UNIVERSITY OF NAIROBI

Climate Proofing of Malawi's National Agriculture Policy, with Special Reference to Rice Production

By

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DEDICATION

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ABSTRACT

Climate change affects and is predicted to affect rice production in the future. This has implications on food and livelihood security, particularly for rural smallholder farmers in developing countries like Malawi. One of the responses to these implications is climate risk reduction, which is the integration of climatic risks into development projects, programmes and policies in a bid to reduce potential and actual impacts. Climate risk reduction can be streamlined into policies that guide development through climate-proofing which is the deliberate integration of climate threats and opportunities into a project, programme or policy.

The overall objective of the study was to develop a crop-specific climate-proofing model for streamlining adaptation in the agriculture sector using rice as a case study. An analysis of climatic impacts on rice production and an assessment of whether Malawi's guiding policy for the agriculture sector, the National Agriculture Policy 2016 effectively integrated climate change to a level satisfactory to reducing risks because of climate change across various temporal scales where done. Rice production was used as a case study.

The study revealed that average rainfall in the area has a std dev 222.67 which varies beyond the expected 68% of deviation. Minimum temperatures also vary with the temperatures becoming cooler beyond -2 sigma. Maximum temperatures are increasing, with variations observed beyond 1 sigma. No significant impacts on rice production were established, (R^2 = 0.110). The policy review showed that there was insignificant reference to climate change. Over 90% of factors had moderate linkage to 1 of the 5 themes developed to depict inclusion of climate proofing concepts. Other significant linkages with other themes were 38% and 52%. Less than 10% were strongly linked to any of the themes. KII to establish whether incorporation of climate change issues was deliberate found that inclusion of climate was more of a secondary goal. There were no specific strategies that were being implemented as a result of the policy in the study area despite there being evidence of various strategies towards dealing with the impacts. The policy does not deliberately include climate change issues that impacts on rice production which potentially increases the climatic risks on production. As a recommendation, the study suggested a proposed conceptual framework approach that can contribute to increasing incorporation of climate change in agricultural production as guided by national policies and thereby contributing to the reduction of the level of climate risk reduction in crop production, more specifically in rice production in the target district.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: Introduction

1.1: Background

Agriculture is vital for food, nutrition and economic security across the world (OECD, 2011). Despite contributing only about 1.3% of global GDP, it represents a larger percentage of national GDP, more especially in middle and low-income countries (Kwon & Kim, 2014). Agriculture is however sensitive to climate impacts (Rosenzweig et al., 2014). Projected global temperature increase under Representative Concentration Pathways (RCPs) 4.5, 6.0 and 8.5 all depict over 2 ^{o}C increase in temperature by the end of the century, which will be coupled with a global intensification of various climatic impacts including sea-level rise, erratic rainfall events and droughts (IPCC, 2013). These impacts affect agricultural production to varying intensities across the world (Montmasson-clair, 2016).

The climatic risk and impact on agriculture also depend on the localized climatic and other non-climatic factors (IPCC, 2014b). Studies on projected climatic impacts on cereal production depict a negative impact on cereals such as maize and rice (Thorlakson, 2012; Trinh et al., 2014). The impacts vary depending on other factors such as biogeography and socioeconomic vulnerabilities. The complexity of the impacts calls for coordinated, strategic and tailor-made solutions to dealing with the said impacts to reduce impacts on various human systems (Webber et al., 2014).

Africa is one of the continents greatly affected by climate change (IFAD, 2011). This is because of the interaction of climatic risks, climate change impacts and pre-existing food security, socio-economic and environmental issues such as poverty and environmental degradation (Maidment et al., 2015). The Southern African Development Community (SADC) region, for instance, has recorded an increase in drought and flood-related impacts that partly due to climatic variations (Terdoo & Feola, 2016). These events affected over 20.9 million people in the 2016/17 agricultural year in southern Africa only, representing 30% of the population (FAO et al., 2018). Climate will continue to be erratic and result in such disastrous impacts. Such a threat to human life calls for the integration of extreme climatic events in devising adaptation strategies.

Malawi is not exempted from the impacts and risks associated with climate change on agriculture. Climatic impacts affect food and nutrition security as well as socio-economic development in the country (GoM, 2016b). The country has been experiencing climatic impacts such as the increasing intensity of drought and flood events (Pauw & Seventer, 2010). These affect agriculture and all systems that depend on agriculture in the country (Mulwa et al., 2017). As of 2017, agriculture contribution to GDP was 26% and was responsible for employing over 70% of the country's population. Agriculture is one of the most sensitive sectors in the country with regards to climate change (Olson et al., 2017). For instance, 3.3 million people were affected by flood and dry spell related impacts that magnified vulnerabilities in the 2017/2018 (GoM, 2018). The number of people that have been faced with food shortages and the number of malnourished children and adults has also been increasing (Masante et. al, 2018). The reliance of the nation on agriculture requires that agricultural systems be resilient to changing climate to reduce sensitivities of livelihoods and the economy to any unprecedented shocks. This is the core motivation for climate proofing the sector.

Approaches have been developed to deal with climatic risks and impacts. One such approach is mitigating climate change by curbing the anthropogenic influence on climate change and attempting to reverse impacts that have already been made (IPCC, 2014a). In response to the impacts, adaptation and building resilience of vulnerable units are some of the approaches that are employed (IPCC, 2014c). these two responses can be integrated into systems through a concept referred to as climate proofing. According to Hahn & Frode, (2011), climate-proofing is defined as '*a process of mainstreaming climate change into mitigation and/or adaptation strategies and programs'*. In essence, it is the deliberate integration of climatic impacts, threats and opportunities across temporal and spatial scales (GTZ, 2012). These approaches are sometimes developed as climate policy, or they are integrated into sector-based policies (Kahsay & Hansen, 2014). However, national policies function as umbrella frameworks and often fail to adequately cover the unique vulnerabilities faced within systems at lower scales.

At a global level, coordinated responses to climate change included developing global and regional frameworks. These include the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. The UNFCCC is the guiding policy framework for dealing with climate change issues across the United Nations member states. It outlines key interventions and strategies required to mitigate and adapt to climate change while also providing the opportunity for nations to meet their respective specific targets and goals (IPCC, 1992). The UNFCCC coordinates with other global policies such as the Sendai Framework which succeeded the Hyogo Framework, the Convention on Biological Diversity, the Convention on Combating Desertification and the Sustainable Development Goals to create guidelines for managing the causes and impacts of climate change at global, regional and national scales (Stern, 2015). However, lack of statistical evidence at the national level, particularly as is the case for most developing countries, so often results into un-justified incorporation of climate change issues into national policies with repercussion on both development goals and climate action (Schipper & Pelling, 2006). The global policies coordinate with existing regional policies such as the 2014 Malabo Declaration on Agriculture and the SADC's Darussalam's Declaration on Agriculture and Food Security. The global and regional policies inform national policies. These policies are a key intervention point for informing climate proofing of sector-based policies such as the agricultural policies.

At a national level, Malawi has addressed climate change risks and impacts through several frameworks. These include the Malawi National Agricultural Policy (MNAP 2016), The National Climate Change Policy (NCCMP 2016), The National Disaster Risk Management Policy (DRMP 2015), The National Resilience Policy and the National Adaptation Plan of Action (NAPA). These are developed in their various capacities to contribute to the country's Millennium Development Goals (MGDs). A policy is a strategic tool for coordinating activities and is an ideal entry point for climate-proofing a sector against the impacts of climate change.

Climate proofing of policies is an approach which centres on integrating climatic impacts, and consideration of opportunities and threats presented by the said climatic impacts to reduce risks presented by climate change (ADB, 2005, 2013; Bärring & Andersson, 2017; Eickhof, 2014; GTZ, 2010; Hahn & Frode, 2011; Hjerp et al., 2012). Based on this, themes were developed and used to assess the MNAP 2016's coherence to climate-proofing guidelines. Government and Non-Governmental organisations make up the key players in guiding the implementation of the MNAP 2016 in Malawi (GoM, 2016b). Interviews were done with government and other officials involved in the implementation of the MNAP 2016 to identify the level to which the policy informs activities being implemented by the organisations. This was also used to identify gaps in the translation of policy directives to activities. The last objective of this thesis sought to identify how the strategies have been translated to actual activities and how effective those activities are at reducing sensitivity to climatic impacts, utilising current and future opportunities to climate change while also considering climatic threats over temporal scales. This was done in Karonga, a district in northern Malawi. The strategies designed for management of general agricultural production sometimes fail to take into account specific climate risk reduction requirements of all agricultural products hence the need to climate-proof crop production.

This study focused on rice to assess whether general guidelines can inform the climate proofing of a crop that is not a key staple and cash crop despite being one of the most important crops in the country. According to Oort et al., (2017), rice is sensitive to changes in many climatic parameters such as rainfall, temperature and humidity fluctuations. However, this study focused on impacts on rice yields presented as a result of rainfall and temperature changes. The climatic impacts interact with non-climatic factors such as soil properties and culture to further contribute to unique vulnerabilities in a given locality (Sonwa et al., 2017; Tubiello et al., 2008). The argument was that an in-depth mapping of such impacts would be a key step in identifying appropriate strategies to reduce vulnerabilities (Powell & Reinhard, 2016).

1.2: Problem Statement

Climate variability and change has been one of the key challenges to realising global and national food and nutrition security goals. Even though agricultural policies have been recognised as ideal tools for improving adaptation, most of these have not articulated the impacts of climate change variability and change on crops such as rice. One of the strategies advocated by Malawi is developing national agricultural policies for a resilient agriculture sector. Climate proofing has been advocated as a key solution for resilient agriculture. There is however little evidence on whether it was applied when developing and implementation of the Malawi National Agriculture Policy 2016 which is the first policy of its kind that is also being developed in an era where climate change is an acknowledged threat to agricultural production in Malawi.

1.3: Research Questions

The following were the research questions for the study:

1. How have past climate variations affected rice production in Karonga, Malawi?

2. To what extent has the MNAP 2016 included the climate-proofing concept?
3. How has the implementation of the MNAP 2016 informed climate proofing in rice production?
4. How does the policy inform reduction of climate change impacts on rice production?
5. What model can be adopted to inform climate proofing of agriculture in the country?

1.4 Objectives

The main objective of the study was to develop a crop-specific climate-proofing model for streamlining adaptation in the agriculture sector using rice as a case study. Specifically, the objectives of the study were to:

1. Analyse the climate change risks associated with rice production
2. Analyse climate-proofing inclusion in the MNAP 2016
3. Investigate the relevance of strategies devised by the MNAP 2016 in relation to the climate-proofing of rice production and develop an ideal model for incorporation of climate change.

1.5 Justification and Significance

Climate variation and change has resulted in shifting threshold levels of weather parameters such as rainfall amount, rainfall patterns, temperature and other weather parameters (IPCC, 2018). These have been mapped to have affected yields for some crops such as maize and rice in Malawi (Msowoya & Madani, 2016; Olson et al., 2017), and have been projected to also affect the yields of other key crops (Ray et al., 2015). Climatic events such as floods, dry spells and droughts that are sometimes as a result of changes in these parameters have and continue to affect the quality and quantity of harvests (Pauw & Seventer, 2010). It is unknown if these are fully incorporated when developing national agricultural policies and whether assessments are done to identify opportunities for integration of these impacts. This is the main justification for conducting a climate-proofing exercise which aids in identifying climatic risks and areas for effective interventions and is a key reason for integrating climate change into agricultural production to reduce the costs posed by climatic risks and shocks.

The impacts of climate change are differentiated depending on the crop in question, and also depending on the locality of the crop and bioclimatic requirements of the crop (Adhikari et al., 2015). Sensitivity to climate change, for instance, can vary within a district, meaning that generalised responses to climate change at the national level might not be effective in dealing with specific climatic impacts that affect local areas (Powell & Reinhard, 2016). Again, since climatic impacts tend to be generalised and therefore underestimate the impact on specific systems which could result in the implementation of ineffective adaptation measures (Sonwa et al., 2017). A crop-specific climate-proofing model would therefore be ideal in ensuring that strategies implemented by a policy take into account the variations in sensitivity of crops (looking at different crops under different agro-ecological zones) to climatic risks to develop climate-proofed strategies that can significantly reduce the impact of climate variation and change on agricultural production (Urwin & Jordan, 2008).

