income level is relatively scarce. To my knowledge, no quantitative and qualitative assessment of the direct impact of landslide disasters on household income levels in the community in Gakenke District exists at this time. Such an assessment is, however, necessary to understand how landslide disasters have an impact on the development in the region and how important this impact is. It is also a necessary step for the implementation of cost-effective disaster risk reduction in the region.

3.2.2. Effect of landslide disasters on school attendance rates and educational outcomes

Education as a paramount factor of economic development suffers from the uncontrollable effects of landslide disasters (Wong, 2021). Globally, educational resources are destroyed, directly and indirectly, students and teachers are displaced or killed, and parents' income is affected because of natural disasters. Investments in human capital for rich and low-income countries are exposed to the uneven impact of natural disasters that adjust household and country-level decisions, leaving them to short-term and long-term losses (Mike, 2020).

Theoretical evidence shows that the direct effects of these shocks, such as the destruction of critical educational centers and related infrastructure and complementary resources (roads and teachers), degenerate into indirect effects. Empirically, the effects of these events have proven largely negative, where natural shocks leave households with tighter budgets, causing them to cut down on basic investments in health, education, and productive physical capital. Guatemala hurt the number of grades attained by adults born in four villages of the country. According to Jensen (2000), the enrolment rates in regions in Ivory Coast declined by approximately 20 percent for regions that experienced extreme weather shocks between 1986 and 1987 as compared to non-shock regions. Also, a study by Stein et al (2003) showed that the 1976 landslides in eastern

Furthermore, another link for the landslide disaster-human-capital study is the shifts in parental investments in children due to cuts in expenditure that seem to be temporary adjustments to shocks now become permanent shifts (Baez et al, 2010). Past literature on shocks and human capital describes educational attainment as "path-dependent1", which is a behavioral effect of experiencing a shock (Kousky, 2016; Baez et al, 2010). Also, in addition to behavioral responses, the underlying effects of the landslide disaster shocks goes further to effect changes in the use of children's time.These studies show that disasters, economic downturns, idiosyncratic shocks, and risky environments are strongly correlated with the several responses. These include the effects of changes in the incidence of child labor or substitution effects in the aftermath of

these landslide disasters (Gitter and Braham, 2007), psychological effects like Post Traumatic Stress Disorder and depression (Kousky, 2016), which affect academic grades, attendance and subsequently, educational attainment.

Empirically, these shocks thereby affect the allocation of time in the formation of human capital. This empirical discussion of the importance of the years of schooling in human capital formation (Barro- Lee, 2023) gives the paper its foundation. The likelihood of positive productivity shocks has been seen to lower levels of educational attainment, just by a move from regular rainfall to a positive rainfall shock. Such that wages increase by 2 percent math test scores decrease by 2–7 percent of a standard deviation; school attendance decreases by 2 percentage points; and the probability that a child is enrolled in school decreases by 1 percentage point (Shah and Steinberg, 2017). On the other hand, the impact of extreme landslide shocks in the early life of women shows a higher 0.22 grade of schooling (Maccini and Yang, 2018).

The long-term impacts of landslide disaster shocks in India show that more landslide disasters during school years (particularly ages 11–13) lowers total years of schooling. For this age group (which is the age group that transitions from primary to secondary school), the likelihood to drop out significantly increases with positive rainfall shocks. Thus, positive employment shocks are particularly detrimental to human capital investment during this period (Shah and Steinberg, 2017). An important concern in the disaster-human-capital literature is the death effects of land slide disasters on educational attainment. Loss of a parent or guardian is one of the most traumatic events a child can face. Several studies show that if the loss of a parent reduces investments in children, it can also have other long-lasting implications. Using Indonesia's survey data during 1994-1996, Gertler et al (2004) empirically show that the demographic change caused by the death of a parent can affect the investment in children's education.

The rate at which one human capital investment factor, school enrollment, is largely affected by a parent's recent death. In addition, Kousky (2016) reports that disaster shocks indirectly lead to high infant mortality due to malnutrition. Additionally, there were records of a high likelihood of depression and post-traumatic stress disorder for adolescents who lived in the most-damaged cities and those who experienced the death of a family member six months after Hurricane Mitch hit Nicaragua. After the 2004 tsunami, about 14 to 39 percent of the 264 children (aged 8 to 14 years) observed in affected areas of Sri Lanka had post-traumatic stress Disorder symptoms (Kousky, 2016; Lonigan, 1994; Neuner, 2016).

