Association of socio-demographic characteristics with climate change knowledge level among Frontline Communities in Bukoba Municipal, Tanzania

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ABSTRACT

Climate change continues to pose serious environmental and socio-economic challenges to frontline communities, yet knowledge levels and their different dimensions remain uneven, limiting the adoption of effective adaptation measures. Guided by the Knowledge, Attitude and Practice (KAP) Model, this study assessed the influence of socio-demographic characteristics on climate change knowledge among frontline communities in Bukoba Municipality, Tanzania. A cross-sectional quantitative research design was employed, involving household heads from climate-vulnerable wards. A total of 265 respondents were selected using multistage sampling, combining purposive selection of climate-vulnerable wards and simple random sampling of households. Data were collected through structured questionnaires and analysed using IBM SPSS Statistics Version 27. Descriptive statistics were used to assess climate change knowledge across its key dimensions, while one-way ANOVA and multiple linear regression examined variations in knowledge across wards and the association with socio-demographic characteristics. The findings revealed a relatively high overall level of climate change knowledge (Mean = 51.47), with respondents demonstrating stronger knowledge of climate change impacts and adaptation strategies than of its causes (Mean = 6.43). Significant differences were observed across wards in knowledge of the nature of climate change and adaptation strategies, with respondents from Bakoba and Kashai reporting relatively higher knowledge levels than those from other wards. Multiple linear regression showed that education level positively and significantly predicted climate change knowledge (B = 1.473, p = 0.041), while marital status was negatively associated with knowledge level (B = -1.715, p < 0.001). The study concludes that although frontline communities possess high knowledge of climate change impacts and adaptation practices, important knowledge gaps remain regarding the causes and scientific basis of climate change. The study recommends strengthening community-based climate change communication programmes that provide context-specific information, with greater emphasis on improving understanding of the causes and underlying science of climate change to support informed adaptation decisions.

Keywords: Bukoba-Tanzania, Climate Change Knowledge, Climate Change Communication, Climate Vulnerability, Frontline Communities, Socio-Demographic Characteristics

I. INTRODUCTION

Climate change has become a major global challenge affecting environmental systems, human health, livelihoods, and economic development (Abbass et al., 2022). Rising temperatures, changing rainfall patterns, and increasing climate variability have contributed to more frequent and intense droughts, floods, and landslides across many parts of the world (Das et al., 2024). According to the Intergovernmental Panel on Climate Change, global temperatures are projected to exceed 1.5°C above pre-industrial levels unless mitigation measures are implemented (IPCC, 2023). These impacts are expected to be particularly severe among vulnerable populations with limited capacity to respond to climate-related risks (Ali et al., 2025).

In Tanzania, climate-related hazards continue to affect livelihoods and socioeconomic development, particularly in climate-vulnerable regions such as Kagera. Communities frequently experience floods, landslides, strong winds, and prolonged rainfall, affecting agriculture, infrastructure, and household livelihoods. The World Bank Group (2024) projects that climate change could reduce Tanzania's economic growth by up to 4% by 2050 while increasing the number of people living in poverty. These challenges raise the need for effective climate communication that enables vulnerable communities to understand climate risks and respond appropriately.

Among frontline communities, the effectiveness of climate communication largely depends on the intended audience's level of climate change knowledge. Frontline communities are populations that experience the direct and immediate impacts of climate-related hazards due to their geographical location, livelihood dependence, and socioeconomic conditions (Ricart et al., 2023). Climate change knowledge level refers to the extent to which individuals

understand the causes, impacts, and adaptation measures related to climate change (Oruonye, 2011). Individuals with higher climate change knowledge levels can easily understand climate information, interpret risk warnings, and make informed decisions regarding adaptation (Khatibi et al., 2021). Improving climate change knowledge levels is therefore important for strengthening adaptive capacity and community resilience.

However, climate change knowledge levels are not uniform across populations. Differences in socio-demographic characteristics such as age, education level, occupation, income, and marital status may influence how individuals access, interpret, and apply climate-related information (Ifegbesan & Mabekoje, 2021). These characteristics are important in climate communication because they represent attributes of the receiver. According to Berlo's Source–Message–Channel–Receiver (SMCR) Model, the receiver's characteristics influence how communication messages are understood and acted upon (Muyanga, 2024). Consequently, understanding variations in climate change knowledge levels across socio-demographic groups is essential for developing communication strategies that effectively address the information needs of different audiences.

Previous studies have shown that socio-demographic characteristics are associated with climate change knowledge levels, although the findings vary across contexts. For example, Kabir et al., (2016) reported that education level significantly influenced climate change knowledge levels and adaptation practices among communities in Bangladesh. Similarly, Appiah and Guodaar (2022) found that education and farming experience were associated with higher climate change knowledge levels among farmers in Ghana. Although these studies demonstrate the importance of socio-demographic characteristics, the influence of these factors differs across geographical and socio-cultural settings, making context-specific evidence necessary.