National agricultural policies often fail to grasp specific climatic impacts on specific crops partly as a result of the lack of statistical information to inform this change (Dohlman, 2012). In relation to the MNAP 2016, there is lack of evidence that climate-proofing was incorporated in the development of the policy. There is a further gap in understanding how policies affect different farming communities with respect to their localities and crops grown. A crop-specific climate-proofing model could therefore aid in increasing the applicability and effectiveness of strategies in policies. The strategies developed have to translate to specified outcomes on developmental and climate action fronts for the various players (Asfaw et al., 2014). This hasn't been fully exploited for rice production in Malawi.

Malawi lacks research on the implications of climate change on various aspects of economy and development including agriculture (Zulu, 2017). For Karonga specifically, rice cultivation is one of the key sources of income, livelihood and food security. Integration of various climatic risks in production serves to reduce the overall impact thereby also reducing vulnerability to agricultural-based climatic risks and at the same time increasing vulnerability. Inadequate research challenges the development of evidence-based policy, particularly with regards to linking climate change and impacts to development. The ultimate goal of the study is to develop a climate-proofing process model that can be employed for future agriculture policies in ensuring reduced impacts of climate change on the agricultural sector. Climate proofing the strategies as assigned by the policy assists in the identification of both key threats and opportunities with regards to climate impacts and hence would serve as an ideal tool in ensuring that the goals of the MNAP 2016 are not compromised due to climate change (GTZ, 2012).

Economic development has been linked to more effective action against climate change and also the reduction of vulnerability of member states (Ling, 2012). Protecting the country's economy should therefore come as a core function of all climate-based actions. This can be a secondary benefit for climate-proofing agricultural production in the country. The agriculture sector is also one of the major contributors to climate change and therefore also the key focal point for Malawi's climate amelioration contribution (IFAD, 2011). Effective strategies in this sector that have been climate proofed will therefore not only have desired implications on the country's economy but also on global climate action.

1.5 Scope of the Research

The research focused on how the Malawi National Agriculture Policy 2016 is informing integration of the impacts of and sensitivities to climate change in agricultural production. The policy was selected because it is the first holistic policy that has been designed to guide the agriculture sector in the country. Climate proofing of the policy can be done to different elements of policy, but this study focused specifically on production because it is the departure point of all other agricultural activities and is also the most sensitive to climatic shocks with implications on livelihood, food, nutrition and economic security. Rice production was used as a case study and temperature and rainfall as the parameters for assessments. These were selected for analysis based on their role in rice production (GRiSP, 2013). Slight shifts in temperature and changes in the amount of rainfall in the development stages of rice have implications on yields (Rahman et al., 2017). The analysis was done for Karonga, a district in northern Malawi that has one of the highest rice yield estimates in the country (AICC, 2017). Rice as a case study was selected because it is firstly the second most important cereal crop in the country, and secondly because of its current and potential economic importance to the country.

The second objective employed a Qualitative Document Analysis (QDA) to identify coherence between climate-proofing and the MNAP 2016's strategies (Wach et al., 2013). Strategies guiding agricultural production were selected for assessments based on the relevance to the focus case study of this research. Other factors such as those contributing to processing and employment creation were not analysed because of the specified focus on the production of this study. Other policies like the Disaster Risk Management policy and the National Climate Change Management policy were briefly assessed to identify the links between the MNAP

2016 goals and their respective specific policy goals. The selection of these policies was based on their relevance to climate action for agricultural production specifically.

The last objective assessed the degree to which the MNAP 2016 informed a reduction in climatic impacts in Karonga targeting farmer households and officials from relevant organisations. Identification of farmers in Karonga was done with assistance from the District Agricultural Office. An estimated total number of farmers in the district was provided by the office. The office did not have information on the percentage of farmers that specialise in rice production or any of the other crops grown in the district. The approach used ownership of land (some farmers simply rented fields to cultivate in, these were found to be less consistent in farming history) for rice farming and the number of years of rice farming experience as criteria for identifying farmers. This was done in the field through purposive sampling. This was concluded with drafting of a model that can be used to inform climate proofing of rice production in the sector.

1.6 Overview of the Methodological Approach

The research employed a mixed research design using both quantitative and qualitative methods to achieve the objectives. The first objective mapped rainfall and temperature (maximum and minimum) for Karonga in relation to rice production. Climate data for Karonga Airport meteorology station was collected from the Department of Climate Change and Meteorological Services (DCCMS) and crop production estimates were collected from the Ministry of Agriculture and Irrigation and Water Development (MAIWD). Sensitivity for both production and yields (production/hectare) were mapped against the climate parameters. Graphical presentations, regression analysis and correlations were used for the analysis of data for this objective.

The second objective used Qualitative Document Analysis (QDA) to assess the MNAP 2016's coherence to climate change and climate-proofing of the agriculture sector (Wach et al., 2013). The first QDA used climate change while the second referred to climate-proofing based on themes in climate-proofing. Cross tabulation and frequency distribution tables were used for assessments.

The last objective involved a survey of rice production vulnerabilities in relation to climate change and activities being practised to reduce impacts of climate change and variation on rice production as were informed by the implementation of the MNAP 2016. This survey targeted smallholder farmer households in the district. The Kobo-toolbox application for electronic data collection and analysis was used for data collection. The analysis was done using cross-tabulations. This objective also addressed how the strategies are translated into actions and the gaps that exist at the organisational level. An initial list of stakeholders was drafted from the identified implementing partners in the MNAP 2016, particularly those of relevance to agricultural production. This was supplemented by selected suggestions from the interviewees. This then incorporated a conceptual model that can be adopted for better inclusion of climate proofing.

CHAPTER TWO: Literature Review

2.1 The Relevance of Agriculture

Agriculture is an important aspect of food and nutrition security across the globe (Chun et al., 2016). It is also a very important element for the economic development of some nations contributing to employment and a relatively large per cent of GDP (Alston & Pardey, 2014). Africa particularly relies on agriculture with over 25% of value-added production contributing to GDP in most countries as seen in Figure 1. Some other countries such as Nepal and Ethiopia have a some of the most significant reliance on agriculture for their GDP representing ~30% and 40% respectively (Khanal et al., 2018; Ng'ang'a et al., 2016). This role that agriculture plays in development is mirrored elsewhere in the world, to however different degrees (IPCC, 2014c). This contribution to different aspects of human development makes it imperative to safeguard agricultural production from any external impacts including those hailing from climate change.

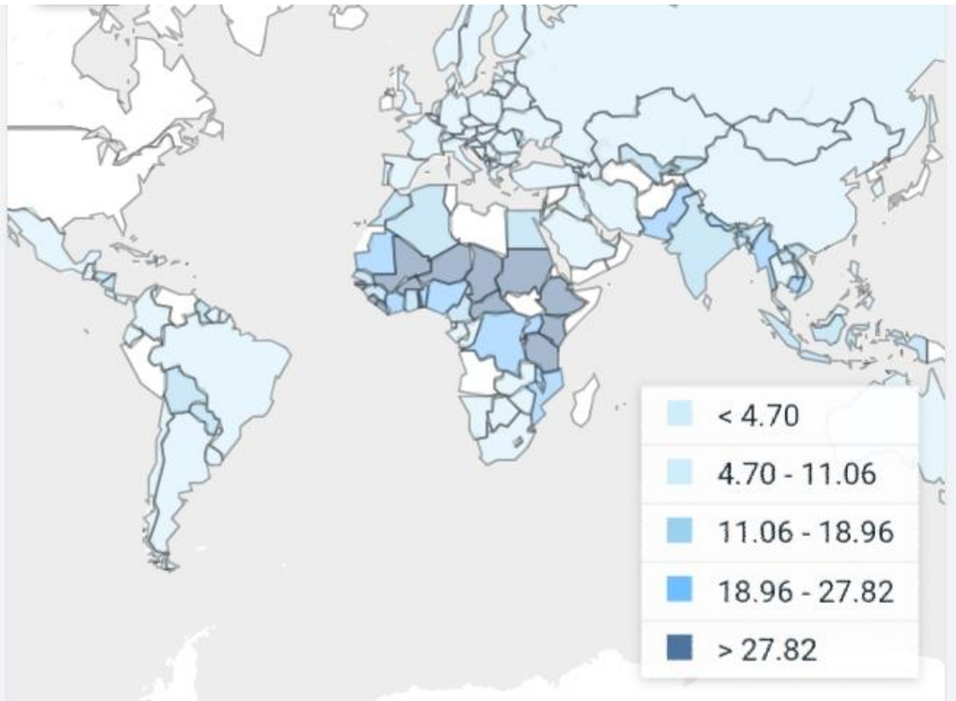

Figure 1: Agriculture, Forestry and Fisheries Value-Added National GDP contribution. Source: World Bank Website (2018)

Malawi follows a similar trend in reliance on agriculture. Despite the country having taken steps to divest from agricultural production as its economic stronghold, agriculture still contributes in excess of 25% to GDP (Makoka et al., 2015). Agriculture also contributes to over 80% of all foreign exchange earnings and the contribution to employment in the country is also high accounting for about 70% of all employment (Mulwa et al., 2017). The country's population has also been rapidly increasing which has contributed to an increase in food demand (Grist, 2015; NSO, 2019). The country has also not been food secure in the past years evidenced by the high variability in the annual production of the main staple food maize (Mulwa et al., 2017). This has been as a result of various socio-economic and environmental factors of which climate change is one (Msowoya & Madani, 2016). Reducing the impacts from climate change is one of the ways of securing food security and promoting sustainable agricultural production in the country.

2.1.1 Climatic Sensitivity of Agriculture

Climate change can extensively impact agriculture by resulting in variations in rainfall, temperature and other climatic elements that are vital for agricultural production (IPCC, 2014b). the impacts are some of the most pressing concerns on food security in the world (Schlenker & Lobell, 2010). The vulnerability of agricultural production to climate change is the key basis for the integration of relevant and appropriate climate action into agricultural production systems.

Agriculture production's vulnerability to climate change is experienced across the world, affecting production based on species sensitivity and geographical locations (IPCC, 2014b). The Asian region for instance is vulnerable to floods and droughts which result in devastating impacts on rice production, the main food source in the region (Chun et al., 2016). This is also mirrored in the Americas where changes in temperature ranges are affecting the physiological development of crops and therefore affecting crop productivity and production (IPCC, 2014c). This is a concern especially for developing nations that face other challenges such as high and rapid population growth that increases the demand for food (Ray et al., 2015). Developing countries are already unable to meet the recommended standard of living. Such impacts further exacerbate the nutritional balance, food and livelihood security hence the need for a more vigorous approach in dealing with impacts presented by climate change.

Africa is one of the most affected continents as far as climatic impacts are concerned(Kassie et al., 2015). Existing socio-economic vulnerabilities interact with agriculture-based vulnerabilities to result in unprecedented climatic impacts on agricultural production (Davis-Reddy & Vincent, 2015). Such climatic impacts are a chief concern because they contribute to the further deterioration of socio-economic systems that rely on agriculture(Gornall et al., 2010). They also contribute to increased poverty were affected households are not able to able to cope with impacts (Giertz et al., 2015).

Malawi faces different climatic impacts ranging from droughts and erratic rainfall events to floods, dry spells rainfall variability and changes in the seasonal distribution of rainfall (Vincent, et.al. 2014). An increase in the frequency and intensity of climate-related disasters as depicted in Figure 2 below has been on the rise since the 1990s which further contributes to variations to agricultural production (ECA, 2015). As the climate continues to change and vary, the impacts will continue to be felt across the globe. Integration of these climatic risks and sensitivities serves to assist nations in managing climatic impacts.

