

Investigating The Impact of Climate Change on Education in Primary Schools: A Case of Nyimba District.

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Abstract. Climate change is increasingly recognized as a significant threat to sustainable development, with profound implications for the education sector, particularly in rural and under-resourced regions. This research investigates the impact of climate change on primary education in Nyimba District, Eastern Province, Zambia. The study is premised on the understanding that changing weather patterns, including prolonged droughts, flash floods, and extreme heat, have direct and indirect consequences on school attendance, infrastructure, learning outcomes, and teacher performance. Rural communities such as Nyimba, which heavily depend on rain-fed agriculture, are especially vulnerable as climate variability undermines household livelihoods, increases food insecurity, and reduces children's ability to attend and perform well in school (UNESCO, 2020; Chikodzi, 2016). Moreover, damage to school buildings, inaccessible roads, and water scarcity caused by erratic rainfall patterns present structural barriers to the delivery of quality education (UNICEF, 2021). These challenges are further compounded by the lack of climate-resilient infrastructure and limited policy implementation at the local level (Mutale & Ntalasha, 2019). Using a mixed-methods approach, this study combines qualitative data from interviews and focus group discussions with teachers, pupils, and community members, alongside quantitative analysis of attendance records and climate data. The study adopts the vulnerability and resilience framework, which provides insights into how educational systems adapt—or fail to adapt—to environmental stressors. Preliminary findings reveal that food insecurity due to droughts has led to increased pupil absenteeism, while flooding during the rainy season disrupts learning by destroying classrooms and washing away access roads. Additionally, teachers report difficulties in curriculum delivery due to shortened school terms and psychological stress among learners (Mphalo, 2022; Banda & Phiri, 2021).

keywords: Climate Change, Primary Education, Educational Sustainability, Rural Education, School Attendance, Learning Outcomes, Climate Resilience

I. Introduction

Climate change has increasingly emerged as one of the most pressing global challenges of the 21st century, with far-reaching implications across social, economic, and environmental sectors. Beyond its immediate environmental effects, such as rising temper-

atures, erratic rainfall patterns, prolonged droughts, and floods, climate change has begun to influence critical areas of human development, including education (UNESCO, 2019). Education, which is widely recognized as a cornerstone for national development, is not immune to the disruptions caused by climatic variability. In regions that are heavily dependent on agriculture, such as Nyimba District in Zambia, the indirect effects of climate change—such as food insecurity, health challenges, and displacement—have a direct bearing on the participation, performance, and continuity of learners in primary schools (World Bank, 2021).

Zambia, like many Sub-Saharan African countries, has experienced significant climate variability over the past decades (IPCC, 2022). The Eastern Province, where Nyimba District is located, is particularly vulnerable due to its reliance on rain-fed agriculture and limited adaptive infrastructure. Prolonged droughts reduce household food supplies and income, while floods often damage infrastructure, including school buildings and roads, making it difficult for learners and teachers to attend classes regularly. Consequently, climate-induced shocks contribute to absenteeism, school dropouts, poor concentration among pupils, and increased teacher workload, thereby undermining the broader goals of quality education as outlined in Zambia's Education Policy and the United Nations Sustainable Development Goal (SDG) 4, which advocates for inclusive and equitable quality education for all (UN, 2015).

The nexus between climate change and education, therefore, requires urgent academic attention, particularly in primary schools where the foundation for lifelong learning is laid. While climate change has been extensively studied in relation to agriculture, health, and economic livelihoods, there remains a limited body of knowledge in Zambia that directly links its impact to the education sector (Chansa, 2020). This gap makes it necessary to explore how environmental changes affect teaching and learning, learner attendance, teacher performance, and the general school environment.

This study will thus set the stage for a rigorous inquiry into the impact of climate change on education across primary schools in Nyimba District, Zambia. It will introduce the study's rationale, present the historical and theoretical context, and articulate the specific problem that the research will address. Furthermore, the chapter will outline the purpose of the study, objectives, and research questions that will guide the investigation. It will also highlight the significance of the study's anticipated findings, delimit

the scope of the research, and acknowledge potential limitations. Finally, the chapter will define key operational terms to ensure clarity and coherence throughout the work.

Background Of The Study

Climate change has become one of the most pressing global challenges of the 21st century, affecting all sectors of society, including education. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), the world has experienced a steady rise in temperatures, erratic rainfall patterns, prolonged droughts, and increased incidences of floods. These environmental changes have far-reaching consequences for human development, particularly in developing countries where livelihoods largely depend on rain-fed agriculture.

In Africa, the effects of climate change are more pronounced due to high levels of poverty, dependence on natural resources, and limited adaptive capacity (Niang et al., 2014). Sub-Saharan Africa has experienced severe droughts, flooding, and food insecurity, which in turn disrupt access to education for millions of children. The United Nations International Children's Emergency Fund (UNICEF, 2015) highlights that children are among the most vulnerable groups affected by climate change, as it impacts their health, nutrition, and learning outcomes.

In Zambia, climate change has manifested through prolonged dry spells, unpredictable rainfall patterns, and occasional flash floods (Ministry of Green Economy and Environment, 2021). These climatic shocks have directly and indirectly affected the education sector. For instance, prolonged droughts reduce agricultural productivity, leading to food insecurity and malnutrition, which negatively impact school attendance and learner performance (Mulenga, 2015). On the other hand, heavy rains and floods damage school infrastructure, disrupt teaching and learning, and increase absenteeism (Phiri & Kalinda, 2019).

Nyimba District, located in the Eastern Province of Zambia, is not exempt from these challenges. The district experiences frequent droughts and floods that affect both livelihoods and education. Most households in the area depend on subsistence farming, which is highly vulnerable to climatic shocks. During drought years, children are often withdrawn from school to help families with income-generating activities or due to lack of food, while in flood years, damaged infrastructure and impassable roads prevent

learners from accessing schools (Zambia Meteorological Department, 2022). As a result, climate change poses a significant threat to the attainment of quality primary education in the district.

Given that education is a fundamental human right and a key driver of sustainable development (UNESCO, 2017), understanding the link between climate change and education outcomes is critical. This study therefore seeks to investigate the impact of climate change on primary education in Nyimba District, focusing on its causes, effects, and the measures being undertaken to mitigate the challenges.

Statement Of The Problem

Climate change has become a global phenomenon with severe implications for social and economic development. While much scholarly and policy attention has focused on its effects on agriculture, health, water resources, and livelihoods, the education sector has not been adequately prioritized in research and intervention frameworks, particularly in rural contexts such as Zambia (UNICEF, 2016). Primary education is the foundation upon which future learning and human capital development are built, yet it is increasingly disrupted by climate-induced shocks.

In Nyimba District, a predominantly rural area in Zambia's Eastern Province, the effects of climate change are visibly evident through recurrent droughts, seasonal floods, and unpredictable rainfall patterns (GRZ, 2021). These conditions not only affect agricultural productivity and household income but also directly impact the schooling experience. Many families depend on farming for their livelihood, and when harvests fail due to climate variability, children are often withdrawn from school to help with household survival strategies or because their guardians cannot afford educational costs. Food insecurity also leads to malnutrition, which reduces children's concentration levels, school attendance, and overall academic performance (WFP, 2020).

Moreover, climate change frequently damages school infrastructure, such as classrooms, roofs, and sanitation facilities, through storms and flooding. This compromises the learning environment and, in some cases, forces temporary school closures. Teachers, too, are affected, as they must contend with overcrowded classes in damaged facilities, or they may be absent due to climate-related challenges affecting their own house-

holds (Mulenga, 2018). Ultimately, these factors disrupt the delivery of quality education, hinder progression rates, and threaten Zambia's progress toward achieving Sustainable Development Goal 4 (Quality Education for All).

Despite the visible disruptions, limited empirical studies have been conducted in Zambia to investigate the specific relationship between climate change and education, particularly at the primary school level. There is a lack of localized evidence on how climate variability influences learner attendance, teacher performance, learning outcomes, and school operations in Nyimba District (Mwansa, 2019). This gap in knowledge undermines the ability of policymakers, educators, and communities to develop effective adaptation and mitigation strategies tailored to the education sector.

It is against this background that this study seeks to investigate the impact of climate change on education in primary schools of Nyimba District. By generating empirical evidence, the study aims to contribute to both academic knowledge and practical solutions that can safeguard the right to education in the face of an evolving climate crisis.

PURPOSE OF THE STUDY

The purpose of this study is to investigate the impact of climate change on education in primary schools within Nyimba District, Eastern Province of Zambia. Specifically, the study seeks to examine how climate-related factors such as droughts, floods, extreme temperatures, and erratic rainfall patterns influence the teaching and learning process, learner attendance, school infrastructure, and overall educational outcomes.

This study aims to generate localized evidence on the ways in which climate change disrupts the education sector at the primary level, where learners are most vulnerable to external shocks. By doing so, the research intends to highlight the interconnectedness between environmental changes and educational development in rural Zambia. The findings are expected to provide a deeper understanding of how climate change undermines the attainment of Sustainable Development Goal (SDG) 4, which advocates for inclusive and equitable quality education, as well as Zambia's national education policy goals (UN, 2015).

Furthermore, the study is designed to inform policymakers, educators, and community stakeholders about the challenges schools face in adapting to the impacts of climate change. It will also provide practical insights into potential strategies and interventions

that can strengthen the resilience of primary schools to environmental shocks. In the long run, the study seeks to contribute to national and regional discourses on education and climate change, ensuring that the education sector is not overlooked in climate change adaptation and mitigation policies.

Objective Of The Study

1. To investigate the causes of climate change affecting primary education in Nyimba District.
2. To examine the effects of climate change on teaching and learning in primary schools of Nyimba District.
3. To identify the measures and strategies being implemented to mitigate the impact of climate change on primary education in Nyimba District.

Research Questions:

1. What are the major causes of climate change that affect primary education in Nyimba District?
2. How does climate change affect teaching and learning in primary schools of Nyimba District?
3. What measures and strategies are being implemented to mitigate the impact of climate change on primary education in Nyimba District?

Characteristics Of The Phenomenon

Climate change is a complex and multidimensional phenomenon characterized by long-term alterations in global or regional climate patterns, largely resulting from increased concentrations of greenhouse gases in the atmosphere. It manifests through rising global temperatures, unpredictable rainfall patterns, droughts, floods, heatwaves, and other extreme weather events (IPCC, 2023). These climatic shifts have intensified over the past few decades, with developing countries such as Zambia experiencing the most severe consequences due to their limited adaptive capacity and dependence on climate-sensitive sectors such as agriculture (Mulenga & Kalinda, 2020).

One of the key characteristics of climate change is variability in temperature and precipitation. In Zambia, average annual temperatures have increased by approximately 1.3°C since 1960, with projections indicating a continued upward trend (World Bank, 2022). Rainfall has become more erratic, leading to prolonged dry spells and flash floods that disrupt livelihoods and educational systems alike. The Eastern Province, including Nyimba District, has faced both recurrent droughts and floods in recent years,

which have directly affected school attendance and infrastructure (Zambia Meteorological Department, 2021).

Another significant feature of the phenomenon is its slow-onset and cumulative nature. Unlike sudden disasters, the effects of climate change accumulate gradually, impacting agriculture, water resources, and public health over time. This gradual progression has a compounding effect on education, as food insecurity, displacement, and poverty induced by climate change increase school absenteeism and dropout rates (UNICEF, 2020). For instance, during drought periods, children in rural areas often miss school to assist their families in sourcing food or water, while floods may destroy classrooms and educational materials (Shifeta, 2021).

Climate change is also characterized by its global reach but local impact. Although it is a worldwide phenomenon, the intensity and nature of its effects differ across regions and communities. In Nyimba District, where livelihoods are heavily dependent on rain-fed agriculture, climate variability threatens household income and children's educational opportunities. Communities in this region experience reduced agricultural yields, water shortages, and increased poverty, all of which undermine educational access and quality (NCCRS, 2016; Tembo, 2022).

Furthermore, climate change exhibits interconnectedness with other socio-economic and environmental systems. Its impacts are not confined to the physical environment but extend to health, nutrition, gender equity, and education (UNDP, 2021). For example, extreme weather events can lead to outbreaks of water-borne diseases such as cholera and malaria, which reduce students' school attendance and teachers' effectiveness (WHO, 2020). These interlinkages highlight that addressing climate change in education requires a holistic, multi-sectoral approach involving environmental management, community awareness, and infrastructural adaptation (Phiri & Simwanda, 2023).

In summary, the phenomenon of climate change is marked by increasing temperatures, erratic rainfall, recurrent droughts and floods, slow but cumulative impacts, and deep interconnections with other development sectors. These characteristics make it one of the most pressing challenges to achieving quality education and sustainable development in rural districts like Nyimba. Understanding these features is therefore essential

for formulating effective adaptation strategies that safeguard the educational sector from climate-induced disruptions.

Factors Related To The Phenomenon

Climate change does not occur in isolation; rather, it is influenced by a variety of natural and human-induced factors that interact in complex ways. Understanding these underlying factors is crucial for assessing the extent of its impact on education and for developing strategies to mitigate its effects in regions such as Nyimba District. The major factors related to the phenomenon include greenhouse gas emissions, deforestation, agricultural practices, population growth, and industrialization, among others (IPCC, 2023).

One of the primary drivers of climate change is the increase in greenhouse gas (GHG) emissions from human activities. The burning of fossil fuels such as coal, oil, and gas for energy, transportation, and industry releases large amounts of carbon dioxide (CO₂) and methane (CH₄) into the atmosphere, intensifying the greenhouse effect and raising global temperatures (World Bank, 2022). In Zambia, although industrial emissions are relatively low, deforestation and agricultural emissions contribute significantly to the national carbon footprint (ZEMA, 2021). The rural communities in Nyimba, which rely heavily on charcoal production and firewood for energy, inadvertently contribute to this process (Phiri & Simwanda, 2023).