Despite the recognised importance of climate change knowledge levels for effective adaptation, empirical evidence on the association of socio-demographic characteristics of climate change knowledge levels among frontline communities in Bukoba Municipal remains limited. This gap limits the ability of climate communication programmes to design audience-centred communication strategies that consider receiver characteristics, as emphasised in Berlo's SMCR Model. Understanding how climate change knowledge levels vary across socio-demographic groups is important for identifying populations that may require targeted communication interventions to improve their understanding of climate information and support informed adaptation decisions. Therefore, this study examined the influence of socio-demographic characteristics on climate change knowledge levels among frontline communities in Bukoba Municipal.

1.1 Statement of the Problem

Climate change knowledge level is widely recognised as an important foundation for effective climate communication because it influences individuals' ability to understand climate information, interpret risk messages, and make informed adaptation decisions (Moser, 2014). Effective climate communication requires an understanding of the socio-demographic characteristics of the intended audience and their differences in climate change knowledge levels, to ensure that communication strategies are appropriate and responsive to their needs. Despite the increasing exposure of frontline communities in Bukoba Municipal to climate-related hazards such as floods, droughts, strong winds, and El Niño-associated malaria outbreaks (World Bank Group, 2024), limited evidence exists on how climate change knowledge levels vary across socio-demographic groups within these communities. In the absence of such evidence, climate communication initiatives may rely on generalised approaches that do not address differences in audience characteristics, resulting in unequal understanding of climate information and reduced effectiveness of adaptation messages. Consequently, some population groups remain less prepared to respond to climate-related risks, increasing their vulnerability to livelihood losses, poverty, displacement, and health-related challenges (Guardian Correspondent, 2024).

Existing studies in Tanzania have primarily examined farmers' awareness and perceptions of climate change (Below et al., 2015; Elia, 2017). Limited empirical attention has been given to the influence of socio-demographic characteristics on climate change knowledge levels among frontline communities, particularly in Bukoba Municipal. As a result, there is insufficient context-specific evidence to identify which socio-demographic groups possess relatively higher or lower climate change knowledge levels and how these differences may influence the design of climate communication interventions. To address this gap, the study examined the influence of socio-demographic characteristics on climate change knowledge levels among frontline communities in Bukoba Municipal. Evidence generated from the study is expected to support the development of audience-centred climate communication strategies that consider receiver characteristics to improve the effectiveness of climate information dissemination and strengthen community adaptation efforts.

1.2 Research Objectives

i. Examine the level of climate change knowledge among frontline communities.

ii. Determine the relationship between socio-demographic factors and climate change Knowledge among frontline communities.

II. LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Knowledge, Attitude, and Practices (KAP) Model

Understanding climate change knowledge and the factors that influence it requires an appropriate theoretical perspective. This study is guided by the Knowledge, Attitude, and Practice (KAP) Model, which originated from public health and behavioural research and has been widely applied to explain how individuals acquire knowledge and how that knowledge shapes subsequent attitudes and behaviours (Launiala, 2009; Liao et al., 2022). The model assumes that knowledge is the foundation upon which attitudes are formed, and practices are developed. Individuals who possess adequate knowledge are generally better equipped to make informed decisions and adopt appropriate responses to social and environmental challenges. The KAP model comprises three interrelated components: knowledge, attitude, and practice. The knowledge component refers to an individual's understanding and awareness of a particular issue. Attitude reflects beliefs, perceptions, and feelings toward that issue, while practice represents the actions or behaviours undertaken in response (Wang et al., 2020). Although these components are interconnected, this study specifically focuses on the knowledge component because its primary objective is to assess the level of climate change knowledge among frontline communities rather than their attitudes or adaptation practices.

Drawing on the KAP model, climate change knowledge in this study is conceptualised as an individual's understanding of the nature of climate change, its causes, impacts, and adaptation strategies (Zarei et al., 2024). Assessing these dimensions indicates the extent to which community members understand climate change and can recognise appropriate responses to its impacts. The model further provides a useful basis for identifying knowledge gaps that may limit informed decision-making and effective adaptation among frontline communities. Although the KAP model does not explicitly explain the socio-demographic factors that shape knowledge, it provides a suitable framework for examining differences in knowledge levels across population groups. In this study, socio-demographic characteristics are considered as factors that may influence individuals' opportunities to acquire climate-related knowledge. The model, therefore, offers a useful theoretical foundation for examining how variations in education, age, gender, income, occupation, and other social characteristics are associated with differences in climate change knowledge among frontline communities.

