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Original Article

## The Most Vulnerable and High-Risk Groups Sensitive to Impacts of Climate Change in Arusha Region, Tanzania

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The study investigated the groups that are more vulnerable and at high risk of climate change impact among the population of the Arusha Region, where four districts out of these seven districts were purposively picked, namely Longido, Arumeru, Arusha Urban, and Karatu districts. A cross-sectional research design was adopted in this study. The systematic random sampling method was used to obtain a sample size. The sample size was 300 respondents. To explore the most vulnerable and high risked groups to impacts of climate change among the population in Arusha region, eight socioeconomic variables such as age, sex, physical ability, topographical location, house status, degree of urbanization, income status, and occupational status were investigated. The findings indicate that children and older adults aged 65> years and above, women, disabled, people in lowlands, rural dwellers, crop cultivator, temporary houses, and lower-income earners are the most vulnerable and high risked groups to impacts of climate change. The chi-square test result of association indicates that there is a statistically significant relationship between (gender, age, physical ability of the population, topographical location, occupational type of the population, degree of urbanization, and type of residential houses of the population) and climate change impacts. However, the chi-square test result of association indicates no statistically significant relationship between the level of income and the effects of climate change. The study concludes that some groups in the population are more vulnerable and high risk to climate change than others because of their location, age, health, income, occupation, and how they go about their day-to-day lives. The study recommends that the government organs critically offer assistance to the mentioned groups by formulating a friendly framework for adaptability and mitigation of climate change impacts.

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## INTRODUCTION

Climate change alters statistical and climatic properties such as precipitation, temperature, wind patterns, and humidity over a long period, arising from natural events and anthropogenic activities (Patil & Lamnganbi, 2018; Joseph, 2022). Mont et al. (2018) asserts that effects of climate change such as global warming contributed to depletion of the ozone layer, destruction of atmospheric genetic diversity, and consequent increase in warming and loss of atmospheric productivity. Climate change has many potential social, economic, and environmental impacts (Azarkhish et al., 2021). It is a serious threat to the ecosystem, biodiversity, and health. It is associated with alterations in the physical environment of the planet Earth and affects life around the globe (Patil & Lamnganbi, 2018). In this context, climate change as a global environmental challenge has caused impacts on natural and human systems across the world (McMichael & Lindgren; 2011; Joseph & Kaswamila, 2017; Sintayehu, 2018).

Climate change impacts the well-being of the indigenous population in many ways. Climate change makes it harder for the population to access safe and nutritious food, including traditional foods important to many tribes' cultural practices (Graciela et al. 2014). Many populations already lack access to safe drinking water and wastewater treatment in their communities. Climate change is expected to increase health risks associated with water quality problems like contamination and may

reduce water availability, particularly during droughts (Lepetz et al., 2009). By affecting the environment and natural resources of various communities, climate change also threatens the cultural identities of individual indigenous people. Plants and animals used in traditional practices or sacred ceremonies become less available, tribal culture and ways of life are greatly affected (IPCC 2014). Climate change could affect our society on several different social, cultural, and natural resources. For example, climate change could affect human health, infrastructure, transportation systems, energy, food, and water supplies (Graciela et al. 2014).

The African Region is known as one of the major areas of the world that are largely susceptible to climate change (IPCC, 2014; Graciela et al. 2014). Changes in climatic variables have been reported as a major threat to agricultural production and productivity (Deressa et al., 2008). Current and predicted climate change scenarios have identified emissions of greenhouse gases such as CO<sub>2</sub> and CH<sub>4</sub> as a threat to human socioeconomic activities such as agriculture, forestry, livelihoods, biodiversity conservation, and ecosystem functions (Lepetz et al., 2009; Sintayehu, 2018).

The outcome of climate change in Tanzania and its drastic consequence on the production of crops for the entire nation has been shown by studying seasonal rainfall patterns in selected cities across Tanzania (Joseph, 2022). Rainfall and temperature trends are presented to justify the situation, and the

climate change is responsible for the shifting of the seasonal rainfall, making rainfall amount to come at the time not required, or the plants have already damaged. The results showed that temperature trends in selected cities had been dramatically increasing. This is responsible for increased evapotranspiration in the soil, hence making crops fail to reach maturity due to a lack of enough moisture, causing shortage of food. On the other side, it shows that rainfall pattern has been decreasing in selected places in Tanzania, hence making water responsible for farming activities inadequate hence making plants fail to develop.