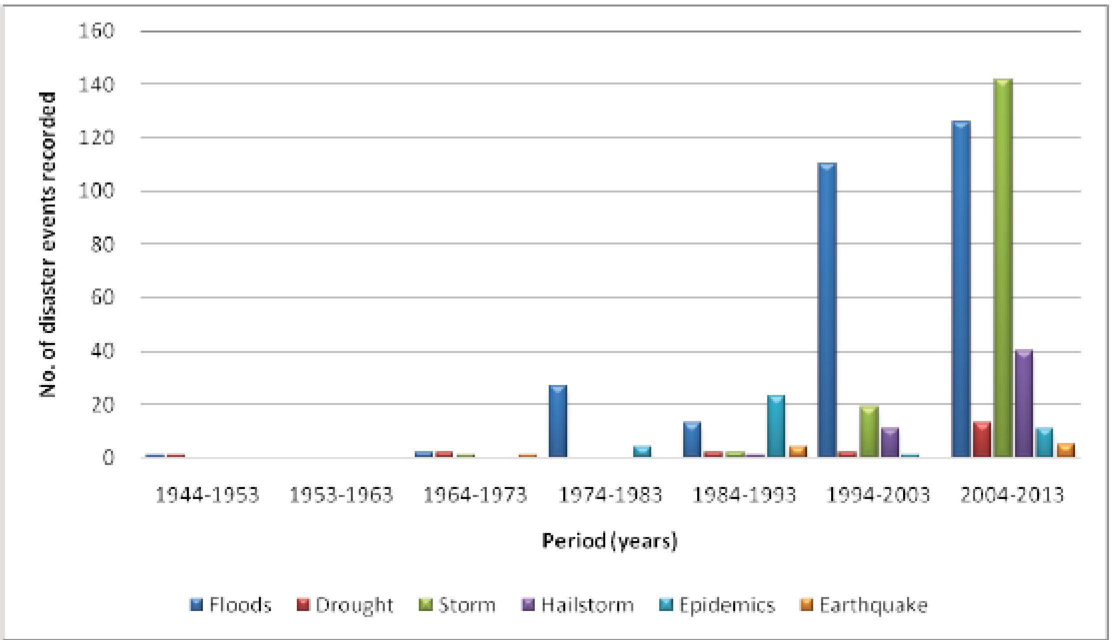

Figure 2: Summary of disasters observed between 1944 and 2013 in Malawi(ECA, 2015)

Figure 2 also depicts an increase in the intensity and frequency of climate-related impacts that could potentially affect agriculture production. It is worth noting that agriculture is already associated with certain risks and uncertainty associated with production (Zinyengere et al., 2015). The climatic change further exacerbates those risks calling for the integration of such issues to boost existing coping strategies (Perez et al., 2015). Of particular concern in this sense is the smallholder farmers, whose capacity to adapt is usually undermined by the extent to which climate change magnifies risks and vulnerabilities (Maganga & Malakini, 2015).

2.2 Interventions for Dealing with Climate Change

The issue of climate change brings about approaches to reduce the anthropogenic contribution to the problem and also to reduce the impact on people. Mitigation focuses on reducing and curbing the anthropogenic contribution of climate change (IPCC, 2014a). It is a vital part of dealing with climate change. However, scientists' estimate that the impacts on the climate system will take at least a 100 years to reverse and become stabilized under the current status quo (IPCC, 2018). Impacts will therefore continue to be felt hence requiring approaches that safeguard agricultural production. Climate change adaptation encompasses different approaches, these include an anticipatory approach and a reactionary approach (Montmasson-clair, 2016).

Climate Risk Reduction (CRR) is define mitigation of climate based impacts by reducing their likelihood and severity(Perez et al., 2015). This involves the consideration of all possible climatic impacts that enhance vulnerabilities of human system (Pervin et al., 2013). After this, integration of those impacts in the development of guidelines or strategies for management of that particular system to contribute to resilience (Davis-Reddy & Vincent, 2015). Climate Risk Reduction also takes into account those impacts that can affect production including those that might not necessarily result in a disaster (UN-OHRLLS, 2009).

Policies are strategic tools that are designed to direct the process of attaining goals that would otherwise be difficult to attain without coordinated efforts (Fünfgeld & McEvoy, 2013). The key challenge, however, is the adoption rate of adaptation practices despite obvious climatic impacts (Montmasson-clair, 2016). Another challenge is that policies are very vulnerable to political and donor influence with their structure changing as a result of changing political influence as well as donor priorities (Sovacool et al., 2015). This is often at par with issues of integrating climate change which requires unchanging, user rather than developer-defined approaches to deal with specific issues on the ground.

2.2.1 Global Frameworks for Climate Risk Reduction

Climate risk reduction (CRR) is a cross-cutting issue, and as such is guided by several frameworks, chief of which is the United Nations Framework Convention on Climate Change (UNFCCC). This framework outlines the key interventions and strategies that are required to mitigate and adapt to climate change for the United Nation member states (IPCC, 1992). The framework convention works with supporting legislation and publications such as the 2018 Katowice special report on global warming and the 2015 Paris Agreement (IPCC, 2015, 2018). This major climate framework coordinates with other global policies and is also translated into regional and national climate policies, while also being integrated into other non-climatic policies (Stern, 2015).

Elements of CRR cover climatic disasters and other impacts that do not translate into disasters. Globally, climatic disasters are also covered under the Sendai Framework which succeeded the Hyogo Framework for Action. The Hyogo Framework For Action focused on disaster risk management and phased out in 2015 (UNISDR, 2005). Its successor identified the need for an anticipatory approach with regards to disaster management. The Sendai Framework is implemented to guide the reduction of disaster risk in various fields (UNISDR, 2015). Reduction of risk in agriculture is a key interest as it contributes to desired sustainable production goals.

2.2.2 National Policies for Climate Risk Reduction

Global and regional climate policies inform the development of national policies. Countries such as Kenya and South Africa have implemented policies to fulfil goals under the UNFCCC. Kenya has in place, among its climate policies, a National Climate Change Response Strategy which provides guidance for dealing with climate change at a national level and also developed and implemented its National Climate Change Action Plan II (Ongugo et al., 2014; Government of Kenya (2018)). An example from South Africa is the Western Cape regional response framework for the agricultural sector. It is a detailed integration of the country’s national climate change goals into the agricultural sector in the Western Cape to deal with climatic issues specific to that sector (Midgley et al., 2016). The deliberate and detailed streamlining of climate change from national goals to specific agriculture sector issues is the main outcome that this study would like to contribute towards in a bid to reduce impacts from climate change and increase the effectiveness of climate risk reduction strategies.

The Malawi government ratified several global conventions to aid national goals. As a mandate under the UNFCCC, Malawi developed its first National Climate Change Management Policy (NCCMP) 2016 to guide mitigation and adaptation activities in different sectors in the country (GoM, 2016c). The policy focuses on vulnerable sectors in Malawi (including agriculture) and is in-line with the country's development goals (GoM, 2016c). With reference to agriculture in the country, the NCCMP 2016's implementation strategy outlines general interventions in rural agricultural production to promote resilience amongst farming communities (GoM, 2016a). This policy is the guiding framework for all climate-based interventions in the country. In addition to this, the country also has the National Adaptation Plan of Action (NAPA) which aims at guiding adaptation in vulnerable sectors in the country and the National Resilience Policy which aims at enhancing resilience as a result of various impact factors (GoM, 2006, 2016d).

In trying to address disaster challenges, the government of Malawi developed the National Disaster Risk Management policy in 2015 (GoM, 2015b) in line with the Hyogo Framework. The policy also makes a provision of mainstreaming disaster risk management into all sectors in the country (GoM, 2015b). This policy, however, is more focused on disaster management as opposed to risk reduction. Even though global frameworks call for multi-hazard approaches and inclusive risk decision-making based on IPCC, (1992) and UNISDR, (2015), there is lack of information at country level to show whether this principle has been applied in the process of climate proofing the agriculture sector through policy directives. Climate risk reduction at the national level ought to incorporate various climate risks in the development of its national guiding frameworks, but there is little evidence of such in Malawi.

2.2.3 Malawi's National Agricultural Policy

In line with national development agendas in the agricultural sector, the country developed the MNAP 2016 (GoM, 2016b). Prior to the policy, several sub-sectoral policies were in place to enhance productivity of the sector. Most of these however achieved isolated goals within the sector. This contributed to uncoordinated efforts within the sector and prompted the development for the National Agricultural Policy 2016 (MNAP 2016) which is the country's first holistic agricultural policy. It aims at achieving sustainable agricultural production through commercialization of agricultural production (GoM, 2016b). Initial analysis has however shown that despite climate change being an eminent and current threat to agricultural production in the country and across the globe, it was not efficiently integrated into the MNAP 2016. Jerven (2013) argues that in some instance, the political economy influences the development of policies rather than key evidence on practical solutions to nationally observed problems. As such, the concept of climate risk reduction as defined by GFDRR (2011) was employed to understand the extent to which the agricultural policy promotes adaptation in the sector through climate proofing.

2.2.4 Other Relevant Policies

One of the key policies that guide agricultural production in Africa is the 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods which realises the important role of African agriculture on households, communities and the nations themselves (AU, 2015). Regions also sometimes have guiding frameworks specific to them such as the 2005 SADC Darussalam Declaration on Agriculture and Food Security. These policies are responsible for guiding national policies to harmonize goals.

Other policy documents also guide different aspects of agriculture in Malawi. This includes the Agriculture Sector-wide Investment Plan, which was developed to inform the promotion of agricultural production and poverty reduction in Malawi due to its importance in economic development, food security, and wealth creation in the country and also to work towards achieving the country's Millennium Development Goals Agenda (GoM, 2011). In addition to this, despite options like farm input subsidy programs being there to cushion the country's most vulnerable, there have been continued impacts on food security (Jeanne Y. Coulibaly et al., 2015). The effectiveness of such policies is however usually hard to accurately define due to the role that government plays in the development and assessment techniques of such policies (Montmasson-clair, 2016). This could also be an issue with defining the level of integration of climate issues and climate change success stories as they could be driven by political agenda. It is however worth noting that despite implementation of such proper policies, the country continues to have over 66% of its locals living below the poverty line (World Bank, 2019).

The country's NAPA targets specific vulnerabilities, including in the agricultural sector for different districts (GoM, 2006). This, however, has strategies that were simply upscale in the 2016 MNAP 2016 such as the development of new irrigation schemes and rehabilitation of existing ones (GoM, 2016b). This misses out on a key element of integrating the actual vulnerabilities to climate change as opposed to the generalised vulnerabilities. Despite the introduction of the MNAP 2016 being key to reducing climatic impacts, the disconnect between sub sectoral policies in agriculture has also brought to light discrepancies with other sectoral policies on issues to do with implementation.

A study done by the United Nations Economic Commission for Africa (UNECA) through the African Climate Policy Centre (ACPC) and the Lilongwe University of Agriculture and Natural Resources (LUANAR) assessed the agricultural sector policies and climate change in Malawi (Montmasson-clair, 2016). The study established that not only do agricultural policies lack components that exhaustively cover climate change issues, but they also lack clear monitoring and evaluation mechanisms, as well as the capacity required to carry out such functions. There is also the duplication of efforts by several government departments, and development partners in the implementation of strategies for climate change adaptation and mitigation (Le Blanc, 2015).

2.3 Climate Proofing as a Climate Risk Reduction Strategy

Climate proofing aims at identifying risks and opportunities associated with climate change for a particular project, programme or policy (Kabat & Vellinga, 2005). There are a lot of action areas for the reduction of the impacts of climate change (Midgley et al., 2016). Some agriculture risk management strategies for instance promote insurance as a strategy of reduction of impacts on the livelihoods of farmers (Mulwa, et.al 2017). Climate proofing encompasses premeditated interventions that ensure that impacts do not affect agricultural production in the first place (Hjerp et al., 2012).

