



Original Article

Assessing Residents' Perception of Flood Risk: A Case Study of Nyabugogo Floodplain

Carine Nanalngar Roy-Allah¹, Marius Mbarndouka Oumarou², Nanalngar Moyengar³, Blah Kamdoko Nabia¹ & Richard Mind'Je¹

¹ University of Lay Adventists of Kigali, P. O. Box 6392, Kigali, Rwanda.

² Adventist University of Central Africa, P. O. Box 2461, Kigali, Rwanda.

³ United Nations Children's, P. O. Box 1146, N'Djamena, Tchad.

* Author for Correspondence Email: mindjerichard@gmail.com

Article DOI: <https://doi.org/10.37284/ajccrs.4.1.3224>

Date Published: ABSTRACT

30 June 2025

Keywords:

Flood Risk
Perception,
Urban Flooding,
Climate Change,
Community
Preparedness,
Mitigation Strategies,
Socio-Demographic
Factors.

Flood remains a global threat, particularly for those living in flood-prone areas such as the Nyabugogo floodplain. Therefore, there is a huge concern to reduce floods through community perception. This paper aims to assess the perceptions of Nyabugogo residents toward flood risk and its impact. The paper used a mixed method combining both quantitative and qualitative analysis. Data were gathered through systematic interviews and surveys across areas surrounding the floodplain. A sample size of 300 households has been used to collect primary data and analysed using the Statistical Package for Social Science (SPSS). The results indicated that socio-economic factors such as age (70% youth), gender (51.33% female), financial condition (73.33% low income), education level (42.33% primary education), marital status (70% married), etc., influence residents' perceptions. Results have also revealed that 63% of the respondents are aware of the risk of flooding. While 37% have no experience. The sources of flooding reported by the study are climate change 30.67%, poor drainage systems 29.67%, land use and land cover changes 21.33%, proximity to water bodies 15%, and deforestation 3.33%. The study also established a high statistical significance relationship ($P < 0.05$) between residents' perception and flood risk, whereby physical flood impacts such as economic loss, property damages, etc., led to a high perception of risks. The overall mitigation strategies implemented by the local government were weakly rated by residents, 61% of respondents described them as "non-effective". These findings highlighted the need for tailored intervention to foster resilience, reduce vulnerability to flooding and promote sustainable urban development in the Nyabugogo floodplain.

APA CITATION

Roy-Allah, C. N., Oumarou, M. M., Moyengar, N., Nabia, B. K. & Mind'Je, R. (2025). Assessing Residents' Perception of Flood Risk: A Case Study of Nyabugogo Floodplain. *African Journal of Climate Change and Resource Sustainability*, 4(1), 445-462. <https://doi.org/10.37284/ajccrs.4.1.3224>.

CHICAGO CITATION

Roy-Allah, Carine Nanalngar, Marius Mbarndouka Oumarou, Nanalngar Moyengar, Blah Kamdoko Nabia and Richard Mind'Je. 2025. "Assessing Residents' Perception of Flood Risk: A Case Study of Nyabugogo Floodplain", *African Journal of Climate Change and Resource Sustainability* 4 (1), 445-462. <https://doi.org/10.37284/ajccrs.4.1.3224>.

HARVARD CITATION

Roy-Allah, C. N., Oumarou, M. M., Moyengar, N., Nabia, B. K. & Mind'Je, R. (2025) "Assessing Residents' Perception of Flood Risk: A Case Study of Nyabugogo Floodplain", *African Journal of Climate Change and Resource Sustainability*, 4(1), pp. 445-462. Doi: 10.37284/ajccrs.4.1.3224.

IEEE CITATION

C. N. Roy-Allah, M. M. Oumarou, N. Moyengar, B. K. Nabia & R. Mind'Je "Assessing Residents' Perception of Flood Risk: A Case Study of Nyabugogo Floodplain", *AJCCRS*, vol. 4, no. 1, pp. 445-462, Jun.

MLA CITATION

Roy-Allah, Carine Nanalngar, Marius Mbarndouka Oumarou, Nanalngar Moyengar, Blah Kamdoko Nabia & Richard Mind'Je. "Assessing Residents' Perception of Flood Risk: A Case Study of Nyabugogo Floodplain". *African Journal of Climate Change and Resource Sustainability*, Vol. 4, no. 1, Jun. 2025, pp. 445-462, doi:10.37284/ajccrs.4.1.3224.

INTRODUCTION

Climate change has roughly altered the frequency of rainfall all over the world. Floods are the most common of all natural hazards [1, 2], causing hundreds of deaths and casualties. Severe flood events have been reported across continents in the last decade, most especially in Asia, Africa and Europe, with significant social and economic costs underscoring the increased need to manage floods [3, 4]. Globally, many people are exposed to a high risk of flooding and other natural disasters due to climate change. According to Smith [4], flooding is the most common among the environmental hazards, and it regularly claims over a huge number of lives per year and adversely affects millions of people worldwide. Flooding usually refers to a natural disaster, but its impacts can be intensified by human activities such as urbanisation. Urbanisation is one of the major sources of flooding in cities. Floods in cities roughly affect hundreds of people worldwide, especially those with inadequate infrastructure and located in highly sensitive areas.

Africa has become the continent most affected by floods, with an average of 3.4 million people affected annually between 2000 and 2018. The number of flood events in Africa has also been increasing, with a 50% increase in the frequency of floods between 1995 and 2015 [5]. Recently in 2023, OCHA counted 716,000 people affected by flooding in the Central African Republic, Chad, Côte d'Ivoire, the Democratic Republic of the Congo, Liberia, Mali, Nigeria, Niger and Togo.

In Rwanda, the Ministry of Emergency Management in Rwanda [6], has reported 3,309 natural disasters from 2011 to 2019, with the majority being 107 windstorms, 66 rainstorms,

three mine disasters, 77 lightning, 7 landslides, 13 houses collapsed, 8 hailstorms, 29 floods, as well as 98 fires. The overall economic loss of the flood in Kigali is estimated at 200,000 USD [7]. In this perspective,

the Nyabugogo floodplain has a critical history of floods, affecting human lives, safety, livelihood and economy. Flooding events in Nyabugogo led to the loss of people's lives, injuries, economic loss, and a burden to the government [8, 9]. Despite the significant impacts of flooding in this area, few studies attempt to assess the perceptions of the affected community. For example, a study by different authors [10, 11, 12, 13] has discussed and assessed flood-prone regions using different hydrological modelling and flood technology, such as GIS.

However, these studies have only focused on the flood hazard and flood vulnerability, and most of the studies have revealed the use of hydrological modelling in assessing and delineating floods in Kigali City, none focused on resilience or social aspects. For example, [14] has estimated the impact of rainwater harvesting system installation using hydrological models in the Nyabugogo Valley, Kigali. As well as [15], who assessed the impacts of climate change and land-use interventions on flooding in the Nyabugogo catchment (Kigali-Rwanda). These studies, while only focusing on flood hazard and flood vulnerability, have neglected the qualitative aspects of how residents experience, interpret and react to flood risks. Assessing residents' perceptions of flood risk allows us to understand how people perceive and understand that flood risk affects the actions they take to prepare for and respond to flood events [16]. [17] Found that

informing people about the flood danger usually improves perception.

Previous studies on flood risk perception have assessed the role of socioeconomic and demographic factors in shaping residents' perceptions [18, 19, 20, 21, 22, 23, 24]. Higher-income households appear to be better prepared for natural disasters [26, 27].

This study aims to assess the residents' perceptions of flood risk. Four objectives have been designed throughout this paper. First, the study identifies key factors influencing residents' perceptions. Second, to investigate the extent to which Nyabugogo residents perceive flood risk and its associated effects and third, to establish a relationship between residents' perceptions and flood risk. Finally, to identify and examine the effectiveness of existing mitigation strategies implemented by the government.

