Effect of Environmental Disasters on the Socio-Economic Livelihoods of the People; A Case of Musanze District in Rwanda

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Abstract

The main purpose of this research is to examine the effect of environmental Disasters on socio-economic livelihoods in Musanze District, Rwanda. The research used descriptive research design with quantitative method where a systematic sampling technique was used to 400 respondents from selected sectors in Musanze, by the help of Solven formula. Data collection method involved use of the questionnaire and observational method while before actual process of data collection; the questionnaire was validated and made reliable through a pilot study. The results of the study have revealed a high concern (mean scores 3.740 to 4.040) for environmental Disasters such as water pollution and landslides. Perceptions show strong associations between Disasters and livelihoods (mean scores 3.750 to 4.100). Correlation analysis indicates significant positive relationships ($p < 0.01$) between Disasters and income, agriculture, and health services. Regression analysis suggests a weak relationship (4.8% variability explained) between Disasters and income but significant impacts on agriculture and health services provision ($p < 0.05$). Landslides notably affect agricultural productivity and health services ($p < 0.05$). This study underscores the urgent need for intervention in addressing environmental disasters in Musanze District. It highlights socio-economic challenges and advocates for comprehensive measures to improve healthcare access and economic stability. Integrated approaches are crucial, supported by correlation and regression analyses indicating the impact of disasters on income and livelihoods. Recommendations include awareness campaigns, regulatory enforcement, and collaborative efforts for sustainable development and community resilience.
Keywords: *Environmental Disasters, Inadequate Waste Management, Income levels, Landslides, Socio-economic livelihoods.*

1. Introduction

Musanze District in Rwanda struggles with environmental Disasters, primarily characterized by landslides and unpredictable weather patterns, posing a severe menace to the socio-economic livelihoods of its residents (Harmon, 2022). The extant challenges are worsened by an inadequacy of comprehensive literature, demand urgent attention. The absence of a holistic understanding of the direct implications of these environmental Disasters on the socio-economic well-being of Musanze's population underscores the pressing need for this study.

The district's pivotal sectors, agriculture, and tourism, crucial for the community's economic sustenance, bear the brunt of these environmental difficulties (Welteji & Zerihun, 2018). Thus, tourism is affected by environmental Disasters like soil erosion and landslides which degrade natural attractions, damage infrastructure, raise safety concerns, disrupt activities, and create negative perceptions, Disruptions in agricultural practices and the looming threat to the burgeoning tourism industry create a cascading impact, jeopardizing the economic stability of the entire region. Despite the evident and palpable challenges faced by Musanze due to environmental Disasters, a conspicuous void persists in empirical literature that explicitly investigates the intricate intersection of these Disasters with socio-economic livelihoods.

The limited existing research deals with the complex and multifaceted nature of environmental challenges in the region such as the study of Twahirwa et al. (2023) and the study of Harmon (2022) but did not address fully these environmental Disasters that affect socioeconomic livelihoods of the people in Musanze. Hence, emphasizing the urgency of this research endeavour. This study endeavours to fill this critical research gap by exploring the nuanced dynamics between environmental Disasters and the socio-economic well-being of Musanze's inhabitants, striving to provide insights for the formulation of effective strategies that foster resilience and sustainable development in the face of these challenges.

1.1 Research Objectives
1.1.1 General objective
The general objective of this research is to examine the effect of environmental Disasters on socio-economic livelihoods of the people in Musanze District of Rwanda.
1.1.2 Specific objectives
The specific objectives of this study are the followings:
  (i)   To examine the environment disasters that affect people in Musanze District of Rwanda.
  (ii)   To assess the socio-economic livelihoods of people in Muzanze District of Rwanda.
  (iii)   To determine the relationship between environmental Disasters and socio-economic livelihood status of people in Musanze District of Rwanda.

