Understanding Local Knowledge and Information Preferences for Climate Change Adaptation in Rangeland Management: A Case Study of Shagayu Ward, Lushoto, Tanzania

Philbert S. Nyinondi
Sokoine University of Agriculture, P.O. Box 3038, Chuo Kikuu, Morogoro, Tanzania. E-Mail: pnyinondi@sua.ac.tz

Abstract

This study aims to assess how local knowledge, information and communication strategies contribute to supporting rangeland management and enhancing community resilience to climate change. Data were collected through structured questionnaires administered to 140 respondents. Key findings reveal that 95% of respondents were aware of climate change, a significantly higher rate compared to previous surveys in Tanzania. However, gaps in understanding the long-term impacts of climate change were evident. Respondents attributed climate change mainly to deforestation (57.7%), poor farming practices (40%), and pollution (28.5%). The most commonly reported impacts included low agricultural yields (36.3%), food insecurity (35.6%), and the emergence of new pests and diseases (26.7%). Radio emerged as the dominant source of climate change information (56.4%), with a preference for radio (77.7%) and television (44.6%) for information dissemination. Age, education, and marital status showed significant associations with information access, while farm size and house ownership had minimal effects. The study highlights the importance of integrating local knowledge into climate adaptation strategies, with community-driven strategies like reforestation (49.6%), mass education (35.4%), and local regulations identified as key rangeland management measures. However, it also reveals gaps in aligning local practices with global sustainability goals, particularly in integrating livestock management with rangeland conservation. The study recommends that stakeholders involved in rangeland management and climate

change adaptation include improving access to reliable climate information through preferred media platforms, enhancing community education programs on climate impacts and adaptation strategies, and promoting sustainable rangeland management practices that integrate livestock keeping and biodiversity conservation. Additionally, engaging local communities in decision-making processes and supporting the development of policies that address both climate change and sustainable rangeland use are critical for fostering long-term resilience.
Keywords: Climate Change Adaptation, Rangeland Management, Local Knowledge, Community Resilience, Communication Strategies.

1.0 Introduction

The global understanding of climate change varies significantly across different regions, largely shaped by diverse environmental experiences and levels of awareness among populations (Calculli et al., 2021). In highly industrialized countries, such as the United States of America (USA) and many European nations, climate change is often viewed as a distant, long-term threat that primarily affects future generations. However, in regions like Sub-Saharan Africa (SSA), the impacts of climate change are already being felt in real time, with vulnerable rural communities at the forefront of these changes. These communities are directly dependent on natural resources in the rangelands and the alterations in climate patterns pose a significant challenge to their way of life (Trisos et al., 2022; Bukari, 2023). This contrast in perception and experience influences how different communities' access climate-related information and the strategies they adopt to cope with these challenges (Githiora et al., 2023). Understanding these variations is essential for formulating effective communication and adaptation strategies in the face of climate change.

Rangelands are ecosystems that are integral to the livelihoods of many rural communities, particularly in the developing world. These ecosystems are characterized by natural or semi-natural

vegetation, which primarily supports grazing livestock and wildlife. Rangelands are found in areas with varying climatic conditions, ranging from semi-arid zones with sparse vegetation to more humid regions where the vegetation is denser and more diverse. Despite these differences in vegetation types, all rangelands share the common goal of providing a sustainable environment for livestock and wildlife, while also maintaining ecological balance (Grebner et al., 2021; Sircely, 2022). In many developing countries like Tanzania, these ecosystems are critical to the survival of rural populations who rely on rangelands for their food, income, and overall well-being (Belay and Lebeza, 2024).

However, climate change presents an immediate threat to these fragile ecosystems in the rangelands. The impacts of climate change, including altered rainfall patterns, prolonged droughts, and increasingly erratic weather, are putting immense pressure on rangeland ecosystems. These changes disrupt vegetation growth, water availability, and the overall capacity of rangelands to support livestock and wildlife. As a result, rural communities are facing challenges in maintaining their livelihoods and adapting to the changing environment (Wong-Parodi and Feygina, 2021; Field and Barros, 2014). Research has highlighted that rural communities are particularly vulnerable to climate change due to their reliance on climate-sensitive resources and limited access to the tools and knowledge necessary for effective adaptation (Ncoyini et al., 2022). Furthermore, the lack of access to reliable and timely climate change information exacerbates these vulnerabilities, underscoring the need for effective communication strategies to ensure these communities are informed and prepared.

Mass media, including radio, television, and mobile platforms, plays a pivotal role in communicating climate change information to rural populations. Studies have shown that, despite the rise of digital media, radio remains the most trusted and widely used

form of communication in many rural areas, particularly when broadcasts are delivered in local languages. This accessibility makes radio an invaluable tool for reaching rural communities, raising awareness about climate change, and influencing public attitudes and behaviours (Tume et al., 2018). In addition to mass media, local communication channels such as village meetings, word of mouth, and community gatherings also play a crucial role in disseminating climate change information at the grassroots level (Mwalukasa, 2020). These traditional forms of communication are often rooted in community ties and cultural practices, which can enhance their effectiveness in reaching local populations.