MATERIALS AND METHODS

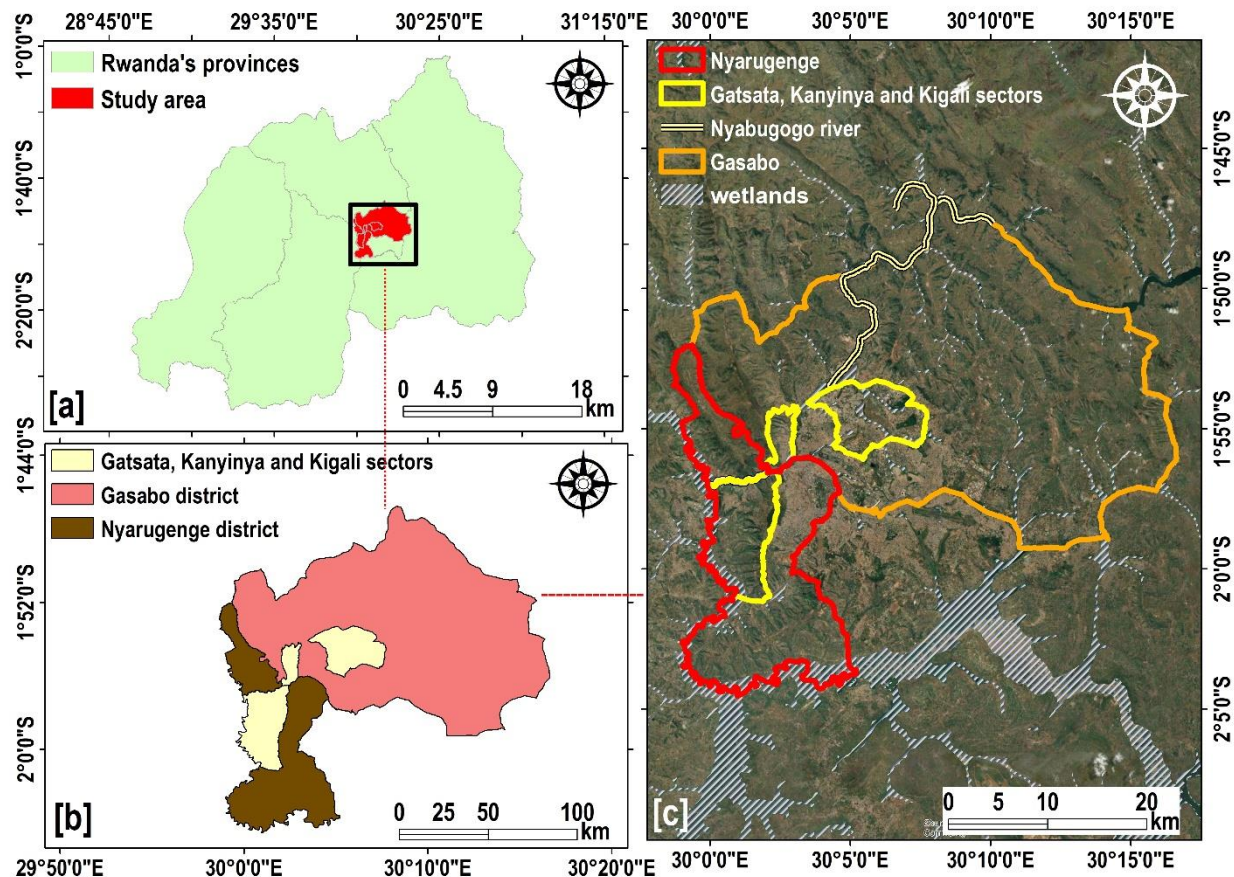
Study Area

The study was conducted across the Nyabugogo floodplain, located between 1,354 and 2,278 meters above sea level and between 30°04'E and 1°94'S. Covering an area of 1,647 square kilometres within the NYABUGOGO watershed, including both rural and urban parts of Kigali. The Nyabugogo floodplain spans elevations between 1,354 and 2,278 meters, situated near 1°09'S and 30°04'E, and covers 1,647 km², encompassing both rural and urban parts of Kigali [28]. This area

is highly susceptible to flooding events such as flash floods. According to [29], the Nyabugogo floodplain is increasingly susceptible to frequent and destructive urban flash floods in Kigali City. The heightened precipitation linked to climate change, coupled with urban development in the Nyabugogo floodplain, amplifies the risk and damage associated with floods in the wetland [30]. The study area is located between steep hills like Gisozi, Mount Jari and Mount Kigali, which are characterised by a swampy feature valley that poses a significant threat to drainage and settlement along the Nyabugogo River. Kigali city is built on relatively hilly terrain ranging between 1400 meters and 1850 meters above sea level, and hilltops are separated by relatively large valleys [31]. Contribute to landslide risks on the slopes and frequent flooding in the valley, especially during rainy seasons.

The study encompassed areas such as Nyamugari and Nyamabuye of the Gatsata sector, Nyamweru and Nzove of the Kanyinya Sector, and the Nyabugogo cell of the Kigali sector. And stretching from the Nyamugari cell of the Gatsata sector to the Nyabarongo Bridge. These areas have been extremely developed over the years due to the rapid urbanisation of Kigali City, which was favourable for low-income groups that needed to settle in the urban fringes of the city. The combination of intense rainfall, wetland areas, and steep slopes makes the areas around Kigali City highly susceptible to the risk of flooding.

Figure 1: The Geographical Location of the Study Area; [a] The Study Area at a National Scale, [b] The Study Area Boundaries, [c] The Study Area in Google Earth Imagery Along with the Wetlands.



Sample Size and Sampling Techniques

A sample size is a tiny subset of a population; a sample should be representative, which means it should be based on the size of the population; the larger the population, the larger the sample size [32]. Following the current Rwanda National Census report, the estimated population (N) of the Nyabugogo is 825,767 individuals subdivided into 1209 households [33]. However, investigating the complete population to answer specific issues typically requires a significant amount of time, money, and other resources. For this, a representative sample size was calculated using Yamane's formula [34]:

$$n = \frac{N}{1 + Ne^2}$$

Where: n is the sample size, N is the population size, and e is the margin of error (0.05).

$$n = \frac{1209}{1 + 1209 * 0.05^2}$$

$$= \frac{1209}{4.0225} = 300.5 \approx 300 \text{ households}$$

Source: Yamane, T. (1967). *Statistics: An Introductory Analysis* (2nd ed.). Harper & Row.

These participants were selected in each village that makes up the different sectors surrounding it.

Data Collection and Analytical Approaches

This study used a mixed-method approach, combining both quantitative and qualitative data collection techniques in order to assess the perception of Nyabugogo residents on flood risk.

Primary data were obtained through a structured and semi-structured household questionnaire, which incorporates open-ended as well as Likert scales to assess residents' responses on flood risk. Data collection also included direct field observations by the researchers, endorsed by photographs to enhance the understanding of flood risk and community behaviour.

The sample size was determined by Yamane's formula, ensuring a statistically valid representation of the 825,767 individuals according to NISR living in 1209 households across the study area. A final number of 300 respondents was selected through a stratified random sampling considering socio-economic and demographic factors such as age, income, education, and household location (Gasabo and Nyarugenge districts).

Data analysis was performed through Microsoft Excel and SPSS (Statistical Package for the Social Sciences). Microsoft Excel was used for data entry, cleaning, basic statistics, and preparation of graphs (e.g., bar charts, pie charts, and histograms). SPSS, on the other hand, was used for advanced descriptive and inferential statistical analysis. Particularly, logic regression models were applied to examine the relationship between flood risk perception and socio-economic and demographic factors.