2. Materials and methods

2.1 Profile of Musanze District

Musanze District in Rwanda's Northern Province, comprising 10 sectors and 68 cells, spans 530.4 km², featuring diverse landscapes like the Volcanoes National Park. Environmental disasters such as deforestation and soil erosion threaten biodiversity, impacting agriculture and livelihoods. Soil erosion particularly affects agricultural

productivity, leading to economic losses. Environmental challenges also affect health services due to water contamination. Addressing these issues, as highlighted by Twahirwa et al. (2023) and Ngwijabagabo et al. (2020), is vital for sustaining agriculture, improving income, and ensuring overall well-being in Musanze District.
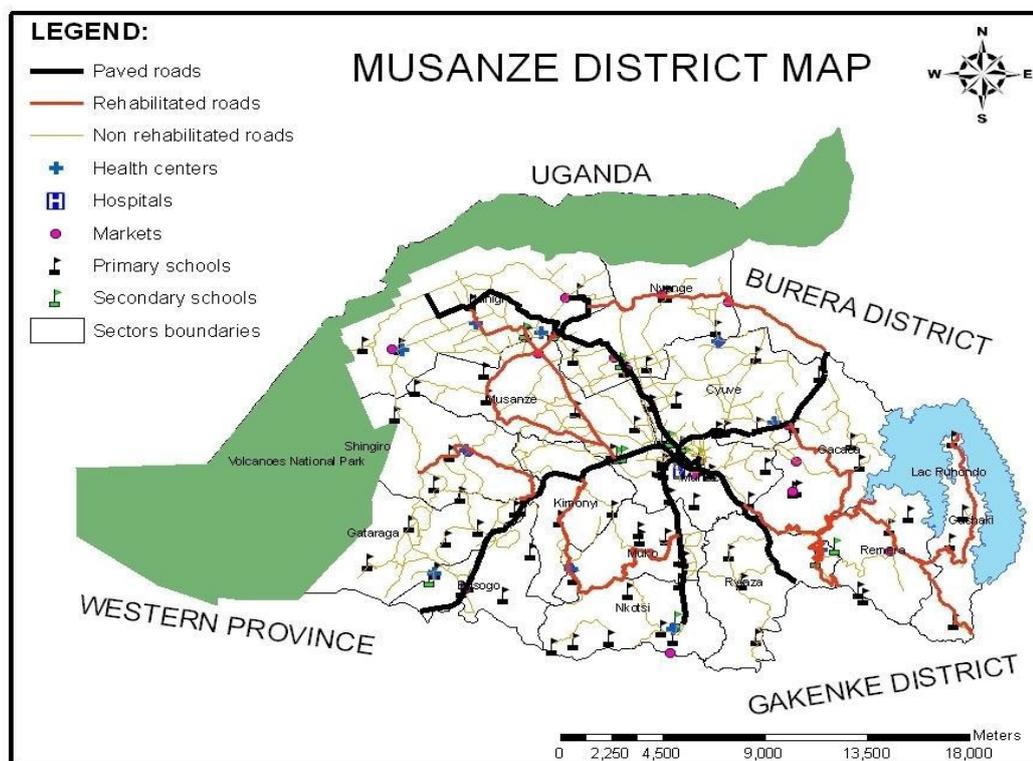

 Figure 3. 1: Map of Musanze District

Source: designed by researcher using GIS Software (Arc MAP, 2024)
2.2 Research design and sampling techniques
This study in Musanze District, Rwanda, employed a mixed-methods approach to assess the impact of environmental disasters on socio-economic livelihoods. The target population comprised 220,000 households in seven selected sectors. Using the Solven formula, a sample size of 400 respondents was determined. Systematic sampling was then utilized to select respondents from each sector, ensuring equal representation and reliability.

Table 3. 1: Number of respondents

Name of the sector	Households	Sample size	Sampling technique
Muko	35,000	58	Systematic
Kinigi	30,000	57	Systematic
Nyange	25,000	54	Systematic
Musanze	45,000	64	Systematic
Shingiro	30,000	57	Systematic
Gataraga	28,000	56	Systematic
Busogo	27,000	55	Systematic
Total	220,000	400	