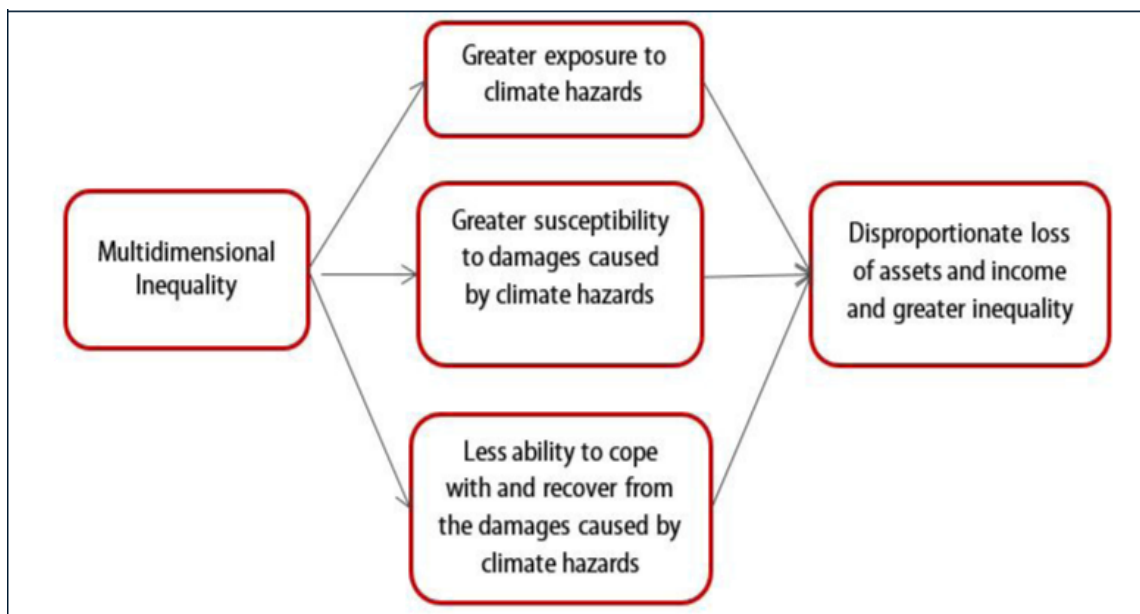
Those most vulnerable to the adverse effects of climate change are people who already face marginalization (Islam & Winkel, 2017). Therefore, the climate change impacts fall more heavily on those in vulnerable situations. Climate change impacts every person's life; however, there is little comprehensive understanding of the direct and indirect effects of climate change on the groups of people within the population. Because our food, feed, fibre, and fruit are derived from agricultural systems, understanding the effects of changing temperature, precipitation, and carbon dioxide on plant growth and development is critical (USGCRP, 2014).

Climate change has the greatest impact when they affect vulnerable populations, which are highly susceptible to adverse impacts and are without strong coping and adaptive capacities (USGCRP, 2016). This triggered the researcher to investigate the more vulnerable and higher risked group to impact of climate change in the population of Arusha regions population in Tanzania, as no study has been conducted to explore the more vulnerable group. In this context, the study concentrated on socioeconomic factors such as age, sex, physical ability, topographical location, houses status, degree of urbanization, income status, and occupational status.

### Conceptual Framework

This study was guided by the Analytical Framework of social inequality (Fig. 1). This framework is used to improve the understanding of multidimensional inequality of vulnerability within the population, even if they are in the same place (Islam & Winkel, 2017). The framework illustrates three main channels for the emergence of this inequality in the intensity of impactions that aggravate the disadvantaged groups vis-à-vis climate change impact.

**Figure 1: Three channels influence inequality the intensity of impaction**



**Source:** Adopted from Islam & Winkel, 2017

The framework suggests that inequality aggravates the position of the disadvantaged groups in the society vis-à-vis climate change impact in the following three major ways. i) Increase in the exposure to climate hazards (IPCC, 2014; Mutter, 2015); ii) increase in susceptibility to damage caused by climate hazards, and iii) decrease in the ability to cope with and recover from the damage (IPCC, 2014; Islam & Winkel, 2017). The framework enables the climatologists and communities, in general, to understand that vulnerability to climate change is not determined by external climatic conditions alone but rather through the interaction between ecosystems, climate-related hazards, the built environment, governments, communities, individuals, and other social factors.

## METHODOLOGY

### Design and Approach

The study employed the cross-sectional research design in collecting, analysing, and interpreting the data (Zangirolami-Raimundo et al., 2018). This design enabled the researchers to collect data easily on all variables simultaneously (Kothari, 2019). The design also enabled the study of multiple outcomes and exposures related to climate change.

### Study Area

The study was conducted in *the Arusha Region*, one of Tanzania's 31 administrative regions. Its capital and largest city is the city of Arusha (URT, 2012 a). The location of the Region is at the Latitude: -3° 22' 0.01" South, longitude: 36° 40' 59.99" East. The daily average temperature ranges from 21/22 °C (71/72 °F) between January and April to 18/19 °C (64/65 °F) in June and July. During November and March, the temperature gets hot during the day. Nights are cool throughout the year, especially from June to September, when lows can drop to 10 °C (50 °F), while during the day, the temperature fluctuates around 22/23 °C (72/73 °F). On the side, rainfall varies from 70 inches (1,800 mm) annually on Mount Meru to 20 inches (508 mm) on the semiarid plains (URT, 2012a). Terrain ranges from wooded savannas and montane forests to alpine areas. On the side of economic activity, the Arusha region is an important coffee-producing area. Other crops include grain, vegetables, cotton, pyrethrum,

papain, sisal, and sunflower seeds. Magnesite and meerschaum are mined in the Region; salt, mica, saltpetre, and ochre deposits are mined (URT, 2012a).

### Population and Sampling Procedures

The Arusha region has seven administrative districts, with a population number 1, 694,310 (URT, 2012b). Four districts were purposively picked out of these seven districts, namely Longido, Arumeru, Arusha Arban, and Karatu districts. The districts were selected over other districts in the Region due to several reasons. Firstly, it is because of the persistent devastating natural calamities associated with climate change impacts such as floods and droughts (Homewood *et al.*, 2009). Second, it is because of the increase in climatic challenges that diversely affect the livelihoods of communities. The third is due to ecological and geographical issues of some study areas whereby part of Arumeru and Longido are situated at the leeward side of two mountains i.e., Kilimajaro and Meru, so it is almost dry, and for the Arusha Urban districts at the windward side of Mountain Meru.

