

PAN-AFRICAN UNIVERSITY
INSTITUTE FOR WATER AND ENERGY SCIENCES
(including CLIMATE CHANGE)

Master Dissertation

**ASSESSMENT OF SECONDARY SCHOOL STUDENTS'
AWARENESS OF CLIMATE CHANGE AND ADAPTATION
PRACTICES. A CASE STUDY OF MAKETE DISTRICT COUNCIL,
TANZANIA.**

Master's Degree in Climate Change Policy

Elisha Milabagano Nyambere

Submitted: March, 2025

TLEMCEN-ALGERIA



**Institute for Water
and Energy Sciences
(incl. Climate Change)**



جامعة أبو بكر بلقايد
UNIVERSITY OF TLEMCCEN

PAN-AFRICAN UNIVERSITY

INSTITUTE FOR WATER AND ENERGY SCIENCES

(including CLIMATE CHANGE)

Master Dissertation

Submitted in partial fulfillment of the requirements for the Master degree in

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Presented by

ELISHA MILABAGANO NYAMBERE

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AWARENESS OF CLIMATE CHANGE AND ADAPTATION
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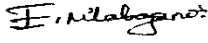
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THESIS APPROVAL PAGE

Assessment of Secondary School Students' Awareness of Climate Change and Adaptation Practices. A Case Study of Makete District Council, Tanzania


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DEDICATION

This thesis is dedicated to the boundless oceans of knowledge, the depths of understanding, and the journey of unraveling the mysteries of climate change. May our efforts contribute to resilience of humanity and the innovative spirit that drives us to adapt and thrive in the face of climate challenges

Gratitude flows like a river to my mentors, family, and friends who have been my steadfast companions on this academic voyage.

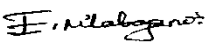
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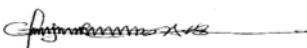
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SUPERVISOR'S DECLARATION

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Signature: 

Date: 25/03/2025

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ABBREVIATIONS AND ACRONYMS

DRRE	Disaster Risk Reduction Education
DED	District Executive Director
DEO	District executive Officer
EE	Environmental Education
ESD	Education for Sustainable Development
GHGs	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
NGOs	Non-government Organizations
PAUWES	Pan African University Institute of Water and Energy Sciences Including Climate Change
TIE	Tanzania Institute of Education
SSA	Sub-Saharan Africa
UN	United Nation
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Agency for Children’s Fund
USAID	United States Agency for International Development
URT	United Republic of Tanzania
WMO	World Meteorological Organization
WEO	Ward Education office

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ABSTRACT.

Human induced climate change remains one of the most pressing global challenges of the 21st century, with developing countries, including Tanzania, being particularly vulnerable to its impacts. As the world fights with measures of finding lasting solutions to the problem of climate change, it is essential to know the awareness and knowledge level the youth, especially secondary school students, possess about the causes, impacts, mitigation and adaptation practices of climate change and their involvement in addressing the problem of climate change. This can be done through improved awareness that will lead to behavioral changes in mitigation and adaptation practices. This study assesses the awareness of climate change and adaptation practices among secondary school students in Makete District, Tanzania. Using a descriptive survey design, data were collected from 330 students across eight secondary schools through questionnaires, interviews, and observations. The study employed both quantitative and qualitative data analysis methods, utilizing the Statistical Package for Social Sciences (SPSS) for quantitative data and thematic analysis for qualitative insights.

The findings reveal that a significant majority of students (79.7%) have high awareness level of climate change with 20.3% of student with medium awareness, with females demonstrating slightly higher awareness levels (79.3%) than males (77.1%). Students also showed a high level of knowledge regarding climate change mitigation with 78% and adaptation practices with 81%, such as tree planting, renewable energy use, and water conservation. Moreover, 87.6% of students showed that they participated in adaptation practices at home, school or at their community. The study highlights the importance of integrating climate change education into school curricula and enhancing practical, hands-on learning experiences to improve students' understanding and engagement in climate adaptation and mitigation practices. Recommendations include making climate change education examinable, organizing regular teacher training workshops, and promoting future-oriented, problem-solving approaches in teaching. These measures are essential for fostering a generation of environmentally conscious citizens capable of addressing the challenges posed by climate change.

Keywords: Students, awareness, climate change, climate change adaptation, gender issues in climate change

Elisha Milabagano Nyambere

Assessment of secondary students' awareness of climate change and adaptation practices. A case study of Makete district, Tanzania.

1. INTRODUCTION

1.1. Background of the study

Climate change mainly caused by anthropogenic induced Greenhouse gases (GHG) remains one of the 21st Century key challenges to global development (Lal, 2017). It has been highlighted as a crucial topic discussed in mass media, reports, campaigns, multiple conferences, research, and publications (Abd Hamid et al., 2021; Mohsin et al., 2022). The effects of the ongoing global warming (heat wave), drought, floods, and storms, are felt in marine species, freshwater and terrestrial that have shifted their species interactions, abundances, migration patterns, seasonal activities and geographic ranges, and, especially freshwater fishes (Lee et al., 2022; Ofori et al., 2023). At the same time, developing countries, especially those in Sub-Saharan Africa (SSA), are experiencing rapid social and economic development, driven by exponential urban and population growth. However, this progress is increasingly threatened by the unprecedented harms of climate change, which pose significant risks to both ecosystems and human livelihoods (Conor & McGlynn, 2014). Given these challenges, there is an urgent need for global collaboration and immediate action to mitigate and adapt to climate change, ensuring its impacts on individuals and communities are minimized (IPCC, 2023).

The call for adaptation and mitigation has become a recurring theme in both national and international conferences, emphasizing the need for action from both developed and developing countries (Ract, 2023). Sub-Saharan Africa stand out as one of the most vulnerable regions to climate change due to its heavily reliant on climate-dependent sectors like rain-fed agriculture, water resources, and ecosystems, as well as its limited adaptive capacity (IPCC, 2023). Additionally, a substantial number of people in this region live in conditions of extreme poverty and are heavily dependent on rain-fed agriculture to maintain economies and livelihoods. Erratic rainfall characterized by floods and droughts, heat waves, and strong winds cause food insecurity; water security is deteriorating; a decrease of aquatic resources in large lakes due to rising temperatures; an increase in vector-borne diseases; rising sea levels affecting low-lying coastal areas with dense populations and increased water tensions and displacement of people. These

interconnected issues underscore the urgent need for targeted interventions to address the region's vulnerability to climate change. (Ahmed, 2023).

This is particularly evident in Tanzania, a country with a population of approximately 65 million, where over 60% of the population depends on rain-fed agriculture as their primary livelihood. The impacts of climate change, including floods, droughts, strong winds, heat waves, hailstorms, and severe cold spells, have become increasingly severe in the region. These challenges have forced the country to allocate around 1 million USD annually to address climate-related risks (Chegere & Mrosso, 2022). Among the most affected groups are young people, particularly secondary school students, whose lives and futures are being disrupted by these environmental changes. As emphasized by the IPCC (2023), there is an urgent need for global cooperation and partnerships to combat the unprecedented effects of climate change through effective adaptation and mitigation measures. This call to action highlights the critical importance of collective efforts to address the growing threats posed by climate change, particularly in vulnerable regions like Tanzania. Nevertheless, the effectiveness of mitigation and adaptation strategies hinges on educating and raising awareness among the public to foster their acceptance and application. Knowing the level of awareness the public possesses, including students, is critical for encouraging communities and individuals to adopt sustainable behaviors that reduce GHG emissions and build resilience to climate impacts (Karami et al., 2017).

With severe flooding, drought, and heatwaves being felt in Africa, including Tanzania, where students demonstrate a low level of awareness and misconception on the causes and consequences of climate change (Carr et al., 2015; Sjöblom et al., 2022). This sparks the need to assess the secondary school student's awareness of the climate change impact and adaptation practices. The students' awareness will help them in influencing and promoting environmental protection and measures against climate hazards by their parents and the community at large. Moreover, since students are future leaders, being aware of climate change issues will help to have future leaders with positive attitudes on environmental conservation and protection (Lal, 2017). To reduce associated effects and increase revenue, changes should be addressed by increasing awareness among the communities. Other than that, further emphasis should focus on the younger generations, especially secondary school students who are highly exposed to the issue and have

opportunities to learn about climate change through mass media and comprehensive learning from school. This will increase participation in environmental protection and reduce associated climate impacts that negatively affect youth and community at large (Abd Hamid et al., 2021).

1.2. Statement of the Problem.

Tanzania encounter heterogeneous climate conditions characterized by spatial climatic variety (Nyembo et al., 2021). This diversity in climatic conditions has positioned Tanzania as the 20th most vulnerable country globally to the impacts of climate change (NBS, 2020). The nation faces a wide range of climate-related challenges, including frequent floods, prolonged droughts, heatwaves, hailstorms, strong winds such as the devastating Hidaya cyclone in 2024, and severe cold spells, all of which vary considerably across different regions (NBS, 2020). These extreme weather events pose significant risks to both rural and urban populations. However, the situation is particularly dire in urban areas, where a large proportion of the population resides in unplanned settlements

Almost two-thirds of the Tanzanians live in rural areas, which to a great extent, depend on rain fed agriculture. Climate change has significantly disrupted the production of key food crops such as maize, beans, sorghum, and rice, threatening food security and economic stability. Since 2008, the country has faced increasingly severe and frequent floods and droughts, particularly in regions like Dar es Salaam, Kilosa, Mpwapwa, and Kilombero. These extreme weather events have led to widespread destruction of infrastructure and homes, as well as the forced relocation of communities. Additionally, rising sea levels have caused the displacement of coastal populations, the degradation of critical infrastructure and ecosystems, and the submergence of islands like Pangani and Fuvu la Nyani in Rufiji. Compounding these challenges, the iconic glaciers atop Mount Kilimanjaro have been steadily shrinking since 1912, a stark indicator of rising global temperatures and the far-reaching impacts of climate change on Tanzania's natural heritage (NBS, 2020).

Secondary students in Tanzania are also significantly impacted by the adverse effects of climate change, which directly and indirectly disrupt their education, health, and overall well-being. Extreme weather events, such as the devastating floods in Dar es Salaam in 2020 (UNCEF, 2020)

and the heavy rains that triggered flooding and landslides in Makete district, caused extensive damage to school infrastructure and displaced families, forcing temporary school closures. These disruptions not only hinder learning but also create long-term setbacks for students. Furthermore, food shortages and malnutrition resulting from declining agricultural productivity directly impair students' ability to concentrate and perform academically (FAO, 2023). The (IPCC, 2022) highlights that students, particularly rural girls, often spend countless hours fetching water, which affects their study time and increases absenteeism. Compounding these challenges, climate-related economic shocks exacerbating household poverty, reducing access to school fees, uniforms, and supplies (World Bank, 2024).

Studies continue arguing that Tanzania will continue experiencing changes in climate patterns as projected by the 2050s. This will include, yearly rise of temperature by 1.4 to 2.3°C, longer heat waves (increasing by 7–22 days) and extended dry spells (up to 7 additional days), and a potential increase in average annual rainfall (ranging from -3 to +9 percent); Additionally, heavy rainfall events are expected to become more frequent (by 7–40 percent), sea levels are projected to rise by 16 to 42 cm, and glaciers on Mount Kilimanjaro are likely to continue shrinking (USAID, 2018). Climate change should therefore be considered as an important challenge which Tanzanian households faces and are expected to continue facing (NBS, 2020). This will continue affecting Students especially girls who spend a lot of hours fetching water due to water scarcity especially in rural areas causing them to miss studies (IPCC, 2019)

Climate awareness on causes, impact, and adaptation and mitigation measures as addressed by IPCC are very important to fight current climate problems (Kumar et al., 2020; Reid, 2019). Climate change represents a formidable challenge to both the environment and humanity, with far-reaching consequences for ecosystems, economies, and societies. Addressing these challenges, both now and in the future, requires the collective involvement of all stakeholders, particularly the younger generation.

As pointed by Sedera and Dey (2013) that climate awareness is an important tool for addressing and reducing harm from climate change. They argue that awareness fosters knowledge, which shapes personal values and leads to the development of specific attitudes, intentions, and beliefs that drive behavioral change. Where society adjustment and resilient capability are functions of

investment incurred in raising awareness through training (education), programs and advocacy. In addition, effective climate change response fundamentally depends on education systems. Climate change education enables youths to understand and tackle the effects of global warming, while also fostering shifts in their behaviors and attitudes and helping them adapt to trends linked to climate change (Karami et al., 2017). Owolabi et al. (2012) continue arguing that a society with more climate awareness have less risk of vulnerability and exposure to climate threats. Education given to students through school are considered as one among the means of creating awareness on climate change. Students are considered as vulnerable group as they are youth. Understanding awareness of climate among them is vital as they are key player and future leaders who will carry forward the crucial work of climate action.

It is essential for the youth to be informed about climate change causes and impact and to take an active interest in addressing them (Deshiana et al., 2022). Students, as a critical part of the younger generation, are among those who most acutely experience its effects. It is anticipated that the younger generation, especially secondary students, will possess the knowledge and a proactive attitude toward strategies for climate change mitigation and adaptation.

However, despite the disturbing indicators of climate change in Tanzania, and the importance of improving secondary school students' awareness as a strategy to enhance climate change mitigation and adaptation, there is scanty of researches conducted to assess students' awareness of climate change and adaptation practices. This study sets out to address such a research gap by seeking to ascertain secondary school students' level of awareness and attitude towards climate change adaptation practices in Makete district in the Njombe region of Tanzania.

1.3. Research Questions

The study sought to answer the following research questions

- i. Are there gender differences in relation to climate change awareness?
- ii. What is the level of the Students' knowledge of adaptation to climate change practices?
- iii. What is the level of the Students' knowledge of mitigation to climate change practices?

iv. What are the climate change adaptation practices by secondary school students in Tanzania?

1.4. Objective of the Study

1.4.1. General objective

The main objective of the study is an assessment of secondary school students' awareness of climate change and adaptation practices in Makete district.

1.4.2. Specific Objectives.

1. Analyze the gender difference in the level of awareness about Climate Change
2. Assess students' knowledge level of climate change adaptation practices
3. Assess students' knowledge level of climate change mitigation practices
4. Examine the climate change adaptation practices by secondary school students in Tanzania

1.5. Significance of the Study

This study will provide insight on the levels of climate change awareness among secondary school students, in order to determine the knowledge gaps on climate change and its suggested better solutions and alternatives ways on how to prepare the next generation on ways to deal with climate related issues. Furthermore, the results of this study will not only shed light on students' knowledge of mitigation and adaptation practices related to climate change but also benefiting Tanzania government for climate policy making and international agencies for policy interventions.

The study can serve as a foundation for curriculum developers to make necessary adjustments and integrate academic activities that boost students' awareness of climate change (Floranza & Campus, 2020), Additionally, it can provide valuable insights for schools to design and implement climate change awareness seminars and programs for their students and other stakeholders.

The information could also help identify strategies for involving youth in climate change adaptation efforts, particularly those tailored to their local environments (Kawambwa, 2022). The gender-differentiated information to be obtained from the study will help to foster gender-specific

policy targeting of secondary school students for climate adaption and mitigation initiatives. Lastly the study result will serve as a reference point to other researchers.

2.7. Scope of the Study

This study focused on assessing the awareness of climate change and adaptation practices among secondary school students. The research was limited to students aged 16–25 years enrolled in public and private secondary schools within Makete district. The study explored students' knowledge of climate adaptation and mitigation strategies, as well as their involvement in practical adaptation measures that are implemented at the home, community, and institutional levels.

The study primarily relied on quantitative data collected through survey questionnaires, supplemented by qualitative insights from interviews and observation. The research examined factors influencing students' awareness, including gender, school location, age, school type, occupations of parents and area of specialization. However, it did not delve into the broader societal or policy-level implications of climate change adaptation, as the focus remains on student awareness and practices.

Despite the study being confined to Makete district, the findings may be generalizable to other regions or age groups of advanced students. The research aims to provide a baseline understanding of secondary students' awareness, which can inform future educational interventions and awareness campaigns.

2.8. Limitation of the Study

Several potential obstacles were encountered during the conduct of the research including:

- i. Poor infrastructure: Since some schools were located in rural areas where accessibility to school and internet connectivity were limited, this posed challenges for the accomplishment of the task.
- ii. The research was limited to only one district. Time factor and financial constraints made the researcher to conduct in one district out of 184 districts currently present.

- iii. Time and financial allocation: Another limitation was insufficient time allocated for the fieldwork and financial constraints, which limited the number of respondents that the study aimed to interview.

Despite these potential obstacles, the study had the potential to make a significant contribution to the field of climate change awareness, and with careful planning and execution, the study overcome the challenges and limitations encountered.

2.7.Tentative Thesis Chapter Outline

This dissertation is comprised of seven chapters, each of which serves a distinct purpose. Chapter one provides an introduction to the study, outlining the background to the study, the problem statement, the significance of the study, the scope of the work, the objectives, and the outline of the dissertation. In chapter two, relevant literature is reviewed, including the definition of key concepts, theoretical review, and empirical review. Chapter three delves into the methods used, including the introduction, description of the study area, interviews, Observation, questionnaires, data presentation, data analysis, and ethical considerations. Chapter four presents the results and discussion, while chapter five provides conclusions and recommendations. Chapter six is dedicated to references, and the final chapter is the appendix.

The following is a tentative chapter outline for the thesis on the assessment of secondary school students' awareness of climate change and adaptation practices. A case study of Makete district.

Chapter 1: Introduction

- 1.1.Background to the study
- 1.2.Statement of the problem
- 1.3.Research questions
- 1.4.Objectives of the study
- 1.5.Significance of the study

1.6.Scope and limitation of the study

Chapter 2: Literature review

2.1. Introduction

2.2. Conceptual issues and conceptual framework

2.2.1. Conceptual issues

2.2.2. Research model

2.3. Theoretical concern

2.4. Empirical review

2.4.1 Evolution of Climate change as a problem of Global concern

2.4.2 Factors Influencing the Public Level of Awareness on Climate Change

2.4.3. Mitigation and adaptation practices in climate change

2.4.4. Global public perception and level of awareness on climate change

2.4.5. Public Climate Change Awareness and Perception in Africa

2.4.6. The Role of Education in Creating Awareness of Climate Change

Chapter 3: Methodology

3.1.Study area

3.2.Study design

3.3.Sample technique and sample size

3.4. Data collection

3.5.Data analysis

Chapter 4: Results and discussion

1. Results and discussion of gender awareness on climate change
2. Result and discussion of climate change adaptation practices
3. Result and discussion of climate change mitigation practices
4. Result and discussion of secondary school adaptation practices

Chapter 5: Conclusion and recommendation

5.1. Summary

5.2. Conclusion

5.3. Recommendation

2. LITERATURE REVIEW

2.1. Introduction

This chapter synthesizes relevant literature through four thematic lenses: (1) conceptual foundations, (2) theoretical underpinnings (learning theory, awareness theory, and climate change theory), and (3) empirical research encompassing climate change evolution as a global crisis, education's role in climate change awareness, public perceptions, awareness determinants, mitigation and adaptation strategies of climate change. The analysis aligns explicitly with the study's objectives throughout these sections.

2.2. Conceptual Issues and Research Model

2.2.1. Conceptual issues

For this study, Students, Awareness, climate change, Climate change adaptation, and gender issues in climate change are key concepts that were clarified as follows.

2.2.1.1. Students

Under this study, the student was considered as a person enrolled at school, who studies under supervision and guidelines and receives instruction from the supervisor (Ulugbek, 2020). Students' understandings are influenced by multiple factors, including creative and inquisitive teaching styles, the attitude of students toward the subject matter, and the physical environment of learning (Ulugbek, 2020). In Tanzania, the education system progresses through five tiers: two years of pre-school, seven years of primary education, four years of ordinary secondary, two years of advanced secondary, and three or more years of tertiary study (TIE, 2007). Students' awareness of climate change and adaptation practices are influenced by environmental inputs like interactions, books, internet and individual memory, this helps students to develop pro-environment habits (Devanur & Fortnow, 2009)

2.2.1.2. Awareness

This can be explained as understanding about climate change issues based on causes, impacts and adaptation practices. This is because as human, we have senses to understand and feel something that happens around us which is known as awareness. This is supported by Devanur & Fortnow (2009) who perceives awareness as the ability or state to perceive, to feel, or to be conscious of object or pattern. Meaning that awareness can be understood through experiences people encounter in their lives, such as learning, socialization, and self-reflection and Oruonye, (2011) adds climate change awareness is a combination of how people conceptualize, interpret, and perceive climate-related issues, influencing their behavior and shaping the quality of their responses and reactions to these challenges.

2.2.1.3. Climate change

Under this study climate change is referred as the long-term (11-40 years) average change of temperature, precipitation (rainfall, hail, and snow), wind, and humidity. This is evidenced by indicators like rising/ lowering of temperature (frequent and intense heatwaves and extreme cold), rising sea level or decline, changing precipitation cycle (intense and frequent rainfall, too early or late rainfall season, floods, drought, snow increase or decline, and hailstone). Nguyen, (2023) argues that climate change is long-term alterations in Earth's atmospheric conditions, principally caused by anthropogenic factors that modify atmospheric composition, evidenced through measurable variations in temperature regimes and precipitation distribution.

2.2.1.4. Climate change Adaptation

This refers to the actions that are put down to adjust to the current and anticipated harms caused by climate change. Climate harms include floods, heatwaves, drought, unpredictable rainfall characterized by early or late rain season, severe cold, the rise of sea level, etc. Wearing light/ thick clothes, frequent drinking of water, agricultural practices (adoption of crop varieties and improved seed, irrigation methods, zero grazing), tree planting, water conservation (efficient appliance use and water reuse and recycling), evacuation from flooded areas and coastal area due to sea level rise will be considered as indicators of student's adaptation practices. Owen (2020)

asserts climate change adaptation as systematic adjustments across human communities, natural ecosystems, and engineered environments to enhance resilience against changing climatic conditions. The adjustments can be reactive to events that have already occurred or anticipatory in response to future events or conditions (IPCC, 2022).