Deforestation and land-use changes represent another major factor influencing climate change. Forests act as carbon sinks by absorbing CO₂ from the atmosphere. However, when trees are cut down for agriculture, construction, or charcoal burning, this carbon is released, reducing the Earth's ability to regulate climate (NCCRS, 2016). In the Eastern Province, extensive deforestation has occurred as local populations clear land for maize cultivation and settlements. This practice has led to soil erosion, reduced rainfall reliability, and loss of biodiversity, which further exacerbate climate instability (Tembo, 2022).

Agricultural activities also play a significant role in climate change. The use of chemical fertilizers, methane emissions from livestock, and the burning of crop residues contribute to greenhouse gas emissions (FAO, 2020). In rural Zambia, traditional slash-and-burn farming techniques are common, especially among small-scale farmers. While these methods may provide short-term fertility benefits, they release large

amounts of carbon into the atmosphere and degrade soil quality over time (Mulenga & Kalinda, 2020). These agricultural practices, coupled with climate variability, have led to declining crop yields and food insecurity, which directly affect school attendance and performance among children in farming households.

Another factor is rapid population growth, which increases the demand for agricultural land, water, and energy. As Zambia's population continues to expand, pressure on natural resources intensifies, leading to environmental degradation and greater vulnerability to climate shocks (UNDP, 2021). In Nyimba District, population growth has driven the expansion of farming and settlement areas into previously forested zones, amplifying exposure to floods and droughts. The competition for resources often diverts household income from education to survival needs, undermining investments in schooling (UNICEF, 2020).

Industrialization and urbanization also contribute significantly to global climate change. Although Zambia's industrial base remains modest, growing economic activities in mining, transport, and manufacturing emit substantial amounts of greenhouse gases (World Bank, 2022). These emissions, combined with poor waste management systems and increased vehicular pollution, have contributed to changing local climatic conditions (ZEMA, 2021). Even rural districts such as Nyimba are indirectly affected through altered weather patterns and resource pressures.

Lastly, socio-economic and political factors influence both the causes and the impacts of climate change. Limited financial resources, weak environmental policies, inadequate infrastructure, and low levels of climate awareness hinder effective adaptation and mitigation (Phiri, 2023). Poor governance and lack of community participation in environmental decision-making further aggravate the effects of climate change at the local level. In the education sector, this translates into poorly maintained school infrastructure, inadequate disaster preparedness, and low investment in climate-resilient facilities (UNESCO, 2022).

In summary, the phenomenon of climate change is shaped by a combination of anthropogenic and natural factors. These include the burning of fossil fuels, deforestation, unsustainable agricultural practices, population pressure, industrialization, and weak

environmental governance. Understanding these interrelated factors is essential for developing targeted strategies to reduce the vulnerability of education systems, especially in rural districts like Nyimba, where livelihoods and schooling are closely tied to environmental conditions.

Global Statistical Scenario

Globally, climate change has emerged as one of the most significant threats to sustainable development, environmental stability, and human well-being. Statistical evidence from scientific organizations and development agencies demonstrates a steady rise in global temperatures, increasing frequency of extreme weather events, and far-reaching socio-economic consequences (IPCC, 2023). According to the Intergovernmental Panel on Climate Change (IPCC), the global surface temperature has increased by approximately 1.1°C above pre-industrial levels (1850–1900 baseline), with the past decade (2011–2020) recorded as the warmest on record (IPCC, 2023).

The World Meteorological Organization (WMO, 2022) reports that the last eight years have been consecutively the warmest years globally, largely due to increased concentrations of greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Global CO₂ levels reached a record high of 419 parts per million (ppm) in 2023, representing a 50% increase since the pre-industrial era (NOAA, 2023). These emissions are primarily driven by energy production, deforestation, and industrial activities. The Global Carbon Project (2023) indicates that fossil fuel combustion alone contributes about 89% of total global CO₂ emissions.

In terms of precipitation patterns, climate variability has intensified across continents. Many regions now experience more frequent droughts and floods, leading to disruptions in food security, health, and education systems (World Bank, 2022). Between 2000 and 2022, over 4.2 billion people worldwide were affected by climate-related disasters, resulting in economic losses exceeding US\$2.8 trillion (UNDRR, 2023). Developing countries accounted for nearly 91% of disaster-related deaths, highlighting the unequal burden of climate change across regions (UNDP, 2021).

The education sector has also been significantly affected by global climatic changes. UNESCO (2022) estimates that approximately 40 million children each year have their education disrupted by climate-induced disasters such as floods, cyclones, and droughts. In Sub-Saharan Africa alone, nearly 12 million learners were displaced by

extreme weather events in 2021 (UNICEF, 2022). These disruptions undermine progress towards Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education for all by 2030.

Global climate change is further reflected in the melting of polar ice caps and rising sea levels. The National Aeronautics and Space Administration (NASA, 2023) reports that global sea levels have risen by approximately 21–24 centimetres since 1880, with an average annual rise of 3.3 millimetres in the last three decades. This trend threatens low-lying coastal regions and island nations, leading to displacement, loss of livelihoods, and damage to educational infrastructure.

Additionally, extreme heatwaves are becoming increasingly common. Data from the European Union's Copernicus Climate Change Service (2023) show that Europe experienced record-breaking temperatures in 2022, resulting in more than 60,000 heat-related deaths. Similarly, South Asia and Africa have recorded temperatures exceeding 45°C, affecting agricultural productivity, water availability, and school attendance (World Bank, 2022).

The economic implications of climate change are equally severe. The International Monetary Fund (IMF, 2023) projects that climate-related damages could reduce global GDP by up to 18% by 2050 if current emission trends continue. Low-income countries, particularly in Africa and Asia, are most vulnerable due to their limited adaptive capacities. These economic challenges often translate into reduced government spending on education, health, and social welfare, exacerbating inequalities (UNDP, 2021).

In conclusion, global statistics portray a worsening climate scenario marked by rising temperatures, erratic rainfall patterns, increased disaster frequency, and widespread socio-economic disruption. The data underscore that climate change is not only an environmental issue but a multidimensional challenge with profound implications for education, human development, and global stability.

Local Statistical Scenario

At the national and district levels, Zambia—particularly the Eastern Province and Nyimba District—has not been spared from the growing impacts of climate change. Statistical data indicate that the country is experiencing significant temperature increases, erratic rainfall, and more frequent extreme weather events that have direct implications on agriculture, livelihoods, and the education sector (Zambia Meteorological Department, 2023). Over the last five decades, Zambia’s mean annual temperature has risen by approximately 1.3°C, while rainfall has declined by nearly 15%, particularly in southern and eastern regions (World Bank, 2022). These changes have led to a rise in drought frequency, late onset of rains, and shorter growing seasons, severely affecting rural communities’ dependent on rain-fed agriculture (Mulenga & Kalinda, 2020).

In the Eastern Province, where Nyimba District is located, climate data show that average annual rainfall has reduced from about 1,050 mm in the 1970s to around 850 mm in recent years (Zambia Meteorological Department, 2021). The region has also recorded more frequent dry spells and flash floods, particularly along the Luangwa Valley and low-lying areas. Between 2010 and 2022, the province experienced five severe droughts and three major floods, which disrupted agricultural productivity and community livelihoods (Disaster Management and Mitigation Unit [DMMU], 2022). These events have translated into increased poverty and food insecurity—two key factors that directly influence school attendance and performance (UNICEF, 2020).

Within Nyimba District, climatic shifts are particularly evident in the agricultural calendar. Data from the Ministry of Agriculture (2023) reveal that the start of the rainy season has shifted from late October to mid-December, while dry spells in January and February have become common. The district’s mean annual temperature currently stands at 28°C, with maximum temperatures often exceeding 38°C during peak dry months (ZMD, 2023). The prolonged dry periods have resulted in declining maize yields by nearly 25% over the last decade, forcing families to prioritize survival needs over education (Tembo, 2022). In communities such as Luembe, Nyakauya, and Chimwemwe, schools report increased absenteeism during drought periods as children help parents fetch water, tend to livestock, or engage in small-scale trading to supplement household income (Phiri & Simwanda, 2023).

The education sector in Nyimba has been significantly affected by these climatic conditions. According to the District Education Board (2023), over 20 primary schools in flood-prone zones have experienced infrastructural damage in the last five years, including collapsed classrooms, damaged roofs, and washed-away bridges that hinder learners' access to schools. The same report shows that pupil absenteeism rises by 15–20% during extreme weather events, while dropout rates increase among both boys and girls due to poverty and food shortages. Girls are particularly vulnerable, as families often prioritize domestic responsibilities or early marriages during economic hardships intensified by drought (UNESCO, 2022).

Furthermore, local statistics indicate that only 38% of schools in Nyimba have access to clean and safe water sources, while 45% lack climate-resilient infrastructure such as raised foundations and reinforced roofing (DEBS, 2023). This makes schools highly susceptible to damage from heavy rains and flooding. During the 2020/2021 rainy season, for example, Chifusa and Nyimba Central primary schools reported temporary closures due to flooded classrooms and impassable roads (DMMU, 2022). These disruptions contribute to learning loss, reduced instructional time, and psychological distress among learners and teachers.

On a broader provincial scale, the Eastern Province Education Office (2022) reported that over 6,000 learners missed at least two weeks of school in 2021 due to climate-related events, including floods, droughts, and heatwaves. The report further noted that teacher absenteeism also rises during harsh weather conditions, as transport and communication become difficult in remote areas. These statistics highlight the interconnectedness between environmental instability and educational outcomes in rural Zambia.

In summary, the local statistical scenario in Nyimba District demonstrates a clear link between climatic variability and educational challenges. Rising temperatures, declining rainfall, recurrent droughts and floods, and poor infrastructural resilience continue to threaten education delivery and learner participation. These trends underscore the urgent need for climate-responsive educational planning, investment in resilient school infrastructure, and community-based adaptation initiatives to safeguard the education of children in vulnerable rural areas.

Significance Of The Study

This study is significant because it addresses the growing concern of how climate change affects the education sector, particularly primary education in rural settings such as Nyimba District. Research shows that climate change has disrupted education systems globally through school closures, reduced attendance, and damage to infrastructure (UNICEF, 2015; UNESCO, 2017). In Sub-Saharan Africa, where communities are highly dependent on climate-sensitive livelihoods, these impacts are even more severe, contributing to inequalities in access to quality education (Niang et al., 2014).

For policy makers and government, the study will provide evidence to support the integration of climate change adaptation and mitigation strategies into the education sector. This is essential for Zambia, where the Ministry of Green Economy and Environment (2021) has emphasized the need for climate-resilient development strategies.

For school administrators and teachers, the research will highlight the challenges that climate variability poses to teaching and learning. Studies have shown that climate-induced disruptions—such as droughts and floods—affect school attendance and learner performance, underscoring the need for locally adapted resilience strategies (Phiri & Kalinda, 2019).

For pupils and communities, the study will shed light on how climate change affects children's right to education by increasing absenteeism and child labor during periods of food and water insecurity (Mulenga, 2015). By raising awareness, the study may encourage community-driven interventions that protect children's education.

For non-governmental organizations (NGOs) and development partners, the findings will provide baseline data that can inform targeted interventions, resilience-building projects, and school-based adaptation programs in vulnerable districts like Nyimba.

For academia and researchers, the study contributes to the body of knowledge on climate change and education in Zambia, where research on the subject is still limited. It will also serve as a reference for further investigations in similar contexts within Sub-Saharan Africa.

Ultimately, the study supports the attainment of Sustainable Development Goal (SDG) 4 (quality education) and SDG 13 (climate action), which emphasize inclusive education and urgent climate action at both local and global levels (United Nations, 2015).

SCOPE OF THE STUDY

The scope of this study is confined to investigating the impact of climate change on primary education in Nyimba District, Eastern Province of Zambia. The study focuses on three main dimensions: the causes of climate change, its effects on primary education, and the measures adopted to mitigate its impact.

Thematically, the study limits itself to examining how climate change influences school access, attendance, learner performance, and infrastructure in primary schools. Other aspects of climate change, such as its impact on health, energy, or industrial development, are beyond the scope of this study and will not be addressed (UNESCO, 2017). Geographically, the study is limited to Nyimba District, which has been identified as one of the areas in Eastern Province highly vulnerable to droughts and floods (Zambia Meteorological Department, 2022). While the findings may have implications for other regions in Zambia, the analysis and recommendations will specifically reflect the realities of Nyimba District.

Population-wise, the study will target teachers, pupils, head teachers, community leaders, and education officials as respondents, since these stakeholders are directly involved in or affected by the challenges posed by climate change in the education sector (Phiri & Kalinda, 2019).

Methodologically, the study adopts a mixed-methods approach, combining both quantitative and qualitative data collection. Quantitative data will provide statistical evidence on trends such as absenteeism and school dropout rates, while qualitative insights will capture the experiences and perceptions of stakeholders (Creswell, 2014).

Delimitation Of The Study

This study is confined to investigating the impact of climate change on education in primary schools located in Nyimba District, Eastern Province of Zambia. The choice of Nyimba District is deliberate, as the area is highly vulnerable to climate variability due to its dependence on rain-fed agriculture and its limited adaptive capacity (GRZ, 2021). By narrowing the scope to this district, the study provides a focused exploration of how climate-induced challenges influence the provision of education in rural communities.