Moreover, the authors find that the intensity of landslide disasters (measured by the ratio of casualties to population) is positively correlated with a larger differential effect on women's life expectancy. These effects, however, are reduced the higher the socio-economic status of women (Maccini and Yang, 2013). This goes alongside studies that have shown that a higher level of female attainment stimulates the acquisition of human capital by children, while male educational attainment is more important in terms of the direct effects on GDP growth and non-human investment (Barro and Lee, 1993, 2001). Overall, this study tries to contribute to the disaster-human capital study by investigating the effects of landslide disaster shocks on educational attainment for a broad group of countries, but this new research seeks to investigate the effect of landslide disasters on school attendance rates and educational outcomes in the Community in Gakenke District.

3.2.3. Effects of landslide disasters on the life expectancy of people

Landslide disasters have serious and diverse destructive impacts. Globally, the figures were much more serious in the last decade, with 32,322 fatalities recorded; monitoring, mapping, and forecasting of these landslide hazards are less than adequate as required within different countries worldwide (Highland, 2008). Different types of landslides, such as rockslides, debris flows, rock falls, avalanches, and others generated a huge number of losses of lives and other related consequences, and they continue to intensify, particularly in hill and mountainous regions (Capitani *et al*., 2013). Apart from natural factors influencing landslides, anthropogenic factors have also been identified to increase landslides with highly recurrent rainfalls (Wangari, 2011).

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anthropogenic factors have also been identified to increase landslides with highly recurrent rainfalls (Wangari, 2011).

Although not as dangerous to human life as fast-moving landslides, a slow moving landslide, that may be moving a few inches per year can, over periods of months to years, severely damage and destroy buildings, roads, pipelines, and other utilities built on and adjacent to the landslide (Highland, 2008).

Like many other countries in Africa, landslides in Rwanda are among the very deadly natural disasters that are taking lives and inducing numerous negative impacts in the community (Nsengiyumva *et al.*, 2018). 15,000,000 tons of more fertile soils are lost on average every year in Rwanda to foreign countries through flowing water from the Nile and Congo River catchments (De Taeye, 2016). Different types of soils are negatively affected by high annual intense rainfalls, by providing high saturation of soil profiles, resulting in frequent occurrences of mass movements (Paper, 2012).

In addition, high population pressure on land also results in Environmental disasters and encroachment on fragile ecosystems. Hence, the topographic nature of the Gishwati and Mukura Landscape is characterized by mountainous and hilly relief, and steep slope areas, which make it more susceptible to landslide hazards, which affect life expectancy in Rwanda (Nsengiyumva *et al.*, 2018). People affected by landslides can also have short- and long-term mental health effects due to loss of family, property, livestock, or crops. Landslides can also greatly impact the health system and essential services, such as water, electricity, or communication lines, in many areas of Rwanda, but the literature related to the impacts of landslide disasters on the social and economic development of the Community in the Gakenke District is insufficient.

4. Methodology

4.1.Research Design

The article adopted a descriptive research design combining both qualitative and quantitative approaches. Descriptive research aims to accurately and systematically describe a population, situation, or phenomenon. Descriptive research is suitable because it provides a comprehensive picture of the characteristics, behaviors, and attributes of a particular population or phenomenon, which can be useful in informing future research and policy decisions. The study used a quantitative approach in the sense that it was based on methodological principles of description and use of statistical measurements (Neuman, 2016). The qualitative approach was also used, and the decision to use the qualitative approach in this research was influenced by the fact that this approach permits a considerable amount of flexibility (Neuman,2016).

4.2.Population, Sample, and Sampling Techniques

This article was conducted in Gakenke District, the District is located in the familiar area of the researcher. The researcher chose Gakenke District among other districts because Gakenke District experiences frequent landslides due to its steep topography and higher rainfall than other districts in Northern province. The respondents totaled 395, 3 key informants (1 District land Administrator, 1 District Agronomist, and 1 Work in charge of Disasters in the District) were purposively sampled, while 392 household heads were selected using simple random sampling techniques. The questionnaire was administered to 392 household heads, while an interview guide was conducted with 3 key informants, since their number is small, thus easy to manage, and they possess all the necessary information.