A cross-section research design was adopted during data collection whereby data were collected once at a single point in time (Creswell, 2012). Systematic random sampling was used to pick 70 respondents per the studied district. The interval for depicting the sample varied as per the total number population in the award. Only people aged 18 years and above were considered in this study as they were able to signify the impact imposed by climate change. The number of 280 respondents who filled the questionnaires was obtained from the four wards: Sombetinni in Arusha Urban district, King'ori in Arumeru district, Karatu in Karatu district, and Longido ward in Longido district. Households were sampled using simple random sampling. Simple random sampling was chosen over other sampling techniques for two main reasons. First, the method ensures the likelihood of any individual element in the population having an equal chance of being selected and representative, minimizing sampling biases (Kothari, 2019). The second was the population's homogeneous nature, i.e., dependency on natural resources for their livelihoods.

Purposive sampling was used to obtain 20 key informants (five (5) from each district. Purposive sampling has opted against other types of sampling because it involves selecting individuals knowledgeable and experienced with a phenomenon of interest (Creswell, 2012). In this context, a sample of 300 respondents was picked for this study.

### Data Collection Methods

Data was gathered through a questionnaire survey, focus group discussion, interview, and field visits. This mixture of data collection was used to assess data from diverse perspectives and to enhance data validity and reliability (Bryman & Cramer, 1999). The questionnaires consisted of both closed and open-ended items. In each Region, 70 households were sampled from the region register using a simple random sampling method. The key informant interview was conducted using interview guides. Purposive sampling was used to obtain five discussants from each ward, making 20 focus group discussants from four wards (Sombetinni, King'ori, Karatu, and Longido wards. Ward leaders, village leaders, and gender aspects were attributes considered. Purposive sampling has opted against other types of sampling because it involves selecting knowledgeable and experienced individuals with a phenomenon of interest (Creswell, 2011; Kothari, 2019). The focus group encourages discussions with other participants. Participants tend to perceive issues differently, even for the same problem (Creswell, 2012). During the discussion, the author mainly facilitated the sessions to allow participants to discuss issues at hand freely and without fear.

Direct field visits and observations were also used in this study. The observation method enabled a researcher to systematically select, watch, listen, read, touch, and record the behavior of biodiversity and agro-pastoralists impacted by climate change. For example, through field study, the author observed how rivers and dams were dry, causing much vulnerability to communities.

### Validity and Reliability

The Validity was achieved through the critical preparation of research data collection methods,

which involved pretested questionnaires before data collection. In addition, a triangulation methodological approach was employed, which ensured the reliability of the findings obtained in this study.

### Statistical Treatment of Data

Data was collected using questionnaires which entailed both qualitative and quantitative data; on the other hand, interviews and focus group discussion methods both had qualitative data. Therefore, the nature of the data necessitated qualitative and quantitative data analysis techniques. In this perspective, both qualitative and quantitative information were analyzed separately to complement and supplement each other. For example, the qualitative data collected from Focused Group Discussions were analyzed based on themes and content which covered objectives. The themes were classified whereby every answer was patterned concerning themes. For Key Informant interviews, data was analyzed through themes and content analyses. Subsequently, quantitative data were collected through questionnaires and were analyzed through a statistical analysis where data were edited, coded, summarized, and analyzed using the Statistical Package for Social Sciences (SPSS) version 21.

### Ethical Considerations

Ethical considerations were observed during data collection in different ways. Before data collection, permission was sought from district and region administrative organs. As for tape recording and taking respondents photographs, this was done after asking consent from the concerned. In addition, all information collected from respondents' subjects was treated as confidential. Cohen *et al.* (2010) argue that adequate explanations of the objectives and purpose of the study should be made clear to the respondents.

## RESULTS AND DISCUSSION

This study sought to determine whether climate impacts and extreme weather events impacted some groups of people within a population more than others. The study's findings indicate that 87.5% (N=280) of the respondents agreed that groups are

more vulnerable and at high risk of the impact of climate change than the other groups in the population. In this context, the analysis of this study based on socioeconomic variables such as gender, age, financial capability, economic activities, geographical location, and physical ability of the individual was investigated.

### The More Vulnerable and high-risk Group in Gender Aspect

Overall, results from four districts indicate that 67.9% (N=280) of the respondents pointed out that women were more intensified to climate change

than males (See Table 1). On the other hand, only 32% (N=280) pointed out that males were highly vulnerable than women. The probable reason for the respondents why women are highly affected is due to the reason that in the African context, women are the domestic caretakers of the family. Women are responsible for fetching water from distant areas primary caregivers and food providers to children at the family level. The findings noted that women depend much on natural resources for survival; hence are highly vulnerable during floods, drought, and other natural disasters as they cannot respond effectively to climate variability.

**Table 1: Impact of climate change on the gender of the population**

Gender	Frequency	Percent	Mean	Std. Deviation	X <sup>2</sup>	df	P-Value
Women	190	67.9	2.2107	1.47448	37.105	2	.001
Male	90	32.1					
Total	280	100.0					

On the other hand, a chi-square test result of association indicates a significant relationship between the two variables,  $\chi^2 (2, N = 280) = 18.381$ ,  $p = .001$ ). The result signifies that women were a more vulnerable and high-risk group than men. The result is in line with WHO (2011), which asserts that women are also more vulnerable because they have less access to education and information that would allow them to manage climate-related risks to agriculture and livestock.

