UTILISATION OF CLIMATE INFORMATION IN UNDERSTANDING CLIMATE CHANGE AND ADAPTATION BY SMALLHOLDER FARMERS: A CASE STUDY OF PHALULA EXTENSION PLANNING AREA (EPA), BALAKA DISTRICT

MSc THESIS (TRANSFORMATIVE COMMUNITY DEVELOPMENT)

BLESSINGS BANDAWE

MZUZU UNIVERSITY

APRIL 2024

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A RESEARCH THESIS SUBMITTED TO THE FACULTY OF ENVIRONMENTAL SCIENCES, DEPARTMENT OF AGRI-SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (MSc) DEGREE IN TRANSFORMATIVE COMMUNITY DEVELOPMENT

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DECLARATION

I hereby declare that this thesis titled, "Utilisation of climate information in understanding climate change and adaptation by smallholder farmers: a case study of Phalula Extension Planning Area (EPA), Balaka district" has been written by me and is a record of my research work. All citations, references, and borrowed ideas have been duly acknowledged. It is being submitted in fulfilment of the requirements for the award of a Master of Science Degree in Transformative Community Development at Mzuzu University. None of the present work has been submitted previously for any degree or examination in any other University.

______________________________ __________20-06-2024____________________

Student name: Blessings Bandawe Date

CERTIFICATE OF APPROVAL

I, the undersigned, certify that this thesis is a result of the author's own work, and that to the best of my knowledge, it has not been submitted for any other academic qualification within the Mzuzu University or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on ______________________

______________________________ ________20-06-2024______________

Supervisor: Date

Name : Dr Frank Mnthambala

ABSTRACT

Climate change information is crucial for farmers in making informed decisions and adapting to changing conditions. However, scientific weather information is criticised for lacking concise information, while traditional information is being overshadowed by scientific information.

The study aimed at assessing the utilisation of climate change information in understanding climate change and adaptation by smallholder farmers in Phalula EPA in Balaka district. It reviewed traditional and scientific channels of climate change information, established potential synergies on the use of traditional and scientific climate change information and determined factors that influence farmers' preference on traditional or scientific climate change information.

Fifteen key informants were purposively selected while 300 smallholder farmers were selected through simple random sampling. Primary data was collected through survey using semi structured questionnaire and a checklist. Secondary data was collected from the Department of Climate Change and Meteorological Services. Data was analysed using STATA version 17. Descriptive statistics were generated to determine communication channels of climate change information, while bivariate analysis was performed using logistic regression to determine factors that influence farmers' preference on a type of climate change information. Thematic and content analysis was done to analyse potential synergies.

The results showed that majority of farmers agreed to the change in climate such as alteration of seasonality. Radio (68.7%) and extension workers (28.3%) were the dominant channels for disseminating climate change information. There was coexistence of modern science and indigenous knowledge with promising synergies between traditional and scientific climate information. Many farmers (54.33%) preferred scientific information over traditional information (45.67%). Factors such as sex, accuracy, timeliness, accessibility, and language of climate information influenced farmers' choice to a source of climate information.

The study recommended increasing public awareness through mass media like radio and formal documentation of traditional climate information to preserve it. Furthermore, policymakers should integrate indigenous climate information into modern scientific policies.

DEDICATION

This thesis is dedicated to my three sons, Triumph Bandawe, Samuel Bandawe and Legacy Bandawe through which my confidence, courage and enthusiasm came, as I thought of my huge responsibility to them ahead of me.

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ABBREVIATIONS AND ACRONYMS

ACPC: Area Civil Protection Committee

ADC: Area Development Committee

ADD: Agriculture Development Division

CBO: Community-Based Organisations

CPAC: Climate Prediction and Adaptation Centre

DCCMS: Department of Climate Change and Meteorological Services

DCPC: District Civil Protection Committee

DEC: District Executive Committee

EPA: Extension Planning Area

FAO: Food and Agriculture Organisation

IFRC: International Federation of Red Cross and Red Crescent Societies

IGAD: Intergovernmental Authority on Development

IKS: Indigenous Knowledge System

IPCC: Intergovernmental Panel on Climate Change

KII: Key Informants Interview

MGDS: Malawi Growth and Development Strategy

MVAC: Malawi Vulnerability Assessment Committee

NAPA: National Adaptation Programmes of Action

NDC: Nationally Determined Contributions

NGO: Non-Governmental Organisation

NSO: National Statistics Office

PDNA: Post Disaster Need Assessments

SPSS: Statistical Package for Social Science

TA: Traditional Authority

UNFCCC: United Nations Framework Convention for Climate Change

UNICEF: United Nations Children’s Fund

US: United States

VCPC: Village Civil Protection Committee

WFP: World Food Programme

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CHAPTER ONE: INTRODUCTION

1.1 Background

Climate change is a major global concern in various parts of the world. It has been recognised as one of the biggest challenges facing humanity with serious worldwide implications for economic development, food security and poverty eradication for developing countries (Malawi Government, 2020a). Climate change is defined as the long-term change in the earth's average surface temperature and the large-scale changes in global, regional and local weather patterns that persist for an extended period, typically decades or longer (The Inter-government Panel of Climate Change (IPCC), 2014). According to the Food and Agriculture Organisation (FAO) (2016), anthropogenic greenhouse gas emissions are the main reason for climate change at the global level and the agriculture sector is directly affected by changes in temperature, precipitation and carbon dioxide concentration in the atmosphere. World Bank (2013) stressed that the greatest climate change threat, particularly in Africa, is to food security and further states that by 2030 up to 122 million people, mainly in Africa and South Asia, could fall into extreme poverty owing to the effects of climate change. In response to the growing threat of climate change, different stakeholders proposed mitigation and adaptation strategies to effectively combat the impacts of climate change. United Nations Framework Convention on Climate Change (UNFCCC) resolved that emissions of greenhouse gases should be reduced through a coordinated effort by adopting the Kyoto Protocol for mitigation and formulation of National Adaptation Programmes of Actions (NAPA) for adaptation measures (Nyirongo, 2019).

Climate extremes and weather events severely erode the resilience and adaptive capacity of individuals and communities in Malawi via declining agricultural yields and food security. According to the updated Malawi strategy on climate change learning (2021), Malawi, like many other developing countries, is struggling with adverse impacts of climate change, which is causing harm to the population; often manifested in the frequent occurrence of climate-related hazards such as severe floods, strong winds, drought episodes, protracted dry spells, and outbreaks of pests and diseases (Malawi Government, 2021a). Malawi has been affected by the impacts of climate hazards such as Eli Nino conditions, cyclone Idai and cyclone Ana. According to the 2016 Malawi

Vulnerability Assessment Committee (MVAC) Report on food security, at least 6.5 million people in Malawi were affected by the drought due to strong El Nino conditions during 2016/17 (Malawi Government, 2016). Malawi Government report (2019) estimated that approximately 975,600 people were affected by the heavy rains, floods and strong winds associated with Tropical Cyclone Idai in the 2018/19 agriculture season. Cyclone Ana caused serious damage and loss of life in the southern and central regions of Malawi and as of February 2022, more than 221,127 households (more than 995,072 people) were affected by its induced floods and stormy winds (United Nations Children's Fund (UNICEF), 2022). Tropical Cyclone Freddy affected an estimated total of 2,267,458 people including 659,278 people who were displaced (336,252 females; 323,026 males), 679 killed, and over 530 people declared missing by mid-March 2023.

These extreme events cause loss of life, damage property and infrastructures, affect food security and hinder efforts of poverty eradication (Malawi Government, 2015). Malawi launched the National Adaptation Programmes of Action (NAPA) in 2008, which emphasised improving community resilience. The second edition of NAPA in 2015 highlights the vulnerable sectors that need urgent adaptation interventions such as the agricultural sector, which is usually affected by increase in temperature, changes in rainfall patterns, especially the uncertainty in the rainfall onset. Climate change interventions, goals, plans, policies and strategies have been incorporated in several developmental blueprints in Malawi. In Sustainable Development Goals (SDG, 2015) Goal number 13 stressed that every country in the world is seeing the drastic effects of climate change and its impacts is worse in vulnerable regions such as land-locked countries like Malawi and island states that have low resilience capacity. Malawi Growth and Development Strategies III (MGDS III) proposed to improve weather and climate monitoring for early warning, preparedness and timely response, enhance community resilience to climate change impacts and strengthen operating environment for climate change and meteorological services. Malawi's 2063 developmental agenda recognise that increasingly variable and adverse climatic conditions continue to affect rain-fed agriculture systems and that investment in sustainable irrigation systems and technologies, as well as approaches to averting adverse climatic variability, should be prioritised by, among other things, promoting and prioritising climate-smart technologies and practices in the agriculture sector (Malawi Government, 2020a).

Contemporary scientific weather forecasting is a relatively new phenomenon in some areas compared to local methods of weather forecasting and thus, most communities are still not conversant with its credibility in Africa, especially for those in remote rural areas (Chagonda et al., 2014). Malawi has a sub-tropical climate which is characterised by seasonal changes from wet (November to April) to dry (May to October) conditions. The Department of Climate Change and Meteorological Services (DCCMS) is responsible for meteorological stations in Malawi. The capacity and adequacy of DCCMS on early warning systems depend on meteorological stations network, experience and technical knowledge of meteorological station staff (Chabvunga et al., 2015); hence the credibility, reliability and dissemination of information is based on both performance of meteorological station network and technical knowledge of staff. One of the challenges highlighted by Chabvunga et al, (2015) was that hydro-meteorological stations in Malawi were sparsely and not evenly distributed and worse still the number of stations in the country has not increased since the 1970s. For example, during the 1970s, there were 800 rainfall stations and 23 meteorological stations; by 1988, rainfall stations were reduced to 135. By 2022, the network of meteorological stations comprised 22 full meteorological stations and 700 rainfall stations (DCCMS, 2022). The National Meteorological Policy (2019) reported several gaps in Malawi's meteorological system. For example, there was one air weather monitoring station against a target of two; 9 institutions marking weather observations against a target of 20; distance of 80 km radius from nearest station against a target of 20 km; 30% of people accessed weather and climate service and products against a target of 50%; 40% meteorological data was utilised against a target of 90%; 30% was level of compliance to international agreements against a target of 70%; and 65% of weather and climate prediction was accurate against a target of 90% (Malawi Government, 2019a).

Local people have never been, at any time, without climate and weather forecasting knowledge as they have been using Indigenous Knowledge (IK) since time immemorial in weather and seasonal rainfall prediction (Chagonda et al., 2014). Despite changes that have been occurring over generations, rural farmers have been adapting to these changes throughout their lives using local environmental knowledge (Mafongoya & Ajayi, 2017). Perry and Falzon (2014) pointed out that indigenous people prefer Indigenous Knowledge to scientific forecasts as the former offers observations and interpretations at a much finer spatial scale with considerable temporal depth by highlighting elements that may not be considered by climate scientists. This contrasts with scientific scenarios developed at broader spatial and temporal scales (Whyte, 2013).

Malawi as a country with a high risk of weather, climate and hydrological hazards, needs a systematic plan of adaptation. Malawi, through the revised Nationally Determined Contributions (NDCs) (2021), planned to implement adaptation actions toward an increased resilience of the most vulnerable Malawians. Science has unequivocally established that climate change will impact communities differently and that it is necessary to develop and implement location- and context-specific adaptation plans that seek to enhance the adaptive capacity and resilience of all stakeholders, considering their specific contexts (Government of Malawi, 2020b).

Climate change across Africa is exacerbated by low levels of adaptation and mitigation (Montpellier Panel Report, 2015). The Cancun Adaptation Framework (CAF) adopted at the UNFCCC (2010) conference, has a guiding principle that emphasises the need for adaptation to be based on and guided by the best available science and, as appropriate, Indigenous Knowledge (IK). National Adaptation Plan Framework of 2020 pointed out that climate change will impact communities differently hence it is necessary to develop and implement adaptation measures that seek to enhance the adaptive capacity and resilience of all stakeholders by, among other things, lobbying the active participation and ownership of local communities in local adaptation planning (GoM, 2020a). Malawi's Strategy on Climate Change Learning (2021) showed that the country's current adaptive capacity is still very weak and that the low adaptive capacities were attributed to, among other things, low investment in individual capacity building, institutional capacity building; resource mobilisation, and monitoring and evaluation.

Traditional climate change information are beliefs and assumptions that have been passed down through generations often based on cultural or religious beliefs, personal experience, or folklore such as using seasonal change in behaviour of plants and animals (Chanza, 2014). Scientific climate information is based on data-driven research and empirical evidence gathered by climate scientists using rigorous scientific methods such as seasonal forecasts from DCCMS and IPCC reports (IPCC, 2014). Climate change information is crucial in farm decision-making and adaptation as it influences farmers' understanding, resource utilisation and development (Muema et al., 2018). Ambani and Percy (2012) reported that access to climate change information offers scientists and farmers an opportunity to analyse the nature and scale of impacts of climate change.