Climate proofing can be applied at different scales (Hjerp et al., 2012). Some applications involve nation-wide programs in a specific sector, some are multi-sectoral, while others are more refined to projects such as the development of an irrigation scheme (ADB, 2016; Eickhof, 2014; ERI, 2014). Each of these must take into account how climate change can be dealt with in order to ensure that the policy can perform despite any impacts from climate (Medarova-

Bergstrom, et.al., 2014). The MNAP 2016 is a key intervention point for climate-proofing the agricultural sector. It was designed to guide sustainable agricultural production in the country (GoM, 2016b). The importance of integrating efficient adaptation strategies into development cannot be stressed enough given the challenges that climate change has already been having on developing nations like Malawi.

2.3.1 Steps in Climate Proofing

Climate proofing generally includes: assessment of factors motivating this integration; assessment and identification of the scientific and technical support needed for development: and implementation of said policies (ADB, 2013, 2016; ERI, 2014; Hjerp et al., 2012; Medarova-Bergstrom et al., 2014). The policy approach is very different based on climatic impacts faced in the application area (Oliver et al., 2014). This differs between and within countries hence calling for an approach defined for specific localized situations within countries (McNeeley & Lazrus, 2014). Developing nations have a low capacity for carrying out sufficient scientific requirements to back policy interventions which contribute to losing out on a vital role of informing policy-based strategies

Climate-proofing is a process-based approach which differs in steps based on the mode of application and the authority responsible for the integration. The GIZ and the Asian Development Bank are some of the organizations that produced a general guideline for the application of climate-proofing to development (Hahn & Frode, 2011). A project under the GIZ also developed a framework for climate-proofing the water sector that involves a four-step outline seen in Annex 5 (Eickhof, 2014). The Asian Development Back developed a similar framework that includes detailed interventions for agriculture, transport, water and energy climate-proofing among others (ADB, 2005, 2011, 2012, 2013, 2016). The framework outlines a 6-Step outline that can further be divided into 20 steps as is shown in Annex 2 & 3.

Despite the difference in steps, all these frameworks have similar goals and elements. The Asian Development Bank framework, for instance, informs climate-proofing by firstly assessing the need for climate-proofing various investments by informing the following decision: climate integration decision; business as usual decision; or no action decision (ADB, 2016). This is similar to the decisions that the GIZ framework also aims to achieve. All the decision pathways are selected based on the appropriate balance of climate action, economic costs and social costs of the particular case. The process itself involves three key elements as shown in the more generalised framework by ADB (Annex 6). These include assessment of climatic risk, assessment of needs and prioritisation of action for current and future scenarios (Altvater et al., 2011). All other frameworks are developed around these key elements. The key elements were used to guide research to assess how the MNAP 2016 can be used to climate-proof the agriculture sector and therefore increase the effectiveness of sustainable production strategies under changing climate.

2.3.2 Applications of Climate Proofing in Agriculture

Climate-proofing has been used for different applications in the world, including climate-proofing cities as is a case of India (ERI, 2014). The assessment highlighted the need to have institutional, structural, social and economic capacities to withstand the impacts of climate change, with the development of systematic processes as a pathway (ERI, 2014). Climate proofing can be done for sectors as well. Zambia for instance developed a climate-proofing manual to aid financial planning in the country using the GIZ framework (GIZ, 2014). A similar study was done to climate-proof the European Union budget (Medarova-Bergstrom et al., 2014). It can also be done for specific sectors as was done for the energy sector by Williamson, Connor, & Moezzi, (2009). The Western Cape in South Africa developed an elaborate guide for climate proofing the agriculture sector in the region (Midgley et al., 2016). With specific reference to agricultural policy, the European Union developed methodological guidelines for climate proofing the Common Agricultural Policy in the EU region (Hjerp et al., 2012). Despite climate change being a major threat to agricultural production in Malawi, such comprehensive approaches to climate-proofing have not been developed for agriculture sector in the country.

2.4 Sensitivity of Rice to Climate Change

Rice (*Oryza sativa* L) is the second most important food crop in Malawi (AICC, 2017). It is mainly grown through lowland rain-fed production (Before et al., 2018). Other rice production systems include lowland irrigated production and upland irrigation. Rice production in Malawi is characterised by low yields (Daccache et al., 2014). Despite rice production in lowland areas being possible, (even in the absence of fertilizer supplements) it is still sensitive to climate change (Trinh et al., 2014). Of the locally available species, some are long maturing (more than 150 days) varieties while others are short maturing (90 days) (GRiSP, 2013).

Rice is adapted to a specific range of biogeochemical conditions that vary according to species (GRiSP, 2013). These include optimal climatic and soil conditions. Weather parameters such as temperature, rainfall and humidity play a role in the productivity of rice. This is however dependent on the growth stage of rice (GRiSP, 2013). Rice has 3 main growth phases: the vegetative phase which ranges from germination to tillering; reproductive phase which is characterised by spikelet formation and pollination; and the maturity phase characterised by the seed maturing and yellowing and drying of seed (Achiase & Aninagyei, 2014). Understanding these biological sensitivities therefore plays a vital role in the development of appropriate strategies for climate-proofing rice production.

Sensitivity can also occur due to the nature of the production system. Lowland production for instance, due to its reliance on flooding for productivity, and due to the type of paddy environment it is practised in is particularly sensitive to variability to rainfall (Yoshida et al., 2012). The sensitivity of rice can nevertheless vary depending on the varieties in question, the kind of management factors being employed, and of course environmental factors (Chun et al., 2016). This means that generalized strategies risk overlooking specific sensitivity of given rice species as well as reduced ability to cover sensitivity of rice broadly

2.4.1 Impacts of Climate Change on Rice Production

Climate change proves to be a major threat to rice production across the globe (IPCC, 2014b). Observed impacts mainly hail from variabilities in temperature and rainfall which affect optimal biophysical conditions required for rice growth (Li et al., 2015). These impacts are differentiated depending on geographical location (Oort et al., 2017). An increase in carbon dioxide concentration in the atmosphere (carbon fertilization) is expected to contribute to increased rice yields, however, other factors such as variation of precipitation and extreme increases in temperature, and extreme weather events can affect rice production (Terdoo & Feola, 2016). Carbon fertilization is expected to increase heat accumulation and this associated increase in temperature could affect the physiological wellbeing of the crop and therefore result in reduced yields(van Oort & Zwart, 2017). Temperature also influences atmospheric humidity that in turn affects rice production (Rathnayake et al., 2016). A general change in yield variability is however expected across the globe in areas where climate variability is also high (Ray et.al, 2015).

Studies in Malaysia show that although precipitation increase is expected up to 50% in some areas, rice production will be affected by reduced grain weight and reduced yield per hectare with every 1°C change in climate (Alam et. al, 2011). Such impacts are also expected in other parts of Asia such as South Korea and China where water requirements for rice production are expected to increase (Kim et al., 2016; Wang et al., 2017). This will also be coupled with a reduction in irrigated land area due to other climatic stresses (Kim et. al, 2016). It is worth noting however that other studies show that there are high uncertainties in predicting the impact that climate change will have on rice production (Li et al., 2015). This is mainly due to the uncertainties from precipitation which is a major input in rice production (Ray et al., 2015). There is consensus however that even moderate changes in optimal climate for rice production can lead to reduced yields. Appropriate adaptation measures can contribute to reducing the overall impact of climate change and therefore aid in the reduction of vulnerabilities (Challinor et al., 2014).

The general trend of high yield variability and reduced yield is also expected in the sub-Saharan context. Reduced negative impacts on rice yields were projected for all East African nations with expected changes of between 1% and 15% under the SRES projections (Adhikari et al., 2015). Other projection studies alternatively show a projected increase in rice production due to an increase in carbon dioxide concentration and an increase in temperature for most parts of Africa. Water availability however still poses a key threat despite any positive expected yields (Oort et al., 2017). South Africa for instance is projected to have reduced crop productivity mainly based on water stress projections (Terdoo & Feola, 2016). Heavy reliance on rain-fed rice production across the continent puts rice production at risk due to variations in precipitation (Adhikari et al., 2015). The impact for countries such as those in the Southern African Development Region (SADC) is expected to be high because 97% of agricultural production in this region is said to be rain-fed (Davis-Reddy & Vincent, 2015).

Rice is the second most important food crop in Malawi after maize (Adhikari et al., 2015). The districts with the highest production in the country are in the lakeshore and part of the Shire Valley agro-ecological zones (AICC, 2017). Like most other crops, the climatic impact on rice production depends on the geographical location (Ray et al., 2015). Malawi has seen an increase in rice production over the past 15 years as depicted in Figure 3 below (Olson et al., 2017). This was mainly due to increased use of irrigation between 2002 and 2013 (Makoka et al., 2015). The drop in production from 2013 is however associated with variable rainfall which affected the availability of water for irrigation (Olson et al., 2017).

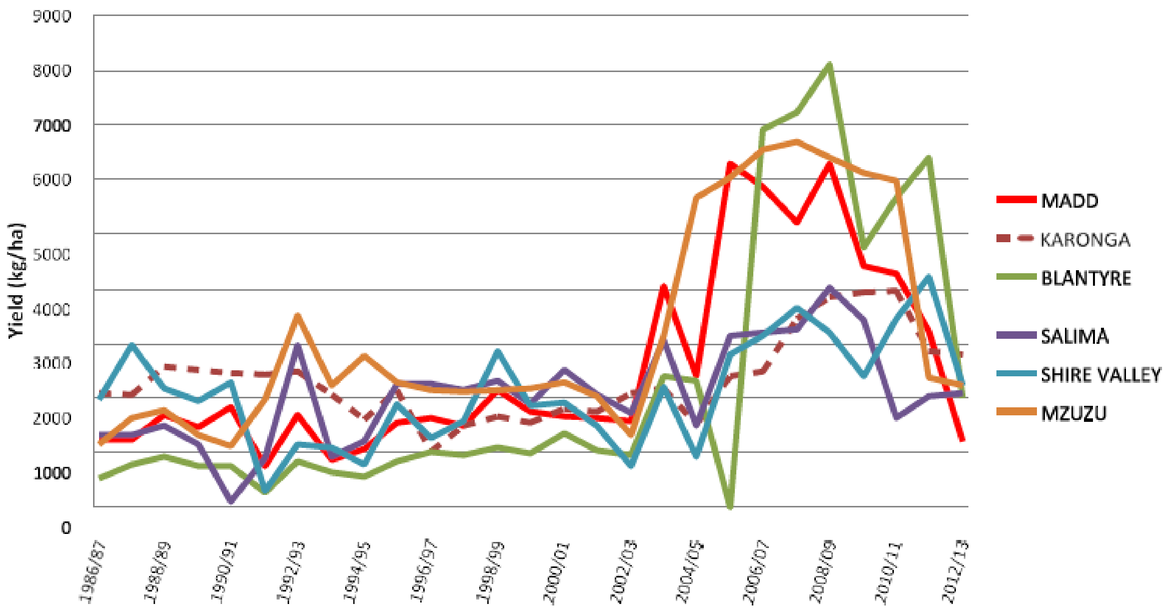

Figure 3: historical rice production trends in Malawi Source: (Olson et al., 2017)

In Malawi, rice production is affected by changes in climate mainly as a result of uncertain rainfall variability. A study by Oort & Zwart, (2018) simulates that temperatures in Malawi could increase by between 2 and 2.5 degrees Celsius by 2030. This could have serious implications on rice production, especially in the development and vegetative stages of production. Other research also shows that Malawian rice species are sensitive to increase in temperature and low precipitation (Olson et al., 2017). Irrigation is one of the key methods for improving production, however, projections depict a reduction in irrigated rice yields as well due to precipitation deficits (Oort et al., 2017). Rice is one of the key crops targeted for the food diversification program to shift reliance on maize as a core crop (GoM, 2016b). Developing adaptation strategies that take into account such projected impacts would therefore reduce the overall impact of climate change on rice production while also ensuring an increase in production. The observed increase in yields over the years is as a result of an increase in the production area as compared to the increase in productivity of the crop (Olson et al., 2017). For instance, farmers currently get a yield of less than 45% of the maximum potential yield of the main rice varieties grown which are Kilombero and Faya (Before et al., 2018).