During the focus group discussion in the Longido district, one of the women discussants stood and stated the following:

*Climate change is a tragedy to women in our communities. During and after extreme weather events such as strong wind, drought and floods, women are more vulnerable than men and are at increased risk of violence and exploitation, including physical and sexual trafficking, and abuse. These risks are sensitive when collecting food, water and firewood, or when staying in temporary shelters. Due to disasters, disruption to health services increases unintentional pregnancies and sexual and reproductive health problems” (Anonymously, October 2021).*

Furthermore, Care International (2010) asserts that men may be able to migrate for economic

opportunities. However, women are more likely to remain home to care for children and elderly or sick family members. Climate change has a significant impact on securing household water, food, and fuel activities that usually are the responsibility of women and girls. In drought and erratic rainfall, women and girls must walk farther and spend more time collecting water and fuel (Care International, 2010; WHO, 2011). Changing climates also affect the health of crops and livestock, and women, who are often responsible for producing the food eaten at home, must work harder for less food (WHO, 2011; Neumayer & Plümper, 2007).

### The Most Vulnerable and high-risk groups in Age Aspect

In this study, the variable of age was divided into four groups for risk stratification, which are 0–17 years old children (paediatric group), 18 – 25 of age (youth), 26–65 years old (Elders), 65 > years old, older adults). This age group classification is effective in evaluating climate change risk. In this manner, the results in the overall four districts combined, 58.8 % (N=280) of the respondents perceived children as a highly vulnerable group in the population, followed by the older adults’ group by 41.4% (N=280) (See Table 2). On the other hand, a chi-square test result of association indicates a

statistically significant difference between gender and the impact of climate change,  $\chi^2(4, N = 280) = 25.089, p = .001$ ). This result indicates that children and older adults are more vulnerable and high-risk groups to climate change impacts than youth and elders at a young age. In addition, the study noted that children are potentially much more vulnerable than adults to environmental factors (for example, heat, pollution, or famine) because they are physically weaker and less able to dissipate heat

(Huq et al., 2005). As a result, climate change is likely to increase the incidence of infectious and vector-borne diseases. Because health care, sanitation, and coordinated pest control can greatly reduce human vulnerability to such diseases, they have largely been eradicated in the developed world. But they are still among the primary killers of children in developing countries (Rodó et al., 2002).

**Table 2: Impact of climate change on Age of the population**

Age category	Frequency	Percent	Mean	Std. Deviation	X <sup>2</sup>	df	P-Value
Children	159	56.8	2.2786	1.47412	25.089	4	.001
Youth	00	00%					
Elders	05	1.8					
Older Adults	116	41.4					
Total	280	100.0					

Children and older adults were pointed out as highly vulnerable groups because children are vulnerable to diseases and malnutrition. Approximately every child in the world is uncovered to one environmental disaster and climate variability. The rising temperatures and decreased air quality affect kids by increasing asthma attacks and allergies, worsening pregnancy outcomes, creating food insecurity, increasing mental health problems, developmental delays, and changes in their genetic makeup. On the other hand, older adults are also very sensitive to climate variability as their immunity system is low, and they respond very slowly to changes. The result is in line with that of Schwartz & Morris (1995) asserting, elderly adults have a complex relationship with the environment. They are more sensitive to environmental changes and exposure to toxins, toxic agents, and infectious agents. This greater sensitivity results from a lower physiological reserve capacity, slower metabolism, and a more slowly responding immune system. They also have a higher disease burden (morbidity) than people younger.

**The Most Vulnerable and high-risk group in a type of Occupation Aspect**

Overall, in the four districts combined, 77.1% (N=280) established that crop cultivators were highly vulnerable to climate change impacts,

followed by pastoralists by 11.8% (N=280) respectively (See Table 3). The probable reason is that crops and livestock directly relate to the environmental parameters. The change of one climatic parameter affects crops and livestock. For instance, the rise in temperature causes crops and water sources to dry due to high evaporation. Changes in temperature, atmospheric carbon dioxide (CO<sub>2</sub>), and the frequency and intensity of extreme weather significantly impact crop yields (USDA, 2015).

On the other hand, a chi-square test of independence was performed to examine the relationship between the occupational of an individual and the intensity of climate change impacts. The relation between these variables was significant,  $X^2(6, N = 280) = 113.937, p = .001$  (See Table 3). Crop cultivators (farmers) were more vulnerable than pastoralists, traders (business persons), and miners in this context. The study noted that climatic calamities such as floods, wind, and prolonged drought negatively impact the growing of crops. The flood problem damages agricultural land and crops. The result is in line with Malebajoa (2010). The crop modelling result suggested that under climate change, the yield per hectare for the three crops would fall consistently as the temperature rises beyond 2.5°C and rainfall decreases.

According to Moonenet al. (2002), climate is one of the most important limiting factors for agricultural production: frost risk during the growing period and low and irregular precipitation with high risks of drought during the growing period are common problems in agriculture. The critical agro meteorological variables associated with agricultural production are precipitation and air temperature (Hoogenboom, 2000). During the

spring, floodwaters overflow the banks of low-capacity channels and inundate thousands of acres of adjacent cropland. Erosion and soil displacement from flooding ruin fields and destroy crops. Erosion washes the fertile topsoil away, which leaves crop plants with nowhere to set roots. Sand, gravel, and rocks deposited by floodwaters can smother and destroy exposed crops.