The improved climate information is particularly important for making informed decisions, implementing adaptation strategies and effectively managing potential climate change risks. Tamene (2017) hinted on the importance of improved quality of climate information and the need to understand the cycle, frequency and trends of past climate extremes, which provide the potential to reduce the severity of climate-related disasters in the future. Access to climate change information by farmers is crucial in farm preparation and proper timing and planting of crops. In most African countries, farmers access climate change information through extension officers, radio, television, village meetings and mobile phones (Elia, 2017). Improved access to these sources, which is a challenge in the study area, can enhance usage of climate information for farm decision-making. It is against this background that the study seeks to assess the utilisation of traditional and scientific information in understanding climate change and adaptation by smallholder farmers.

1.2 Problem statement

Climate extremes and weather events severely erode the resilience and adaptive capacity of individuals and communities through declining agricultural yields and food security. Despite Malawi being highly vulnerable to rainfall variability and climatic shocks like droughts and floods, micro-level studies at the farm-level on how rural smallholder farmers perceive these changes are limited (Joshua et al., 2017). In the study area, while there is a growing awareness of the adverse impacts of climate change on smallholder farmers and the importance of climate information for their adaptation strategies, a clear gap exists in understanding how smallholder farmers perceive, access, and utilise both traditional and scientific climate information to adapt to the changing climate conditions. A study by Deressa et al. (2011) on the perception of adaptation to climate change by farmers, revealed that most studies assessing the potential effects of climate change on African agriculture are regional or national and yet adaptation is place-based and needs the use of place-specific strategies. The climate change and meteorological sector in Malawi is fraught with major challenges in the delivery of meteorological services which include: few and poorly distributed functional observational stations, shortage of trained personnel, vandalism of equipment, weak telecommunication support systems, and inadequate data processing and information dissemination facilities, which affect provision of reliable weather and climate services to meet national, regional and international requirements (GoM, 2019b).

Ambrosino et al. (2011) found out that increased rainfall variability in southern Africa had also increased uncertainty in seasonal rainfall prediction, thereby posing a greater challenge to scientists in their efforts to improve forecast accuracy and reliability. Joshua et al. (2017) observed that scientific weather and climate forecasting is often criticised for not delivering concise information on local climatic variation and for its poor communication as messages are often too scientific and technical for farmers, and is inaccessible by some smallholder farmers. On the contrary, traditional or local approaches are slowly being eroded and overshadowed by modern or scientific ways of weather forecast. It is widely agreed that scientific forecasts have spatial and temporal limitations for use at lower spatial scales such as village level (Chang'a et al., 2010). Farmers have a natural inclination towards reliance on indigenous forecasts as opposed to scientific forecasts, because they value their own experiences above scientific data (Kolawole et al., 2014). Orlove et al. (2010) observed that farmers rely on historical patterns, weather observations and signs to formulate their expectations on weather and climate. In Malawi, the study done in Chikwawa (Joshua et al., 2017) revealed that the value of indigenous knowledge was declining in guiding farm operations mainly due to increased rainfall variability and reducing confidence in indigenous knowledge (IK) and its adaptive capacity to climate change.

It is only an enlightened community that would be able to adopt appropriate and robust resilient strategies for countering adverse impacts of climate change, either through the implementation of adaptation or mitigation measures. Reliable climate and weather forecasting information is crucial in guiding community-level farming decisions, and adaptation and resilience capacity of smallholder farmers depend on the quality of weather and climate change information. Based on the observed shortfalls and limitations from each source of weather and climate information, evidence-based information was needed through exploring smallholder farmers' access, perception, preferences on sources of climate change information and their adaptive capacities to the impacts of climate change. Hence, it was imperative to assess how farmers' use of tradition and scientific information in understanding and interpreting climate change affects their adaptation to the impacts of climate change.

1.3 Study objectives

1.3.1 Main objective

To assess the utilisation of climate information in understanding climate change and adaptation by smallholder farmers in Phalula EPA, Balaka district.

1.3.2 Specific objectives

i. To review traditional and scientific channels of climate change information used by farmers.

ii. To establish potential synergies in the use of both traditional and scientific climate change information.

iii. To determine factors that motivate farmers' preference on the use of climate information sources for adaptation to climate change.

1.3.3 Research questions

i. What are the traditional and scientific channels of climate change information used by smallholder farmers?
ii. What are the potential synergies in the use of both traditional and scientific climate change information?
iii. What are the factors that motivate farmers' preference on the use of climate information for adaptation to climate change?

1.4 Significance of the study

The study's results, recommendations, best practices and lessons learned will guide government's and other stakeholders' interventions in managing climate change and its associated impacts through appropriate, evidence-based and sound climate change information and adaptation measures such as channels and means of communication, and revision of institution arrangements to create a conducive environment. Concerned institutions such the Department of Climate Change and Meteorological Services (DCCMS), Water Resources Department and Non-Governmental Organisations will utilise the study to review their interventions and align them with the recommendations from the study.

The thesis will offer substantial contributions to academia by providing valuable insights into climate change management and adaptation. The research will enrich the understanding of climate change and its impacts, contributing new data and analyses to the existing knowledge base, hence enhancing academic discourse by presenting practical applications that bridge theory and real-world strategies. Academic institutions specialising in climate science, meteorology and environmental studies will use the theses as educational material, augmenting curricula with real-world case studies.

Policymakers will use the results to formulate evidence-based policies in areas of climate change and adaptation such as Meteorological policy, National Climate Change and Management policy and National Environmental policy. Smallholder farmers will be able to make timely and informed choices on adaptation measures in the face of climate change-related hazards.

1.5 Ethical consideration

Ethical approval was sought from the Mzuzu University Research Ethics Committee. Permission to carry out the study was granted at district level from District Agriculture office, Department of Disaster, Non-governmental Organisations such as World Food Programme and Find Your Feet. Participants were given the right to freely choose whether to participate in the research or not. At community level, permission was granted by local leaders and all participants were given all the necessary information for them to make informed decisions regarding their participation, hence getting informed consent before participating. Lastly, confidentiality of the names of the individual participants was tightly safeguarded for some critical information that might bring condemnation from the public.

CHAPTER TWO: LITERATURE REVIEW

2.1 Empirical evidence

2.1.1 Traditional and scientific means, channels and sources of weather and climate information used by smallholder farmers.

In Malawi, there are two drought monitoring and early warning systems: scientific based and traditional based (Malawi Government, 2013). Traditional systems use behaviour of plants or animals, while scientific systems are based on indicators derived from variables such as climate (rainfall, wind and humidity), soil moisture and streamflow. Iseh and Woma (2013) point out that scientific weather and climate information uses methods such as persistence, climatology, looking at the sky, use of barometer, nowcasting, use of forecasting models, analogue and ensemble forecasting. Local people often know climatic conditions and extreme events going back generations and have developed local effective strategies for adaptation and resilience. According to Orlove et al. (2010), farmers rely on historical patterns, weather observations and signs to formulate their own expectations on weather and climate. Kolawole et al. (2014) and Roudier et al. (2014) attribute the significant role of chiefs and other traditional stakeholders as the main catalyst for smallholder farmers' inclination to traditional forecasting. The significance of chiefs is also shared by Orlove et al. (2010), where farmers have confidence in and act upon advice provided by the chief, as it is believed that the chief and the elders of the community, including ritual specialists, have connections with spiritual beings who give instructions in line with the approaching season. In West Africa, Braman et al. (2013) demonstrate how local seasonal rainfall forecast information is used to reduce the loss of lives, property and infrastructure caused by floods. Bolden et al. (2018) agree with Braman et al. (2013), by stressing that such knowledge systems are critical in informing local and national adaptation responses, which is quite contrary to conventional adaptation strategies, which mostly use top-bottom approaches.

Farmers have also been using the behaviour of plants and animals to predict weather and climate changes. Chanza (2014) observes that indigenous people in Muzarabani keenly study the life cycle of certain trees and animals, which they use to predict events in the climate system, ranging from temperature and seasonal changes to drought, winds and floods. In studies carried out in the Chimanimani (Risiro et al., 2012), Mberengwa (Shoko, 2012), and Muzarabani (Chanza, 2014) districts, a variety of biotic indicators used to predict weather changes were revealed. In addition to the use of plant and animal behaviour in weather prediction, the science of weather prediction through studying the stars is well documented. In Zimbabwe, apart from the use of plant and animal behaviour, it was revealed that the use indigenous astronomy correlates movement patterns of stars with weather changes (Speranza et al., 2010). They report that astrological constellations, such as the position of the sun and moon, are also interpreted as indicators for the upcoming season by agro-pastoralists.

Information sources are crucial in informing farmers on proper ways to apply new knowledge to adapt to climate change impacts. Mwalusaka (2013) hints that lack of relevant information sources has been found to restrain farmers' efforts to increase agricultural outputs in rural areas. Improving the provision of appropriate climate information services to farmers can facilitate crop production and address their agricultural information needs (Mtega, 2012). Sources widely used by farmers to access climate change information include radio, television, internet, printed materials such as newspapers and magazines, professional organisations, colleagues, village meetings, mobile phones, and extension officers and fliers (Muema et al., 2018). Unlike farmers in developed countries, those in most developing countries prefer accessing climate change information from informal sources rather than formal ones (Oyekale, 2015).

2.1.2 Potential synergies on the use of local and scientific climate information

Several studies on the farmers' perception and preference on the use of local and conventional information have been done to explore means, approaches and platforms, where the two sources can supplement each other. Despite challenges of uncertainty in the application of IK due to increased rainfall variability (Intergovernmental Authority on Development (IGAD) and Climate Prediction and Applications Centre [CPAC] 2015), many studies are increasingly acknowledging that the integration of IK in weather and climate predictions offers a potential solution to contemporary challenges in climate science, including seasonal rainfall predictions. Mafongoya and Ajayi (2017), challenge that while global and regional observation systems do not incorporate IK when forecasting weather and climate patterns, the integration of science and IK to improve forecasting is of interest to agricultural scientists. The boundaries of science in climate change are increasingly being perforated to incorporate indigenous ways of understanding the phenomenon and responding to climatic events (Chanza & Mafongoya, 2017). Accordingly, Chanza and de Wit

(2016) advocate that climate governance as a concept, to embrace inclusivity in designing mitigation and adaptation strategies by all climate stakeholders, should include indigenous communities that are affected by climate change. They argue that this concept creates some space for the recognition of IK at the front of climate science, against a backdrop of the common dismissal of this knowledge form as being archaic, rudimentary, primitive and unscientific.

In Malawi, a study done in Chikwawa (Joshua et al., 2017) on the relevance of indigenous knowledge in weather and climate forecasts for agricultural adaptation to climate variability and change, major climatic events that were reported by the villagers, agreed with empirical evidence. However, it was revealed that the value of some of the indicators was declining in guiding farm operations mainly due to increased rainfall variability, reducing confidence in IK and its adaptive capacity to climate change. Whyte (2013) indicates that IK, as a collaborative concept with scientific approaches, can be applied to produce better knowledge systems and informed policies that are context-specific, while Perry and Falzon (2014), support the idea of combining Indigenous Knowledge (IK) and Scientific forecast, as they are both now increasingly recognised as the important source of climate knowledge for adaptation strategies in the face of climate variability and climate change. Marin (2010) provides a different scenario on the integration of local and conventional forecasts in which the indigenous observations of nomadic pastoralists in Mongolia were divergent and contradictory to meteorological records and predictions. Nicholas et al. (2010) stress that even when indigenous people and scientists observe the same phenomenon in the same environment, the nature of their observations may differ quite profoundly.

2.1.3 Smallholder farmers' preference on the use of local and scientific climate information for adaptation to climate change

There is a debate in literature on smallholder farmers' perception and preference on the use of local and conventional weather forecasts and climate change prediction. Suiven et al. (2019) reveal that indigenous smallholder farmers value their ability to accurately observe and anticipate local conditions in various ways to serve their local realities more aptly than outside forecasts. Mafongoya and Ajayi (2017) highlight similar observations in which they stress that despite changes that have been occurring over generations, rural farmers have been adapting to these changes throughout their life using local environmental knowledge. Nchu et al. (2019) attribute the comparative advantage of local knowledge to convention as being relatively cheap and readily available to rural farmers, and that it is a climatically smart tool for sustainable development and the management of climate variability. In a study to understand indigenous coping strategies against climate risks in Muzarabani, Zimbabwe, Chanza (2014) argues that local communities do not seriously consider conventional early warning alerts given by outsiders, especially if previous warnings are understood to be less serious or inaccurate. According to Kolawole et al. (2014), evidence is there to show that farmers have a natural inclination towards reliance on indigenous forecasts as opposed to scientific forecasts, because they value their own experiences above scientific data. The literature indicates that indigenous knowledge systems are critical in informing local and natural adaptation responses, unlike the convention, which most often uses the top-down approach that does not reflect grassroots realities. However, Mekbib et al. (2017) argue that building on local knowledge only brings the risk of maladaptation and inappropriate responses to the impacts of climate change.