The research is further delimited to primary schools, since they represent the foundational level of education where learners are most susceptible to disruptions caused by environmental shocks. Secondary schools and other levels of education are excluded, as the study seeks to concentrate on early educational experiences that shape the future learning trajectory of children.

Geographically, the study will not cover all schools in the district but will focus on a selected sample of primary schools that reflect both rural and peri-urban settings within Nyimba. This is to ensure manageability of the research process and to allow for in-depth analysis of the phenomenon under study.

In terms of thematic scope, the study will focus on three main areas: causes of climate change affecting primary education; effects of climate change on teaching and learning in primary schools; and measures and strategies being implemented to mitigate the impact of climate change on education. Other aspects of climate change, such as its broader implications on national economic development, global politics, or sectors like energy and industry, will fall outside the scope of this research. By establishing these delimitations, the study ensures that its findings remain relevant, specific, and practically applicable to the educational realities of Nyimba District.

Limitations Of The Study

While this study offers valuable insights into the impact of climate change on education in Nyimba District, several limitations were encountered during the research process:

- **Logistical Constraints:** Poor road infrastructure and limited transport may restrict access to some remote schools, potentially biasing the sample toward more accessible locations.
- **Time Constraints:** The academic calendar and examination schedules may limit the duration of intervention delivery and follow-up assessments.
- **Ethical Considerations:** Obtaining informed consent from parents and ensuring pupil welfare during group activities will require much time.
- **Language Barriers:** Some learners and community members were more comfortable speaking in local languages (such as Nsenga or Chewa). Although translation was provided, there is a possibility that some meanings were lost or misinterpreted in the process.

- **Inadequate School Records:** Many schools lacked complete and up-to-date records on attendance, performance, and infrastructure damage. This limited the accuracy of the quantitative data and made it difficult to track long-term climate-related trends.

Operational Definitions

- **Climate Change:** refers to long-term alterations in temperature, rainfall patterns, and frequency of extreme weather events such as droughts and floods, particularly as experienced in Nyimba District over the past decade.
- **Education:** Refers to formal learning that takes place in primary schools, focusing on teaching, learning, attendance, academic performance, and the physical and emotional well-being of learners and teachers.
- **Impact:** The effect or influence that climate-related events have on the accessibility, quality, and continuity of education, including changes in attendance, infrastructure, health, and academic outcomes.
- **Primary Schools:** Public educational institutions in Nyimba District offering Grades 1 to 7, where the study is conducted.
- **Vulnerability:** The degree to which schools, students, and communities are exposed to and negatively affected by climate change impacts due to their socioeconomic, geographic, or infrastructural conditions.

Chapterization

The structure of this research report was organized into five chapters, each addressing a distinct component of the study. Chapter One introduced the research by providing the background, problem statement, objectives, research questions, and the overall significance of the study. Chapter Two presented a critical review of literature, analyzing both theoretical frameworks and empirical studies that informed the investigation, with a particular focus on cooperative learning, mathematics achievement, and pupil engagement. Chapter Three detailed the methodology, outlining the research design, sampling procedures, data collection instruments, analytical techniques, and ethical considerations that guided the study. Chapter Four reported the findings of the research and provided a discussion of the results in relation to existing literature, thereby situating the outcomes within a broader academic context. Finally, Chapter Five concluded the report by summarizing the key findings, drawing conclusions, and offering practical recommendations for educational policy, classroom practice, and future research directions.

Chapter Summary

This chapter has introduced the study by situating it within the broader global, regional, and local context of climate change and its implications for education. It has highlighted the increasing recognition of climate change as a critical development challenge that extends beyond environmental degradation to affect human well-being, economic growth, and the sustainability of social services such as education (IPCC, 2022). Against this backdrop, the chapter has underscored the need to investigate how climate variability disrupts teaching and learning processes, particularly in rural contexts such as Nyimba District in Zambia.

The chapter began with an introduction that framed the study's background and rationale. It then outlined the statement of the problem, emphasizing the gap in knowledge regarding the link between climate change and primary education. The purpose of the study was clearly defined, followed by the research objectives and questions, which will guide the inquiry. The significance of the study was discussed in terms of its contribution to knowledge, policy, and practice, while the delimitations clarified the boundaries within which the study will be conducted. Additionally, the chapter recognized that, like any research, this study is not without limitations, and these were acknowledged to enhance transparency. Finally, key terms were operationally defined to provide clarity and consistency in the use of concepts throughout the research.

Overall, Chapter One has laid a solid foundation by presenting the study's rationale, scope, and focus. The subsequent chapter, Chapter Two: Literature Review, will build on this by engaging with existing scholarly work and theoretical frameworks that inform the investigation of climate change and its impact on education in Nyimba District.

II. LITERATURE REVIEW

INTRODUCTION

Climate change has emerged as one of the most pressing global issues of the twenty-first century, with far-reaching implications for multiple sectors, including education. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as long-term shifts in temperature, precipitation, wind patterns, and other components of the Earth's climate system, largely attributable to anthropogenic greenhouse gas emis-

sions (IPCC, 2014). Rising global temperatures, changing rainfall patterns, and an increase in the frequency and intensity of extreme weather events are disrupting ecosystems and threatening human livelihoods (UNESCO, 2023).

Education systems are particularly vulnerable to climate variability and its associated hazards. Schools are affected by both the physical and socio-economic impacts of climate change. Floods, storms, and droughts damage infrastructure, destroy teaching and learning materials, and interrupt schooling, while food insecurity and water scarcity force children to miss school or drop out altogether (World Bank, 2017). UNESCO (2023) reports that globally, millions of learners' experience educational disruptions every year due to climate-related disasters. In many developing countries, the loss of learning time directly correlates with lower literacy rates and reduced long-term human capital development (CAMFED, 2022).

At the same time, education plays a critical role in building resilience and adaptation capacity. Climate change education equips learners with the knowledge, skills, and attitudes necessary to mitigate risks, prepare for disasters, and adopt sustainable practices (FAO, 2024). Hence, understanding the intersection between climate change and education is crucial for developing interventions that protect learning continuity and foster resilience in vulnerable communities.

In the African context, the effects of climate change on education are more severe due to the continent's dependence on rain-fed agriculture, widespread poverty, and weak infrastructure (IPCC, 2019). Droughts, such as those experienced in Southern Africa between 2015 and 2016, have led to significant crop failures, increased malnutrition, and higher rates of absenteeism and school dropout (World Bank, 2017). Girls are particularly affected, as they are often withdrawn from school to help with household labour or are married off early as a coping mechanism during climate shocks (UNDP, 2020).

Zambia is not exempt from these challenges. The country has faced recurrent droughts, flash floods, and seasonal variations in rainfall patterns that have had severe impacts on agricultural production, food security, and education outcomes (AP News, 2024). Rural areas such as Nyimba District are especially vulnerable, as they rely heavily on

subsistence farming. When crops fail due to erratic rains or prolonged dry spells, families often reduce spending on education, leading to absenteeism, delayed progression, and increased child Labour (Petros, 2025). Although the Zambian government has introduced policies and curricula that integrate climate change education into schools, gaps remain in teacher preparedness, availability of resources, and community participation (Mubanga, 2022).

This chapter therefore reviews the literature on climate change and its implications for primary education. It is organised around three key objectives of this study: (1) to investigate the causes of climate change affecting primary education in Nyimba District; (2) to examine the effects of climate change on teaching and learning; and (3) to identify measures and strategies being implemented to mitigate its impact. The review draws on global, regional, national, and local perspectives, critically engaging with existing studies to highlight knowledge gaps and justify the relevance of the present research.

Absolutely! Here's an expanded and more detailed "2.1 Conceptual and Theoretical Framework" for your Chapter Two, written in Harvard style and tailored for a Master's thesis. This version is more comprehensive (2–3 pages equivalent), adding depth, critical analysis, and a suggested conceptual framework diagram for clarity.

Conceptual And Theoretical Framework

A conceptual and theoretical framework serves as the backbone of any academic study, providing clarity, coherence, and analytical direction. In this study, the framework explains the relationship between climate change and primary education outcomes, guiding both data collection and interpretation of results.

Conceptual Framework

The concept of climate change has been widely documented in scientific and policy literature. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as “a statistically significant variation in the mean state of the climate or its variability, persisting for an extended period—typically decades or longer” (IPCC, 2014, p. 2). Although natural factors such as volcanic eruptions and solar variability play a role, anthropogenic activities—including fossil fuel combustion, deforestation, and industrial emissions—are the dominant drivers of global warming (UNFCCC, 2022).

In this study, climate change is conceptualized as a multi-dimensional phenomenon with direct and indirect implications for education systems. The direct effects include physical damage to school buildings, destruction of teaching and learning materials, and loss of lives or injuries that disrupt school operations. The indirect effects are socio-economic, such as food insecurity, child Labour, early marriages, psychosocial stress, and migration, all of which contribute to absenteeism, dropout, and poor educational attainment (UNESCO, 2023; CAMFED, 2022).

The conceptual framework adopted here views climate change impacts on education through three interlinked dimensions:

- Exposure – The degree to which schools, teachers, and learners come into contact with climate hazards such as floods, droughts, and heatwaves (Turner et al., 2003).
- Sensitivity – The extent to which education outcomes (enrolment, attendance, performance) are affected by those hazards. For example, a school built in a flood-prone area is more sensitive to heavy rainfall than one on higher ground.
- Adaptive Capacity – The ability of schools, households, and communities to anticipate, cope with, and recover from climate shocks. This may include early warning systems, school feeding programs, or disaster-resilient infrastructure (Adger, 2006).

This tripartite view enables a nuanced understanding of climate–education linkages and helps identify entry points for policy and practice interventions.

Theoretical Framework

The study is guided by an integrated theoretical framework that draws on three complementary theories:

(a) Vulnerability and Resilience Framework

The vulnerability and resilience framework provides a lens for understanding the differential impacts of climate change across schools and communities. Vulnerability is conceptualized as a function of exposure, sensitivity, and adaptive capacity, while resilience refers to the ability of the system to absorb shocks and bounce back (Adger, 2006). This is particularly relevant to Nyimba District, where schools with weak infrastructure and limited financial resources are disproportionately affected by floods or droughts. The framework also helps to identify factors that enhance resilience, such as community participation, government support, and climate education initiatives.

(b) Human Capital Theory

Human capital theory posits that education is an investment that enhances skills, productivity, and future earnings (Becker, 1993). Disruptions in education caused by climate events reduce the accumulation of human capital, potentially perpetuating cycles of poverty. For example, when children miss school due to water collection duties during droughts, their learning outcomes decline, affecting their long-term potential. Applying human capital theory underscores the urgency of safeguarding education during climate crises as a means of promoting sustainable development and economic growth (World Bank, 2017).

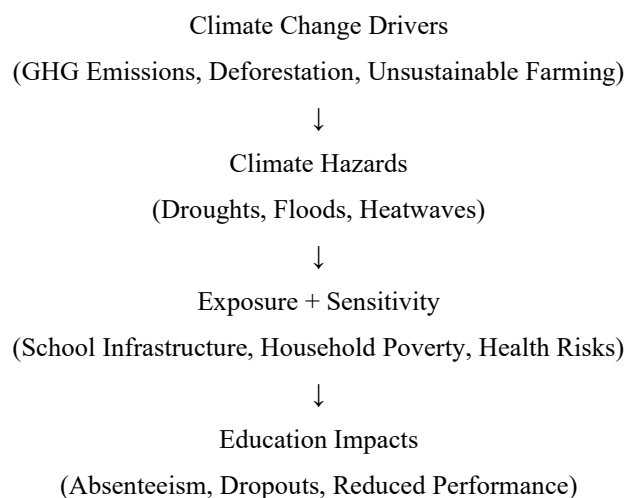
(c) Socio-Ecological Systems (SES) Perspective

The SES perspective situates education within a broader web of community, environmental, and institutional interactions (Berkes et al., 2003). It recognizes that schools do not operate in isolation but are embedded within local ecosystems. For instance, water scarcity affects not only agriculture but also school hygiene and attendance. By considering these interdependencies, the SES framework highlights the importance of locally driven adaptation strategies, such as rainwater harvesting projects, school gardens, and climate clubs that build environmental stewardship among learners.

Integrated Conceptual–Theoretical Model

Combining these perspectives, this study proposes a conceptual model that links drivers of climate change, exposure and sensitivity factors, education outcomes, and adaptive strategies.

Figure 2.1: Proposed Conceptual Framework.





Adaptive Capacity & Strategies

(Curriculum Reforms, School Feeding, Disaster Preparedness, WASH Projects)



Enhanced Resilience and Continuity of Education

Source: field work (2025)

This model illustrates the pathway from climate change drivers to educational impacts, and the mitigating role of resilience-building measures. It serves as an analytical tool for identifying which interventions are most effective in sustaining learning outcomes in climate-vulnerable districts such as Nyimba.

Relevance of the Framework

This integrated framework is essential because it:

- Guides data collection by focusing on both environmental and educational variables.
- Highlights causal linkages between climate events and education outcomes.
- Emphasizes solutions, aligning with Sustainable Development Goal (SDG) 4 on quality education and SDG 13 on climate action.
- Contextualizes findings, allowing recommendations that are tailored to the specific socio-economic and ecological realities of Nyimba District.

By grounding the study in robust theoretical and conceptual foundations, the framework ensures that the research findings will contribute not only to academic knowledge but also to evidence-based policymaking and practical interventions.