4.3.Instruments

This article used both primary data and secondary data. Primary data was collected using a questionnaire administered to 392 household heads. Correspondingly, qualitative primary data was collected using an interview guide conducted with 3 key informants. However, secondary data was collected using a documentary review/checklist.

4.4.Validity and Reliability

The study ensured acceptable validity of the instruments through testing them in politing study conducted in Ngororero District. The questionnaire was subjected to a statistical test to establish an acceptable reliability, which was 0.7 Cronbach's Alpha.

4.5 Statistical Treatment of Data

Collected data related to the study subject were edited, coded, summarised, and analysed using the Statistical Package for Social Science (SPSS) and presented in tables. The respondents' data is analysed and the results are tabulated. Frequencies and percentages are calculated for analyses. Qualitative data collected using an interview guide were categorised and analysed according to themes; transcripts were thoroughly reviewed to note the main themes.

5. Results and Discussion

5.1. Descriptive statistics analysis

This section presents the results of the study, and it is guided by research questions as follows:

Research Question 1: What is the impact of landslide disasters on the household income of the local community in Gakeneke District

This research question sought to establish the opinion of respondents on whether landslides affect the household income level of the local community in Gakenke District.

Table 1: Respondents' Perceptions on the Impact of Landslide Disasters on Household Income

Respondents' Perceptions	Agreement		Undecided		Disagreement	
	f	%	f	%	f	%
Landslides reduce agricultural productivity	392	100	0	0	0	0
Landslides damage livestock	305	77.8	0	0	87	22.2
Landslides close business activities	345	88.0	0	0	47	11.9
Landslides disrupt the supply chain	200	51.0	70	17.9	122	31.2
Landslides destroy commercial houses	72	30.4	0	0	329	83.9

Information from Table 1 shows respondents' perception of the impact of landslide disasters on the household income of the local community in Gakeneke District. The majority of the respondents agreed that landslides reduce agricultural productivity (100%), damage livestock (77.8%), and close business activities (88.0%), as well as disrupt the supply chain. The respondents disagreed that landslides destroyed commercial houses in the Gakenke District. One potential respondent quoted saying that Landslides significantly impact people's incomes by causing direct losses of property, infrastructure, and livelihoods, leading to reduced agricultural productivity and income, and forcing people to seek alternative, often lower-paying jobs".The second key informant narrated that: Landslides can lead to significant costs for clean-up, repair, and reconstruction, which can strain household budgets and economic resources, landslides can disrupt economic activity and reduce overall productivity, leading to slower economic growth and lower incomes and Landslides can disproportionately affect vulnerable populations, such as those living in remote areas or with limited access to resources, exacerbating poverty and inequality.