2.2.1.5. Gender Issues on Climate Change

Gender represents socially constructed roles, responsibilities, and power dynamics between men and women that extend beyond biological differences (Guerra & Ledesma, 2015). In SSA, these gendered norms create distinct climate vulnerabilities: men typically control resource ownership and decision-making, while women and girls shoulder the labor of climate-sensitive tasks, particularly water collection and household management. This division of roles, compounded by socioeconomic inequalities, renders women disproportionately vulnerable to climate impacts like water scarcity, natural disasters, and resource conflicts. Their constrained decision-making power and primary responsibility for climate-affected resources simultaneously limit both their adaptive capacity and opportunities to develop climate awareness, creating a cycle of gendered climate vulnerability (Guerra & Ledesma, 2015).

2.2.2. Research model.

The study aims to assess secondary school students' awareness of climate change and adaptation practices. The dependent variables for this study are levels of climate change awareness and climate change adaptation (CCA) among secondary school students. The independent variables are Gender, grade level, school type, and school location. An awareness model as developed by Kawambwa (2022) with explanatory variables such as age, school location, ownership gender, and grade was used as a theoretical support baseline for the study.

Explanatory variables

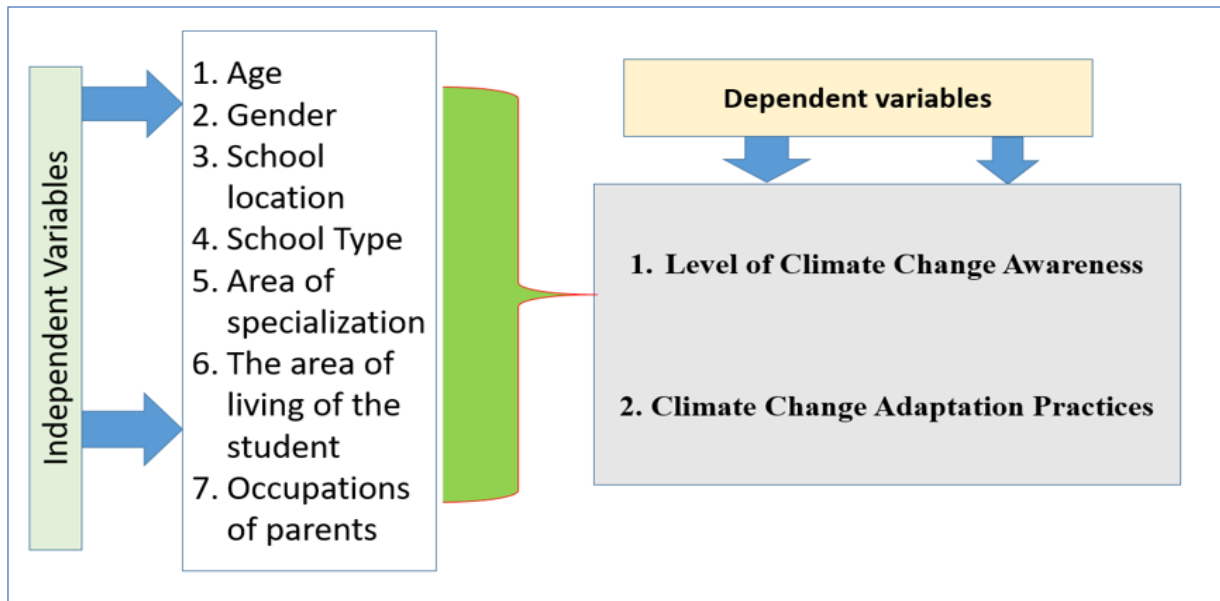


Figure 1. Conceptual Framework

2.3. Theoretical concern

Under this section different theories were used to ascertain the level of awareness of climate change and climate change issues in general.

2.3.1. Theory of awareness

The study of Devanur & Fortnow (2009) on the theory of awareness claims that awareness does not occur in a vacuum but rather through inputs. Such as context and environment, which incorporate all information sources, including personal memory, interactions with people and nature, the internet, books, and any other available materials. This implies that students' awareness of climate change and adaptation practices are influenced by environmental inputs like interactions, books, internets and individual memory. Awareness can be explained as understanding about something that happened around (Rechal, 2019).

Awareness refers to an understanding of the conditions within a specific environment, which is defined by its temporal and spatial boundaries. When individuals become aware, they often adjust

their behaviors in response to their level of understanding. Awareness fosters knowledge, which in turn shapes attitudes, ultimately influencing behavioral intentions, actions, and even cultural norms. Through awareness, personal values are strengthened or developed, leading to the formation of particular attitudes, beliefs and intentions that drive changes in behavior (Sedera & Dey, 2013). It also suggests that modifying behavior and consistently maintaining it can foster loyalty, where an individual becomes deeply committed to carrying out a particular action. The change to student's behavior on climate change responses and adaptation practices is a result of heightened awareness (Wathuge, 2021). Thus, students' Environmental awareness is important. It involves comprehending ecological challenges and the key relationships that shape environmental impacts. It also highlights the significance of individual awareness and understanding of environmental issues, which in turn influence their behavioral decisions. Consequently, environmental awareness is a strong indicator of pro-environmental behavior (Karami et al., 2017).

2.3.2. Learning Theory

The Learning theory examines the cognitive processes through which learners acquire, interpret, and internalize information within educational contexts. Environmental influences, prior experiences, and emotional and cognitive all mediate both conceptual understanding formation and the consolidation of learned abilities. From the theory, Stroobants (2018), suggested that education and knowledge is crucial for youth to prevent the adverse effects of climate change through learning. This is because the level of education indicates knowledge acquired which then helps people to be more aware and perceive given issues in relation to climate change more knowledgeable. (Rahman et al., 2014).

Moreover, Monroe et al. (2019) suggest gaining and utilizing information through learning about climate change is crucial for evaluating its impacts on both natural systems and human societies, as well as for developing strategies to mitigate, cope with, and adapt to these changes. Additionally, access to current, timely, and reliable climate change information is essential for increasing public awareness of its effects and improving the management of risks associated with climate change.

2.3.3. Theory of climate change.

Theories of climate change explain the causes of climate change. Scientists account that climate change is caused by both human and natural influence through emission of greenhouse gases that traps infrared reflected rays from the earth's surfaces. These theories are volcanic eruptions; Cloud Formation and Albedo; Human Forcing Besides Greenhouse Gases; Ocean Currents; Planetary Motion; Solar Variability and Anthropogenic Global Warming (Bast, 2010). All these theories explain drivers of climate change, however the current climate changes witnessed today is mostly attributed by human influence (Chen & Lackner, 2020). For the sake of this study, the following theory was used to describe human influence on climate change

Human Forcing Besides Greenhouse Gases and Anthropogenic Global Warming theories account as the major contributing factors for current climate change (Bast, 2010). Both of these theories agree that human being through his/her activities is a major cause for climate changes. Anthropogenic Global Warming theory contents that global warming is being catastrophically exacerbated by human emissions of GHG, namely nitrous oxide, methane and carbon dioxide (CO₂) (Bast, 2010). The enhanced greenhouse effect is the process responsible for this phenomenon. Solar energy travels through space and reaches the Earth. Because the Earth's atmosphere is mostly transparent to incoming sunlight, heat is absorbed by the planet's surface and partially reflected back. Certain atmospheric molecules, referred to as 'greenhouse gases,' trap thermal radiation, both from within and outside the atmosphere, causing the Earth's atmosphere to retain more heat than it would otherwise (Bast, 2010). These GHG are results of man's doing from industries, agriculture, transportation, energy and poor waste management (Perry, 2004).

Human Forcing Besides Greenhouse Gases theory describes that the biggest impact of human activity on the gas emissions, but rather the alteration of Earth's surface by building cities, irrigating deserts climate is not greenhouse, clearing of forests and urban heat island such that due to the fact that they contain higher concentrations of energy-producing machinery and automobiles as well as substantial quantities of asphalt, concrete, and other building and road materials that absorb solar radiation and then release thermal energy (Bast, 2010)

2.4. Empirical review

This section presents the review of different literature trying to focus on four objectives. It is organized in three broad categories namely; evolution of climate change as a problem of global concern, public climate change awareness and perception, lastly the role of education in creating awareness on climate change.

2.4.1. Evolution of Climate Change as a Problem of Global Concern

Climate change is surrounded by opposing arguments that make debate to the term (Nguyen, 2023). A lot of controversial argument are raised, on one side is a group of people who believe that climate change is real and present scientific and environmental observable proofs to the global community that climate change is unequivocal and is being exacerbated by unfriendly anthropogenic activities while on the other side is a group of skeptics rejecting climate proofs presented and continue to propagate their belief that global warming is a myth (Kawambwa, 2022). Climate change experts and meteorologists stated warnings on the end of 19th century on the potential of anthropogenic influence on the global climate system. However, substantial evidence emerged linking climate change to human causes gained more momentum from 1950s, where scientists and climate scientists began measuring the concentration of CO₂ in the atmosphere. In 1958 Charles Keeling's measurement at the Mauna Loa Observatory in Hawaii observed that CO₂ in the atmosphere was increasing with seasonal variation and anthropogenic activities, mainly fuel-dependent industries, was considered the main causative (Keeling, 1960)

Climate change history has evolved from being a scientific concern to public agenda, and it has currently been integrated into every country's development sector, plans, framework, and regional and global targets like SDG. This transformation has brought a complete paradigm shift in climate change concern, as currently being considered both political and scientific. Human-induced GHG emission that cause climate change have become more severe since pre industrial era. This has caused devastating and exacerbated climate threats to both global north and south. This threats not only affects people but also species and ecosystems (North, 2014). According to kawambwa (2022). Human induced GHG emission have reached the level where, from now, widespread climate-related physical impacts will be witnessed across the globe. The increased climate harms

have caused global attention and focus toward achieving common targets of limiting global temperature below 1.5°C. Because climate change is fact and real (Nguyen, 2023; North, 2014), this has increased global attention and cooperation toward addressing climate change challenges through multiple and annual base climate conventions and COP (Abd Hamid et al., 2021; Mohsin et al., 2022).

2.4.2. Factors Influencing the Public Level of Awareness of Climate Change

Studies indicate that public perception and awareness of climate change vary across and within regions (Dorji et al., 2021; Kawambwa, 2022). This section responds to the question of why climate change awareness varies? Studies reveal that individuals' perception and awareness of climate change are shaped by factors that fall into three main categories: demographic factors such as education level, gender, and age; personal experiences, including exposure to extreme weather events; and access to information through advocacy efforts and media coverage.

Age is one of the critical factors determining human familiarity with the surroundings in the environment, including climate change. Several studies reveal that the level of awareness of climate change is significantly influenced by an individual's age (Tabago, 2010). However, most studies conducted on assessing the level of awareness reveal that young people like students have a significant level of understanding which might be attributed to being exposed more to teaching from schools, televisions, radios, telephone (smartphone), newspapers, and magazines (Carr et al., 2015).

Family status and background: The nature of family background has significant impact on the level of climate change awareness of their children. Nature of occupation of parents, income level and educational level of parents significantly affects children understanding of climate change. Tasmin et al. (2014) assert that children or students whose parent have higher educational, children of service holder mothers, and businessman or service holder fathers exhibited higher understanding of climate change. This is the same to children whose parents are academic. This is because Children from highly educated families often benefit from socioeconomic advantages that enhance climate change education. Their parents' greater financial resources and educational background typically enable investment in quality schooling, enriched home learning environments, and

educational technologies including digital devices, reference materials, and online resources that facilitate deeper understanding of climate-related issues. (Knight, 2016).

Access to information from media coverage of the issue and advocacy. It is strongly argued that media like television, radio, magazines, and advocacy play an important role in increasing mass awareness of climate change. People with high access to mass media demonstrate a high understanding of climate change. The study of Sola & Michael (2016) on awareness of climate change and sustainable development among undergraduates in Oyo State, Nigeria reveals that about 88.9% of undergraduates strongly agree that they obtain information on climate change through broadcasts and enlightenment programs on television and radio. Tobler et al. (2012) concluded that media usage is strongly associated with increased awareness of the effects, causes, and solutions related to climate change. However, media that present climate topics in terms of controversy, uncertainty, or debate reduce positive consumers' perceptions of research findings about climate change.

Level of education: Education plays a pivotal role in raising public awareness and fostering active community participation in addressing climate change (Akrofi et al., 2019). Elsharkawy et al. (2024) and Sola and Michael (2016) emphasize that education is a critical catalyst for promoting adaptive behaviors and effective responses to global climate change. Empirical evidence consistently shows that climate change awareness increases with higher educational levels (Kawambwa, 2022; Tasmin et al., 2014). This is supported by Floranza and Campus (2020) who argue that as individuals advance to higher levels of education, their attitudes and awareness of climate change also increase. For instance, Elsharkawy et al. (2024) found that over 50% of university students are aware of climate change, a finding consistent with Dorji et al. (2021), who reported similar levels of awareness among high school teachers. However, these results contrast Kawambwa (2022), who found that only 35.7% of students demonstrated high climate awareness. Additionally, Dorji et al. (2021) highlight that educational background, particularly the subjects studied, significantly influences the level of climate awareness, further underscoring the importance of education in shaping understanding and responses to climate change.

Also, personal experiences play a significant role in shaping perceptions of climate change. The study by Akrofi et al. (2019) reveals that students living in Central and East Africa strongly agree

that climate change causes water conflicts, compared to students from North Africa, with the lowest agreement from West Africa. This result is influenced by the fact that students in Central and East Africa experience transboundary water conflicts in the Nile River and Congo Basin. In addition, literature supports the idea that individuals (such as farmers, students, and other stakeholders) involved in activities related to or affected by climate change demonstrate higher awareness compared to others. Nguyen (2023) adds that some peoples' awareness and perception change after first hand encountering of extreme weather impact. Moreover, the study of Sola and Michael (2016) asserts that about 73.5% of student are aware of the information on climate change through excursions and field trips.

Moreover, the area of specialization or academic program plays a crucial role in shaping students' understanding of climate change. For instance, the subjects or courses a student studies directly influence their awareness of the issue. In secondary schools, some subjects include topics related to the climate or the environment. Floranza & Campus (2020) highlight that academic programs significantly affect the level of awareness regarding climate change, its effects, and potential adaptation and mitigation strategies

2.4.3. Mitigation and Adaptation Practices in Climate Change

Climate change is unquestionable, and its devastating impact is beyond no doubt. It has already impacted and projections indicate that it will continue to cause negative effects on all humans and well-being, including water and food accessibility, energy use and production, migration, political stability, governance, international trade, socio-economics, human health lifestyles, governance and political stability (Ofori et al., 2023). Hill et al. (2016) add that natural systems, including terrestrial and marine ecosystems, are unexceptional to the damaging effects of climate change. Moreover, disease, pests, and the invasion of alien species have been exacerbated. The devastating impact of climate change poses a threat to attaining the UN SDG (Anderson, 2016; Ebi & Hess, 2020).

To address these impacts UN, IPCC, Environmental experts, and climate and environment conventions and conferences advocate for mitigation and adaptation practices as a solution to the current climate change global crisis. This is strongly supported by Hiller (2011) that, it is not

unethical to carry out actions in cases where there is potential expected harm if that person does not actually anticipate expected harm.

Mitigation practices involves the range of interventions that aims to reduce or stop GHG emission from sources or concentration in the atmosphere (Nguyen, 2023). It involves practices like investment in clean and renewable energy, energy efficiencies, afforestation and reforestation, waste management, sustainable transportation (electric vehicles, public transport, and non-motorized transport such as biking and walking), sustainable agriculture like crop rotation, reduced tillage and organic farming, change of lifestyle and reduced consumptions including meat and carbon capture and storage technologies and green food (Anderson, 2016). These actions reduce GHG emissions or remove CO₂ from the atmosphere, contributing to the stabilization and reduction of atmospheric GHG levels. As a result, they help mitigate many of the adverse effects of climate change.

Since concentrations of GHG in the atmosphere is too much, the measures taken cannot significantly stop occurrence of adverse impact of climate change (Ben Naceur, 2024). Anderson (2016) add that some impact of climate change will continue despite mitigations measures, hence adaptation measures are paramount strategy to the current exacerbated negative consequences of climate change.

Adaptation practices is stated by Anderson (2016) as enhancing resilience in both ecological and societal systems by modifying social, environmental, and economic structures to cope with climate change impacts. It involves all practices that help to adjust to the current and expected climate hazards like floods, drought and heatwaves that minimize harms or help human to exploit benefits resulting from opportunities of climate change. These practices may involve crop diversifications, drought tolerant farming, early or late timing of planting season, sustainable farming (agroforestry, intercropping, mixed cropping, cover cropping, crop rotation), water management (rainwater harvesting, improved irrigation like drip irrigation), reforestation and afforestation, wetland restoration, strengthen healthcare systems and migration or Withdrawal of threatened populations (Ben Naceur, 2024).

It is important to note that there is no way people will adapt and mitigate without being informed. Hence education that imparts knowledge and skill on mitigation and adaptation measures should be prioritized. The skills and knowledge provide a chance for the changing behaviors of people to decrease exposure to climate impacts while building the capacity to anticipate, absorb, and reorganize in response to climatic stressors (Anderson, 2016).

2.4.4. Global Public Perception and Level of Awareness of Climate Change

Climate change perception among people is relative as it varies across nations and time (Capstick et al., 2015). The responses to climate change by individuals, societies, and governments often depend on how the public perceives its causes, effects, and broader impacts (Pietsch & McAllister, 2010). For instance, when people understand the anthropogenic drivers of climate change, they are more inclined to support or adopt proactive measures (Pietsch & McAllister, 2010).

Studies indicate that early in the 1970s, people across the globe had negative perceptions and low awareness about climate change. This was attributed to the fact that the negative consequences of climate change were not so severe and pandemic. Positive opinions and awareness have significantly increased across the globe due to the devastating effect of climate hazards, which are felt all over the earth (Capstick et al., 2015). However, there is growing skepticism about climate change more in the United States, the UK, and Austria than in Sub-Saharan and South America, where climate change concerns have increased (Capstick et al., 2015; Pidgeon, 2012). This is believed to be caused by various factors such as climate fatigue, inaccurate media coverage, the global financial crisis of 2008, and over-scientific projections and estimations (Capstick et al., 2015). This slightly differs with the study of Knight (2016) which highlights two key points: (i) climate change awareness correlates more strongly with national wealth and education levels than with political ideology or geographic vulnerability to climate effects; and (ii) acceptance of anthropogenic climate change is significantly higher in economically developed nations, more vulnerable, and better-educated countries. This shows that developed countries demonstrate a high positive awareness and perception of climate change compared to the developing countries (global south). However, Korkmaz (2018) notes that notable variations within countries exist both developing and developed countries like Turkey.

2.4.5. Public Climate Change Awareness and Perception in Africa

Africa is not an exception to the devastating threats of climate change with the huge population living in rural areas (Elum et al., 2017). The majority of Africans are employed in farming and agriculture that heavily depends on rainfall. This has made majorities vulnerable to climate change hazards like floods, drought and hailstorms. The increased rainfall and prolonged drought have resulted to low crop yield affecting rural farmers whose income and employment depend on agriculture and livestock keeping (Elum et al., 2017).

Since most of Africans depend on climate-related economies, they are best to tell their experience and how they are impacted by climate change (Ibeabuchi et al., 2017). The majority of farmers reveal that they are aware of climate change, this is corroborated by Ibeabuchi et al. (2017), which examined farmers' perceptions and awareness of climate change in Nigeria. However, some farmers view climate patterns as naturally occurring and others associate it with traditional beliefs (curse) and God. The perception and awareness of climate patterns in Africa are relative to the person, and place. For example, most educated people acknowledge the truth of climate change and need immediate action, this is similar to businessmen. Studies also reveal that some people especially farmers and the elderly know that seasons and durations of rainfall, drought periods, and environmental temperature have changed, however, they do not understand climate change (Akponikpè et al., 2010). This shows that the majority do not know the meaning of terminologies used to express the average changes in atmospheric weather conditions.

A significant number of Africans demonstrate low awareness of mitigation and appropriate adaptation measures of climate change (Knight, 2016). Most farmers do not know anthropogenic activities that accelerate climate change, very few are aware while the majority associate it with their faith (God) and curse. The study of Akponikpè et al. (2010) conducted on West African countries shows that farmers often seek services from rainmakers to stop prolonged drought by making rainfall to fall after special rituals. Community level, mosque and church prayers are common in Africa for dry spell and prolonged rainfall. Moreover, these rituals and prayers are said to be performed at the beginning of rain season (Akponikpè et al., (2010).

Although African communities have been using indigenous knowledge for climate change adaptation like migration, building house with big wall, Zai technique, using ashes for crop pests, ritual ceremonies (by rainmakers), early planting seasons and early harvesting (Akponikpè et al., 2010). Majorities are unfamiliar with the scientific measures for climate change adaptation which are currently advised by experts and IPCC. This is because the current climate hazards are too extreme, frequent and unpredictable such that, they cannot be adapted by using native or local or indigenous knowledge. Low investment in scientific methods of adaptation, financial constraints, insufficient experts and limited access to information and low government supports accounts for low awareness and negative perception about climate change (Elum et al., 2017)

However, increased multiple initiatives, programs, and efforts like media influence, youth engagement (activisms), climate regional and national meetings and conferences, and implementations of government climate-related projects like construction of dams for farmers and for electricity, afforestation campaign and employment of extension officers is significantly contributing to the change of negative perceptions and increase of climate change awareness among communities (Elum et al., 2017).

