Unveiling the nexus: Understanding socio-ecological determinants of children's sensitivity and vulnerability to climate change

Laurent Joseph
Department of Management Science, Faculty of Business and Economics, The Institute of Finance Management
5 Shaaban Robert St, Dar es Salaam, Tanzania
E-mail: laurent.joseph@ifm.ac.tz

Abstract

Children in every corner of the globe face climate change challenges, including Tanzania. This study explores the socio-ecological factors that predisposed and made children more sensitive to climate change's impact in Longido District, Tanzania. The study was guided by social vulnerability, resilience, and intersectionality theories, among others, and employed the mixed-methods design comprising household survey and focus group discussions in data collection with a sample size of 123 respondents. The study's findings indicate that several social and ecological factors shape the impact of climate change on children, such as water stress, inundation, disease and pest outbreaks, food insufficiency, whirling of air, threats to livelihoods, drought, extreme heat, and many more. Also, this research revealed various strategies in which children's vulnerability to climate change is lessened. These include improving clean drinking water, sanitation, and health services, building schools, introducing climate-smart agriculture, and education. They aim to reduce and lessen climate change's effect on children in areas with the same characteristics. Therefore, the study recommends collaboration among policymakers, local authorities, and other players to implement integrated and location-specific strategies that address children's issues in climate change-affected regions.

Keywords: socio-ecological; determinants; vulnerability; children; climate changes impacts

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Introduction

Climate change significantly impacts societies, economies, cultures, and global social and environmental stability (Debesai, 2020). Children, particularly vulnerable due to their physiological, developmental, and socioeconomic characteristics, are particularly affected by vector-borne diseases (Talukder, van Loon, Hipel, Chiotha, & Orbinski, 2021). Unhygienic conditions and disruptions in clean water and food security, and unhygienic conditions contribute to these risks. Climate change is a growing global threat, causing negative impacts on health, jobs, and the environment (Debesai, 2020). Indeed, climate change is a global challenge that affects various sectors, particularly children. According to studies by Cordero, Centeno, and Todd (2020) and Talukder et al. (2021), children's health, education, and general well-being are at risk due to severe weather conditions, water and food shortages, and patterns of illness. Rural children are especially susceptible to the effects of climate change, as shown by Debesai (2020). Additionally, vulnerable communities, particularly children in Africa and Asia, including Eastern Africa, are significantly impacted by climate change, as found by Rahman, Atta-ur-Rahman, Samiullah, and Dawood (2018).

In some countries like Bangladesh, Kiribati, and Tuvalu, Flooding and salinization of water sources increase risks of displacement, malnutrition, and waterborne diseases for children, as reported by UNICEF (2023) and Bennett and Friel (2014). Prolonged droughts and erratic rainfall

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patterns in the Horn of Africa also impact children's health and result in malnutrition due to food insecurity and increased disease risk (Stanberry, Thomson, & James, 2018).

Tanzania, an East African country, is grappling with climate change challenges such as erratic rainfall rising temperatures, and rising sea levels (Jackson, Claude, & Godfrey, 2018). These issues disproportionately affect vulnerable populations, particularly children, reducing agricultural productivity, food insecurity, and loss of livelihoods (Mary & Majule, 2009; Mugabe, 2016). Frequent floods and droughts cause infrastructure damage, population displacement, and disruptions to services like healthcare and education. These impacts worsen socioeconomic disparities and increase poverty (Lugendo, Tsegaye, Wortman, & Neale, 2017; Luhunga, Chang'a, & Djolov, 2017).

Within the context, the Longido rangelands in Tanzania have become a focal point of concern, where climate change is affecting the livelihoods of pastoralist communities particularly children who are more vulnerable due to their physical and mental health and socioeconomic status (Joseph, 2022a, 2022b; Salanga & Muhanga, 2023). This study aimed to understand the social-ecological dynamics amplifying vulnerability among Longido District children to climate change effects. The research provides insights into effective community resilience-building strategies and sustainable livelihood interventions by analyzing specific demographic features and environmental factors that worsen vulnerability.

Therefore, this study has two objectives: i) to examine socio-ecological determinants of children's vulnerability to climate change impacts in the Longido District and ii) to suggest and recommend interventions and strategies to provide insights into how to minimize children's vulnerability amidst climate change. Through fulfilling these objectives, the study bridges existing knowledge gaps, offering actionable recommendations to minimize the vulnerability of the adverse effects of climate change on vulnerable populations, especially children in semi-arid rangelands and similar contexts.

This study is guided by three interrelated theories: social vulnerability theory, resilience theory, and intersectionality theory. The social vulnerability theory contends that social factors, such as age, race, gender, socioeconomic status, and community structures, influence vulnerability. It suggests that these social attributes determine the capacity of individuals and communities to anticipate, cope with, resist, and recover from the impacts of disasters. Social vulnerability is often measured using indices considering access to resources, socioeconomic status, and demographic characteristics (Cutter, Boruff, & Shirley, 2003). It views vulnerability as a lack of freedoms and opportunities referred to as capabilities necessary to adapt to and mitigate the impacts of climate change.

On the other hand, resilience theory focuses on the capacity of ecological and social systems to absorb disturbances and reorganize while changing. In the context of climate change, resilience theory explores how communities and individuals can maintain functionality and well-being despite environmental stressors (Folke, 2006). Furthermore, the theory of intersectionality maintains that vulnerability is never a single incredible; instead, it dramatically variates depending on the interaction between these intersecting identities, such as disasters and climate change. The theory spots how disadvantaged groups are made to suffer most when socio-political dynamics are complicated (Crenshaw, 1989).

Methods

Longido District, located in the Arusha Region, is the driest area in Tanzania, with temperatures ranging from 20c to 35c and rainfall ranging from less than 500 mm in lowlands to 900 mm in high elevations with a total area of 7,782.01 km^2 (Martin, 2017). It is characterized by a mix of low and high-elevation areas, with isolated mountains like Ketumbeine, Gelai, Oldonyo Lengai, and Longido Mountains. The population is 175,915, with 82,887 males and 92,028 females (The United Republic of Tanzania, Ministry of Finance and Planning, Tanzania National Bureau of Statistics, President's Office - Finance and Planning, & Office of the Chief Government

Statistician Zanzibar, 2022). The main economic activities are livestock rearing and wildlife tourism, with over 90% of the population engaged in livestock keeping. Meru, Rombo, Ngorongoro, Monduli, Arusha, and Siha border the district. In this context, the study was conducted in the district wards of Engikareti, Kimokouwa, Sinya, and Mundarara.

The study used both purposive and random sampling methods. Purposive sampling was used to select 32 participants for Focus Group Discussions (FGDs), eight participants from each of the 4 wards (four males and four females). Meanwhile, simple random sampling was used to choose 93 household respondents who completed the questionnaire (see Table 1). Therefore, the total sample size of the study was 123 respondents. The study utilized Yamane's (1967) formula of n = N/[1+N (e)2], where 'n' represents the sample size, N denotes the sampling frame, and e represents the prediction error at 10%. The sample size of the household survey was set at 10% of the total number of household heads within each study station, based on The United Republic of Tanzania et al. (2022) findings that the total number of households in Longido District is 42,477. This results in the equation n = 42,477/[1+42,477 (0.1)2], which gives n = 99.81, i.e., about 100 respondents. With another 15%, the total number of respondents rises to 115. Therefore, the sample of 123 is representative.

Table 1.
The sample size in each ward

Wards	Number of respondents who filled the questionnaires	Number of discussants in each ward	Sample size per each ward
Engikaret	43	8	51
Kimokouwa	03	8	11
Sinya	14	8	22
Mundarara	31	8	39
Total	91	32	123

Source: Field data (2023)

The study used a Mixed Research Design (MRD). The MRD allowed the collection of both Qualitative Data (QLD) and Quantitative Data (QND) (see Figure 1). The QLD was collected through Focus Group Discussions (FGDs) with members of communities, parents, teachers as well as local leaders who shared their views and experiences concerning how climate change affects the vulnerability of their children. The QND was obtained through Household Surveys (HHS) and data from District Governmental Offices (DGO) and Non-Governmental Organizations (NGOs). This provided statistical details on socio-ecological sources behind high sensitivity and vulnerability in children. The use of MRD enabled the process of triangulating data from multiple sources and methods, thus enhancing overall validity and reliability within findings, as suggested by Smith, Glass, and Miller (2020). While qualitative data provided rich contextual information about the lived experiences of children in communities, quantitative information enabled broader trends and tendencies of climatic disasters.