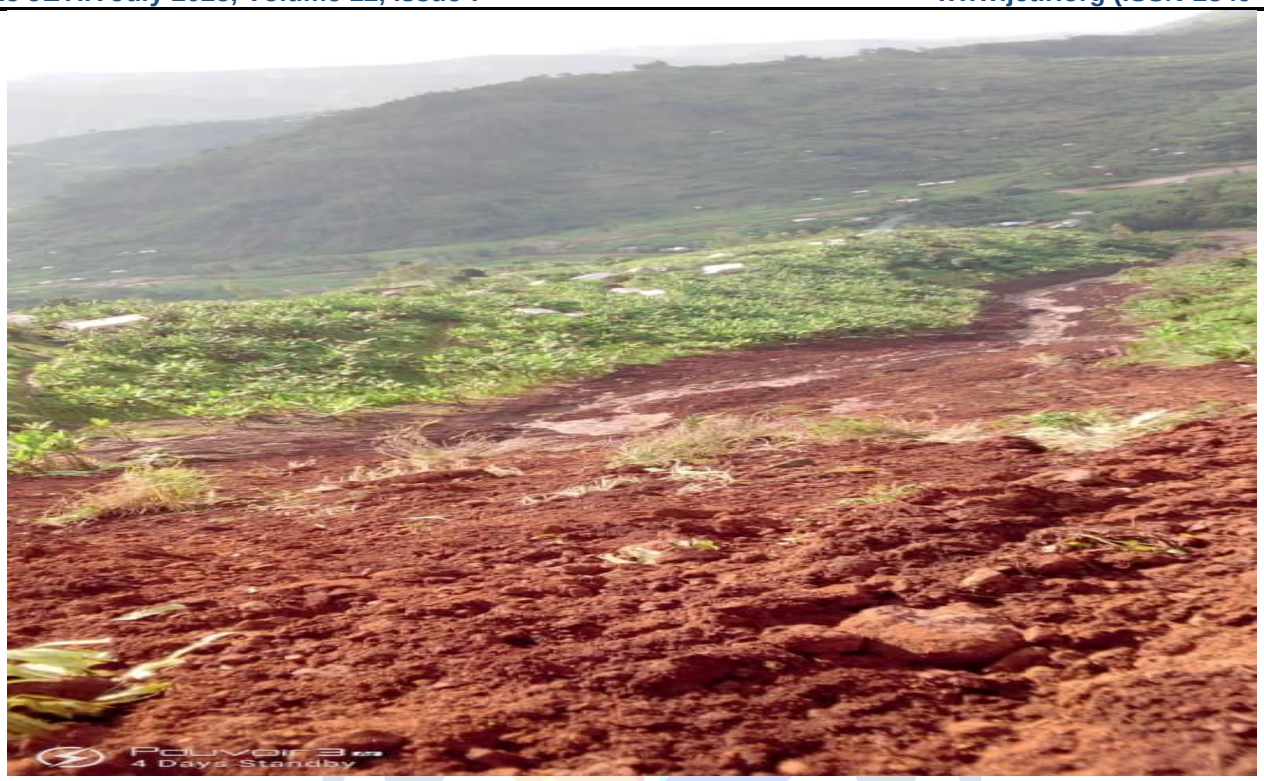

Figure 1: Land resources destroyed by landslides in Cyabingo sector –Gakenke District

The findings from of interviews indicated that the impacts of landslides on agriculture performance in Gakenke District and they cited that landslides destroy crops, prevent farmers to do their activities, lead to loss of people' income that is capital to do business and kill many varieties of livestock. Therefore, the finding is in tandem with the qualitative data.

The above findings were in line with the literature that Landslides cause severe damage in the Gakenke district in different periods. This includes the loss of 119 ha of crops in 2019, loss of 208 ha of crops and 12 ha of forest in 2020, loss of 24.5 ha of crops and 6 ha of forest in 2021, as well as loss of 34.4 ha of crops in 2022, loss of 7 livestock in 2019, 12 cattle and 95 other livestock in 2020, 1 cattle and 1 other livestock in 2022 (MINEMA, 2022). In addition to that, 77 living houses were also destroyed in 2023, while 1,211 houses are still in high-risk zones (MINEMA, 2023).

The literature also showed that Landslides significantly impact household income sources by destroying or burying agricultural land, leading to reduced crop yields and income from farming, and they directly kill livestock or damage infrastructure essential for raising them, resulting in reduced income from animal husbandry (Nkurunziza, 2022). The literature also revealed that Landslides can damage roads, bridges, and other infrastructure, disrupting access to markets and hindering the operation of small businesses, leading to income losses (Noy, 2019). Landslides can force people to leave their homes and land, leading to displacement and the loss of traditional livelihoods, such as farming or small business ownership (Nsengiyumva, 2022). Landslides can damage or block transportation routes, disrupting supply chains for both agricultural products and other goods, leading to price increases and reduced income for businesses (Huang et al, 2022).

Research Question 2: Do landslide disasters affect the school attendance of the local community in Gakeneke District?

This research question sought to establish the opinion of respondents on whether landslides affect the school attendance of the local community in Gakenke District.