2.3.6 The Role of Education in Creating Awareness of Climate Change

Since 1992, the UNFCCC has recognized the role of education against the global climate change (Léna & Wilgenbus, 2020). Countries are responding to the call by integrating climate change into their education curriculum. IPCC's working groups argue that education sector as a paramount entity must emphasize the development of strategies for climate change adaptation and mitigation strategies. Disaster Risk Reduction Education (DRRE), Education for Sustainable Development (ESD) and Environmental Education (EE) are used in an approach of climate change education, however countries teach climate change either in form of single-disciplinary or multidisciplinary approach (Belma et al., 2019).

Since global climate change is triggered by human being. It is important people to know how they cause, how to avoid the causative activities, how to respond to anticipated effects, how to develop innovate solution which does not compromise the development of countries and how to strengthen the developed actions. All this needs to be learnt and communicated through capacity building

from one region or community to another and generation to another (Frans, 2009). Hence, education plays an important role in addressing the global climate crisis by enhancing individuals' awareness of the necessity for action and enabling them to make sustainable choices in both personal and professional settings (Damoah, 2023; Floranza & Campus, 2020). In addition, Damoah asserts that CCE equips individuals with the knowledge and skills needed to take meaningful steps in lowering their environmental impact, push for changes in policies, and contribute to solutions at the community level.

However, most countries' formal education is not well-equipped to teach individuals how to adjust to a shifting climate (Frans, 2009). Most of the educational adaptation practice takes place outside of schools, in communities, and is not well-documented (Léna & Wilgenbus, 2020). The reluctance of people to change their lifestyle with the claim that it will cost their lives poses a challenge to climate change education. Studies prove that people's awareness of an environmental issue does not necessarily make people take action. Moreover, structural characteristics of a country like war, insufficient resources, and poverty, limit education on climate change. Since climate change becomes the last when society lacks survival food (Naoufal, 2015).

2.5. Conclusion

According to the evidence examined in this chapter, notwithstanding the doubts of a small percentage of experts, there is global agreement that a climate crisis is occurring. In the underdeveloped world, understanding of climate change is shockingly low, even though the impacts of climate risks are most likely to affect these nations. The research review also revealed that public perception and awareness of climate risks are significantly influenced by gender, age, educational attainment, life events, and information availability. However, there is an inadequacy of research on climate change understanding and perception, particularly in the Makete district of Tanzania.

2.6. Research Gap

To date, the bulk of literature on climate risks have focused more on causes and effects, particularly focusing on agriculture and energy sectors. Even a few of the present have focused on assessing

knowledge of students on causes and effects. Assessing secondary student awareness of climate change and adaptation practices has not been a priority of environmental researchers (Monroe et al., 2019b).

In Tanzania, there is no clear understanding of the knowledge of students on climate change and adaptation practices who are key stakeholders in spreading climate awareness. Few researches that focused on assessing students' awareness of climate change were based on university students and the one research that was conducted on secondary students was based only in a city and focused only on climate change awareness, ignoring assessing students' knowledge of mitigation and adaptation practices. Additionally, existing studies did not reveal the gender disparity in secondary students' awareness of climate change adaptation practices. Moreover, there is a paucity of studies in Tanzania that examine the locational (rural and urban) difference in secondary school students' awareness of climate change and adaptation practices.

To effectively gauge students' understanding of climate change, it is important to assess their awareness of both climate change and adaptation practices while examining disparities across factors such as gender, age, school location, class level, and grade level. Insights into students' awareness levels can guide education practitioners and curriculum developers in implementing targeted measures to enhance their understanding and engagement with climate change issues.

3.0. METHODS

3.1. Introduction

This section outlines the methodological framework employed in the study, detailing both data collection and analysis approaches. Precisely, it focused on sample size and sampling procedure, the research design, target population, research instruments, data collection procedure and analysis tools. Additionally, the study area is described to provide contextual understanding.

3.2. Descriptions of the Study Area

The study area, Makete District Council, is geographically located in Njombe Region, Tanzania, as shown in figure 2

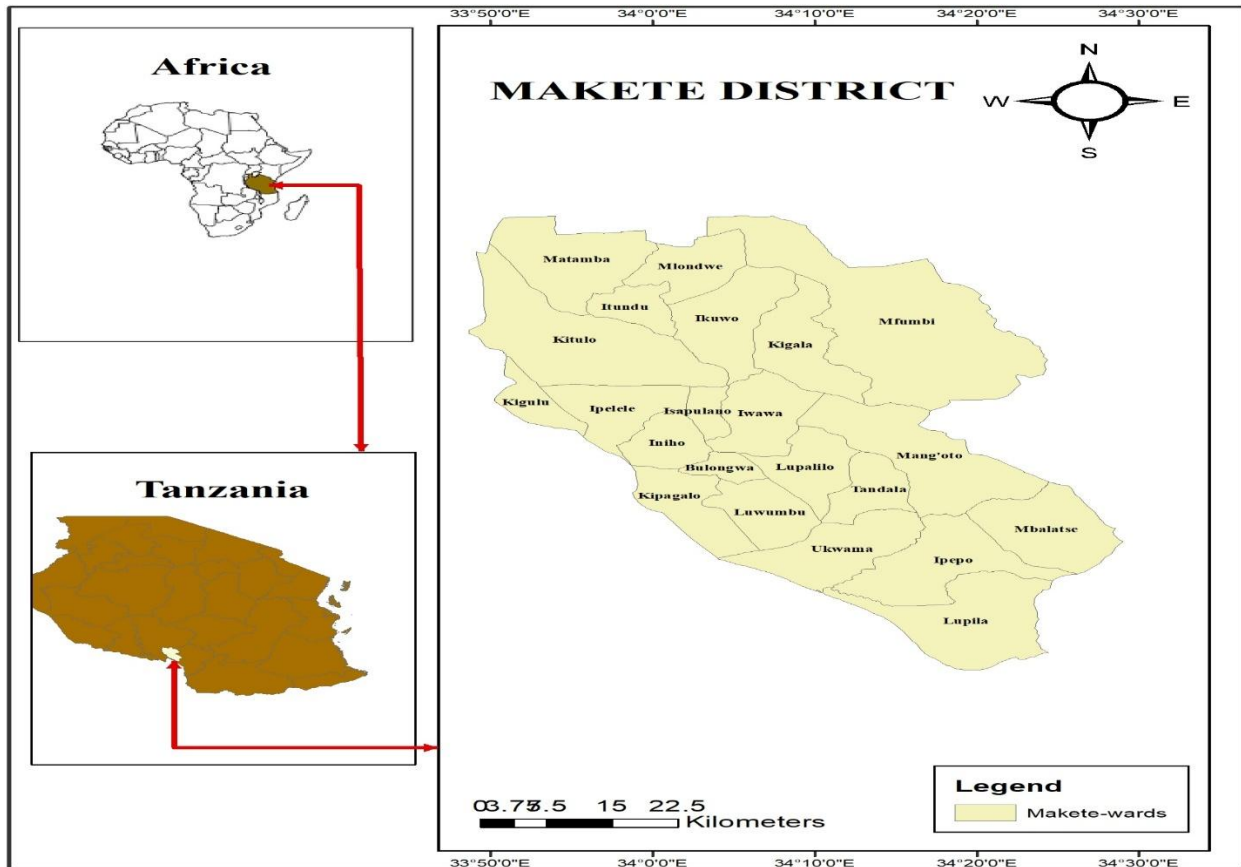


Figure 2. Location map of Makete district

3.2.1. Geographical location and climate

The research was conducted in Makete District, located in the Njombe Region of Southern part of Tanzania. The district borders Lake Nyasa to the south, Mbeya Region to the west, and Njombe District to the east. Geographically, the district lies between latitudes 08°45' and 09°40' south of the Equator and longitudes 33°85' and 34°30' east of Greenwich. Makete District features a tropical climate, characterized by cold zones in high-altitude areas, where mean surface temperatures range between 2°C and 20°C, and annual rainfall averages between 1,500 and 2,800 mm. These high-altitude areas, ranging from 1,500 to 3,000 meters above sea level, include the Kipengere and Numbi Mountains, as well as plateau regions such as Kitulo National Park, making Makete one of the coldest districts in Tanzania. In contrast, low-altitude areas, such as the Usangu plains, experience higher mean surface temperatures (2–30°C) and lower annual rainfall (300–800 mm). The district has a unimodal rainfall pattern, with the wet season occurring from November to May and the dry season extending from June to October (Ndaki et al., 2021).

The district has a total surface area of 5,800 sq. km. It shares borders with the Mbeya Region to the north and west, the Njombe District to the east, and the Lake Nyasa and Ludewa District to the south. It has seventeen wards and six divisions (Makete District Council & Ministry of Finance, 2013).

3.2.2. Population

According to the 2022 Tanzania National Census, the population of Makete district is 109,160 inhabitants (52,180 are males and 56,980 are females and the population in the age group 10-19 is 22,635) (URT, 2022).

The study was conducted in both public and private secondary schools, located in both rural and urban areas within Makete District. The study focused a population of higher secondary school students (Form 5 &6) with a student population of around 1860 in a total of eight schools currently present in the study area. The public schools used were Usililo, Lupalilo, Iwawa, Makamba, Makete Girls and Mwakavuta while the private school were Ikamba and Bulongwa. Advanced secondary school students were chosen because the researchers assumed that they are more familiar with the concept of climate change and that they are more likely to be exposed to climate-

related information. In addition, advanced secondary school students in Tanzania are selected from different region of the country, thus they are exposed and experience in different climate issues and events.

3.2.3. Economic Activities

Makete District offers diverse economic opportunities, primarily driven by agriculture due to its 4,195 sq. km of arable land. Farming includes annual and permanent crops, supplemented by salaries, casual labor, and businesses. In highland zones, food crops like sorghum, beans, maize, and cash crops such as coffee and pyrethrum are grown. Lowland zones rely on irrigation for maize, groundnuts, sorghum, and tropical fruits, with grazing dominating due to temperature conditions. However, only 371 sq. km of arable land is cultivated annually, while the remaining 3,824 sq. km is unused due to infertility, grazing, or reserved for riverbeds and investors (e.g., Ibagha Farm, Kitulo Game Reserve). Natural resources like fisheries, forestry, wildlife, and bee-keeping support fishing, lumbering, and tourism, employing over 0.5% of the district's labor force (Makete District Council & Ministry of Finance, 2013).

3.3. Research Design

This study adopted a descriptive survey design. A descriptive survey seemed most appropriate for this study as it allowed for the identification and description of student's awareness of climate change and adaptation practices. A descriptive survey design based on a proportioned random sampling method for selecting the students to be used. This is because Advanced students are grouped based on their combination of subjects (Arts, business, and Science subjects) each combination takes three subjects plus compulsory subjects (CBG, HGK, GHL, HKL, PCM, PGM etc.)(TIE, 2007). Primary data were collected by the use of interviews, observation, and questionnaires which were distributed in Advanced Secondary Schools, while secondary data were collected by reviewing existing literature from journals, previous publications made concerning the same topic, and the District Education office (DEO) of Makete.

3.3. Sample size and sampling techniques

3.3.1. Sample size

In this research, sample size was used to refer to the number of participants (advanced students) in a sample (Bhalerao & Kadam, 2010). Proper sample size calculation serves as a cornerstone of research design, affecting both the reliability of results and their potential for population-level interpretation (Das et al., 2016).

In this survey study, the total population (advanced secondary students) was 1860 with a sample size of 330. To arrive that sample size of advanced students, the quantitative study formula proposed by Israel (2012) was used to select a sample size. Below shows how the sample size of 330 was obtained from the population of 1860.

The sample size for advanced-level students

Equation 1: $n = N \div (1 + N(e)^2)$:

Where n = sample size,

N = total population (1860),

e = margin of error (sampling error) set at 5% (0.05) and a 95% confidence level.

Using the above formula, the sample size was calculated as follows:

$N \div (1 + N(e)^2)$:

Equation 2: $n = 1860 / (1 + 1860(0.05)^2) = 330$

Thus, the formula yielded a total sample size of about 330 secondary school students.

3.3.2. Sampling Techniques.

Makete district was purposely selected as a study area due to a diverse nature of its geography and settlement pattern, which gave chance for the researcher to collect data from advanced schools both located in rural and urban areas. Occurrence of climate phenomenon such as flooding,

drought, severe cold reaching to 2°C and sea level rise in Lake Nyasa was another reason for the selection of this area. Additionally, familiarity of the district by the researcher added the cause for its selection.

The study employed simple random sampling. The district consists of only eight advanced (High) schools. All eight schools were used and students from those schools were proportionately selected randomly from their class level. The difference in the number of samples obtained from each school through proportionate sampling was due to the disproportionate size of the student population in each school.

To get proportionate sample from each school, the researcher used proportionate approach, which begins by determining the probability of selecting total students to be sampled from each school unit using the formula:

$$n/N$$

Where: **n** is the desired sample size; **N** is the total population of all students from all eight school

$$n= 330 \quad N=1860$$

$$\text{probability} = n/N = 330/1860$$

The probability of occurrences of each student in a school was 0.177

Table 1.0 shows the sample size of students from each school. The chance for inclusion of any student from each school within the advanced school of Makete was thus 0.177 or (330/1860). The number of sample sizes from each school to be included in the sample was then achieved at by multiplying the total students of each school by 0.177 as illustrated in columns 4 and 5

Table 1. Sample Size of Students from each school (Source: District education office (DEO), 2024)

NAME OF SCHOOL	TYPE OF SCHOOL	TOTAL STUDENTS IN A SCHOOL	FORMULA n/N	NUMBER OF STUDENTS TO BE SAMPLED
Bulongwa	Private	46	$46/1860 * 330$	8
Itamba	Private	98	$98/1860 * 330$	17
Iwawa	Public	290	$290/1860 * 330$	51
Matamba	Public	246	$246/1860 * 330$	44
Makete girls	Public	168	$168/1860 * 330$	29
Mwakavuta	Public	466	$466/1860 * 330$	83
Lupalilo	Public	360	$360/1860 * 330$	64
Lupila	Public	186	$196/1860 * 330$	35
Total		1860		330

Moreover, the researcher randomly selected students from each school based on the proportion of the total sample size to be selected from each school. The selection of sample size based on the proportionality of gender and subject specialization was not considered since some schools were single-sex, like Makete Girls' secondary school, and other schools had one or two specializations only. For example, Iwawa secondary school had no science subject and Bulongwa secondary had only art subjects.

A total of 350 questionnaires were prepared to be distributed to a sample size of 330 students from eight schools. 20 questionnaires were distributed to 20 students who were used in a pilot survey. There was no modification to the questionnaire since the questions were well responded to. Moreover, students who were used in a pilot survey were not included in the data collection. A total of 330 sample size were believed by the researcher to be enough representation in this survey study out of 1860 students from 8 schools.

3.4. Data Collection Method

To obtain the needed data, an introductory letter from the Pan African University Institute of Water and Energy Sciences including climate change (PAUWES) was presented to the District Education Office (DEO) to get authorization for collecting data from schools in the district. The research authorization letter from DEO was handed to the researcher. Then the researcher reported to the reception desk in the school, where the researcher was directed to the Head of the school, who was in charge of the institution. After presenting an introductory letter from DEO and PAUWES and briefing on the objective of the visit, the researcher was granted authorization to conduct the research.

Data were collected through secondary and primary sources. The data collected from the primary source include: students' level of awareness of climate change; students' knowledge of adaptation and mitigation strategies for climate change; and climate change adaptation practices by secondary school students. These data were collected through a school field survey using questionnaires, observation sheets, and interview guides. The field data collection took sixteen days (approximately two weeks). On the other hand, scholarly journal articles, books, reports, and documentaries were used to collect secondary data.

3.5. Research Collection Instruments

For the entire processes of collecting field information from eight secondary schools, the researcher used three tools which were questionnaires sheet, observation guides and interview guides along with voice recorder instrument.

3.5.1. Questionnaires

For this study, the researcher employed semi-structured questionnaires. A total of 350 questionnaires were used, 20 questionnaires were used during a pilot survey, and the remaining 330 were distributed to a total of 330 students, who were used as the sample size. The questionnaires were divided into 5 sections labeled A, B, C, D, and E. Section A constituted background information; Section B, consisted questions about students' level of awareness of climate change with twelve Likert statements; Section C consisted correct, incorrect and I don't

know statements about students' knowledge on the adaptation; Section D contained correct, incorrect and I don't know statements about students' knowledge on the mitigation of climate change and Section E contained about climate change adaptation practices by secondary school students with ten (10) statements showing whether a student participate or do not in adaptation practices at home or school.

3.5.1.1. Validation and pre-testing of questionnaires

The pre-testing process was conducted at MWL. Tutuba Secondary School located in kibondo town. The school consisted of advanced and ordinary level students with a mix of boys and girls. Only advanced-level students were used to reflect the targeted group of this study. About 20 students (10 girls and 10 boys) were supplied with a questionnaire. The primary goal of the pre-test was to confirm that the target group could truly provide meaningful answers and comprehend the questions and proposed answer possibilities as intended by the researcher (Bishoge et al., 2022).

In addition, the questionnaires were distributed to teachers of MWL. Tutuba secondary school for pre-testing. Moreover, the supervisor of the researcher approved the questionnaires. A few modifications were added due to comments from the supervisor and the 20 students used in the pre-testing were able to understand and answer the questions correctly. The English language used in constructing the questionnaires before pre-testing was not translated, as the students in the pilot study were able to answer the questions correctly. The fact that students of advanced level have already mastered the English language was the reason for being able to comprehend fully the questions.

3.5.1.2. Construction of Likert Scale

Rensis Likert created Likert Scaling in 1932, and it is used in surveys to gauge respondents' attitudes according to how much they agree to a series of statements (Hooker, 2016). The researcher employed a Likert Scale to measure students' level of awareness of climate change. A scale of 0-4 was used, where 0 = Strongly Disagree and 4 = Strongly Agree for the given statements and 2 = 'Don't know', this response in this study was used to mean lack of knowledge against the statement given.

3.5.2. Interviews

The study employed semi-structured interviews. The interview guide was divided into five sections: A, B, C, D, and E. Section A focused on demographic information and included three questions. Section B addressed climate change awareness, while Section C explored climate change adaptation. Section D covered climate change mitigation with four questions, and Section E focused on climate change adaptation practices among secondary school students, comprising three questions.

A semi-structured interview was arranged and used to interrogate teachers who are responsible for imparting knowledge to students (head/second master, academic master and other 8 environmental teachers). In addition, 2 WEOs were also interviewed. The interview questions varied based on the category of interviewees. The interviewees were 3 head of schools, 3 academic masters, 2 ward education officers, 8 teachers of environment and education for self-reliance and 20 students who included head of students, environmental prefects and other school leaders.

3.5.3. Observation checklist

This method was used to assess adaptation and mitigation practices that have been or are being implemented at the school. Environmental conservation practices and resource use were observed under the guidance of the environmental teacher and the environmental student prefect. The observation instrument consisted of ten (10) climate adaptation or mitigation indicators, behaviors, or practices, with three open-ended spaces. The sheet was filled out by the researcher based on direct observations. A total of eight observation sheets were used, with one sheet completed for each school.

3.6. Data analysis

The data collected were summarized, coded, and analyzed both quantitatively and qualitatively. Then the data was processed with the Statistical Package for Social Sciences (SPSS) for quantitative data and description for qualitative data such as interviews, open questionnaires, observation, and documentation. Data analyzed using SPSS were presented in tables and graphs

using frequency distribution and percentages, while the qualitative data were analyzed using thematic analysis and presented in text format

Descriptive statistics such as mean and standard deviation were used to summarize and describe the central tendencies and variations in the data that were collected. This provides a basic overview of students' awareness level of climate change and adaptation practices. Simple descriptive statistics like mean, frequency count, percentage and standard deviation were used. Likert statement and others with three optional responses were analyzed as individual item and group with additional use of summative method. Detailed analysis employed were Independent-t test, One-way ANOVA, Spearman's rho test-correlation analysis and the Mann-Whitney-U test. The hypotheses were tested at a statistical confidence level of 95%. The data analyzed were presented in tables, charts and graphs.

3.7. Ethical Consideration

In his survey study, ethical issues were considered. First by obtaining permission to undertake the research at the site. The researcher requested a research introduction letter from the Director of the Pan African University Institute of Water and Energy Sciences including climate change (PAUWES), then, the introduction letter was used to request a research data collection letter from the district education office (DEO). Both two letters were presented to the heads of schools after a brief introduction of the aim of the visit. Secondly, the study adhered to ethical research standards by implementing voluntary participation, where respondents retained the right to withdraw at any stage without penalty. Participants were explicitly informed that the research served exclusively academic objectives. All data were collected anonymously, with no personally identifiable information recorded.

Moreover, to ensure the trustworthiness of the data collected, the distribution of questionnaires and clarification of questions to respondents were provided by the researcher himself. Furthermore, interview processes and filling observation sheets were done by the researcher.

4: RESULTS AND DISCUSSION

4.1. Introduction

The outcomes of the analysis and the discussion of the research data collected from the various study participants are presented in this chapter. For the results, quantitative and descriptive statistics of the study samples were used, while the qualitative aspect was also addressed, with the findings discussed in detail below.