Several studies on the farmers' preference and perception on the use of local and conventional information reveal that a combination of the two yields desirable results. In Africa, rainmakers in the Nganyi communities of western Kenya (Ogallo, 2010) and farmers in the Messa village of southern Malawi, collaborate with meteorological scientists to produce integrated forecasts that were being disseminated by both indigenous and conventional methods to enhance community resilience. The study where farmers used both local indicators such as the flowering of peaches, the appearance of swarms of butterflies, frogs, ants and grasshoppers, and meteorological forecasts to predict whether a season will have good rainfall or early rains, yielded similar results in Zimbabwe (Chanza, 2014). Adaptation can greatly reduce vulnerability to climate change by making poor farmers better able to adjust to climate change and variability, moderating potential damage, and helping them cope with adverse consequences. Smallholder farmers depend on the quality of weather and climate information to make informed decisions and choices of adaptation measures and approaches for an imminent and impending climate-related hazard. Bryan et al. (2009) report the accessibility and usefulness of weather information as one of the factors that affect a farmer's ability to adapt to climate change. In addition, related studies demonstrate that climate-related concerns and information are among the major factors considered by farmers in their decision-making (Hansen et al., 2011).

Communities have developed a variety of adaptive measures that have helped them survive climate changes with little or no help from outside, such as growing drought-tolerant and early maturing indigenous crops, gathering wild fruits and vegetables, cultivating wetlands, and diversifying and selling livestock (Mafongoya & Ajayi, 2017). As a comparative advantage to individual or household-level adaptation, Rankoana (2016) supports community-based adaptation to climate change, which is accomplished through community-based measures to sustain human livelihoods. In understanding how IK for adaptation can be fostered, Ford et al. 2010) stress the importance of highlighting policy decisions that facilitate the fullest expression of indigenous adaptive capacity where such policies, among other things, may include those that maintain the integrity of and access to traditional societies, reinforce local practices for sustaining crop or herd diversity, indigenous knowledge and climate change in Africa, and enhance transmission of IK values, attitudes and worldviews. Olawale and Isaac (2017) point out that access to climate and weather information to farmers who are prone and unable to adapt to changing climate, may find alternative livelihoods or become resilient by developing alternative systems of production that help them to cope with changing climate.

2.2 Theoretical and Conceptual Framework

2.2.1 The theoretical framework

The study was guided by modernisation, post-modernisation, and Afrocentricity theories. Modernisation theory is assumed to be the earliest theory that explains development in 1950s by Walt Rostaw. The theory has been defined as a theory (Reyes, 2001) that uses a systematic process to move underdeveloped countries to a more sophisticated level of development, associating it with United States (US) and European-centric normative model of development. The publication of Lyotard interpreted modernisation as a process where the plurality of local cultural traditions was destroyed and their various narratives were rearticulated into a unified modern canon under the repressive metanarratives of science, progress, and the Enlightenment (Heiskala, 2011). Modernisation theory, which emerged in the mid-20th Century, posits that societies undergo a linear progression from traditional to modern stages. It suggests that with economic development, technological advancement, and cultural change, societies transition toward a modern, westernized model. In the context of climate change adaptation by farmers, modernisation theory might predict a shift from traditional, indigenous practices to the adoption of scientific methods as societies modernise. Modernisation is assumed to be a systematic and transformative process in which for a society to move into modernity, its structures and values must be replaced by a set of modern values which builds change into the social system. The theory might predict that as societies modernise, farmers will increasingly rely on scientific information and technologies for climate change adaptation. Traditional practices might be viewed as less effective or efficient in the face of modern challenges, potentially leading to a decline in their use. Modernisation theory supports the scientific way of predicting climate and weather events which, is deemed superior (modern) and accurate than local means of weather forecast, which are assumed to be primitive, archaic, and out of date. Due to the influence of modernity, indigenous ways of forecasting climate and weather events are being eroded and overshadowed by modern or scientific ways.

Post-modernisation theory, stemming from the broader postmodernist framework, challenges the linear development associated with modernity. It posits that societies undergo a complex, nonlinear process marked by a fusion of traditional and modern elements, leading to diverse and fragmented cultural expressions. Applied to the utilisation of traditional and scientific knowledge in climate change adaptation by farmers, the theory suggests the coexistence and blending of these knowledge forms. Smallholder farmers may not rigidly adhere to either traditional or scientific knowledge, but may create a hybrid system, integrating indigenous practices with contemporary methods for contextually relevant adaptive strategies. In this context, postmodernism rejects the notion of a universal truth, recognising multiple narratives. Farmers, in adapting to climate change, draw on both traditional and scientific knowledge, each contributing to different aspects of their understanding. The theory acknowledges the existence of multiple, equally valid truths, allowing farmers to navigate between them based on their experiences and needs. Furthermore, post-modernisation theory highlights cultural diversity within societies, emphasising variations in the use of traditional and scientific knowledge among smallholder farmers across different cultural contexts. Researchers are encouraged to appreciate and consider this diversity, recognising the influence of local cultural factors on the adoption and adaptation of knowledge systems. Merriam-Webster describes postmodernism as any of the various movements in reaction to modernism that are typically characterised by a return to traditional materials and forms (Merriam, 2016). So, Merriam points out important distinctions between the classical studies and the new studies of the modernisation school in which tradition is deemed as an obstacle to development in the classical approach, while in the new approach of post-modernisation, tradition is an additive factor of development. Postmodernity supports the integration of traditional and scientific ways of weather and climate forecasts by recognising the importance of supplementing modern methods with indigenous approaches.

The theory of Afrocentricity, which supports the use of indigenous African knowledge, is deemed the most appropriate theoretical perspective supporting local weather and climate change forecasts, as it shares opposite perspective with modernisation theory. Asante (2016) defines Afrocentricity as a manner of thought and action in which the centrality of African interests, values, and perspectives predominate. This concept was termed 'Afrocentricity' by Molefe Asante to convey the profound need for African people to be relocated historically, economically, socially, politically, and philosophically. According to Elia (2014), the Afrocentric paradigm provides methods and practices that African people can use to make sense of their everyday experiences from an indigenous African's point of view. They imply a greater dependability on the use of indigenous practices to sustain their lives. Afrocentricity deals with the aspects of African identity from the perspective of African people. Afrocentricity, as a perspective, centers on the experiences and perspectives of people of African descent. It emphasises the importance of valuing and promoting African cultural heritage and traditions. In the context of climate change adaptation, Afrocentricity might encourage the integration of indigenous African knowledge and practices into strategies for coping with environmental challenges. It places significance on preserving and respecting the cultural identity of African communities. The paradigm is generally opposed to theories that alienate Africans in the periphery of human thought and experience. Afrocentricity emphasises the importance of preserving and integrating traditional African knowledge into adaptation strategies. It recognises the value of indigenous practices and encourages a balance between traditional and scientific approaches, promoting a holistic and culturally grounded response to climate change. For example, in Zimbabwe, the Afrocentric paradigm was embraced to understand how Mutoko rural community members explain the use of indigenous practices to adapt to climate change (Chanza, 2014).

2.2.2 Climate Change Adaptation Conceptual Framework

The link between climate-related hazards and the choices made by smallholder farmers regarding the utilisation of climate change information, whether traditional or scientific, involves a complex interplay of factors. Understanding this interconnectedness is crucial for comprehending how farmers adapt to climate-related challenges at the farm level. IPCC (2014) describes adaptation as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. It is widely known that adaptation to climate change is a complex, multidimensional, and multi–scale process which, according to literature, is characterised in terms of type, scale, timing and outcome of the responses, as well as the factors that influence adaptation. (Figure 2.1).

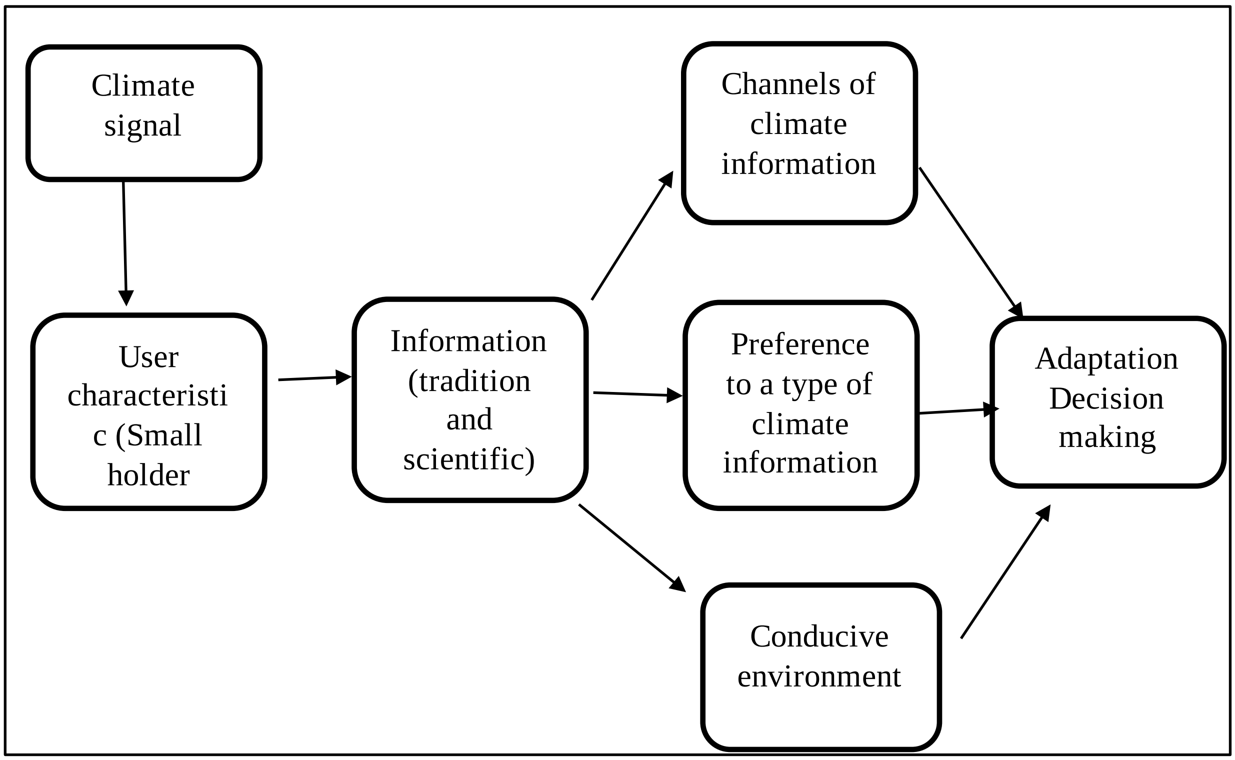

Figure 2.1: Climate Change Information and Adaptation Framework

Source: adapted from Bryan and Behrman (2013).

Smallholder farmers are vulnerable to a range of climate-related hazards, including droughts, floods, pests, and extreme weather events. These hazards directly impact agricultural productivity and livelihoods. When faced with a climate-related hazard, smallholder farmers often need immediate and reliable information to make informed decisions. The type of hazard (for example, drought or flood) influences the specific information required. User characteristics refer to some actors or groups that can be considered more vulnerable to climate change impacts given their livelihood activities, assets, social characteristics and cognitive ability (Adger et al., 2009). For example, local people who mostly rely on natural resources for their livelihoods may be more sensitive to climate change impacts. Traditional knowledge may be more accessible for certain hazards, while scientific information might be crucial for others. Preference for tradition or scientific information may depend on either cultural relevance or the urgency and accuracy of the information. The cultural context plays a significant role in information preference. If a hazard aligns with traditional knowledge embedded in local practices, farmers may prefer traditional sources. In situations demanding rapid response and accuracy, scientific information may be favoured, especially when hazards are unfamiliar or more complex (Bryan & Behnman, 2013).

There is potential for synergy between traditional and scientific information. Traditional knowledge, rooted in local wisdom, can offer context-specific insights, while scientific information provides data-driven, broader perspectives. Smallholder farmers may adopt hybrid strategies, combining elements of both sources to create more effective adaptation strategies (Power, 2010).