Source: Musanze District, 2023

In the study, a systematic sampling technique was employed across sectors in Musanze District. The sample size was determined proportionally based on the households in each sector, totaling 400 respondents, ensuring a representative selection for comprehensive data analysis.
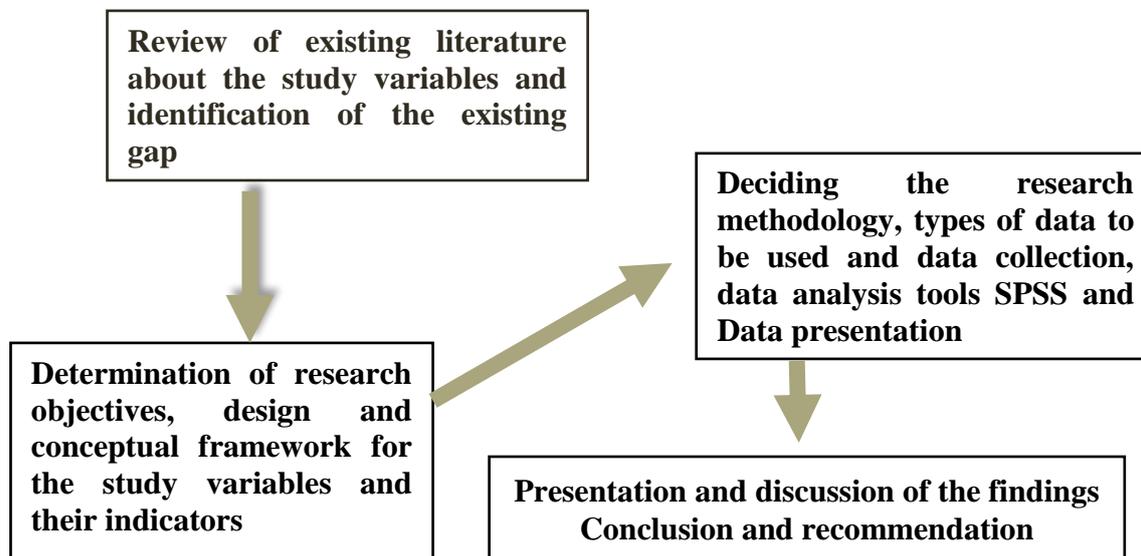
2.3 Illustration of research methodology

Review of existing literature about the study variables and identification of the existing gap

Determination of research objectives, design and conceptual framework for the study variables and their indicators

Deciding the research methodology, types of data to be used and data collection, data analysis tools SPSS and Data presentation

Presentation and discussion of the findings Conclusion and recommendation

Figure 2.1: Methodology flowchart followed by the researcher

3. Results

3.1 The environment Disasters status in Musanze District, Rwanda

The results on environmental Disasters indicate considerable concerns among residents. Issues such as water pollution and landslides stand out, along with challenges like poor waste management and shifting agricultural practices. Immediate interventions are necessary to tackle these Disasters and ensure the safety, sustainability, and well-being of the community in Musanze District, Rwanda.

Table 3. 1: Environment Disasters in Musanze District, Rwanda

Statements regarding environmental Disasters	Mean	SD
Old records and pictures show soil is washing away	3.740	0.658
Some areas show the land slides down easily	3.890	0.716
The grounds and compounds show people are not managing wastes well	3.970	0.723
Some rivers have too much dirt in the water	4.040	0.729
Landslides and erosion show that community is not safe and not prepared	4.000	0.719
Plants and animals changes show the land is getting worse	3.920	0.767
Special maps show how the land is being harmed by different problems	3.920	0.727
The current weather changed methods of growing crops are also changing	3.840	0.746
There are much of the wastes that are not thrown away correctly	3.940	0.743
Cleanliness of the air and water shows us how wastes are causing problems	3.870	0.684
Overall mean	3.913	