However, the accessibility of climate change information is not uniform across all demographic groups. Factors such as education level, age, socio-economic status, and geographic location significantly influence individuals' ability to access and process climate information (Azeez et al., 2024; Ifegbesan et al., 2021). In rural Tanzania, for example, challenges such as poor infrastructure, language barriers, and limited access to modern technology make it difficult for many community members to access accurate climate information. These barriers contribute to widespread misinformation or lack of awareness about climate risks, which hinders the community's ability to adopt effective adaptive strategies (Kapinga et al., 2020; Msemo et al., 2021).

The local people in Lushoto district are particularly vulnerable to climate change, as they are heavily reliant on rangelands for their crops and livestock-based livelihoods (UNCCD, 2024). The district is already experiencing the adverse effects of climate change, including shifting rainfall patterns, more frequent droughts, and the degradation of pasturelands. These changes threaten not only the local economy but also the ecological sustainability of the area (UNCCD, 2024; Blomley et al., 2024). In response to these challenges, the community has relied on both traditional knowledge and scientific methods for managing

rangelands. Traditional knowledge, passed down through generations, includes practices that are closely attuned to local environmental conditions. However, as climate change continues to affect the district, there is an increasing recognition of the need to integrate modern scientific knowledge with these traditional methods for more effective climate change adaptation (Leal Filho et al., 2022).

This study aims to assess the local knowledge and information preferences for climate change adaptation in rangeland management among the local community members of Lushoto. It examined how local knowledge, communication strategies, and media platforms are used to support rangeland management and enhance community resilience to climate change. The study seeks to improve our understanding of how rural communities can adapt to climate change and develop more effective communication strategies to build their adaptive capacities.

2.0 Methodology

2.1 Study area

This study was conducted in Lushoto District, located in the Tanga Region of Tanzania. The district is characterized by its diverse geographical features, including mountainous terrains, valleys, and varying altitudes, ranging from 200 meters in the lowlands to 2,000 meters in the highlands (URT, 2016). These varied landscapes contribute to Lushoto's agro-ecological diversity, making it a crucial area for both agricultural and livestock activities, which are highly sensitive to climate change (URT, 2016).

2.2 Climatic conditions and agro-ecological zones

Lushoto experiences a bimodal rainfall pattern with short rains occurring from October to December and long rains from March to June. The rainfall is variable across the district, with the highland areas receiving 800 - 2,000 mm annually and the lowland areas receiving 500 - 800 mm. The short rains, although

less reliable, are essential for seasonal crops such as maize and beans, while temperatures generally exceed 20°C in the lowlands from October to March, with cooler temperatures in the highlands ranging from 16°C to 30°C (URT, 2016). The district's agro-ecological diversity is shaped by variations in altitude, rainfall, temperature, and humidity, creating distinct zones that support different agricultural activities. The following are the main agro-ecological zones of Lushoto:

2.2.1 Dry Hot Zone

This zone, situated at altitudes between 300 and 600 meters, experiences low annual rainfall (400 to 600 mm). The climate is ideal for drought-tolerant crops such as cotton, sisal, rice, and cassava. Livestock grazing is the dominant activity in this zone, with pastoralist communities adapting to the dry conditions.

2.2.2 Humid Cold Zone

The zone is located at elevations ranging from 800 to 1,500 meters, it receives moderate to high rainfall (600 to 1,200 mm annually). The cooler and wetter conditions support the cultivation of high-value crops such as coffee, vegetables, bananas, potatoes, and fruits, making it a significant area for commercial agriculture.

2.2.3 Dry Warm Zone

Spanning altitudes between 800 and 1,800 meters, this zone receives moderate rainfall (500 to 800 mm). Despite limited rainfall, subsistence farming thrives here, with crops like maize, beans, cassava, and vegetables being cultivated, particularly in fertile valley-bottom areas.

2.2.4 Dry Cold Zone

Found at altitudes of 1,700 to 2,100 meters, this zone receives annual rainfall between 500 and 800 mm. The cooler temperatures make this zone ideal for cultivating Irish potatoes, fruits, and a variety of vegetables. Its unique microclimate supports

specialized farming practices suited to high-altitude farming. Each agro-ecological zone in Lushoto showcases the adaptability of its farmers to the region's diverse environmental conditions, highlighting the importance of local knowledge in agricultural practices and climate change adaptation.

2.3 Livestock sector

Livestock farming is a key component of Lushoto's economy. The 2022 Population and Housing Census and the Lushoto District socio-economic profile indicate that the district is home to 85,846 cattle, including both indigenous and improved dairy cattle, alongside substantial numbers of goats, sheep, pigs, donkeys, and poultry. Livestock farming is influenced by the district's diverse landscapes, with the availability of 51,999 hectares for grazing (NBS, 2022; URT, 2016). However, the limited grazing areas, combined with the region's topographical variations, pose challenges to sustaining livestock production. This makes it necessary for farmers to adopt adaptive management strategies in the face of changing climatic conditions (URT, 2016).