Decision-making at the farm level may depend on resource constraints or risk perception. Smallholder farmers often face resource constraints. Their decisions on information use depend on factors such as access to technology, education and financial resources (Jones et al., 2010). The perception of risk influences decision-making. Farmers may rely on traditional information for familiar risks but turn to scientific sources for emerging or less understood hazards. The choice between tradition and science in information use shapes the adaptation strategies implemented at the farm level. Farmers may develop context-specific strategies that blend both sources for a more comprehensive approach. The ability to adapt involves being flexible and innovative. The synergy between tradition and science allows for a dynamic and adaptive decision-making process (Meinzen-Dick et al., 2010).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area

The study was conducted in Phalula Extension Planning Area (EPA), Balaka district. According to the Balaka Agriculture Production Estimate of 2022, the EPA is divided into 10 sections, 80 blocks and 7,624 smallholder farmers. The EPA is in a disaster-prone area that is frequently affected by floods, stormy winds and dry spells. Balaka district is one of the fifteen disaster-prone districts in Malawi (NAPA, 2015). The Balaka Participatory Vulnerability Capacity Assessment (PVCA) (2020) found that the district is highly vulnerable to the impacts of climate change such as dry spells, pest and disease infestations, floods and stormy rains due to climate change and variability. Dry spells and stormy rains affect almost each Extension Planning Area (EPA)) in the district (Participatory Vulnerability Capacity Assessment, 2020). Data from Agriculture Production Estimates of 2021 indicated that dry spell affected 43,180 hectares of land and 20,365 (18%) farm households due to wilting of field crops such as maize, while 165 hectares were washed away due to floods, which affected 786 farm households. In Phalula EPA, 2,306 hectares of land and 4,696 (62%) farm households were affected due to wilting of field crops. Agriculture production estimates for 2022 indicated that 6,053 (7%) and 555 (7%) farm families in Balaka district and Phalula EPA respectively, were without food due to the impact of dry spells and floods (PVCA, 2022). The figure below shows a map of Balaka showing the study area (Figure 3.1).

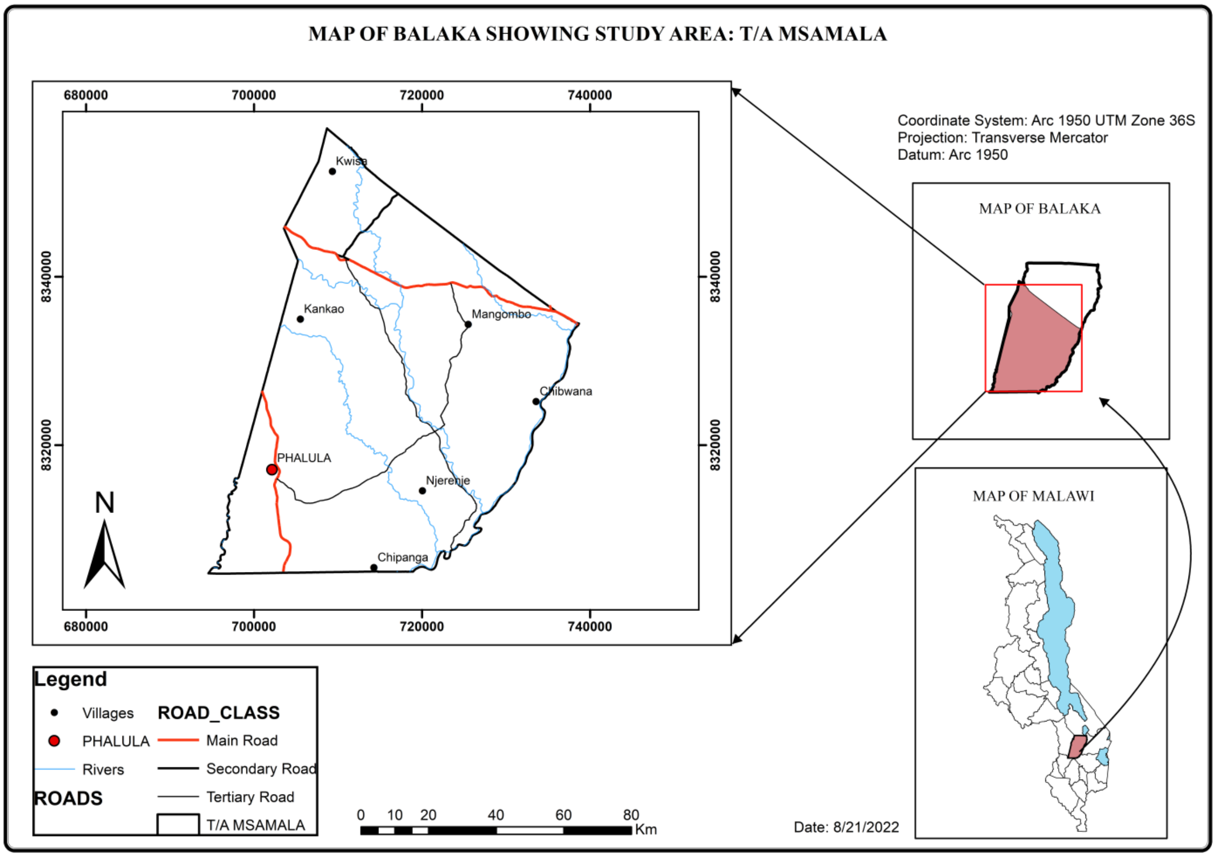

Figure 3.1: Map of Balaka showing the Phalula EPA

Source: Mzuzu University, Lands Department

3.2 Research design

Cross-sectional study, which is useful in obtaining an overall picture as it stands at the time of the study and is designed to study some phenomenon by taking a cross-section of it at one time, was adopted. This design was best suited to the study as it has helped in assessing how tradition and scientific information are utilised by smallholder farmers for their adaptation to climate change, by studying a cross-section of smallholder farmers population. To address the key research objectives, this research used a Convergent Mixed Methods design, where both qualitative and quantitative data were collected and integrated during the analysis. Specifically, one phase design was employed where both qualitative and quantitative data were collected and analysed, then compared the analysis to see if the data confirmed or disconfirmed each other (Creswell & Creswell, 2018).

The research study adopted a qualitative research approach to establish an understanding of potential synergies in which both scientific and traditional information are utilised for climate change adaptation. Nyirongo (2019) used a similar qualitative research approach to establish an understanding of the importance of local and scientific knowledge in adapting to climate change. Theodory (2016) used mixed approaches to study Indigenous Knowledge and Adaptation to Climate Change in the Ngono River Basin, Tanzania. Quantitative methods helped in quantifying sources, channels and means of climate information, and factors that affect farmers' choice of weather and climate information sources.

3.3 Sampling

3.3.1 Sampling techniques

Purposive sampling of Phalula EPA from a total of six EPAs was done. This sampling method was suitable to specifically target a particular group or entity that possesses unique characteristics related to the research question. In this case, Phalula EPA was purposefully selected because it is one of the EPAs in the district frequently experiencing the impacts of climate change (NAPA, 2015). This choice was logical as it focuses on an area where the effects of climate change are pronounced, providing valuable insights into the local context. Proportional sampling of small holder farmers from the 10 sections was employed. Proportional sampling ensured that the sample was representative of the overall population. In this case, selecting smallholder farmers from each of the 10 sections helped in avoiding biases and over sampling in certain sections. This approach contributed to the generalisability of the study's findings to the entire population of small holder farmers in the district. Simple random and systematic sampling of smallholder farmers from each section was done to compute the complete sample. Simple random and systematic sampling methods are widely accepted for obtaining a representative sample from a larger population. By employing these techniques, it ensured that each smallholder farmer in the selected sections had an equal chance of being included in the study. This randomness adds a level of objectivity and minimises potential biases in the selection process.

Purposive selection of key informants for interviews was done. Purposive sampling for key informants was appropriate to seek individuals with specific knowledge or expertise related to the study's focus. Selecting key informants knowledgeable in climate change and adaptation, and those whose day-to-day activities involve these issues, ensured that the researcher gathered in-depth insights from individuals who can provide valuable perspectives and information on the topic.

3.3.2 Sample size

Simple random sampling of smallholder farmers was used based on Dillman's (2007) suggested sample size determination. Thus, given the population size of 7,624 smallholder farmers, the sample size was computed using the formula below:

$n = [(N) (p) (1 - p)] / [(N - 1) (B/C)^2 + (p) (1 - p)]$.

Where n is the computed sample size needed for the desired level of precision; N is the population size; p is the proportion of population expected to answer a certain way; B is acceptable amount of sampling error, or precision; and finally, C is Z statistic associated with the confidence level which is 1.96 that corresponds to the 95% level. B was set at 0.05, which are ± 5% of the true population value, respectively. The acceptable amount of sampling error or precision was set at 0.05 or 5%. Confidence level of 1.96 corresponds to the 95% level. Where N = 7,624, p = 0.8, B = 0.05, C = 1.96.

$n = [(7,624) (0.5) (1-0.5)] / [(7,624-1) (0.05/1.96)^2 + (0.5) (1-0.5)] = 238$ **= 300** (plus 26% contingence for nonresponse).

To determine each section's sample size, proportional sampling was employed. Total number of smallholder farmers from each section was determined through simple random sampling technique in each section. The size of each section was denoted as **Nh** and $\sum_{h=1}^{H} N_h = N$. Proportional sampling with a total sample size ***n*** such that

$$n_h = n\frac{N_h}{N}$$

$$\sum_{h=1}^{H} n_h = n.$$

A simple random sample with size ***nh*** was selected within each block. Proportional sampling was a suitable method since the population was divided into subgroups (sections in this case), and it helped to maintain representation across these subgroups. Using simple random sampling within each section to determine the total number of smallholder farmers ensured that each section contributed proportionally to the overall sample size. This approach enhanced the generalisability of the findings to the entire population.

Purposive sampling of 15 key Informants for interviews was done to establish potential synergies on the utilisation of traditional and scientific information. From the 15 informants, 4 were selected from offices of Agriculture and Disaster Management, 3 were extension workers from Non-governmental Organisations (NGOs), 5 were civil protection committee members and 3 were local leaders from the study area. The selection of key informants from various backgrounds, such as offices of Agriculture and Disaster Management, NGOs, civil protection committee members, and local leaders, added diversity and depth to the information collected. This diversity contributed to a comprehensive understanding of the utilisation of traditional and scientific information.

3.4 Data collection

3.4.1 Primary data

Primary data on channels and means of disseminating climate change information, potential synergy and factors that influence farmers choice of type of climate change information was collected through survey, using a semi-structured questionnaire and a checklist. Survey was conducted to smallholder farmers while interviews were done to key informants. In the study, a comprehensive questionnaire was designed to collect data on the demographic and general characteristics of respondents, their farming practices, and their preferences regarding the utilisation of traditional and scientific means of climate information for adaptation. The first section delved into the demographic details of respondents, including gender, age, marital status, education level, household size, and the type of household head. Information on the source of income and agricultural practices, such as farming land size, crops grown, and livestock kept, was also sought. The second section focused on the means and channels through which respondents accessed both traditional and scientific climate change information, with a detailed inquiry into specific examples from each category. The third section explored farmers' awareness of climate change, observable changes they have noticed, and their preferences for either traditional or scientific climate change information. Additionally, the questionnaire included detailing of key informant interview questions, addressing topics such as awareness of climate change, indicators of climate change, sources of information, coexistence of local and scientific sources, and the integration of climate change in policies and strategies at both community and district levels. This comprehensive survey instrument ensured a clear understanding of the respondents' characteristics, farming practices, and their perspectives on climate change adaptation, contributing valuable insights to the overall research objectives.

Ensuring validity and reliability of the data gathering instruments involved a combination of expert reviews, alignment with existing literature, pilot testing, and a structured format for key informant interviews. These measures ensured that the questionnaire effectively captured the intended information, minimising biases and enhancing the overall quality of the collected data for meaningful analysis and interpretation.

3.4.2 Secondary data

In the study, crucial meteorological data, including the amount of rainfall and minimum and maximum temperatures, was acquired from the Department of Climate Change and Meteorological Services (DCCMS) for both the study area (Phalula) and the broader Balaka district. To provide a comprehensive understanding of the meteorological conditions in these regions, specific variables such as yearly precipitation levels, and the range of minimum and maximum temperatures were retrieved from the DCCMS records. The time frame covered by this secondary data was a critical aspect of the study, as it established the temporal context for the climatic conditions under investigation. The quality and reliability of the secondary meteorological data collected from the DCCMS for Phalula and Balaka district were achieved, since the credibility of the data source was fundamental. DCCMS is a reliable institution for meteorological information with a good track record, adherence to data quality standards, and a certified institution for generating and disseminating climate change information in Malawi.

3.5 Data analysis

3.5.1 Reviewing of traditional and scientific sources of climate change information

Data was analysed using STATA Version 17. Scientific and traditional sources of climate information were coded, and descriptive statistics was performed to generate and interpret frequency.

3.5.2 Establishing potential synergies on the use of both traditional and scientific climate information

Thematic and content analysis was done to analyse potential synergies by grouping variables such as policies and strategies, financing, institutional arrangements, programmes, projects, initiatives, and traditional climate change information sources commonly used in the study area, alongside their synergy with scientific climate change information into codes, themes and patterns.