Table 2*:* Respondents' Perceptions on Impact of Landslide Disasters on School Attendance

Respondents' Perceptions	Agreement		Undecided		Disagreement	
	f	%	f	%	f	%
ndslides led to school closures and disruptions	209	53.3	10	2.6	173	44.2
Landslides damage infrastructure	392	100.0	0	0.0	0	0.0
Landslides displaced teachers and students	392	100.0	0	0.0	0	0.0
They led to the loss of parents as students' supporters	210	53.5	140	35.7	42	10.7
They led to the loss of income/ school fees	392	100	0	0.0	0	0.0

The majority of respondents agreed that landslides affect school attendance, this was evidenced by 53.3% respondents agreed that landslides led school closures and disruptions, 100% respondents agreed that land slides damage infrastructure and displaced teachers and students while 53.5% agreed that they led to loss of parents as students' supporters and 100% respondents knew that landslides led to loss of income as school fees for the children. the field results agreed with the interview that Landslides damaged or destroyed school buildings in Gakenke District, making them unsafe for use. This led to temporary or even long-term school closures, disrupting the learning process and impacting student attendance. other key informants felt that landslides can damage roads, bridges, and other infrastructure, making it difficult or impossible for students and teachers to travel to school. This can lead to reduced attendance and learning disruptions. The field results agree well with Howell and Elliott's (2019) findings that Landslides forced families in the Gakenke District to evacuate their homes, leading to the displacement of students and teachers. This can disrupt schooling and lead to reduced attendance as students and teachers struggle to find new housing and settle into new communities. Felbermayr & Groschl (2023) found out almost the same findings that landslides caused economic hardship for families, particularly those who rely on farming or other land-based livelihoods, and this led to families being unable to afford school fees, uniforms, or other essential school supplies, resulting in reduced school attendance. Finally, primary data correlate well with the literature that Landslides were a traumatic experience in Gakenke District, leading to psychological distress for students and teachers, and this manifested as anxiety, depression, and other mental health issues, which can further impact school attendance and learning.

Research Question 3: Do landslide disasters influence the life expectancy of the local community in Gakeneke District?

This research question sought to establish the opinion of respondents whether landslides influence lifeexpetency of of local communiry in Gakenke District.

Table 3*:* Respondents' Perceptions on the Impact of Landslide Disasters on life Expectancy

Respondents' Perceptions	Agreement		Undecided		Disagreement	
	f	%	f	%	f	%
ı Landslides led Direct Mortality and Injury	251	64.0	41	10.4	0	0.0
Land slides coused Psychological Trauma	280	71.5	12	3.1	0	0.0
Landslides caused Economic Hardship	220	56.2	50	12.7	22	5.6
Displacement and Forced Migration	290	73.9	12	3.0	32	8.2
Disrupting essential services (Schools and hospitals and roads	392	100	0	0.0	0	0.0

The majority of respondents (64.0%) agreed that landslides led Direct Mortality and Injury, 71.5% respondents were in agreement that Land slides coused Psychological Trauma, 56.2% respondents agreed that Landslides caused Economic hardship, 73.9% agreed that landslide led to Displacement and Forced Migration while 100% respondents knew that landslides disrupting essential services (Schools and hospitals and roads as well as bridges). The interview results indicated that landslides can block roads and disrupt transportation and communication networks, impacting businesses and people's ability to work and earn income and landslides can lead to the loss of jobs and businesses, particularly in areas where people rely on agriculture or other natural resources for their livelihoods.

Figure 2: Destroyed bridge (Gakenke-Nemba) by landslide (2023)

Figure 3: Damaged road (Musanze-Kigali) due to landslides in Gakenke District.

Infrastructure damages, figures 2 and 3, including roads and bridges, faced and highlighted the vulnerability of essential services to landslides. Landslides damaged or destroyed critical infrastructure like roads, bridges, and utilities, disrupting essential services and hindering disaster recovery efforts, potentially impacting long-term health outcomes and life expectancy (Cutter et al, 2018). The interview results showed that landslides can cause immediate deaths and severe injuries due to being buried, crushed, or struck by debris, impacting the lives of those directly affected. The findings are supported by the literature that 7

deaths and 16 injuries were assessed in 2023, 2 deaths and 2 injuries in 2022, 27 deaths and 49 injuries in 2021, and 2 deaths and 13 injuries in 2020 (MINEMA, 2024). However, witnessing or experiencing a landslide can lead to severe mental health issues like post-traumatic stress disorder (PTSD), anxiety, and depression, which can negatively impact long-term health and well-being, affecting life expectancy (Richard et al., 2023). Furthermore, landslides damaged homes, businesses, and infrastructure, leading to economic losses, job displacement, and increased poverty, which negatively impact health and life expectancy (Bui et al, 2014). Landslides can force communities to evacuate their homes and relocate, leading to displacement and the disruption of livelihoods, which can have long-term negative impacts on health and life expectancy (Cameron and Shah, 2020).