2.4 Research design

This study employed a cross-sectional research design, which was ideal for assessing local knowledge, information preferences, and communication strategies for climate change adaptation in rangeland management among the community members of Lushoto. The design allowed for the collection of data at a single point in time, providing a snapshot of how local knowledge and media platforms support adaptive strategies in farming and livestock activities (Kesmodel, 2018; Kothari, 2004). This approach enabled an understanding of the community's current climate change adaptation practices, highlighting challenges and opportunities for improving communication strategies to enhance resilience and adaptive capacities (Kesmodel, 2018).

2.5 Selection of Shagayu Ward

Shagayu ward was purposively selected for its significant vulnerability to climate change, particularly regarding rangeland degradation and resource management (Wickama *et al*., 2004). The ward's population is heavily reliant on farming and livestock-keeping, making it an ideal location to study the intersection of livelihoods and climate change adaptation. Shagayu's ecological and socio-economic conditions are similar to other rural wards in the district, making it a representative sample for the study. While the findings may not fully capture the experiences of all wards in Lushoto, Shagayu offers a valuable case study of climate change impacts and adaptation strategies in the district.

2.6 Study population and sample size

According to the 2022 Population and Housing Census, Lushoto District has a total population of 350,958 people, with 160,815 males and 190,143 females, distributed across 85,149 households (NBS, 2022). The district is predominantly rural and densely populated, with the Sambaa tribe being the largest ethnic group, followed by the Pare and Mbugu, among other smaller communities. This demographic diversity creates a unique cultural context for studying climate change adaptation strategies (Mahoo *et al.*, 2015). The target population for this study consisted of residents of Shagayu ward who were fluent in the local language to ensure effective communication. Participants were selected based on their direct involvement in farming and/or livestock-keeping activities, as these livelihoods are most affected by climate change in the area. A total of 140 respondents were targeted, with 35 participants selected from each of the four villages in Shagayu ward: Kweshindo, Mpondekaya, Mpanga, and Kisangazi. This sample size was deemed sufficient for reliable statistical analysis, meeting the requirements for normal distribution (Ryan, 2013; Tanaka, 1987). Although this sample represents a fraction of Shagayu's total population of approximately 7,251 residents, it was selected based on practical

constraints and the study's focus on generating insights rather than generalizing to the entire district population (Nardi, 2018).

2.7 Sampling and data collection techniques

A combination of probability and non-probability sampling techniques was used to ensure both feasibility and targeted data collection (Khan, 2020). Shagayu ward was purposively selected due to its rainfall pattern (500 - 800 mm annually), which influence climate change impacts on rangelands and livestock farming (Oluwabunmi et al., 2023). Within Shagayu, the four villages were selected using convenience sampling for efficient data collection, considering logistical constraints in the rural setting (Kothari, 2004). The sample was chosen to reflect the ward's ecological characteristics, including its reliance on rangelands and livestock, and its vulnerability to climate change. The respondents were selected from those actively engaged in farming or livestock-keeping.

Data were collected using structured questionnaires designed to capture both quantitative and qualitative information on participants' knowledge, information, and practices regarding climate change and rangeland management. These instruments were developed to align with the study's objectives. Primary data collection was done directly by the researcher, allowing for in-depth insights into local climate change dynamics and resource management (Kothari, 2004).

2.8 Data analysis

The data collected for this study were analysed using both descriptive and inferential statistical techniques to provide an understanding of the research objectives. Descriptive statistics, including percentages and frequencies, were used to summarize key findings, offering an overview of data distribution and trends within the sample. Cross-tabulation was employed to examine relationships between demographic factors and study variables, with Pearson Chi-square tests applied to categorical data and

Somers' d used for ordinal data. These tests were selected for their ability to assess the strength and direction of relationships, ensuring the reliability of the observed patterns (Kotronoulas et al., 2023).

The analysis was conducted using IBM SPSS Statistics Version 28, which includes advanced data visualization tools to enhance the interpretation of results. Notably, relationship maps were utilized to visualize the connections between community knowledge, attitudes, and climate change responses. The thickness of the lines and the size of the category indicators on these maps visually represented the strength of relationships and the relative prevalence of specific responses. These visual tools complemented traditional statistical outputs, allowing for a more nuanced exploration of the data's relational structure and validating the statistical findings (Field, 2024).

3.0 Results and discussion

3.1 Socio-demographic characteristics of respondents

The results of the socio-demographic characteristics of the respondents in Table 1 revealed several key information into the community's structure and its capacity to engage with climate change adaptation strategies. A significant proportion of the respondents, 57.1%, were female, suggesting that women are at the forefront of engaging with climate-related information. This finding aligns with previous research that highlights the critical role of women in rural communities, particularly in resource management and decision-making processes related to agriculture (Shikuku et al., 2016). Women's roles in household management and agriculture may provide them with heightened awareness of climate changes, driving their engagement in seeking information on adaptive strategies to mitigate climate impacts on farming activities.