At district level, the study reviewed how planned and/or existing district/EPA policies and strategies; financial means and measures; planned and/or existing plans; programmes and initiatives, as enabling environment incorporate issues of both traditional and scientific climate change information. For each enabling condition, we specified indicator(s) that could guide the assessment of progress made toward synergy. Availability of an indicator was given a value of 1 and otherwise 0. The sum score across all eight indicators was used to assess the levels of potentials for synergy in the study area. This summed up value; the 'synergy score' was used to compare the relative position of the district and study area. The study area was considered as having promising synergy potential if threshold score was 4 and above (halfway from the maximum possible value of 8); given that the synergy concept considers a holistic approach rather than segregated measures (Lalisa et al., 2014).

3.5.3 Determining factors that motivate farmers' preference on the use of either traditional or scientific climate information

Data was coded and analysed using STATA version 17. Descriptive statistics were run where frequency and associated percentages were generated. Logistic Regression analysis was done to determine how demographic and socioeconomic characteristics (age, sex, marital status, education level, religion, level of income, farm size), accuracy, timing accessibility and language factors motivate farmers' preference for climate change information.

Breakdown of variables in logistic analysis:

1. Demographic and Socioeconomic Characteristics:

    - Age: The age of the farmers participating in the study.
    - Sex: The gender of the farmers (e.g., male or female).

- Marital status: Whether the farmer is married, single, widowed or divorced.
- Educational level: The level of education attained by the farmers (e.g., secondary, primary, etc.).
- Religion: The religion of the farmer.
- Level of income: The income level or socioeconomic status of the farmers.
- Farm size: The size of the farms owned or operated by the farmers.

2. Accuracy, Timing Accessibility, and Language Factors:

    - Accuracy: The perceived accuracy of the climate change information provided to the farmers.
    - Timing accessibility: The ease of accessing climate change information when needed by the farmers.
    - Language factors: The influence of language-related aspects, such as the clarity or comprehensibility of the information provided.

Logistic regression formula:

$p = 1 / (1 + e^{-z})$

Where:

- p is the probability of the outcome variable (preference for climate change information)
- e is the base of the natural logarithm (approximately 2.71828)
- z is the linear combination of the independent variables and their coefficients.

The linear combination (z) was calculated as:

$z = \beta0 + \beta1x1 + \beta2x2 + ... + \beta nxn$

Where:

- $\beta0$ is the intercept term (constant)
- $\beta1, \beta2, ..., \beta n$ are the coefficients for each independent variable (age, sex, educational level, level of income, farm size, accuracy, timing accessibility, and language factors)
- x1, x2, ..., xn are the values of the independent variables.

Age (x1), sex (x2), marital status (x3) education level (x4), religion (x5), level of income (x6), farm size (x7), accuracy (x8), timing accessibility (x9), and language factors (x10) were the independent variables. The final logistic regression model was:

$p = 1 / (1 + e\hat{}\ (-(\beta0 + \beta1x1 + \beta2x2 + \beta3x3 + \beta4x4 + \beta5x5 + \beta6x6 + \beta7x7 + \beta8x8+ \beta9x9\ \beta10x10)))$

In this model, the coefficients ($\beta1, \beta2, ..., \beta8$) represent the influence of each independent variable on the preference for climate change information.

CHAPTER FOUR: RESULTS

This chapter gives the results of the study based on data collected and analysed. The purpose of the study was to assess utilisation of traditional and scientific information in understanding climate change and adaptation by smallholder farmers in Phalula Extension Planning Area in Balaka.

4.1 Demographic characteristics of smallholder farmers in Phalula EPA

Demographic characteristics, such as sex, marital status, education, household type, religion and income source, significantly shape how farmers interact with climate change information. These factors illuminate the socio-cultural, economic and educational influences on farmers' attitudes toward adaptation. Gender and marital status impact information dissemination, with potential differences in decision-making between male and female farmers. Education affects access to scientific information and openness to traditional knowledge. Religious beliefs also influence preferences for climate change information. Recognising these intersections is crucial for developing effective communication and interventions tailored to the cultural context of the farming community. Majority of study participants from the survey were males (59.7%), with 83.6% households headed by males. The study was dominated by married respondents (76.3%). A higher number of respondents had gone up to primary school (65.7%). Almost all households depend on farming as a source of living. The area is dominated by Christians (80.3%) (Table 4.1). The main crops grown were maize, pigeon peas, cotton and groundnuts, while livestock kept were cattle, goats, chickens and rabbits.

Table 4.1: Categorical demographic variables of smallholder farmers in Phalula EPA

Variable	Description	(%)
Sex		
	Male	59.7
	Female	40.3
Marital status		
	Single	8
	Married	76.3
	Divorced/ Separated	9.3
	Widowed	6.3
Education level		
	No education	14.3
	Adult education	0.3
	Primary	65.7
	Secondary	17.7
	Tertiary	2
Household type		
	Male headed	83.6
	Female headed	16.3
Religion of the household head		
	Christian	80.3
	Islam	16.7
	Other religion	1.3
	No religion	1.7
Source of Income (multiple responses)		
	Employment	8.7
	Business	21
	Farming	100
	Piece works	32.3

Demographic factors like age, household size, and farm size provide crucial insights into farmers' engagement with climate change information. The age distribution of participants influences their perspectives on adaptation, with generational differences affecting preferences for traditional or scientific information. Household size shapes social dynamics, impacting how information is shared. Larger households may foster collaborative efforts, influencing the establishment of synergies between traditional and scientific knowledge. Farm size, reflecting the economic scale, affects the challenges and opportunities for climate change adaptation. Economic implications of farm size also play a role in influencing farmers' preferences for information. The mean household size was 4.52, while mean age of the study participants was 43 years. The average farm size in the study area was 1.9 acres (Table 4.2).

Table 4.1:Continuous demographic variable of smallholder farmers in Phalula EPA

Variable name	Minimum	Maximum	Mean	Std. deviation
Age (years)	19	89	43	16.64
Household size	1	12	4.52	2.04
Farm size (acres)	1	6	1.92	1.15

4.2 Means and channels of climate information used by farmers

4.2.1 Awareness of climate change

Smallholder farmers were asked about their perception of climate change, especially on whether climate has changed in the area. Most respondents (65%) strongly agreed that climate has changed, 26% just agreed, while 7.3% were not sure. The remaining 1.7% did not agree that climate has changed in the study area (Figure 4.3).

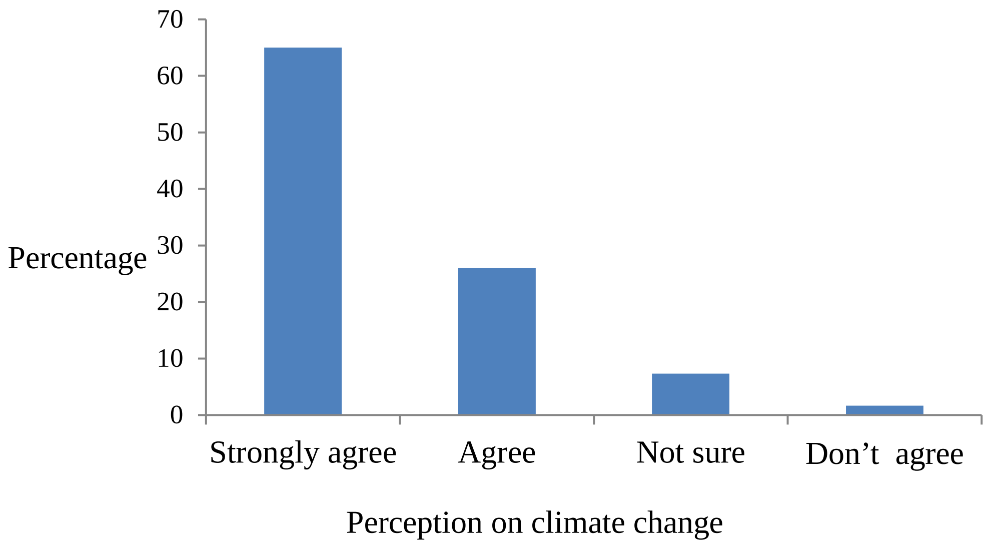

Figure 4.2: Smallholder farmers’ awareness on climate change in Phalula EPA

4.2.2 Awareness on climate change based on climate indicators

On perception to climate change, smallholder farmers were further asked which climate indicators have changed and to what extent. The majority of the respondents pointed out on the alterations in seasonality such as decline in rainfall amount, changes in the onset, cut off and duration of rainfall as evidence of climate change. They also pointed to the greater variability and the general rising in temperatures, prolonged dry spells, (Figure 4.4). The observations by the respondents were collaborated by the experiences shared by key informants (Table 4.4) and the past 20 years meteorological data from the Department of Climate Change and Meteorological services (Figures 4.5 and 4.6).

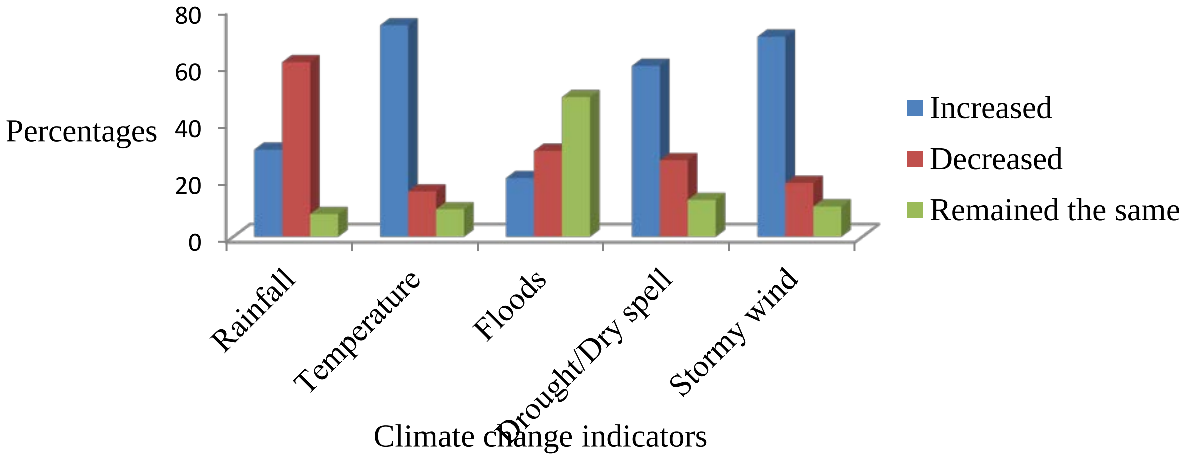

Figure 3.4: Smallholder farmers' awareness of climate change based on climate indicators in Phalula EPA

Smallholder farmers' awareness of climate change was compared with data from the Department of Climate Change and Meteorological Services (DCCMS). Meteorological data on rainfall and temperature for the past 20 years for Phalula and Balaka was analysed. Meteorological data on both rainfall and maximum temperatures agreed with smallholder farmers' perception of climate change as it showed the decreasing trend of rainfall and increasing trend of temperature, (Figure 4.5).