The general logistic regression model used in this study was expressed as follows:

$$\begin{aligned} \text{logit}(p) &= \ln\left(\frac{p}{1-p}\right) \\ &= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \\ &\quad + \beta_k X_k \end{aligned}$$

Source: Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression (3rd ed.)*. Wiley.

Where P is the probability, β_0 is the intercept, $\beta_1, \beta_2 \dots + \beta_k$ is the regression coefficients for the independent variables X_1, X_2, \dots, X_k . A significance level of $p < 0.005$ was adopted to determine statistical significance.

A statistical significance level of $p < 0.05$ was adopted to determine the statistical correlation between the variables. This ensured a strong evaluation of the relationship between perceived risk, real-world flood experiences, and the impact of mitigation strategies.

Finally, to complement the primary data, secondary data were obtained from institutional libraries, including UNILAK, Kigali Public Library, and the National Library of Rwanda. As well as government documents, electronic sources, and scholarly articles. This improves the understanding of the background and context of flood risk in this area.

RESULTS

Key Factors Influencing Nyabugogo Residents' Perceptions of Flood Risk

This section emphasises the demographic and socio-economic characteristics of the household that play an important role in food risk perception, such as gender, age, household size, marital status, education level, flood experience, employment status and household income per district. Empirical studies show the role of socio-economic and demographic factors such as age, gender, income, education, etc., in shaping residents' perceptions of flood risk [35, 36, 37, 38, 39, 40, 41]. The overall results found that 77% were youths, 51.33% were females, 73.33% were low-income earners, 42.33% had primary education, and 70% of the residents were married. 61.44% lived in an extended family. 32.33% lived in lower floodplain areas. Regarding the length of residency, most residents have lived there for at least 10 years.

Table 1: Socio-economic and Demographic Factors

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Female	154	51.33
	Male	146	48.67
Age	18-30	231	77
	31-40	40	13.34
	41-50	13	4.33
	>50	16	5.33
Education level	No formal education	44	14.67
	Primary	127	42.33
	Secondary	113	37.67

	High institutions	16	5.33
Employment	Employed	188	63
	Unemployed	112	37
Income Level	Low	220	73.33
	Middle	74	24.67
	High	6	2.00
Housing tenure	Rent	170	56.67
	Own	130	43.33
Family Size	Extended family	188	61.44
	Single-person	118	38.56
Housing Position	Middle	114	38.00
	Lower	94	32.33
	Upper	55	18.33
	Valley	32	10.68
	Lower, valley	1	0.33
	Middle, Valley	1	0.33
Time lived in the area.	Over 20 years	26	8.67
	15-20 years	34	11.33
	1-5 years	48	16.00
	Less than 1 year	59	19.67
	5-10 years	66	22.00
	11-15 years	67	22.33

Source: primary data, 2025

Analysing the Socioeconomic and Demographic Factors Using Logic Regression.

The table below presents the results of a statistical model, likely a multiple regression, attempting to explain the flooding experience based on several socioeconomic and demographic factors (marital status, home ownership, employment status, family size, and homestead position). In general,

the models reveal that only two factors, employment status and family size (specifically, being a single-person household), have a statistically significant relationship with flood risk perception. Employment is associated with a higher valuation on the result measure ($p=0.002$), and likewise single living in a solitary-person household ($p=0.0025$).

Table 2: Summary of Logic Regression

Term	Estimate	Std. Error	Statistic	P.Value
(Intercept)	0.0142	0.4008	0.0355	0.9716
Marital Status Married	-0.2293	0.3523	-0.6509	0.5151
Marital Status single	0.4020	0.3387	1.1868	0.2353
Marital Status Widowed	-0.8596	0.4805	-1.7888	0.0737
Own House Rent	-0.5350	0.2866	-1.8666	0.0620
Employed Yes	0.8495	0.2744	3.0959	0.0020
Family Size Single-person	0.8952	0.2959	3.0250	0.0025
Homestead position Lower, Valley	-13.7207	882.7436	-0.0155	0.9876
Homestead position Middle	0.3399	0.3218	1.0562	0.2909
Homestead position Middle, Valley	-13.8160	882.7435	-0.0157	0.9875
Homestead position Upper	0.5235	0.4068	1.2869	0.1981
Homestead position Valley	-0.9895	0.4606	-2.1481	0.0317

*Significance levels: *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$, ns: not significant*

Source: primary data, 2025

Perception of Nyabugogo Residents on Flood Risk and Its Associated Effects

The table below shows that the majority of respondents (63%) have experienced flooding

hazards, indicating that flooding is a significant issue in the area. Meanwhile, (37%) have not faced flooding, suggesting that some locations might be less affected or better protected.

Table 3: Count of Participants Experiencing Flooding

Experienced flooding	Frequency	Percentage
Yes	189	63.00
No	111	37.00
Total	300	100

Source: *primary data, 2025*

Table 4 provides information about residents' perceptions of flooding risk causes. Results demonstrate a high percentage of resident (30.67%) acknowledging climate change as the first cause of flooding in their area followed by poor drainage systems (29.67%), land use and

cover changes (21.33%), proximity to water bodies (15%), and then finally deforestation (3.33%). Both factors indicate that human activities and geographical features influence flooding in this area.

Table 4: Perception of the Residents on Flooding Causes

Flooding cause	Frequency	Percentage
Climate change	92	30.67
Poor drainage systems	89	29.67
Land use and land cover changes	64	21.33
Proximity to the water body	45	15.00
Deforestation	10	3.33
Total	300	100

Source: *primary data, 2025*

The table below shows the impacts of flooding on Nyabugogo residents. Overall, a great number of participants equally recognised economic loss (26.67%) and property damages (26.67%) as the most common impacts of flooding in their area.

The health issue is the second cited impact by residents, with a percentage of 23.33%, followed by displacement and relocation, with a proportion of 16.67%, then emotional damage (stress and anxiety), represented by 6.66%.

Table 5: Flooding Impacts Experienced by the Nyabugogo Community

Flooding impacts	Frequency	Percentage
Economic loss	80	26.67
Property damages	80	26.67
Health impacts	70	23.33
Displacement and relocation	50	16.67
Emotional damage (Stress and anxiety)	20	6.66
Total	300	100

Source: *primary data, 2025*

The majority of participants revealed an equal percentage (26.67%) between traditional media (TV and radio) and government websites as their source of information. Therefore, 20% highlighted

the role of community training in the process of flood risk communication. Mouth-to-ear (16.66%) is also among the channels used for flood risk communication, followed by social media (10%).