Source: Field Data, 2024

Table 3.1 provides insights into various environmental Disasters present in Musanze District, Rwanda, as perceived by the local community. The mean scores, ranging from 3.740 to 4.040, indicate a relatively high level of concern regarding these environmental Disasters. The standard deviations (SD), ranging from 0.658 to 0.767, suggest moderate variability in responses across different statements. The highest mean score (4.040) is associated with the statement "Some rivers have too much dirt in the water," indicating significant concern about water pollution. This is closely followed by concerns regarding landslides and erosion (mean = 4.000), reflecting apprehension about safety and preparedness within the community. In addition, statements regarding poor waste management practices, evident in grounds and compounds (mean = 3.970), and improper waste disposal (mean = 3.940), highlight environmental degradation concerns. The relatively lower mean scores for statements about the changing landscape's effect on plants and animals (mean = 3.920) and the use of special maps to document land harm (mean = 3.920) suggest slightly lesser concern in these areas. The overall, the mean score across all statements is 3.913, indicating a considerable level of apprehension regarding environmental Disasters within the community. These findings emphasize the urgent need for environmental management interventions to address soil erosion, landslides, poor waste management, and water pollution in Musanze District. Implementing strategies to mitigate these Disasters is essential for safeguarding community safety, promoting environmental sustainability, and ensuring the well-being of residents in Musanze District, Rwanda.

3.2 The socioeconomic livelihoods of people in Musanze District, Rwanda

The socio-economic livelihoods reflect different aspects of the well-being and economic circumstances of the people in Musanze District, Rwanda. It indicates varying levels of satisfaction across domains such as access to jobs, healthcare, and land ownership. Overall, there's a moderate level of satisfaction, highlighting the need to address challenges in healthcare access, land ownership, and financial stability for improved community well-being in Musanze District, Rwanda.

Table 3. 2: Socioeconomic livelihoods of the people in Musanze District, Rwanda

Statements regarding socio-economic livelihoods	Mean	SD
Money and jobs make our households get enough and quality food staffs	3.98	.839
Households have enough crops grown to help earn a living	2.740	0.841
Health services are easily offered and they are good	2.760	0.899
Households have enough land to generate income for them	2.770	0.863
People help each other to understand how everyone gets by	2.910	0.772
People's education affects their jobs	3.580	0.781
Farming in a good way makes more money for us	3.620	0.819
People live here show their living conditions	3.130	0.804
Households can handle problems that happen	2.820	0.823
Households have medical insurance	2.840	0.775
Overall mean	3.115	

Source: Field Data, 2024

Table 3.2 presents the socio-economic livelihoods of people in Musanze District, Rwanda, reflecting various aspects of their well-being and economic opportunities. The mean scores range from 2.740 to 3.980, indicating varying levels of satisfaction and challenges across different domains. The standard deviations (SD), ranging from 0.772 to 0.899, suggest moderate variability in responses. The highest mean score (3.980) is associated

with the statement "Money and jobs make our households get enough and quality food staffs," indicating that access to financial resources and employment is perceived as crucial for securing food security within households. In addition, the lowest mean scores are observed for statements related to health services availability and quality (mean = 2.760), household land ownership for income generation (mean = 2.770), and access to medical insurance (mean = 2.840), highlighting concerns regarding healthcare access and economic stability. The mean scores for statements concerning education's impact on employment (mean = 3.580) and the financial benefits of farming practices (mean = 3.620) suggest moderate satisfaction levels in these areas. Overall, the mean score across all statements is 3.115, reflecting a moderate level of satisfaction with socio-economic livelihoods in the district. These findings underscore the importance of addressing challenges related to healthcare access, land ownership, and financial security to improve the overall well-being and economic prosperity of residents in Musanze District. Implementing policies and interventions aimed at enhancing healthcare services, promoting land ownership opportunities, and expanding financial support mechanisms could contribute to enhancing socio-economic livelihoods in the community.

3.3 The environmental Disasters and socioeconomic livelihoods of the people in Musanze District, Rwanda

This part examines how residents perceive the link between environmental Disasters and socio-economic livelihoods in Musanze District, Rwanda. The results revealed high mean scores, indicating the perceived importance of environmental factors in shaping livelihoods. These findings highlight community awareness of these associations, emphasizing the importance of effective environmental management for improving overall well-being and prosperity in Musanze District, Rwanda.