**Table 3: Impact of climate change on the occupational of the population**

Occupation of the population	f	%	Mean	Std. Dev	X <sup>2</sup>	df	P-Value
Crop cultivators	216	77.1	1.41	.858	113.937	6	.001
Livestock keeper	33	11.8					
Traders	12	4.3					
Miners	19	6.8					
Total	280	100.0					

Nelson et al. (2009) assert that agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. FAO (2014) asserts that climate change affects food production and thus food availability. Climate change impacts the livelihoods and income of small-scale food producers. Through food price increases and volatility, the livelihoods of poor net food buyers are restricted access to food. Climate change has been found to impact food safety, particularly the incidence and prevalence of food-borne diseases. Increased climate variability, increased frequency and intensity of extreme events, and slow ongoing changes affect the stability of food supply, access, and utilization.

#### **The More Vulnerable and high-risk group in the Physical Ability aspect**

Table 4 indicates that 88.2% (N=280) of respondents from four districts confirm that people with physical disabilities are highly vulnerable to climate change compared to the nondisabled group. A chi-square test of independence was performed to examine the relationship between a person's physical ability and the intensity of impactation to climate change. The relation between these variables was significant, X<sup>2</sup> (2, N = 280) = 110.570, p = .001 (See Table 4). The disabled group is more vulnerable to climate change than the nondisabled group. Persons with disabilities are diversely vulnerable because they are directly and indirectly affected by climate change impact. The study noted that persons with disabilities face threats to health, water, food security, sanitation, and livelihoods. People with disabilities lack resources to mitigate and cope with climate change impacts, especially emergency climatic parameters like strong floods and wind.

**Table 4: Physical abilities of the population**

	f	%	Mean	Std. Dev	X <sup>2</sup>	df	P-Value
Disabled	247	88.2	1.1179	.32302	110.570	2	.001
Nondisabled	33	11.8					
Total	280	100.0					



USGCRP (2016) asserts that climate change-related health impacts may affect people with disabilities more than others. On the other hand, Brown et al. (2015) state that people with disabilities often face barriers in accessing healthcare services and receiving timely public health or emergency information in an accessible format. Smith et al. (2017) asserts that due to discrimination, marginalization, and certain social and economic factors, people with disabilities experience the effects of climate change differently and more intensely than others. USGCRP (2016) lines that people with disabilities also experience poverty at more than twice the rate of people without disabilities. Change impacts put people with disabilities at heightened risk. The world's poorest people continue to experience the most severe

impacts of climate change through lost income, displacement, hunger, and adverse impacts on health (Smith et al., 2017).

**The More Vulnerable and High-risk group in the Wealth Status aspect**

The results in Table 5 indicate that 99.3% (N=280) of the respondents perceived that low-income earners are highly vulnerable to climate change than high-income earners. On the other hand, a chi-square test of association was performed to check the relationship between the income status of a person and the intensity of impactation to climate change. The relation between these variables was not significant,  $X^2(2, N = 280) = .288, p = .866$  (See Table 5).

**Table 5: Respondents' Perception of the Income status of the population**

	<b>f</b>	<b>%</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>X<sup>2</sup></b>	<b>df</b>	<b>P-Value</b>
High-income earners	2	0.7	1.9929	.08436	.288	2	.866
Low-income earners	278	99.3					
Total	280	100.0					

According to Walliman (2005), statistically significant does not mean: (i) that the observed difference is large (only that it is probably real, (ii) that the results are important, and (iii) that the results will generalize. Statistical significance means none of these things. It only tells us that the observed sample result probably reflected the particular population sampled (*ibid.*). A non-significant result does not establish that the null hypothesis is necessarily true (Bryman & Crammer, 1999). Similarly, a non-significant result does not imply that the results are meaningless (Walliman, 2005).

In this context, low-income earners are susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. The result is in line with Rayner & Malone (2001) asserts that climate change and poverty are deeply intertwined because climate change affects poor people in low-income communities. Those in poverty have a higher chance of experiencing the ill effects of climate change due to the increased exposure and vulnerability. In addition, Smit et al., (1999) assert that climate change highly influences

health, economy, and human rights, which affect environmental inequities.

**The More Vulnerable and High-risk group in Topographical Location preference**

The field results in Table 6 indicate that 86.4% (N=280) of respondents pointed out that people settled in the lowlands are more vulnerable to climate change impacts than those in the high lands. The study revealed that during heavier rain, floods destroy settlements, cause death to livestock, crops, and sometimes people. A Chi-Square Test of Independence was performed to assess the relationship between the intensity of climate change impacts and the topographical location of the human population. The results indicate a significant relationship between the two variables,  $X^2(2, N=280) = 6.28, p = .043$  (See Table 6). This result signifies that the populations living in the lowlands were more vulnerable than those living in the highlands. FAO (2009) stated that temperature determines the length of the growing season of crops by determining the germination of the crop.

**Table 6: Respondents’ perception of the topographical location is affected by**

Topographical Location	f	%	Mean	Std. Dev.	X <sup>2</sup>	df	P-Value
Highlands	38	13.6	1.8643	.34310	6.281	2	.043
Lowlands	242	86.4					
Total	280	100.0					

On the other hand, lowlands are more affected during heavy rainfall as rainwater flow from high lands, causing floods in the lowlands. For instance, in Arusha urban district, floods often originate from the slopes of Mt. Meru when raging waters break the banks of rivers and streams. The study through discussants in a focus group revealed that in January 2022 alone in the Arusha district, property worth about a 1.5billion/= was destroyed by heavy rains in King’ori ward (in the lowlands) in the Arumeru district. Consequently, 200 families in the Leguruki ward of Kingo’ri in the Arumeru District lost their residential houses. Furthermore, one of the discussants in the Arusha region had the following to state:

*During heavy rains, floodwater from the highlands of Mt. Meru has destroyed the household items; domestic animals have been swept away. Yesterday, the flood swept away our goats and sheep. Come and see and take a photograph (See Plate 1). It is a real pain for the death of the livestock as it is the source of income. People are planning to migrate to the highlands once enough money to purchase pieces of land is obtained. Living in the lowland is just putting our lives at high risk because our livestock and properties can be swept any time when floods and wind increase (Anonymously, December 2020).*

**Plate 1:** Dead livestock caused by floods in the lowlands of the Arusha region



**The More vulnerable and high-risk group in the Degree of Urbanisation**

Overall, the results indicate that 82.5% (N=280) of the respondents perceived rural dwellers as more vulnerable to climate change impacts than those living in urban areas. On the other hand, only 17.5%

pointed to urban dwellers. The rural people are mainly vulnerable because most of their economic activities, such as crop cultivation and livestock keeping, are directly linked to the environment. In this context, any change in the environment system affects the dwellers. To check the significance of the

relation between the variable thus climate change impacts and the degree of urbanization. A Chi-Square Test of Independence was performed, and

the results indicate a statistically significant relationship between the two variables,  $X^2(2, N=280) = 6.161, p = .046$  (See Table 7).

**Table 7: The impact of climate change on the degree of urbanization**

	<b>f</b>	<b>%</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>X<sup>2</sup></b>	<b>df</b>	<b>P-Value</b>
Rural	231	82.5	1.1750	.38065	6.161	2	.046
Urban	49	17.5					
Total	280	100.0					

As a fact of life, climate change is particularly formidable to low-income rural communities whose livelihoods heavily depend on rain-fed subsistence agriculture. According to Hellmuth et al. (2007), climate change presents risks to lives and livelihoods at the individual level and the economy and the infrastructure at regional and national levels. Rural people are particularly vulnerable to climate change. However, their vulnerability is not attributed to climate change only but is also a combination of social, economic, and environmental factors that interact with it (Turpie & Visser 2013). Ofoegbu et al. (2015), rural communities have remained vulnerable to climatic-induced shocks, although they employ many mechanisms to mitigate the effects of climate change.

**The More vulnerable and high-risk group in the Nature of Housing**

Overall, 75.7% (N=280) of the respondents pointed out that people living in temporally built houses are more vulnerable to climate change impacts than those living in permanent houses. A chi-square test of independence was performed to examine the relation between the nature of houses lived by the population and the intensity of climate change. The relation between these variables was significant,  $X^2(2, N = 180) = 49.019, p = .001$  (See Table 8). People living in temporal-built houses were more vulnerable than those living in permanent houses.

**Table 8: Respondents’ Perception nature of houses lived**

	<b>f</b>	<b>%</b>	<b>Mean</b>	<b>Std Dev.</b>	<b>X<sup>2</sup></b>	<b>df</b>	<b>P-Value</b>
Permanent residential houses	68	24.3	1.7571	.42958	49.019	2	.001
Temporal residential houses	212	75.7					
Total	280	100.0					

The findings of this study revealed that any changes in climate parameters like floods and strong winds in the area destroy the temporary houses easily and cause death to people in those houses. It was noted that permanent houses can withstand the destruction unless the event is very intense. Strong wind and floods trigger the destruction of old and temporary built houses. The Focus group discussants stated that From December 2021 to January 2022 alone, strong winds and heavy downpour had demolished more than 20 houses and left 100 people homeless in the Arusha district.

**CONCLUSION AND RECOMMENDATIONS**

**Conclusion**

The study intended to investigate the more vulnerable and high risked groups to impact climate change impact among the population of the Arusha Region. The socioeconomic variables investigated include age, sex, physical ability, topographical location, house status, degree of urbanization, income status, and occupational status.

The results indicate a group more vulnerable to each variable investigated than the other. For example, on the age variable; children and older adults were

more vulnerable than youth and elders; in the case of gender, women were more vulnerable than men; on the physical ability variable, the disabled were more vulnerable than nondisabled, on the side of the topographical location of the population, the findings revealed that people settled at the lowlands were more vulnerable than those living on highlands. On the other hand, for the house status residential, the results indicate that people with temporary built houses were more vulnerable than those living in permanent built homes. Furthermore, on the variable for a degree of urbanization, the findings show that rural dwellers were highly vulnerable than urban dwellers, for the variable of occupational status; crop cultivators and pastoralists were more vulnerable, and lastly, on the income status of the population; the results show that low-income earners were more vulnerable to the impact of climate change compared to those with high income.

On the other hand, cross-tabulation (at a 95% level of significance) was performed to explore the association between eight variables (gender, age, physical ability of the population, topographical location, occupational type of the population, degree of urbanization, type of residential houses, and income level of the population) and climate change impacts using Chi-square tests. The chi-square test result of association indicates a statistically significant relationship between (gender, age, physical ability of the population, topographical location, occupational type of the population, degree of urbanization, and type of residential houses of the population) and climate change impacts. However, the chi-square test result of association indicates no statistically significant relationship between the level of income and the effects of climate change.

### Recommendations

The study has the following recommendations to the stakeholders and government organs:-

- Education and mass consciousness programs are required within the lowlands to create communities conscious of the importance of mountains, their linkages with lowlands, and the need to apply conservation and sustainable

management measures to scale back the impacts imposed by climate change-related hazards.