Table 6: Source of Information

Information source	Frequency	Percentage
Traditional media (radio, TV)	80	26.67
Government websites	80	26.67
Community workshop	60	20
Mouth to ear	50	16.66
Social media	30	10
Total	300	100

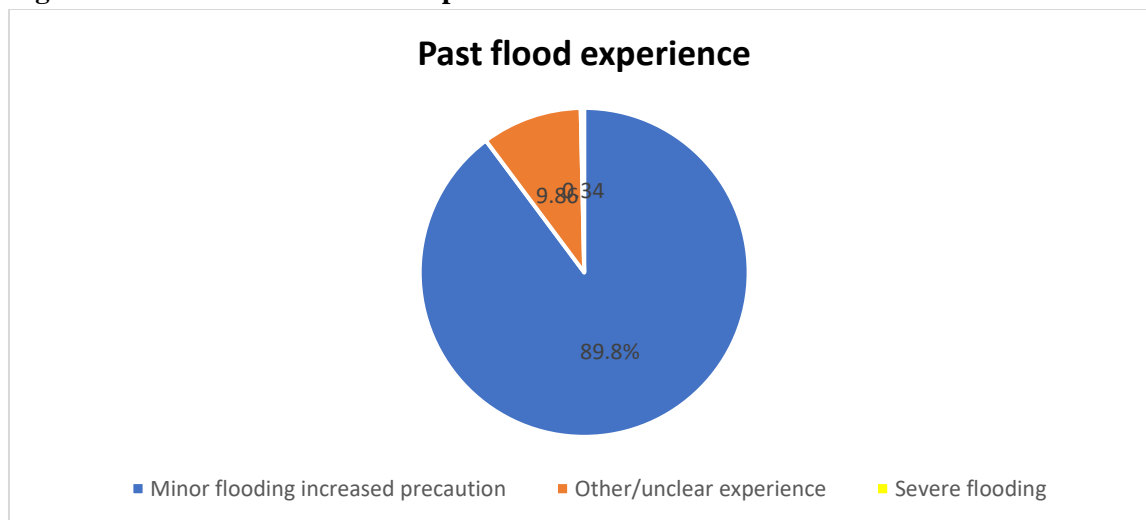
Source: *primary data, 2025*

Past Flood Perception

The figure below presents information on participants' perceptions of past flooding experiences. The majority (89.8%) had experienced minor flooding and, as a result, they

became more cautious. A percentage (9.86%) falls into an "other/unclear" category, indicating a lack of specific information or a different type of experience. Finally, a tiny fraction (0.34%) has witnessed severe flooding, leading to increased caution and proactive measures.

Figure 2: Resident's Past Flood Experience and Precaution



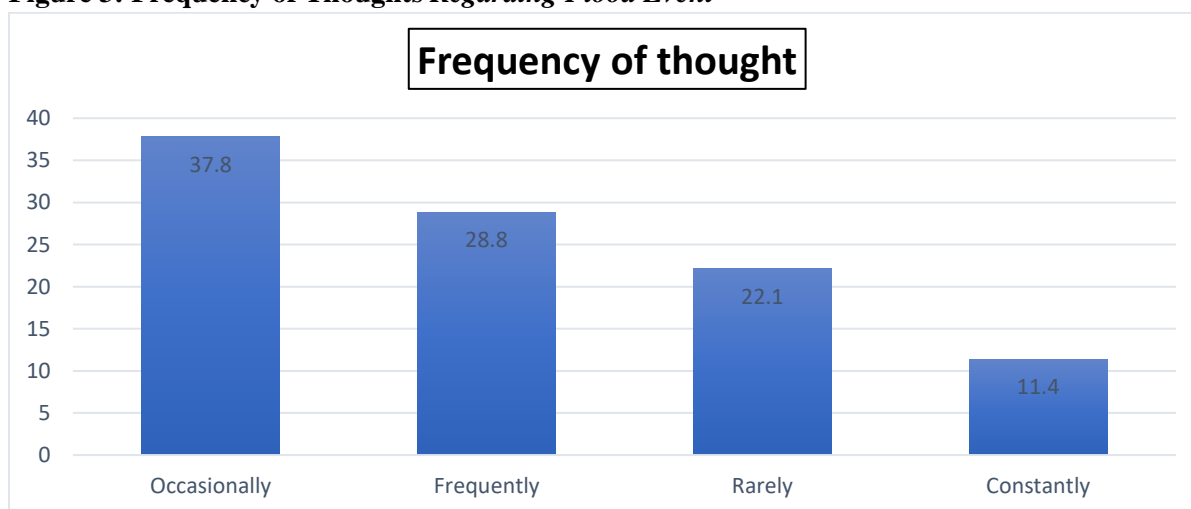
Source: Primary data, 2025

Frequency of Thought Regarding Flood Events

The figure below shows an average of 37.8% of respondents acknowledged thinking about floods

occasionally, followed by 28.8% who think about it frequently. 22.1% think about it rarely, and finally, 11.4% constantly think about it. This result proves sufficiently that flooding affects the area.

Figure 3: Frequency of Thoughts Regarding Flood Event



Source: Primary data, 2025

Relationship between Flood Risk and Residents' Perceptions Across the Nyabugogo Floodplain

The table below shows a clear relationship between flood risk and residents' perception,

considering a coefficient level of 0.05. The result shows two probabilities of results (positive/negative). The negative assessment factors are flooding impact on the local economy ($P \geq -0.532$) and flooding source ($P = -0.739$), both

show a result which $P \geq 0.05$. Other factors, such as flooding impacts on residents' lives, impacts on the environment, and flooding impacts such as

economic loss, property damage, health issues, etc., showed a positive correlation ($P < 0.05$) on the outcomes.

Table 7: Relationship between Flood Risk and Residents' Perception

Term	Estimate	Std. Error	Statistic	p-value
(Intercept)	1.7091	0.272	6.277	0.000
Source of flooding	-0.0500	0.080	-0.625	0.532
Flooding impacts	0.3000	0.050	6.000	0.003
Flooding impacts on lives	0.2500	0.048	5.208	0.002
Flooding impact on the environment	0.4000	0.100	4.000	0.004
Flooding's impact on the local economy	-0.0200	0.060	-0.333	0.739

Significance levels: *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$, ns: not significant

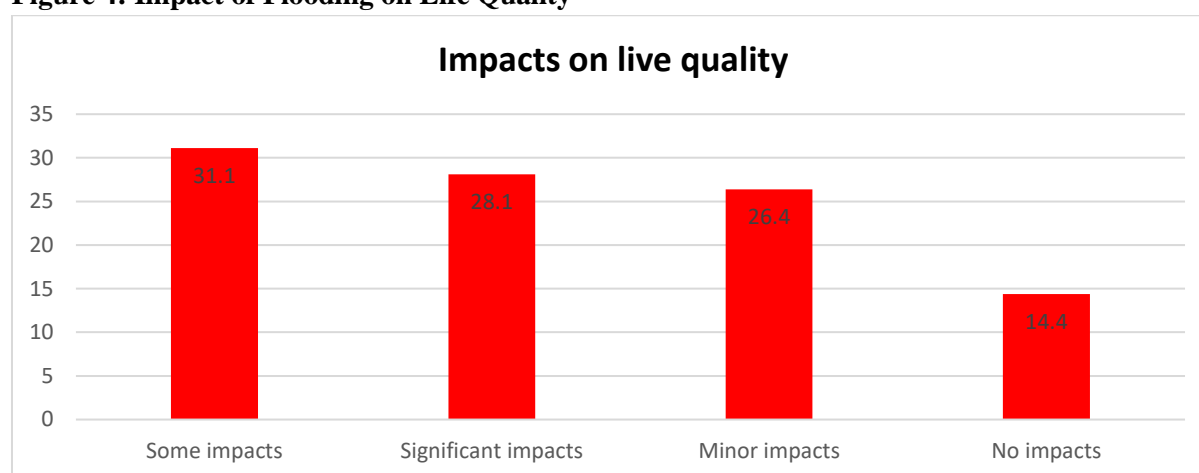
Source: primary data, 2025

Impacts of Flood Risk on Quality of Life

The figure below presents information on the impact of floods on life quality. Overall, 31.1% of participants acknowledged some impacts, followed by 28.1% who reported significant

impacts, then 26.4% who noticed minor impacts and finally 14.4% who reported no impacts. The overall result suggests that flood is an important concern which affects the lives of Nyabugogo residents and puts the area in vulnerable disaster conditions.