2.2 Empirical Review

2.2.1 Level of climate change knowledge among Frontline communities

Climate change knowledge level has increasingly been recognised as an important factor in strengthening communities' capacity to respond to climate-related risks (Khatibi et al., 2021). It refers to the extent to which individuals understand the causes, impacts, and adaptation strategies associated with climate change (Belay et al., 2022). This knowledge enables people to recognise climate risks, interpret climate information correctly, and make informed decisions about appropriate adaptation measures. In climate change research, knowledge level is commonly assessed by asking respondents a series of questions covering key dimensions of climate change, including its causes, impacts, and adaptation practices (Oruonye, 2011). Responses are scored based on the number of correct answers, and the overall scores are then classified as low, moderate, or high knowledge. Although the cut-off points vary across studies depending on the measurement approach, higher scores generally indicate a broader and more accurate understanding of climate change issues, while lower scores reflect important knowledge gaps that may limit adaptive decision-making (Sarkar et al., 2014).

Existing studies indicate that knowledge of climate change causes is largely centred on the distinction between human-induced and natural drivers. Human activities are consistently identified as the primary cause of contemporary climate change, mainly through greenhouse gas emissions from fossil fuel use, deforestation, industrial activities, transportation, and agricultural production (Nunes, 2025). Other human activities, including land-use change, urbanisation, and environmental pollution, further accelerate climate change (Gabric, 2023). Although natural processes such as volcanic eruptions, changes in solar radiation, ocean circulation, and variations in Earth's orbit also influence climate systems, their contribution to recent climate change is comparatively limited (Abbass et al., 2022). Understanding the dominant role of human activities is therefore important, as misconceptions about climate drivers may weaken public support for mitigation and adaptation efforts.

Knowledge of climate change impacts is another essential dimension of climate literacy. Previous studies show that climate change affects environmental, agricultural, health, and socio-economic systems simultaneously(Raihan, 2023). Environmental impacts include biodiversity loss, forest degradation, disruption of hydrological systems, and coastal erosion (Ekka et al., 2023). Agricultural impacts include reduced crop yields, increased pest outbreaks, and

greater livestock disease prevalence (Nega, 2025), while health impacts include heat stress, respiratory illnesses, vector-borne diseases, and mental health challenges (Ligsay et al., 2021). Climate change also contributes to food insecurity, water shortages, displacement, and damage to infrastructure such as roads, schools, health facilities, bridges, and energy systems (Schneider et al., 2022). These findings demonstrate that climate change extends beyond environmental concerns and poses significant challenges to sustainable development and human well-being.

Knowledge of adaptation is important to because awareness of climate risks alone does not necessarily lead to adaptive behaviour. The literature identifies a range of adaptation measures implemented across different sectors. Agricultural adaptation includes climate-smart farming practices, drought-tolerant crop varieties, irrigation technologies, and improved crop management (Zhao et al., 2023). Environmental adaptation focuses on afforestation, reforestation, water conservation, drainage improvement, and flood protection infrastructure. Health-related adaptation includes measures that reduce disease transmission and improve sanitation, while socio-economic adaptation involves avoiding settlement in hazard-prone areas and investing in climate-resilient infrastructure (Nunes, 2025). These examples indicate that adaptation knowledge encompasses not only awareness of climate risks but also an understanding of practical actions that reduce vulnerability.

Empirical evidence shows considerable variation in climate change knowledge levels across populations and geographical settings. Gazzaz and Aldeseet (2021) reported relatively high climate change knowledge among university students, particularly regarding climate change impacts, although understanding of the underlying causes was comparatively lower. Similarly, Nasri et al. (2024) found that about half of farmers in Algeria demonstrated moderate levels of climate change knowledge, suggesting that awareness existed but remained insufficient to support effective adaptation decisions. In contrast, Odonkor et al. (2020) reported low levels of knowledge regarding climate change causes and impacts among respondents in Ghana. The differences observed across these studies suggest that climate change knowledge level is shaped by contextual factors such as education, occupation, access to climate information, and personal experience with climate-related events. Also, the findings demonstrate that knowledge levels vary across populations and cannot be generalised. Consequently, assessing climate change knowledge within specific contexts is necessary for identifying knowledge gaps, designing appropriate communication strategies, and promoting informed adaptation practices.

2.2.2 Association between socio-demographic factors and climate change knowledge level among Frontline communities

Climate change knowledge is not acquired uniformly across populations but is shaped by individuals' socio-demographic characteristics, which influence their opportunities to access, understand, and use climate-related information. Socio-demographic factors such as age, gender, education level, occupation, income, and length of residence determine the extent to which people are exposed to climate information, participate in learning processes, and accumulate experiences related to climate variability (Ifegbesan et al., 2021). These characteristics also influence people's ability to interpret scientific information and translate it into practical knowledge. Consequently, differences in climate change knowledge level often reflect broader social, economic, and educational inequalities within communities.