Age distribution among respondents also provided valuable information. The majority of respondents were middle-aged, with

27.1% in the 40-49 age range, followed by 24.3% in the 30-39 age range. This demographic trend suggests a community composed primarily of individuals with considerable experience in agriculture, a factor that may enhance their ability to manage climate variability. The presence of older adults (16.4% aged 60 and above) is particularly noteworthy, as these individuals often possess valuable traditional knowledge passed down through generations. This aligns with findings from Mahoo et al. (2015) and Mahoo et al. (2014), who emphasized that older community members are vital sources of indigenous knowledge, which can help build resilience to climate change through a better understanding of historical climate patterns and practices.

The marital status of the respondents revealed that 75% were married, which suggests a relatively stable social structure within the community. This high percentage of married individuals may indicate stronger familial and community networks that can be leveraged for collective action in addressing climate change. Married individuals, particularly in rural areas, tend to engage more in community-based initiatives due to their established social connections and responsibilities. This could be crucial in fostering a cooperative approach to tackling climate change challenges, as collective action is often more effective in rural contexts.

Table 1. The socio-demographic characteristics of the respondents

Characteristics	Variable	Percent
Gender	Male	42.9
	Female	57.1
Age	20-29	10.7
	30-39	24.3
	40-49	27.1
	50-59	21.4
	60+	16.4
Marital status	Single	0.0
	Married	75.0
	Divorced	12.9
	Widowed	7.1
	Separated	5.0
Education level	Informal	17.1
	Primary	63.6
	Secondary	15.0
	College	2.9
	University	1.4
Household size	1-5	65.0
	6-10	32.9
	11-15	2.1
Farm size	0-4	83.6
	5-9	12.1
	10-14	3.6
	15-19	0.7
House ownership	Yes	79.3
	No	20.7
Farming crop	Yes	85.0
	No	15.0
Keeping livestock	Yes	27.9
	No	72.1
Employment	Yes	3.6
	No	96.4
Business	Yes	5.7
	No	94.3

In terms of educational background, the respondents exhibited a relatively low level of formal education. Most (63.6%) had completed only primary school, and 17.1% had no formal education at all. This low educational attainment could present a barrier to understanding complex climate-related information and adopting new technologies or practices for adaptation. Research has shown that education is a fundamental factor in enhancing awareness of and responsiveness to climate change (Hoekstra et al., 2024), making it crucial to design accessible communication strategies that cater to individuals with varying levels of education. The community's educational needs suggest that information dissemination efforts should be simplified and culturally appropriate to ensure widespread understanding and engagement.

Agriculture remains the dominant livelihood activity in the community, with 85% of respondents relying on farming as their main source of income. The majority (83.6%) own small farms, primarily ranging from 0 to 4 acres. This reliance on agriculture underscores the community's vulnerability to climate variability, as changes in rainfall patterns and temperature can have immediate and significant effects on crop yields and food security. Twinomugisha and Mushy (2021) and Kahimba et al. (2015) highlighted the vulnerability of small-scale farmers to the impacts of climate change, particularly when they depend on rain-fed agriculture, which is highly sensitive to fluctuations in weather patterns. The high reliance on crops as a primary income source further emphasizes the need for adaptation strategies that enhance agricultural resilience.

Livestock farming was notably less common among respondents, with only 27.9% engaging in this activity. This limited engagement in livestock keeping could stem from various constraints, such as insufficient land, lack of resources, or socio-economic challenges. However, the low participation in livestock farming has broader implications, particularly in the context of

rangeland management and climate change adaptation. Livestock plays a critical role in rangeland ecosystems by supporting nutrient cycling, maintaining vegetation balance, and serving as a buffer against crop failures during periods of climate variability (Grebner et al., 2021; Sircely, 2022).

The limited engagement in livestock keeping may undermine the potential of rangelands to provide sustainable livelihoods and maintain ecological balance. Without livestock to utilize and manage rangeland resources effectively, overgrowth or underutilization of vegetation may occur, potentially leading to ecological degradation or loss of biodiversity (Wickama et al., 2004). Moreover, from the perspective of climate change adaptation, livestock farming could provide a vital source of income and food security, especially during times when crop production is adversely affected by erratic weather patterns.

This finding highlights the need for targeted interventions to address barriers to livestock farming and to promote its integration into the community's livelihood strategies. Policies and programs aimed at improving access to grazing land, veterinary services, and credit facilities could help encourage livestock keeping while ensuring sustainable rangeland management. Additionally, initiatives to build the capacity of local communities in sustainable livestock practices could enhance both livelihoods and the ecological health of rangelands, contributing to long-term resilience against climate change impacts.

Furthermore, while a significant proportion of respondents (79.3%) owned their homes, the high rates of unemployment (96.4%) and limited engagement in business activities (94.3%) highlight significant socio-economic challenges within the community. These challenges may impede the community’s ability to invest in climate-resilient technologies or diversify income sources. Limited financial resources could hinder the

adoption of climate-smart practices, such as improved irrigation systems or drought-resistant crops, which could otherwise enhance the community's ability to adapt to changing climate conditions. Bukari and Aluko (2023) pointed out that financial constraints are a significant barrier to climate adaptation in rural areas, as households with limited income are less able to invest in the necessary technologies and practices to build resilience. Therefore, socio-demographic factors presented in Table 1 should be considered when designing effective communication strategies and adaptation interventions that can enhance the community's capacity to cope with the challenges posed by climate change.