5.2. Regression Analysis

The impact of the landslide on socio-economic development was determined using multiple regression. In regression, the researcher analyzed the model summary, variances, and coefficients of variables.

Table 1: Model Summary

Model	R	R-Square	Error of the Estimate	Change in statistics			
				F Change	df1	df2	Sig. F Change
1	0.953[a]	0.908	.16282	123.031	2	392	.0000

a. **Predictors**: (Constant), landslide

b. **Criterion:** Socio-economic development

From Table 4, regression analysis revealed a positive impact (R = 953). The R coefficient of 0.953 indicates that the predictors of the model, which land landslide and socioeconomic development, meaning that there is a strong positive relationship between the two variables, which are: the impact of landslides (independent variable) and the socioeconomic development (dependent variable). That is, the landslides occurrence has a strong impact on the community's livelihoods and socio-economic development.

Table 2: ANOVA

Modal		Sum of squares	df	Mean	F	
1	Regression	.992	2	0.248	4.673	.011[a]
	Residual	.369	390	0.045		
	Total	1.361	**391**			

a. **Dependent variable**: Landslides

b. **Predictor (Constant)**: Socio-economic development

Table 5 shows ANOVA, that variations in socioeconomic development can be explained by the model to the extent of 0.992 out of 1.361 or 72.8%, while other variables not captured by this model can explain 27.2 % (0.369 out of 1.361) of the variations in socioeconomic development. The F value of the model produces a p-value of 0.011, which is significantly different from zero. A p-value of 0.011 is less than the set level of significance of 0.05 (0.011) for normally distributed data. This means that the model is significant in explaining social socioeconomic development of Gakenke District, and this is an indication that landslides significantly affect the socioeconomic development of the community in Gakenke District.

Table 3: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95% Confidence Interval for B	
	B	Std.Error	Beta			Lower Bound	upper Bound
1							
(Constant)	-0.562	0.863		0.292	0.774	0.262	0.601
Landslide	-0.864	0.225	-0.652	3.849	0.046	0.185	0.322

a. **Predictors**: (Constant), Landslide
b. **Criterion:** Socio-economic development

The regression output is laid out in Table 6. Standardized coefficients (Beta) were used to determine the relative importance of the significant predictors of socioeconomic development. The larger the absolute standardized coefficient, the larger the contribution of that predictor to socioeconomic development as indicated by the T-statistics. The landslide negatively contributes to (β=-0.652) socioeconomic development. A unit change in landslide would lead to a reduction in social socioeconomic development of Gakenke district by a factor of -0.652, which is the most significant predictor of the research. To clarify this, the results mean that a one-unit increment in landslide occurrence will result in 0.652 units of reduction in socioeconomic development (household income levels, school attendance rate, and life expectancy) in Gakenke District.

Specific percentage for a regression coefficient between landslides and socio-economic development is estimated between 10% to 77% in Rwanda, landslides can significantly impact economic development, leading to losses in infrastructure, agriculture, and overall GDP (National Bank of Rwanda, 2024).

6. Conclusion and Recommendations

The study undertaken in Gakenke District aimed to explore the impact of landslide disasters on household income of the local community, determine the effect of landslide disasters on school attendance of the local community, and analyse the influence of landslide disasters on life expectancy of the local community in Gakenke District. the study concluded that Landslides significantly impact household income sources by destroying or burying agricultural land, leading to reduced crop yields and income from farming, and they directly kill livestock or damage infrastructure essential for raising them, resulting in reduced income from animal husbandry. However, the survey results concluded that Landslides can significantly impact school attendance rates by causing school closures, damage to infrastructure, displacement of students/teachers, economic hardship, and psychological distress, leading to reduced attendance and learning disruptions. Moreover, the field results revealed and concluded that landslides negatively affected life expectancy by damaging homes, businesses, and infrastructure, leading to economic losses, job displacement, and increased poverty. The researcher concluded that landslides harmed the Gakenke community's socioeconomic development because