Among these characteristics, education is consistently identified as one of the strongest predictors of climate change knowledge level. Appiah and Guodaar (2022) and Lee et al. (2015) found that individuals with higher levels of formal education possess a high knowledge level of climate change and its associated risks. Education enhances literacy, critical thinking, and the ability to obtain and evaluate information from diverse sources, enabling individuals to better understand climate change causes, impacts, and adaptation options. Conversely, limited educational attainment reduces access to reliable information and constrains understanding of complex environmental issues. These findings suggest that improving educational opportunities can contribute significantly to strengthening climate literacy and informed adaptation decisions.

Gender has also been identified as an important determinant of climate change knowledge, although its influence differs across settings. Gazzaz and Aldeseet (2021) found that female respondents demonstrated a higher climate change knowledge level than their male counterparts. However, the relationship between gender and knowledge is often shaped by contextual factors rather than biological differences. Social roles, access to education, participation in community activities, and responsibility for managing natural resources create differences in exposure to climate information between men and women (Organisation, 2014). The findings reported across studies suggest that the influence of gender depends largely on the social and cultural environment in which people live.

Occupation and livelihood experience further contribute to variations in climate change knowledge because they determine the extent to which individuals interact with climate-sensitive environments. Appiah and Guodaar (2022) reported that farmers with longer farming experience possessed greater awareness of climate variability and adaptation practices than less experienced farmers. Continuous exposure to changing weather conditions enables individuals to observe climate patterns, compare seasonal changes over time, and develop practical knowledge based on lived

experience (Lebel, 2013). This indicates that climate knowledge is acquired not only through formal education but also through everyday interaction with the environment.

Other socio-demographic characteristics, including age, income, ethnicity, religion, household background, and length of residence, have also been associated with differences in climate change knowledge. Older individuals may accumulate knowledge through prolonged exposure to environmental changes, whereas younger people may benefit from greater access to formal education and digital information. Similarly, higher income levels can improve access to information technologies, training programmes, and communication platforms that enhance climate awareness (Qureshi, 2019). Ofori et al. (2023) further reported that climate change knowledge among students was significantly associated with programme of study, ethnicity, religion, and mother's occupation, highlighting that climate knowledge is shaped by multiple interrelated social and contextual factors rather than by a single characteristic.

Therefore, the literature demonstrates that socio-demographic characteristics influence climate change knowledge level by affecting individuals' educational opportunities, access to information, livelihood experiences, and social interactions. However, the direction and magnitude of these relationships vary across populations and geographical contexts, indicating that the influence of socio-demographic factors is context-specific rather than universal. Research gap: Despite this evidence, most previous studies have concentrated on students and farming communities (Appiah & Guodaar, 2022; Gazzaz & Aldeseet, 2021; Ofori et al., 2023)., with relatively limited attention given to frontline communities that experience direct and repeated exposure to climate-related hazards. Consequently, empirical evidence remains limited on how socio-demographic characteristics shape climate change knowledge levels among frontline communities, particularly in Bukoba Municipal, Tanzania. Addressing this gap is important because understanding which population groups have lower levels of climate change knowledge can inform targeted climate communication and capacity-building interventions that strengthen local adaptation efforts.

III. METHODOLOGY

3.1 Research design

The study adopted a cross-sectional quantitative research design. This approach was considered appropriate as it allowed the assessment of social-demographic factors on climate change knowledge level at a single point in time.

3.2 Study area

This study was conducted in Bukoba Municipal, Kagera Region, in northwestern Tanzania. The area lies along the western shore of Lake Victoria and experiences a tropical climate characterised by relatively high rainfall and moderate temperatures throughout the year. In recent years, the municipality has been increasingly affected by climate-related hazards, including floods, strong winds, rainfall variability, and outbreaks of climate-sensitive diseases (Guardian Correspondent, 2024). These events continue to negatively affect livelihoods, infrastructure, public health, and socio-economic activities. Bukoba Municipal was selected because it is among the climate-vulnerable urban areas in Tanzania where frontline communities frequently experience the impacts of climate variability and extreme weather events.

3.3 Target Population

The target population comprised frontline community members residing in climate-risk-prone areas of Bukoba Municipality. In this study, frontline communities refer to residents whose livelihoods and well-being are directly affected by climate-related hazards such as floods, strong winds, and prolonged droughts (Ojha et al., 2026). Participants were eligible for inclusion in the study if they met the following criteria: first, they were recognised by local government authorities as residents directly affected by climate-related hazards; second, they resided in one of the selected climate-risk-prone wards; and third, they were aged 18 years or older. These criteria were used to ensure that participants had direct experience with climate-related risks and could provide relevant information on climate change knowledge.