Figure 4: Impact of Flooding on Life Quality



Source: Primary data, 2025

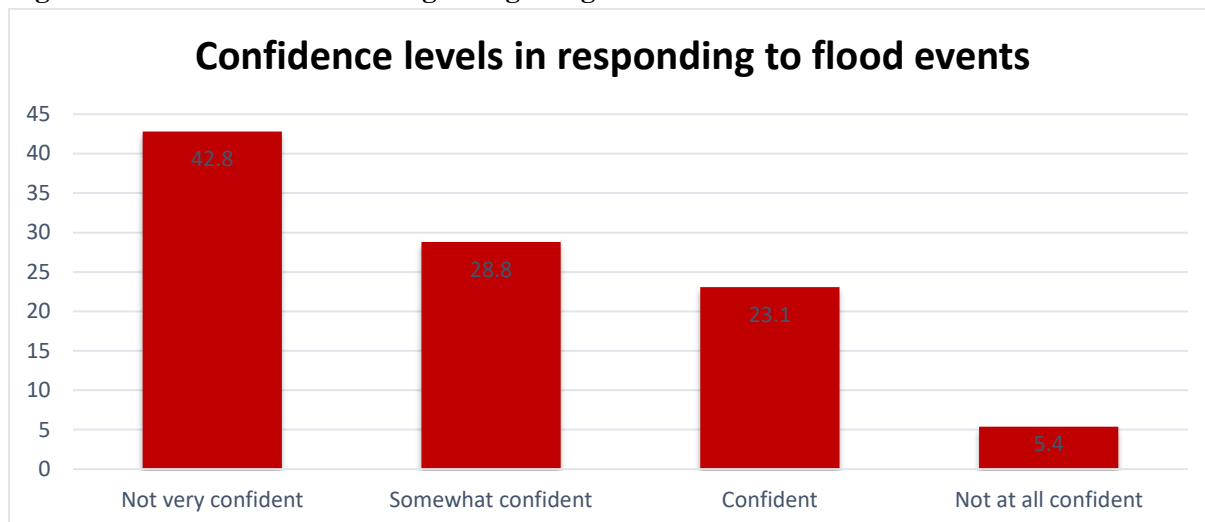
Identification and Examination of the Effectiveness of the Existing Mitigation Strategies

Level of Confidence to Respond to Future Flood Events

The figure below shows the level of confidence of participants regarding their capacity to respond to future flooding events regarding the impacts of the

last one. Almost half (42.8%) of the residents responded not very confident. 28.8% responded somewhat confident. 23.1% declared to be confident, and 5.4% responded not at all confident. Globally, the average level of preparedness is small and needs further improvement.

Figure 5: Level of Confidence Regarding Mitigation Measure



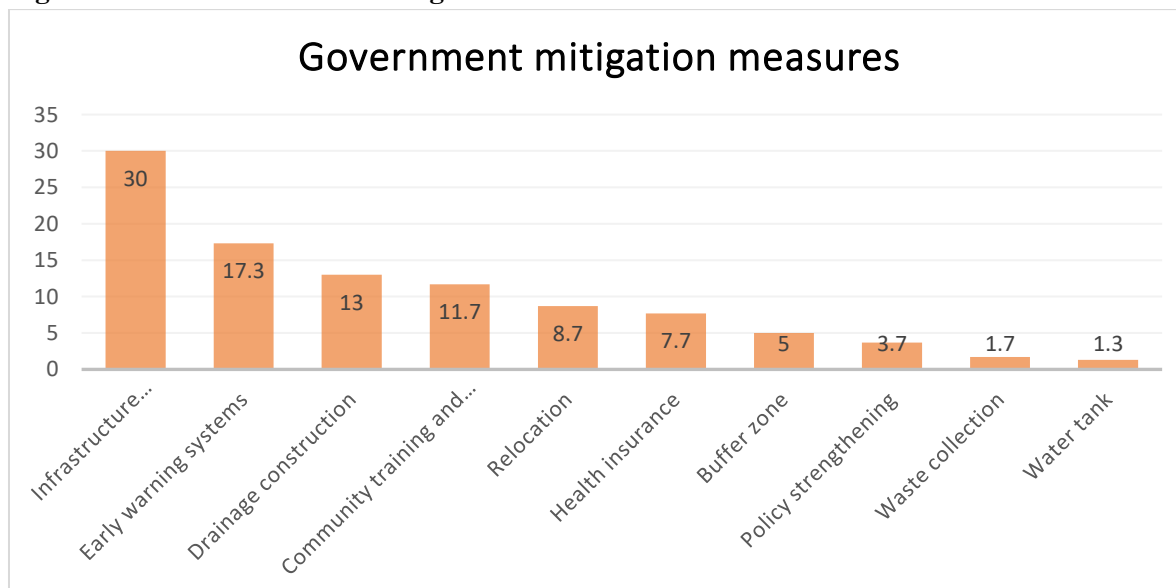
Source: primary data, 2025

Identification of Mitigation Measures Implemented by the Government

The figure below represents how Nyabugogo residents rate mitigation measures implemented by the government. Overall, the participants rate infrastructure reinforcement by 30%, early warning systems by 17.3%, drainage construction by 13%, community training and support by 11.7%, relocation by 8.7%, health insurance by

7.7%, buffer zone by 5%, policies strengthening by 3.7%, waste collection by 1.7%, and finally water tank by 1.3%. These results showed the role of the government in flood risk management and disaster reduction all over the Nyabugogo floodplain. The government has implemented diverse disaster response strategies to minimise flood effects.

Figure 6: Government Flood Mitigation Measures



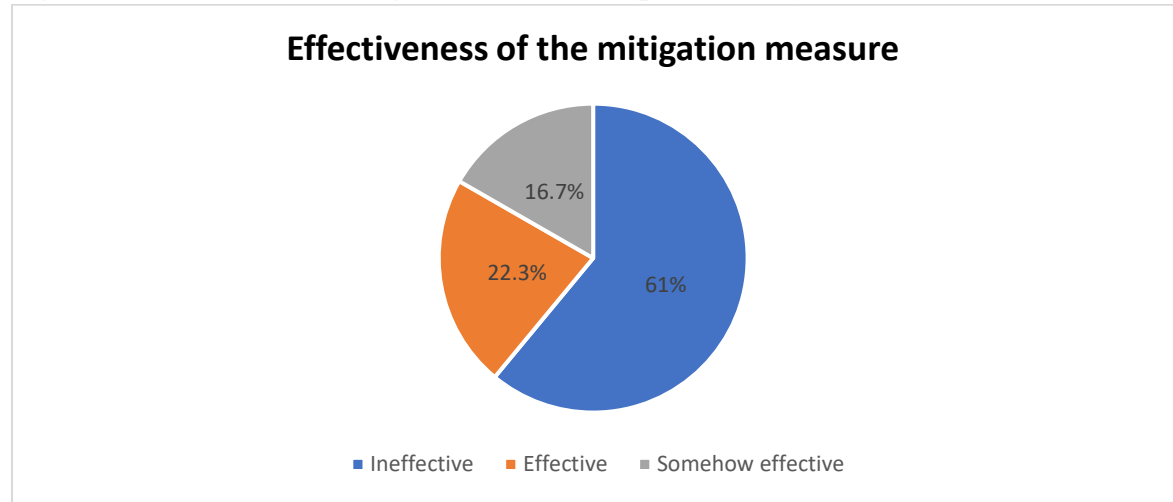
Source: primary data, 2025

Effectiveness of Mitigation Measures Implemented by the Government.

The figure below represents the effectiveness of mitigation measures implemented by the government. The result showed that 61% rate it as ineffective and late to respond to community

needs, especially during post-disaster recovery. 22.3% of respondents rate it effectively. And 16.7% per cent rate it somehow effectively by emphasising the need for some improvement, especially on communication measures and financial support.