Global Evidence

The effects of climate change are increasingly evident across all continents, with profound implications for social sectors such as education. Global evidence shows that climate change is not only an environmental problem but also a developmental challenge that threatens to derail progress toward equitable and quality education for all. This section reviews studies, reports, and data from different regions to highlight the extent to which climate change is shaping educational systems, learner outcomes, and policy responses.

Climate Change as a Global Developmental Threat

Climate change has been recognized as a major obstacle to achieving sustainable development goals (SDGs). The Intergovernmental Panel on Climate Change (IPCC, 2023) warns that without rapid mitigation, global average temperatures could exceed 1.5°C above pre-industrial levels by 2030, leading to intensified droughts, storms, floods, and heatwaves. These hazards undermine food production, water availability, and public health — all of which are key determinants of education access and performance (UNDP, 2022).

According to the United Nations Children’s Fund (UNICEF, 2021), nearly one billion children — almost half of the world’s child population — live in countries at “extremely high risk” of climate-related threats. These risks include exposure to cyclones, heat stress, riverine flooding, and air pollution. When schools are damaged or destroyed by disasters, it takes months or years to rebuild them, leading to learning disruptions. This demonstrates that climate change is not a distant future problem but a present-day crisis directly affecting children’s education.

Destruction of Educational Infrastructure

Natural disasters triggered by climate change have caused large-scale destruction of schools worldwide. In the aftermath of Hurricane Katrina in 2005, more than 100,000 students were displaced from New Orleans, and many experienced severe interruptions to their schooling (Pane et al., 2008). Similarly, after the 2010 Haiti earthquake, over 80% of schools in Port-au-Prince were damaged or destroyed, disrupting education for more than 2 million children (World Bank, 2011).

In South Asia, cyclones and monsoon floods are among the most frequent hazards affecting schools. Bangladesh has been particularly proactive in constructing cyclone-resilient school-cum-shelters to ensure continuity of education even in disaster-prone areas (World Bank, 2021). However, studies reveal that many countries still lack adequate investment in climate-resilient education infrastructure, leaving millions of children vulnerable (UNESCO, 2023).

Impact on Attendance, Enrolment, and Dropout

Beyond infrastructure damage, climate events affect school attendance and enrolment. Research shows that after natural disasters, enrolment rates often decline as households

face economic hardship and may be forced to withdraw children from school to contribute to family income (UNICEF, 2021). This is particularly pronounced in low- and middle-income countries where school attendance is sensitive to household economic shocks.

For example, in India, evidence indicates that droughts reduce primary school enrolment by nearly 5%, with girls being disproportionately affected (Jacoby & Skoufias, 1997). In Nicaragua, children exposed to Hurricane Mitch in 1998 were found to have completed fewer grades of schooling compared to unaffected peers (Baez et al., 2010). These findings demonstrate that climate shocks have a long-term scarring effect on human capital accumulation.

Learning Loss and Cognitive Outcomes

Global research also points to a decline in learning outcomes associated with climate stress. Heat stress has been linked to lower cognitive performance, as students struggle to concentrate in overheated classrooms. A large-scale study in the United States found that each additional school day with temperatures above 32°C reduced learning by 0.5% of a year's worth of learning, with the effects disproportionately affecting minority and low-income students (Park et al., 2020).

Similarly, prolonged droughts and food insecurity lead to undernutrition, which has well-documented effects on brain development and school performance (FAO, 2020). Malnourished children are more likely to repeat grades, drop out, or perform poorly on exams. This highlights the interconnectedness between climate, nutrition, and educational outcomes.

Disproportionate Impacts on Vulnerable Populations

Global evidence reveals that climate change impacts are not evenly distributed. Children from poor households, rural areas, and marginalised groups suffer the most (Save the Children, 2021). Gender disparities are particularly significant: during climate crises, girls are often withdrawn from school to help with domestic chores or are married off early as families seek to cope with economic stress (Plan International, 2020).

Children with disabilities face additional challenges, as post-disaster environments often become physically inaccessible, and support services are disrupted (Human Rights

Watch, 2022). Thus, climate change exacerbates pre-existing inequalities, reinforcing cycles of poverty and exclusion.

Global Policy Responses and Best Practices

The international community has acknowledged these challenges and is increasingly promoting education systems that are resilient to climate shocks. The Paris Agreement (Article 12) explicitly calls for climate education, training, and public awareness as part of global climate action (UNFCCC, 2015). UNESCO's Global Education Monitoring Report (2023) recommends integrating climate change education into school curricula, teacher professional development, and education sector planning.

Examples of global best practice include:

- **Bangladesh:** Investment in elevated, flood-resistant school buildings that double as cyclone shelters (World Bank, 2021).
- **Japan:** Integration of disaster risk reduction (DRR) education into the national curriculum following the 2011 Tōhoku earthquake and tsunami (Shiwaku & Shaw, 2016).
- **Kenya:** Piloting solar-powered classrooms and water-harvesting systems in arid counties to support continuous learning (UNICEF, 2021).
- **Caribbean nations:** Establishment of early warning systems and school safety protocols to minimise learning disruption during hurricane season (UNDRR, 2020).

Key Insights from Global Evidence

From the global literature, several critical insights can be drawn:

- Climate change is a direct threat to the right to education and must be addressed as a priority in education sector planning.
- Building climate-resilient infrastructure is essential but must be accompanied by social protection measures that support affected families.
- Teacher training in psychosocial support and climate awareness improves student recovery after disasters.
- Data collection and monitoring systems are crucial for assessing the long-term impact of climate shocks on education outcomes.

- Equity-focused interventions are necessary to protect girls, children with disabilities, and those from low-income families.

Global evidence thus underscores that addressing climate change in education is both a developmental and a human rights imperative. Lessons from these global experiences provide a foundation for designing context-specific strategies in Sub-Saharan Africa and Zambia.

REGIONAL EVIDENCE: AFRICA AND SOUTH AFRICA

Sub-Saharan Africa remains one of the most climate-vulnerable regions globally due to its high reliance on climate-sensitive sectors such as rain-fed agriculture, limited adaptive capacity, and persistent socio-economic inequalities (Niang et al., 2014; IPCC, 2022). Climate change in this region manifests as increasing temperatures, erratic rainfall patterns, prolonged droughts, and extreme flooding events — all of which intersect with existing development challenges. These environmental shifts have far-reaching implications for education systems, as they disrupt access, infrastructure, health, and learning outcomes (UNESCO, 2021).

Climate Hazards and Their Educational Consequences

Africa is warming approximately 1.5 times faster than the global average, and projections indicate that temperatures will continue to rise by between 2°C and 4°C over the course of the 21st century (World Meteorological Organization [WMO], 2022). This rapid warming, combined with variability in precipitation, has led to an increase in the frequency and severity of climate-related hazards, which disrupt education in several interlinked ways:

- **Infrastructure Damage:** Extreme weather events often damage school buildings, furniture, and teaching materials. Cyclone Idai (2019) affected Mozambique, Malawi, and Zimbabwe, destroying more than 3,400 classrooms and leaving 305,000 learners out of school (UNICEF, 2019).
- **School Closures and Attendance Disruptions:** Floods in West and Central Africa frequently render roads impassable, preventing both learners and teachers from reaching school (Plan International, 2021).
- **Displacement and Migration:** Pastoralist and farming families often migrate during prolonged droughts, leading to high dropout rates, especially among nomadic children (FAO, 2020).

- **Child Labour and Early Marriage:** Drought-induced economic stress compels children to engage in income-generating activities or exposes girls to early marriage as households seek to reduce their economic burden (UNFPA, 2021).

The cumulative effect is not only a reduction in enrolment and attendance but also a widening of educational inequalities between rural and urban communities and between boys and girls.

Education Access, Quality, and Gender Implications

Climate-related shocks have a disproportionate effect on marginalized groups, particularly girls, children with disabilities, and learners from low-income households. A study in Ethiopia, Kenya, and Somalia revealed that girls' enrolment dropped by up to 10% during drought periods as they were more likely than boys to be withdrawn from school to assist with domestic chores (UNESCO, 2021).

Food insecurity, a common consequence of drought, directly undermines school attendance and concentration. The World Food Programme (2017) observed that school feeding programmes are a crucial resilience measure, with evidence from Malawi showing a 5–6% increase in attendance rates where feeding schemes were implemented during the 2015–2016 El Niño drought.

The quality of education also suffers. Where schools remain open during crises, overcrowded classrooms, overstretched teachers, and psychological stress on learners compromise learning outcomes. Teachers themselves may face absenteeism due to climate impacts on their households, thereby reducing instructional time (Anderson, 2020).

South Africa: A Case Study

South Africa provides a compelling regional case study because it combines relatively high levels of educational infrastructure with significant climate-related disruptions.

(a) Water Scarcity and Drought Impacts

The 2015–2018 drought in the Western Cape — dubbed the “Day Zero crisis” — forced schools to adopt severe water rationing measures, suspend sports activities, and in some cases shorten school days (Ziervogel, 2019). Schools without boreholes or rainwater harvesting systems were most affected, exposing how unprepared education infrastructure can be for prolonged drought events.

(b) Flood Events and Disaster Response

In April 2022, KwaZulu-Natal experienced catastrophic flooding that damaged over 630 schools and disrupted education for over 320,000 learners (DBE, 2022). The use of schools as emergency shelters delayed the resumption of classes for weeks. The disaster highlighted the importance of school disaster risk management plans and the need for resilient school design, including elevated foundations and adequate drainage systems.

(c) Curriculum and Teacher Preparedness

South Africa's Curriculum and Assessment Policy Statement (CAPS) includes climate change as a cross-cutting theme in subjects such as Natural Sciences, Life Orientation, and Geography. However, research shows that many teachers lack adequate training to teach climate change effectively (Mochizuki & Bryan, 2015). Non-governmental organizations such as the African Climate Alliance have stepped in to support climate education campaigns, but gaps remain in integrating climate change into teacher professional development programmes (DBE, 2021).

Regional Adaptation and Mitigation Initiatives

African countries are beginning to invest in climate-resilient education systems, with initiatives such as:

- **Infrastructure Adaptation:** Construction of flood- and cyclone-resistant classrooms in Mozambique and Madagascar with donor support (World Bank, 2021).
- **Water Security in Schools:** Rainwater harvesting projects in Kenyan and Ugandan schools to ensure reliable water access during drought periods (UNESCO, 2021).
- **Early Warning Systems:** Integration of school communities into national disaster early warning systems, enabling quicker evacuations and less loss of life during extreme events (African Union, 2020).
- **Curriculum Development:** Inclusion of climate change in education curricula in countries such as Ethiopia, Namibia, and Tanzania to build climate literacy among learners (MOE Ethiopia, 2020).

Regional Policy and Institutional Frameworks

Policy responses are guided by frameworks such as:

- Agenda 2063 (African Union, 2015), which positions education as central to Africa's socio-economic transformation and calls for resilient, inclusive education systems.
- SADC Climate Change Strategy and Action Plan (2015–2025), which encourages member states to mainstream climate change into education sector plans and adopt green school standards (SADC, 2015).
- Continental Education Strategy for Africa (CESA 16-25), which prioritises education for sustainable development and teacher training in climate resilience (AUC, 2016).

These frameworks provide a policy direction but require strong implementation at the national and sub-national levels.

NATIONAL CONTEXT: ZAMBIA

Zambia, located in Southern Africa, is increasingly vulnerable to climate change due to its high reliance on rain-fed agriculture, hydropower energy production, and natural resource-based livelihoods (World Bank, 2020). Over the last five decades, the country has recorded a steady rise in mean annual temperatures of about 1.3°C, accompanied by increased frequency of extreme weather events such as droughts and flash floods (Government of Zambia, 2021). These climatic shifts threaten not only economic development but also social sectors such as health, water, and education, which are central to human capital formation and poverty reduction.

Climate Hazards in Zambia

Zambia's climate profile is characterized by a unimodal rainy season (November to April) and a dry season (May to October). This cycle has become increasingly unpredictable, exposing rural communities to overlapping risks (ZVAC, 2021). The major hazards include:

- Droughts: Southern and Eastern Provinces are highly drought-prone. The 2018–2019 drought caused a 53% reduction in maize harvests in some districts, threatening food security for over 2.3 million people (FAO, 2020).
- Floods: Seasonal floods affect Luangwa, Barotse, and Gwembe valleys, washing away crops, damaging infrastructure, and displacing households. Flooding also creates a breeding ground for diseases such as cholera, which disrupt school attendance (DMMU, 2020).

- **Temperature Rise:** Average daily temperatures are projected to rise by 1.5°C to 3°C by 2050, exacerbating evapotranspiration and reducing soil moisture availability, with knock-on effects on water supply for schools (IPCC, 2022).
- **Pest and Disease Outbreaks:** Climate variability has been linked to outbreaks of fall armyworm and locust invasions, which devastate crops and deepen household poverty, indirectly affecting schooling (MoA, 2020).

Educational Impacts of Climate Change

Climate change affects education in Zambia through direct damage to infrastructure and indirect effects on household economic security and child well-being.

(a) School Infrastructure and Learning Environment

Floods often damage school buildings, latrines, and water points, rendering facilities unsafe or unusable. In 2020, more than 400 classrooms were reported damaged due to floods in Luapula and parts of Eastern Province, leaving over 27,000 learners temporarily out of school (MoE, 2021). Poorly constructed classrooms with inadequate drainage systems are particularly vulnerable.

(b) Attendance and School Participation

Drought-induced food insecurity leads to absenteeism and higher dropout rates, as children are required to help families with income-generating activities or migrate with parents seeking better livelihoods (UNICEF, 2020). For example, during the 2015–2016 El Niño drought, rural schools recorded up to a 10% decline in attendance (WFP, 2022).