3.2 Awareness and knowledge of climate change

The findings of this study reveal that 95% of respondents have heard about climate change, indicating a significantly higher level of awareness compared to the 32% reported by Msafiri (2023) in the Afrobarometer survey on Tanzanians' climate change awareness. This heightened awareness among the study population underscores the critical role of localized communication and engagement strategies in rural communities. Awareness serves as a foundation for fostering attention to climate-related challenges, encouraging early adaptive actions, and building resilience at the community level, as emphasized by Azeez et al. (2024). Awareness alone, however, is insufficient without a deeper understanding of the phenomenon and its implications.

While awareness is high, the study identifies gaps in respondents' knowledge of climate change concepts. Of those familiar with the term, 22.9% defined it as long-term changes in average weather conditions, and 45% described it as fluctuations in temperature and rainfall (Table 2). An additional 28.6% associated it with variations in seasonal patterns, while 3.6% admitted to not knowing its meaning. This variability in understanding reflects the community's reliance on observable changes in their environment, such as irregular weather patterns and temperature

shifts, which are directly tied to their livelihoods. These findings align with Mahoo et al. (2015), who emphasize the need for clear and accurate knowledge of climate change concepts to enhance community engagement in adaptation efforts.

Table 2. Knowledge of climate change

What is climate change?	Percent
Rise and falling of temperature and rainfall	45.0
Variation of seasons in an area	28.6
Average changes of weather condition in long time	22.9
Don't know	3.6

The predominance of descriptions focusing on short-term weather fluctuations suggests that respondents are more aware of the immediate and visible impacts of climate change rather than its systemic and long-term nature. This aligns with findings by Azeez et al. (2024), who observed that rural communities often conceptualize climate change through the lens of their direct experiences and local environmental changes. While this practical perspective can prompt localized responses, it also highlights the need for educational interventions to broaden their understanding of climate change beyond observable phenomena to include its root causes, long-term trends, and broader impacts on ecosystems and livelihoods.

Improving knowledge of climate change is essential for effective adaptation. Studies by Blomley et al. (2024) and Belay & Lebeza (2024) emphasize that informed communities are better equipped to adopt adaptive strategies that address both immediate challenges and systemic vulnerabilities. In the context of this study, targeted educational initiatives could enhance the community's capacity to interpret and respond to climate variability. For example, integrating local knowledge with

scientific information, as advocated by Mahoo et al. (2015), can empower communities to make informed decisions about sustainable rangeland management and climate-resilient agricultural practices.

These findings underline the need for knowledge-building programs to complement awareness campaigns. By bridging the knowledge gap, communities can better understand the interconnectedness of climate change impacts, enabling them to develop holistic and sustainable adaptive strategies. As highlighted by Azeez et al. (2024) and Mahoo et al. (2015), such integration of knowledge and awareness is critical for building resilient systems that can withstand the multifaceted challenges posed by climate change.

3.3 Sources of climate change information

The findings presented in Table 3 reveal that radio is the dominant source of climate change information, with 56.4% of respondents reporting it as their first source of awareness. This aligns with the established role of radio as a key medium for information dissemination in rural Africa, where access to other forms of mass media, such as television or the internet, is often limited due to infrastructural constraints (Azeez *et al.*, 2024). Radio's accessibility, affordability, and ability to broadcast in local languages make it a particularly effective communication tool in reaching remote populations. Television, identified as the second most common source at 14.3%, highlights the growing influence of visual media in these areas, though its reach is still limited compared to radio.

The study also highlights a significant gap in information access, with 12.9% of respondents reporting no exposure to climate change information. This gap can be attributed to infrastructural and geographic isolation, which hampers the dissemination of information, particularly in more remote areas of the district. Moreover, the irregular frequency of information reception

reported as daily (29.3%), weekly (22.9%), monthly (23.6%), or rarely (24.3%) suggests inconsistencies in outreach efforts. These findings are consistent with the observations by Mwalukasa (2020) that information dissemination in rural Tanzania contexts is often fragmented, limiting its effectiveness.

Table 3. The First heard source of climate change

Source	**Percent**
Radio	56.4
Television	14.3
Village meetings	5.0
Friends	3.6
Others	3.6
Relatives	2.9
Mosque or church	2.1
Ngomani	2.1
Newspapers	2.1
Extension officers	1.4
Mobile phone	1.4
Local leaders	1.4
Teachers	1.4
Political leaders	0.7
Books	0.7
Public Announcement	0.7

Preferred channels for receiving climate change information revealed a strong inclination toward radio (77.7%), followed by television (44.6%) and mobile phones (33.1%). Interestingly, social media, mentioned by 7.7% of respondents, indicates a gradual penetration of digital communication technologies into rural areas. This reflects an emerging opportunity to complement traditional communication channels with digital platforms, as recommended by Azeez *et al.* (2024), to target younger, more tech-savvy segments of the population. Expanding the use of

mobile phones and social media could address some of the barriers to information access, including geographic and infrastructural constraints (Mwalukasa, 2020).