3.4 Sample size and Sampling procedure

The sample size for household respondents was determined using Cochran's (1977) formula for large populations:
$n_0 = Z^2pq/ e^2$, where
(n_0) = required sample size;
(Z)= standard normal deviate corresponding to the 95% confidence level (1.96);
(p)= estimated proportion of the population possessing the characteristic of interest (0.5);
(q) = (1-p) (0.5); and
(e) =acceptable margin of error (0.06).

Substituting these values into the formula provides a required sample size of approximately 267 household respondents. A total of 265 household respondents were successfully interviewed, resulting in a response rate of 99.3%, which was considered adequate for statistical analysis.

A multistage sampling technique was employed to select the study participants. In the first stage, five climate-risk-prone wards (Kashai, Bakoba, Nshambya, Miembeni, and Bilele) were purposively selected from the municipality's 14 wards for their recurrent exposure to climate-related hazards, including floods, strong winds, and prolonged droughts. In the second stage, affected streets within the selected wards were purposively identified in consultation with local government authorities using records of communities affected by climate-related hazards, as shown in Table 1 below. In the third stage, households were selected using simple random sampling from the registers of households affected by climate-related hazards obtained from local government authorities. The household registers were entered into Microsoft Excel and the RAND () function was used to generate random numbers for each household. The list was then sorted in ascending order of the generated random numbers, and households were selected in sequence until the required sample size for each ward was attained.

Table1

Distribution of the studied wards and streets

		N	%	Street		N	%
Wards	Kashai	65	24.5		Kashai halisi	27	10.2
	Bakoba	35	13.2		Katatorwansi	16	6.0
	Nshambya	43	16.2		National Housing	22	8.3
	Miembeni	70	26.4		Nyakanyansi	35	13.2
	Bilele	52	19.6		Migera	43	16.2
	Total	**265**	**100.0**		Nyamukazi	70	26.4
					Omukigusha	52	19.6
					Total	**265**	**100**

3.5 Data collection instrument and procedures

Data were collected using a structured questionnaire administered to household respondents. The questionnaire consisted of sections covering socio-demographic characteristics and climate change knowledge among frontline communities. The instrument was developed based on the study objectives and adapted from relevant previous studies to ensure that the collected information addressed the research questions.

Climate change knowledge level was assessed using the Climate Change Knowledge Test (CCKT) developed by Gazzaz and Aldeseet (2021), with minor modifications to reflect the local context of frontline communities in Bukoba Municipality. The knowledge assessment covered four major variables: knowledge of the nature, causes, effects, and adaptation strategies related to climate change risk. The effects and adaptation variables were further categorised into environmental, agricultural, health, and socio-economic dimensions. Each knowledge item was measured using a Yes/No response format, where correct responses were assigned a score of one (1) and incorrect or "No" responses were assigned a score of zero (0). The scores were summed to generate an overall climate change knowledge level score for each respondent. Data collection was conducted through face-to-face interviews with selected household members who met the inclusion criteria. Trained data collectors administered the questionnaires and provided clarification where necessary while maintaining objectivity to minimise interviewer bias. Completed questionnaires were checked daily for completeness and consistency before data entry and analysis.

3.6 Data analysis

Data were analysed using SPSS version 27. Descriptive statistics (frequencies, percentages, and means) were used to summarise socio-economic characteristics and levels of climate change knowledge. One-way ANOVA was used to examine differences in knowledge across wards, while multiple linear regression was applied to determine socio-demographic predictors of climate change knowledge.

The regression model was specified as:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \ldots + \beta 5X5$

Where:

Y = Climate change knowledge index score

B_0 = Constant

B1…βn = Regression coefficients

X_1 = Gender

X_2 = Age

X_3 = Education level

X_4 = Marital status

X_5 = Main source of income

Before analysis, diagnostic tests were conducted. Multicollinearity was assessed using the Variance Inflation Factor (VIF) and tolerance values. All VIF values ranged from 1.040 to 1.195, while tolerance values ranged from 0.837 to 0.961, indicating no multicollinearity among variables. The Durbin-Watson statistic was also used to test autocorrelation of residuals. Statistical significance was set at $p < 0.05$.

3.7 Data quality assurance

In addition to ensuring data quality, the research instrument was reviewed and refined before data collection to improve clarity and relevance. A pilot test was conducted, and necessary adjustments were made based on the findings. Data collectors were trained on study objectives, ethical considerations, and proper questionnaire administration to ensure neutrality and accuracy. During data collection, respondents were clearly informed about the study's purpose to reduce misunderstanding and improve response quality. Finally, data were cleaned and checked for completeness and consistency before analysis.

3.8 Research Ethics

Ethical principles were observed throughout the study. Participation was voluntary, and informed consent was obtained from all respondents. Participants were informed of their right to withdraw at any time without penalty. Confidentiality and anonymity were maintained, and all data were used strictly for academic purposes. Respect for respondents and local community norms was upheld throughout the research process.