4.2. Socio-Demographic Characteristics of Respondents

Information on respondents' sex, grade, school type, and location was gathered to categorize them and provide a comprehensive picture of the sample characteristics. Thus, the following diagrams depict the features of the sample population:

4.2.1. Gender Distribution

Figure 3.0 below illustrates the respondents' distribution by gender. The results revealed that 56% were female, while 43.9% were male. The data shows a slightly higher representation of female students compared to males. This small difference indicates that there were even and fair representations of both genders. However, the reason for this small discrepancy was that some schools like Makete Girls were single-sex, meaning they only had girls

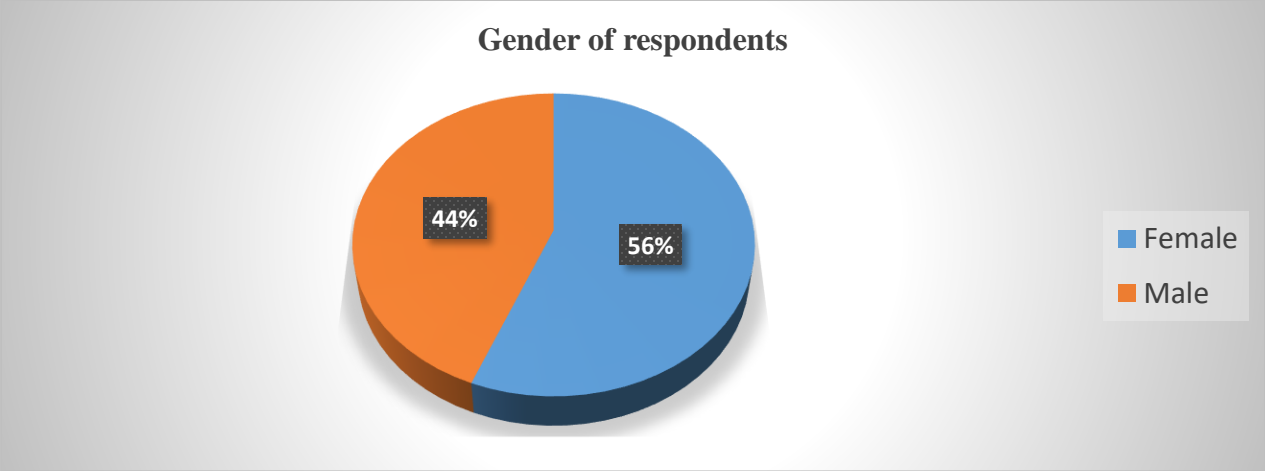


Figure 3. Distribution of Respondents by Sex. (Source: Field data, 2025)

4.2.2. Grade Distribution

Table 2 below presents the grade/ class level distribution of respondents. For the purpose of this study, only two class levels were used, form five and form six.

Table 2.0: Distribution of Respondents by Class Grade. (Source: Field data, 2025)

		student Class grade			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	form five	167	50.6	50.6	50.6
	form six	163	49.4	49.4	100.0
Total		330	100.0	100.0	

Table 2 above shows the distribution of respondents by grade. It presents the class grades of the 330 respondents included in the study. The respondents were divided into two groups: Form Five (Grade 12) and Form Six (Grade 13). The data reveals that Form Five accounted for 50.6% of the respondents, while Form Six represented 49.4%. These findings indicate that Form Five was the modal grade group, as it had the highest response rate at 50.6%.

4.2.3. School Type/Ownership

Table 3 shows the respondents' distribution by school type/ ownership in this study. From surveyed area, schools were either government or privately owned.

Table 2 : Distribution of Respondents by school ownership. (Source: Field data, 2025)

		Ownership of school			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	public school	265	80.3	80.3	80.3
	private school	65	19.7	19.7	100.0
	Total	330	100.0	100.0	

The results from Table 3 show that 19.7% of respondents were from private schools, while 80.3% of respondents attended Government/Public Schools. This demonstrates that the majority of research participants (80.94%) came from government schools. In particular, there were only two private secondary schools in the research area, making it clear that there are fewer private secondary schools in the area compared to Government schools which were six.

4.2.4. Age Last Birthday of Respondents

To provide a clear understanding of the study population, Table 4 outlines the age distribution of the respondents

Table 3: Distribution of Respondents by Age. (source: Field data. 2025)

Age last birthday of respondents students					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16	1	.3	.3	.3
	17	28	8.5	8.5	8.8
	18	95	28.8	28.8	37.6
	19	81	24.5	24.5	62.1
	20	75	22.7	22.7	84.8
	21	14	4.2	4.2	89.1
	22	14	4.2	4.2	93.3
	23	17	5.2	5.2	98.5
	24	3	.9	.9	99.4
	25	2	.6	.6	100.0
	Total		330	100.0	100.0

As shown in Table 4, the ages of the respondents ranged from 16 to 25 years. The majority of respondents were 18 years old, representing 28.8%, followed by those aged 19, who accounted for 24.5%. The smallest proportion of respondents (0.3%) were 16 years old, while the oldest respondents, aged 25, made up 0.6% of the sample. The age range was 9 years, which is relatively small because the study focused on only two grade levels: Form Five and Form Six. According to URT (2022), most students begin Form Five at around 18 years of age. The results also indicate that the minority of respondents (0.6%) were 25 years old, followed by the smallest group (0.3%) of 16-year-olds

4.2.5. Students' Areas of Residence

Figure 4 displays the respondents' area of residence. The result shows that 51% of respondents live in rural areas meanwhile 49% of respondents live in urban areas. The slightest difference asserts that the researcher was fair since there was almost equal representation from both areas of living.

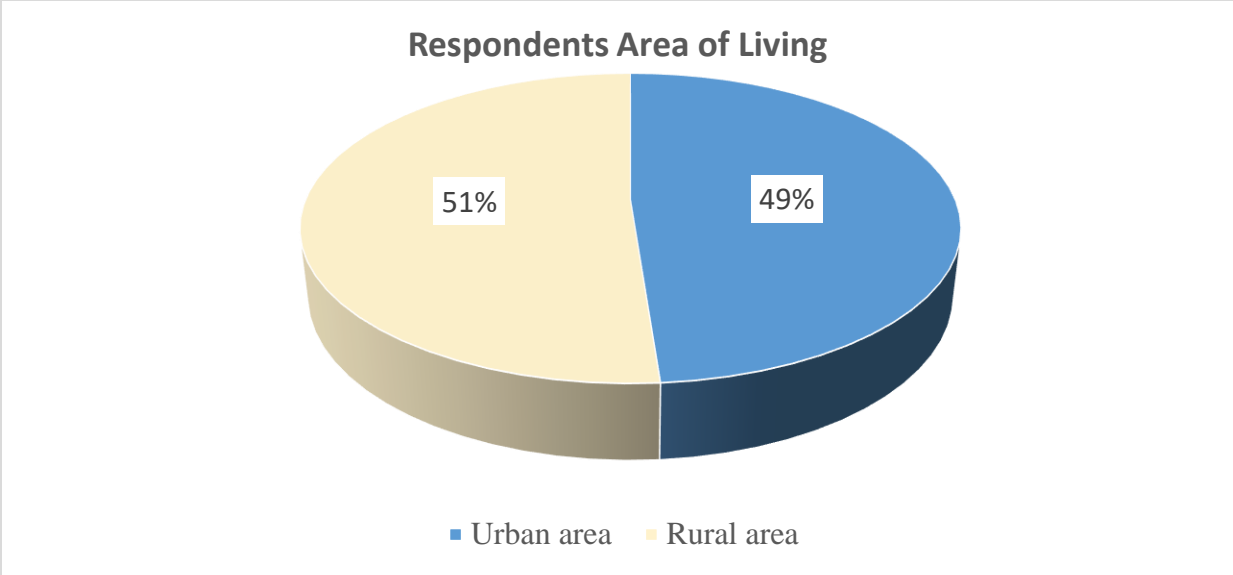


Figure 4. Distribution of Respondents by Area of Residence. (Source: Field data. 2025)

4.2.6. Occupation of Parents

Table 5 indicates the occupations of the parents of the respondents. Four categories of occupations were used namely, farmers, businessmen, civil servants, and the category of others.

Table 4: Distribution of Respondents by occupation of their parents. (Source: Field data, 2025)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Civil servant	36	10.9	10.9	10.9
	Farmers	218	66.1	66.1	77.0
	Business man	60	18.2	18.2	95.2
	Others	16	4.8	4.8	100.0
	Total	330	100.0	100.0	

The result from Table 4 shows that most of the respondents' parent are farmers (66.1%), followed by Business man (18.2%), then civil servant (10.9%), and others (4.7%). Most of respondents' parent occupations are farming, followed by Business man and lastly civil servants. The high percentage of parents to be farmers is because agriculture in developing countries is the main economic activity that employs over 50% in Sub-Saharan countries (World Bank, 2021). Moreover, UNESCO (2015) adds that the majority of the population in SSA including Tanzania reside in rural areas where farming is the main occupation

4.2.7. Area of Specialization of Students

Figure 5 shows students' subjects/areas of specialization. Most of the respondents studied Art (48%), followed by Science (38%), and lastly, Business subjects (16%). The variation was because not each school taught all three subjects of specialization. For instance, Bulongwa and Makete girls' schools taught art subjects only; Matamba secondary school taught Science and Arts subjects, and Mwakavuta secondary school taught all Art, Business, and Science subjects (Field data. 2025).

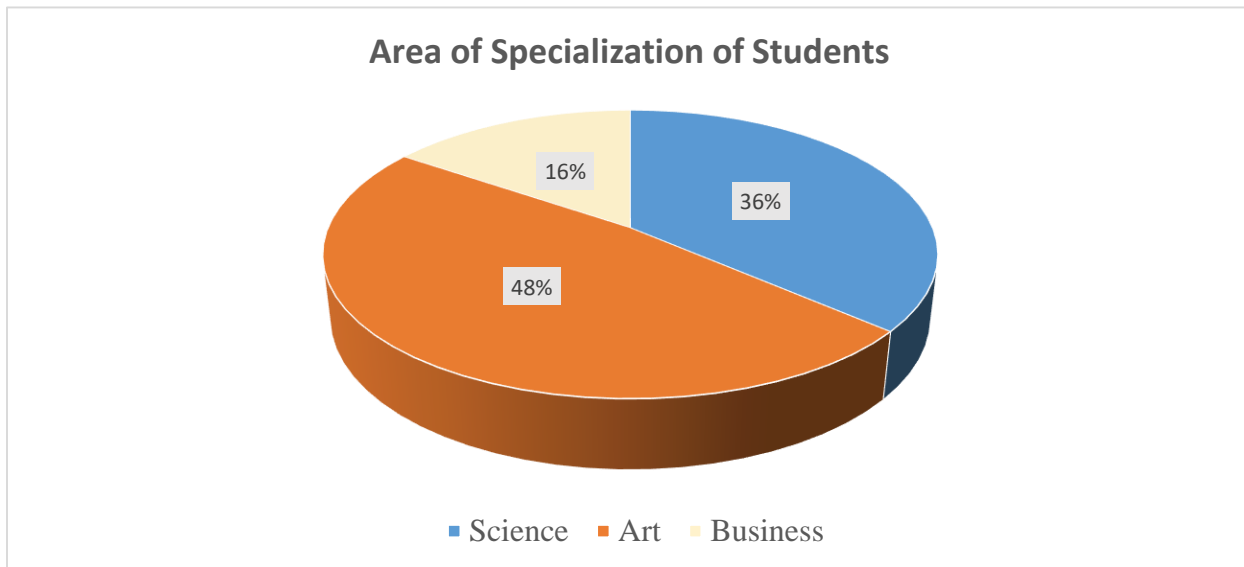


Figure 5. Distribution of Respondents by area of specialization. (Source: Field data. 2025)

4.2.8. School Location

The results from Figure 6 shows that majority of respondents were from school located in rural areas forming 59% and from urban accounted 41%. In particular, school were evenly distributed,

four in rural (Iwawa, Mtamba, Lupalilo and Lupilo) and four in urban (Bulongwa, Itamba, Makete girls and Mwakavuta). However, they had different number of students as shown in Figure 6 below.

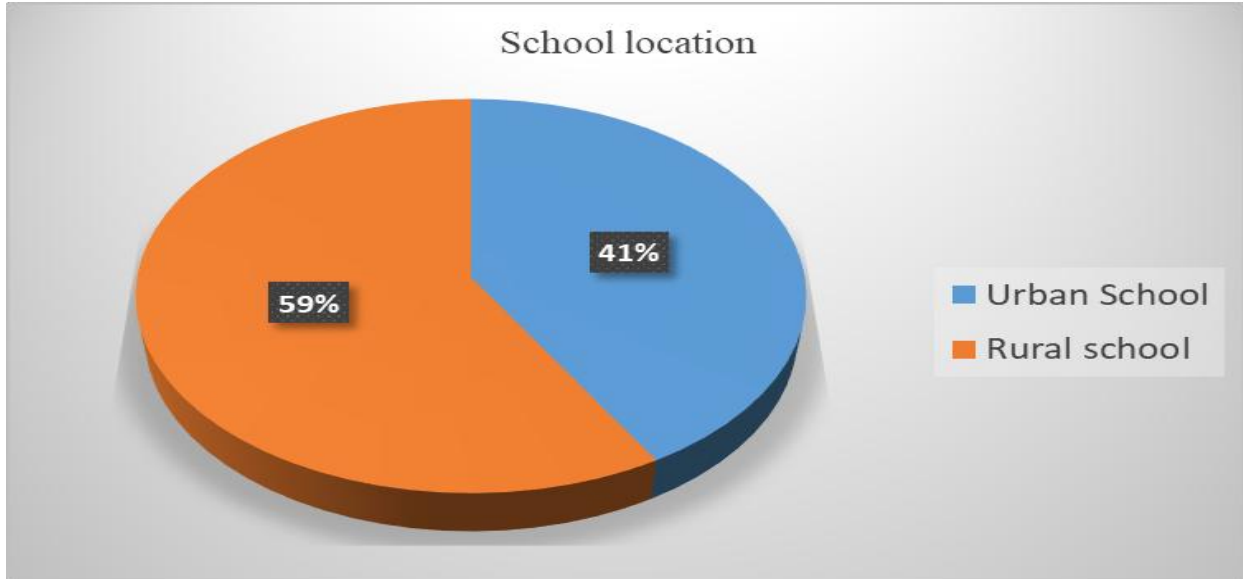


Figure 6: School location

4.4. Awareness of Climate Change

This section analyzes and discusses the level of awareness about climate change, with a focus on gender differences. The analysis compares the awareness levels of male and female respondents, addressing the third research objective, which aimed to examine gender differences in climate change awareness

4.4.1. Sources Used by the Students to Obtain Climate Change Information

According to the survey, when respondents were asked if they had heard of climate change, all agreed that they had. Table 6 presents the gender distribution of responses to the question of whether they had heard of climate change.

Table 5: Students hearing of climate change. (Source: Field data, 2025)

Gender	Yes (%)	No (%)	Total
Female	185 (100)	0	185
Male	145 (100)	0	145
Total	330 (100)	0	330

The result from Table 6 shows that all students surveyed have heard about climate change. All 185 females responded yes, similar to all 145 males. Furthermore, the respondents were asked about the medium (media) which they used to hear about climate change and the results are shown in Figure 7.

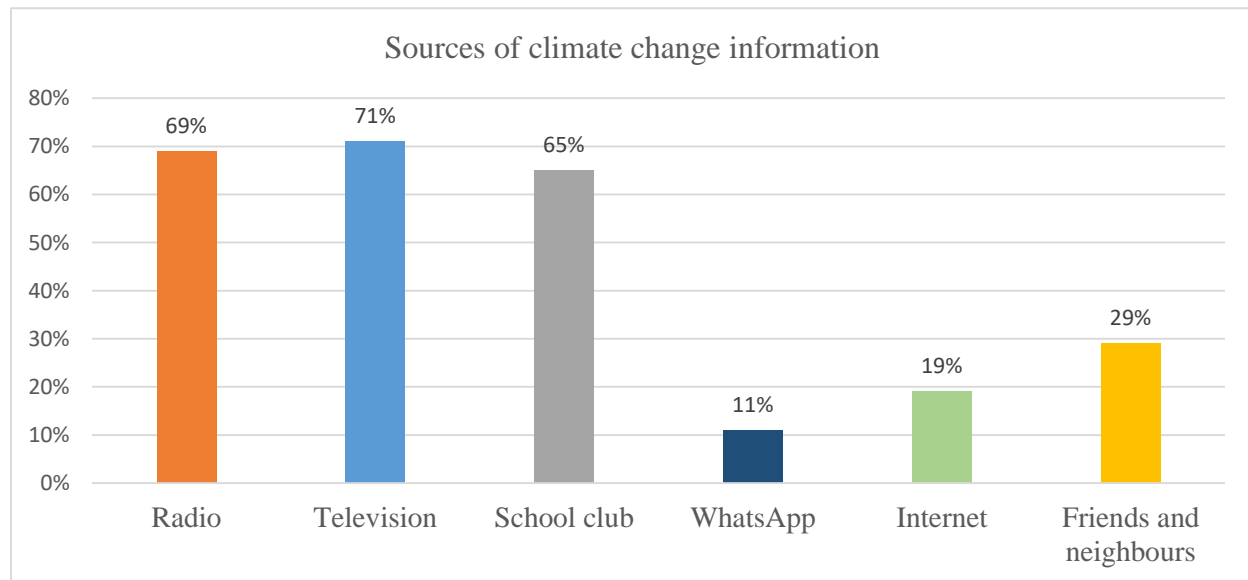


Figure 7. Students' sources of climate change information. (Source. Field data, 2025)

The results from Figure 7 reveal that the majority of respondents prefer to use Radio, Television, and School clubs. 70.91 % of respondents indicated that they used Television, followed by Radio (68.79%) and school clubs (65.7%). WhatsApp method appeared to be a source of climate change information with 11.2% together with the Internet (19.7%). Also, about 29% of the respondents mentioned that they access climate change information through friends or neighbors. Internet and

WhatsApp appeared to be the least used to access climate information. This might be attributed to the Tanzanian education regulations that prohibit Students from using telephones like Smartphones at school. In addition, insufficient use of computers at secondary schools in Tanzania accounts for another reason for the low use of the internet in accessing climate information by students. This result agrees with Joseph (2021), who noted that even some schools in Tanzania with computers lack internet connections, large number of students with few facilities of ICT and lack of steady electricity are other challenges.

4.4.2. Opinion about Reality of Climate Change

Table 7 below indicate the results of respondents on opinion about climate change. Respondents were asked to give their opinion about the reality of climate change. Yes, and no options were provided as response choices for the question.

Table 6: Students’ opinion about the reality of climate change. (Source: field data 2025)

Gender	Yes (%)	No (%)	Total
Female	175 (94.5)	10 (0.5)	185
Male	145 (100)	0	145
Total	320 (96.9)	10 (3)	330

The results presented in Table 7 indicate that 97% of all respondents agreed that climate change is real. Both male and female respondents demonstrated a high level of agreement, with 95.5% of females and 100% of males affirming their belief in the reality of climate change. The slight gender difference observed reveals that males are more likely to perceive climate change as a concrete issue rather than an abstract concept. This higher level of belief among males may be attributed to their greater trust in scientific institutions and increased exposure to formal science education. Such exposure reinforces the credibility of climate science and aligns with social norms that encourage males to engage more frequently with technological and scientific information. This, in turn, strengthens their understanding of the evidence supporting the reality of climate change (Lee et al., 2015).

4.4.3. Indicators of Climate Change

Tanzania exhibits a number of climate change indicators like the rise of seal level, frequent drought and flooding, rise of temperature and decrease of glaciers on the top of Mount Kilimanjaro (NBS, 2020). In this survey students were asked to indicate climate change indicators. Figure 8 below indicates respondents' responses on indicators of climate change. Respondents were asked to tick more than one indicator wherever possible.

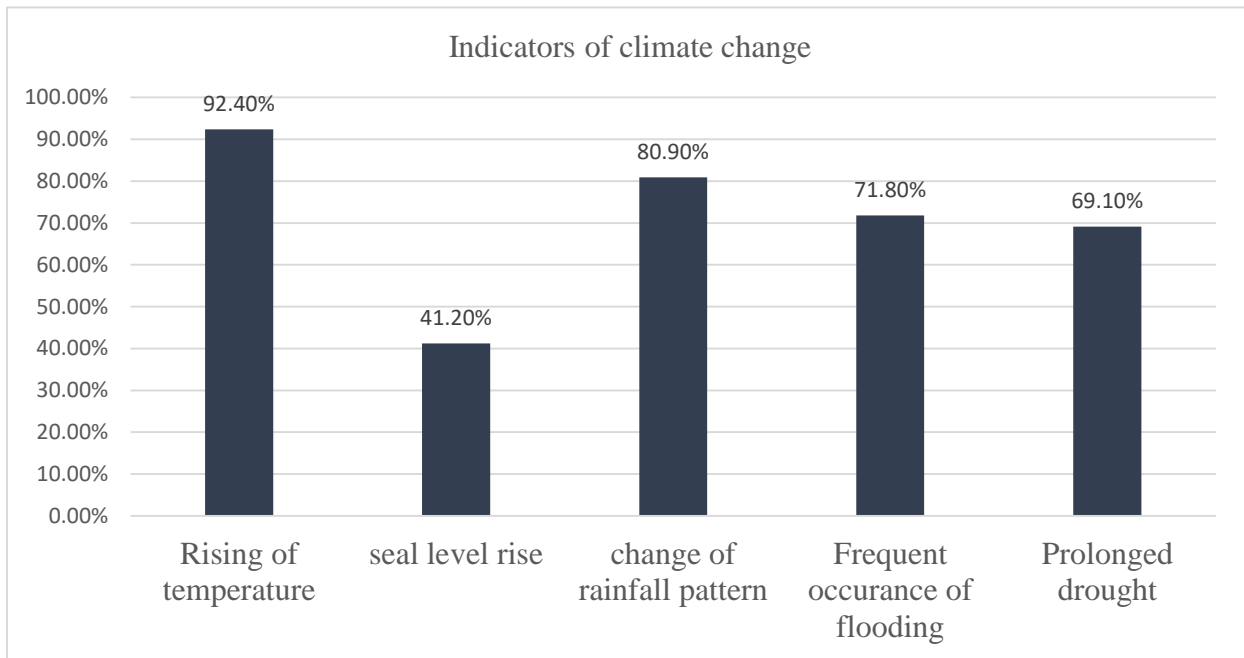


Figure 8: Indicators of change. (Source. Field data 2025)

The results from Figure 8 revealed that most respondents (92.4%) picked the rising temperature, followed by the change of rainfall pattern at 80.95%. A higher number of respondents also revealed a high level of awareness of the frequent occurrence of flooding by 71.8% as an indicator of climate change. This is similar to prolonged drought with 61.09%. And 41.2% picked seal level rise. This indicates that respondents' awareness of sea level rise as a climate change indicator is relatively low. This might be attributed to the fact that not all students live near water bodies such as lakes or oceans. Additionally, oceans and lakes are unevenly distributed across the country. For instance, the central regions of Tanzania lack lakes, which limits students' exposure to these phenomena and contributes to their lack of awareness “United Republic of Tanzania [URT], 2015). Additionally, Leiserowitz (2007) asserts that students low understanding and disagreement is because the rise of

sea level is frequently viewed as a distant or localized issue, especially for those residing in inland areas. But also lack of attention to mass media, the gradual nature of sea level rise, and the lack of emphasis of coastal processes account for the students' knowledge gape of seal level rise (Cline, 2010).