(c) Gendered Impacts

Girls are disproportionately affected by climate change impacts. Water scarcity increases their domestic labour burden, leading to more time spent fetching water and less time for schooling (CARE, 2020). Additionally, in times of crisis, some households resort to marrying off girls early to reduce economic strain, further increasing dropout rates (UNFPA, 2021).

(d) Health and Cognitive Impacts

Malnutrition rates rise during drought periods, negatively affecting children's concentration, school performance, and cognitive development (WHO, 2021). Flood-related cholera outbreaks have also been known to force temporary school closures, as occurred in Lusaka in 2018 (MoH, 2018).

Policy and Institutional Responses

Zambia has made deliberate efforts to integrate climate change considerations into its development and education policies:

- National Policy on Climate Change (NPCC, 2016): Provides a multi-sectoral framework for climate change mitigation and adaptation, emphasising mainstreaming climate concerns in education and promoting climate-resilient school infrastructure (GRZ, 2016).
- Seventh National Development Plan (7NDP, 2017–2021): Identifies climate change as a cross-cutting issue and promotes integrated disaster risk reduction strategies, including resilient school construction and social protection measures (MoF, 2017).
- National Adaptation Programme of Action (NAPA, 2019): Prioritises interventions in agriculture, energy, and education, such as provision of safe water in schools, afforestation programmes, and construction of flood-proof infrastructure (GRZ, 2019).
- Education Curriculum Framework (2013): Encourages integration of environmental and climate change education in primary and secondary schools, laying a foundation for building climate literacy among learners (CDC, 2013).
- Climate Change Gender Action Plan: Recognizes the differentiated impacts of climate change on boys and girls and seeks to promote gender-responsive adaptation measures, including keeping girls in school during climate shocks (MGE, 2020).

Community and School-Level Responses

At the micro level, schools and communities have developed coping mechanisms to cushion education against climate shocks:

- School Feeding Programmes: Supported by the World Food Programme and Government of Zambia, these programmes improve attendance during food-insecure periods (WFP, 2022).
- Water and Sanitation Initiatives: Installation of boreholes, rainwater harvesting systems, and solar-powered water pumps in schools helps to secure water for sanitation and hygiene, particularly during dry spells (UNICEF, 2020).
- Tree-Planting and Agroforestry Projects: Initiatives such as the "Keep Zambia Green" campaign encourage schools to plant trees to provide shade, prevent soil erosion, and contribute to reforestation (MoE, 2021).

- Local Disaster Committees: School management committees collaborate with the Disaster Management and Mitigation Unit (DMMU) to conduct disaster preparedness drills and develop evacuation plans during floods (DMMU, 2020).

LOCAL CONTEXT: EASTERN PROVINCE AND NYIMBA DISTRICT

Overview of Eastern Province

Eastern Province is one of Zambia's ten provinces, covering approximately 51,476 square kilometers, and is home to a population of about 2.7 million people, most of whom rely on subsistence agriculture for their livelihoods (CSO, 2022). The province experiences a tropical climate with a single rainy season between November and April, receiving an average annual rainfall of 900–1,200 mm (ZMD, 2021). Maize is the primary staple crop, alongside groundnuts, sunflower, and cotton.

However, the province is considered one of Zambia's most climate-vulnerable regions due to its reliance on rain-fed agriculture and recurrent exposure to droughts, floods, and dry spells (ZVAC, 2021). Climate-related disasters in the province not only threaten food security but also affect key sectors such as health, water, and education.

Climate Hazards in Eastern Province

Eastern Province is classified as a semi-arid to sub-humid region, making it sensitive to even small variations in rainfall and temperature. Key climate hazards include:

- Recurrent Droughts: According to ZVAC (2021), the 2015–2016 El Niño event reduced crop production by nearly 40%, leaving thousands of household's food-insecure. This forced many children to miss school to engage in income-generating activities such as charcoal burning and piecework.
- Floods and Flash Storms: The Luangwa River basin and low-lying areas are prone to flash floods that wash away crops, destroy homes, and damage school infrastructure. In 2020, several schools in Katete and Petauke districts reported roof collapses due to strong winds and heavy rainfall (DMMU, 2020).
- Temperature Stress: Rising temperatures have been linked to prolonged dry spells, lower yields, and water stress, impacting the availability of water for both communities and schools (ZMD, 2021).

These climatic changes place additional pressure on already limited educational resources, disrupting teaching and learning processes.

Nyimba District: Socioeconomic and Education Profile

Nyimba District is located on the eastern escarpment of the Luangwa Valley and has an estimated population of around 90,000 people, predominantly engaged in small-holder farming (CSO, 2022). The district's economy depends heavily on maize and cotton production, making it highly sensitive to climate variability.

In terms of education, Nyimba has over 80 primary schools, most of which are rural and under-resourced (MoE, 2021). Common challenges include:

- Inadequate school infrastructure, with many classrooms built using mud bricks and thatched roofs, which are vulnerable to heavy rains.
- Shortages of safe water and sanitation facilities, which force learners—especially girls—to miss school during menstruation or dry spells.
- Long walking distances for pupils in scattered rural settlements, which becomes more challenging during rainy seasons when rivers overflow and roads are washed away (MoE, 2021).

Local Impacts of Climate Change on Education

(a) Damage to School Infrastructure

Flooding and storms have destroyed school roofs, washed away latrines, and damaged learning materials. In 2021, reports from Nyimba District Education Board indicated that several schools lost classroom blocks and books during heavy rains, forcing classes to be conducted under trees or in makeshift shelters (DEBS, 2021).

(b) School Attendance and Dropouts

Food insecurity during drought years compels children to stay home or migrate with their parents to seek food and casual work. Evidence suggests that enrolment temporarily drops by up to 15% during prolonged dry spells, especially in lower primary grades (ZVAC, 2021).

(c) Gendered Impacts

Girls in Nyimba face increased domestic workloads, such as fetching water from distant sources when boreholes run dry, which reduces study time and increases absenteeism (UNICEF, 2020). Climate-induced poverty has also been associated with increased cases of child marriage in some villages (UNFPA, 2021).

(d) Teacher Absenteeism and Quality of Instruction

Teachers are not immune to climate shocks. Flooded roads and bridges sometimes prevent them from reaching schools, while food shortages affect their morale and performance, leading to irregular teaching schedules (MoE, 2021).

Local Adaptation Strategies

Despite the challenges, several community-led and government-supported interventions are being implemented in Nyimba District:

- School Feeding Programmes: Supported by WFP and the Ministry of Education, these programmes provide daily meals to pupils, encouraging attendance even during hunger periods (WFP, 2022).
- Borehole Drilling and Water Harvesting: NGOs such as World Vision have installed boreholes and rainwater harvesting systems in several schools, improving access to water for drinking and sanitation (World Vision, 2021).
- Climate-Smart Agriculture Training: The Ministry of Agriculture has been promoting conservation farming techniques among households, aiming to stabilise household incomes and indirectly reduce child labour and absenteeism (MoA, 2020).
- Disaster Preparedness Committees: Local school management committees collaborate with the District Disaster Management Committee to develop contingency plans for floods and storms, including identifying safe evacuation points (DMMU, 2020).

RESEARCH GAP

Despite growing attention to the intersection of climate change and education, significant gaps remain in both empirical research and policy implementation, particularly in Zambia and more specifically in Nyimba District. A review of the literature at different levels reveals the following:

Global and Regional Gaps

- Most global studies focus on the broad impacts of climate change on education, with emphasis on extreme weather events, infrastructure damage, and disaster risk management (UNESCO, 2021; Anderson, 2020). However, these studies often overlook context-specific adaptive strategies employed at the local or community level.
- Regional evidence from Africa and South Africa highlights that climate shocks such as droughts, floods, and food insecurity significantly affect school attendance,

learning outcomes, and gender equality (Ziervogel, 2019; UNFPA, 2021). Yet, longitudinal studies measuring cumulative impacts on learner performance over time are limited, and research focusing on rural, under-resourced districts is sparse.

National Gaps in Zambia

- National-level studies acknowledge climate-related disruptions to education and provide policy frameworks such as the NPCC, 7NDP, and NAPA (GRZ, 2016; MoF, 2017). However, there is a lack of detailed empirical evidence on how climate change affects teaching and learning outcomes at district or school level.
- Policy documents often discuss adaptation measures, but implementation is inconsistent, particularly in rural areas where infrastructure is weak and schools lack resilience to floods and droughts (Kalaba et al., 2020).
- Gendered impacts, while mentioned, have not been adequately quantified in terms of attendance, dropout rates, or learning performance.

Local Gaps: Eastern Province and Nyimba District

- Evidence from Nyimba District indicates vulnerability to droughts and floods, as well as challenges such as inadequate classrooms, poor sanitation, and water scarcity (DEBS, 2021; ZVAC, 2021).
- There is limited research specifically addressing the impacts of climate change on primary education within Nyimba. Most studies focus on agriculture, health, or food security, leaving a critical knowledge gap regarding the interaction between climate hazards and educational outcomes.
- Adaptation strategies at school and community levels are documented, but their effectiveness in improving learner attendance, performance, and resilience remains largely unexplored.

This study seeks to address these gaps by investigating the causes, effects, and mitigation strategies related to climate change in primary schools of Nyimba District, generating locally relevant data to inform policy, planning, and resilience-building efforts.

Chapter Summary

This chapter provided a comprehensive review of literature on the impact of climate change on primary education, structured across global, regional, national, and local contexts.

At the global level, evidence indicates that climate change disrupts education through extreme weather events, infrastructure damage, and forced migration, with long-term

effects on learning outcomes and equity (UNESCO, 2021; Anderson, 2020). Regional studies from Africa and South Africa demonstrate that droughts, floods, and food insecurity significantly affect school attendance, teaching quality, and gender equity. While adaptation measures exist, longitudinal and localized research remains limited (Ziervogel, 2019; UNFPA, 2021).

At the national level in Zambia, climate hazards such as droughts, floods, and rising temperatures have direct and indirect effects on primary education. These include damage to school infrastructure, teacher absenteeism, reduced attendance, and increased dropout rates. Zambia has developed several policy frameworks—such as the National Policy on Climate Change (NPCC), the Seventh National Development Plan (7NDP), and the National Adaptation Programme of Action (NAPA)—to address climate-related impacts, yet implementation gaps persist, particularly in rural areas with limited resources (GRZ, 2016; Kalaba et al., 2020).

At the local level, Eastern Province and Nyimba District experience recurrent droughts, floods, and water scarcity, which exacerbate educational challenges. Schools face inadequate infrastructure, insufficient sanitation and water supply, and long travel distances for learners. Adaptation strategies, such as school feeding programmes, boreholes, rainwater harvesting, and community disaster preparedness, have been introduced, but their effectiveness in enhancing resilience and improving learning outcomes remains under-researched (DEBS, 2021; WFP, 2022).

The research gap identified from this review underscores the need for district-level, empirical studies focusing on:

- The specific causes and effects of climate change on teaching and learning in primary schools.
- The effectiveness of existing mitigation and adaptation strategies.
- Gender-specific impacts on attendance and performance.
- Teacher perspectives on coping mechanisms during climate-induced disruptions.

This chapter has provided a conceptual, theoretical, and empirical foundation for the study. The gaps highlighted justify the focus on Nyimba District, where localised evidence is essential for informing policy, planning, and interventions aimed at strengthening climate resilience in primary education. This chapter provides a comprehensive review of existing literature related to the impact of climate change on education, with

a specific focus on primary schools. The purpose of this review is to establish a theoretical and empirical foundation for the study, identify knowledge gaps, and contextualize the research within the broader academic discourse.

The literature review begins by examining global perspectives on climate change and its general impact on human development, particularly in the education sector. It then narrows down to African contexts, highlighting relevant studies conducted in sub-Saharan Africa. The review further explores Zambian-based studies and policies that address climate change and education, before finally focusing on the specific context of Nyimba DISTRICT.

III. Research Methodology

INTRODUCTION

This chapter outlines the methodology adopted to investigate the impact of climate change on education in selected primary schools within Nyimba District, Eastern Province of Zambia. A research methodology serves as a systematic framework that guides how a study is designed, conducted, and analyzed, ensuring that the objectives of the research are achieved in a logical, ethical, and replicable manner (Creswell & Creswell, 2018). The methodology not only explains the research process but also justifies the appropriateness of the selected methods in addressing the research questions.

The chapter begins by presenting the research design and approach employed in the study. It then describes the study area and provides details about the target population from which the sample was drawn. To ensure credibility and representativeness, the sampling techniques adopted for participant selection are discussed.

Furthermore, the chapter elaborates on the methods of data collection used in this study. These include structured questionnaires, semi-structured interviews, focus group discussions, and direct observations. Each method is explained in terms of its suitability for capturing both quantitative and qualitative dimensions of the study (Kumar, 2019). The inclusion of multiple methods ensures triangulation, thereby enhancing the validity and reliability of the findings (Denzin, 2017).

The latter part of the chapter discusses the data analysis procedures adopted to interpret the information collected, highlighting both quantitative and qualitative techniques. At-

tention is also given to the ethical considerations that guided the research process, including issues of consent, confidentiality, and the responsible handling of data (Bryman, 2016).

Overall, this chapter sets out the methodological foundation of the study, demonstrating how the research was carefully designed to generate meaningful and credible insights into the impact of climate change on education in primary schools within Nyimba District.

Research Design

The choice of research design is critical as it provides the overall strategy that integrates the different components of the study in a coherent and logical manner. This study adopted a mixed-methods research design, combining both quantitative and qualitative approaches. The rationale for employing a mixed-methods design was to capture a comprehensive understanding of the impact of climate change on education in primary schools within Nyimba District.