Despite the high awareness levels, communication of climate change information among respondents remains limited. While 50% of respondents shared such information during social gatherings and 9.3% discussed it in official village meetings, 32.9% reported never communicating climate change information. This lack of engagement may stem from limited understanding of the issue or low perceived importance of discussing it in formal settings. As Githiora et al. (2024) emphasize, fostering dialogue and community engagement is crucial for building collective action toward climate adaptation.

Social gatherings were identified as critical platforms for disseminating climate change information, indicating the importance of leveraging informal networks for communication. However, the reliance on these informal channels underscores the need for more structured and formal platforms for discussing climate-related issues. Establishing regular village meetings or integrating climate education into existing community activities could enhance the effectiveness of information sharing, as recommended by Twinomugisha and Mushy (2021).

These findings highlight the importance of a multi-channel approach to climate communication, combining traditional media such as radio and television with emerging tools like mobile phones and social media. Moreover, efforts to improve the consistency and accessibility of climate change information should focus on addressing geographic and infrastructural challenges while enhancing the knowledge and engagement of the community through targeted education campaigns. Such strategies could be essential for fostering informed decision-making and collective action to build resilience to climate change impacts.

Furthermore, the study revealed significant associations between socio-demographic factors and access to climate change information, offering critical insights into how different groups interact with information sources (Table 4). Age emerged as a key variable, with the Pearson Chi-square test showing a statistically significant association (p=0.007). Younger individuals were found to access information through digital platforms such as mobile phones and social media, while older respondents relied more heavily on traditional media, including radio and village meetings. Although the Somers' d value of 0.007 indicated a weak predictive relationship, the findings suggest that age, while not a strong determinant, does influence the diversity of information sources accessed. These observations align with existing studies, such as Azeez et al. (2024), which highlight younger populations' greater engagement with technology for information access.

Table 4. Association between socio-demographic factors and accessibility to climate change information

Factors	**Pearson Chi-square**	**Somers' d**
Age	0.007	.007
Sex	0.0769	.395
Marital status	0.001	.015
Education level	0.000	.090
Number of households	0.062	.092
Farm size	.666	.993
House ownership	.666	.877

Sex, on the other hand, did not show a statistically significant relationship with access to information (p=0.0769), but the Somers' d value of 0.395 suggested a moderate directional relationship. This indicates that while sex may not strongly influence access overall, there are underlying patterns worth

exploring further. For example, gender-based roles or societal norms could shape the way men and women engage with information channels, even if such influences do not appear strongly in statistical tests.

Marital status demonstrated a highly significant association with access to information (p=0.001), with married individuals likely benefiting from broader social networks and shared resources, enabling them to access information more consistently. However, the predictive strength, as indicated by the Somers' d value of 0.015, was relatively weak. This finding underscores the complexity of how social structures, such as marital status, interact with access to environmental information. Married individuals, for instance, might have more regular exposure to traditional communication platforms such as radio or village meetings, while single individuals might explore newer channels like social media.

Education level emerged as one of the most significant factors influencing access to climate change information. The Pearson Chi-square test showed a highly significant association (p=0.000), while the Somers' d value of 0.090 indicated a stronger predictive relationship compared to other variables. Respondents with higher levels of education accessed information through more diverse and sophisticated channels, including print media, mobile phones, and social media. This finding highlights the critical role of education in equipping individuals with the skills to seek, interpret, and utilize complex environmental information. Similar results have been reported in studies such as Ifegbesan et al. (2021), where education was highlighted as a pivotal factor in environmental awareness and engagement.

The number of households showed a marginal association with access to climate change information, with a Pearson Chi-square value of 0.062 and a Somers'd value of 0.092 indicating a moderate predictive relationship. Larger households likely

benefited from the diversity of their members' roles, ages, and education levels, which increased exposure to varied information sources. However, the results suggest that this factor alone is not a strong determinant of access to information.

Farm size and house ownership did not show significant associations with access to climate change information, as reflected by Pearson Chi-square values of 0.666 for both variables. The Somers' d values, 0.993 for farm size and 0.877 for house ownership, also suggested minimal predictive relationships. This indicates that these variables, while important in other socio-economic contexts, are not directly tied to how individuals' access or engage with climate-related communication channels.

The implications of these findings are profound. Efforts to improve access to climate change information must consider the socio-demographic diversity of the target population. Younger and more educated individuals can be reached effectively through digital tools such as social media and mobile applications, while older and less educated populations may benefit more from traditional media like radio. Furthermore, while variables such as farm size and house ownership do not appear to influence access directly, this highlights the importance of tailoring communication strategies to focus on more impactful demographic factors, such as education and age. These dynamics are vital for effective climate change communication, by ensuring that all segments of the population are equipped with the knowledge needed to respond to environmental challenges.

3.4 Perceived causes of climate change

The respondents identified several causes of climate change, with deforestation (57.7%) being the most commonly cited, followed by poor farming practices (40%) and pollution (28.5%) (Table 5). These findings are consistent with global research emphasizing deforestation and unsustainable agricultural practices as significant contributors to climate change. For instance, Grebner

et al. (2021) highlight that deforestation directly impacts carbon sequestration, exacerbating greenhouse gas emissions. Similarly, Jones *et al.* (2023) note that poor farming methods, such as slash-and-burn agriculture, intensify soil degradation and increase greenhouse gas emissions, particularly in regions reliant on subsistence farming.