IV. FINDINGS & DISCUSSION

4.1 Socioeconomic characteristics of respondents

Table 2 presents the socio-demographic characteristics of the respondents. The females were dominant (63.4%), indicating that women constituted a larger proportion of the frontline communities included in this study. This is important because gender influences access to climate information, livelihood responsibilities, and exposure to climate-related risks, which may shape climate change knowledge. Most respondents had attained primary education (58.1%). The finding suggests that many community members may have limited opportunities to access and interpret scientific information on climate change, which affects their level of climate change knowledge. Since education enhances individuals' ability to understand environmental issues, the predominance of respondents with lower educational attainment highlights the needs of strengthening climate communication through accessible and locally appropriate approaches. Most respondents were between 35 and 54 years of age, representing an economically active population. Individuals within this age range are likely to have accumulated substantial experience with climate variability through their livelihoods and daily interactions with the environment. Such experience may contribute to a better understanding of climate-related changes, although the extent of this knowledge depends on access to reliable climate information. The majority of respondents were married and relied primarily on small-scale business activities as their main source of income. Livelihood activities determine the extent to which people experience climate-related impacts and seek information to manage associated risks. Differences in livelihood sources may influence exposure to climate information and shape respondents' understanding of climate change and its implications for their well-being.

Table 2

Respondents' socioeconomic characteristics

Variable	Category	Frequency(N)	Percentage (%)	Variable	Category	Frequency(N)	Percentage (%)
Age group	18-24	23	8.7	**Marital status**	Married	187	70.6
	25-34	51	19.2		Single	21	7.9
	35-44	78	29.4		Widowed	18	6.8
	45-54	70	26.4		Divorced	25	9.4
	55-64	33	12.5		Cohabitation	14	5.3
	Total	**265**	**100**		**Total**	**265**	**100**
Education	Informal	14	5.3	**Source of income**	Small business	161	60.8
	Primary	154	58.1		Agriculture	27	10.2
	Secondary	85	32.1		Fishing	25	9.4
	Certificate	7	2.6		Employed	21	7.9
	Diploma	1	.4		Transport services	12	4.5
	Bachelor	3	1.1		Tailoring	10	3.8
	Masters	1	.4		Agent services	5	1.9
	Total	**265**	**100**		Construction	4	1.5

Sex	Male	97	36.6		**Total**	**265**	**100**
	Female	168	63.4				
	Total	**265**	**100**				

4.2 Frontline community knowledge level on climate change.

Table 3 indicates that frontline communities demonstrated a relatively high overall level of climate change knowledge, with a mean score of 51.47 (SD = 9.22). However, the distribution across knowledge dimensions was uneven. Knowledge of climate change effects recorded the highest mean score (M = 22.42, SD = 4.40), followed by knowledge of adaptation measures (M = 20.54, SD = 4.19). In contrast, knowledge of the causes of climate change (M = 6.43, SD = 2.59) and knowledge of its nature (M = 2.08, SD = 0.82) were comparatively lower. This pattern suggests that respondents are more familiar with the visible and experience-based aspects of climate change than with its scientific foundations. The higher scores on climate change effects and adaptation can be explained by the fact that frontline communities are directly exposed to climate-related events such as irregular rainfall, floods, droughts, and declining agricultural productivity. These experiences make the consequences of climate change more immediate and easier to recognise in everyday life. Similarly, knowledge of adaptation measures is likely to have developed through repeated exposure to climate risks, where households and communities learn and share practical coping strategies over time.

In contrast, the relatively low knowledge of the causes and nature of climate change indicates a gap in conceptual understanding. This suggests that while respondents can observe and respond to climate-related impacts, they may have a limited understanding of the underlying scientific processes driving climate change, including both natural variability and human-caused factors. Understanding the causes and nature of climate change is essential for distinguishing between short-term weather variability and long-term climate trends, which in turn influences the sustainability of adaptation decisions. These findings are similar to those of Gazzaz and Aldeseet (2021), who reported higher levels of knowledge on climate change impacts compared to its causes among students. Similarly, Sarfo et al. (2019) found limited understanding of the causes of climate change among respondents in their study. Together, these studies show a consistent pattern in which respondents tend to have better knowledge of climate change effects than its underlying causes. Therefore, the results suggest that although frontline communities possess practical and experience-based knowledge of climate change, strengthening their conceptual knowledge can enhance the ability of communities to interpret climate information correctly, support informed decision-making, and promote more proactive and long-term adaptation strategies.