- It is vital to think about communities' vulnerability to global climate change in a broader socioeconomic context. As temperature change may unfold over decades, socioeconomic differences may significantly impact communities in a much shorter timeframe, thus potentially changing the vulnerability context completely. Therefore, global climate change vulnerability assessments must analyze socioeconomic dynamics.
- The framework should be accessible to diverse users and applicable to local contexts.
- Participatory approaches are essential for climate vulnerability assessment at the community level. Participatory tools help fill information gaps and validate a community's climate and non-climate concerns. Additionally, community participation within the assessment process ensures a joint visualization of future scenarios and a selection of context-appropriate adaptation options.

### REFERENCES

- Azarkhish, A., Rudra, R., Daggupati, P., Dhiman, J., Dickinson, T., & Goel, P. (2021) Investigation of Long-Term Climate and Streamflow Patterns in Ontario. *American Journal of Climate Change*, **10**, 467- 489. <https://doi.org/10.4236/ajcc.2021.104024>.
- Bryman, A. And Cramer, D. (1999), *Quantitative Data Analysis with SPSS Release 8 for Windows. A Guide for Social Scientists*. Routledge, USA.
- Brown, M., Antle, J., Backlund, P., Carr, E., Easterling, B., Walsh, M & Tebaldi, C. (2015). Climate change, global food security and the US food system. *Global Change Research Program*
- Bryman, A., & Cramer, D. (1999). *Quantitative data analysis with SPSS release 8 for Windows: A guide for social scientists*. Taylor & Francis, US.
- Care International. (2010). Adaptation, Gender and Women's Empowerment. *Care International*

- Climate Change Brief*. [www.careclimatechange.org/files/adaptation/CARE\\_Gender\\_Brief.pdf](http://www.careclimatechange.org/files/adaptation/CARE_Gender_Brief.pdf)
- Cohen, L., Manion, L., and Marrison, K. (2010). *Research Methods in Education*, Sixth Edition, Pearson Education inc. London, New York
- Creswell, J. (2012), *Educational Research*. New Jersey, Pearson Education Inc
- Deressa, T., Hassen R., Alemu, T., Yesuf, M. & Ringler, C. (2008). Analysing the determinants of farmers' choice of adaptation measures and perceptions of climate change in the Nile Basin of Ethiopia. *Global Environmental Change* 19, 248– 255. <https://doi.org/10.1016/j.gloenvcha.2009.01.002>.
- Food and Agriculture Organization (FAO), (2014). The State of Food and Agriculture. Innovation in family farming. Rome (available at <http://www.fao.org/publications/sofa/2014/en/>).
- Food and Agriculture Organization (FAO), (2009). The State of Food and Agriculture. Food and Agriculture Organization of the United Nations, Rome, pp 211
- Graciela, M., Andrea, S., & Jason, S. (2014). Climate change vulnerability, impact and adaptation assessment. *International Journal of Climate Change Strategies and Management*, 6 (4) 442 – 476. <https://doi.org/10.1108/IJCCSM-06-2013-0076>
- Hellmuth, M.E., Moorhead, A., Thomson, M.C., & Williams, J. (2007). *Climate Risk Management in Africa: Learning from practice*. International Research Institute for Climate and Society (IRI), Columbia University, New York.
- Holmén, H. 2003. 'Reflections on natural preconditions for a green revolution in Africa, Department of Geography. Linköping University, The Tema Institute, SE-581 83. Linköping Sweden.
- Homewood, K., Kristjanson, P. and Trench, P.G. (2009), *Staying a Maasai; Livelihoods Conservation and Development in East Africa Rangelands*, Springer, London.
- Hoogenboom, G. (2000). Contribution of agrometeorology to the simulation of crop production and its applications. *Agric. and Forest Meteorol* (103), 137-157.
- Huq, A., Sack, R. B., Nizam, A., Longini, I. M., Nair, G. B., Ali, A., ... & Colwell, R. R. (2005). Critical factors influencing the occurrence of *Vibrio cholerae* in the environment of Bangladesh. *Applied and environmental microbiology*, 71(8), 4645-4654.
- Intergovernmental Panel on Climate Change (IPCC), (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summaries, Frequently Asked Questions, and Cross-Chapter Boxes. A Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R., Barros, D.J., Dokken, K.J., Mach, M.D., Mastrandrea, T. E., Bilir, M., Chatterjee, K. L., Ebi, Y.O., Estrada, R.C., Genova, B., Girma, E.S., Kissel, A.N., Levy, S., MacCracken, P. R., Mastrandrea, & L.L. White (eds.)]. Intergovernmental Panel on Climate Change (IPCC). World Meteorological Organization, Geneva, Switzerland, pp.190 [accessed May 25, 2021].
- Islam, S. N., & Winkel, J. (2017). Climate change and social inequality DESA working paper no. 152. *UN Department of Economic and Social Affairs* [https://www.un.org/esa/desa/papers/2017/wp152\\_2017.pdf](https://www.un.org/esa/desa/papers/2017/wp152_2017.pdf)
- Joseph, L.&Kaswamila, A. (2017). Mainstreaming Impacts of Climatic Change Affecting Pastoralists in Semi-Arid Rangelands of Longido District, Northern Tanzania. *International Journal of Modern Social Sciences*, 6(1), 103-111.
- Joseph, L. (2022). The Liability of Climate Change on Constraining Women's Rights in the Southern Highlands, Tanzania: A Case of Kilolo District. *East African Journal of Environment and Natural Resources*, 5(1), 58-74. <https://doi.org/10.37284/eajenr.5.1.577>
- Kothari, C.R. (2019). *Research Methodology: Methods and Techniques*. 4th Edition, New Age International Publishers, New Delhi.