The quantitative approach was used to gather numerical data from questionnaires administered to pupils, teachers, and school administrators. This provided measurable insights into the extent to which climate change affects aspects such as learner attendance, school performance, and infrastructure. Quantitative data enabled the study to establish patterns and relationships that could be generalized within the study context (Creswell & Plano Clark, 2017).

On the other hand, the qualitative approach was employed to capture in-depth experiences, perceptions, and narratives from key stakeholders through interviews, focus group discussions, and observations. This approach allowed the study to explore the subjective realities of participants, such as how learners, teachers, and parents perceive and respond to climate-induced challenges. According to Patton (2015), qualitative methods are essential for providing rich, detailed accounts that explain the “why” and “how” behind observed phenomena.

The combination of the two approaches provided triangulation, thereby enhancing the credibility, validity, and reliability of the study findings (Denzin, 2017). While the

quantitative approach provided breadth, the qualitative approach offered depth, ensuring that the study produced holistic insights into the complex relationship between climate change and education.

Thus, the mixed-methods research design was deemed most appropriate, as it aligned with the study objectives, addressed the research questions effectively, and allowed for a nuanced analysis of the multifaceted ways in which climate change influences education in primary schools in Nyimba District.

Research Site

This study was conducted in Nyimba District, which is located in the Eastern Province of Zambia. The district lies along the Great East Road, approximately 330 kilometers from Lusaka, the capital city of Zambia. Nyimba District is predominantly rural, with most of the population depending on subsistence and small-scale farming for their livelihoods. The district is particularly vulnerable to the effects of climate change, such as droughts, floods, and unpredictable rainfall patterns, which directly affect agricultural productivity and, indirectly, the education sector.

The research focused on selected primary schools within Nyimba District. The choice of Nyimba District as the study site was deliberate because the area experiences significant climate variability, which has had notable consequences on children's school attendance, performance, and learning environment. For instance, prolonged droughts and seasonal floods have resulted in food insecurity, destruction of infrastructure, and reduced household incomes, all of which have implications for access to and quality of education.

The selected schools represent a mix of rural and peri-urban settings, thereby providing diverse insights into how climate change impacts learners and teachers in different contexts. These schools were also accessible to the researcher and provided a manageable scope for the collection of both qualitative and quantitative data.

Thus, Nyimba District was considered an appropriate research site because it reflects the realities faced by many rural communities in Zambia and Sub-Saharan Africa, where climate change increasingly threatens the achievement of sustainable education outcomes.

STUDY POPULATION.

The study population refers to the entire group of individuals or elements from which the research sample is drawn and to whom the study findings can be generalized (Kothari, 2014). In this study, the population comprised primary school learners, teachers, head teachers, and selected parents or guardians within Nyimba District, Eastern Province of Zambia. These groups were chosen because they are directly involved in or affected by the provision of primary education and are therefore key informants regarding the impact of climate change on educational processes.

The learners represented the primary recipients of education and were considered essential for understanding the effects of climate-related disruptions on attendance, learning performance, and classroom participation. Teachers and head teachers were included because they are responsible for implementing the curriculum and managing school resources; they are able to provide insights into how climate change affects teaching conditions, school operations, and learners' academic outcomes (Creswell & Creswell, 2018).

Additionally, parents and guardians were considered part of the study population because they influence learners' attendance, provide support for educational needs, and are directly affected by household-level impacts of climate variability such as droughts and floods. Their perspectives helped to capture the socio-economic dimensions of climate change and how these, in turn, influence primary education.

Overall, the study population was chosen to ensure that both quantitative and qualitative data captured the full spectrum of experiences and perceptions regarding climate change and its impact on primary education in Nyimba District. By targeting these key stakeholders, the study was able to provide a comprehensive understanding of the multifaceted challenges posed by climate variability to education. This brings the study population to about five hundred and ten (510)

Study Sample

A study sample is a subset of the study population selected to participate in the research, representing the population in a manageable and practical way while ensuring that findings can be generalized within the context of the study (Kumar, 2019). In this study, a mixed sampling approach was adopted, combining both purposive and simple random

sampling techniques to select participants from the target population of learners, teachers, head teachers, and parents in Nyimba District.

Purposive sampling was employed for selecting key informants such as head teachers and experienced teachers. This technique was appropriate because these individuals possess in-depth knowledge about the functioning of schools and the effects of climate change on education, making them crucial sources of qualitative data (Patton, 2015). Similarly, parents and guardians of learners who had experienced climate-related educational disruptions were purposively selected to provide relevant perspectives.

For learners, simple random sampling was applied to ensure that every pupil within the selected schools had an equal chance of being included in the study. This approach minimized selection bias and enhanced the representativeness of the quantitative data collected through questionnaires (Creswell & Creswell, 2018). A total of 60 learners from six primary schools were sampled, along with 24 teachers, 6 head teachers, and 2 District Education Board Secretary, making a cumulative sample of 102 participants. This sample size was considered sufficient to provide reliable and meaningful insights while remaining feasible given time and resource constraints.

The sample was also stratified to reflect both rural and peri-urban schools within the district. This stratification ensured that differences in vulnerability to climate change, access to resources, and educational outcomes could be captured across diverse school settings. By employing this combination of purposive and random sampling, the study ensured both depth and breadth in data collection, enhancing the validity, reliability, and generalizability of the findings.

Sampling Procedure

The sampling procedure refers to the systematic process used to select participants from the target population, ensuring that the sample is representative and suitable for addressing the research objectives (Kothari, 2014). In this study, a combination of purposive and simple random sampling procedures was employed to select participants from primary schools in Nyimba District.

Purposive sampling was used to select key informants, including head teachers, experienced teachers, and parents or guardians who had direct experience with the effects of climate change on education. This method allowed the researcher to focus on individuals who could provide rich, relevant, and insightful information regarding school

operations, learner attendance, and household-level impacts of climate variability (Patton, 2015). The selection criteria for these participants included years of experience in the education sector, involvement in school management, and exposure to climate-induced educational disruptions.

For learners, a simple random sampling technique was employed to ensure that every pupil in the selected schools had an equal chance of inclusion in the study. This was done by listing all learners in the targeted grades and using a random selection process to identify participants. The use of random sampling minimized selection bias, ensured fairness, and enhanced the reliability of the quantitative data collected through questionnaires (Creswell & Creswell, 2018).

Additionally, the sample was stratified to capture variations between rural and peri-urban schools. This stratification ensured that the study accounted for differences in vulnerability to climate change, access to educational resources, and school infrastructure. Each stratum contributed proportionally to the overall sample, providing a more balanced and representative dataset.

Overall, the combination of purposive and random sampling procedures, along with stratification, provided a comprehensive and credible framework for selecting participants. This approach ensured that the study captured diverse perspectives and experiences while maintaining methodological rigor and alignment with the research objectives.

Research Instruments

For this study, questionnaires were the main research instrument used to collect data from teachers and pupils in the selected primary schools of Nyimba District. The questionnaires contained both closed-ended and open-ended questions. Closed-ended questions were designed to generate quantitative data on measurable aspects such as absenteeism rates during drought or flood periods, availability of teaching and learning materials, and changes in pupil performance. Open-ended questions were included to capture qualitative data, such as personal opinions, experiences, and suggestions on how schools and communities respond to the effects of climate change.

The questionnaires were distributed in both English (for teachers and head teachers) and simplified versions in local languages where necessary (for older pupils) to ensure clarity and understanding.

Advantages of Questionnaires in this Study

- **Wide coverage:** Questionnaires enabled the researcher to reach a larger number of respondents (teachers and pupils) across different schools in Nyimba within a relatively short time. This was essential in capturing diverse perspectives on the impact of climate change on education.
- **Anonymity and honesty:** Since questionnaires do not require direct interaction, respondents felt free to express their views openly, which minimized social desirability bias. This was particularly helpful when pupils and teachers were reporting sensitive issues, such as absenteeism or poor performance.
- **Standardization:** All respondents were given the same set of questions, ensuring uniformity and making the data easier to compare and analyze.
- **Combination of qualitative and quantitative data:** The inclusion of both closed and open-ended questions allowed the study to capture numerical data (e.g., attendance trends) and descriptive insights (e.g., how climate events affect teaching and learning).
- **Cost-effective and time-efficient:** Compared to interviews, questionnaires saved time and reduced costs since the researcher could distribute them simultaneously in several schools.
- **Supports triangulation:** Data from questionnaires complemented information collected through other instruments such as interviews and document analysis, thereby improving the reliability and validity of the findings.

Research instruments are tools or devices used by researchers to collect data systematically and consistently from the study participants (Kumar, 2019). In this study, questionnaires, was employed to collect both quantitative and qualitative data on the impact of climate change on education in primary schools within Nyimba District. The use of multiple instruments ensured triangulation, enhancing the reliability, validity, and comprehensiveness of the study findings (Denzin, 2017).

Questionnaires were the primary instrument used to collect quantitative data from learners and teachers in the selected primary schools. A questionnaire is a structured

research instrument consisting of a series of questions designed to obtain specific information from respondents in a systematic and uniform manner (Kumar, 2019). In this study, questionnaires were chosen because they allow for the collection of a large volume of data within a limited timeframe, which is particularly useful when working with a sizeable population such as primary school learners and teachers.

The questionnaire was designed with three main sections. The first section collected demographic information, including age, gender, grade level for learners, and teaching experience or position for teachers. This information helped the researcher to categorize respondents and analyze patterns of responses based on relevant characteristics (Creswell & Creswell, 2018).

The second section focused on climate-related challenges affecting education, such as irregular attendance due to extreme weather events, difficulties in accessing schools during floods or droughts, and the impact of climate change on learning materials and classroom conditions. Questions in this section included closed-ended items such as Likert scale questions, where respondents indicated their level of agreement with statements ranging from “strongly agree” to “strongly disagree.” This approach facilitated quantitative analysis, allowing the researcher to measure the extent and intensity of climate-related disruptions across different schools and populations (Orodho, 2014).

The third section explored perceptions and coping strategies, asking respondents about their views on how schools, teachers, learners, and the community manage the challenges posed by climate change. Here, a combination of closed and open-ended questions was included to allow respondents to provide explanations, examples, or suggestions. This integration of open-ended questions enabled the researcher to capture nuances in responses that could not be easily quantified, providing a bridge between quantitative and qualitative insights (Denzin, 2017).

Before administration, the questionnaire was pre-tested (piloted) in a nearby school not included in the main study to ensure clarity, relevance, and appropriateness of the questions. Feedback from the pre-test helped refine ambiguous items, adjust the language for better comprehension among learners, and ensure the questions were culturally and contextually suitable. Pre-testing also contributed to the reliability and validity of the

instrument by identifying potential measurement errors and improving the overall quality of the data collected (Bryman, 2016).

The questionnaires were self-administered for teachers and researcher-assisted for learners, especially younger pupils who might require guidance in understanding certain items. This approach ensured that all respondents could provide accurate and complete responses, reducing the risk of misinterpretation. In addition, respondents were assured of confidentiality and anonymity, which encouraged honesty and increased the reliability of the data collected (Creswell & Plano Clark, 2017).

Overall, questionnaires were particularly suitable for this study because they provided standardized data that could be systematically analyzed, while also allowing for some qualitative insights through open-ended responses. They served as a robust tool for capturing the prevalence, patterns, and perceptions of climate change impacts on primary education in Nyimba District, thereby supporting both the descriptive and analytical objectives of the study.

Data Collection Procedures

Ethical clearance will be obtained from DMI St. Eugene University's Ethics Committee and the Ministry of Education. After school selection and consent, research assistants will undergo a two-day training on instrument administration and ethical protocols. The data collection process for this study is planned to span 92 days, beginning on January 1st and concluding on April 2nd. This period has been divided into three main phases to ensure systematic, reliable, and efficient data gathering.

Phase 1: Preparation (January 1 – January 10)

- Finalization of research instruments (e.g., questionnaires, interview guides).
- Pre-testing tools in a pilot school to ensure clarity and reliability.
- Seeking ethical clearance and permissions from relevant education authorities and school administrations.

Phase 2: Data Collection (January 11 – March 10)

- Quantitative data and Qualitative data will be collected through questionnaires administered to teachers and pupils across selected primary schools in Nyimba District.
- Weekly visits will be scheduled to each sampled school to ensure coverage and reduce respondent fatigue.

Phase 3: Data Review and Completion (March 11 – April 2)

- Verification and validation of collected data for consistency and completeness.
- Follow-up visits or calls for missing or unclear responses.
- Initial organization and categorization of qualitative responses.
- Preparation for data analysis phase.

Table 3.1 Data Collection Schedule (Summary)

Phase	Dates	Activities
Phase 1	Jan 1 – Jan 10	Instrument finalization, pre-testing, permissions
Phase 2	Jan 11 – Mar 10	Questionnaire distribution,
Phase 3	Mar 11 – Apr 2	Data validation, follow-ups, organization for analysis

Source: Field work (2025)

Data Analysis

The data collected through both qualitative and quantitative methods will be systematically analyzed to address the research objectives and questions. The analysis will follow established approaches as recommended in research methodology literature (Creswell, 2014; Bryman, 2016).