Table 5. Perceived causes of climate change

Perceived Cause	**Percent**
Deforestation	57.7
Farming system/practice	40.0
Pollution	28.5
Bush fire	16.2
Natural disasters	14.6
Lack of education	9.2
God's Punishment	7.7
I don't know	7.7
Global warming	3.8

Pollution, recognized by 28.5% of respondents, also aligns with studies like Calculli et al. (2021), which featured the role of industrialization, urbanization, and waste mismanagement in amplifying carbon and methane emissions. Interestingly, 16.2% of respondents identified bushfires as a cause of climate change, reflecting the regional susceptibility to wildfire-induced carbon emissions.

A small but significant proportion (7.7%) attributed climate change to divine punishment, reflecting cultural and religious interpretations of environmental phenomena. While such beliefs are deeply rooted in local traditions, they may hinder scientific understanding and action, as observed in studies by Kahimba et al. (2015). Educational initiatives that integrate scientific concepts with respect for cultural values could enhance community

understanding and engagement with climate change mitigation strategies.

The diversity of perceived causes indicates varying levels of awareness among respondents, highlighting the importance of tailored communication strategies to address knowledge gaps and promote sustainable practices. As Kapinga et al. (2020) emphasize, community-based broadcast media and participatory knowledge-sharing approaches could be particularly effective in disseminating accurate climate change information.

3.5 Impacts of climate change

The study revealed that respondents experienced various impacts of climate change, with the most significant being low agricultural yields (36.3%) and famine or food insecurity (35.6%) (Table 6). These findings emphasize the direct link between climate change and food security, as highlighted by Field and Barros (2014), who discuss how unpredictable rainfall patterns and prolonged droughts disrupt crop production in vulnerable regions. Similarly, Kahimba et al. (2015) note that Tanzanian farmers are increasingly experiencing reduced harvests due to shifting weather patterns, compounding food insecurity risks.

Table 6. Impacts of climate change

How climate change is affecting you?	Percent
Low agricultural produce	36.3
Famine/food insecurity	35.6
Diseases and new pests	26.7
Dry of rangelands/ No pasture	20.0
No rain, thus everything falls apart	20.7
Destruction of infrastructure	16.3
No effects	7.4

In addition to agricultural impacts, 26.7% of respondents reported increased diseases and new pests, consistent with the observations of Hoekstra *et al.* (2024), who link changing climatic conditions to the proliferation of disease vectors and invasive species. These health challenges further strain already fragile healthcare systems in rural areas.

The drying of rangelands and lack of pasture, noted by 20% of respondents, highlights the adverse effects of climate change on livestock-dependent communities. As Grebner et al. (2021) emphasize, changes in rainfall and vegetation patterns disrupt traditional grazing cycles, leading to economic losses for pastoralists. Similarly, infrastructure destruction, reported by 16.3%, reflects the vulnerability of rural communities to extreme weather events, such as floods and storms, which damage homes, roads, and public facilities.

While 7.4% of respondents claimed no noticeable effects of climate change, this could indicate limited exposure or a lack of awareness about indirect impacts. Hoekstra et al. (2024) suggest that improving education on the less visible effects of climate change such as gradual soil degradation or economic consequences could bridge such gaps in perception.

Therefore, these findings emphasize the need for integrated strategies to address both the immediate and long-term impacts of climate change. Promoting climate-smart agricultural practices (Jones *et al*., 2023), enhancing public health systems, and investing in resilient infrastructure are critical steps toward mitigating the adverse effects of climate change on vulnerable communities.

3.6 Strategies for rangeland management amid climate change

The findings on community-driven strategies for rangeland management amid climate change in Table 7 reveal important information but also raise critical questions about their adequacy

in achieving the global goals of rangelands. Globally, the sustainable management of rangelands is often centred on balancing grazing, biodiversity conservation, and ecosystem services to support rural livelihoods (Grebner et al., 2021; Sircely, 2022). However, the results indicate a notable gap in aligning local perceptions with these broader objectives, particularly given the predominance of crop farming (85% of respondents) over livestock keeping (27%) in the study area.

Table 7. Strategies for rangeland management amid climate change

Rangeland management measures	**Percent**
Reforestation	49.6
Provision of mass education	35.4
Establishment of by-laws and local regulations	16.5
Adopt climate Smart farming practices	16.5
Praying to God	11.8
I don't know	6.3

The high prioritization of reforestation (49.6%) as a strategy is commendable and aligns with global efforts to combat deforestation and restore degraded rangelands. Tree planting can improve vegetation cover, enhance soil health, and mitigate erosion, all of which are essential for rangeland resilience. However, reforestation alone does not fully address the multifaceted challenges of rangeland management, especially in the context of livestock grazing, which is a defining feature of rangelands. In regions where livestock plays a minor role, as observed in this study, there is a risk that rangelands may be underutilized or mismanaged, potentially leading to ecological degradation or loss of biodiversity (Wickama et al., 2004). This gap highlights the need to promote livestock keeping as an integral component of rangeland management to achieve the

common global goals of sustaining livelihoods and ecological balance.