- Lepetz, V., Massot, M., Schmeller, D., & Clobert, J. (2009). Biodiversity monitoring: Some proposals to adequately study species' responses to climate change. *Biodiversity and Conservation*, 18, 3185–3203. <https://doi.org/10.1007/s10531-009-9636-0>.
- Malebajoa, M. (2010). *Climate Change Impacts on Crop Yields and Adaptive Measures for Agricultural Sector in the Lowlands of Lesotho*. Masters Degree Thesis submitted to Lund University Sölvegatan 12 S-223 62, Lund Sweden.
- McMichael, A. J., & Lindgren, E. (2011). Climate change: present and future risks to health, and necessary responses. *Journal of internal medicine*, 270(5), 401-413.
- Montt, G., Fraga, F., & Harsdorff, M. (2018). The future of work in a changing natural environment: Climate change, degradation and sustainability. *ILO Research Paper Series, Geneva: International Labour Office*.
- Moonen, A. C., Ercoli, L., Mariotti, M., & Masoni, A. (2002). Climate change in Italy indicated by agrometeorological indices over 122 years. *Agricultural and Forest Meteorology*, 111(1), 13-27.
- Mutter, John C. (2015). *Disaster Profiteers: How Natural Disasters Make the Rich Richer and the Poor Even Poorer*. New York: St. Martin's Press.
- Neumayer, E., & Plümper, T. (2007). The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981–2002. *Annals of the association of American Geographers*, 97(3), 551-566.
- Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., & Lee, D. (2009). *Climate change: Impact on agriculture and costs of adaptation* (Vol. 21). Intl Food Policy Res Inst.
- Ofoegbu, C., Chirwa, P., Francis, J., & Babalola, F. (2015, September). Understanding forest-based livelihood practices as a climate change mitigation and adaptation option in Vhembe Districts of South Africa. In *XIV world forestry congress, Durban, South Africa* (pp. 7-11).
- Patil, A. & Lamnganbi, M. (2018) Impact of Climate Change on Soil Health: A Review; *International Journal of Chemical Studies*, 6, 2399-2404.
- Rayner, S., & Malone, E. L. (2001). Climate change, poverty, and intragenerational equity: the national level. *International Journal of Global Environmental Issues*, 1(2), 175-202. <https://doi.org/10.1504/IJGENVI.2001.000977>
- Rodó, X., Pascual, M., Fuchs, G., & Faruque, A. S. G. (2002). ENSO and cholera: a nonstationary link related to climate change? *Proceedings of the national Academy of Sciences*, 99(20), 12901-12906.
- Schwartz, J., & Morris, R. (1995). Air pollution and hospital admissions for cardiovascular disease in Detroit, Michigan. *American journal of epidemiology*, 142(1), 23– 35. <https://doi.org/10.1093/oxfordjournals.aje.a117541>
- Sintayehu, D. W. (2018). Impact of climate change on biodiversity and associated key ecosystem services in Africa: a systematic review. *Ecosystem health and sustainability*, 4(9), 225- 239. <https://doi.org/10.1080/20964129.2018.1530054>
- Smit, B., Burton, I., Klein, R. J., & Street, R. (1999). The science of adaptation: a framework for assessment. *Mitigation and adaptation strategies for global change*, 4(3), 199-213. <https://doi.org/10.1023/A:1009652531101>. S2C ID 17970320.
- Smith, F., Simard, M., Twigg, J., Kett, M., & Cole, E. (2017). Disability and climate resilience: a literature review. *London: Leonard Cheshire*.
- Turpie, J., & Visser, M. (2013). The impact of climate change on South Africa's rural areas. *Submission for the, 14*, 100-162.
- United Republic of Tanzania (URT), (2012a). National Sample Census of Agriculture 2007/2008 Volume Vb: Regional Report: Arusha Region

United Republic of Tanzania (URT), (2012b). *Population and Housing Census*. National Bureau of Statistics Ministry of Finance, Dar es Salaam

Brown, M.E., Antle, P., Backlund, E.R., Carr, W.E., Easterling, M.K., Walsh, C., Ammann, W., Attavanich, C.B., Barrett, M.F., Bellemare, V., Dancheck, C., Funk, K., Grace, J.S.I., Ingram, H., Jiang, H., Maletta, T., Mata, A., Murray, M., Ngugi, D., Ojima, B., O'Neill, & C. Tebaldi. (2015). *Climate Change, Global Food Security, and the U.S. Food System*. pp; 146

United States Global Change Research Program (USGCRP), (2016). *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Crimmins, A., J. Balbus, J.L., Gamble, C.B., Beard, J.E., Bell, D., Dodgen, R.J., Eisen, N., Fann, M.D., Hawkins, S.C., Herring, L., Jantarasami, D.M., Mills, S., Saha, M.C., Sarofim, J., Trtanj, & L. Ziska. (Eds). U.S. Global Change Research Program, Washington, DC, 312 pp. <http://dx.doi.org/10.7930/J0R49NQX>

Walliman, N. (2005). *Your Research Project* (2<sup>nd</sup> ed.). Sage Publications, London.

World Health Organization (WHO). (2011). *Gender: Climate Change, and Health* (Geneva: World Health Organization).

Zangirolami-Raimundo J, Echeimberg J, Leone C. (2018). Research Methodology Topics: Cross-sectional studies. *Journal of Human Growth and Development*, 28(3): 356-360. DOI: <http://dx.doi.org/10.7322/jhgd.152198>