The key relevance of this study with regards to the identified problems is that it could aid climate risk reduction needs in the agricultural sector. Policies are key tools in reducing climate-based risks through interventions such as climate proofing. There is however little literature on the climate-proofing process in developing countries. As such, this study assessed the Malawi case to understand what processes have been taken in climate-proofing the MNAP 2016 and whether such processes have shown initial climate risk reduction on rice production.

CHAPTER THREE: Data and Methods

The research was a mixed designed focusing on how the MNAP 2016 can inform climate-proofing production using rice as a case study. It used qualitative and quantitative approaches to achieve the objectives in the study. Policy analysis can be done through three broad approaches. The first is traditional policy analysis which encompasses a range of methodologies aimed at identifying the best solution to a problem through the analysis of a range of solutions. The next is the mainstream policy analysis approach which depicts assess the interaction between policy actors and policymakers. The last branch is the interpretive policy analysis approach which covers analyses that include establishing how policies reflect the social construction of problems (Oliver et al., 2014). This is the approach under which the policy analysis for this research falls. A trend analysis was used to identify climatic impacts on rice production in Karonga. A Qualitative Document Assessment (QDA) method was employed for policy review, and cross-sectional study design was used to identify the institutional coherence of climate-proofing as well as to identify the level to which adaptation strategies devised through the MNAP 2016 have been translated to actual activities on the ground

3.1 Study area

The following sections describe the study area and other elements relevant to the understanding of the research.

3.1.1 Location

The study analysed how the MNAP 2016 integrates climate change into its strategies and is able to guide climate proofing of the sector. To do this, a case study of rice production was used and Karonga district in Northern Malawi was selected as a study site. The bulk of rice in Karonga is classified as rain-fed long-maturing rice which is grown in banded fields that are either under irrigation schemes or regular farmlands. Short-maturing varieties are also grown in irrigated banded fields (schemes) mainly for the winter cropping relying on various degrees of flooding for production. The regular fields are classed under different agro-ecological zones such as dambo and low-lying floodplains. The overall study context is the policy process focusing particularly on implementation and institutions enabling implementation for climate-proofing purposes. The study however employed a case study to better define the assessments to be employed. Figure *4* below shows the location of Malawi in Africa, the location of Karonga, in Malawi and the Extension Planning Area targeted for the research. The district is located at the latitude 9.9525 degrees south, and the longitude 33.9248 degrees south.

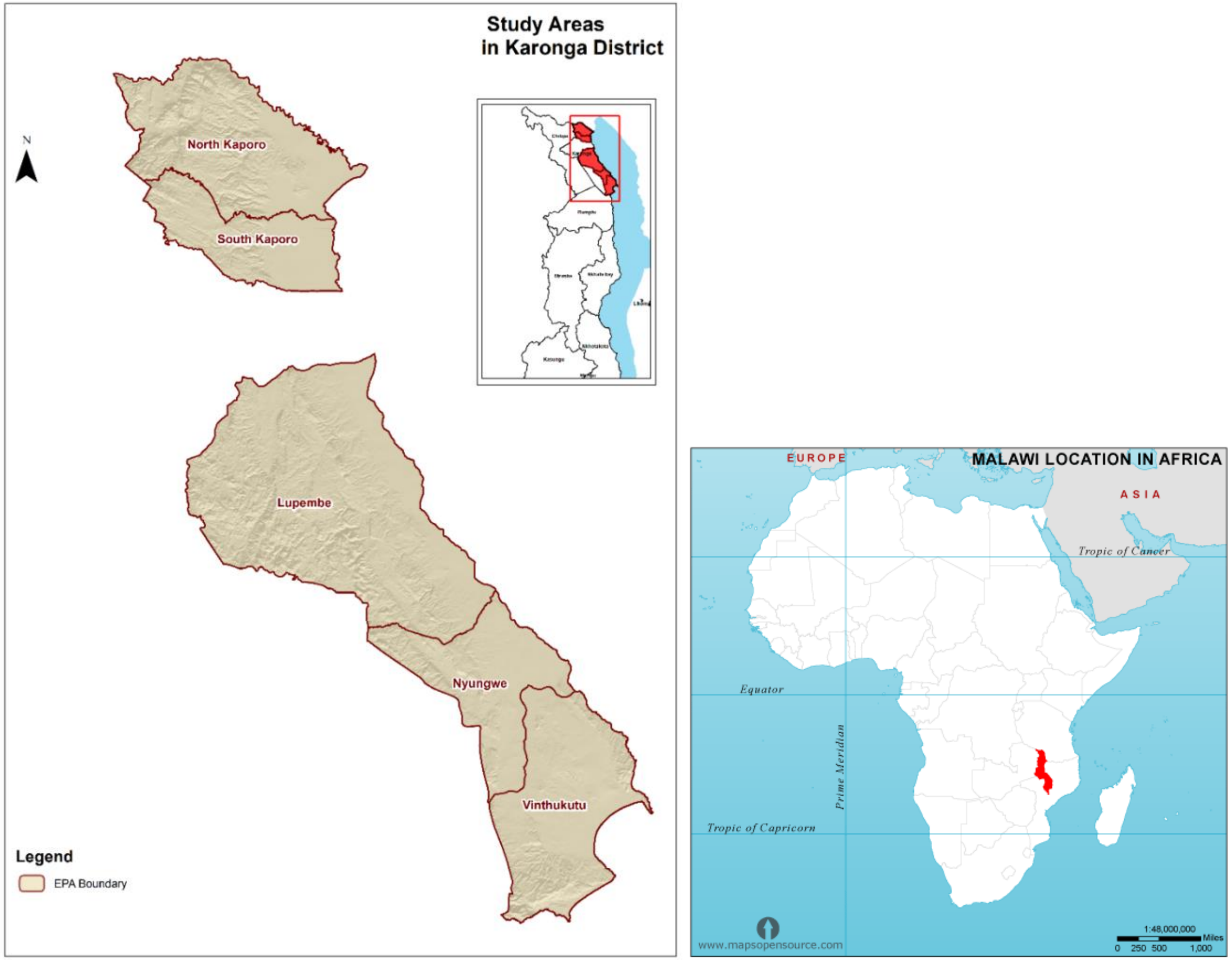

Figure 4: the figure shows an excerpt of the study area as is focussed from Malawi. Source: Africa Map with Malawi Highlighted from emapsworld website, Excerpt of Malawi and study EPAs output from Quantum GIS.

3.1.2 Biophysical Setting

Malawi has Lake Malawi covering one-fifth of the country's area and is part of the Great African Rift Valley (Grist, 2015). The country has diverse ecological zones that are grouped into five major zones: the lakeshore plains; the lower shire valley; the upper shire valley; the mid-latitude plateaus; and the highlands (Benson, 2016). The lakeshore plains, which are key to this study, have a relatively higher concentration of rice production compared to other sections of the country. The soils in the section range from sand and sandy loam soils to clay loam soils (Zulu, 2017). Central and Northern Malawi are part of Lake Malawi's basin which drains into the southern region that is of lower elevation (Zulu, 2017)

3.1.2.1 Climatic Conditions

The country is mainly subtropical, and hence experiences a subtropical climate defined by a wet season (November to April) and a dry season (May to October) (Zulu, 2017). During the wet season, rainfall averages of 400-1200mm per annum. This is followed by a cool and wet season between May and August, and later a hot and dry season from August to October (GoM, 2015a). Variations are however observed across the country with the northern and southern regions usually experiencing an early onset. The central mid-latitudes' rainfall ranges from 600-800 per Annum, and the central highlands range from 800-1000. Low lying areas can, however, experience rainfall of about 400mm per annum while highlands, on the other hand, can experience over 2500mm per annum (Vincent et al., 2014). Average temperatures in the country range from 18 to 27 degrees Celsius, again taking into account spatial variations across the country. Locally climate is influenced by terrains and lake effects. The ICTZ and the ENSO are the 2 global weather systems that affect the local climate (Zulu, 2017).

3.1.2.2 Biophysical Vulnerabilities

Reliance on rain-fed agriculture is one of the key vulnerabilities that the country faces (Magrath & Sukali, 2009). Shifts in precipitation resulting in flood or drought events that immensely affect food security in the country have become more frequent and intense (Zulu, 2017). The country has also been experiencing an increase in the intensity and frequency of weather-related disasters that also contribute to impacts in agriculture production cascading into income, livelihood, and economic impacts (Vincent et al., 2014). The country’s economy is also affected by fluctuating flood and drought events. In addition to this, climate-related disasters are associated with some of the highest impacts on loss of life and property in the country (Jeanne Yekeleya Coulibaly et al., 2015). High inter- and intra-annual precipitation variation in the country also causes undesired impacts in agricultural production (Grist, 2015). Increase in temperature characterised by hotter dry seasons, increased prevalence of flood and drought events as well as inter-annual rainfall variability (Maganga & Malakini, 2015)

3.1.3: Socio-economic Setting

3.1.3.1 Political and Administrative Setting

Malawi is a democratic nation. The political structure includes the ruling party and opposition which are jointly key players in the policy process. Civil society and other non-governmental organisations also play a key role in the policy process. The country is divided into three regions: northern, central, and southern regions which encompass the 28 districts in the country. The Ministry of Agriculture Irrigation and Water Development at the national level is divided into six departments (Animal Health and Industry; Agriculture Extension Services; Agriculture Research Services; Irrigation and Water Development; Land Resources Conservation; Fisheries; and Crop Production) (Kaarhus & Nyirenda, 2006). the Department of Crop Production is the main section under which this research falls, however, it integrates aspects of the other departments as well. The next hierarchical level is the Agricultural Development Divisions (ADD) that are in eight of the 28 districts, but each handles the key department duties of a set of districts each. Under the ADDs falls 28 District Agricultural Development Offices found in each of the districts in the country. these are further divided into 154 Economic Planning Areas that are further divided into sections (Chinsinga, 2009). Karonga is found in Karonga ADD which comprises of Karonga and Rumphi Districts.

3.1.3.2 Policy Framework

The MNAP 2016 is currently the key guiding framework for managing agricultural production in the country. It was designed to promote the transformation of agricultural production in the country from subsistence to commercial production (GoM, 2016b). Apart from this policy, the sector also has several other frameworks to guide elements of agricultural production in the country. The Agricultural Sector-Wide Approach Project (ASWAP) is also another key framework that was implemented from 2011-2015 and is currently being reviewed (FAO, 2014). The ASWAP was designed to aid the implementation of various activities in the agriculture sector, and also the direct investment in the sector to achieve agricultural goals and poverty reduction goals as directed by Malawi's MDGs (Janet et al., 2016). The Revised National Seed Policy is yet another policy framework that guides the agriculture sector particularly with regards to the development and improvement of seed to support sustainable agricultural production in the country (Chinsinga et al., 2012). In a bid to promote the productivity of resource-poor farmers, the government also implemented the Farm Input Subsidy Programme which increases the ability of the said farmers to access vital inputs for their agricultural production activities (Nkhoma, 2016). Nationally, the MGDs and the SDGs work to link national development agendas with regional and global agendas and it has been elemental in the development of the current MNAP 2016.

3.1.3.3 Socio-Economic Vulnerabilities

The country is classed as one of the poorest countries in the world based on the 2017 Human Development Index (World Bank, 2019). It has comparatively low literacy levels and low accessibility to required social services across the country (FAO, 2014). Reliance on agriculture as a core source of economic development puts the country at risk from climate-based impacts. Over 90% of agricultural production is rain-fed which exposes vulnerabilities to climate variability (Coulibaly et al., 2015). Apart from this, the agricultural sector is comprised of over 70% of smallholder farmers who rely on agriculture as a main source of livelihood. This is one of the biggest socio-economic vulnerabilities in the sector as production is characterised by low input and low production rain-fed agriculture which does not contribute much beyond subsistence (Grist, 2015). Reliance on specific crops like maize as a staple food further puts the country at risk. High population growth also affects access to social amenities.