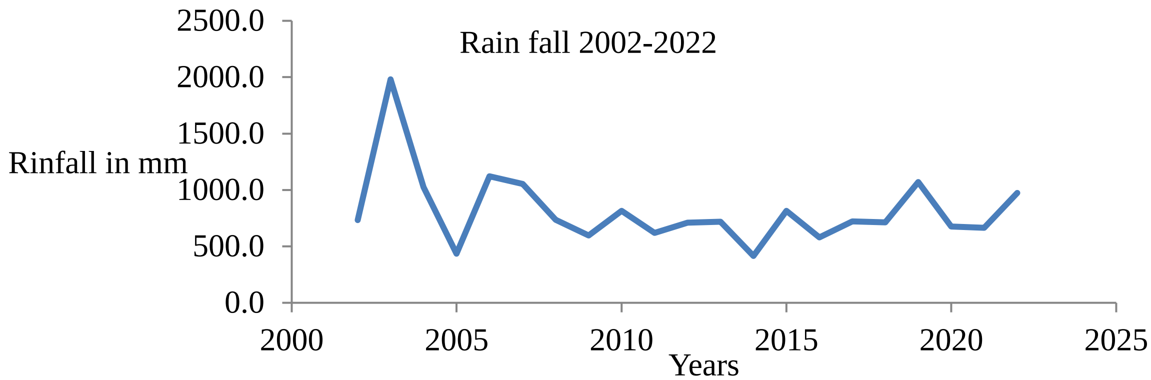

Figure 4.4: Phalula EPA rainfall data from 2002-2022. Data from the Department of Climate Change and Metrological Services, 2022

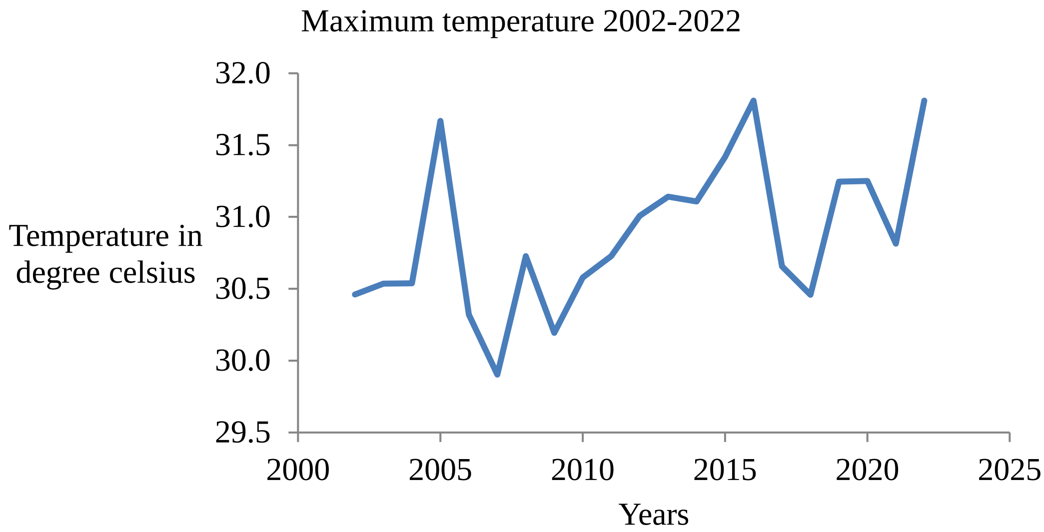

Figure 4.5: Phalula EPA maximum temperature data from 2002-2022. Data from the Department of Climate Change and Meteorological Services, 2022

4.2.3 Means and channels of climate information used by farmers

The study identified and reviewed farmers' traditional and scientific channels of climate change information. Results from KII supported the survey's quantitative findings, which indicated that farmers mainly access climate change information from radio and extension workers. Radio (68.7%) was the most commonly used and preferred communication channel, although extension workers (28.3%) were the second most used by the farmers. Other means of disseminating climate change information included public meetings, public criers and elders. The preference was mainly based on better understanding, accessibility and reliability of the channel (Figure 4.7).

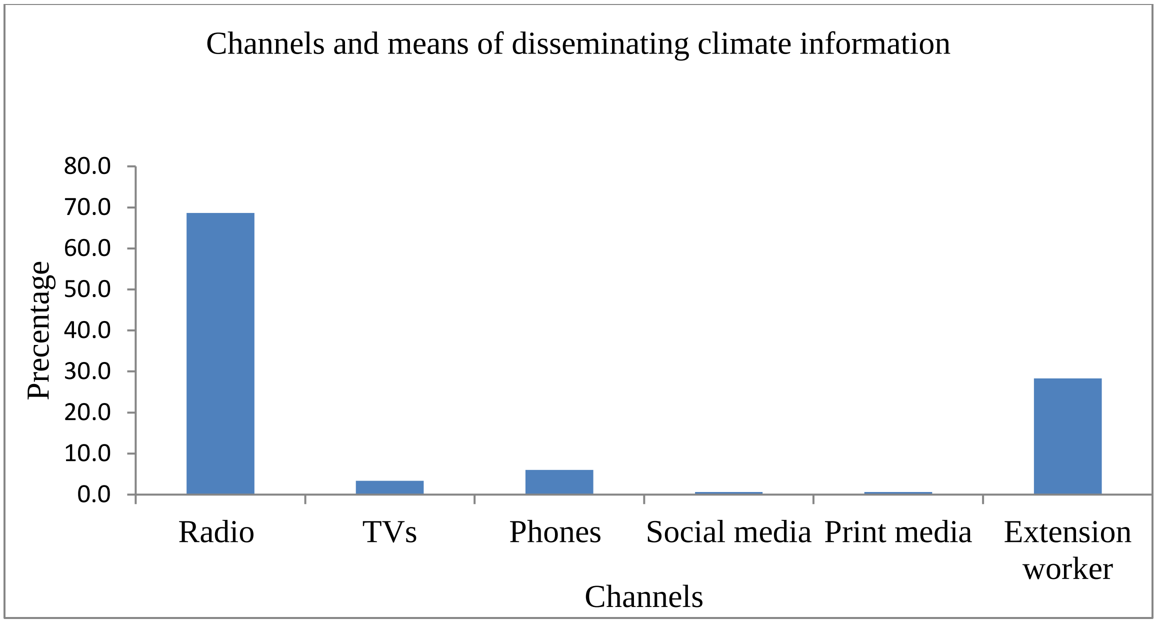

Figure 4.6: Channels and means of disseminating climate change information in Phalula EPA

4.3 Potential synergies on the use of both traditional and scientific climate change information

The study evaluated potential synergies as enabling environments for utilisation of both traditional and scientific climate information. The results of the study showed the coexistence of modern science and indigenous knowledge in the study area. The study revealed some traditional climate change information sources commonly used in the study area, alongside their synergy with scientific climate change information.

Table 4.2: Traditional climate change information used for climate change prediction in Phalula EPA

Traditional climate change information	Examples	Indicator
Indigenous Knowledge Systems (IKS)	Plant behaviour	
	Poor fruiting of mango (*Mangifera indica*)	Low rainfall
	Heavy fruiting on mango and new fruits on baobab trees	Imminent rains
	Heavy fruiting of mango tree on one side and poor fruiting on the other side	A good onset of rains but followed by a prolonged dry spell, with rains picking up towards the end
	Many flowers on monkey thorn (*Acacia galpinii/Acacia nigrescens*)	Drought
	Animal behaviour	
	Large numbers of ants	High rainfall
	Large numbers of elegant grasshoppers (*Dichromorpha elegans*)	High rainfall
	Ants and northern harvester termites (*Hodotermes mossambicus*) taking food to their holes	Imminent rains
	Increased occurrence of termites and mounds in gardens	Prolonged dry spell
Seasonal Forecasting	Traditional forecasters known as rainmakers or weather prophets	Predict weather conditions for specific seasons
Indigenous Agricultural Practices	Traditional planting calendars	Informed by local climate indicators-planting time
Oral Histories and Folklore	Oral traditions and folklore	References to past climate events and their impacts

Table 3.4: Synergy of traditional with scientific climate change information

Areas of synergy with scientific climate change information	
Data Validation	Validation and calibration of scientific climate data, enhancing the accuracy of climate models and predictions.
Localised Climate Forecasts	Development of localised climate forecasts that consider both national climate trends and local knowledge of the study area.
Early Warning Systems	Improving early warning systems for extreme weather events, enabling timely responses and reducing vulnerability.
Adaptive Strategies	Providing valuable insights into adaptive strategies that have been successfully used in the study area. Designing context-specific adaptation measures.

4.3.1 Synergy at district level

At district level, the study reviewed how planned and/or existing district/EPA policies and strategies; financial means and measures; planned and/or existing plans, programmes and initiatives, as enabling environment incorporated issues of both traditional and scientific climate change information. This thesis rigorously evaluated the integration of traditional and scientific climate change information at the district level across various enabling conditions, including policies, plans, strategies, committees, institutional arrangements, funds, and programmes/projects. The assessment assigned scores based on the presence or absence of indicators related to both types of information. Notably, policies demonstrated a lack of synergy, with a score of 0 due to the absence of traditional knowledge in comprehensive scientific policies. In contrast, plans exhibited a more balanced approach, earning a synergy score of 1 as they integrated both scientific and traditional elements. The evaluation of strategies leaned towards a scientific emphasis, resulting in a score of 0. Committees and institutional arrangements, however, displayed promising synergy, with platforms like the District Executive Committee and District Civil Protection Committee earning a score of 1. Overall institutional arrangements, including committees at various levels, showcased commendable synergy potential with a combined score of 1. While the absence of dedicated funds for climate change information scored 0, the programmes and projects category demonstrated strong synergy potential, earning a score of 1. In summary, the total synergy score amounted to 4, indicating a district-level environment with promising potential for integrating both traditional and scientific climate change information into various aspects of adaptation (Table 4.5).

Table 4.4: Enabling conditions with their respective indicators used to determine the synergy potential

Enabling condition	Availability Available-yes X-no		Examples	Score
	Scientific	tradition		
Policy	yes	X	National climate change policy National environmental policy National climate change management policy National meteorological policy	0
Plan	yes	yes	National Adaptation Plan National climate change investment plans National resilience plans District disaster risk plans	1
Strategy	yes	X	National resilience strategy Malawi strategy on climate change learning National adaptation strategy to climate change impacts	0
National Adaptation Plan of Action (NAPA)	yes	X	National Adaptation Plan of Action	0

Committees	yes	yes	District Executive Committee (DEC) District Civil Protection Committee (DCPC)	1
Institution arrangement	yes	yes	DEC- District Executive committee (district level) DCPC- District Civil Protection Committee (sub-district level) ACPC-Area Civil Protection Committee (TA level) VCPC-Village Civil Protection Committee (village level)	1
Funds	X	X	No special funds for climate change information	0
Programs and projects	yes	yes	Participatory integrated climate services Phone text programme Farm field schools Radio listening clubs-farm radio	1

4.3.4 Synergy of traditional and scientific information at EPA level

The study evaluated potential synergies at community level to appreciate an enabling environment that may facilitate utilisation of both traditional and scientific at EPA level. During key informant interviews, participants acknowledged the noticeable changes in climate within the study area, underscoring a shared awareness that was substantiated by observed alterations in various climate indicators. This consensus among key informants served as a foundational understanding of the community's recognition of climate change. In terms of accessing climate change information, radio and extension workers emerged as the primary conduits, particularly for scientific information. Informants highlighted the key role these channels played in disseminating knowledge about climate change, emphasising their effectiveness in reaching a large audience within the community. The interviews revealed a coexistence of both traditional and scientific climate change information within the community. Furthermore, the presence of well-structured

Civil Protection Committees, with support from Area Development Committees (ADCs), emerged as a notable aspect. This organisational structure signifies a community-level initiative to address climate-related challenges. The support from ADCs suggests a collaborative effort involving various stakeholders at different levels of governance, enhancing the resilience of the community to climate change impacts, (Table 4.6).

Table 4.5: Synergy of traditional and scientific information at EPA level

Area of focus	Themes	Codes	Summed up points
Awareness on climate change in the area	All Key Informants (KI) agreed strongly on the climate change observed in the study area	1-strongly agree to climate change 2-agree to climate change 3- were not sure 4- didn't agree to climate change	All KI were aware of climate change
Indicators of climate	The KII revealed that for the past 20 years; rainfall has decreased, temperature has increased, floods have remained the same while drought/dry spells and stormy winds have increased.	1-Increase in intensity 2-Decrease in intensity 3-Remained the same	The awareness is supported by changes observed in all climate indicators
Sources and channels of climate change information in the area	Both scientific (meteorological) and traditional information were utilised. Government and Non-Governmental organisation KI preferred scientific while local leaders and some faith-based leaders preferred both. Radio was the main channel of climate change	Sources of climate information 1-Tradition 2-Scientific channels of climate information 1-radio, 2-phones, 3-television, 4-extension workers	Radio and extension workers were the main channels of climate change information especially on scientific information

	information especially on dissemination of scientific information		
Coexistence of both local (indigenous) and scientific (conventional) source of climate change information in the area	There is fair coexistence of both local (indigenous) and scientific (conventional) source of climate change information in the area with the young generation preferring scientific, while the old generation preferring traditional climate information	1-traditional information preference 2-scientific information preference	There is coexistence of both traditional and scientific climate change information in the area
Availability of civil protection committees and other committees at community and village levels	The area has Area Civil Protection Committee (ACPC) at Traditional Authority level and Village Civil Protection Committee (VCPC) at village level	1-ACPC 2-VCPC	There are well-structured Civil Protection Committees supported by Area Development Committees

4.4 Farmers' preference on the use of either traditional or scientific climate change information for adaptation to climate change

The study determined factors that motivate farmers' preference on the use of either traditional or scientific climate change information for adaptation to climate change. The study revealed that 54.33% preferred scientific information to tradition informational (45.67%).

The study further analysed factors that motivate or influence farmers' choice of type of climate change information for decision making on adaptation to climate change. The factors were sex of the respondent, age of the respondent, marital status of a respondent, education level of household head, religion of household head, accuracy of previous forecast, timing of exposure to climate information, accessibility of information and language used. Other factors that affect farmers' preference to and use of climate change information such as social status, social networks, culture, and the availability of communication resource were kept constant. Multinomial and linear logistic regression were done to determine how sex, age, marital status, educational level, religion of household head, accuracy of previous forecast, timing of exposure (timeliness), accessibility and language, influence smallholder farmers' choice of a type of climate change information. The study revealed that sex, accuracy of previous forecast, timeliness of exposure to the information, accessibility of the information and easiness of the language used, influenced small holder farmers' preference to a source of climate change information (scientific and traditional) (Table 4.7).