The high percentage of respondents on climate change indicators on the rise of temperature, change of rainfall pattern, frequent occurrence of flooding, and prolonged drought shows that students have high awareness on these climate change indicators. This might be because the indicators highlighted are felt by students since they are yearly happening in Tanzania (Drakenberg & Fernqvist, 2016). Moreover, digital platforms, social media coverage, educational initiatives and school curricula and hands-on learning of students like field trip visits have amplified students' awareness of climate change indicators (Monroe et al. (2019b)

4.4.4. Students' Awareness of Greenhouse Gases

The global focus of limiting atmospheric concentration of GHG below 1.5° c requires an understanding of GHGs. The result in Figure 9 indicates respondents' opinions on awareness of GHG. Respondents were asked to put a tick to any Gas that they know is a GHG.

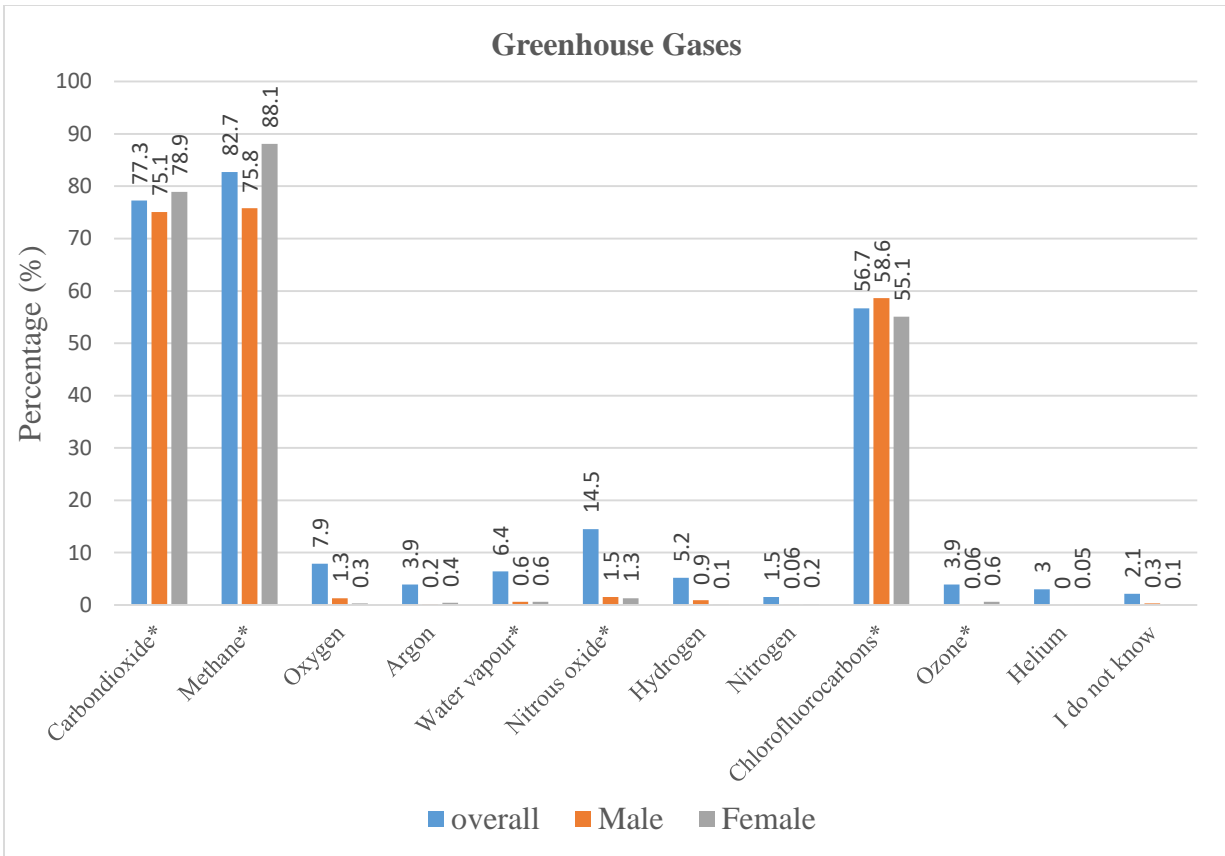


Figure 9: Greenhouse gases. (Source: Field data. 2025)

From Figure 9, most students selected Carbon dioxide (77.3%), Methane (82.7%), and Chlorofluorocarbons (56.7%) as among the principal GHGs. Both genders showed a better understanding of the three GHGs where 75.1% of all males and 78.9% of females responded yes for Carbon dioxide. Also, 75.8 % of all men and 88.1% of all females picked Methane as one of the GHGs, similar to Chlorofluorocarbons where 58.6% of all males and 55.1% of all females responded yes. On the other hand, Ozone, water vapor, and nitrous oxide with star indication from the figure were less selected by respondents while they are among GHG. Few students were aware that Ozone (3.9%), Water vapor (6.4%), and Nitrous oxide (14.5%) are GHG. A minority of students incorrectly identified Helium (3%), Nitrogen (1.5%), Hydrogen (5.2%), Argon (3.9%) and oxygen (7.9%) as among GHG. 2.1% of all respondents answered I do not know, indicating that they are not familiar with GHG. The results obtained differ from the study by Carr et al. (2015) on GHGs awareness among secondary students in Dar es Salaam, which found that none of the GHGs were correctly identified by more than 50% of the students.. This shows positive changes

of increase of awareness among students, despite these two research were conducted in two different geographical areas. High awareness of students about GHG gives them a pro-environment attitude. As argued by Corner et al. (2015), increased awareness of students about climate change significantly increases their willingness to adopt friendly practices and support mitigation measures.

Minority of students incorrectly identified Helium (3%), Nitrogen (1.5%), Hydrogen (5.2%), Argon (3.9%) and oxygen (7.9%) as among GHG. This highlights the knowledge gap as regards awareness of some students about GHG. As highlighted by Chhokar et al. (2011) this confusion of respondents about GHG might be attributed to the fact that most teachers and educational systems give precedence to examination performance over conceptual clarity and reasoning. Moreover, the abstract nature of GHG and their impact which tend to be intangible, and visualize account for the identified gap.

4.4.5. Respondents’ Awareness on the Meaning of Climate Change

Table 8 presents the results of students’ awareness of the meaning of climate change. Respondents were asked to pick one option which they believed to be the correct meaning of climate change.

Table 7: Awareness about the meaning of climate change. (Source: Field data, 2025)

Statement	Gender	Frequency (%)	Total
Rising global temperatures	Male	12 (0.8%)	16 (0.5%)
	Female	4 (0.2%)	
Changes in the average weather conditions towards extremes recorded over long periods (20-30 years)	Male	112 (77.2%)	281(84.2%)
	Female	169 (91.3%)	
Short-term variations in weather patterns	Male	16 (1.1%)	28 (0.8%)
	Female	12 (0.6%)	
Holes in the ozone layer	Female	1	1
	Female	0	
I don’t know	Male	5 (0.3%)	5 (0.3%)
	Male	5 (0.3%)	

The results from Table 8 show that the majority of respondents 281 (84.2%) were aware of the meaning of climate change. They selected a statement that climate change is the Changes in the average weather conditions towards extremes recorded over long periods (20-30 years). Both males and females demonstrated a good understanding of the meaning of climate change 77.2% and 91.3% respectively. However, the minority of the respondents selected incorrect options. 0.5% considered climate change as rising global temperatures; short-term variations in weather patterns (0.8%); Holes in the ozone layer (1 respondent). 5 respondents responded that they do not know the meaning of climate change.

From the results obtained, it is clear that greater emphasis on climate change awareness for students is essential. Approximately 15.8% of all respondents either provided an incorrect definition or stated that they did not know about climate change. These students can be supported through school clubs, classroom activities, and participation in environmental programs. Monroe et al. (2019b) argue that students' inability to accurately define climate change stems from a lack of emphasis on climate science in school curricula and a shortage of engaging, practical learning opportunities that could help them understand the concept. Similarly, Shafiqul Islam et al. (2023) concluded that students cannot develop a positive attitude toward environmental conservation without being aware of climate change climate change.

4.4.6. Students' Opinions on Solving Problems of Climate Change.

Figure 10 presents the respondents' views on whether the problem of climate change can be solved. Respondents were asked the question, 'Do you think the problems of climate change can be solved at all?'

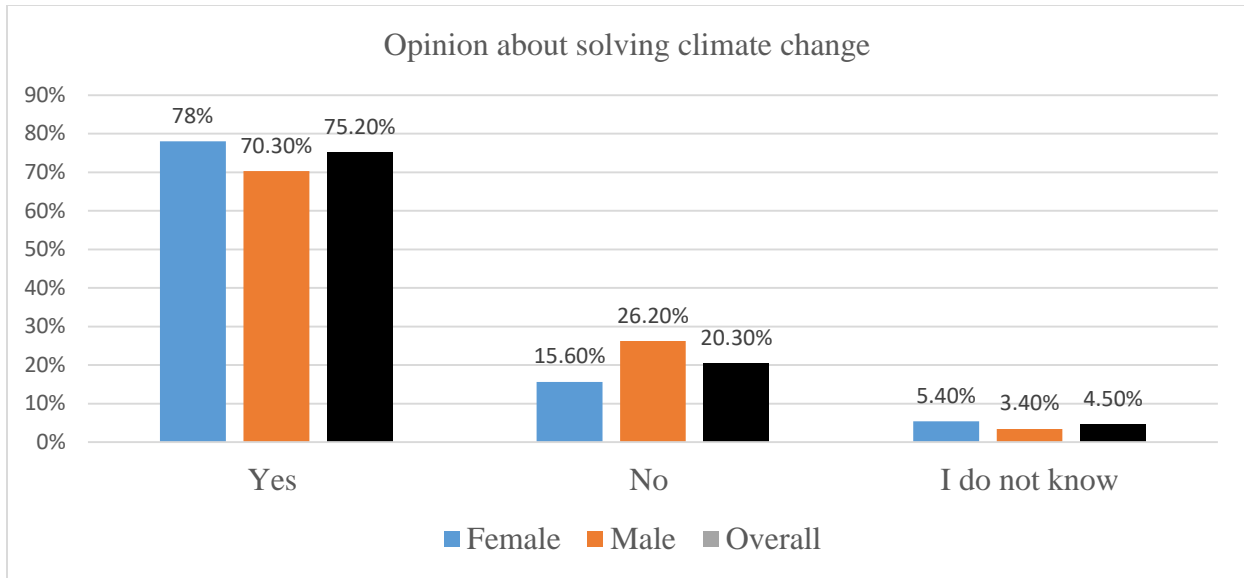


Figure 10: Respondents’ opinion on solving climate change. (Source: Field data. 2025)

The result from Figure 10 shows that a significant majority of respondents 75.2% responded yes believing solvability of the problem of climate change. 20.3% of respondents believe that the problem of climate change cannot be solved at all. This indicates that most students are not pessimistic about the potential for addressing climate change.

Female respondents show a slightly higher percentage of yes with 78% compared to males with 70.3% indicating that Females are more optimistic about addressing climate change. The higher acceptance of females on the solvability of climate change problems is argued by Zelezny et al. (2000) that women are more likely to believe in group efforts and locally driven solutions, which are often the heart of mitigation and adaptation plans for climate change. Also, Ergas & York (2012) add that the traditional and societal caregiving role women make them to plan the future sustainability of their families. This culminates in their strong belief in the solvability of environmental problems. This trust bolsters their optimism in combating climate change. This is contrary to men who often focus on immediate technological and economic challenges which may reduce their optimism on solving climate change (Ergas & York (2012)

On the other hand, 4.5% of all respondents picked ‘I do not know’ of whom 5.4% were female and 3.4%. In addition, 20.3% of all respondents believed that climate change cannot be solved at all. This highlights the necessity of additional climate education and involvement since students might

gain from knowing more about ways to slow down climate change as students may benefit from knowing how to mitigate climate change. Kahan et al. (2012) argues students' skepticism on solvability of climate change might be caused by contradictory messages regarding climate change from political figures and the media and Monroe et al. (2019b) adds that absence of practical ways of teaching students to combat climate change makes them feel helpless and believe that the issue is too big or complicated to handle.

4.4.7. Students' Awareness of the Contribution of Human Activities to Climate Change

Table 9 presents the results from respondents who were asked if human activities contribute to climate change.

Table 8: Contribution of human activities to climate change. (Source: Field data 2025)

Gender	Yes (%)	No (%)	I don't know	Total
Female	184 (99.9)	1 (0.5)	0 (0)	185
Male	143 (98.6)	2 (1.37)	0 (0)	145
Total	327 (99.09)	3 (0.9)	0 (0)	330

The results from Table 9 show that most of the respondents (99.9%) overwhelmingly agree that anthropogenic activities contribute to climate change. Both males (98.6%) and females (99.9%) show significantly affirmed high awareness of the contribution of anthropogenic activities to climate change. The very high percentages indicate a strong consensus among students regarding the contribution of anthropogenic activities to climate change. The number of respondents who selected "No" is incredibly low for both genders, with only 1 female and 2 males expressing disagreement. This implies that the belief in human contributions to climate change is almost universal among the surveyed students. No responders in either gender category chose "I don't know," suggesting that everyone had a strong viewpoint on the issue.

Female respondents (99.9%) demonstrated slightly higher degree of agreement that anthropogenic activities are great cause of climate change than male (98.6%). This concedes with other studies like the study of Alston (2015) who argued that women's high awareness in developing countries are more influenced by their direct exposure to the threats of climate change, like floods, droughts, and food insecurity. In addition, the study of Zelezny et al. (2000) adds that the degree of high

agreement of women is because women are socialized to prioritize nurturing roles, and caregivers, have strong ethical care, and exhibit helping behavior and altruism. All these increase their feeling of empathy which makes them to think about the future of their children, and this empathy extends to the environment including climate change awareness.

Respondents who selected yes were further asked to pick anthropogenic activities that contribute to climate change in Tanzania. Figure 11 presents students' selection of activities that mainly contribute to climate change in Tanzania. Students were allowed to select more than one activity wherever possible.

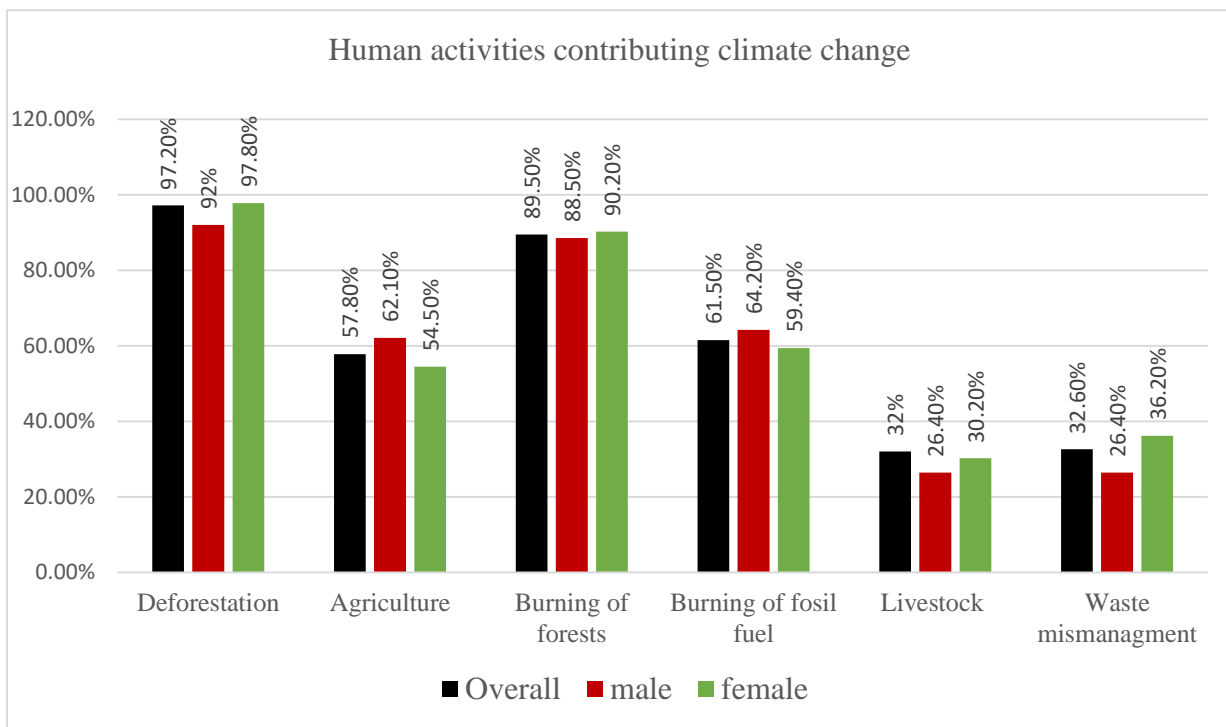


Figure 11: Contribution of Human activities to climate change. (Source: Field data. 2025)

The results from Figure 11 indicate that the majority of students demonstrated a high degree of awareness of deforestation (97.25%), agriculture (57.8%), burning of forests (89.5%), and burning of fossil fuels (61.5%) as major human activities contributing to climate change in Tanzania. Both genders exhibited strong awareness of deforestation, with 92% of males and 97.8% of females recognizing its impact. Similarly, awareness of agriculture was reported by 62.2% of males and 54.5% of females, while the burning of forests was acknowledged by 88.5% of males and 90.2%

of females. For the burning of fossil fuels, 64.2% of males and 59.4% of females demonstrated awareness.

The high understanding of students is attributed to the presence of different environmental campaigns through mass media, Non-Governmental Organizations (NGOs), and School and youth programs like Eco-school Tanzania which are widely used to disseminate information about environmental conservation. Additionally, Mariki (2016) highlights that environmental education in Tanzania has been a priority for conservationists, the government, NGOs, and the private sector since 1992. It has been integrated into primary, secondary, and college education, which collectively explains students' awareness of the impacts of deforestation, agriculture, and burning of forests on climate change.

However, the selection of Livestock and Waste mismanagement seemed to be lower at 32% and 32,5%, respectively. Females exhibited higher awareness of livestock (30.2%) and waste mismanagement (36.2%) compared to males, with 26.4% for both Livestock and waste mismanagement. Overall, females tend to have a slightly higher understanding of activities in deforestation, burning of forests and livestock and waste mismanagement compared to males. Meanwhile males demonstrated slightly higher awareness on agriculture and the burning of fossil fuels compared to females. This might be attributed to the fact that in many traditional Tanzanian societies men are assigned resource management and agricultural activities than females. This gives men higher exposure to and involvement in agricultural methods and practices and energy use, which increases their awareness. Moreover, men tend to participate more in formal and informal networks like community meetings and farmers' cooperatives where information about energy and agriculture are shared (Doss, 2001). This is reinforced by FAO (2011), which states that male farmers are often the target of technical training programs and extension services, while women face barriers due to household activities and social norms.

4.4.8. Individual Methods for Addressing Climate Change Problems

Figure 12 illustrate the response of students about the way an individual can overcome the problems of climate change. Respondents were allowed to select more than one option.