Table 3.3: Environment Disasters and socioeconomic livelihoods of the people in Musanze District, Rwanda

Statements	Mean	SD
Soil problems are linked to how much money Households make.	3.750	0.684
Landslides affect farming and land use.	4.000	0.685
Not managing waste well is related to how healthy people are.	3.950	0.709
Water problems are linked to how safe people are.	3.900	0.751
Harming the land is making life harder for people.	3.920	0.750
Households poverty affects their well being	4.100	0.694
Not handling waste well affects how much people earn.	3.980	0.713
Landslides make life change for bad among the people in Musanze	3.980	0.727
Farming in a good way is linked to making more money.	4.010	0.713
Environmental problems affect how people live and earn money	3.770	0.695
Overall mean	3.936	

Source: Field Data, 2024

Table 3.3 presents the perceptions of residents in Musanze District, Rwanda, regarding the relationship between environmental Disasters and socioeconomic livelihoods. The mean scores range from 3.750 to 4.100, indicating the perceived importance of environmental factors in shaping various aspects of livelihoods. The standard deviations (SD) range from 0.684 to 0.751, suggesting moderate variability in responses. The highest mean score (4.100) is associated with the statement "Households poverty affects their well-being," indicating a strong perception that poverty significantly impacts overall quality of life and welfare. Other statements with high mean scores (above 3.950) highlight the perceived linkages between environmental Disasters and socioeconomic outcomes, such as the

effects of landslides on farming and land use, the impact of waste management on people's health and earnings, and the association between water problems and safety. The lowest mean score (3.750) pertains to the statement "Soil problems are linked to how much money households make," indicating a somewhat weaker perception of the relationship between soil issues and household income. The overall mean score across all statements is 3.936, suggesting a generally high level of agreement among respondents regarding the significant influence of environmental Disasters on socioeconomic livelihoods in the district. These findings underscore the community's awareness of the complex interplay between environmental conditions and various aspects of well-being and economic prosperity. Addressing environmental challenges effectively could thus have substantial positive implications for improving overall livelihoods and quality of life in Musanze District, Rwanda. Efforts to mitigate environmental Disasters and enhance sustainable practices are crucial for promoting resilience and prosperity in the region.

3.4 Correlation and regression analysis

The inferential statistics, comprising correlation and regression analyses, reveal significant relationships between environmental Disasters and socioeconomic factors in Musanze District, Rwanda. The correlation analysis indicates positive correlations between soil erosion, landslides, poor waste management, and income levels, agricultural productivity, and health services ($p < 0.01$), emphasizing their relationships. Regression analysis further explains the effect, with landslides significantly decreasing health service provision ($p = 0.003$). These findings emphasize the need for integrated strategies to address environmental challenges and promote sustainable socioeconomic development in the district.

3.4.1 Correlation analysis

The correlation analysis examines the relationship between environmental Disasters and socioeconomic livelihoods in Musanze District, Rwanda. Results show significant positive correlations between soil erosion, landslides, poor waste management, and income levels, agricultural productivity, and health services ($p < 0.01$). This suggests that as environmental Disasters worsen, there's a similar effect on socioeconomic factors. These findings highlight the interconnectedness of environmental Disasters and socioeconomic livelihoods, advocating for integrated strategies to promote sustainable development in the Musanze District, Rwanda.

Table 3.4: The relationship between environment Disasters and socioeconomic livelihoods of the people in Musanze District, Rwanda

		Income level	Agricultural productivity	Health services
Soil erosion	Pearson Correlation	.217**	.222**	.221**
	Sig. (2-tailed)	.000	.000	.000
	N	400	400	400
Landslides	Pearson Correlation	.219**	.191**	.179**
	Sig. (2-tailed)	.000	.000	.000
	N	400	400	400
Poor waste management	Pearson Correlation	.216**	.221**	.220**
	Sig. (2-tailed)	.000	.000	.000
	N	400	400	400

**. Correlation is significant at the 0.01 level (2-tailed).
Source: Field Data, 2024

The Table 3.4 indicated that there are statistically significant relationships between environmental Disasters (soil erosion, landslides, poor waste management) and socioeconomic livelihoods (income levels, agricultural productivity, health services). The positive correlations, ranging from approximately 0.179 to 0.222 at p<0.01, suggest that as environmental Disasters worsen, there is a tendency for the income levels, agricultural productivity and health services to be affected similarly. This implies that challenges such as soil erosion, landslides, and poor waste management can potentially affect income levels, agricultural productivity and the demand for health services. Such findings underscore the interconnectedness of environmental Disasters and socioeconomic livelihoods, emphasizing the need for integrated approaches to address both environmental sustainability and economic development in Musanze District, Rwanda. Hence, based on the correlation results the null hypothesis (HO) stating that environmental Disasters do not have significant effect on socioeconomic livelihoods among people in Musanze District of Rwanda will be rejected whereas the alternative will be accepted.