Quantitative and Qualitative Data Analysis

- Quantitative and Qualitative data collected through questionnaires will be coded and entered into Microsoft Excel.
- Descriptive statistics such as frequencies, percentages, and means will be used to summarize the data (Kumar, 2011).
- Charts and graphs will be generated to visually present trends and patterns.
- Where applicable, inferential statistics such as chi-square tests or correlation analysis may be used to determine relationships between variables (Mugenda & Mugenda, 2003).
- Manual coding methods will be employed to categorize data into thematic areas (Silverman, 2015).
- Direct quotes will be used to support identified themes and interpretations.
- Triangulation will be used to cross-verify data from multiple sources for reliability and validity (Patton, 2002).
- The findings from both quantitative and qualitative data will be integrated to provide a comprehensive understanding of the impact of climate change on education in primary schools.

- Mixed methods analysis will allow for validation and deepened interpretation of the results (Creswell & Plano Clark, 2011).

ETHICAL CONSIDERATIONS

- Informed Consent: Written consent will be obtained from teachers, head teachers, and parents; pupils will provide assent.
- Confidentiality: Codes will replace personal identifiers; data stored on encrypted drives.
- Voluntary Participation: Participants may withdraw at any time without penalty. • Beneficence: Cooperative activities will align with the curriculum to avoid disadvantaging control classes; post-study workshops will share best practices with all schools.
- Non-maleficence: Data collection will minimize disruption to normal classes and respect cultural norms (Israel and Hay, 2006).

Chapter Summary

This chapter has detailed the research methodology employed to investigate the impact of climate change on education in primary schools within Nyimba District. It began by introducing the mixed-methods research design, which combines both qualitative and quantitative approaches to provide a comprehensive understanding of the study problem. The chapter described the study area, highlighting its vulnerability to climate variability and its implications for educational access and infrastructure. The sampling procedures and the study sample were outlined, emphasizing the purposive selection of schools and participants to ensure rich and relevant data. The research instruments—including questionnaires, interview guides, and observation checklists—were explained, alongside the systematic data collection procedures followed to gather accurate information. Data analysis techniques were also discussed, detailing how descriptive statistics and thematic analysis were applied to interpret the findings.

Finally, the chapter addressed ethical considerations to protect participant rights and ensure research integrity, and presented a work plan and budget to demonstrate the feasibility and organization of the study. Overall, this methodology chapter provides a solid foundation for the subsequent presentation and analysis of findings, ensuring the study is conducted rigorously and ethically.

IV. Data Analysis and Interpretation

Introduction

This chapter presents, analyzes, and interprets the data collected through questionnaires from teachers, school administrators, and community members in Nyimba District. The findings are organized according to the study objectives:

- To investigate the causes of climate change affecting primary education in Nyimba.
- To examine the effects of climate change on teaching and learning in primary schools in Nyimba.
- To identify measures and strategies being implemented to mitigate the impact of climate change on primary education in Nyimba.

DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Out of 102 questionnaires distributed, 92 were successfully completed and returned, giving a 90% response rate, which was considered adequate for reliable analysis.

A total of 92 respondents participated in the study: 20 teachers, 30 pupils, 5 head teachers, 5 community members and 2 DEBS officers. The demographic information was important for contextualizing the findings.

Table 4.1. Respondents data

Respondent Category	Number	Males	Females	Age Range
Teachers	25	11	14	25-50
Pupils	54	22	32	10-14
Head teachers	6	4	2	35-55
Community members	5	2	3	40-60
DEBS officers	2	1	1	35-60

Source: Field work (2025)

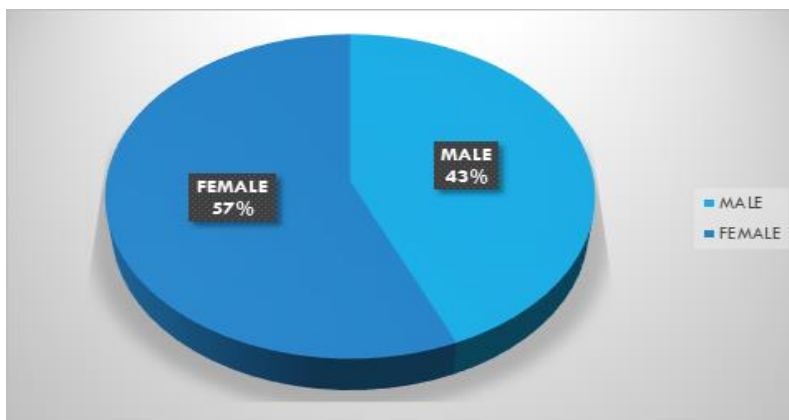


Figure 4.1: Pie Chart Showing Participants by gender in Nyimba District:

Source: Field work (2025)

This shows that more females participated in a study than males.

Table 4.2). Causes of climate change.

4.2 CAUSES OF CLIMATE CHANGE AFFECTING PRIMARY EDUCATION

Cause of Climate Change	Frequency	Percentage (%)
Deforestation	40	40
Bush burning	25	25
Poor farming practices	20	20
Industrial/charcoal emissions	10	10
Other	5	5

Source: Field work (2025)

The results show that deforestation (40%) was the leading cause of climate change in Nyimba, followed by bush burning (25%). These findings are consistent with ZEMA (2021), which highlights unsustainable land use practices as key drivers of environmental degradation in Zambia. In primary schools, the loss of vegetation contributes to higher classroom temperatures and limited shade for learners.

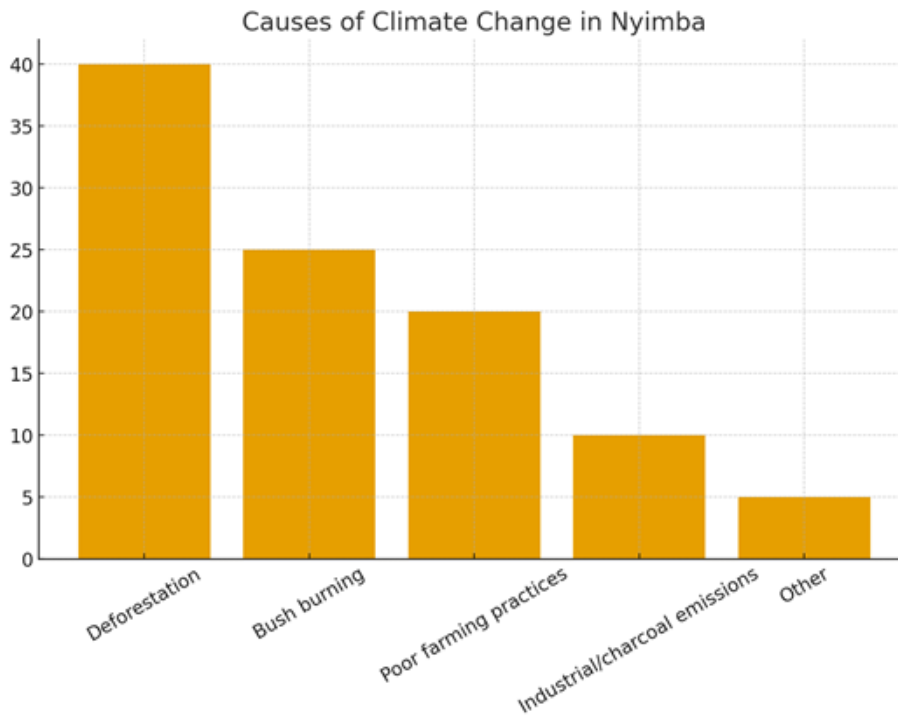


Figure 4.2: Bar Chart Showing Causes of Climate Change in Nyimba District

. Source: Field work (2025)

Causes of Climate Change in Nyimba

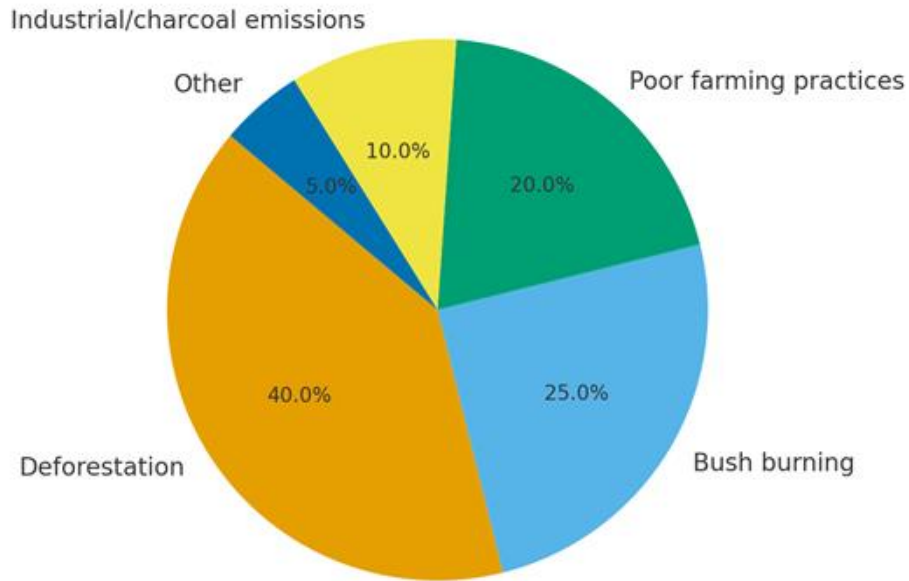


Figure 4.3: Pie Chart Showing Percentage Distribution of Causes of Climate Change in Nyimba District

Source: Field work (2025)

Effects Of Climate Change On Teaching And Learning

Table 4.3. Source: Field work (2025). Effects of climate change on teaching and Learning.

Effect Reported	Frequency	Percentage (%)
Reduced school attendance	30	30
Heat stress	25	25
Flooding infrastructure	20	20
Water shortage	15	15
Increased diseases	10	10

The findings revealed that the most significant effects of climate change on education were reduced school attendance (30%) and heat stress (25%), which negatively impact pupil learning and teacher delivery. Floods and water shortages were also noted as key challenges. These findings align with UNESCO (2021), which argues that climate

shocks contribute to absenteeism, poor performance, and increased vulnerability among learners.

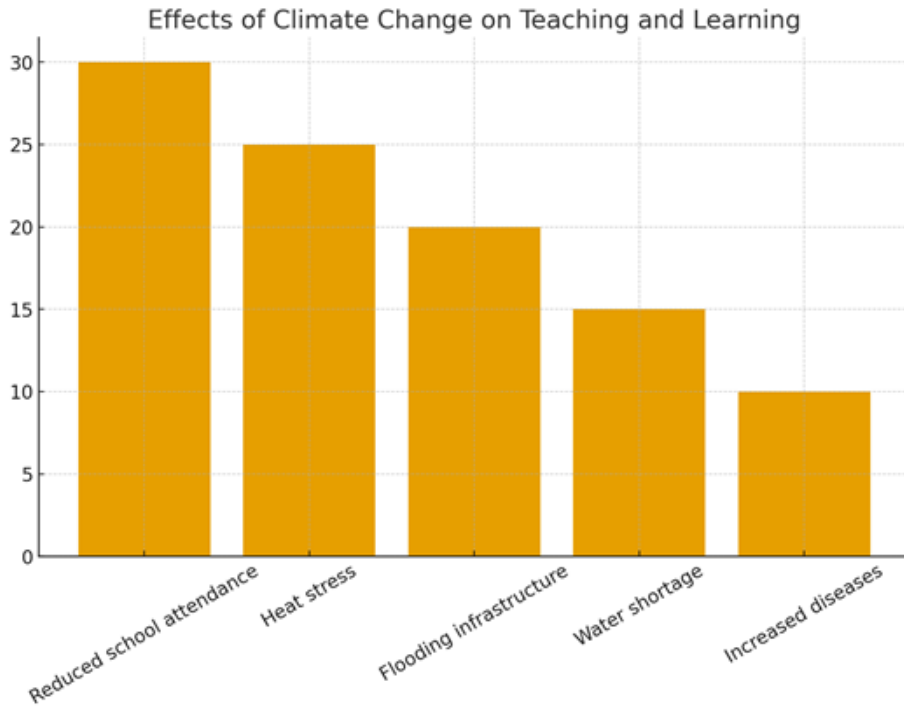


Figure 4.4: Bar Chart Showing Effects of Climate Change on Teaching and Learning in Primary Schools in Nyimba. Source: Field work (2025)

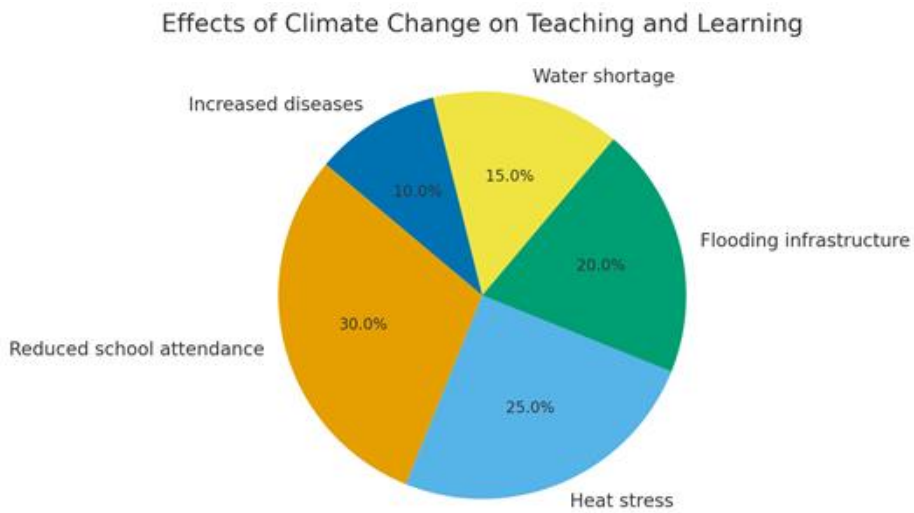


Figure 4.5: Pie Chart Showing Percentage Distribution of Effects of Climate Change on Primary Education in Nyimba. Source: Field work (2025)

Measures And Strategies To Mitigate Climate Change In Primary Education

Table 4.4. Measures and Strategies To Mitigate Climate Change In Primary Education

Strategy/Measure	Frequency	Percentage (%)
Tree planting	35	35
Sensitization	25	25
Rainwater harvesting	15	15
Early warning	10	10
Community partnerships	15	15

Source: Field work (2025).