3.2: Conceptual Framework

Figure 5 is the conceptual framework for the study.

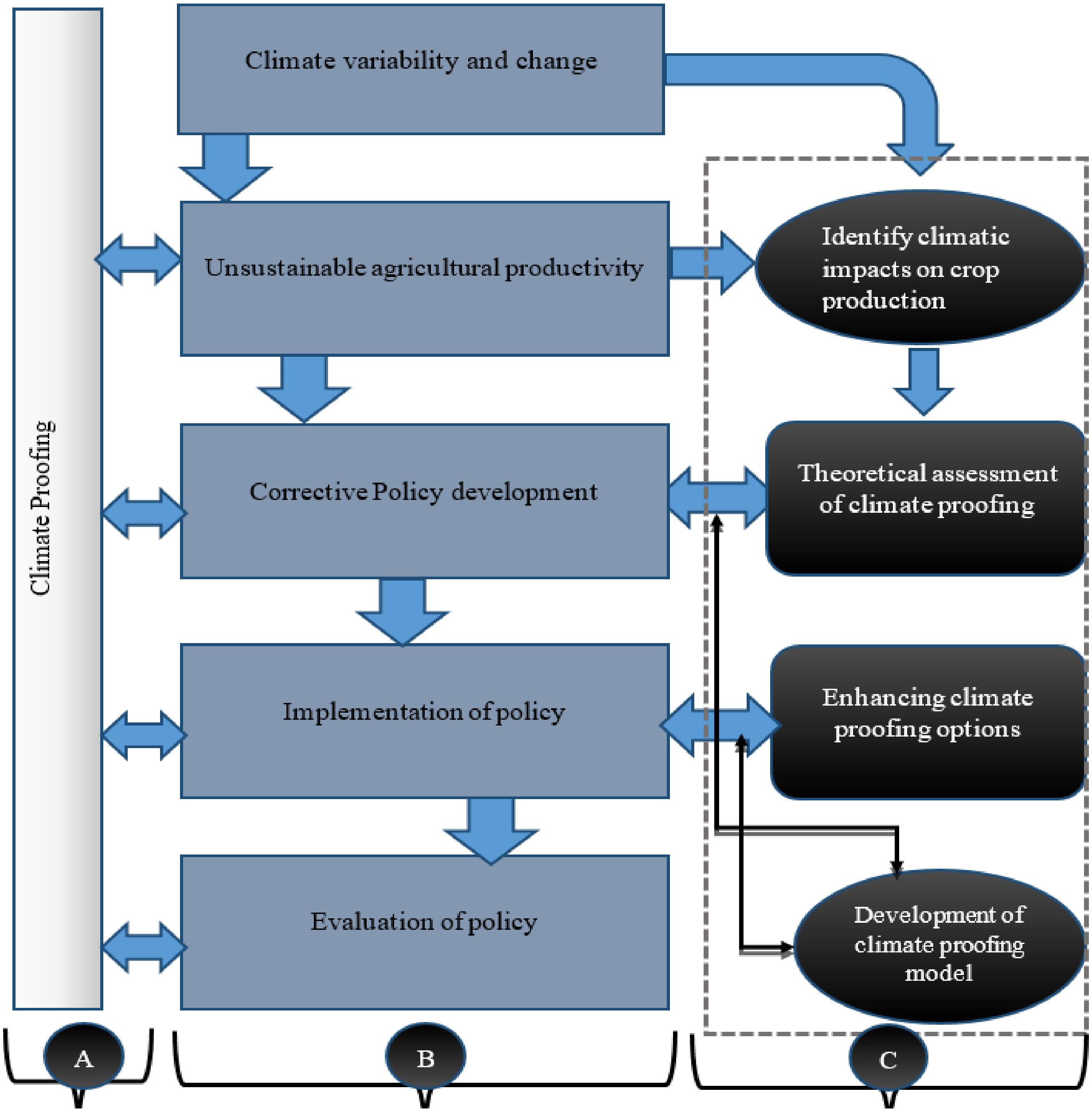

Figure 5: the conceptual framework for the study which outlines the key elements of climate proof a policy which is guiding formation of the study

The study assessed 2 of the key intervention points from which climate-proofing (depicted as A in figure 5) can be done throughout the agricultural policy development process summarized as B. The pathway of the research and the relation to the policy process is shown in component C of figure 5. The key intervention points for these impacts include the development of policy that takes into account climate change and its impacts. Climate proofing can be done at different stages of the policy process; this study focused on how it can be incorporated by focusing on strategies developed to employ sustainable rice production in the sector.

Agricultural research faces some challenges which affect the ability to adequately inform policy and practice. These include: ineffective collaborations and synergies among researchers, policymakers, and other key stakeholders; inadequate and limited technical and financial capacity of the agriculture sector; and limited logistic support and poor format of dissemination of research messages for policymakers to find useful (Jerven, 2013).. There is a need to harmonise all agricultural sector policies to mainstream climate change issues in order to influence practice and reduce duplication of efforts in addressing climate change issues. There is also a need to harmonise the agricultural policies with policies dealing with other sectors such as environment and water resources. These can collectively contribute to reduction of impacts of climate change on agriculture while also contributing to the achievement of assorted development goals contribution to overall country goals (Hahn & Frode, 2011).Climate proofing informs climate risk reduction in this approach by integrating climate change into projects, programmes, and policies.

3.3 Methodology

3.3.1 Introduction

Objective one utilised trend analysis to simulate climatic impacts on rice production. The second objective employed qualitative document analysis. The last objective used surveys to assess how strategies devised under the MNAP 2016 are contributing to adaptation based on the farmer and expert perceptions and targeted key informant interviews to assess the coherence between actual implementation activities and the strategies devised by the policy.

Objective 1: Analyse the climatic change risks associated with rice production

This objective used past trends (1986-2016) to map climate sensitivities of rice production and establish climatic-based vulnerabilities to rainfall, maximum temperature (T_{max}) and minimum temperature (T_{min}) which can be considered for sustainable production to be enhanced. These are attached as annexes 1 and 2.

Desk Top Studies

Secondary data between 1986 and 2016 were collected from the Department of Climate Change and Meteorological Services (DCCMS). This was mapped against the production and yield of rice (yield per ha) for the same period. Rice production estimates for each growing season were collected from the Department of Crops at the MAIWD. Literature review and key informant interviews were also used to triangulate the results.

Field Work or Field Studies

Key informant interviews with open questions were used to identify other stressors that could have led to impacts in the past, as well as to verify findings (this was combined with questions from objective three). Interviews were done with selected climate and agricultural experts from the MAIWD and development partners from the ICRISAT at the national level. These were identified through cluster sampling to identify experts to be sampled based on the outlined development partners in the MNAP 2016 and through the interviews with MAIWD officials. Key informants consulted are listed in table 1.

Data Analysis Section

Microsoft Excel was used to map and graphically present trends in climatic variables and rice yields. Regression analysis was used to determine the strength and direction of the linear relationship between the two climatic stressors and rice yields. Rainfall and Temperature were the independent variables while rice yields were the dependent variable. This computation was carried out in SPSS. The following formula was used for regression analysis:

$$Y = f(X_i\,\beta) + e_i$$

Where:

Y = Independent Variable (Rainfall/Temperature)

X = Dependent Variable (Rice Yields)

β = regression coefficient

e = expected random error term

Pearson's correlation was used to test the strength of the relationship and to make a statistical decision of the relationship. Lastly an assessment of 3 sigma limits of the variation of climatic variables was done.

Objective 2: Analyse climate-proofing inclusion in the MNAP 2016

This objective assessed the climate-proofing needs of the MNAP 2016. The tool employed was Qualitative Document Analysis (Wach et al., 2013).

Desk Top Studies

Initially, the proposal outlined that one QDA was going to be used to achieve this objective. However, it was later realised after the first assessment that a second QDA was required to provide an in-depth understanding of the level of climate-proofing incorporation in the policy. The first QDA was assessing general reference to climate change in the MNAP 2016. This was done by assessing whether the policy referred to some of the key terms used in climate change, and the degree to which these terms were relevant to the policy goals. A scale of between 0 and 3 was used to assess the relevance of the keywords to the policy, with 3 signifying the highest possible score (Appendix 3). The following is the process approach:

1. Identification of key words in relation to climate change through search function in excel
2. Assessment of the relevance of their mention in relation to the sentence or paragraph or section in which they appear
3. Mention and area of occurrence in the policy document recorded in an excel sheet and scoring done immediately.
4. Graphical presentations and analyses were done last

The second QDA was designed to assess the coherence of strategies devised under different priority areas in the policy to climate-proofing principles (Appendix 4) . The assessment adopted the framework devised by Fünfgeld & McEvoy (2013) which outlined approaches that can be used to assess impacts based on hazards, risks resilience and vulnerability towards the implication to observed or anticipated risk. Thematic areas of climate-proofing were developed to assess whether hazards, risks and opportunities for resilience had been effectively taken into account (Theme 1: integration of climate change impacts; Theme 2: Consideration of current challenges of climate change; Theme 3: Consideration of Future Climate Change Challenges; Theme 4: Exploiting current opportunities of climate change: Theme 5: Exploiting future opportunities of climate change). The development of thematic areas was done through reviewing published literature quoted in this document. The thematic areas were used to assess the coherence of the policy with climate proofing guidelines. This was assessed with a scale of between 0 and 2 with 2 signifying the highest possible score This involved:

1. Development of thematic areas that determine adaptation
2. Extraction of strategies from MNAP 2016 and sorting them in an excel fill
3. Reviewing strategies to isolate specific strategies dealing with sustainable production of rice production
4. Assess the strategies based on the thematic areas devised
5. Analysing the results developed and developing approaches

This is adapted from the process for qualitative document analysis that has been used for climate-proofing policy in Schipper & Pelling, (2006). This was used to assess and develop a framework of how climate change adaptation and mitigation can jointly be applied to achieve development goals. In addition, the coherence of the policy with Malawi's National Adaptation Plan, National Resilience Policy, the NCCMP and the DRMP 2015, were also assessed.

Data Analysis Section

The main analysis was to grade the ability of the policy to inform adaptation by using selected thematic areas to map contributions of strategies to adaptation either as a response to impacts or in anticipation of impacts. Frequency tables were developed for the first QDA and analysed in

Microsoft Excel. Microsoft Excel was also used to assess the level of coherence for the second objective. The results were then statistically analysed in SPSS using cross-tabulations to show the counts of different themes against the level of significance.

The comparisons between the MNAP 2016 and other national climate risk reduction policies were done and presented using a matrix generated in Microsoft excel.

Objective 3: Investigate the relevance of strategies devised by the MNAP 2016 in relation to the climate-proofing of rice production.

The ability of the strategies in the MNAP 2016 to result in desired practices that inform the reduction of the impacts of climate on the farmers was assessed in this objective. This was done through a cross-sectional survey of rice farmers to assess their perception of the practices with regards to climate change adaptation (Questionnaire template in Appendix 5). Desired practices being advocated for sustainable rice production were identified through consultations with key stakeholders involved in agricultural research and development initiatives (practices such as fertilizer application and growing early maturing varieties were highlighted).

In addition to this, the study also assessed the level of institutional consistency to climate proofing the sector. Implementing adaptation options requires a variety of criteria including information, capacity, financial resources, institutions and technologies (Burton et al., 2006). Herr, Himes-Cornell, & Laffoley, 2016; & Hjerp et al., (2012) also identify legal requirements in addition to criteria outlined by Burton et al (2012). This study integrated these criteria and elements from the strategies assessed under objective 2 to develop a key informant interview guide for government and development partners involved in activities that contribute to climate risk reduction in crop production (Appendix 6). This objective also assessed how the policy has resulted in the development of new practices aimed at achieving specific strategies and also assessed the level of implementation of those strategies.