Figure 7: Effectiveness of Mitigation Measures Implemented by the Government



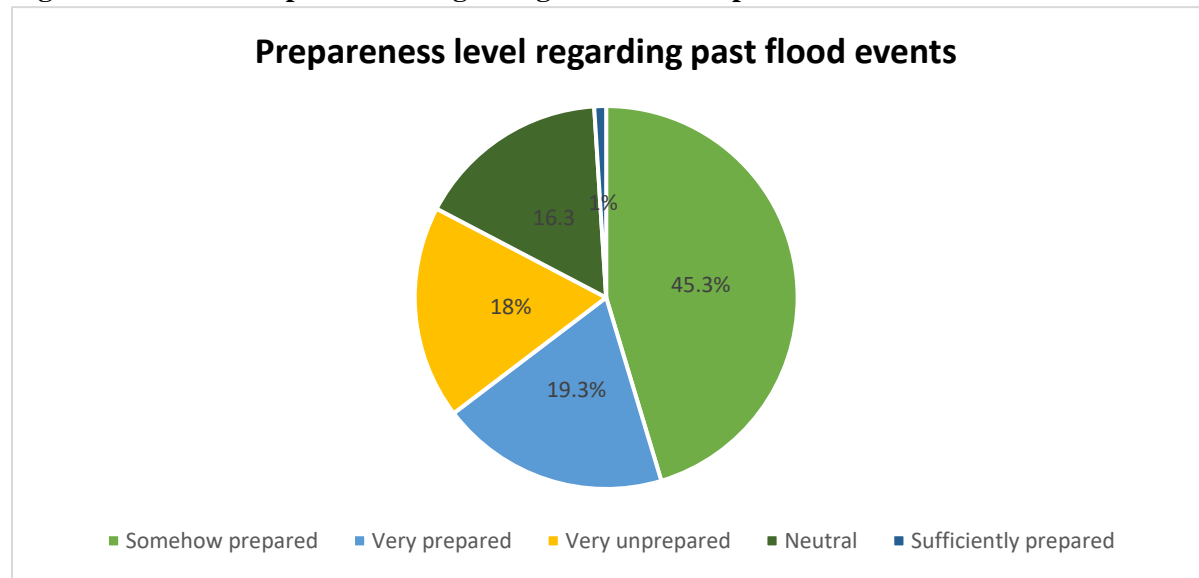
Source: primary data, 2025

Level of Preparedness Regarding Past Flood Experience

The figure below shows a high percentage of participants who responded somewhat prepared, 45.3%, 19.3% who responded very prepared, 18%

who responded very unprepared, 16.3% who preferred to stay neutral, and finally 1% declared to be sufficiently prepared. The overall result shows that the resident community understand flood risk but struggles to reduce its impact due to several factors.

Figure 8: Level of Preparedness Regarding Past Flood Experience



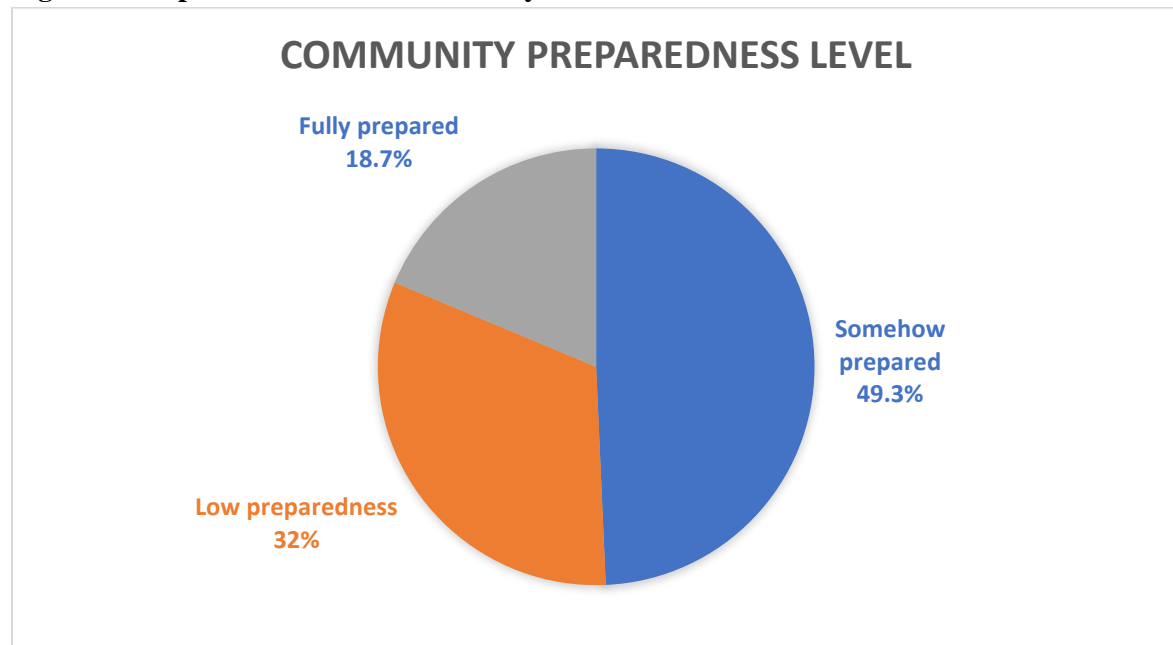
Source: primary data, 2025

Level of Preparedness within the Nyabugogo Community

The figure below shows the overall preparedness of the Nyabugogo floodplain community. The result has shown 49.3%, and 32% are reported to have very low preparedness regarding flood events. Therefore, only a few numbers (18.7%)

acknowledge their full preparedness. The overall results suggest a low level of readiness, with a significant need for improvements in awareness and resources. By addressing these gaps, policymakers, local government, and community leaders may build resilience for future flood events.

Figure 9: Preparedness at the Community Level



Source: primary data, 2025

DISCUSSION

This study aims to assess the perceptions of residents across the Nyabugogo floodplain. The findings of the study highlighted the complexities of flood risk perception among the residents of Nyabugogo while emphasising subjective and objective factors influencing residents’ flood risk perceptions.

Previous studies highlighted the role of socioeconomic and demographic factors, such as education level, age, marital status, income, house ownership, time duration, and gender, among others were found to have critical impacts on risk perception of flooding. For example, a study by [43] explicitly indicates that older people usually have higher flood risk perceptions. Therefore, no correlation has been found in this study regarding age. The overall perception is based on experience. Gender plays an important role in

shaping individual perception. According to [44], who found that females are aware of the flooding impacts while men underestimate its impacts. Referring to this study, the majority of females have shown a higher perception than men. Education level, on the other hand, roughly affected resident perception, such stated by [45], who suggests that educated residents have great resources and awareness of flooding. House ownership, as suggested by [46], found that renters are more affected by flood impacts while owners are more proactive and community-oriented.

The length of duration influences flood risk perception. The more residents stay in a place, the more they experience flood risk as assessed by the study [47]. Finally, homestead position influences residents’ perception, as explained by [48]. According to this study, residents living in lower

homesteads are more susceptible to being affected more by flood impacts. A great number of participants (63%) demonstrated a higher awareness of flood risk. Therefore, a significant number (37%) remain uninformed about the risk of flooding in their area. Resulting from a gap in proactive preparedness measures.

The findings from this research disconnect the relationship between perceived flood risk and preparedness actions. Respondents have acknowledged the role of climate change and poor drainage systems, land use change, etc. (Table 3) as major sources of flooding in their area. The most cited impacts of flooding are economic loss, health impacts, house damage, emotional damage, etc. Although due to a lack of resources, equipment, community involvement and many other personal reasons, these perceptions have not affected their preparedness. This aligns with prior studies by [45, 46], which suggested that perceived vulnerability is not always followed by behavioural adaptation but is influenced by factors such as income, gender, education, etc.