3.3.2 Regression analysis

The regression analysis examines the relationship between environmental Disasters and health services provision in Musanze District, Rwanda. Results show that landslides significantly decrease access to health services (p = 0.003), whereas soil erosion and poor waste management don't exhibit significant effects. Landslides have the most substantial standardized impact (-0.587). These findings emphasize the critical importance of addressing landslides to enhance health service provision in the district, highlighting the need for further exploration of factors influencing healthcare accessibility and quality.

Table 3.5: Model summary of environmental Disasters and income level of people in Musanze District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.220ᵃ	.048	.041	1.09152

a. Predictors: (Constant), Poor waste management , Landslides, Soil erosion
Source: Field Data, 2024

The Table 3.5 of the above model summary illustrates a weak relationship (R = 0.220) between environmental Disasters (poor waste management, landslides, soil erosion) and income level in Musanze District, Rwanda. Only 4.8% of the variability in income level can be explained by these environmental factors. The standard error of the estimate is 1.09152, indicating a considerable amount of variability around the predicted income levels.

Table 3.6: Analysis of variance (ANOVA) of environmental Disasters and income level of people in Musanze District, Rwanda

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	23.945	3	7.982	6.699	.000ᵇ
Residual	471.805	396	1.191		
Total	495.750	399			

a. Dependent Variable: Income level
b. Predictors: (Constant), Poor waste management, Landslides, Soil erosion
Source: Field Data, 2024

The Table 3.6 of analysis of variance (ANOVA) reveals a significant relationship between environmental Disasters (poor waste management, landslides, soil erosion) and income levels in Musanze District, Rwanda (F = 6.699, p < 0.001). The regression model accounts

for a significant portion of the variability in income levels, as indicated by the large F-value. This suggests that the combined influence of these environmental Disasters has a notable impact on the income levels of people in the district, underscoring the socioeconomic implications of addressing environmental challenges.

Table 3.7: Regression coefficients of environmental Disasters and income level of people in Musanze District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.261	.445		-.588	.557
Soil erosion	.180	1.179	.096	.153	.879
Landslides	.262	.364	.143	.719	.472
Poor waste management	-.033	1.105	-.018	-.030	.976

a. Dependent Variable: Income level

Source: Field Data, 2024

In the Table 3.7 of regression analysis for income levels in Musanze District, Rwanda, the results indicate that none of the environmental Disasters—soil erosion, landslides, and poor waste management—significantly predict income levels. This is evidenced by the non-significant p-values ($p > 0.05$) associated with each coefficient. Moreover, the standardized coefficients (Beta) are quite low, suggesting minimal impact of these variables on income levels. The constant term is also not statistically significant. These findings imply that, in this model, environmental Disasters do not serve as significant predictors of income levels. Other unexplored factors may play a more substantial role in determining income disparities within the district. Therefore, further investigation into additional variables influencing income levels is warranted to gain a comprehensive understanding of the socioeconomic dynamics in Musanze District.

Table 3.8: Model summary of environmental Disasters and agricultural productivity of people in Musanze District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.243ᵃ	.059	.052	1.09547

a. Predictors: (Constant), Poor waste management , Landslides, Soil erosion

Source: Field Data, 2024

The Table 4.8 of model summary suggests a weak relationship (R = 0.243) between environmental Disasters (poor waste management, landslides, soil erosion) and agricultural productivity in Musanze District, Rwanda. Approximately 5.9% of the variability in agricultural output can be explained by these environmental factors. The standard error of the estimate is 1.09547, indicating considerable variability around the predicted agricultural productivity levels.