The HHS was conducted through well-structured open and closed questionnaires pretested to ensure validity and reliability. That involved pretesting the questionnaires through a small sample size and considering participant comments regarding revisions needed (Smith et al., 2020). The pretesting involved both conventional pretesting, as recommended by Lenzner, Neuert, and Otto (2016), and cognitive pretesting, as suggested by Ridolfo and Schoua-Glusberg (2011), Willis (2005), Beatty and Willis (2007), who assert that pretesting is very vital before administering questionnaires. After pretesting, final questionnaires were administered to a selected sample size of 93 households in the Longido District. The themes included are socio-economic factors, environmental conditions, health indicators, adaptive capacities, and the vulnerability and sensitivity of children towards climate change impacts. The questionnaire methodically collected information about socio-ecological determinants, explaining this issue comprehensively; it allowed for both quantitative and qualitative analyses.

FGDs, including Single Focus Group Discussions (SFGDs) and Mini Focus Group Discussions (MFGD), were used to collect qualitative data. With selected participants, FGDs were conducted to explore thematic areas on children's sensitivity and vulnerability towards climate change impacts. The interactive nature of these groups allowed the participants to share their experiences, perceptions, and insights on the subject matter (Morgan, 2018). Major themes discussed during the FGDs comprised the effects of climate change on children's health, education, and livelihoods, as well as social well-being, local adaptation measures, and community resilience. Further, the FGDs enabled a holistic and contextualized understanding of the research topic while at the same time ensuring that members contributed to shaping the process of investigation.

Eight FGDs were conducted in four wards, with two groups in each ward, one for males and the other for females. Each group consisted of four discussants, as guided by Stalmeijer, McNaughton, and Van Mook (2014) as well as Barbour (2010) assert that the FGD should be small enough, that is, 4-12 participants. On a time basis, approximately, each group took one hour as guided by Reichstadt, Depp, Palinkas, and Jeste (2007) as well as Muijeen, Kongvattananon, and Somprasert (2020), who suggest that FGDs should range from one to two hours. All FGDs were held in Ward Executive Officers Offices (WEO's offices) because the rooms were adequate in size, lighting, and temperature. The seating was arranged in a circle format to create a relaxing atmosphere, as recommended by Muijeen et al. (2020), who assert that seating should be arranged in a circle format and the setting should be safe from disturbances or external noise. Therefore, Figure 1 shows the procedural practice of this study in data collection, analysis, and interpretation.

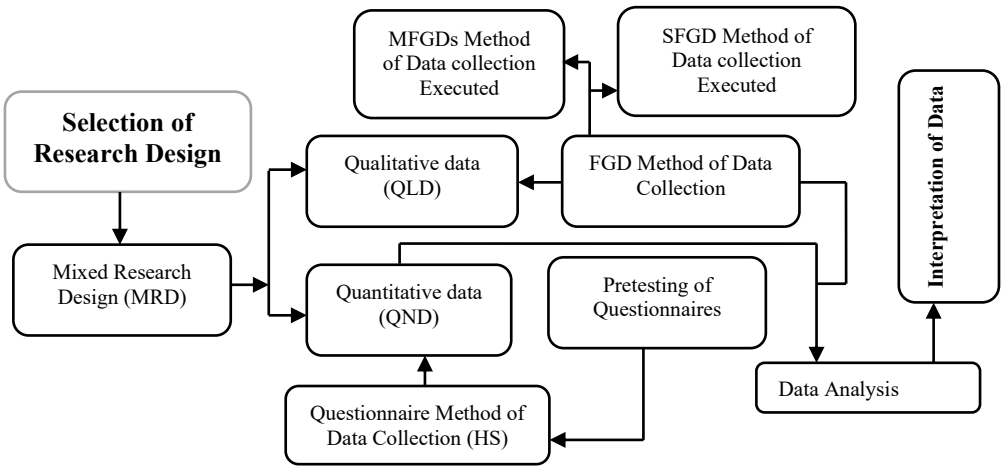

Figure 1.
The flow of data collection, analysis, and interpretation

Numerous methods were employed to analyze the findings of this research, which involved quantitative analysis of questionnaire data and qualitative analysis of Focus Group Discussion (FGD) data. The statistical techniques were used to analyze the questionnaire data quantitatively using SPSS software version 21. That is because the closed-ended questions had numerical responses that could be subjected to descriptive statistic measures like frequencies, percentages, means, standard deviations, and chi-square tests. It was through this process of analysis that patterns, trends, and connections between variables regarding how children are exposed to climate change effects were identified. A qualitative analysis was performed on FGD data to identify meaningful themes and insights. The researcher carefully examined what each participating individual said and assigned a code based on any recurring themes or major concepts. That included a thematic approach where data was systematically organized, categories were created, and interpretation was done finally. The mixed-methods design was employed to integrate

quantitative findings with qualitative methods. The objective was to comprehensively understand socio-ecological determinants that impact children's vulnerability against sensitivity to climate-related conditions in the Longido District. The results of the questionnaires were analyzed to obtain quantitative data, which was then combined with thematic statements derived from Focus Group Discussions (FGDs). The aim was to capture a complete range of determinants influencing children's vulnerability and sensitivity toward climatic conditions.

Results and Discussion

Socioeconomic characteristics of respondents

This section presents the socioeconomic characteristics of respondents in the field survey. The survey results showed that 51.6% (see Table 2) of respondents were male, with varying gender proportions across different wards. Both genders were included in this study for a comprehensive analysis. The study emphasized the importance of collective decision-making in addressing climate change-related challenges, emphasizing the need to consider gender for addressing vulnerability.

Table 2.
Socioeconomic characteristics of respondents

	Variables	Number of respondents	Proportion (%)
1	Gender of respondents		
	Male	47	51.6
	Female	44	48.4
2	Age of Respondents		
	15 -30 years	11	12.0
	31- 45 years	40	44.0
	46 -60 years	28	30.8
	61>	12	13.2
3	Economic Activities		
	Pastoralists	19	20.8
	Farmers	29	31.9
	Employed	29	31.9
	Small business	14	15.4
4	Education level of Respondents		
	Non-formal education	42	46.2
	Primary education	19	20.8
	Secondary education	16	17.6
	Above secondary Education	14	15.4

Source: Field data (2023)

The study involved age attributes of children, youths, elders, and older people. The composition includes 12.0%, 44.0%, 30.8%, and 13.2%, respectively. The study emphasized the importance of all ages being involved as they play a vital role in the community's sustainable development. The overall results on economic activities indicate that about 52.7% (see Table 2) of the respondents depend on nature-based economic activities (pastoralism and farming). Depending on nature-based activities results in more vulnerability to impacts imposed by climate change, as any change in weather will directly impact them as a community. Overall, the literacy level in the four wards is moderate, as only 53.8% of respondents had primary education and above, and the remaining (46.2%) had non-formal and primary education. Cordero et al. (2020) asserts that the level of education is vital in dealing with climate change-related strategies.

State of children's susceptibility and vulnerability

This section aimed to determine the extent of vulnerability among children in the Longido District. The findings revealed that climate change's impact had significantly increased children's vulnerability in Longido by a staggering 83.5% (N = 91), as shown in Figure 2. The probable reasons for the high degree of perceived children's vulnerability are dry water sources during drought, lack of food, increased diseases that affect children, and failure to attend school during heavier rainfall in the Longido District (Joseph, 2022b). Only 16.50% of respondents did not acknowledge the children's vulnerability to the effects of climate change in the area.