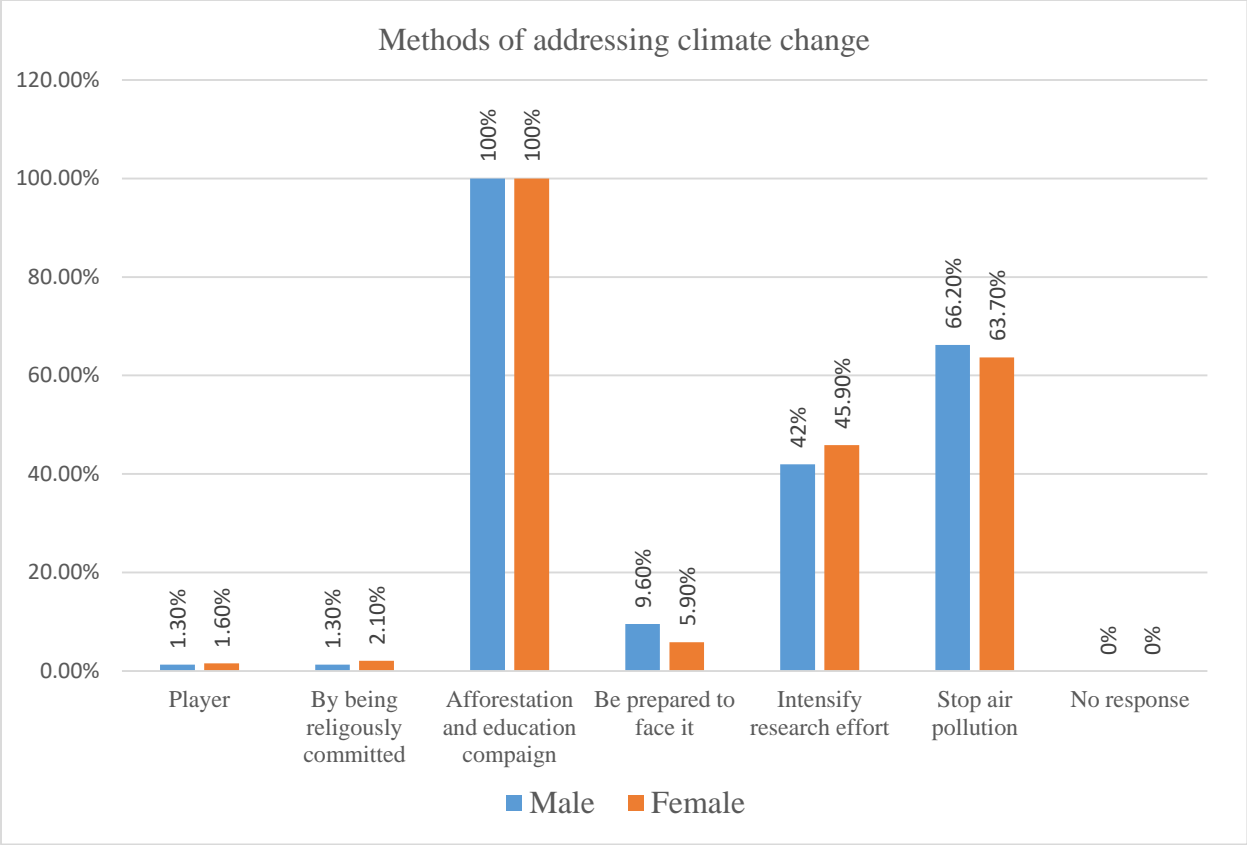


Figure 12: Individual methods of addressing climate change. (Source: Field data. 2025)

The results from Figure 12 show that the majority of respondents believed that the problems of climate change can be addressed through afforestation and education campaigns with 100% agreement of all respondents, by stopping air pollution with 64.9% agreement, and lastly through intensifying research efforts with 44.2%. 9.6% of females and 5.9% of male respondents believed that being prepared to face climate change, can help to overcome the harms of climate change. There was a slightly low difference between males and females on ways to overcome climate change problems. Females seemed slightly higher in percentage in intensifying research with 45.9% than males with 42%. However, males also demonstrated higher scores in the measures that, by stopping air pollution (66.2%) and being prepared to face it (9.6%) can help to overcome the problems of climate change compared to females with 5.9% and 63.7%.

On the other hand, a minority of students believed that praying (1.4%) and being religiously committed (1.7%) can help to overcome the problems of climate change. Studies show that religious convictions have been shown to affect people's views on environmental issues.

Nonetheless, the degree of this impact differs depending on the cultural setting and religious tradition. The study of Taylor (2010) asserts that since many religious beliefs stress the preservation of nature as a divine creation, religious commitment can cultivate a sense of stewardship and duty toward the environment. For instance, Christians are encouraged to take action to protect the environment by the Christian concept of "creation care" (Calvin, 2007)

4.4.9. Students Level of Awareness of Climate Change

The focus of this section is to ascertain the general aim of this study of assessing students' level of awareness of climate change.

Table 10 presents the results of secondary students' awareness of climate change. To determine students' level of awareness of climate change, the mean of every student was recorded as shown below.

Table 9: Level of climate awareness per student. (Source. Field data. 2025)

Climate Change Awareness (CCA) Response per Student				
Mean response	Frequency	Percentage	Cumulative percent	Level of awareness based on the scale (0 - strongly disagree to 4 –strongly agree)
1.58	2	0.6	0.6	Medium Level (20.3%)
2.17	1	0.3	0.9	
2.25	1	0.3	1.2	
2.33	5	1.5	2.7	
2.42	5	1.5	4.2	
2.50	10	3.0	7.3	
2.58	8	2.4	9.7	
2.67	23	7.0	16.7	

2.75	12	3.6	20.3	
2.83	19	5.8	26.1	High level (79.7%)
2.92	17	5.2	31.2	
3.00	19	5.8	37.0	
3.08	51	15.5	52.4	
3.17	33	10.0	62.4	
3.25	22	6.7	69.1	
3.33	28	8.5	77.6	
3.42	25	7.6	85.2	
3.50	15	4.5	89.7	
3.58	7	2.1	91.8	
3.67	5	1.5	93.3	
3.75	4	1.2	94.5	
3.83	5	1.5	96.1	
3.92	9	2.7	98.8	
4.00	4	1.2	100.0	
Total	330	100.0		

The individual mean value and distribution of the average responses were used to gauge the secondary school students' level of awareness of climate change. Table 9 shows that 79.7% of students had a high level of awareness, while 20.3% had a medium level of awareness.

Table 11 highlights the scale used to show the level of climate change awareness. Where SA = strongly agree, IDK = I do not know, D = disagree, and SD = strongly disagree

Table 10: Scale showing the level of climate change awareness

Key for Interpreting Climate Change Awareness			
	Low Level	Medium Level	High Level
Scale based on Likert	0-1.3	1.4-2.7	2.8-4
Description	SD-D	D-IDK	A-SA

4.4.10. Gender Differences in Level of Awareness of Climate Change

Under this objective, respondents were presented with a list of 12 climate change awareness statements. Students were asked to show their degree of agreement using a Likert scale from strongly agree to agree, I do not know, disagree, and strongly disagree.

The decision was based on the mean scores of climate awareness, analyzed in relation to gender. To do this, the study used the mean to make a decision, which is advised by Boone (2012) and Kiemtoré et al. (2020). The decision was made based on the interval for the decision where the mean fell. The results are shown below.

Table 11: The decision of the analysis

Level	Scale	Interval Level	Interval level for decision	Level of awareness
Strongly Disagree	0	0.8	0-0.8	Low awareness
Disagree	1	0.8	0.8-1.60	
I don't know	2	0.8	1.6-2.40	Medium
Agree	3	0.8	2.40-3.20	High awareness
Strongly agree	4	0.8	3.20-4	

Students were given the list of 12 statements of the Likert scale mainly based on the causes and effects of climate change to assess their awareness level. The statements presented on the questionnaire were the following.

- i. Cutting down trees causes climate change
- ii. Climate change is caused by poor agricultural practices (such as monoculture and overuse of chemical fertilizers)
- iii. Air pollution from industries causes climate change
- iv. More garbage/improper waste disposal causes climate change
- v. Using firewood and charcoal for cooking causes climate change
- vi. Climate change is a punishment from lesser gods
- vii. Climate change causes gender inequalities
- viii. Climate change causes low crop production and leads to food insecurity
- ix. Climate change causes biodiversity loss.
- x. Climate change can cause the death of people and animals due to flooding.
- xi. Climate change affects renewable energy sources like hydroelectric power plant
- xii. Increased health risks (Diseases from dry air, malaria from mosquito bites as a result of flooding or dryness), which are both caused by climate change

Table 12: Gender differences in awareness of climate change. (Source: Field data. 2025)

Statement	Gender	SA	A	IDK	D	SD	Mean	P*
		n (%)	n (%)	n (%)	n (%)	n (%)	n	
1	Female	161 (87)	24 (12.9)	0	0	0	3.83	.098
	Male	117 (81)	24 (16.5)	4 (0.2)	0	0		
2	Female	103 (57)	65 (35)	0	7 (3.7)	5 (2.7)	3.21	.035
	Male	67 (46)	50 (34)	3 (0.2)	20 (13)	5 (0.3)		
3	Female	155 (84)	30 (16)	0	0	0	3.81	.418
	Male	117 (81)	25 (17)	3 (0.2)	0	0		
4	Female	68 (37)	94 (50.8)	11 (0.5)	10 (0.5)	2 (0.1)	3.05	.126
	Male	51 (35)	60 (41)	8 (0.5)	22 (15)	4 (0.2)		
5	Female	111 (60)	53 (28)	5 (0.2)	12 (0.6)	4 (0.2)	3.20	.001

	Male	62 (43)	56 (38.6)	6 (0.4)	4 (0.2)	17 (12)		
6	Female	12 (0.6)	22 (11.8)	24 (13)	34 (18)	93 (50)	1.06	.899
	Male	12 (0.8)	10 (6.8)	25 (17)	27 (18)	71 (49)		
7	Female	22 (12)	18 (0.9)	9 (0.4)	47(25)	89 (48)	1.13	.730
	Male	17 (12)	20 (13.7)	2 (0.1)	29 (20)	76 (52)		
8	Female	145 (78)	38 (20.5)	2 (0.1)	0	0	3.73	830
	Male	117 (80)	19 (13)	2 (0.1)	8 (5.5)	0		
9	Female	162 (88)	20 (10.8)	3 (0.1)	0	0	3.84	.382
	Male	122 (84)	21 (14)	0	2 (0.3)	0		
10	Female	153 (83)	30 (16.2)	1 (0)	1 (0)	0	3.78	.813
	Male	122 (84)	18 (12.4)	0	2 (0.1)	3 (0.2)		
11	Female	95 (51)	65 (35)	7 (3.7)	13 (7)	5 (0.2)	3.27	.699
	Male	78 (53)	47 (32.4)	11 (7.5)	3 (0.2)	8 (5.5)		
12	Female	114 (62)	46 (24.8)	9 (0.4)	6 (0.3)	10 (0.5)	3.35	463
	Male	81 (56)	45 (31)	11 (0.7)	8 (0.5)	0		

The result from table 13 suggests that females showed a slightly higher overall awareness of climate change compared to males. The mean percentage of females who either "Strongly Agree" or "Agree" with statements related to climate change was 79.36%, while for males, it was 77.18%. This indicates that females were, on average, 2.18% more aware of climate change issues than males

However, both genders demonstrated a high level of awareness of climate change, with a mean score of 3.1, falling within the interval range of 2.40–3.20. This indicates that the majority of respondents had a high level of awareness. Specifically, 84% of respondents were aware that cutting down trees contributes to climate change, with females showing slightly higher awareness (87%) compared to males (81%). Similarly, 84% of females and 81% of males recognized that air

pollution from industries is a cause of climate change. Additionally, 86% of respondents understood that climate change can lead to the death of people and animals due to flooding. Furthermore, 86% of all respondents agreed that poor agricultural practices such as monoculture and the overuse of chemical fertilizers contribute to climate change, with 92% of females and 90% of males in agreement. The high degree of awareness demonstrated by students on climate change awareness is similar to the study of Corner et al. (2015), who discovered that students from a variety of geographic areas exhibit high awareness because they view climate change as a significant threat due to its consequences for their future. Also, Mohsin et al. (2022) add that the current overwhelmingly scientific consensus and report have increased the perception of students on climate change since they are more likely to trust scientific evidence about climate change.

When asked about climate change with spiritual beliefs, 49% of respondents strongly disagreed that climate change is the punishment from a lesser god, with 50% of females and 49% of males. This might be attributed to the fact that Climate change is widely understood by the scientific community as caused by anthropogenic activities, especially the emission of GHGs such as carbon dioxide and methane. The IPCC has continuously provided evidence that links global warming to deforestation, industrialization, and other anthropogenic factors (IPCC, 2022). These scientific agreements are taught to students in schools and colleges, which probably leads them to believe that climate change is a human-caused event rather than a punishment from God.

The $P > 0.05$ to the statement that climate change causes low crop production and leads to food insecurity demonstrated that there was a statistically insignificant difference between gender and climate awareness, where 98% of females and 90% of males showed their awareness. On the other hand, some respondents demonstrated low awareness, where about 6% were unaware that climate change affects renewable energy sources (hydroelectric power plants) with 5.5% for males and 7.2% for females.

Despite the overall high level of awareness among respondents, a significant majority, both male and female demonstrated limited understanding of the link between climate change and gender. Specifically, 73.5% of females' respondents and 72% of males' respondents disagreed that climate change contributes to gender inequality. This high percentage of respondents with low awareness regarding the gendered impacts of climate change underscores a critical gap in knowledge. These

results agree with the study of Alston, (2015) who found that the impacts of climate change on gender are scarcely addressed in public awareness campaigns and educational curricula causing low perception among students and the general public. IUCN (2021) argues that Gender Based-violence (GBV) is currently exacerbated by climate change and, the displacement of people due to climate disasters which leads to an overcrowded settlement where girls and women face higher risks of exploitation, violence, and sexual harassment. Additionally, FAO (2011) observed that women residing in rural areas are frequently affected by climate change in their main dependent economic activities like agriculture, forests, and fishing, but also lack of access to land ownership, and financial support makes them more harder to adapt to climate change.

Overall, there is the presence of some respondents who showed low awareness of climate change, highlighting the need for more awareness. The gap should be addressed since these students are future leaders and policymakers, enriching them with high knowledge will determine the future pro-environmental attitude and actions of our leaders (Lal, 2017).

4.5. Students' knowledge of climate change adaptation

This objective aimed to gauge respondent's knowledge level on adaptation to climate change. Respondents were given a lists of ten statements in the questionnaire where respondents were supposed to select one option from correct, incorrect and I don't know. The knowledge level that is shown from this objective is very important for policy makers and education curriculum developers. The results are shown as follows

Table 13: Students' knowledge of climate change adaptation practices. (source: Field data. 2025)

Statements	C	INC	IDK	Mean	Decision
	N (%)	N (%)	N (%)		
Planting drought tolerant crop help to adapt to drought	297 (90.0)	20 (6.1)	13 (3.9)	1.86	High knowledge
Conservation agriculture (planting cover crop, mulching, and crop rotation) help to adapt to climate change	291 (88.2)	19 (5.8)	20 (6.1)	1.82	High knowledge
We can Migration away from flooding or drought-affected areas	238 (72.1)	55 (16.7)	37 (11.2)	1.61	Average knowledge
We are advised to construct flood walls and berms against flooding	241 (73.0)	47 (14.2)	42 (12.7)	1.60	Low knowledge
People are advised to drink enough water during extreme heat.	275 (83.7)	48 (14.5)	7 (2)	1.81	High knowledge
We are advised to wear heavy clothes during the cold season	299 (90.6)	25 (7.6)	6 (1.8)	1.89	High knowledge
Building houses away from floodplain areas help to avoid flooding	274 (83.0)	48 (14.5)	8 (2.4)	1.81	High knowledge
Planting short-term crops like spinach, lettuce, peas and new improved seeds like Maize sidco can help to adapt against drought hazards.	240 (72.7)	59 (17.9)	31 (9.4)	1.63	Average knowledge
Drip irrigation helps to minimize water usage	247 (74.8)	57 (17.3)	26 (7.9)	1.67	High knowledge
Water reuse and recycling can help during water scarcity period	273 (82.7)	30 (9.1)	27 (8.2)	1.75	High knowledge
weighted average value	267 (81)	40 (12)	23(7)	1.678	

Note N = 330, C = Correct; INC = Incorrect; IDK = I do not know; Decision- weighted average = $16.78/10 = 1.678$.

The decision in this section was based on the participants' knowledge. To do this, the study used the weighted average value. To calculate the weighted average value, the researcher summed up the mean value for each item divided by the total number of items.

The results from Table 14 show that the majority of respondents, 81% demonstrated high knowledge on adaption to climate change. For example, 72% of respondents knew that planting short-term crops like Spinach, Lettuce, Peas, and newly improved seeds like Maize sidco can help to adapt against drought hazards, and migrating away from flooding or drought-affected areas can help to adapt against flooding and drought. Also, most respondents, 90% demonstrated high knowledge that planting drought-tolerant crops helps to adapt to drought. Moreover, 88% correctly agreed that conservation agriculture like planting cover crops, mulching, and crop rotation, can help to adapt to climate change. 73% of respondents knew that they are advised to construct flood walls and berms against flooding and 83 agreed that building houses away from floodplain areas helps to avoid flooding. Similarly, 83% of respondents agreed that they are advised to drink enough water during hot days.

The high knowledge demonstrated by respondents can be attributed to the fact that currently, information is easily accessed through digital platforms and other mass media. Similar results were found by Liu et al. (2019) who noted that students who were involved in digital media, such as videos, online courses, and interactive simulations demonstrated high knowledge of adaptation practices. Moreover, the presence of school programs, environment clubs like Roots and Shoots and school farms contribute to the high knowledge of students on adaptation practices. As argued by Monroe et al. (2019) in their study of investigating the effectiveness of climate change education in enhancing students' understanding of adaptation strategies. He found that students who participated in structured climate change programs demonstrated a high level of knowledge about adaptation practices, such as sustainable agriculture, water conservation, and disaster preparedness. A global study conducted by UNESCO (2021) assessing the knowledge of students about climate change across 46 countries found that students residing in areas most vulnerable to climate change (like Southern Asia and Sub-Saharan Africa) show a high level of knowledge of climate change adaptation practices, such as drought-resistant farming and flood management.

On the other hand, 16% of respondents provided incorrect answers, and 11% responded 'I do not know' to the statement about people migrating away from flooding or drought-affected areas. Additionally, 14% answered incorrectly, and 12% did not know about the recommendation to construct flood walls and berms to mitigate flooding. Furthermore, 25% demonstrated a lack of knowledge regarding how drip irrigation can help minimize water usage. Similarly, 17% lacked awareness of the application of water reuse and recycling to reduce water consumption during periods of scarcity. These findings highlight a significant knowledge gap, underscoring the need for greater integration of climate change topics into the education curriculum. Additionally, the establishment of practical environmental education initiatives, such as school farms and gardens, could foster hands-on learning and enhance students' understanding of adaptation practices(UNESCO, 2021).

4.5.1. Distribution of Climate Change Awareness and level of Adaptation practices among Explanatory Variable

This section tries to ascertain how explanatory variables explain climate change awareness and adaptation practices. The explanatory variables used were age, gender, school type, school location, class level /grade, occupation of parents, area where respondents live, and area of specialization or study.

Table 15 presents results on the distribution of climate change awareness and adaptation practices among explanatory variables through a hypothesis test using the independent samples Mann-Whitney U test, Kruskal-Wallis test, and One-way ANOVA.

Table 14: Distribution of climate change awareness and adaptation practices among variables

Hypothesis Test Summary				
Explanatory variables	Null hypothesis	Test	Sig.	Decision
Gender	The distribution of the level of climate change awareness is not the same across all gender	Independent sample Mann-	058	Retain null hypothesis

	The distribution of the level of adaptation practices awareness is not the same across all gender	Whitney U Test	929	Retain null hypothesis
Age	The distribution of the levels of climate change awareness is not the same across all age	Kruskal-Wallis Test	666	Retain null hypothesis
	The distribution of the adaptation practices change is not the same across all age		104	Retain null hypothesis
Grade	The distribution of levels of climate change awareness is not the same across all grade	Independent sample Mann-Whitney U Test	498	Retain null hypothesis
	The distribution of the level of adaptation practices awareness is not the same across all grade		699	Retain null hypothesis
School type	The distribution of the level of climate change awareness is not the same across all school-type	Independent sample Mann-Whitney U Test	008	Reject the null hypothesis
	The distribution of the level of climate change is not the same across all school-types		005	Reject the null hypothesis
School location	The distribution of the level of climate change awareness is not the same across all school location	Independent sample Mann-Whitney U Test	013	Reject the null hypothesis
	The distribution of the level of adaptation practices awareness is not the same across all school location		050	Reject the null hypothesis
Area of residence	The distribution of the level of climate change is not the same across both areas of residents	Independent sample Mann-Whitney U Test	257	Retain null hypothesis
	The distribution of the level of climate change is not the same across both areas of residents		749	Retain null hypothesis
Area/ Subject Specialization	The distribution of the level of climate change is not the same across all areas of specialization	One-way ANOVA	083	Retain null hypothesis

	The distribution of the level of climate change is not the same across all areas of specialization	Kruskal-Wallis Test	934	Retain null hypothesis
Occupation of parents	The distribution of the level of climate change is not the same across all occupations of parents	One-way ANOVA Kruskal-Wallis Test	036	Reject the null hypothesis
	The distribution of the level of climate change is not the same across all occupations of parents		012	Reject the null hypothesis
Asymptotic significances are displayed. The significance level is .05				

4.5.1.1. Correlation Analysis of Explanatory Variable

Table 16 below displays a Spearman's rank correlation coefficient analysis that was performed to support and validate the above-stated Hypothesis statements in Table 15 concerning climate change awareness and adaptation practices and various Explanatory Variable (gender, area of specialization, occupation of parents, respondents' residence, school type, Grade, and School Location).