Desk Top Studies

The main desktop studies were reviewing of various data to on extreme climatic events that was to be used to tally with climate-based impacts for development of questionnaires

Field Work or Field Studies

1. **Survey Interviews**

The survey targeted extension workers and farmer households to establish activities that are being done to achieve each of the strategies under the MNAP 2016.

a) Development of the questionnaire. The questionnaire was developed based on the strategies that were assessed under the QDA in objective 2
b) Integration of the questionnaire into kobo-toolbox and kobo-collect. This included testing of the questionnaire in line with desired results
c) Sampling: key informant interviews were used. The selection of participants employed a multistage sampling for farmer households. At the district level, five out of the six Extension Planning Areas (EPAs) in the district were selected. The sixth EPA was not included in the survey because rice is sparsely grown in that EPA. The EPAs were the primary sampling unit. This was then followed by purposive sampling were rice farmers, with more than 10 years of rice farming experience were selected (snowballing was used to some extent in identifying other farmers to interview within the EPAs). Karonga has different types of farmers, and records are kept for only farmers in certain groups or cooperatives, but no record of crops grown are kept. The extension officers in each EPA facilitated the identification of farmer households that met the criteria and snowballing sampling was used to identify additional farmers until data saturation was achieved
d) Data was collected by concentrating on one EPA at a time and uploaded to the kobo-toolbox sever immediately or at the end of each day where internet connections were not available
e) The data was downloaded from the server and sorted in excel for graphical presentations and assessments in SPSS

2. **Key Informant Interviews**

Targeted interviews were done with key personnel at the national, district and community levels that were involved in the development of policy process and climate change adaptation experts in the country. These were aimed at determining the translation of policy strategies into implementation activities and assessing the degree to which the needs of climate proofing can be met at each level of the implementation process.

The following was the process approach for key informant interviews.:

a) Development of interview guide
b) Identification of informants relevant to climate change integration and rice production. This was done based on the list of stakeholders listed against strategies in the policy document and feedback from the ministry of agriculture. One person was interviewed from each organization or district office identified. This was mainly directed to the personnel responsible for contribution to development or active implementation of the MNAP
c) Experts were interviewed to determine the degree to which the policy theoretically informs climate proofing of the agriculture sector
d) Transcribing and analysing key feedback.

Table 1 List of Organization consulted:

National Level	District Level	Community Level
1. Ministry of Agriculture Irrigation and Water Development -Department of' -Department of Land Resources and Conservation -Department of Planning -Department of Crop Production -Department of Agricultural Research Services	1. Ministry of Agriculture, Irrigation and Water Development - District Agricultural Development Officer - Crops Protection Officer Lifuwe Research Station	1. Agriculture Extension and Development Officers: -Kaporo North EPA -Kaporo South EPA -Vinthukutu EPA -Lupembe EPA -Nyungwe EPA
2. National Smallholders' Association of Malawi		
3. ICRISAT		
4. Civil Society Agriculture Network (CISANET)		
5. Community Savings and Investment Promotion (COMSIP)		
6. World Agroforestry Centre (ICRAF)		

*(One personnel was interviewed from each organization, except at Lifuwe Research Station, where 3 people were interviewed)

Data Analysis

Data collected was sorted in excel files and cross-tabulations in SPSS were used to summarise the results by highlighting key climatic impacts faced and perception of the relevance of various practices towards reducing them. Graphical outputs were exported to Microsoft excel for graphical representations. Responses from the key informant interviews were grouped and coded to match responses from the survey for triangulation purposes.

After analysis of all elements of this study, a detailed process model was developed. The general climate-proofing framework is key to the development of terms for the needs assessments for executing climate proofing. For each stage in the model climate-proofing needs were discussed using the framework to highlight the key needs. The assessment of the effectiveness of the strategies under the MNAP 2016 was then used to further highlight the climate-proofing needs with regards to any potential impacts to be expected under different climate futures.

CHAPTER FOUR: Results and Discussions – Objective One

The section presents results and discusses the findings for objective 1.

Objective 1: Analyse the climatic change risks associated with rice production

4.1 Introduction

Climate is one of the factors that influence the growth and development of rice and therefore the yields (Oort et al., 2017). Understanding the sensitivities is important for climate-proofing production. This chapter presents the results of the first objective that sought to identify sensitivities as a result of temperature and rainfall. Rice grown in Karonga is grown in rainy and winter seasons. The rainy season is mainly used to grow long maturing varieties such as Kilombero and Faya. The winter season is used for shorter maturing varieties such as Senga, Pussa and TCG10 which take about 90 days to mature. Kilombero and Faya are the preferred species in the district because of their aroma, market and cultural significance. They however only flower during the rainy season hence are not applicable for winter cropping. Understanding the local sensitivity of rice serves two purposes. The first is to show the sensitivity of rice to climate. The next is to depict the changes in trends for the benefit of planning future interventions.

4.2 Results

This objective employed trend analyses as have been highlighted in chapter 3. The data used for this analysis is attached as appendices 1 and 2 of this report. Figure 6 is a graphical representation of seasonal rainfall and the total rain-fed rice production estimates.

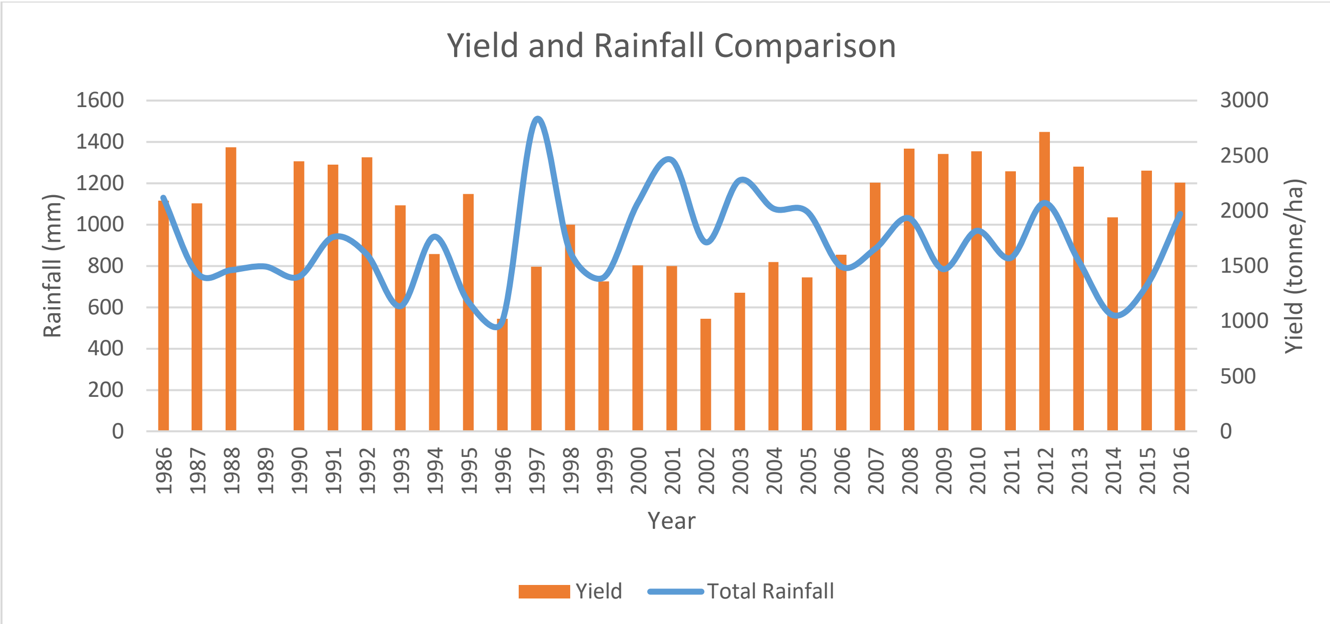

Figure 6: The relationship between rice yield and rainfall for Karonga between 1986 and 2016. Source: excel output from data analysis 2018

Rainfall in Karonga varied between 500mm per annum and 1500mm per annum in the assessment period. The data suggests an increase in the average annual rainfall. However, between 2009 and 2016, there has been an observable increase in below-average rainfall events that coincide with a reducing trend of yields. There has been an increase in yields from 2094.11 (tonnes/ha) at the beginning of the study period to 2255.83 (tonnes/ha). However, production increased from 10414.00 tonnes at the beginning of the study period to 26691. 00 tonnes at the end. This was mainly attributed to increase in cultivation areas.

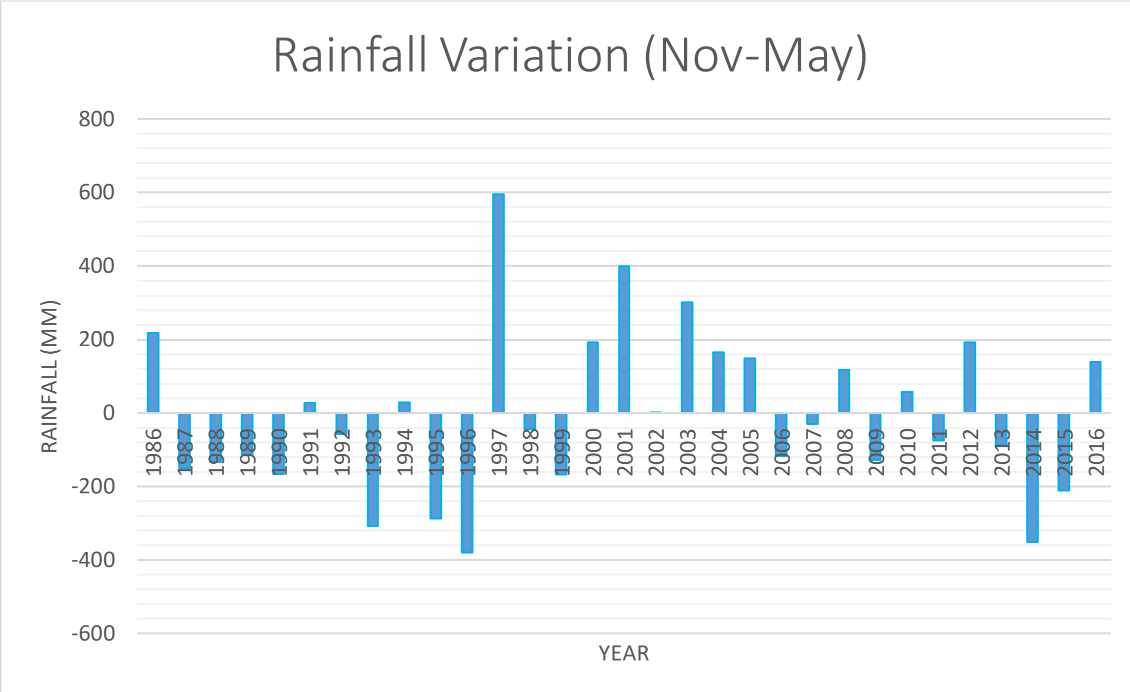

Figure 7: Annual rainfall variation from the expected mean (November to May of the entire study period (1986-2016)). Source: excel output from data analysis 2018

Figure 7 shows the deviation of rainfall from the expected mean of 913mm. the variation has a standard deviation of 222.67 which shows that the rainfall varies widely from the desired mean. This spread is a key concern for water availability. It also depicts how much annual variation in rainfall is to be expected.

The graph below (cross reference) shows monthly rainfall averages depicted across 3 standard deviations. Rainfall trends vary beyond sigma one and negative one, which is the expected normal deviation range of within 68 per cent of all variation. Some rainfall extremes depict values beyond sigma +3 which shows wider variation that is expected to be less than 0.3% of all variation.