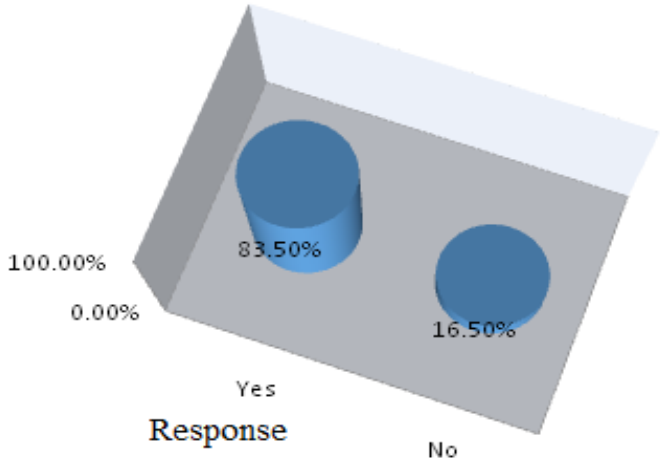

Figure 2.
Degree of vulnerability of children

It was crucial to determine the level of vulnerability in the study area to understand the key factors that make children vulnerable to the effects of climate change. This understanding would then help design effective measures for mitigation and adaptation strategies. This research aimed to identify and analyze the factors that contribute to the increased vulnerability of children in the face of climate change to provide valuable recommendations for addressing them.

Identified socio-ecological determinants increase children's vulnerability by household respondents

This section presents the socio-ecological determinants that make children more susceptible to climate change impacts. These determinants include water scarcity, temperature variability, floods, diseases, food shortage, disruption of livelihoods, drought, and strong winds. Household respondents identified these factors during a survey conducted in the Longido District.

Shortage of water

According to a study, 83% (N=76) of respondents identified water shortage as a major cause of children's vulnerability to climate change and water scarcity (see Table 3). A chi-square test showed a significant link between child susceptibility and vulnerability to climate change and water shortage with ($\chi 2$ (1, N=91) = 6.723[a], p=0.01). A p-value of 0.01 indicates a strong link between children's vulnerability and water scarcity influenced by climate change. The reason behind this correlation is the Shortage of clean drinking water for children during irregular rainy seasons due to climate change. It was revealed that during low rainfall, the rivers and dams in communities dry up, forcing people to walk long distances searching for water. That has a disproportionate impact on children, especially girls, who are physically affected since they are responsible for fetching water.

The findings are affirmed by UNICEF (2023), implying that prolonged droughts cause rivers and ponds to dry; hence, children face more threats from lack of water than adults. The scarcity of

water causes poor health among children. It hampers their education, reducing the time for learning or playing games since they spend most of their time fetching water. The study's results match those obtained by WHO (2018), which showed that girls spent a huge proportion of their energy and time going long distances searching for freshwater sources. Various research done among young people in Tanzania has shown that incidences of waterborne diseases were interrelated with both scarcity and variability in precipitation patterns (UNICEF, 2023).

Table 3.
Perceived socio-ecological determinants of children's vulnerability by household respondents*

Determinants of children's vulnerability	Response Yes % (f)	No % (f)	Total % (f)	Value	df	P-Value
Food shortage*	78% (71)	22% (20)	100% (91)	6.384[a]	1	0.012
Diseases *	76.9% (70)	23.1% (21)	100% (91)	9.262[a]	1	0.002
Drought *	79.5% (72)	20.9% (19)	100% (91)	3.975[a]	1	0.046
Floods *	76.9% (70)	23.1% (21)	100% (91)	5.630[a]	1	0.018
Increase of temperature*	74.7% (68)	25.3% (23)	100% (91)	4.352[a]	1	0.037
Strong Wind*	75.8% (69)	24.2% (22)	100% (91)	4.956[a]	1	0.026
Livelihoods insecurity*	75.8% (69)	24.2% (22)	100% (91)	1.152[a]	1	0.283
Shortage of Water*	83% (76)	16.5% (15)	100% (91)	6.723[a]	1	0.01

*Multiple response
Source: Field data (2023)

Floods

The results in Table 2 indicate that 76.9 (N=91) perceived flood as a cause of children's vulnerability to climate change. Further, chi-square statistic results of 5.630^{a} ($df = 1$, $p = 0.018$) showed a statistically significant relationship between flood and children's vulnerability in both directions. The P-value of 0.018 yielded by this chi-square test indicates a statistically significant linkage between flood and the susceptibility and vulnerability of children to changeable weather conditions. The study rejects H0 and accepts H1, indicating that floods increase children's vulnerability to climate alterations, causing death to livestock, which are the source of livelihoods and food to children (see Figure 3), damaging their homes and infrastructure and impacting their health and education. Because of the flooding, children flee their homes in search of social support, leaving them vulnerable to being abused by people who might take advantage of them.

Figure 3.
Death of goats due to the floods in Longido District
Source: Field data (2023)

For instance, 120,000 animals perished in 2009 and 2010; between 1970 and 2015, the figure more than doubled to 250,000, and around 2016 – 2023, the death of livestock rose to 310,000. The death of animals negatively affects the pastoralists' way of life and makes children more vulnerable. Figure 4 shows that Longido's precipitation trend over the 35 years from 1979 to 2023 is not constant (see Figure 4). The district experienced flooding in the following years: 1979, 1982, 1985, 1988–1989, 1997, 2002, 2006, 2013, 2016, and 2018–2021.

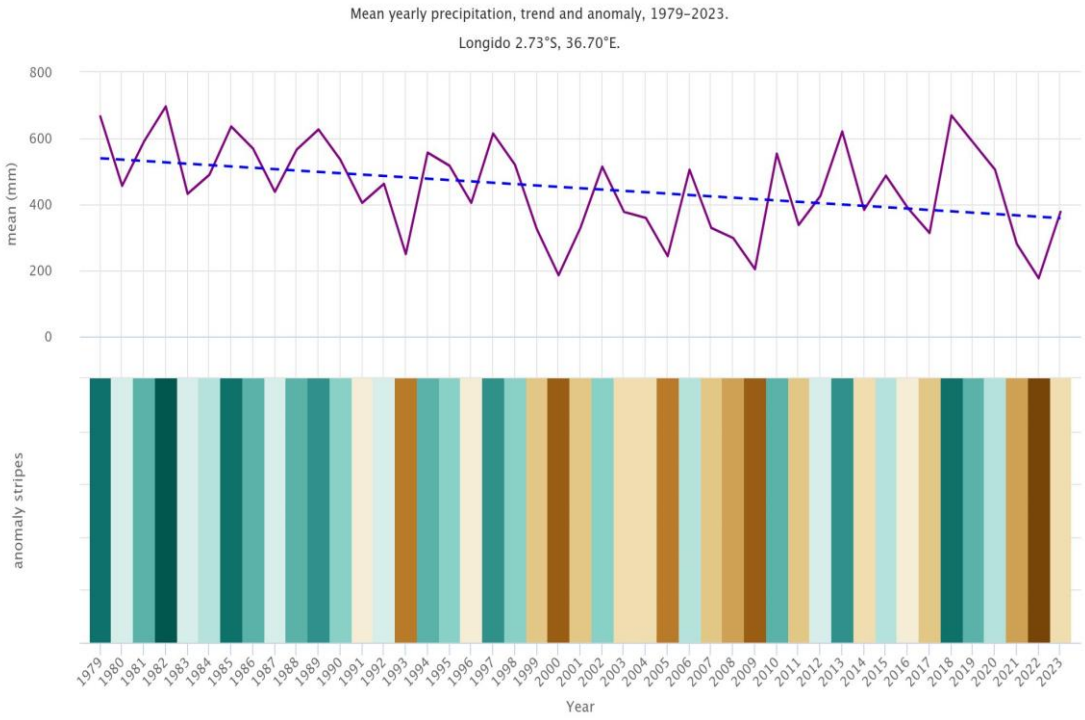

Figure 4.
Variability of precipitation which results to flooding in the study area
Source: Meteoblue (2023)

The findings align with those of UNICEF (2023), which found that floods cause human deaths and destroy properties. Similarly, Abendaño, Recente, and Barroso (2021) found that hydrological disasters negatively impact people, making children highly vulnerable.