Table 15: Correlation Analysis of Variables (demographic characteristics) and Students' level of awareness and knowledge level of adaptation practices

Correlation			Level of climate change awareness	Level of awareness of adaptation practices
Spearman's rank correlation coefficient	Gender	Correlation coefficient	-105 very weak negative correlation	005 weak positive correlation
		sig. (2tailed)	058	929
		N	330	330
	School type	Correlation coefficient	-146 weak negative correlation	155 weak positive correlation
		Sig. (2tailed)	008	005
		N	330	330

	Grade	Correlation coefficient	037 weak positive correlation	021 weak positive correlation
		Sig. (2tailed)	498	699
		N	330	330
	School location	Correlation coefficient	137* weak positive correlation	-108 Weak positive correlation
		sig. (2tailed)	013	050
		N	330	330
	Area of living	Correlation coefficient	-062 weak negative correlation	018 weak negative correlation
		sig. (2tailed)	258	749
		N	330	330
Kruskal-Wallis Test	Age	sig. (2tailed)	666	104
		N	330	330
	Occupation of parents	sig. (2tailed)	036	012
		N	330	330
	Area of specialization	sig. (2tailed)	083	934
		N	330	330

The results from Table 16 show a weak positive correlation of awareness of climate change across grade and school location with coefficients 013 and 137, respectively. Meanwhile, School type ($r=-146$), area of residence of respondents ($r=-062$), and gender (-105) showed a weak negative correlation in relation to awareness of climate change.

On the other hand, the results revealed a positive correlation of the level of awareness of adaptation practices across school type ($r=155$), gender ($r=005$), area of respondents' residence ($r=018$), and grade (021). Meanwhile, weak negative correlations were observed across school locations with a coefficient of -108 .

4.5.1.1.1. Gender

The results from Table 16 of the correlation analysis indicate a very weak negative and statistically insignificant correlation between gender and the level of climate change awareness ($r = -0.105$, $p = 0.058$, $N = 330$). This suggests an insignificant relationship between gender and climate change awareness, with the levels of awareness not equally distributed across genders. Therefore, we retain the null hypothesis.

Regarding adaptation practices, the analysis shows a weak positive correlation that is not statistically significant between gender and awareness of adaptation practices ($r = 0.005$, $p = 0.929$, $N = 330$). This indicates that the relationship is not statistically significant. The p-value of 0.929 suggests that there is no statistically significant relationship between gender and awareness of adaptation practices. Consequently, we retain the null hypothesis in favor of the alternative hypothesis.

H1. The distribution of the level of climate change awareness is not the same across categories of gender

H1. The distribution of awareness of adaptation practices is not the same across categories of gender

4.5.1.1.2. Age

The analysis presented in Table 16 reveals an insignificant relationship between age and awareness of climate change, with a p-value of 0.666. This high p-value indicates that the observed correlation is not statistically significant, leading us to retain the null hypothesis. Similarly, regarding awareness of adaptation practices, the analysis from Table 16 also shows an insignificant relationship with age, as evidenced by a p-value of 0.104. Since this p-value exceeds the conventional significance threshold, we fail to reject the null hypothesis in this case as well.

H2. The distribution of levels of climate change awareness is not the same across categories of age.

H2. The distribution of awareness of adaptation practices is not the same across categories of age.

4.5.1.1.3. Grade

The result presented in Table 16 revealed a weak positive correlation between grade and level of climate change awareness ($r=0.037$, $p=0.498$, $N=330$). This means there is an insignificant relationship between grade and level of climate change awareness. The P value of 498 suggests that we retain the null hypothesis. Concerning adaptation practices, the results show a weak positive correlation between grade and awareness of adaptation practices ($r=0.021$, $p=0.699$, $N=330$). This means there is no significant relationship between grade and level of awareness of adaptation practices. The P value of 699 suggests that we retain the null hypothesis.

H3. The distribution of level of climate change awareness is not the same across categories of grade.

H3. The distribution of the level of awareness of adaptation practices is not the same across categories of grade.

4.5.1.1.4. School Type

The results from Table 16, derived from correlation analysis, indicate a very weak negative correlation between school type and the level of awareness of climate change ($r = -0.146$, $p = 0.008$, $N = 330$). The p-value of 0.008 demonstrates a statistically significant relationship between these two variables, leading to the rejection of the null hypothesis. In contrast, the correlation between school type and the level of adaptation practices reveals a weak positive correlation ($r = 0.155$, $p = 0.005$, $N = 330$). Given that the p-value is less than the conventional significance threshold ($p < 0.05$), the relationship is statistically significant, and therefore, the null hypothesis is rejected.

H4. The distribution of level of awareness of change is the same across categories of school type

H4. The distribution of awareness of adaptation practices is the same across categories of school type

4.5.1.1.5. School location

The results from Table 16 indicate a weak positive correlation between school location and the level of awareness of climate change ($r = 0.137$, $p = 0.013$, $n = 330$). The p-value of 0.013 demonstrates that this correlation is statistically significant, leading to the rejection of the null hypothesis. In contrast, a weak negative correlation is observed between school location and the level of awareness of adaptation practices ($r = -0.108$, $p = 0.050$, $n = 330$). since the p-value of 0.050 is at the conventional significance threshold, the correlation is statistically significant, and therefore, the null hypothesis is rejected

H5. There is a significant correlation between school location and level of awareness of climate change.

H5. There is a significant correlation between school location and awareness of adaptation practices

4.5.1.1.6. Students' areas of residence

The result from Table 16 indicates a weak negative correlation between respondents' residence and awareness of climate change ($r=-0.062$, $p=0.258$, $N=330$). This means the correlation between the two variables is not statistically significant. Since $p>0.05$, we retain the null hypothesis. On the other hand, there is a weak positive correlation between respondents' residence and awareness of adaptation practices ($r= 0.018$, $p= 749$, $N=330$). This means the correlation between the two variables is not statistically significant. Since $p>0.05$, we retain the null hypothesis

H6. The distribution of awareness of climate change is not the same across all areas of the respondent's residence

H6. The distribution of awareness of adaptation practices is not the same across all areas of respondent's residence.

4.5.1.1.7. Occupation of Parents

The result in Table 16 reveals a statistically significant correlation between the occupation of parents of respondents and awareness of climate change ($p=0.036$, $N=330$). The p-value of 036 shows that the correlation of these two variables is statistically significant. Hence we reject the null hypothesis. On the other hand, the results show an insignificant correlation between the occupation of parents and the awareness of adaptation practices of respondents ($p=0.012$, $N=330$). The p-value of 012 suggests that the correlation between the occupations of parents and awareness of adaptation practices is statistically significant, leading us to reject the null hypothesis.

H7. The distribution of awareness of climate change is the same across all categories of occupations of parents

H7. The distribution of awareness of adaptation practices is the same across all categories of occupations of parents

4.5.1.1.8. Area of specialization.

The results from Table 16, based on correlation analysis, show an insignificant relationship between areas of specialization and the level of climate change awareness, with a p-value of 0.083. Since this p-value exceeds the conventional significance threshold of 0.05, we retain the null hypothesis, indicating that areas of specialization do not significantly influence climate change awareness. Similarly, the analysis reveals an insignificant relationship between areas of specialization and awareness of adaptation practices, with a p-value of 0.934. This high p-value further confirms that the correlation is not statistically significant, leading us to retain the null hypothesis in this case as well. Together, these findings suggest that areas of specialization do not play a significant role in shaping respondents' awareness of climate change or adaptation practices.

H8. The distribution of awareness of climate change is not the same across all categories of areas of specialization.

H8. The distribution of awareness adaptation practices is not the same across all categories of areas of specialization.

4.6. Students' Knowledge of Climate Change Mitigation

This section presented lists of eleven statements in a questionnaire trying to gauge students' knowledge of mitigation. Respondents were presented with three options (correct, incorrect and I do not know) in each of the statements. The results are summarized in Table 17 below.

Table 16: Students' knowledge of climate change mitigation. (Source: Field data. 2025)

Statements	C(%)	INC(%)	IDK(%)	Mean	σ	Decision
We can reduce/prevent climate change by planting more trees.	97.9	2.1	0	1.98	0.144	High knowledge
We can reduce/prevent climate change by burning more fossil fuels in our activities.	6.1	87.3	6.7	0.99	0.357	High knowledge
Climate change can be stopped only by God.	7.3	86.4	6.4	1.01	0.370	High knowledge
Increasing number of cattle can help to reduce/prevent climate change.	9.4	89.1	1.5	1.08	0.321	High knowledge
We can reduce/prevent climate change by using renewable energy sources.	81.2	11.2	7.6	1.74	0.589	High knowledge
We can reduce/prevent climate change by minimizing air pollution from industries.	92.1	6.1	1.8	1.90	0.353	High knowledge
We can reduce the effect of climate change by using energy-efficient technologies (like energy bulbs, a refrigerator, and air conditioners),	57.6	27.3	15.2	1.42	0.741	Average knowledge
People can help stop climate change by using more land to grow food.	18.4	66.3	15.3	1.05	0.596	High knowledge
People can help stop climate change by using private cars instead of public cars.	4.8	87	8.2	0.97	0.360	High knowledge

People can help stop climate change by buying more local goods.	22.7	66.1	11.2	1.12	0.572	Low knowledge
We can reduce/prevent climate change by properly managing our waste	88.5	7.6	3.9	1.85	0.458	High knowledge

Note N = 330, C = Correct; INC = Incorrect; IDK = I do not know and σ = Standard deviation

In this study, the weighted average value was used for all direct statements of SN 1,5,6,7,10,11 similar to probing statements of SN 2,3,4,8 and 9. To calculate the weighted average value, the percentage value for each item was summed up and divided by the total number of items to the direct and probing statements. This gave the mean percentage of 73% for no probing statements and 83% for probing statements equal to the overall mean of 78% of correct responses.

The data analysis in table 17 shows that the majority of respondents 78% demonstrated high mitigation knowledge due to their correct response from the given statements. 97.9% knew that they can reduce or prevent climate change by planting more trees. Also, 81.2% correctly knew that they can reduce or prevent climate change by using renewable energy sources, similar to 88.5% who said people can reduce or prevent climate change by properly managing their waste. Moreover, 91% of respondents knew that they could prevent climate change by minimizing air pollution from industries. 87% of respondents also believed that people cannot help stop climate change by using private cars instead of public transport. Also, 66% said people cannot help stop climate change by using more land to grow food. The response that 82% of respondents are members of school clubs where climate issues are taught accounts for the high mitigation knowledge students possess. The results corroborated the study of Aziz et al. (2022) conducted among students in Malaysia which found that 85% of participants demonstrated awareness of critical climate change mitigation approaches, including lowering emissions, adopting clean energy sources, and improving energy conservation practices.

Moreover, 86.4% of respondents selected the incorrect option for the statement, "Climate change can be stopped only by God." Also, 89.1 % of respondents did not agree with the statement that

increasing the number of cattle can help to reduce or prevent climate change. On the other hand, respondents showed average knowledge since 66.3% of respondents did not agree that people can help stop climate change by using more land to grow food. About 66.1% incorrectly responded that People can help stop climate change by buying more local goods. This result demonstrates a knowledge gap on the connection between local goods and climate change. Respondents lack the knowledge that buying local goods that have not passed through industries reduces the carbon footprint that might be generated from the industries which would in turn cause climate change. Moreover, the result also shows that there is a lack of emphasis in teaching on the connection between local goods and climate change. This result is similar to the study conducted in Nigeria which found that only 25% of secondary students understood the connection between locally produced goods and reduced carbon footprints. Most students were unaware that transporting goods over long distances contributes significantly to greenhouse gas emissions. The result emphasizes the need for education on sustainable consumption and local economies (Ezel, 2020)

4.7. Secondary Students' Climate Change Adaptation Practices

This section presents the responses of the students to the question. “What are the climate change adaptation practices by secondary school students in Tanzania?” Respondents were provided with a questionnaire containing 10 statements. For each statement, they were asked to choose one of two options: “I do/participate” or “I do not do/participate.” Initially, students were asked whether they could play any role in addressing climate change, to which all respondents answered affirmatively. The objective of this section was to examine students' behavior regarding their participation in indirect or direct engagement with adaptation practices at school, home, or in their community. The results are presented in Table 18.

Table 17: Students' climate change adaptation practices. (Source: Field data. 2025)

Statements	I participate	I do not participate	Mean	Decision
I participate in cultivating short-term crop/garden	96.1	3.9	0.96	High participation
I plant tree	89.7	10.3	0.90	High participation
I plant rain garden to manage storm water and reduce flooding.	73.0	27.0	0.73	Average participation
I wear lightweight clothes, and avoiding outdoor activities during peak heat days and wear heavy clothes during cold season	92.1	7.9	0.92	High participation
I set up rain barrels to collect rainwater for domestic activities(rainwater harvest)	82.1	17.9	0.82	High participation
I close windows during cold period	98.8	1.2	0.99	High participation
I drink sufficient water to avoid dehydration	91.5	8.5	0.92	High participation
I fix or repair leaks in toilets and pipes to prevent water waste	80.9	19.1	0.81	High participation
I share information about flood risks to my fellow students and community members	91.2	8.8	0.91	High participation
I participate in cleaning drainage systems to remove trash and sediments and allow the smooth flow of stormwater and surface runoff.	80.3	19.7	0.81	High participation
Weighted average value	87.6	12.4	0.877	

To analyze Table 18 above, the study used a weighted average. The weighted average was obtained by summing up (percentage of each response) per the number of statements. The weighted percentage for respondents who said they participated was 87.6%, and those who said they did not participate was 12.4%.

The results from Table 18 show that the majority of students (87.6%) actively participate in climate adaptation practices at home, school, or in their community. There were no adaptation practices for which student participation fell below 73%, indicating widespread engagement in adaptation practices across these settings. Specifically, 98.8% of students reported closing windows during cold periods, followed by 96.1% who actively participate in cultivating short-term crops or gardens. Additionally, 92.1% of students stated that they wear lightweight clothes and avoid outdoor activities during peak heat days, as well as wear heavy clothes during the cold season.

Furthermore, 91% of students mentioned drinking enough water during hot seasons to avoid dehydration and sharing information about flood risks with fellow students and community members. In addition, 80.3% of students participate in cleaning drainage systems to remove trash and sediments, ensuring the smooth flow of storm water and surface runoff. Similarly, 80.9% of students reported fixing or repairing leaks in toilets and pipes to prevent water waste. This high level of student participation in adaptation practices aligns with the findings of Ojala (2012) who explored how children cope with global climate change. Ojala found that students often take the lead in initiatives such as waste reduction programs, energy conservation projects, and tree planting. Similarly, Chawla and Cushing (2007), in their study on education for strategic environmental behavior, observed that students involved in designing and implementing adaptation practices such as managing school gardens or creating green spaces, demonstrated higher levels of engagement and ownership.

Moreover, the report of UNESCO (2021) emphasized the critical role of young people, including students, in community-based adaptation practices. The report highlighted cases where students collaborated with local organizations to address pressing issues such as food security, disaster preparedness, and water scarcity. Overall, the active participation of students in adaptation programs underscores the importance of youth in achieving Sustainable Development Goal 13 (Climate Action). Their involvement not only fosters environmental awareness but also empowers

them to take proactive roles in addressing climate challenges, contributing to broader sustainability efforts.

On the other hand, approximately 12.4% of all respondents reported not participating in climate adaptation practices at home, school, or in their community. Specifically, 27% of students do not engage in planting rain gardens to manage stormwater and reduce flooding, while 19% do not participate in cleaning drainage systems to remove trash and sediments, which is essential for ensuring the smooth flow of stormwater and surface runoff. Similarly, 17% of students do not set up rain barrels to collect rainwater for domestic activities (rainwater harvesting). These results highlight a gap in students' engagement in climate actions, underscoring the need to understand the reasons behind this lack of participation to develop strategies that promote sustainable behaviors among students.

To contextualize these findings, Eilam and Trop (2012) emphasized that limited environmental knowledge and insufficient institutional support, including the absence of curriculum integration, funding, infrastructure, and teacher training, hinder student engagement in sustainability initiatives. Educational institutions, therefore, play a pivotal role in enhancing students' participation in climate adaptation practices. As highlighted by Pauw and Petegem (2011), students who receive comprehensive environmental education are more likely to adopt environmentally beneficial behaviors. For instance, students whose families prioritize environmental sustainability are more inclined to practice similar behaviors at home. Conversely, students who perceive a lack of support from their social circles may be less motivated to participate in climate actions. Addressing these barriers through targeted interventions and institutional support is crucial for fostering greater student involvement in climate adaptation practices.

4.8. Information from the Semi-Structured Interview for Key Informants

For the purpose of collecting sufficient information needed. I interviewed a total of 36 key informants (2 heads of school, 3 heads of academic teachers, 2 ward education officers, 8 teachers of environment and education, and 20 student prefects were interviewed.

4.8.1. Information from Students

During the interviews, 20 students were asked if they were aware of climate change. Seventeen (17) responded "yes," while 3 indicated they knew about it "to some extent." The researcher found that students primarily access information about climate change through radio, school clubs, television, the internet, and social interactions. This aligns with the findings of Bishoge et al. (2022) reported that most students rely on radio and television for environmental information. However, students noted that they are unable to use the internet on their phones while at school, as phones are strictly prohibited. A head prefect shared, *"Last week, two Form Six students were caught using smartphones. They were beaten, suspended for 21 days, and upon their return, their phones will be confiscated and destroyed during a main parade in front of their parents, teachers, and fellow students. Although we were using those phones to access educational materials and climate information."*

When asked how climate change has impacted their local community or environment, the majority mentioned the disappearance of animals, frequent flooding, unpredictable rainfall patterns, and the destruction of property. Regarding greenhouse gases (GHGs), most students could only correctly identify two: carbon dioxide and chlorofluorocarbons. When asked about the causes and effects of climate change, students primarily attributed it to poor agricultural practices, deforestation, mining, and industrial emissions. In terms of effects, they highlighted deforestation, family separation, declining agricultural productivity, and water scarcity as significant consequences.

On the topic of adaptation and mitigating climate change, students were asked if they believe humans can stop climate change. Nineteen (19) students responded 'yes,' while 1 student expressed uncertainty, stating that natural causes such as volcanic eruptions and wildfires also contribute to climate change. This aligns with the IPCC's (2022) findings that while anthropogenic activities are the dominant drivers of contemporary climate change, natural factors can also play a role in shaping climate dynamics. When asked about measures and practices humans can adopt to address climate change, the majority mentioned planting trees, providing education to communities, using renewable energy sources, and implementing policies to restrict deforestation. These responses are consistent with the IPCC's emphasis on nature-based solutions, such as afforestation and sustainable land management, as well as the transition to renewable energy systems, which are critical for both mitigation and adaptation (IPCC. (2022).

Additionally, when questioned about the role students can play in promoting climate change adaptation in their communities, most emphasized the importance of raising awareness through education and participating in tree-planting initiatives. The students' emphasis on raising awareness through education and participating in tree-planting initiatives aligns with Ojala's (2012) research on how youth engage with climate change. Ojala found that education and active participation are critical strategies for empowering youth to cope with and respond to climate change. Specifically, her work highlights that when young people are educated about climate issues and given opportunities to take meaningful action, such as participating in community-based projects, they are more likely to develop a sense of agency and well-being. This sense of agency is evident in the students' responses, as they expressed a strong desire to contribute to climate change adaptation through awareness-raising and practical initiatives like tree planting

4.8.2. Information from Teachers

A total of 14 teachers were interviewed, including 8 environment teachers, 3 academic masters, and 3 school heads. All participants were asked the same set of questions to ensure consistency in data collection.

When asked about the presence of climate change adaptation programs at their schools, teachers from seven schools mentioned initiatives such as environmental clubs and school gardens. Additionally, teachers from five schools reported having tree-planting programs, which are implemented annually in alignment with the National Tree Planting Day observed on April 1. Three teachers from three schools highlighted rainwater harvesting projects, where rainwater is collected in storage tanks for reuse. Environmental teachers from two private schools also noted the use of modern stoves, which consume less firewood and produce minimal smoke, as part of their sustainability efforts.

However, when questioned about the challenges of implementing and establishing climate adaptation and mitigation programs, the majority of teachers cited insufficient funding as a significant barrier. Furthermore, four environmental teachers emphasized that their schools prioritize academic performance over environmental initiatives. One environmental teacher provided the following insight:

“Here at school, I face challenges with prioritization. During meetings to plan the school calendar, the focus is always on exam performance. Environmental issues are rarely discussed unless I bring them up. The daily timetable is fixed, leaving little room for students to engage in environmental programs apart from the 30 minutes allocated each morning for general cleanliness. When I submit funding requests for my environmental club activities, it often takes up to two months to receive a response, and sometimes, they are ignored entirely.”

These findings highlight the tension between academic priorities and environmental initiatives in schools. While some schools have implemented adaptation practices such as tree planting, rainwater harvesting, and energy-efficient stoves, the lack of funding and institutional prioritization of environmental programs remains a significant challenge. The prioritization of academic performance over environmental initiatives, as reported by teachers in this study, is consistent with the findings of Wals and Benavot (2017) who argue that schools often overlook sustainability in favor of traditional academic goals. The insights from teachers underscore the importance of integrating environmental education into school curricula and fostering a culture that values both academic and environmental goals.

4.8.3. Information from Ward Education Officers (WEO)

Two Ward Education Officers (WEOs) were interviewed as part of this research. When asked if there are any climate change programs in their wards, both responded positively. They explained that most of the programs in their schools are facilitated through environmental clubs. Additionally, they noted that seminars on environmental and health programs are occasionally conducted for students by officers from the district environmental department, though such events are infrequent.

When questioned about the challenges they face in implementing climate change programs, both WEOs identified funding as the most significant barrier. One WEO elaborated on these challenges, stating:

“Climate programs at schools are very important; however, the lack of funds to execute these programs is a major challenge. For example, government schools in my ward depend solely on allocated funds from the central government, which are insufficient to cover daily school activities,

let alone environmental initiatives. Additionally, some teachers at my schools show limited interest and innovation in environmental programs. Furthermore, our district and region have very few Non-Governmental Organizations (NGOs) focused on the environment compared to other regions, which could otherwise help disseminate information and support student engagement in climate-related activities.”