The analysis of the relationship between flood risk and residents' perceptions has found that there is a positive correlation between the two variables, mostly regarding physical factors such as flood impacts, including factors like property damage, economic loss, health damage, etc. The negative correlation remains on factors such as flood source or intangible factors. The overall result demonstrates that resident perceptions are mostly influenced by tangible and physical factors. Therefore, these findings underscore the primordial need for designing targeted interventions that correspond to address the unique needs and constraints of flood-affected communities.

Also, individuals with direct experience of historical floods had heightened risk perception and a higher propensity for preparedness actions. The study of [49] supports this assessment result by showing how personal experience influences mitigation behaviour. However, the study also revealed that repeated flooding impacts may lead to a fatalistic culture where residents just accept

accommodating the impacts without looking for solutions.

The study also evaluated the effectiveness of current mitigation strategies. Overall, participants rated infrastructure reinforcement and early warning systems as the most popular, therefore, there is an urgent need for the government to clear technical terms to provide a larger raise of awareness. Some confusion regarding technical terms used in flood warning alerts, such as buffer zones and drainage systems, contributed to the misunderstandings about the likelihood and severity of flooding. [50], emphasising the need to simplify risk communication to ensure accessibility for diverse parts of the community. Moreover, the trust in the source should be important, since it affects residents' perceptions. Suggesting that authorities must prioritise transparency and community engagement to build credibility. In this study, over 53.34% of participants trust and rely on media (radio and TV) to gather information regarding flood risk.

While this research provides valuable information, some limitations need to be noted. Self-reported data may pose bias, such as social desirability or recall bias. Participants' responses are based on personal experience, which may differ from one resident to another one sometimes in the same area. Without a scientific-based experiment, it is hard to estimate the overall awareness and preparedness of the entire community. For example, a study by [51] found that affected communities with more physical impacts on infrastructure were more likely to support flood mitigation measures and actively prepare for future floods.

By addressing the identified gaps and leveraging tailored communication and policy interventions, governments and stakeholders can enhance resilience and reduce the impacts of flooding on vulnerable populations.

CONCLUSION

This research has examined the important nexus between residents' perceptions and flood risk in the Nyabugogo floodplain of Rwanda. Through a

systematic investigation of local perceptions, influencing factors, and existing mitigation strategies, this study contributes to the growing body of knowledge on community-centred approaches to flood risk management. The research provides valuable insights into how residents of Nyabugogo conceptualise and respond to flood risks in their immediate environment. By exploring the relationship between actual flood risk and residents' perceptions, this study highlights potential gaps in risk awareness that could be addressed through targeted interventions. Understanding these perception dynamics is crucial for developing effective flood management strategies that resonate with local communities. This study also evaluates existing flood mitigation measures in the Nyabugogo floodplain, identifying strengths and limitations in current approaches. The scientific research-based strategies proposed in this study offer practical solutions that integrate technical expertise with local knowledge and perceptions.

The findings from this research have significant implications for policymakers, urban planners, and disaster management authorities in Rwanda. By incorporating residents' perceptions into flood risk management frameworks, more holistic and sustainable approaches can be developed. These approaches not only address the physical aspects of flood control but also consider the social and psychological dimensions that influence community resilience. Future research should build upon these findings by exploring different changes in times of Nyabugogo residents' perception, examining the effectiveness of perception-based interventions, and expanding the geographical scope to other flood-prone areas in Rwanda and beyond. Continued engagement with local communities remains essential for translating research insights into meaningful improvements in flood risk management and community resilience.

Acknowledgement

The authors express their sincere gratitude to the University of Lay Adventists of Kigali (UNILAK) for their institutional support throughout this

research process. Moreover, appreciation extends to all respondents who generously shared their time and insights, making this study possible. We also thank Dr Richard Mind'je and Nyabugogo residents for their cooperation and assistance, which greatly facilitated the completion of this work.

Declarations of Conflict of Interest

The authors declare that they have no conflict of interest.

Author's Approval.

We assure you that all the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.

Ethical Approval.

While collecting our data, all applicable guidelines and principles for the care of species were followed under the ethical standards and informed consent was obtained from all individual participants involved in the study by assuring their anonymity and were told about the purpose of conducting the research.

REFERENCES

- [1] Jha, A. K., Bloch, R., & Lamond, J. (2012). *Cities and flooding: A guide to integrated urban flood risk management for the 21st century*. World Bank Publications. <https://openknowledge.worldbank.org/handle/10986/6018>
- [2] Brilly, M., & Polic, M. (2005). Public perception of flood risks, flood forecasting and mitigation. *Natural hazards and earth system sciences*, 5(3), 345-355.
- [3] United Nations Environment Programme. (2012). *UNEP year book 2012: Emerging issues in our global environment*. United Nations Environment Programme. <https://library.sprep.org/sites/default/files/2021-03/Man-SOE-UNEP-2012.pdf>

- [4] Merz, B., Kreibich, H., Schwarze, R., & Thieken, A. (2010). Assessment of economic flood damage. *Natural Hazards and Earth System Sciences*, 10(8), 1697–1724. <https://doi.org/10.5194/nhess-10-1697-2010>
- [5] Locke, D. (2021). Vulnerabilities shape risk perception and influence adaptive strategies to hydro-meteorological hazards: A case study of Indo-Fijian farming communities. *International Journal of Disaster Risk Reduction*, 62, 102401. <https://doi.org/10.1016/j.ijdr.2021.102401>
- [6] Smith, J., Johnson, R., & Parker, M. (2018). *Perceived vulnerability and disaster preparedness: A psychological perspective. Journal of Risk Research*, 21(6), 789–804. <https://doi.org/10.1080/13669877.2017.1302710>
- [7] United Nations Office for the Coordination of Humanitarian Affairs. (2024). *OCHA Annual Report 2023*. <https://www.unocha.org/publications/report/world/ocha-annual-report-2023>
- [8] MINEMA. (2021). *Jya Mbere Project Annual Progress Report 2019–2020*. Ministry in Charge of Emergency Management. Retrieved from <https://www.minema.gov.rw/publications>
- [9] Munyaneza, O., Nzeyimana, Y. K., & Wali, U. G. (2013). Hydraulic structures design for flood control in the Nyabugogo wetland, Rwanda. *Nile Basin Water Science & Engineering Journal*, 6(2), 26–37
- [10] Rwanda Environment Management Authority. (2019). *Assessment of climate change vulnerability in Rwanda – 2018*. Kigali, Rwanda: Rwanda Environment Management Authority. https://rema.gov.rw/fileadmin/templates/Documents/rema_doc/Reports_Updated/2018%20Assessment%20of%20climate%20change%20vulnerability%20in%20Rwanda.pdf
- [11] Rukundo, E., & Doğan, A. (2016). Assessment of climate and land use change projections and their impacts on flooding. *Polish Journal of Environmental Studies*, 25(6), 2541–2552. <https://doi.org/10.15244/pjoes/63781>
- [12] Bizimana, J. P., & Schilling, M. (2010). Geo-Information Technology for Infrastructural Flood Risk Analysis in Unplanned Settlements: a case study of informal settlement flood risk in the Nyabugogo flood plain, Kigali City, Rwanda. *Geospatial techniques in urban hazard and disaster analysis*, 99-124.
- [13] Tsinda, A. (2009). La vulnérabilité face aux risques environnementaux à Kigali (Rwanda): enjeux et facteurs.
- [14] Icyimpaye, G., & Abdelbaki, C. (2022). GIS-based hydrological and hydraulic models to forecast river flood risks and proposition of management measures. In *Spatial Modelling of Flood Risk and Flood Hazards: Societal Implications* (pp. 143-159). Cham: Springer International Publishing.
- [15] Mugisha, F. (2015). *Modelling and assessment of urban flood hazards based on end-user requirements: Kigali, Rwanda* (Master's thesis, University of Twente).
- [16] Uwineza, A., & Irie, M. (2022). Flood analysis for estimating the impact of rainwater harvesting system installation using hydrological models. Case study: Nyabugogo valley, Kigali. *Journal of Arid Land Studies*, 32(S), 145-149.
- [17] Umutesi, M. (2021). *Assessing impacts of climate change and land-use interventions on flooding in Nyabugogo catchment (Kigali-Rwanda)* (Master's thesis, University of Twente).
- [18] Bradford, R. A., O'Sullivan, J. J., Van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., ... & Schelfaut, K. (2012). Risk perception—issues for flood management in