Eruption of diseases

According to the study results, 76.9% (N=91) of respondents believe that the eruption of diseases results from climate change, which makes children more vulnerable (see Table 3). A Cross-tabulation (at a 95% level of significance) was performed to examine the association between the eruption of diseases and children's vulnerability to climate change, using Chi-square tests whereby the results reveal that there is a significant relationship between diseases and children's vulnerability to climate change impact, as indicated by ($\chi 2$ (1, N=91) = 9.262[a], p=0.002). In this context, A p-value of .002 indicates that diseases increase children's vulnerability to climate change. The study found that rising temperatures and erratic rainfall have increased waterborne diseases like dysentery and typhoid, primarily affecting children due to their susceptibility to infections. These climate conditions significantly impact the survival and reproduction of malarial mosquitoes and their life cycle.

The results align with those of Rother et al. (2020) and Sheffield and Landrigan (2011), whose findings indicate that climate modifications also pose significant mental health risks among children. Further, Randell and Gray (2019) and Bennett and Friel (2014) found that traumatic psychological issues like feeling scared and anxious are common impacts of Climate Change

among children as they are exposed to harsh climatic conditions like floods or prolonged droughts that have long-term consequences on their lives, such as anxiety, depression. Studies by Yu et al. (2015) and Watts et al. (2015) found that climate change influenced the increase in malaria incidences.

Food scarcity

The results in Table 3 indicate that 78% (N=91) (see Table 3) of the respondents perceived food insecurity as a factor that increases children's vulnerability to the impact of climate change. A chi-square test showed a significant link between children's susceptibility and vulnerability to climate change and shortage of food with ($\chi2$ (1, N=91) = 6.384[a], p=0.012). A p-value of 0.012 indicates a strong link between children's vulnerability and food insecurity influenced by climate change. The finding of this study revealed that climate change has brought about tough economic times, resulting in food scarcity such that children cannot have proper nutrition since they lack enough food. Malnutrition, which includes undernutrition and deficiencies in vital nutrients needed for body growth, mind development, and disease protection, is caused by limited food intake and poor dietary patterns. The finding of this study concurs with those of UNICEF (2023) which found that prolonged periods of famine lead to stunted physical growth among children resulting in retarded cognitive development abilities and overall reduced growth potential.

Strong winds

Overall, the findings show that 75.8% (N=91) of the respondents pointed to strong wind as the main determinant that increases children's vulnerability. Moreover, across-tabulation (at a 95% level of significance) was performed to examine the association between the strong wind and children's vulnerability to climate change, using chi-square tests whereby the results reveal that there is a significant relationship between strong wind and children's vulnerability to climate change impact, as indicated by ($\chi2$ (1, N=91) = 4.956[a], p=0.026). In this context, a p-value of .026 indicates that strong wind increases children's vulnerability to climate change. The study reveals that children are at risk due to wind, which can damage infrastructure, cause injuries, and disrupt education. Displacement from families also exposes children to inadequate shelter and limited healthcare access, making them more vulnerable to exploitation. Strong winds also compromise their health and welfare.

Insecurity in livelihoods

The study found that 75.8% of children in the Longido District are vulnerable to environmental damage, which affects their livelihoods and families' means of living. That leads to reduced incomes for parents and guardians, limiting their ability to provide basic needs like food, clothes, and medication. Lack of money also causes children to drop out of school, leading to food insecurity and malnutrition. Low-income children also have limited access to medical services, making them more susceptible to diseases worsened by malnutrition and unsanitary conditions. The study's results align with Mushore et al. (2021) findings that climate change negatively impacts livelihoods. Zacarias (2019) emphasizes the importance of financial and social capital in community vulnerability. Brown et al. (2020) argue that economic hardship affects children's mental health, hindering learning and growth. The availability and utilization of financial resources influence livelihood resilience.

Extreme high temperature

The results obtained in this study indicate that 74.7% (N=91) pointed to temperature fluctuation as the ecological factor that increases the vulnerability of children. On the other hand, the chi-square test was conducted to examine the relationship between shortage and the vulnerability of children to climate change. The results indicate a statistically significant association between the variable at ($\chi2$ (1, N=91) = 4.352[a], p=0.037). The study rejects the null hypothesis and concludes a significant relationship between variables. The FGDs reveal that the Longido District experienced high night temperatures from September to November, increasing children's vulnerability to dehydration, heat-related illnesses, and asthma. The inhalation of hot air and increased dust storms exacerbate asthmatic conditions, while food insecurity due to crop failures

and livestock losses heightens malnutrition risks for children. The field data indicate that 1983, 1987, 1994, 2005, 2009, 2011/2012, 2017, and 2019 (see Figure 5) are the years in which temperature was very high in the district, increasing children's vulnerability.

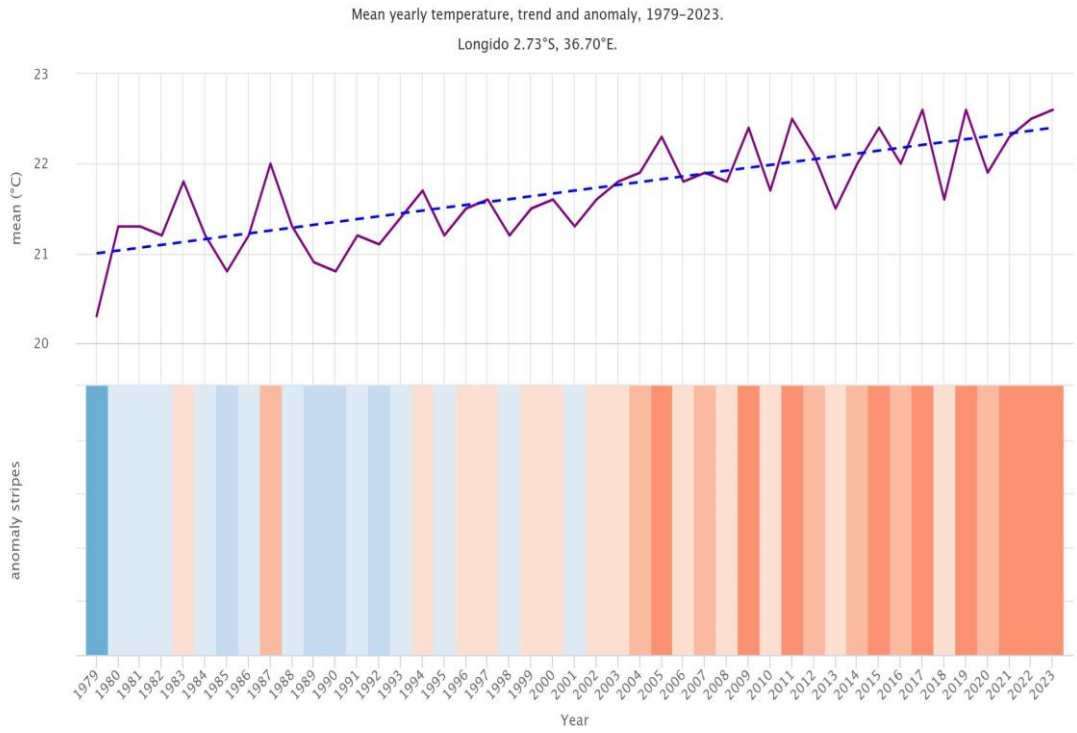

Figure 5.
Temperature variability in the study area
Source: Meteoblue (2023)

Drought

Based on results obtained from the field survey, 79.5% of the respondents thought that drought increases the vulnerability of children to the impacts of climate change. A chi-square association test was conducted to find the connection between drought and increased vulnerability among children. Of the two, the variables: ($\chi 2$ (1, N = 91) = 3.975[a], p = 0.046) are statistically significant. The study found that drought exposes children to food insecurity, malnutrition, waterborne diseases, limited access to clean water, health risks, and economic strain, potentially leading to child labor or early marriages.

The study noted that drought is an ecological phenomenon caused by prolonged water scarcity caused by unusual precipitation decline and temperature variations in the district (see Figure 6). It also causes the death of livestock, which is the basic means of livelihood among the pastoralists; hence, live children are devastated. The study noted that 1982, 1983, 1991, 1993/2097, 2003, 2005, 2007, 2010, 2012, 2014/2015, 2017, and 2019 were the past years of drought in Longido District. It is, therefore, very necessary to understand how the temperature and precipitation vary with time in a given area to help monitor drought, resource management, and adaptation strategies.