Table 3.9: Analysis of variance (ANOVA) of environmental Disasters and agricultural productivity of people in Musanze District, Rwanda

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	29.885	3	9.962	8.301	.000ᵇ
Residual	475.225	396	1.200		
Total	505.110	399			

a. Dependent Variable: Agricultural productivity

b. Predictors: (Constant), Poor waste management, Landslides, Soil erosion

The Table 3.9 of analysis of variance (ANOVA) indicates a significant relationship between environmental Disasters (poor waste management, landslides, soil erosion) and agricultural productivity in Musanze District, Rwanda (F = 8.301, p < 0.001). The regression model explains a significant portion of the variability in agricultural output, as evidenced by the large F-value. This suggests that the combined impact of these environmental Disasters significantly affects the production of agricultural productivity in the district, highlighting the importance of addressing these Disasters for agricultural sustainability.

Table 3.10: **Regression coefficients of environmental Disasters and agricultural productivity of people in Musanze District, Rwanda**

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-.319	.446		-.714	.475
Soil erosion	1.226	1.183	.646	1.036	.301
Landslides	-.743	.366	-.402	-2.032	.043
Poor waste management	-.065	1.109	-.035	-.058	.953

a. Dependent Variable: Agricultural productivity

Source: Field Data, 2024

In the Table 3.10 of regression analysis for agricultural productivity in Musanze District, Rwanda, the results reveal that landslides have a statistically significant negative impact on agricultural output, as indicated by the coefficient of -0.743 (p = 0.043). This suggests that areas experiencing landslides tend to have lower agricultural productivity. However, soil erosion and poor waste management do not show significant effects on agricultural productivity, with non-significant coefficients and p-values above 0.05. The constant term is also not statistically significant. The standardized coefficients (Beta) indicate that landslides have the most substantial standardized impact (-0.402), followed by soil erosion (0.646), albeit not statistically significant. These findings suggest that addressing landslides could be crucial for improving agricultural productivity in the district, while the influence of other environmental Disasters may be less pronounced. Further research could explore additional factors influencing agricultural output in the region.

Table 3.11: Model summary of environmental Disasters and health services of people in Musanze District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.264[a]	.070	.063	1.08342

a. Predictors: (Constant), Poor waste management, Landslides, Soil erosion

Source: Field Data, 2024

The Table 3.11 of model summary reveals a modest relationship (R = 0.264) between environmental Disasters (poor waste management, landslides, soil erosion) and the provision of health services in Musanze District, Rwanda. Approximately 7.0% of the variability in health service provision can be explained by these environmental factors. The standard error of the estimate is 1.08342, indicating moderate variability around the predicted levels of health service provision.

Table 3.12: Analysis of variance (ANOVA) of environmental Disasters and health services of people in Musanze District, Rwanda

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	34.936	3	11.645	9.921	.000[b]
Residual	464.824	396	1.174		
Total	499.760	399			

a. Dependent Variable: Health servies
b. Predictors: (Constant), Poor waste management, Landslides, Soil erosion
Source: Field Data, 2024

The Table 3.12 of analysis of variance (ANOVA) indicates a significant relationship between environmental Disasters (poor waste management, landslides, soil erosion) and the provision of health services in Musanze District, Rwanda (F = 9.921, p < 0.001). The regression model explains a significant amount of the variability in health service provision, as evidenced by the large F-value. This suggests that the combined effects of these environmental Disasters have a notable impact on the availability or quality of health services in the district.

Table 3.13: Regression coefficient of environmental Disasters and health services of people in Musanze District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-.299	.441		-.677	.499
Soil erosion	1.554	1.170	.824	1.328	.185
Landslides	-1.079	.362	-.587	-2.984	.003
Poor waste management	-.062	1.097	-.034	-.057	.955

a. Dependent Variable: Health services
Source: Field Data, 2024

In the Table 3.13 of regression analysis for the provision of health services in Musanze District, Rwanda, the results indicate that landslides have a statistically significant negative impact on the availability or quality of health services, with a coefficient of -1.079 (p = 0.003). This suggests that areas affected by landslides tend to have decreased access to health services. However, soil erosion and poor waste management do not show significant effects on health services, with non-significant coefficients and p-values above 0.05. The constant term is also not statistically significant. The standardized coefficients (Beta) indicate that landslides have the most substantial standardized impact (-0.587). These findings underscore the importance of addressing landslides to improve the provision of health services in the district, while other environmental Disasters may have less pronounced effects. Further research could explore additional factors influencing health service provision in the region.