a one-unit increment in landslide occurrence will result in 0.652 units of reduction in socioeconomic development in terms of household income levels, school attendance rate, and life expectancy. The study recommended that international organizations should emphasize implementing the resolutions (especially those which are related to the climate change issue) of treaties made in international forums like the Conference of the Parties. The Ministry of Local Government, in close collaboration with the districts' management, should strengthen and provide regular awareness campaigns to people who are still in high-risk zones to move to planned settlement sites. More training and technical support from MIDIMAR and other relevant Institutions to increase the level of disaster preparedness, to provide the local community with the knowledge of how to behave during a disaster.

7. References

Bui, A. T., Dungey, M., Nguyen, C. V., & Pham, T. P. (2014). The impact of natural disasters on household income, expenditure, poverty, and inequality: Evidence from Vietnam. *AppliedEconomics, 46*(15), 1751–1766.

Cameron, L. & Shah, M. (2015). Risk-Taking Behavior in the Wake of Natural Disasters. *Journal of Human Resources*, 50(2), pp.484–515.

Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. & Webb, J., (2008). A place-based model for understanding community resilience to natural disasters. *GlobalEnvironmental Change-Human and Policy Dimensions*, 18, pp.598–606.

Felbermayr, G. & Groschl, J., (2023), 'Natural disasters and the effect of trade on Income: Anew panel IV approach', *European Economic Review* 58, 18–30.

Howell, J., and Elliott, J. R. (2019). *Damages done: the longitudinal impacts of natural hazards on wealth inequality in the United States. Soc*. Probl. 66 (3), 448–467. doi:10.1093/socpro/spy016

Huang, D., Chen, Y., Chen, P., and Zheng, Q. (2022). *The protein losses of three major cereal crops by natural disasters in China from 1988 to 2020.* Front. Environ. Sci. 10, 884754. doi:10.3389/fenvs.2022.884754.

Jia, H., Chen, F., Pan, D., and Zhang, C. (2018). The impact of earthquake on poverty: Learning from the 12 May 2008 wenchuan earthquake. *Sustainability 10* (12), 4704–4715. doi:10.3390/su10124704.

Kitutu M.G., Poesen J.M., Deckers J. (2021). Farmer's perception on landslide occurrences in Bududa District, Eastern Uganda. *African Journal of Agricultural Researc*h, 6, 7–18.

MIDIMAR (2022).*"Identification of Disaster Higher Risk Zones on Floods and Landslides in Rwanda Republic of Rwanda, Ministry of Disaster Management and Refugee Affairs, Unit of Research and Public Awareness Disaster High Risk Zones on*," no. March, pp. 1–33, 2022.

MIDIMAR (2023). *The National Risk Atlas of Rwanda*. The National Risk Atlas of Rwanda.

Msilimba, G.G., (2009). *The socioeconomic and environmental effects of the 2003 landslides in the Rumphi and Ntcheu Districts (Malawi). Natural Hazards*, 53(2), pp.347–360.

Mugagga F., Kakembo V., Buyinza M. (2022). Land use changes on the slopes of Mount Elgon and the implications for the occurrence of landslides, *Catena*, 90: 39–46.

NEMA (National Environment Management Authority) (2018). *State of environment report for Uganda for 2017/18*. National Environment Management Authority, Kampala, Uganda.

NEMA (National Environment Management Authority). (2017). *State of environment report for Uganda for 2016/17*.

Neuman, W.L, (2016). *Social Research Methods:* Qualitative & Quantitative Approaches. Boston: Allyn &Bacon Publishers.

Nkurunziza Michel a. (2022). *Disasters kill 15, injure 37 in less than a month. The New Times.* January 27.

Noy, I., (2019), 'The macroeconomic consequences of disasters', *Journal of Development Economics* 88(2), 221–231.

Nsengiyumva, F (2022). *Disaster High Risk Zones for Floods and Landslides. Press.com*

Nsengiyumva, J. B., Luo, G., Nahayo, L., Huang, X., & Cai, P. (2021). Landslide susceptibility assessment using spatial multi-criteria evaluation model in Rwanda. *International Journal of Environmental Research and Public Health,15*(2).6-9