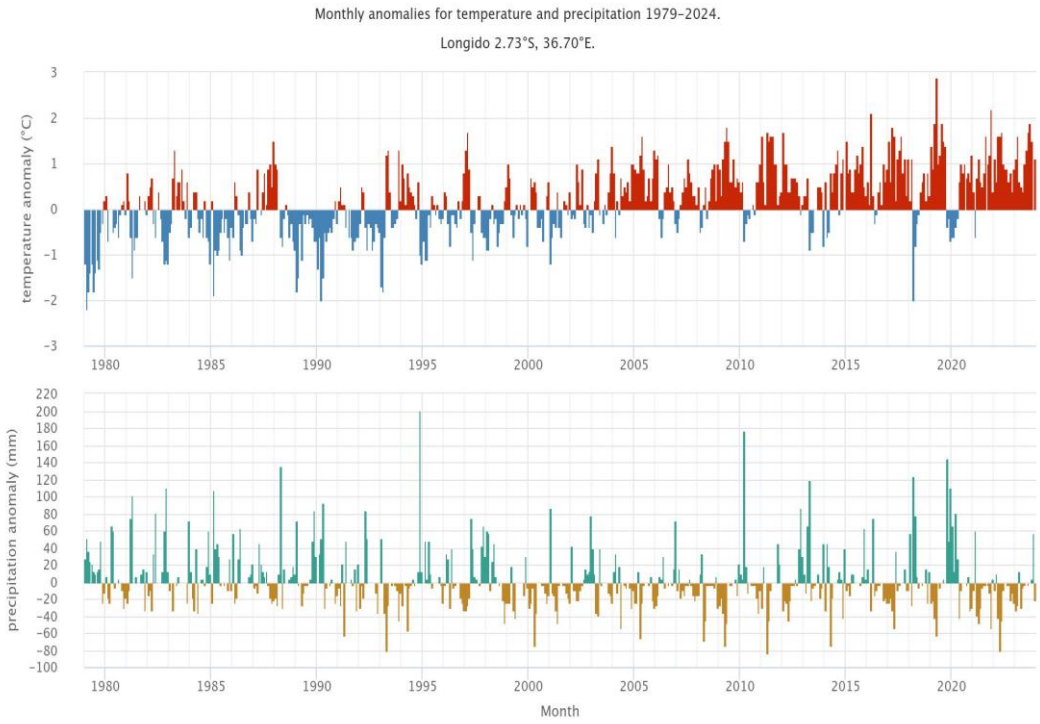

Figure 6.
Fluctuation in temperature trends and rainfall causing drought in Longido District
Source: Meteoblue (2023)

Perceived socio-ecological determinants by FGDs

The FGDs in the study area identified the top five determinants that have been highly increasing children's susceptibility and vulnerability in the district, such as drought, floods, diseases, and temperature variability (see Table 4), and these FGDs went ahead and suggested strategies towards minimizing the children's vulnerabilities.

Table 4.
The socio-ecological determinants as perceived by FGDs

Socio-ecological determinant	Years of event	The impact of each determinant on children's vulnerability	Strategies to reduce children's vulnerability	Authors whose finding concurs
Drought	1982, 1983, 1991, 1993, 2097, 2003, 2005, 2007, 2010, 2012, 2014, 2015, 2017 & 2019	Droughts contribute to waterborne diseases, food shortages, malnutrition, and lack of healthcare access affecting children more due to their undeveloped immune systems	Implementation of emergency food aid programs, water scarcity solutions (dams & water reservoirs), and comprehensive support systems for education, health, and social protection will prevent famines and ensure children's well-being.	Brown et al. (2020) Lwasa (2018)
Floods	1979, 1982, 1985, 1988, 1989, 1997, 2002, 2006, 2013, 2016, 2018 & 2021.	Floods cause displacement of children, disrupt education, expose them to unsafe conditions, increase waterborne diseases, and impede access to basic	Early warning systems, evacuation plans, safe shelters, emergency supplies, child protection mechanisms, water and sanitation infrastructure, hygiene practices, clean	Hassan, Singh, and Sekar (2018) Tanny, Rahman, and Ali

Socio-ecological determinant	Years of event	The impact of each determinant on children's vulnerability	Strategies to reduce children's vulnerability	Authors whose finding concurs
		services, thereby enhancing their vulnerability.	water sources, and basin drainage are essential measures to reduce flood risks for children and their families.	(2017)
Diseases and pests	1982, 1983, 1991, 1993, 2097, 2003, 2005, 2007, 2010, 2012, 2014, 2015, 2017, 2018 2019 & 2021	Anthrax outbreak, Rift-valley caused death of livestock hence decline of income Spread diseases like waterborne infections, vector-borne, respiratory, and malnutrition-related. waterborne diseases such as cholera, dysentery, typhoid fever made children vulnerability	To reduce children's disease vulnerability, prioritize clean water, sanitation, hygiene, vaccination, timely health services, nutrition, and health education. These strategies help prevent waterborne diseases, protect against preventable diseases, and promote early detection and treatment.	Algur, Patel, and Chauhan (2021) Kahinda, Taigbenu, and Boroto (2010) Hassan et al. (2018)
Temperature variability	1982, 1983, 1991, 1993, 2097, 2003, 2005, 2007, 2010, 2012, 2014, 2015, 2017 & 2019	Temperature variability increases children's vulnerability to heat-related illnesses, dehydration, and heatstroke. It disrupts agricultural production, leading to food insecurity and malnutrition.	To reduce vulnerability to temperature variability, infrastructural and building design advocacy, climate-resilient building materials, efficient cooling and heating systems, preparedness, urban greening, and reducing social inequalities are essential.	Algur et al. (2021) Brown et al. (2020) Tanny et al. (2017)
Loss of Livelihoods	All year 1982 to present 2023	The livelihood loss has exposed children to malnutrition, health issues, and limited education, necessitating urgent attention to address underlying factors and implement social protection mechanisms.	Implementing strategies like social services, social protection, and community initiatives, adoption of resistant crops to climate, livelihood diversification and improve their well-being, and promote sustainable agriculture.	Mary and Majule (2009) Olmstead (2014) Osbahr, Twyman, Adger, and Thomas (2008)
Poverty	All year 1982 to present 2023	The situation of poverty brings considerable hardships to people including their health, livelihoods, and the biosphere.	Stakeholders and Governments should invest in social security, improve education, and empower families through training and income-generating activities. Strengthening child protection systems is crucial for societal respect and preventing abuse and neglect.	Driscoll and Evans (2005)

Source: Field data (2023)

Strategies to reduce vulnerability of children to the impact of climate change in semi-arid rangelands in Longido District, Tanzania

The findings indicate that children in the semi-arid rangelands are extremely vulnerable to the effects of climate change. This vulnerability is determined by a set of ecological and socio-economic factors, which interact to amplify negatively the impacts of climate change on children's livelihoods. The development of specific, focused strategies is important to protect the children of this district from high climatic risks and to increase their resilience. This section presents a set of strategies that could reduce and help decrease children's susceptibility to the effect of climate change in the semi-arid rangelands of Longido District. The strategies and interventions presented are based on the findings of this study, insights, and recommendations from various research conducted by various scholars such as (Briske et al., 2015; Coracero, 2021; Debesai, 2020; Dumenu & Tiamgne, 2020; Mesfin, Simane, Belay, Recha, & Schmiedel, 2020; Rana, 2020; Stanberry et al., 2018; Talukder et al., 2021; Zacarias, 2019).

Establishment of a local water management system

The study suggests that implementing a local water management system in semi-arid range lands can reduce children's vulnerability to water scarcity. That involves increasing clean water availability, ensuring consistent and renewable supply, and minimizing health hazards associated with water shortages. The Maasai community traditionally encloses water sources (*engaroni* in the Maasai language), prohibiting use until permission is granted. Implementing rainwater collection systems, borehole drilling, and promoting water-saving practices can help reduce drought severity and improve child growth and well-being. This strategy helps develop children's resilience and minimizes vulnerability to water scarcity, aligning with previous research. The results align with Coracero (2021), Antronico, Carone, and Coscarelli (2023), Misra (2014), and Olmstead (2014) findings, which found that this strategy helps to develop the resilience of children by securing an essential resource that sustains their lives during the climate change.