Table 4.6: Factors that affect smallholder farmers' preference on the use of either traditional or scientific climate change information

Variable	Coefficient	R-Squared	Constant	P value
Sex	-0.4874402	0.0102	0.5209629	0.041*
Age	-0.005688	0.0016	0.083823	0.417
Marital status	0.187313	0.0026	-0.561574	0.304
Educational level	0.0083343	0.0010	-0.4045192	0.515
Religion	-0.0928257	0.0005	-0.0453763	0.659
Accuracy	1.83258	0.0180	-2.055724	0.019*
Timing	-1.780506	0.0186	1.689215	0.021*
Accessibility	-1.448505	0.0155	1.356567	0.025*
Language	-2.198679	0.0179	2.09478	0.037*

P value was set at 0.05

CHAPTER FIVE: DISCUSSION

5.1 Demographic characteristics of smallholder farmers in Phalula EPA

In the context of climate change information, it is important to consider demographic characteristics of smallholder farmers such as sex, household size, household type, marital status, educational level, religion of house head, and source of income. Understanding how these factors relate to access and utilisation of climate change information can inform effective targeting and dissemination of such information.

The study was dominated by male participants with most of their households headed by males. Sex of participants is a critical factor in accessing and utilising climate change information as women often have limited access to information due to cultural barriers and gender norms that restrict their mobility and agency. The mean household size was at 4.52. The size and type of the household can influence the availability of resources and decision-making power within the family (Falaki et al., 2013). Large households may require more support and resources to implement climate smart practices while single headed households may have limited resources and face greater challenges in accessing climate change information (Katrien, 2016). The study was dominated by married respondents (76.3%). Married household heads may have different priorities and decision-making process compared to those who are single or divorced. Thus, understanding the dynamics of married and single households can help tailor climate change information campaigns accordingly (Ahmed & Redemtor, 2020).

A higher number of respondents had gone up to primary school (65.7%). Education is often associated with increased access to information and decision-making power. Farmers with higher educational level may be better equipped to understand and utilise climate change information, while those with lower educational level may require alternative forms of communication and support (Asrat, 2018). The area is dominated by Christians (80.3%). Religion can affect attitudes towards climate change and related practices. Understanding the household beliefs and values can help in designing culturally sensitive climate change information campaigns. Almost all households depend on farming as a source of living. Smallholder farmers who rely on different sources of income, such as off-farm employment or remittances, may have varying degrees of interest and investments in climate change adaptation and mitigation practices. It was therefore important to understand the diversification of income sources and how they intersect with climate change information needs.

5.2 Channels of climate change information used by farmers

5.2.1 Awareness of climate change

Smallholder farmers are often the most vulnerable to the impacts of climate change, as they rely heavily on rein-fed and limited resources to adapt to changing weather patterns. Hence, understanding their awareness and perception of climate change is of paramount importance. The study indicated that smallholder farmers are aware of climate change in their area with 65% strongly agreeing that the climate has changed. The study revealed the increased intensity and alteration of rainfall, drought and stormy winds and a decrease in temperature. The results are consistent with Henry (2011), who reported that farmers perceived an increase in temperature and decrease in rainfall pattern. The results also share similar findings with Banda's study (2015) where farmers pointed out the greater variability and the general rising in temperatures, prolonged dry spells and increased photoperiod. Smallholder farmers' perception of climate change agreed with the past 20 years meteorological data from the Department of Climate Change and Meteorological Services. The comparison of the study results with meteorological data is supported by Habtemariam et al.'s (2016) research, whose findings revealed that most respondents perceive warming temperatures and decreasing rainfall trends that correspond with the local meteorological records. Munthali (2013) reported similar results that showed that the majority (74%) of respondents perceived that the amount of rainfall received by the community over the past 10 years had decreased, though it was contrary to the data from Malawi Meteorological Services.

5.2.2 Channels of climate change information

Climate change disproportionately impacts smallholder farmers, making them one of the most susceptible groups. Therefore, it is crucial to ensure that they have reliable and pertinent information regarding strategies for adapting to and mitigating the effects of climate change. The results have established that radio is the dominant channel often used for dissemination of climate change, information followed by extension officers. The other media channels were phones through text messages, print and social media. Radio may dominate other channels as it is widely used as a mass communication medium and has great potential in disseminating information, since its signals cover almost the entire population. Payal (2012) emphasised that radio being a convenient form of entertainment caters for a large audience. The results from key informants indicated that radio was the main channel of climate change information. It was revealed that Non-Governmental Organisations such as World Food Programme (WFP) distributed radios to enable them listen to agricultural programmes without problems. The results of the study are consistent with Chukwuji et al.'s (2019) study where radio announcements and jingles led to other sources of climate change information owing to its affordability. The results also share similar findings with Idoma and Mamman (2016), who reported that radio and extension services were the most used in rural areas to access climate forecasts because of their affordability. Annor and Nana (2012) also reported that the majority of their respondents used the radio for information on climate change, and it was regarded as the most effective source. According to Oyekale (2015), access to information on climate change through radio has been linked to low cost, low maintenance cost, and wide coverage because of its affordability, availability and accessibility.

However, Nwagbara and Nwagbara (2017) have contrary observations where ***the*** majority of respondents accessed climate change information mainly through their observation, followed by extension agents, farmers' cooperatives, radio, newspapers and television. The farmers, who receive useful information from the radio gradually bring change in farming methods by applying new technologies that help them adapt to climate change and variability impacts (Khanal, 2011). In Malawi, Kalumikiza (2015) and Mataya et al. (2013) established partial results where extension officers, lead farmers and radio were the dominant channels often used for Climate Smart Agriculture technology dissemination based on their availability, immediate feedback and observability of the technology being promoted. Recognising its effectiveness and reach, governments and other stakeholders such as non-governmental organisations (NGOs) and community-based organisations (CBOs) can capitalise on radio to enhance climate change response and adaptation efforts and leveraging it to produce educational programmes, conduct awareness campaigns, and share success stories of climate change adaptation and mitigation efforts within local communities. Radio messages can be tailored to specific regions or communities, considering their unique vulnerabilities and needs. Radio can serve as a vital tool during emergencies, providing real-time updates and early warnings related to extreme weather events.

By disseminating timely information through radio broadcasts, the government can facilitate preparedness and response measures at the community level.

5.3 Potential synergies on the use of both traditional and scientific climate change information.

Smallholder farmers can benefit from using both traditional knowledge and scientific information to adapt to the impact of climate change. Combining traditional and scientific knowledge has the potential to enhance smallholder farmers' resilience to climate change. Traditional climate change sources and examples used in the study area include Indigenous Knowledge System (IKS), seasonal forecasting, Indigenous Agricultural Practices and Oral History and Folklores. Examples of IKS were the use of plants, such as poor fruiting of mangoes indicating low rainfall, heavy fruiting of mangoes predicting imminent rainfall and many flowers of monkey thorn indicating drought. The use of traditional forecasters and rainmakers who predict weather conditions for specific seasons were examples of season forecasting. The use of traditional calendar such as farming time like planting time was an example of agricultural farming practices. Oral histories and folklores such as oral traditions are used as reference for past climate events and their impacts. The results of this study showed the coexistence of modern science and indigenous knowledge in the following areas: validation and calibration of scientific climate data, which help in enhancing the accuracy of climate models and predictions, developing localised climate forecasts that consider both national climate trends and local knowledge of the study area, improving early warning systems for extreme weather events, enabling timely responses and reducing vulnerability, providing valuable insights into adaptive strategies that have been successfully used in the area, and designing context-specific adaptation measures by government and other stakeholders in the district.

At district level, the study further reviewed how planned and/or existing district/EPA policies and strategies; financial means and measures; planned and/or existing plans, programmes and initiatives, as enabling environment incorporated issues of both traditional and scientific climate change information. The district is considered as having promising synergy potential (potential score of 4), since the minimum threshold score was set at 4 (Lalisa et al., 2014). The synergy was supported by the availability of district and EPA level plans, committees, institutional arrangements and programmes and projects that addressed both traditional and scientific climate information. The synergy was weakened by the lack of policies, strategies, financial support and NAPA, that could address traditional climate information. At EPA/community level, there was coexistence of tradition with scientific climate information in the area supported by well-structured Civil Protection Committees. In the context of IK and modern science, some farmers were able to predict weather patterns using traditional indicators, the while majority of farmers largely accessed scientific weather data from the Department of Climate Change and Meteorological Services through radio and extension services. The information provided is mostly linked to how farming practices can respond to climate change and variability. Advice includes planting of early maturing varieties and drought resistant crops, crop diversification, forestation for flood and wind control, and modern farming techniques. The study results shared similar observations with Joshua et al.'s (2017) study in Chikwawa, which revealed coexistence of modern science and IK in the study villages. According to Ziervogel and Opere (2010), some farmers still rely on IK as it is dynamic, with its practices becoming established with long-term experiments or observations. However, according to Ayal et al. (2015), IK is criticised by some scientists as a short-term forecasting method, which cannot adequately prepare farmers for long-term adaptation to climate change. Makwara (2013) found that scientific knowledge has the capacity to provide long-term forecasts and trends, but these are inadequate without reliable short term and local scale forecasts, hence suggests that combining IK with scientific knowledge could produce robust and rigorous weather information.

Results from KII indicated that climate change and meteorological department recognise the vital contribution of IK, but there is limited documentation on IK as the information, meaning and forecasts vary across communities. According to Joshua et al. (2017), local policy recognition of IK in climate science, including its potential to enhance adaptation to climate change, is a recent development and that the climate change and meteorological department lacks the capacity to manage the collection and testing of IK for its integration.

The challenges facing traditional information include poor knowledge transfer system, insufficient documentation, non-inclusion of traditional information in policy, plans and strategic documents, and influence of religion and modern education.

The integration of traditional and scientific climate change information can help identify traditional practices that are resilient to climate change and integrate them with modern scientific approaches, leading to improved resilience in the face of climate challenges, identify traditional practices that are resilient to climate change and integrate them with modern scientific approaches, enhance food security, preserve biodiversity, and mitigate the adverse impacts of climate change on agriculture. It can also recognise and value traditional knowledge in policy and decision-making processes that can motivate its transmission to future generations, fostering cultural diversity and resilience. However, according to Nocole et al. (2018), integrating traditional and scientific climate change information for adaptation is complex, promising comprehensive solutions. Challenges include bridging divergent knowledge systems, ensuring cultural sensitivity, and addressing resource constraints. Balancing traditional practices with scientific strategies, transferring oral knowledge to documented formats, and managing power dynamics pose delicate challenges. Striking a balance is crucial, considering the potential neglect of aspects in resource-constrained communities.

5.4 Factors that motivate farmers' preference on the use of either traditional or scientific climate change information for adaptation to climate change

The choice of information sources used by farmers in understanding climate change is influenced by a range of factors, including traditional and scientific sources. The source of information that farmers use can have a significant impact on their understanding of climate change and their ability to adapt to changing conditions. The survey results showed that the majority of smallholder farmers preferred scientific climate information to traditional information. Factors such as sex, accuracy of information, timing of information sharing, accessibility of information, and language used play significant roles in facilitating effective government, farmer, and stakeholder interventions in the wake of climate change. Logistic regression revealed that sex, accuracy of previous forecast, timely exposure to the information, accessibility of the information and easiness of the language influenced smallholder farmers' preference for a source of climate change information. On how sex of the respondent influenced the choice of climate change information, the study confirms with Ndeye et al. (2019), where being male or female influences their access and preference for a source of climate change information owing to many disparities in several socio-economic characteristics such as the level of education, income and sources of income. Gender plays a crucial role in shaping farmers' experiences, access to resources and decision-making power. Recognising gender dynamics and ensuring equal participation of men and women in climate change interventions can lead to more inclusive and equitable outcomes. Government and other stakeholders can tailor interventions to address the specific needs and challenges faced by male and female farmers, which can result in more effective and sustainable outcomes. The study results are supported by Kalokola (2015), who pointed out that packaging climate change information customised to specific users is crucial, as it influences the usability of information.

Climate change information should be made accessible to all stakeholders, including farmers with limited resources, technological access, or literacy levels. Using multiple communication channels such as radio, community meetings, and mobile technology can help disseminate information widely. Ensuring information accessibility empowers farmers to make informed decisions and participate actively in climate change interventions. Accuracy and easiness of language influenced farmers' choice of climate change information source because it builds trust in farmers. Mudombi and Nhamo (2014) found that to be used by farmers, climate change information needs to be reliable, trusted and understandable. Accurate and reliable information is essential for informed decision-making. Providing farmers and stakeholders with reliable scientific climate change information, combined with localised and traditional knowledge, ensures that interventions are based on sound evidence. Ensuring the accuracy of information can build trust among stakeholders and increase the likelihood of successful intervention outcomes by both government and other stakeholders.