- Europe. *Natural hazards and earth system sciences*, 12(7), 2299-2309.
- [19] Raaijmakers, R., Krywkow, J., & van der Veen, A. (2008). Flood risk perceptions and spatial multi-criteria analysis: exploratory research for hazard mitigation. *Natural hazards*, 46, 307-322.
- [20] Boholm, A. (1998). Comparative studies of risk perception: a review of twenty years of research. *Journal of risk research*, 1(2), 135-163.
- [21] Bubeck, P., Botzen, W. J. W., & Aerts, J. C. (2012). A review of risk perceptions and other factors that influence flood mitigation behavior. *Risk Analysis: An International Journal*, 32(9), 1481-1495.
- [22] Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox—implications for governance and communication of natural hazards. *Risk analysis*, 33(6), 1049-1065.
- [23] Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research. *Risk Analysis: An International Journal*, 33(1), 24-49.
- [24] Birkholz, S., Muro, M., Jeffrey, P., & Smith, H. M. (2014). Rethinking the relationship between flood risk perception and flood management. *Science of the total environment*, 478, 12-20.
- [25] Raška, P. (2015). Flood risk perception in Central-Eastern European members states of the EU: a review. *Natural Hazards*, 79, 2163-2179.
- [26] Hosseini, F. S., Sigaroodi, S. K., Salajegheh, A., Moghaddamnia, A., & Choubin, B. (2021). Towards a flood vulnerability assessment of watershed using integration of decision-making trial and evaluation laboratory, analytical network process, and fuzzy theories. *Environmental Science and Pollution Research*, 28, 62487-62498.
- [27] Ashenefe, B., Wubshet, M., & Shimeka, A. (2017). Household flood preparedness and associated factors in the flood-prone community of Dembia district, Amhara National Regional State, northwest Ethiopia. *Risk Management and Healthcare Policy*, 95-106.
- [28] Uwizeyimana, D., Niyonzima, S., & Habiyaemye, G. (2023). *Land susceptibility to stormwater runoff in Nyabugogo River Catchment, Rwanda*. *International Journal of Climate Research*, 5(2), 112-125. https://www.researchgate.net/publication/374730174_Land_Susceptibility_to_Stormwater_Runoff_in_Nyabugogo_River_Catchment_Rwanda
- [29] **Pérez-Molina, J., Schilling, M., & Bizimana, J. P. (2016).** *Spatial Planning, Growth, and Flooding—Contrasting Urban Development and Flood Risk in Kigali, Rwanda*. ITC PhD Thesis, University of Twente. Available at: https://library.itc.utwente.nl/papers_2019/phd/PerezMolina.pdf. library.itc.utwente.nl
- [30] Rwanda Environment Management Authority (REMA). (2015). *State of Environment and Outlook Report 2015*. Rwanda Environment Management Authority. Available at: <https://www.rema.gov.rw/soe/index.php> REMA+4REMA+4m.moam.info+4
- [31] Manirakiza, V., Mugabe, L., Nsabimana, A., & Nzayirambaho, M. (2019). City Profile: Kigali, Rwanda. *Environment and Urbanization ASIA*, 10(2), 290-307.
- [32] Kadam, P., & Bhalerao, S. (2010). Sample size calculation. *International journal of Ayurveda research*, 1(1), 55.
- [33] National Institute of Statistics of Rwanda. (2022). *The Fifth Rwanda Population and Housing Census: Main indicators report* [Report]. Kigali, Rwanda

- [34] Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper and Row.
- [35] Boholm, A. (1998). Comparative studies of risk perception: a review of twenty years of research. *Journal of risk research*, 1(2), 135-163.
- [36] Bradford, R. A., O'Sullivan, J. J., Van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., ... & Schelfaut, K. (2012). Risk perception—issues for flood management in Europe. *Natural hazards and earth system sciences*, 12(7), 2299-2309.
- [37] Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox—implications for governance and communication of natural hazards. *Risk analysis*, 33(6), 1049-1065.
- [38] Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research. *Risk Analysis: An International Journal*, 33(1), 24-49.
- [39] Birkholz, S., Muro, M., Jeffrey, P., & Smith, H. M. (2014). Rethinking the relationship between flood risk perception and flood management. *Science of the total environment*, 478, 12-20.
- [40] Raška, P. (2015). Flood risk perception in Central-Eastern European members states of the EU: a review. *Natural Hazards*, 79, 2163-2179.
- [41] Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research. *Risk Analysis: An International Journal*, 33(1), 24-49.
- [42] Bradford, R. A., O'Sullivan, J. J., Van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., ... & Schelfaut, K. (2012). Risk perception—issues for flood management in Europe. *Natural hazards and earth system sciences*, 12(7), 2299-2309.
- [43] Bradford, R. A., O'Sullivan, J. J., Van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., ... & Schelfaut, K. (2012). Risk perception—issues for flood management in Europe. *Natural hazards and earth system sciences*, 12(7), 2299-2309.
- [44] Bradford, R. A., O'Sullivan, J. J., Van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., ... & Schelfaut, K. (2012). Risk perception—issues for flood management in Europe. *Natural hazards and earth system sciences*, 12(7), 2299-2309.
- [45] GROTHMANN, Torsten et REUSSWIG, Fritz. People at risk of flooding: Why some residents take precautionary action while others do not. *Natural hazards*, 2006, vol. 38, p. 101-120.
- [46] Cutter, S. L. (2003). GI science, disasters, and emergency management. *Transactions in GIS*, 7(4), 439-446.
- [47] Metzger, A., Marra, F., Smith, J. A., & Morin, E. (2020). Flood frequency estimation and uncertainty in arid/semi-arid regions. *Journal of Hydrology*, 590, 125254.
- [48] Johnson, V., & Parker, M. (2018). *Perceived vulnerability and disaster preparedness: A psychological perspective*. *Journal of Risk Research*, 21(6), 789–804. <https://doi.org/10.1080/13669877.2017.1302710>
- [49] Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research. *Risk Analysis: An International Journal*, 33(1), 24-49.
- [50] Morss, R. E., Demuth, J. L., Bostrom, A., Lazo, J. K., & Lazrus, H. (2015). Flash flood risks and warning decisions in Boulder, Colorado: A mental models study of forecasters, public officials, and media broadcasters. *Risk Analysis*, 35(11), 2009–2028. <https://doi.org/10.1111/risa.12429> mmm.ucar.edu

- [51] Smith, J., Johnson, R., & Parker, M. (2018).
Perceived vulnerability and disaster preparedness: A psychological perspective. Journal of Risk Research, 21(6), 789–804.
<https://doi.org/10.1080/13669877.2017.1302710>