Climate-smart agriculture promotion

The research suggests Introducing Climate-Smart Agriculture (CSA) in the semi-arid Longido District is suggested as a way to reduce children's vulnerability to climate change. CSA involves cultivating drought-resistant crops such as sorghum, millet, cowpea, and pearl millet and implementing conservation agriculture and agroforestry practices. The adoption of CSA promotes sustainable food availability and long-term farm productivity, which helps to reduce vulnerability to soil erosion and land degradation. CSA also enhances children's resilience and reduces their vulnerability to climate change by equipping them with the necessary skills and knowledge to cope with climate change-related challenges. The research findings align with Rana's (2020) study on climate-smart agriculture, which supports the effectiveness of this approach. Additionally, Dumenu & Tiamgne (2020) found that CSA is vital in increasing food availability in the face of climate change.

Enhancing health and sanitation services

The study findings suggest that enhancing health and sanitation services will protect children and minimize susceptibility to menaced climate change impacts. Access to clean water, sanitation facilities, and health infrastructure empowers local communities to mitigate health risks that come with climate change. That is supported by a cascade of findings from research works by Lugten and Hariharan (2022) and Anwar et al. (2020), who reveal that the health programs and sanitation services within communities can make them cope better with the challenges imposed by climate change. The study discovered that local communities can protect children from climate change by improving healthcare services, including vaccination, regular checkups, and medication for climate-sensitive diseases. That enhances children's resilience and well-being, reducing their vulnerability to climate change's negative impacts. The study noted that currently, in Longido District, there are over ten health centers, including Engarenaibor, Sinya, Lerangwa, and Tingatinga, and a district hospital at Endonyoemail. Malaria programs have been implemented within the region to help reduce vulnerability to the disease.

Enhancing education and awareness

The study finds that of the various ways, improvement of education and awareness takes the bar in becoming one of the most potential strategies to reduce vulnerability to climate change in the Longido District rangelands. In this light, it is the findings of research that teaching campaigns on climate change are beginning to let communities and children understand the depth of climate-related risks and adaptive strategies. This study's finding suggests that change adaptation educational programs should be designed to increase resilience in children and communities with the required knowledge and skills for coping with changed weather patterns, water scarcity, and other challenges related to climate change. The finding is in line with that of Dumenu and Tiamgne (2020), as well as UNESCO (2020), who further asserts that through education and awareness of climate change, vulnerability is reduced, and resilience is increased among children and communities.

Building climate-resilient infrastructure

The research findings suggest that building climate-resilient infrastructure is also a significant intervention in reducing children`s vulnerability to climate change effects in Longido District rangelands. That involves constructing stronger structures, making them resistant to floods, and establishing good drainage systems for mitigation against flood risks and other related hazards due to climate change. Similarly, in their research findings, UNICEF (2023) found that investing in resilient infrastructure, including better housing, schools, and health facilities, ensures the safety and well-being of children during extreme weather events. Further, research findings from Anwar et al. (2020) found that building climate-resilient infrastructure reduces the vulnerability of a community. In this perspective, the study revealed that mainstreaming tools for adaptation and resilient infrastructure investment that can be used include: i) Improving spatial planning frameworks, e.g., vulnerability maps, to manage climate risks better, minimize vulnerability, and avoid the construction of new infrastructure in exposed areas; ii) Infrastructure projects and policy appraisals include Strategic Environmental Assessment and Environmental Impact Assessment; and iii) Establish regulatory standards and economic criteria, such as building codes.

The implementation of early warning systems

The research findings suggest that the use and implementation of Early Warning Systems (EWS) play a crucial role in reducing children's vulnerability to climate change impacts in Longido range lands. EWS is cost-effective in disaster risk reduction and climate change adaptation, reducing people's vulnerability. The study area has two types of EWS: local and traditional, using birds, frogs, and locusts to display signs related to weather, scavenger emergence, and seasonal calendars; and scientific EW systems (see Figure 7), using modern tools to predict weather patterns and government announcements to locals. Similarly, Kelman (2015) found that EW systems are useful for realizing pre-disaster preparedness plans, such as ensuring the availability of essential supplies, emergency shelters, and medical services designed specifically to serve the needs of children during climatic emergencies. Furthermore, Kelman (2015) and Šakić Trogrlić et al. (2022) in their studies found that EWS played a role in risk reduction to the local communities.

Education plays an important role in helping kids from semi-arid regions cope with impacts linked with the global warming phenomenon by educating them about their natural surroundings and means of adapting to changes, making them more resilient, and finding solutions. It also prepares older children to be economically independent through vocational training. These may include interventions such as reforestation and agroforestry that align with United Nations recommendations on climate change education and involve partners from government agencies, NGOs, and the private sector.

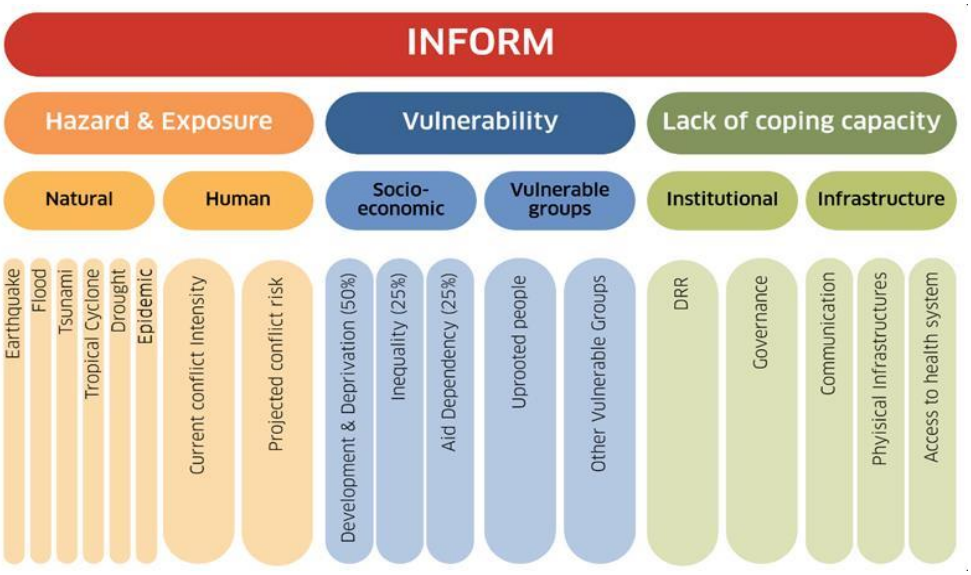

Figure 7.
Scientific EWS and their role in disaster risk reduction
Source: Marin-Ferrer, Poljansek, and Vernaccini (2017)

It is, therefore, evident that a comprehensive approach that brings in several strategies is important in reducing child vulnerability to climate change impacts in the Longido District rangelands. Climate-smart agriculture promotion should increase agricultural productivity, whereas children's general health can be improved through better health and sanitation facilities. Education and awareness raising should be prioritized among children to gain the knowledge necessary for making informed choices and adopting sustainable practices. That implies that resilient infrastructure to climate change must be constructed to protect them from these risks and threats to their well-being and safety; warning systems are created to issue alerts on impending dangers, necessitating timely action. In this regard, Longido District can strengthen its resilience, ensure children's welfare, and mitigate climate change consequences by combining these measures, encouraging future sustainability and security of all inhabitants.

The link between children's vulnerability to climate change and the theories underling the study

The study showed that being vulnerable to climate change disasters is complex and needs a framework that combines Social Vulnerability Theory (SVT), Resilience Theory (RT), and Intersectionality Theory (IT). SVT helps understand how social factors affect people's risk from natural disasters and other dangers. Likewise, the study points out important socioeconomic and demographic groups vital for dealing with climate effects, especially low-income families and vulnerable children who lack basic needs like food, healthcare, and education, making them more at-risk during climate-related disasters. Weak social support systems make vulnerability worse and reduce access to community help. RT looks at how children and their communities handle disturbances and adapt, eventually recovering from environmental shocks. The study noted that resilience grows through community-centered adaptation strategies, with local involvement vital for planning and finding solutions. The study pointed out that it is essential to build psychosocial resilience, as strong support networks and mental health programs can help children deal with the stress of climate disasters. Also, the theory of intersectionality helped show how children with different identities like age, gender, and ethnicity deal with extra problems. Likewise, this study found that girls in Longido face many issues because of set gender roles, which result in fewer chances for education and more exposure to various risks from the environment and climate.