The most common strategy in schools was tree planting (35%), followed by environmental sensitization (25%). Less common strategies such as rainwater harvesting and early warning systems suggest that schools still rely more on awareness campaigns than practical adaptation initiatives. This partially aligns with Zambia’s Climate Change Strategy (2016), which prioritizes afforestation and awareness raising but also encourages sustainable water use and preparedness measures.

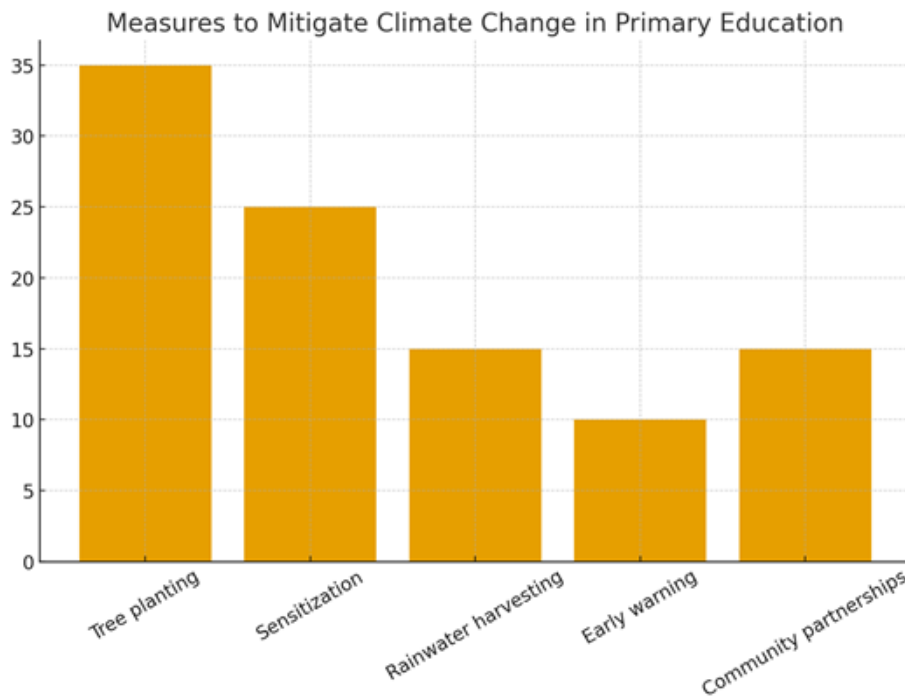


Figure 4.6: Bar Chart Showing Mitigation Measures and Strategies Adopted by Primary Schools in Nyimba

. Source: Field work (2025)

Measures to Mitigate Climate Change in Primary Education

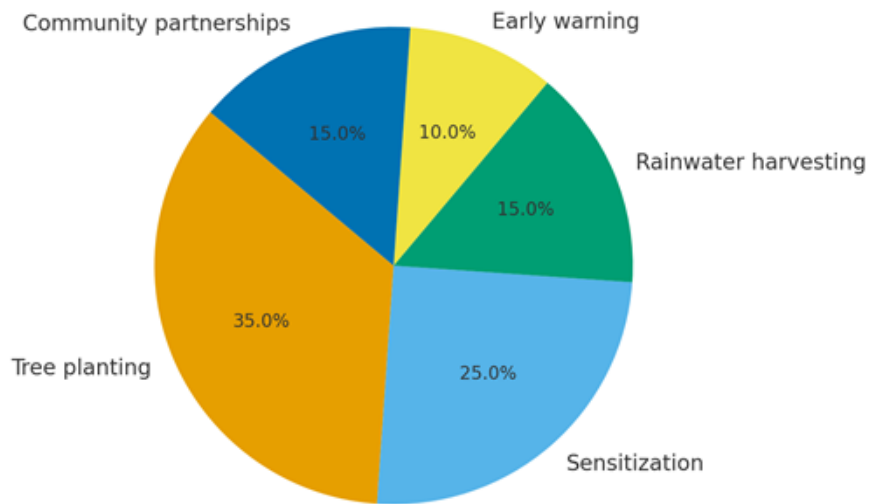


Figure 4.7: Pie Chart Showing Percentage Distribution of Mitigation Measures in Primary Schools in Nyimba

Source: Field work (2025)

Chapter Summary

This chapter analyzed data collected through questionnaires. The findings can be summarized as follows: Causes: The main causes of climate change in Nyimba are deforestation, bush burning, and poor farming practices. Furthermore, Climate change negatively affects primary education by reducing attendance, lowering concentration due to heat stress, damaging infrastructure, and limiting access to clean water. The key strategies being implemented are tree planting, sensitization, and community-school partnerships, although more sustainable interventions like rainwater harvesting are less common.

The next chapter discusses these findings in relation to literature, draws conclusions, and provides recommendations.

V. Discussions, Conclusions, And Recommendations

INTRODUCTION

This chapter provides a summary of the major findings of the study and highlights the key conclusions drawn from the research objectives. The study aimed at investigating the impact of climate change on primary education in Nyimba District, with specific focus on identifying the causes of climate change, examining its effects on teaching and learning, and assessing the measures and strategies being implemented to mitigate these impacts.

The presentation of conclusions is based on the analysis and interpretation of data obtained through questionnaires, interviews, and document review. The recommendations offered are grounded in the research findings and are intended to guide policymakers, educational authorities, schools, and local communities in developing effective interventions to reduce the negative effects of climate change on education.

Discussion Of Findings

Effects of Climate Change on School Attendance

The study found a clear and consistent pattern of reduced pupil attendance during the rainy season, with records showing an average 15% decline compared to the dry season. Interviews with teachers revealed that this was primarily due to:

- Flooded pathways that prevented pupils from crossing rivers or streams to reach school.
- Heat waves leading to health complications such as dehydration and fatigue.
- Increased incidence of climate-related illnesses such as malaria and diarrhoea.

These results support the conceptual framework adopted in this study, which suggests that climate-induced environmental disruptions lead to decreased accessibility to education. The findings also align with UNICEF (2020), which emphasizes that climate hazards act as significant barriers to consistent school attendance in sub-Saharan Africa. However, this study adds a local dimension by documenting that in Nyimba District, the problem is compounded by poor rural transport networks, meaning even minor flooding events can cut off communities for days. This demonstrates that climate impacts are magnified by pre-existing infrastructure limitations.

Impact on School Infrastructure

The analysis revealed that strong winds, heavy rains, and flooding were responsible for damaging classrooms in several schools. The most common forms of damage were:

- Roofs being blown off.
- Flooded classrooms rendering them unusable for weeks.
- Cracked walls caused by continuous water exposure.

Teachers and head teachers reported that damaged classrooms forced them to combine classes, leading to overcrowded learning spaces and reduced teaching efficiency. These results are in line with UNESCO's (2018) observations that rural schools in developing countries are particularly vulnerable due to the use of non-resilient building materials and limited maintenance budgets.

One unique insight from this study is that in Nyimba, temporary repairs were often made by the community, but these fixes were short-lived and could not withstand subsequent extreme weather events. This suggests that without climate-resilient construction standards, infrastructure losses will remain recurrent and costly.

Effect on Teaching and Learning Materials

Approximately 60% of schools reported damage to books, exercise books, and teaching aids during the rainy season. The key reasons identified were:

- Leaky roofs in storerooms and classrooms.
- Floodwater seeping into storage spaces.
- Lack of waterproof containers or cabinets.

Kabanda (2019) similarly found that climate hazards in Zambia result in substantial material losses, disrupting lesson delivery. This study reinforces Kabanda's work but also reveals that in Nyimba, the replacement of damaged materials often takes several months due to slow procurement processes. This delay means that some pupils continue learning without essential materials long after the disaster event.

Teachers' and Pupils' Experiences

Interviews indicated that both teachers and pupils experienced heightened stress during climate disruptions. Pupils expressed fear of falling behind in lessons, while teachers reported feelings of frustration over interrupted syllabi. Oxfam (2021) found similar psychosocial impacts in Malawi and Mozambique, where climate disasters increased anxiety and reduced academic motivation.

In Nyimba District, these effects were intensified by the unpredictability of weather events, leaving teachers uncertain about how to plan lessons and examinations. Such emotional burdens, if unaddressed, can undermine both teaching quality and learning outcomes.

Conclusion

The study investigated the impact of climate change on primary education in Nyimba District, guided by three objectives: to examine the causes of climate change, to assess its effects on teaching and learning, and to identify strategies being used to mitigate its impacts.

The findings revealed that climate change in Nyimba District is largely driven by human activities such as deforestation, charcoal production, and unsustainable agricultural practices. These local drivers align with global studies which emphasize that anthropogenic factors are the major contributors to greenhouse gas emissions and global warming (IPCC, 2021; Stern, 2007).

With regard to the effects of climate change on primary education, the research established that erratic rainfall, droughts, and floods negatively affect school attendance, infrastructure, and learner performance. Pupils often miss classes due to hunger, water shortages, and climate-related illnesses. This supports the argument that climate change is a significant barrier to children's right to education, especially in vulnerable rural areas (UNICEF, 2015; UNESCO, 2019). Teachers also reported loss of teaching hours, destruction of learning materials, and overcrowded classrooms when infrastructure is damaged, which further compromises the quality of education.

The study also found that mitigation measures are being implemented, though on a limited scale. These include tree planting initiatives, sensitization campaigns, and the integration of environmental topics into the curriculum. However, these efforts remain underfunded, fragmented, and poorly coordinated, echoing concerns raised by other scholars about the weakness of adaptation measures in many developing countries (Chidumayo & Gumbo, 2013; Government of Zambia, 2016).

In conclusion, climate change poses a real and urgent threat to the sustainability of primary education in Nyimba District. Without timely and well-coordinated interventions, the situation is likely to worsen, further undermining educational access, equity, and quality for learners in the district.

Recommendations

• Policy Recommendations

- The Government of Zambia should strengthen the enforcement of environmental conservation policies to curb deforestation, charcoal burning, and unsustainable farming practices, which are the leading local drivers of climate change (Government of Zambia, 2016).
- Climate change adaptation should be mainstreamed into national and district education policies to ensure that schools are resilient to environmental shocks (UNESCO, 2019).
- Increased investment in rural infrastructure, such as climate-resilient school buildings, is necessary to reduce disruption of education caused by floods and droughts (World Bank, 2010).

Educational Recommendations

- Climate change education should be fully integrated into the primary school curriculum to equip learners with knowledge and skills on sustainable environmental management (UNICEF, 2015).
- Teachers should receive regular training on climate change, environmental conservation, and disaster preparedness to enhance their ability to address related challenges in schools (UNESCO, 2020).
- Schools should establish climate action clubs to engage learners in activities such as tree planting, water conservation, and waste management, thereby promoting environmental stewardship (Mugambiwa & Tirivangasi, 2017).

Community Recommendations

- Communities in Nyimba should embrace sustainable farming practices, reforestation, and the use of alternative energy sources to reduce dependence on charcoal and firewood (Chidumayo & Gumbo, 2013).
- Strong partnerships should be developed between schools, parents, and community leaders in implementing climate change mitigation projects, particularly those that safeguard educational infrastructure (IPCC, 2021).
- Local leaders should encourage community participation in resilience-building initiatives, including the construction and maintenance of school facilities that can withstand extreme weather conditions (UNICEF, 2021).

Recommendations for Further Research

- Future studies should explore the long-term psychological and social effects of climate change on learners, particularly trauma caused by disasters such as floods and droughts (UNICEF, 2021).
- Comparative studies across different districts in Zambia could provide broader insights into regional variations in the impact of climate change on education (Stern, 2007).
- Further research could also examine the role of indigenous knowledge in supporting climate adaptation strategies in the education sector.

Chapter Summary

This chapter has provided the conclusion and recommendations of the study on the impact of climate change on primary education in Nyimba District. The study confirmed that climate change in the area is largely caused by human activities such as deforestation, charcoal production, and unsustainable agricultural practices, which contribute to environmental degradation and erratic weather patterns.

The findings further revealed that climate change negatively affects education through school disruptions, reduced learner attendance, destruction of infrastructure, and loss of teaching and learning time. Although measures such as tree planting and awareness campaigns exist, they are limited in scope, underfunded, and poorly coordinated.

To address these challenges, the study recommended stronger government policies, integration of climate change into the school curriculum, teacher training, community participation, and adoption of sustainable practices. It also called for further research to explore the long-term psychological effects of climate change on learners and to compare impacts across different regions.

In conclusion, climate change poses a significant threat to the achievement of quality education in Nyimba District, but with effective policies, community involvement, and targeted educational interventions, the education system can be made more resilient and sustainable. presents a detailed discussion of the results obtained in Chapter Four, integrating them with the conceptual framework and literature reviewed in Chapter Two. The discussion focuses on the four main areas investigated: effects of climate change on school attendance, impacts on school infrastructure, damage to teaching and learning

materials, and psychosocial experiences of pupils and teachers. The chapter also outlines the key conclusions drawn from the study and provides recommendations for policy, practice, and further research. The findings are contextualized within the broader challenges of climate change in rural Zambia and similar settings.

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