Table 3

Climate change knowledge among FLCs

Variable	N	Range	Min	Max	Sum	mean	SD
Knowledge concerning the nature of climate change	265	3.00	.00	3.00	551.00	2.0792	0.82420
Knowledge concerning the causes of climate change	265	11.00	.00	11.00	1703.00	6.4264	2.58552
Knowledge concerning the effects of climate change	265	25.00	.00	25.00	5942.00	22.4226	4.40242
Knowledge concerning the adaptation of climate change risk	265	23.00	.00	23.00	5444.00	20.5434	4.18952
Overall knowledge of climate change	265	60.00	2.00	62.00	13640.00	51.4717	9.21873
Valid N (listwise)	265						

4.2.1 Relationship between FLCs' climate change knowledge and location (wards)

A one-way ANOVA was conducted to examine whether climate change knowledge differed across wards. The results revealed statistically significant differences in knowledge of the nature of climate change ($F = 2.444$, $p = 0.047$) and adaptation to climate change risks ($F = 3.082$, $p = 0.017$). Respondents from Bakoba demonstrated relatively higher knowledge of the nature of climate change; again, Bakoba and Kashai recorded higher adaptation knowledge than respondents from the other wards. However, no significant differences were found in knowledge of climate change causes ($F = 0.742$, $p = 0.564$), effects ($F = 1.489$, $p = 0.206$), or the overall climate change knowledge score ($F = 2.359$, $p = 0.054$).

The differences in knowledge of the nature of climate change and adaptation may reflect local environmental and social conditions. Respondents from Bakoba, who recorded relatively higher knowledge of the nature of climate change, may have developed a better understanding through frequent exposure to flooding, while the higher adaptation knowledge observed in Bakoba and Kashai could be associated with their continued experience of climate-related hazards, including floods and strong winds. In addition, these wards serve as municipal centres, where residents are

likely to have better access to climate information, awareness programmes, and adaptation initiatives than those living in less central wards.

These conditions may have enhanced both awareness of climate risks and knowledge of appropriate adaptation strategies. These findings are similar with (Abousoliman et al., 2024), who reported that climate change knowledge differs across geographical settings. The results imply that climate education and adaptation programmes should consider local knowledge needs, particularly in wards with lower levels of understanding of climate change and its adaptation strategies.

Table 4

Variance of the studied variable of FLCs according to their ward

Variable	Location	N	Mean	SD	F	P=value
Knowledge concerning the nature of climate change	Kashai	65	2.0615	.76805	2.444	.047
	Bakoba	35	2.4571	.56061		
	Nshambya	43	1.9070	.97135		
	Miembeni	70	2.0286	.86764		
	Bilele	52	2.0577	.80229		
	Total	**265**	**2.0792**	**.82420**		
Knowledge concerning the causes of climate change	Kashai	65	6.7385	2.02544	.742	.564
	Bakoba	35	6.4286	2.50042		
	Nshambya	43	6.2326	2.81862		
	Miembeni	70	6.0714	2.67745		
	Bilele	52	6.6731	2.94206		
	Total	**265**	**6.4264**	**2.58552**		
Knowledge concerning the effect of climate change	Kashai	65	23.4462	3.38208	1.489	.206
	Bakoba	35	22.6857	3.13211		
	Nshambya	43	21.5814	6.51823		
	Miembeni	70	22.0286	3.71433		
	Bilele	52	22.1923	4.85087		
	Total	**265**	**22.4226**	**4.40242**		
Knowledge concerning the adaptation to climate change	Kashai	65	21.4000	3.33916	3.082	.017
	Bakoba	35	21.7714	2.64670		
	Nshambya	43	19.2093	5.93841		
	Miembeni	70	20.5429	3.06304		
	Bilele	52	19.7500	5.13303		
	Total	**265**	**20.5434**	**4.18952**		
Total score of knowledge regarding climate change	Kashai	65	53.6462	6.80861	2.359	.054
	Bakoba	35	53.3429	5.77491		
	Nshambya	43	48.9302	13.52492		
	Miembeni	70	50.6714	7.16619		
	Bilele	52	50.6731	11.13504		
	Total	**265**	**51.4717**	**9.21873**		

4.2.2 The association of socio-demographic factors with climate change knowledge level among frontline communities

Table 5 presents the multiple linear regression results examining the association between socio-demographic characteristics and climate change knowledge among frontline communities. The overall regression model was statistically significant ($F = 4.377$, $p = 0.001$), indicating that the socio-demographic variables included in the model were together associated with climate change knowledge. However, the model explained only a small proportion of the variation in knowledge level ($R^2 = 0.078$; Adjusted $R^2 = 0.060$), suggesting that other factors not included in this study also contribute to differences in climate change knowledge level.