Conclusion

This research on socio-ecological drivers of children's high sensitivity and vulnerability to climate change impacts in Longido District, Tanzania, has illuminated this problem's complexity. The findings underscore the link between social and ecological factors that make children more vulnerable to the effects of climate change, such as shortage of water and water shortages, floods, the eruption of diseases and pests, food scarcity (shortage), strong wind, insecurity in livelihoods, and extremely high temperature. Further, the research highlights, among other things, the importance of clean water supply infrastructure accessibility, sanitation facilities availability, healthcare services provision, education institutions presence, climate-resilient farming systems, and alertness promotion as strategies to reduce and minimize the vulnerability of children to impacts of climate change in areas with similar characteristics as Longido District rangelands. The research suggests that policymakers, local authorities, and stakeholders should collaborate to develop strategies for children's health, including clean water, sanitation, and healthcare infrastructure. Climate change adaptation training, advocacy campaigns, and early warning mechanisms can reduce vulnerability and create a safer environment for future generations.

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References

Abendaño, M. A. C., Recente, J. M., & Barroso, J. P. (2021). Hydrologic Model for Flooding in Manupali Watershed and Its Implications to Land-Use Policies. *Asia Pacific Journal of Social and Behavioral Sciences*, *18*, 121–135. https://doi.org/10.57200/apjsbs.v18i0.236

Algur, K. D., Patel, S. K., & Chauhan, S. (2021). The impact of drought on the health and livelihoods of women and children in India: A systematic review. *Children and Youth Services Review*, *122*, 105909. https://doi.org/10.1016/j.childyouth.2020.105909

Antronico, L., Carone, M. T., & Coscarelli, R. (2023). An approach to measure resilience of communities to climate change: a case study in Calabria (Southern Italy). *Mitigation and Adaptation Strategies for Global Change*, *28*(4), 20. https://doi.org/10.1007/s11027-023-10056-7

Anwar, A., Anwar, S., Ayub, M., Nawaz, F., Hyder, S., Khan, N., & Malik, I. (2020). Climate Change and Infectious Diseases; Evidence from Highly Vulnerable Countries. *Iranian Journal of Public Health*. https://doi.org/10.18502/ijph.v48i12.3549

Barbour, R. (2010). Focus groups. In I. Bourgeault, R. de Vries, & R. Dingwall (Eds.), *Qualitative methods in health research* (pp. 327–352). Sage Publications.

Beatty, P. C., & Willis, G. B. (2007). Research Synthesis: The Practice of Cognitive Interviewing. *Public Opinion Quarterly*, *71*(2), 287–311. https://doi.org/10.1093/poq/nfm006

Bennett, C., & Friel, S. (2014). Impacts of Climate Change on Inequities in Child Health. *Children*, *1*(3), 461–473. https://doi.org/10.3390/children1030461

Briske, D. D., Joyce, L. A., Polley, H. W., Brown, J. R., Wolter, K., Morgan, J. A., … Bailey, D. W. (2015). Climate-change adaptation on rangelands: linking regional exposure with diverse adaptive capacity. *Frontiers in Ecology and the Environment*, *13*(5), 249–256. https://doi.org/10.1890/140266

Brown, M. E., Backer, D., Billing, T., White, P., Grace, K., Doocy, S., & Huth, P. (2020). Empirical studies of factors associated with child malnutrition: highlighting the evidence about climate and conflict shocks. *Food Security*, *12*(6), 1241–1252. https://doi.org/10.1007/s12571-020-01041-y

Coracero, E. E. (2021). Potential Climate Change Adaptation Strategies Suitable in the Philippine

Setting. *Indonesian Journal of Social and Environmental Issues (IJSEI)*, *2*(1), 1–6. https://doi.org/10.47540/ijsei.v2i1.119

Cordero, E. C., Centeno, D., & Todd, A. M. (2020). The role of climate change education on individual lifetime carbon emissions. *PLOS ONE*, *15*(2), e0206266. https://doi.org/10.1371/journal.pone.0206266

Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum*, *1989*(1), 139–167.

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social Vulnerability to Environmental Hazards*. *Social Science Quarterly*, *84*(2), 242–261. https://doi.org/10.1111/1540-6237.8402002

Debesai, M. G. (2020). Factors affecting vulnerability level of farming households to climate change in developing countries: evidence from Eritrea. *IOP Conference Series: Materials Science and Engineering*, *1001*(1), 012093. https://doi.org/10.1088/1757-899X/1001/1/012093

Driscoll, R., & Evans, A. (2005). Second-Generation Poverty Reduction Strategies: New Opportunities and Emerging Issues. *Development Policy Review*, *23*(1), 5–25. https://doi.org/10.1111/j.1467-7679.2005.00274.x

Dumenu, W. K., & Tiamgne, X. T. (2020). Social vulnerability of smallholder farmers to climate change in Zambia: the applicability of social vulnerability index. *SN Applied Sciences*, *2*(3), 436. https://doi.org/10.1007/s42452-020-2227-0

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Hassan, F. U., Singh, G., & Sekar, K. (2018). Children's Reactions to Flood Disaster in Kashmir. *Indian Journal of Psychological Medicine*, *40*(5), 414–419. https://doi.org/10.4103/IJPSYM.IJPSYM_571_17

Jackson, S., Claude, G. M., & Godfrey, F. K. (2018). The impacts of climate change and variability on crop farming systems in Semi-Arid Central Tanzania: The case of Manyoni District in Singida Region. *African Journal of Environmental Science and Technology*, *12*(9), 323–334. https://doi.org/10.5897/AJEST2018.2481

Joseph, L. (2022a). Sustainable Integrative Framework for Biodiversity Conservation and Pastoralists' Resilience to Impact of Climate Change in Northern Tanzania Rangelands. *East African Journal of Interdisciplinary Studies*, *5*(1), 50–71. https://doi.org/10.37284/eajis.5.1.597

Joseph, L. (2022b). The Most Vulnerable and High-Risk Groups Sensitive to Impacts of Climate Change in Arusha Region, Tanzania. *East African Journal of Arts and Social Sciences*, *5*(1), 88–102. https://doi.org/10.37284/eajass.5.1.606

Kahinda, J. M., Taigbenu, A. E., & Boroto, R. J. (2010). Domestic rainwater harvesting as an adaptation measure to climate change in South Africa. *Physics and Chemistry of the Earth, Parts A/B/C*, *35*(13–14), 742–751. https://doi.org/10.1016/j.pce.2010.07.004

Kelman, I. (2015). Climate Change and the Sendai Framework for Disaster Risk Reduction. *International Journal of Disaster Risk Science*, *6*(2), 117–127. https://doi.org/10.1007/s13753-015-0046-5

Lenzner, T., Neuert, C., & Otto, W. (2016). *Cognitive Pretesting*. Mannheim: GESIS-Leibnitz Institute for the Social Sciences.

Lugendo, P., Tsegaye, T., Wortman, C. J., & Neale, C. M. U. (2017). Climate Variability Implications for Maize Yield Food Security and Rural Poverty in Tanzania. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3233487

Lugten, E., & Hariharan, N. (2022). Strengthening Health Systems for Climate Adaptation and Health Security: Key Considerations for Policy and Programming. *Health Security*, *20*(5), 435–439. https://doi.org/10.1089/hs.2022.0050

Luhunga, P., Chang'a, L., & Djolov, G. (2017). Assessment of the impacts of climate change on maize production in the Wami Ruvu basin of Tanzania. *Journal of Water and Climate Change*, *8*(1), 142–164. https://doi.org/10.2166/wcc.2016.055

Lwasa, S. (2018). Drought and Flood Risk, Impacts and Adaptation Options for Resilience in Rural Communities of Uganda. *International Journal of Applied Geospatial Research*, *9*(1), 36–50. https://doi.org/10.4018/IJAGR.2018010103

Marin-Ferrer, M., Poljansek, K., & Vernaccini, L. (2017). *Index for Risk Management - INFORM: Concept and methodology, version 2017*. Luxembourg: European Union. Retrieved from European Union website: https://op.europa.eu/en/publication-detail/-/publication/b1ef756c-5fbc-11e7-954d-01aa75ed71a1/language-en

Martin, C. (2017). Impact of climate variability on livelihoods of pastoral communities in Longido District-Tanzania. *General Education Journal*, *7*(1), 34–47.