Muema et al. (2018) emphasised that language, style, and type of media through which communication is done are essential factors that make climate change information usable by farmers. The language used to communicate climate change information can significantly impact its effectiveness. Using language that is clear, simple, and easily understandable by farmers and stakeholders is crucial. Avoiding jargon and using local dialects can enhance comprehension and promote effective knowledge transfer. Translating information into local languages can help overcome language barriers and ensure that all stakeholders access and benefit from the information. Ambani and Percy (2014) stressed that the ability to access and make use of climate information depends much on literacy and fluency in a given language. Timely access to climate change information is crucial for farmers to make informed decisions. Providing information well in advance of anticipated climate events or changes allows farmers to plan and adapt their agricultural practices accordingly. Timely information sharing enables farmers to implement preventive measures, adjust planting or harvesting schedules, and make necessary adjustments to their farming practices, minimising the negative impacts of climate change. Understanding farmers' preferences for climate change information is crucial for effective communication and policy development. Acknowledging and respecting traditional sources fosters collaboration between traditional knowledge and scientific expertise, leading to more culturally sensitive strategies. Policymakers can use these insights to design supportive policies, such as incentives for sustainable practices and funding for research combining traditional and scientific knowledge. Empowering communities through inclusive decision-making and integrating local knowledge enhances the success of climate initiatives. Aligning information with farmers' preferences contributes to implementing resilient farming practices, crucial for building food systems resilient to climate change.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

In this research, attention has been on the utilisation of tradition and climate information in understanding climate change information and adaptation by smallholder farmers in Phalula EPA. Results indicated that farmers mainly access climate change information from radio and extension workers. Radio was the most used and preferred communication channel followed by extension workers. There was a fair representation of smallholder farmers on their choice between traditional and scientific information though a slight majority of them preferred scientific to traditional climate information. Factors such as sex, accuracy of previous forecast, timely exposure to the information, accessibility of the information and easiness of the language influenced smallholder farmers' preference for a source of climate information. There is a coexistence of modern science and indigenous knowledge in the study area. The district/study area is considered as having promising synergy potential with the availability of all scientific indicators and partial integration of traditional climate information indicators. The challenges facing traditional climate information include poor knowledge transfer system, insufficient documentation and influence of religion and modern education. However, despite the huge potential of traditional climate information to improve the adaptability and resilience of smallholder farmers to climate change impacts, current policies and strategies do not consider the value of traditional knowledge in agricultural production. Results from this study will inform agricultural research, extension officers and change agents on how they can develop their communication strategies based on farmers' needs and to use appropriate platforms, and communication channels that are available and accessible to farmers in real time.

6.2 Recommendations

A set of actionable recommendations has been proposed to guide efforts toward effective public engagement, knowledge preservation, and policy integration. These recommendations aim to foster collaboration between diverse stakeholders, recognising the importance of both traditional and scientific climate change information.

- Public awareness and enlightenment on climate change and adaptation using the mass media like radio should be encouraged. Such enlightenment should strive to improve its accuracy, accessibility in local languages, use of simple English, and in line with the culture of the audience. Tailoring mass media campaigns to be accurate, accessible in local languages, and in line with the culture of the audience corresponds with the identified preference for radio. To cultivate a widespread understanding of climate change, the establishment of a dedicated task force is proposed. This team would orchestrate public awareness campaigns, with a particular focus on leveraging mass media channels, especially radio. Collaborative initiatives with local radio stations, featuring experts, community members, and traditional knowledge holders, will ensure a culturally sensitive and accessible dissemination of information. Regular surveys and feedback sessions would be conducted to assess the effectiveness of campaigns, allowing for continuous refinement.

- The study revealed that a considerable number of smallholder farmers believed in traditional climate change information (45.67%), hence a need for government to fully document it. The documentation of traditional climate change information is crucial, given its coexistence with scientific information and its utilisation by a significant portion of farmers. Recognising the value of traditional climate knowledge, responsibility for its documentation is assigned to a government agency or specialised research institution. A dedicated unit within this entity would systematically gather and record traditional knowledge in collaboration with local communities, traditional leaders, and farmers. This process would respect cultural protocols and involve community members in decision-making regarding the use of their knowledge, ensuring inclusivity and ethical practices.

- Since current policies and strategies do not consider and appreciate the value of traditional knowledge in agricultural production, it is recommended for policymakers to integrate indigenous climate change information issues into scientific policies and strategies. The study underscores the coexistence of both traditional and scientific climate change information, hence recognising the synergy between traditional and scientific knowledge supports the recommendation to bridge the gap between these knowledge systems at both district and EPA levels. A collaborative working group, inclusive of representatives from government ministries, agricultural experts, traditional leaders, and local communities, would be established. This group would facilitate dialogue through joint workshops and forums, developing guidelines for integrating indigenous climate change information into scientific policies and strategies. Pilot testing in selected regions would precede scaling up, ensuring the effectiveness of integrated approaches. At both district and EPA levels, a cross-disciplinary committee would be formed, engaging representatives from agriculture, environmental science, traditional affairs and community development. This committee would conduct a thorough review of existing policies, identifying gaps in the recognition of traditional knowledge. Joint training sessions and workshops would enhance mutual understanding and collaboration between traditional and scientific communities. Guidelines for incorporating both knowledge systems into local-level climate change initiatives would be developed for comprehensive integration.

6.3 Areas of further studies

- Knowledge transfer systems: Further research can investigate and develop effective knowledge transfer systems to bridge the gap between traditional climate change information and modern scientific knowledge. This can involve exploring methods to preserve and document traditional climate change information, training local experts to transfer their knowledge, and integrating traditional and scientific knowledge systems.
- Policy and strategy development: Further studies can focus on analysing existing policies and strategies related to agricultural production and climate change adaptation to assess the extent to which they consider the value of traditional knowledge. This can inform policymakers and change agents on the importance of incorporating traditional knowledge in policy development and provide recommendations for integrating traditional knowledge into existing strategies.

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APPENDICES

APPENDIX 1: SMALLHOLDER FARMERS' HOUSEHOLD QUESTIONNAIRE

Interview Number: ________________ District: ___________________ Section____________________	
Extension Planning Area: ________________________	

SECTION 1: Demographic and general characteristics of respondents

Please answer the following questions openly and circle the correct answer.

1.1 Sex: (1) Male (2) Female

1.2 Age: __________ (years)

1.3 Marital status: (1) Single (2) Married (3) Divorced /Separated (4) Widowed

1.4 Educational level of the respondent: (1) No education (2) Adult education (3) Primary education (4) Secondary education (4) Tertiary education

1.5 Household size: __________(Members)

1.6 Household Head Type: (1) Male Headed (2) Female Headed (3) Child Headed

1.7 Religion of the household head: (1) Christianity (2) Islam (3) Non-Christian Denomination (4) No Religion

1.8 Source of income of the respondent (multiple responses allowed): (1) Farming (2) Employment (3) Business (4) Other (specify)……………………………………………………

1.9 How many acres of farming land do you have? ______________(acres)

1.9.1 What kind of crops do you grow? ....

1.9.2 What type of livestock do you keep? ………………………………………………...........

SECTION 2: Traditional and scientific channels of climate information used by farmers

2.1 What are the channels of traditional and scientific climate change information used by the household?

2.1.1 Scientific channels: (1) radio (2) TVs (3) phones (4) social media (5) print media (f) others (specify)……………………………………………………………

2.1.2 Tradition channels*:* (1) radio (2) TVs (3) phones (4) social media (5) print media (f) others (specify)……………………………………………………………

2.2 What are the examples from each category of climate change information?

2.2.1 Scientific examples……………………………………………………

2.2.2 Local examples………………………………………………………….

SECTION 3: Farmer preference on the use of climate information for adaptation to climate change

3.1 Are you aware of climate change? (1) I Know a lot (2) I Know (3) I Know little (4) Don't know

3.1.1 If aware of climate change; what changes have you noticed?

Climate parameter	(1) Increased	(3) Decreased	(3) Remain unchanged
Rainfall			
Temperature			
Floods			
Droughts/dry spells			
Winds			

3.2 Which of these two categories of climate change information do you prefer/like?

Category of climate change information	Yes (1)	No (2)
Traditional		
Scientific		

3.3 Give the reason(s) why you like tradition or scientific climate information:

____

____

____

Possible response summarised from the reasons provided:

Category for climate information	Timing (time of exposure to information)	Accessibility (are they able to get the information)	Accuracy of previous forecasts (was the information concise with the outcome)	Language being used (is the language used well known)
Traditional				
Scientific				

APPENDIX 2: KEY INFORMANT INTERVIEW (KII)

Name/code of Key Informant: ……………………………………………………………….

Cadre/position/title of Key Informant: …………………………………………………

Date of the interview________/_____/__________

Potential synergies on the use of traditional and scientific climate approaches

1. Are you aware of climate change in the area?
2. If you are aware of climate change, which indicators of climate have changed?
3. What are the sources of climate change information in the area?
4. Is there coexistence of both local (indigenous) and scientific (conventional) sources of climate change information in the area?
5. What are the strengths and limitations of each source of climate change information?
6. How and where does the community access these sources of information?
7. Does the area have Civil Protection Committees at community and village levels?
8. If committees are available, what are their roles regarding climate change information and adaptation?

How do planned and/or existing district/EPA policies and strategies; financial means and measures; planned and/or existing plans, programmes and initiatives incorporate issues of climate change?

Policies and strategies

- Does the country/district have a climate policy that addresses both local and scientific sources of climate/weather information?

✓ What are the policies?

- Is there a common climate strategy/action plan for both local and scientific sources of climate/weather information?

✓ What are the strategies?

- Has the district/EPA had NAPA?

✓ Which plans address both local and scientific sources of climate/weather information?

Institutional arrangements

- Is there a district/EPA-level committee addressing both local and scientific sources of climate/weather information?
- Is there an implementing body (institution/agency/department/unit) addressing both local and scientific sources of climate/weather information together?

Financing (funds)

- Is there a common climate fund for both local and scientific sources of climate/weather information?

Programmes and projects

- Is there a joint programme addressing both local and scientific sources of climate/weather information?
- Are there district/EPA projects addressing both local and scientific sources of climate/weather information?

The sum score across all eight indicators will be used to assess the levels of potential for synergy in the study area. This summed-up value, the ‘synergy score’ will be used to compare the relative position of the study area as compared to set standards. To consider a study area as having promising synergy potential, the minimum threshold of the score will be set at 4 (halfway from the maximum possible value of 8) (Lalisa et al., 2014).

Traditional climate change information	Examples	Indicator
Areas of synergy with scientific climate change information		

APPENDIX 3: BALAKA METEOROLOGICAL DATA

Balaka Meteorological data

Year	Average rainfall (mm)	Average temperature (degree Celsius)
2002		
2003		
2004		
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
2017		
2018		
2019		
2020		
2021		
2022		

APPENDIX 4: LETTER OF CONSENT/PERMISSION

MZUZU UNIVERSITY

DIRECTORATE OF RESEARCH

Mzuzu University
Private Bag 201
Luwinga
Mzuzu 2
MALAWI
TEL 01 320 722
FAX 01 320 648

MZUZU UNIVERSITY RESEARCH ETHICS COMMITTEE (MZUNIREC)

Ref No: MZUNIREC/DOR/22/104 **12/12/2022.**

Blessings Bandawe,
Mzuzu University,
P/Bag 201,
Luwinga,
Mzuzu 2.

blessbandawe@yahoo.com

Dear Blessings,

RESEARCH ETHICS AND REGULATORY APPROVAL AND PERMIT FOR PROTOCOL REF NO: MZUNIREC/DOR/22/104: ASSESSING UTILIZATION OF TRADITION AND SCIENTIFIC INFORMATION IN UNDERSTANDING CLIMATE CHANGE AND ADAPTATION BY SMALLHOLDER FARMERS IN PHALULA EXTENSION PLANNING AREA, BALAKA DISTRICT, MALAWI

Having satisfied all the relevant ethical and regulatory requirements, I am pleased to inform you that the above referred research protocol has officially been approved. You are now permitted to proceed with its implementation. Should there be any amendments to the approved protocol in the course of implementing it, you shall be required to seek approval of such amendments before implementation of the same.

This approval is valid for one year from the date of issuance of this approval. If the study goes beyond one year, an annual approval for continuation shall be required to be sought from the Mzuzu University Research Ethics Committee (MZUNIREC) in a format that is available at the Secretariat. Once the study is finalised, you are required to furnish the Committee with a final report of the study. The Committee reserves the right to carry out compliance inspection of this approved protocol at any time as may be deemed by it. As such, you are expected to properly maintain all study documents including consent forms.

Committee Address:
Secretariat, Mzuzu University Research Ethics Committee, P/Bag 201, Luwinga, Mzuzu 2; E-mail address: mzunirec@mzuni.ac.mw