3.5 Discussion of findings

The empirical study of Downey and Hawkins (2008) found disparities in environmental Disasters among racial groups regardless of similar income levels, supporting the current study's findings on environmental Disasters that affect socioeconomic livelihoods in Musanze District, Rwanda. Braubach and Fairburn (2010), however, found that low-income populations were disproportionately exposed to environmental risks in Europe, contrasting the current results because the current results didn't show that environmental

Disasters specifically affect negatively the income levels of people in Musanze. Nonetheless, both studies underscore the necessity of addressing socioeconomic disparities to enhance environmental equity.

Narloch and Bangalore (2018) observed a higher poverty incidence in areas with elevated environmental risks in Vietnam, aligning with the current study's findings on the perceived link between environmental Disasters and socioeconomic outcomes. Ma et al. (2022) investigated how socioeconomic factors influence environmental consequences in agricultural production, which resonates with the current study's exploration of the relationship between environmental Disasters and socioeconomic livelihoods.

Tan et al. (2022) highlighted the adverse impact of environmental degradation on agricultural production in Europe, differing from the current study's broader focus on environmental Disasters. Nonetheless, both studies contribute to understanding the relationship between environmental factors and agricultural production. Similarly, Ramzan et al. (2022) emphasized the significant pressure exerted by various factors, including environmental Disasters, on agricultural productivity in Pakistan, aligning with the current study's emphasis on addressing environmental challenges for sustainable agriculture.

Adeleye et al. (2021) found that carbon emissions negatively affect agro-productivity in Nigeria, supporting the current study's observations on the adverse effects of environmental Disasters such as poor waste management that was mentioned specifically as air pollution on socioeconomic livelihoods. White & Hall (2015) stressed the importance of addressing environmental Disasters to improve community health, in line with the current study's results regarding the urgent need for environmental management interventions in Musanze District, Rwanda.

Zhang & Mao (2021) investigated the relationship between environmental pollution and healthcare services in China, aligning with the current study's focus on understanding the impact of environmental Disasters on health services provision. Guo et al. (2017) identified deficiencies in basic WaSH services in rural healthcare facilities in sub-Saharan Africa, contrasting with the current study's emphasis on addressing environmental Disasters to enhance community health and well-being. Huttinger et al. (2017) emphasized the need for improved WASH infrastructure and service provision in healthcare facilities, supporting the current study's findings on addressing environmental challenges to improve healthcare access and quality.

4. Conclusion
In conclusion, the findings highlighted the urgent need for implementing environmental management strategies to ensure community safety and foster environmental sustainability. Moreover, the study revealed varying levels of satisfaction and challenges across socioeconomic livelihood domains, indicating the necessity for comprehensive measures to address issues such as healthcare access, economic stability, and financial security to enhance residents' overall well-being and economic prosperity. Importantly, the perceived relationship between environmental disasters and socioeconomic livelihoods highlights the community's awareness of the intricate interplay between environmental conditions and various aspects of well-being and economic prosperity. This awareness underscores the need for integrated approaches to address both environmental challenges and socioeconomic disparities effectively.

To address the identified environmental disasters and socioeconomic challenges in Musanze District, several recommendations can be made. Community awareness and engagement programs should be implemented to enhance residents' understanding of environmental disasters and promote proactive measures. Additionally, environmental management and regulation should be prioritized, with a focus on enforcement and implementation of environmental policies. The Ministry of Health should prioritize efforts to enhance healthcare access and quality in the district, while agricultural authorities should promote sustainable agricultural practices. Capacity building initiatives and intersectoral collaboration are also recommended. Furthermore, suggestions for further studies include assessing community-based environmental initiatives' effect on disasters mitigation and examining the socioeconomic determinants of healthcare access. In addition, research on the relationship between sustainable agricultural practices and environmental resilience and the effect of intersectoral collaboration on environmental disasters mitigation would provide valuable insights for future interventions in Musanze District, Rwanda.

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