Mary, A. L., & Majule, A. (2009). Impacts of climate change, variability and adaptation strategies on agriculture in semi arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology*, *3*(8), 206–218. https://doi.org/10.5897/AJEST09.099

Mesfin, D., Simane, B., Belay, A., Recha, J. W., & Schmiedel, U. (2020). Assessing the Adaptive Capacity of Households to Climate Change in the Central Rift Valley of Ethiopia. *Climate*, *8*(10), 106. https://doi.org/10.3390/cli8100106

Metoblue. (2023). Stimulated historical climate and Weather data for Longido. Retrieved January 5, 2024, from Metoblue website: https://www.meteoblue.com/en/climate-change/longido_tanzania_155848

Misra, A. K. (2014). Climate change and challenges of water and food security. *International Journal of Sustainable Built Environment*, *3*(1), 153–165. https://doi.org/10.1016/j.ijsbe.2014.04.006

Morgan, D. L. (2018). *Focus groups as qualitative research*. Sage Publications.

Mugabe, P. A. (2016). *Climate Variability and Food Security in Tanzania: Evidence from Western Bagamoyos*. https://doi.org/10.1007/978-3-319-28591-7_6

Muijeen, K., Kongvattananon, P., & Somprasert, C. (2020). The key success factors in focus group discussions with the elderly for novice researchers: a review. *Journal of Health Research*, *34*(4), 359–371. https://doi.org/10.1108/JHR-05-2019-0114

Mushore, T. D., Mhizha, T., Manjowe, M., Mashawi, L., Matandirotya, E., Mashonjowa, E., … Mushambi, G. T. (2021). Climate Change Adaptation and Mitigation Strategies for Small Holder Farmers: A Case of Nyanga District in Zimbabwe. *Frontiers in Climate*, *3*. https://doi.org/10.3389/fclim.2021.676495

Olmstead, S. M. (2014). Climate change adaptation and water resource management: A review of the literature. *Energy Economics*, *46*, 500–509. https://doi.org/10.1016/j.eneco.2013.09.005

Osbahr, H., Twyman, C., Adger, W. N., & Thomas, D. S. G. (2008). Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique. *Geoforum*, *39*(6), 1951–1964. https://doi.org/10.1016/j.geoforum.2008.07.010

Rahman, G., Atta-ur-Rahman, Samiullah, & Dawood, M. (2018). Spatial and temporal variation of rainfall and drought in Khyber Pakhtunkhwa Province of Pakistan during 1971–2015. *Arabian Journal of Geosciences*, *11*(3), 46. https://doi.org/10.1007/s12517-018-3396-7

Rana, I. A. (2020). Disaster and climate change resilience: A bibliometric analysis. *International Journal of Disaster Risk Reduction*, *50*, 101839. https://doi.org/10.1016/j.ijdrr.2020.101839

Randell, H., & Gray, C. (2019). Climate change and educational attainment in the global tropics. *Proceedings of the National Academy of Sciences*, *116*(18), 8840–8845. https://doi.org/10.1073/pnas.1817480116

Reichstadt, J., Depp, C. A., Palinkas, L. A., & Jeste, D. V. (2007). Building Blocks of Successful Aging: A Focus Group Study of Older Adults' Perceived Contributors to Successful Aging. *The American Journal of Geriatric Psychiatry*, *15*(3), 194–201. https://doi.org/10.1097/JGP.0b013e318030255f

Ridolfo, H., & Schoua-Glusberg, A. (2011). Analyzing Cognitive Interview Data Using the Constant Comparative Method of Analysis to Understand Cross-Cultural Patterns in Survey Data. *Field Methods*, *23*(4), 420–438. https://doi.org/10.1177/1525822X11414835

Rother, H.-A., Etzel, R. A., Shelton, M., Paulson, J. A., Hayward, R. A., & Theron, L. C. (2020). Impact of Extreme Weather Events on Sub-Saharan African Child and Adolescent Mental Health: A Protocol for a Systematic Review. *Atmosphere*, *11*(5), 493. https://doi.org/10.

3390/atmos11050493

Šakić Trogrlić, R., van den Homberg, M., Budimir, M., McQuistan, C., Sneddon, A., & Golding, B. (2022). Early Warning Systems and Their Role in Disaster Risk Reduction. In *Towards the "Perfect" Weather Warning* (pp. 11–46). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-98989-7_2

Salanga, R. J., & Muhanga, M. I. (2023). Perceptions of Tanzanian livestock dependent communities on climate related changes: A case of the Maasai pastoralists in Longido District, northern Tanzania. *Tanzania Journal of Agricultural Sciences*, *22*(2), 306–321.

Sheffield, P. E., & Landrigan, P. J. (2011). Global Climate Change and Children's Health: Threats and Strategies for Prevention. *Environmental Health Perspectives*, *119*(3), 291–298. https://doi.org/10.1289/ehp.1002233

Smith, M. L., Glass, G. V., & Miller, T. I. (2020). *The benefits of pretesting questionnaires*. Sage Publications.

Stalmeijer, R. E., McNaughton, N., & Van Mook, W. N. K. A. (2014). Using focus groups in medical education research: AMEE Guide No. 91. *Medical Teacher*, *36*(11), 923–939. https://doi.org/10.3109/0142159X.2014.917165

Stanberry, L. R., Thomson, M. C., & James, W. (2018). Prioritizing the needs of children in a changing climate. *PLOS Medicine*, *15*(7), e1002627. https://doi.org/10.1371/journal.pmed.1002627

Talukder, B., van Loon, G. W., Hipel, K. W., Chiotha, S., & Orbinski, J. (2021). Health impacts of climate change on smallholder farmers. *One Health*, *13*, 100258. https://doi.org/10.1016/j.onehlt.2021.100258

Tanny, N. Z., Rahman, M. W., & Ali, R. N. (2017). Climate-induced Gender Vulnerabilities in Northwestern Bangladesh. *Indian Journal of Gender Studies*, *24*(3), 360–372. https://doi.org/10.1177/0971521517716808

The United Republic of Tanzania, Ministry of Finance and Planning, Tanzania National Bureau of Statistics, President's Office - Finance and Planning, & Office of the Chief Government Statistician Zanzibar. (2022). *The 2022 Population and Housing Census: Administrative Units Population Distribution Report*. Tanzania Zanzibar: The United Republic of Tanzania.

UNESCO. (2020). Education for Sustainable Development Goals: Learning Objectives. Retrieved April 20, 2025, from UNESCO website: https://unesdoc.unesco.org/ark:/48223/pf0000374809

UNICEF. (2023). *The climate-changed child: A children's climate risk index supplement*. New York: UNICEF. Retrieved from https://www.unicef.org/media/147931/file/The%20climage-changed%20child%20-%20Report%20in%20English.pdf

Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., … Costello, A. (2015). Health and climate change: policy responses to protect public health. *The Lancet*, *386*(10006), 1861–1914. https://doi.org/10.1016/S0140-6736(15)60854-6

WHO. (2018). Health and Climate Change: Key Issues. Retrieved April 20, 2025, from WHO website: https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

Willis, G. B. (2005). *Cognitive interviewing: A tool for improving questionnaire design*. Sage Publications. https://doi.org/10.4135/9781412983655

Yu, W., Mengersen, K., Dale, P., Ye, X., Guo, Y., Turner, L., … Mackenzie, J. S. (2015). Projecting future transmission of malaria under climate change scenarios: challenges and research needs. *Critical Reviews in Environmental Science and Technology*, *45*(7), 777–811.

Zacarias, D. A. (2019). Understanding community vulnerability to climate change and variability at a coastal municipality in southern Mozambique. *International Journal of Climate Change Strategies and Management*, *11*(1), 154–176. https://doi.org/10.1108/IJCCSM-07-2017-0145