These results highlight the critical role of financial resources and institutional support in the successful implementation of climate change programs in schools. The reliance on limited government funding, coupled with a lack of teacher engagement and external support from NGOs, underscores the systemic challenges faced by schools in promoting climate adaptation and mitigation practices. This findings align with Wals and Benavot (2017) who noted that schools often struggle to prioritize environmental programs due to competing demands and resource constraints. These systemic barriers underscore the need for increased funding, teacher training, and partnerships with NGOs to support climate change education and adaptation practices in schools.

Photographs documenting the interview process, including interactions between the researcher and the WEOs, are provided in **Appendix 6** for reference.

4.9. Information from Observation

In this section, the researcher used an observation guide to collect data on climate adaptation and mitigation practices, indicators, and behaviors exhibited by students and within the school environment. The teacher used two days in each school to make observations. The results were as follows.

4.9.1. Green spaces and Environmental Aesthetic

The observations were conducted across eight schools, focusing on green spaces, water management, transportation, energy use, waste management, and flood mitigation measures. All eight schools were observed to have green spaces, which serve multiple purposes, including providing resting areas, enhancing the aesthetic appeal of the school environment, and improving air quality through the supply of oxygen. These green spaces contribute to a healthier and more

conducive learning environment. The presence of green spaces in all observed schools aligns with Chawla's (2020) findings, which emphasize the role of nature in fostering environmental awareness and improving mental and physical health among students.

4.9.2. Rainwater Harvesting

The researcher observed that five of the eight schools had rainwater collection tanks, which are used to store water during the rainy season. This practice demonstrates an effort to utilize natural resources sustainably and address water scarcity issues, particularly in regions where access to clean water is limited. Rainwater harvesting not only provides an alternative water source for schools but also serves as a practical example of climate adaptation, teaching students the importance of resource conservation and sustainable water management. Photographs of the rainwater collection tanks observed in the schools are included in **Appendix 7** for reference

This finding corroborate with the work of UNESCO (2021), which emphasizes the critical role of rainwater harvesting in promoting water security and climate resilience, especially in educational institutions. The report highlights that such practices not only address immediate water needs but also serve as educational tools to instill sustainable behaviors in students. By integrating rainwater harvesting systems, schools can reduce their reliance on external water sources, mitigate the impacts of drought, and contribute to broader climate adaptation efforts.

4.9.3. Students' Mode of Transportation

The researcher observed that students from private schools were primarily boarding students, while those from public schools mostly walked to school. A small number of public school students were seen using bicycles. This observation highlights differences in transportation patterns based on school type and location, with private school students relying on institutional arrangements (boarding) and public school students depending on walking or cycling due to limited access to transportation resources.

This finding corroborate with the study by Barrero et al. (2020), which examined transportation patterns among students in urban and rural areas. The study found that students in resource-constrained settings often rely on walking or cycling due to limited access to public or private

transportation. Barrero et al. (2020) also emphasized that active transportation modes, such as recycling and walking, not only reduce GHGs but also promote physical health among students. However, the lack of safe infrastructure for walking and cycling in many regions remains a significant barrier to widespread adoption.

4.9.4. Climate Change Awareness and Education

The researcher noted a lack of visual materials, such as posters, related to climate change in all observed schools. This absence suggests a potential gap in raising awareness and educating students about climate-related issues, which could hinder efforts to promote environmental stewardship among the younger generation. This finding aligns with Monroe et al. (2019), who emphasize the critical role of visual and educational materials in fostering climate change awareness and action, particularly in school settings. Their research underscores the need for targeted strategies to integrate environmental education into school environments effectively.

4.9.5. Energy use and Efficiency

All schools were connected to grid electricity, and some boarding students were observed recharging solar-powered torches during the day. No lights were left on during daylight hours, suggesting that schools practice energy conservation. However, while three schools had modern, energy-efficient kitchens that use less firewood, the remaining five schools still relied on traditional three-stone stoves, which consume significant amounts of firewood and contribute to deforestation. The use of energy-efficient practices, such as solar-powered devices and modern stoves in some schools, supports the IPCC's (2022) recommendations for transitioning to sustainable energy solutions to reduce environmental impact

4.9.6. Waste Management Practices

It was found that all eight schools had waste disposal areas; however, both biodegradable and non-biodegradable waste were mixed in the same dump sites. This indicates a lack of waste separation practices, which could hinder recycling efforts and contribute to environmental pollution. The lack of waste separation practices observed in schools aligns with Zaman and Lehmann's (2011)

findings, which highlight the need for improved waste management systems, including recycling and composting, to reduce environmental pollution.

4.9.7. Flood Mitigation Measures

The researcher observed that six schools had gardens and drainage systems built along classroom walls to facilitate the movement of rainwater and reduce erosion and flooding. Additionally, one school had installed flood barriers to prevent surface runoff from reaching dormitories. These measures demonstrate proactive efforts to mitigate the impacts of flooding, which is a common climate-related challenge in the region. The flood mitigation measures observed in schools, such as drainage systems and flood barriers, are consistent with the UNDRR's (2019) recommendations for integrating disaster risk reduction strategies into educational infrastructure

Overall, the observations reveal a mix of sustainable practices and areas for improvement in the schools. The presence of green spaces and rainwater harvesting systems reflects a commitment to environmental sustainability, while the lack of climate change posters suggests a need for greater awareness-raising efforts. The use of energy-efficient practices, such as avoiding unnecessary electricity use and adopting solar-powered devices, is commendable. However, the reliance on traditional stoves in some schools highlights the need for transitioning to more sustainable energy sources. The absence of waste separation practices underscores the importance of introducing recycling programs and educating students and staff on proper waste management. Finally, the flood mitigation measures observed in several schools demonstrate an understanding of local climate risks and a proactive approach to addressing them. These findings align with studies by UNESCO (2021), emphasizing the role of schools as hubs for promoting sustainable practices and climate resilience.

5: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. SUMMARY

This study assesses the awareness of climate change and adaptation practices among secondary school students in Makete District, Tanzania. Using a descriptive survey design, data were collected from 330 students across eight secondary schools through questionnaires, interviews, and observations. The study employed both qualitative and quantitative data analysis methods, utilizing the Statistical Package for Social Sciences (SPSS) for quantitative data and thematic analysis for qualitative insights.

The findings revealed that a significant majority of students (79.7%) have a high awareness level of climate change, with 20.3% of students with medium awareness, with females demonstrating slightly higher awareness levels (79.3%) than males (77.1%). Students exhibited a strong understanding of key climate change indicators, such as rising temperatures, erratic rainfall patterns, and frequent flooding. However, awareness of specific greenhouse gases (GHGs) like ozone and nitrous oxide was lower, indicating gaps in knowledge. Students also showed a high level of knowledge regarding climate change mitigation, with 78%, and adaptation practices with 81%, such as tree planting, renewable energy use, and water conservation. Moreover, 87.6% of students showed that they participated in adaptation practices at home, school or at their community. Despite this, some misconceptions and knowledge gaps were identified, particularly in understanding the connection between local goods and climate change, as well as the role of gender in climate change impacts.

The study highlights the importance of integrating climate change education into school curricula and enhancing practical, hands-on learning experiences to improve students' understanding and engagement in climate adaptation and mitigation practices.

5.2. CONCLUSION

The research undertaken in Makete District focused on climate change awareness, adaptation, and mitigation practices across eight secondary schools: Bulongwa, Itamba, Iwawa, Matamba, Makete Girls, Mwakavuta, Lupalilo, and Lupila.

The first objective was to analyze gender differences in the level of awareness of climate change. The results in chapter four suggest the difference between male and female students in the level of awareness of climate change. Overall, both genders had a high awareness level of 79.7% and 20.3% with a medium level, indicating that they are more familiar with climate change. However, female students demonstrated a slightly higher awareness, 79%, than male students, 77%. Indicating that females are more aware than males of issues of climate change

Objective two aimed to assess students' knowledge level of climate change adaptation practices. As highlighted in Chapter Four, students demonstrated a strong overall understanding, with 81% showing good knowledge of key adaptation strategies. These include planting drought-tolerant crops, practicing conservation agriculture (e.g., cover crops, mulching, and crop rotation), and migrating from flood- or drought-affected areas. Students also recognized the importance of constructing flood walls and berms, staying hydrated during extreme heat, wearing heavy clothes in cold seasons, and building houses away from floodplains. Additionally, they understood the value of planting short-term crops, using improved seeds, adopting drip irrigation to minimize water usage, and reusing and recycling water during scarcity. These findings reflect students' awareness of practical adaptation measures, underscoring the potential for further education to enhance their capacity to address climate-related challenges

Objective three aimed to assess students' knowledge level of climate change mitigation practices. As presented in Chapter Four, approximately 78% of students demonstrated a high level of knowledge of mitigation, correctly identifying practices such as planting trees, using renewable energy, minimizing industrial pollution, and adopting energy-efficient technologies. However, misconceptions were evident, with some students believing that burning fossil fuels, increasing cattle numbers, or relying solely on divine intervention could mitigate climate change.

Additionally, while students recognized the importance of waste management and local goods, some misunderstood the environmental impact of using private cars or expanding agricultural land

Objective four aimed to examine the climate change adaptation practices of secondary school students in Tanzania. As demonstrated in Chapter Four, students are actively engaging in various adaptation practices, with approximately 87.6% participating in activities such as cultivating short-term crops or gardens, planting trees, managing storm water through rain gardens, and setting up rain barrels for rainwater harvesting. Additionally, students adapt to extreme weather by wearing lightweight clothes during heatwaves and heavy clothes in cold seasons, closing windows during cold periods, and staying hydrated to avoid dehydration. They also contribute to community resilience by fixing leaks to prevent water waste, sharing flood risk information, and cleaning drainage systems to ensure smooth storm water flow. These findings underscore the proactive role students play in climate adaptation, highlighting the importance of supporting and scaling up such practices to enhance community resilience.

5.4. RECOMMENDATIONS

Based on the key findings, the researcher made some key policy recommendations that may promote more engagement and intervention that can improve awareness and foster engagement of students in climate change.

Firstly, Schools, policy makers, and curriculum developers should develop and strongly enforce the implementation of educational interventions and awareness campaigns tailored to address gender-specific vulnerabilities and perspectives. Prioritizing gender-sensitive climate change education programs that encourage equal participation and engagement from both male and female students can help to address the existing gap of awareness.

Secondly, The District environmental department and Ministry of Education, in collaboration with environment-based NGOs, should prioritize the organization of regular seminars and workshops on climate change for teachers, particularly those instructing subjects relevant to Science, Geography, and Social Studies. These professional development opportunities will equip educators with up-to-date knowledge, innovative teaching strategies, and the confidence to integrate climate change education into their classrooms effectively.

Third, schools and local communities should institutionalize future-oriented climate education by integrating problem-solving and hands-on mitigation and adaptation practices into learning frameworks. This can be achieved through student-led projects, experimental activities (e.g., renewable energy prototypes), and environmental clubs that organize tree-planting, waste recycling, and energy-saving competitions. To ensure sustainability, partnerships with local governments and NGOs should be strengthened to provide critical resources, including seedlings, funding, and renewable energy demonstration kits for these initiatives.

Lastly, policymakers, curriculum developers, and education practitioners should prioritize integrating climate change into formal examination systems to ensure both scientific rigor and local relevance. Exams should assess not only foundational climate science but also practical dimensions, such as the carbon footprint of consumer goods, sustainable consumption, and socio-economic impacts. Embedding these topics in exam assessments will incentivize schools and students to prioritize climate literacy, fostering a generation of environmentally informed citizens

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7. APPENDIX

APPENDIX 1: Introduction Letter



APPENDIX 2: Research Questionnaire

Dear Respondent,

This questionnaire is for academic purposes and your responses will not be used for anything else rather than for the stated purpose. The purpose of this study is Assessment of secondary school students' awareness of climate change and adaptation practices. A case study of Makete district:

I thank you most sincerely for your cooperation. Be free in giving your answers without any reservations.

SECTION A: Socio-Demographic Characteristics

Please provide the following information (Tick (√) inside the box for multiple choice questions)

1. Age last birthday?.....

2. What is your gender?

A. Female

B. Male

3. What is the main occupation (work) of your parents?.....

A. Civil servant

B. Farmers

C. Business

D. Other specify

4. I come from

A. Urban area

B. Rural area

5. What class Grade/ form are you?

A. Form five

B. Form six

6. What is your area of specialization?

A. science

B. Art

C. Business

7. What is the type of your school?

A. Public

B. Private

8. Where is the school located?

A. Urban area

B. Rural area

Section B: Students' Awareness of Climate Change

The following are some questions on climate change awareness. Put (Tick (√) to the most appropriate answer

1., Have you ever heard of climate change?

A) Yes

B) No

Through which means have you heard of climate change?

A. Radio

- D. Television
- B. School Club
- E. WhatsApp
- C. Internet
- F. Friends or Neighbors

If you have heard climate change continue with the questions bellow

2. In your own opinion is climate change real?

- A) Yes
- B) No

3. If your answer in question 2 is “Yes “what are some of the indications that it’s real? (You can tick (√) more than one)

- A. Rising of temperature
- B. Sea level rise
- C. Change of rainfall pattern
- D. Frequent occurrence of flooding
- E. Prolonged drought
- E. Other specify

4. Are any of the following Greenhouse Gases (GHGs)? Tick (√) all boxes that you think are correct (multiple answer is allowed)

- | | | | |
|-------------------|--------------------------|------------|--------------------------|
| A. Carbon dioxide | <input type="checkbox"/> | B. Methane | <input type="checkbox"/> |
| C. Oxygen | <input type="checkbox"/> | D. Argon | <input type="checkbox"/> |

E Water vapor

F Nitrous oxide

G Hydrogen

H Nitrogen

I. Chlorofluorocarbons (CFCs)

J. Ozone

K. Helium

L. Don't know

5. What does the phrase "climate change" mean?

A. Rising global temperatures

B. Changes in the average weather conditions towards extremes recorded over long periods (20-30 years)

C. Short-term variations in weather patterns

D. Hole in the ozone layer

E. I don't know

6. Do you think that the problem of climate change can be solved at all?

A. Yes

B. No

C. I don't know

7. Do you think that human's activities contribute to climate change?

A. Yes

B. No

C. I don't know

8. If your answer is yes, which one of these are the main activities that contribute to climate change in Tanzania? (multiple options allowed)

- A. Deforestation
- B. Agriculture
- C. Burning of forest/ Bushfire
- D. Burning of fossil fuels
- E. Livestock
- F. Waste mismanagement

If your answer is no, why?

.....

.....

.....

9. How do you think an individual can help to overcome the problem of climate change? (multiple options allowed)

- A. By prayer
- B. By been religiously committed
- C. Afforestation and education campaign
- D. Be prepared to face it
- E. Intensify research effort
- F. Stop air pollution
- G. No response

Please indicate the extent to which you agree or disagree with the following statements about climate change by placing a tick (√) in the appropriate box

	Statements	Strongly agree	Agree	I don't know	Disagree	Strongly disagree
1	Cutting down trees cause climate change					
2	Climate change is caused by poor agricultural practices (such as monoculture and overuse of chemical fertilizers)					
3	Air pollution from industries causes climate change					
4	More garbage/improper waste disposal causes climate change					
5	Using firewood and charcoal for cooking causes climate change					
6	Climate change is a punishment from lesser gods					
7	Climate change causes gender inequalities					
8	Climate change causes low crop production and leads to food insecurity					
9	Climate change causes biodiversity loss.					
10	Climate change can cause death of people and animals due to flooding.					
11	Climate change affects renewable energy sources (hydroelectric power plants)					
12	Increased health risks (Diseases from dry air, malaria from mosquito bites as					

	a result of flooding or dryness) which are both caused by climate change					
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SECTION C: Students’ Knowledge of the Adaptation Practices of Climate Change

Please put **(Tick (√))** inside the box that represents the extent to which you know is correct or incorrect for adaptation practices against climate change hazards

	Statements	Correct	incorrect	I don’t know
1	Planting drought tolerant crop help to adapt to drought			
2	Conservation agriculture (planting cover crop, mulching and crop rotation) help to adapt to climate change			
3	We can Migration away from flooding or drought-affected areas			
4	We are advised to construct flood walls and berms against flooding			
5	People are advised to drink enough water during extreme heat.			
6	We are advised to wear heavy clothes during the cold season			
7	Building houses away from floodplain areas help to avoid flooding			
8	Planting short-term crops like spinach, lettuce peas and new improved seeds like Maize SIDCO can help to adapt against drought hazards.			
9	Drip irrigation help to minimize water usage			
10	Water reuse and recycling can help during a water scarcity period			

SECTION D: Students' Knowledge of the Mitigation Practices of Climate Change

Please put **Tick (√)** inside the box that represents the extent to which you know is correct or incorrect about the following statements for mitigation practices against climate change

	Statements	correct	incorrect	I don't know
1	We can reduce/prevent climate change by planting more trees.			
2	We can reduce/prevent climate change by burning more fossil fuel in our activities.			
3	Climate change can be stopped only by God.			
4	Increasing number of cattle can help to reduce/prevent climate change.			
5	We can reduce/prevent climate change by using renewable energy sources.			
6	We can reduce/prevent climate change by minimizing air pollution from industries.			
7	We can reduce the effect of climate change by using energy efficient technologies (like energy bulbs, refrigerator, air conditioner etc),			
8	People can help stop climate change by using more land to grow food.			
9	People can help stop climate change by using cars instead of public transport.			
10	People can help stop climate change by buying more local goods.			
11	We can reduce/prevent climate change by properly managing our waste			

SECTION E: Climate Change Adaptation Practices by Secondary School Students

1. Do you think there is any adaptation practices a secondary school student can play in addressing Climate change?

A. Yes

B. No

If your answer in Question 1 above is YES, put tick (√) in the box to the following climate adaptation practices statement that you do/participate or not do/participate at home or school.

	Statements	I do/participate	I don't do/participate
1	I participate to cultivate short term crop/garden		
2	I plant tree		
3	I plant rain garden to manage storm water and reduce flooding.		
4	I wear lightweight clothes, and avoiding outdoor activities during peak heat days and wear heavy clothes during cold season		
5	I set up rain barrels to collect rainwater for domestic activities(rain water harvest)		
6	I close windows during cold period		
7	I drink sufficient water to avoid dehydration		
8	I fix or repair leaks in toilets and pipes to prevent water waste		
9	I share information about flood risks to my fellow students and community members		

10	I participate to clean drainage systems to remove trash and sediments to allow smooth flow of storm water/surface runoff.		
----	---	--	--

If no, why

.....

.....

.....

Thank you very much for having accepted to participate in this discussion and for availing yourself. Further details on this research could be obtained from either my supervisor or me.

Thank you

APPENDIX 3: Interview Guide for Research

Introduction and Welcoming Respondents

My name is **Elisha Milabagano Nyambere**; a student of Climate Change policy at Pan Africa Institute of Water and Energy Sciences including Climate Change (PAUWES). I will be the moderator for this interview. The purpose of this discussion is for me to satisfy partial academic requirements for the award of a Master’s degree in Climate Change policy.

Thus, all the discussions in this meeting will be confidential. First and foremost, I would like to thank you for having accepted to be interviewed on the topic:

Assessment of secondary school students’ awareness of climate change and adaptation practices. A case study of Makete district

SECTION A. DEMOGRAPHIC INFORMATIONS

Name of school/ Institute	What is your position	What are your qualification

SECTION B: CLIMATE CHANGE AWARENESS

1. Do know about climate?
 - A. Yes
 - B. No
2. How did you hear about climate change?

.....
3. How has climate change impacted your local community or environment?

.....

.....

.....
4. What are some examples of greenhouse gases that cause climate change?
 - (i)
 - (ii)
 - (iii)

5. How has school helped you do be aware with climate change issues?

.....
.....
.....

6. What do you think causes climate?

.....
.....
.....
.....

7. What are some of the effects of climate change?

- (i).....
- (ii)
- (iii)
- (iv)

SECTION C: KNOWLEDGE ON THE ADAPTATION AND MITIGATION OF CLIMATE CHANGE

1. Do you believe human being can stop climate change?

- A. Yes
- B. No

2. If No, Why?.....

.....

3. If YES, what are the measures and practices a human can do to prevent climate change

- (i)
- (ii)
- (iii)
- (iv)

4. What role do you think students can play in promoting climate change adaptation in your community?

(i)

(ii)

(iii)

SECTION E: CLIMATE CHANGE ADAPTATION PRACTICES BY SECONDARY SCHOOL STUDENTS

1. Are there any programs for climate change adaptation practices here at school?

.....
.....

2. Can you describe any projects or activities at your school that address climate change?

(i)

(ii)

(iii)

3. What are adaptation practices that you do or participate at school or home?

(i)

(ii)

(iii)

APPENDIX 4: Observation Sheet for Research

Type of School.....

School Location.....

NO	Climate adaptations or mitigations Indicator/ behavior/ practices observed	Observer's Comments
1	Tree Planting and Greening Garden/Projects.	
2	Water Conservation and Harvesting Measures/Facility	
3	Waste management	
4	Flood mitigation measures	
5	Environmental/ Eco-clubs or initiatives	
6	Renewable energy	
7	Sustainable energy use/ energy efficiency	
8	Posters on climate change are available	
9	Modes of transportation used by students	
10	Farming techniques and seed types used for School farm	

Any other

11.....

APPENDIX 5: Photography of Researcher Distributing Questionnaires



APPENDIX 6: Photography of Researcher Conducting Interview



APPENDIX 7: Photograph of Observation Showing Rainwater Harvesting