The provision of education, cited by 35.4% of respondents, offers a pathway to address this gap. Education can empower communities to adopt sustainable livestock practices, such as rotational grazing and fodder cultivation that optimize rangeland resources while minimizing environmental impacts. It can also enhance understanding of the interconnectedness between livestock, vegetation, and ecosystem services, fostering a more comprehensive approach to rangeland management. In areas dominated by crop farming, integrating education on mixed farming systems that incorporate livestock could help diversify livelihoods, enhance food security, and strengthen resilience to climate variability (Azeez et al., 2024; Sircely, 2022).

The establishment of by-laws and local regulations (16.5%) is another critical strategy for rangeland management, particularly in preventing overgrazing, regulating land use, and ensuring equitable access to resources. However, the effectiveness of such regulations depends on community buy-in and enforcement mechanisms. In regions with limited livestock keeping, such regulations should also focus on encouraging the sustainable use of rangelands for both grazing and non-grazing purposes, such as biodiversity conservation and carbon sequestration. This dual focus aligns with global frameworks for rangeland management, which emphasize multi-functionality and the provision of ecosystem services.

The relatively low engagement in livestock farming (27%) and the lack of strategies explicitly addressing grazing management suggest a disconnect between local practices and the broader goals of rangeland management. Livestock serves as a critical component of rangeland ecosystems by facilitating nutrient cycling, controlling vegetation growth, and buffering against crop failures during climate shocks (Belay and Lebeza, 2024; Grebner

et al., 2021). Encouraging livestock keeping through targeted interventions such as improving access to grazing land, veterinary services, and credit facilities could help bridge this gap. Additionally, promoting practices like integrated crop-livestock systems could enhance the sustainable use of rangelands while providing diversified income streams for rural households.

Interestingly, 11.8% of respondents mentioned prayer as a strategy, reflecting the influence of cultural and spiritual beliefs on perceptions of climate change. While these beliefs can provide psychological comfort, they are insufficient as standalone solutions for the complex challenges of rangeland management. Integrating these cultural values with evidence-based strategies can foster holistic approaches that resonate with local communities while addressing global rangeland objectives (Azeez et al., 2024). Promoting sustainable livestock practices, mixed farming systems, and participatory governance, rangeland management strategies can better align with global objectives, ensuring the long-term sustainability of these critical ecosystems.

4.0 Conclusions

This study highlights the significant role that local knowledge, communication strategies, and media platforms play in supporting rangeland management and enhancing community resilience to climate change in Lushoto, Tanzania. The findings indicate that while there is a high level of awareness about climate change among the community, gaps remain in understanding its long-term impacts. The predominant sources of climate information, such as radio and television, were shown to be crucial in shaping community awareness and responses to climate challenges. The study also revealed that local communities rely heavily on traditional knowledge and community-driven strategies, such as reforestation and mass education, to manage rangelands and adapt to climate change. However, the integration of livestock management with rangeland conservation remains a challenge, indicating a need for a more holistic approach to sustainable land

use. The results accentuate the importance of improving access to reliable climate information, particularly through media channels that are most trusted by the community. Enhancing community education on climate impacts and adaptation strategies is essential for fostering resilience. Additionally, the study emphasizes the need for integrating local knowledge with modern scientific approaches to create more effective climate adaptation strategies that align with global sustainability goals. These challenges be transformed into opportunities for local communities to improve their capacity to manage rangelands sustainably and adapt to the changing climate.

5.0 Recommendations

This study highlights several key areas where interventions can significantly improve community resilience to climate change and enhance rangeland management. Firstly, improving access to reliable climate information through preferred media platforms, particularly radio and television, is crucial. These platforms have proven to be the primary sources of climate change information in the community. By developing more targeted and locally relevant communication strategies, stakeholders can ensure that climate-related messages reach broader audiences, including those who may have limited access to other forms of media. This would empower communities to make more informed decisions about climate adaptation and resilience. Secondly, integrating community-driven education programs on climate change impacts and sustainable rangeland management practices is essential. Local communities already recognize the importance of reforestation and education, but a more comprehensive approach that includes training on climate-smart agricultural practices, sustainable livestock management, and biodiversity conservation is necessary. This education should be designed to not only raise awareness but also provide practical solutions for mitigating the effects of climate change, thereby improving the adaptive capacity of rural households.

Lastly, fostering greater involvement of local communities in policy development and the management of rangelands will be vital for ensuring long-term sustainability. As the study shows, local governance structures, such as the establishment of by-laws and regulations, are key to managing rangeland resources effectively. However, their success depends on community participation and the implementation of policies that are not only scientifically sound but also culturally acceptable. Empowering communities through participatory governance and supporting policies that integrate climate change adaptation with sustainable land use practices will help achieve both local and global sustainability goals. These recommendations are essential steps towards building resilience to climate change and promoting the sustainable management of rangelands in Tanzania.

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