Among the variables examined, education was a positive and statistically significant predictor of climate change knowledge ($B = 1.473$, $p = 0.041$). This indicates that respondents with higher levels of education were more likely to possess greater knowledge of climate change than those with lower educational attainment. This is because education improves literacy, access to information, and understanding of environmental issues, enabling individuals to interpret climate-related information and apply it in their daily lives. This finding is consistent with Appiah and Guodaar (2022) and Ofori et al. (2021), who also found that education enhances people's understanding of climate change. The finding further supports the Knowledge, Attitude and Practice (KAP) Theory, which considers knowledge as the foundation for developing informed attitudes and appropriate responses to environmental challenges. Higher educational attainment

may increase individuals' capacity to acquire and understand climate information, thereby strengthening the knowledge needed to support climate change adaptation.

Marital status was also significantly associated with climate change knowledge (B = -1.715, p < 0.001). The negative coefficient indicates that knowledge differed across marital categories. Differences in family responsibilities, social interactions, and participation in community activities may influence how individuals access and exchange climate-related information. Married individuals may have greater opportunities to share experiences and information within households and community networks, while other marital groups may have different levels of exposure to climate information. This finding is consistent with Van Aelst and Holvoet (2016), who reported that social interactions and household characteristics can influence access to information and knowledge. From the perspective of the KAP Theory, differences in access to information across social groups may contribute to differences in knowledge acquisition.

In contrast, gender (B = 0.034, p = 0.986), age (B = 0.062, p = 0.293), and the main source of income (B = 0.118, p = 0.839) were not significantly associated with climate change knowledge. These findings suggest that the climate change knowledge level was relatively similar across these socio-demographic groups within the study area. This indicates that climate information has become accessible to a wide range of community members regardless of age, gender, or occupation. Although the KAP Theory recognises that knowledge may vary across different population groups, the findings suggest that, in this study, educational attainment was a more important factor in explaining differences in climate change knowledge than the other socio-demographic characteristics examined. Therefore, the findings indicate that education is the most influential socio-demographic factor associated with climate change knowledge among frontline communities in Bukoba Municipality. However, the low explanatory power of the regression model suggests that socio-demographic characteristics alone are insufficient to explain the association with climate change knowledge level. Other factors, such as access to climate information, communication channels, and trust in information sources, may also play an important role and should be considered in future research.

Table 5

Results of a multiple linear regression analysis of predictors of climate change knowledge level among FLCs

Predictors	**B**	**SE(B)**	**β**	**t**	**P value**	**Collinearity Statistics**	
(Constant)	49.563	3.652		13.572	.000	Tolerance	VIF
Gender	-.022	1.246	-.001	-.018	.986	.837	1.195
Age	.480	.456	.065	1.053	.293	.922	1.084
Education level	1.473	.718	.127	2.052	.041	.926	1.080
Marital status	-1.715	.467	-.231	-3.675	.000	.897	1.114
Main source of income	-.047	.233	-.012	-.204	.839	.961	1.040

$R=0.279^a$, R^2=0. 078; ΔR^2=0.060; F=4.377, P value= <0 .001 and Durbin Watson= 1.301; SE standard error, β standardized regression coefficient.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study assessed the association of socio-demographic factors on climate change knowledge level among frontline communities. The findings show that respondents have a relatively high level of climate change knowledge, particularly regarding the effects of climate change and adaptation strategies, while knowledge of the causes and nature remains comparatively low.

The results further indicate that socio-demographic factors have an influence on climate change knowledge level. Education level was found to be a significant positive predictor, showing that higher education is associated with better climate change knowledge. Marital status also showed a significant relationship, while gender, age, and income source were not significant predictors. In addition, location-based differences were observed in some knowledge dimensions, especially regarding the nature of climate change and adaptation. Therefore, the findings suggest that climate change knowledge level in frontline communities unevenly distributed, the results also point to the importance of considering social and contextual conditions when addressing climate change knowledge, as these factors collectively shape how information is acquired and used at the community level. These insights offer a useful basis for improving climate change communication and supporting more effective knowledge-building strategies among frontline communities.

5.2 Recommendations

Based on the findings of this study, several practical recommendations are proposed to improve climate change knowledge among frontline communities. Climate change communication programmes should place greater emphasis

on improving understanding of the causes and nature of climate change, as these were the weakest areas of knowledge. Current awareness appears to focus more on impacts and adaptation. Local authorities and development partners should therefore design simplified community education materials that clearly explain the human and natural drivers of climate change using locally relevant examples.

Education was found to be the strongest predictor of climate change knowledge. Efforts should be made to strengthen climate change content within adult education programmes, community training sessions, and school curricula. Special attention should be given to individuals with lower levels of formal education by using participatory and visual-based learning approaches such as community dialogues, radio programmes, and demonstration sessions. Differences across wards suggest that climate information is not evenly accessed within the municipality. Ward-level climate awareness campaigns should be strengthened, particularly in wards with lower knowledge levels. Local leaders and extension officers should be actively involved in disseminating information through existing community networks to ensure a wider reach of messages.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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