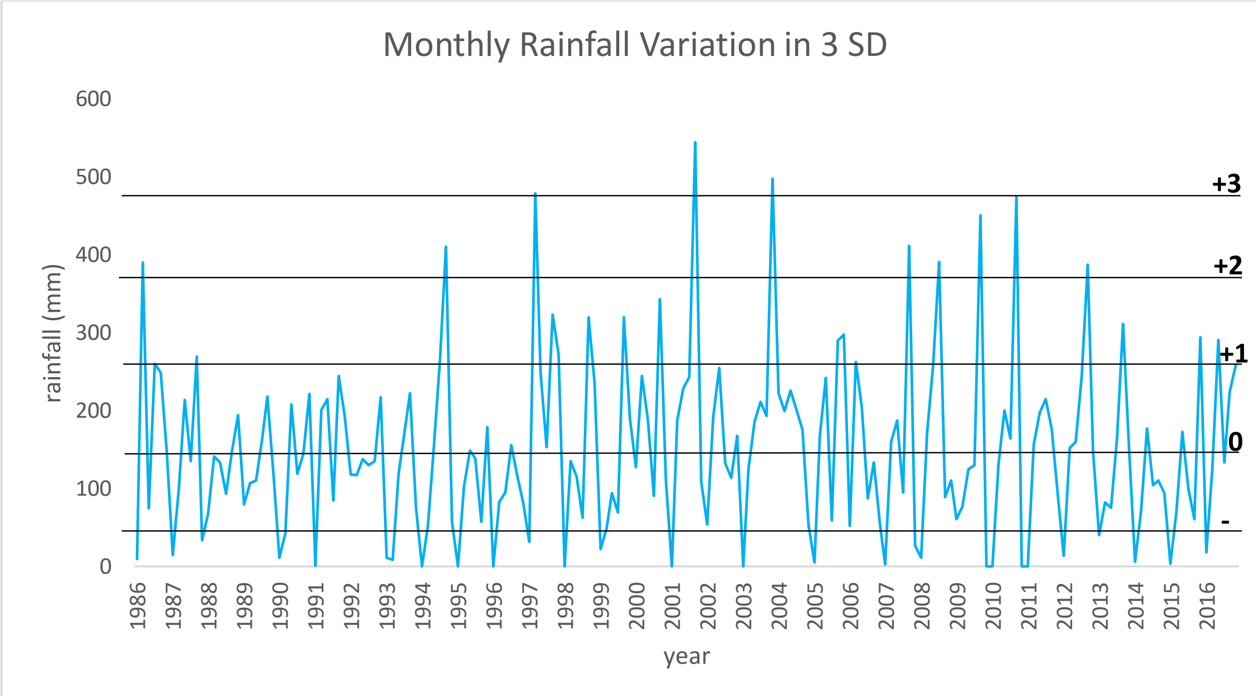

Figure 8: Monthly rainfall averages plotted against 3 standard deviations (data from 1986-2016). Source: excel output from data analysis 2018

Rainfall events observed that were beyond +1 sigma depict increasing occurrence from the late 1990s which suggests an increase in the variation beyond expected rainfall variation that should fall within +1 and -1 sigma which accounts for 68% of all variation.

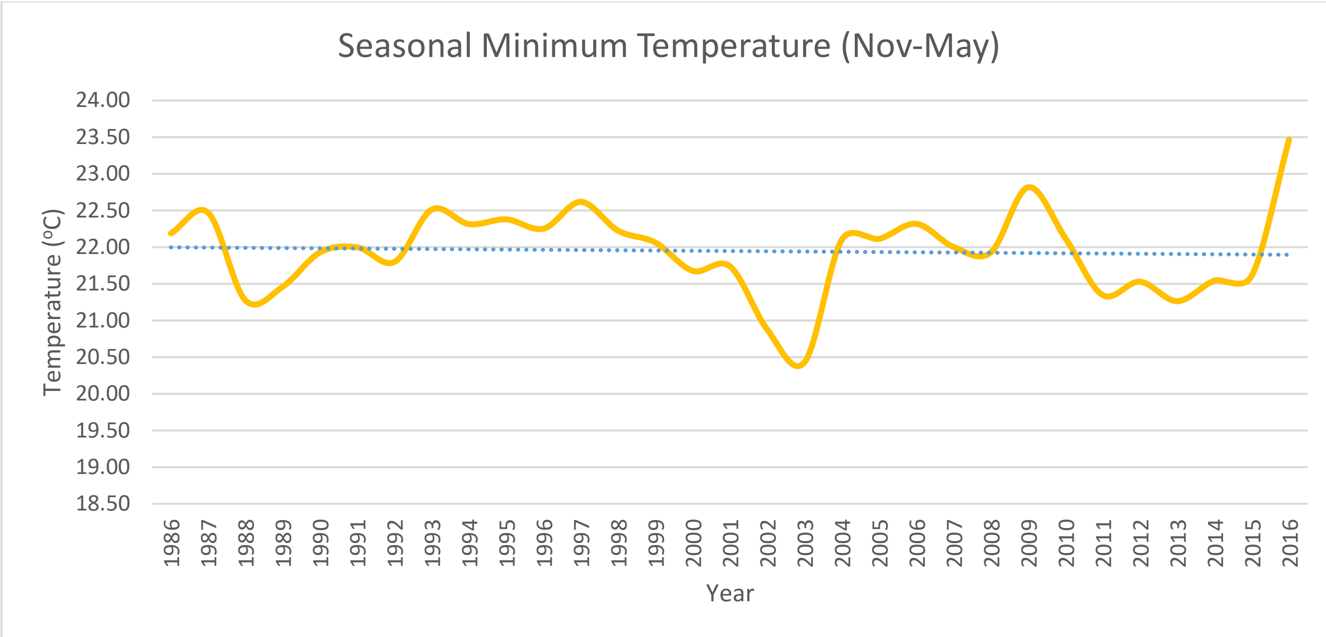

Figure 9: Seasonal minimum temperature trends for the rice-growing period (November to May 1986-2016). Source: excel output from data analysis 2018

Karonga's annual temperatures range from 18 to 35 °C. The rainy season experiences some of the warmest temperatures. The average T_{min} for the assessment period was 21.95 °C. T_{min} temperature (ranges: 20.43 °C to 22.82°C) for the selected season in the entire study period depict a decreasing trend where the district has been getting colder minimum temperatures over time. The variation in the minimum temperatures is however a concern, as Figure 10 depicts. There are sections of consecutive years that are showing below average T_{min} seasonal averages. For instance, between 2011 and 2015, the district experienced below-average T_{min} with differences of up between 0.3 and 0.7 °C. Minute temperature changes are a cause for concern and therefore need to be carefully considered when incorporating climate change into policies.

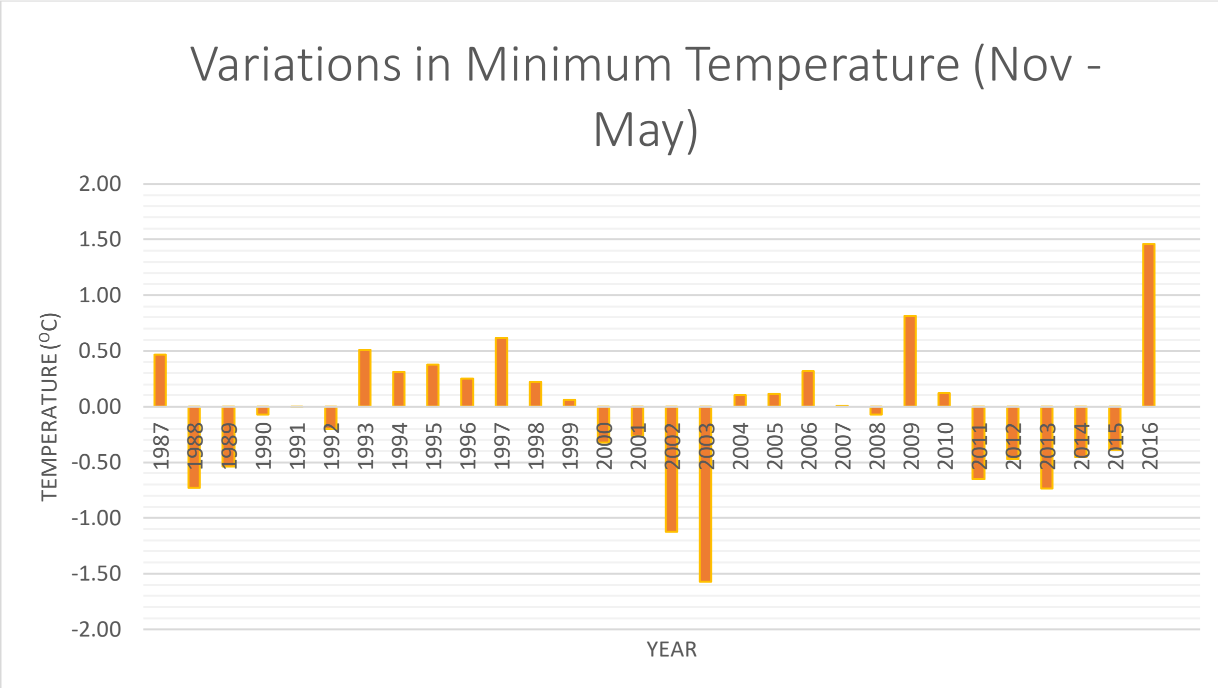

Figure 10:Minimum temperature variations from expected annual mean ((November to May 1986 to 2016). Source: excel output from data analysis 2018

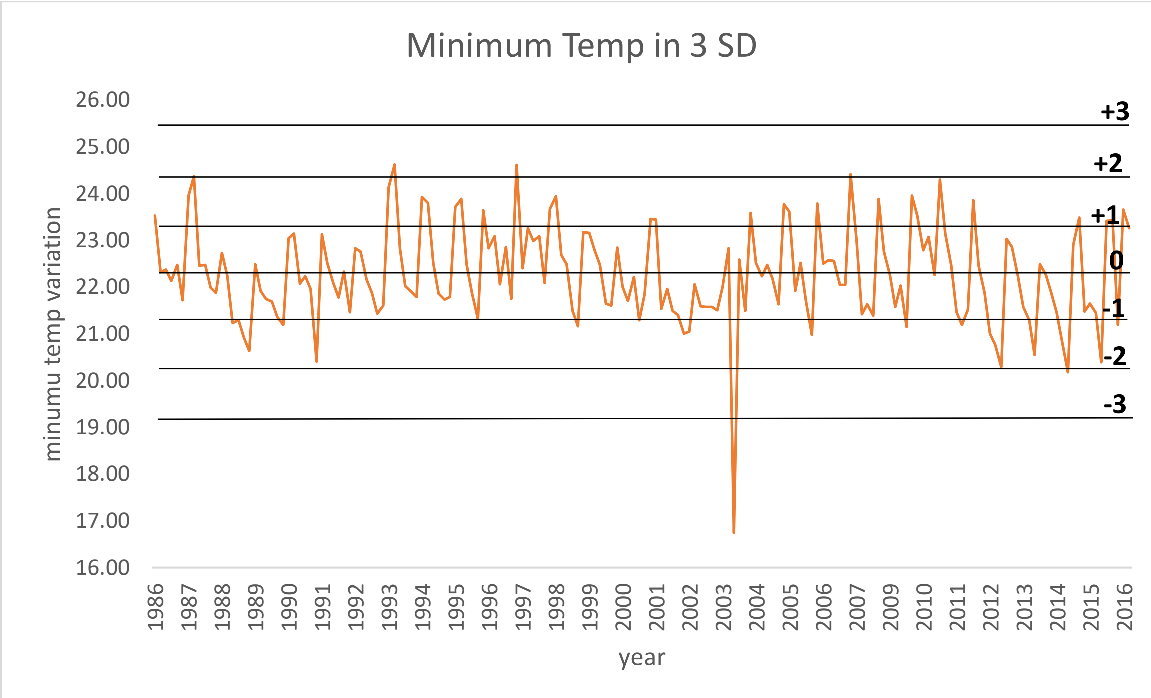

Figure 11: Minimum temperature variation plotted against three standard deviations (November to May 1986 to 2016). Source: excel output from data analysis 2018

The variation of monthly minimum temperatures is showing decreasing trends with variations between 2010 and 2016 going beyond -1 sigma and slightly beyond -2 sigma (Figure 11). This is beyond the expected 68% variation from the mean which would be considered normal. Extreme cold events interfere with the growth and development of rice crops which can result in lower yields.

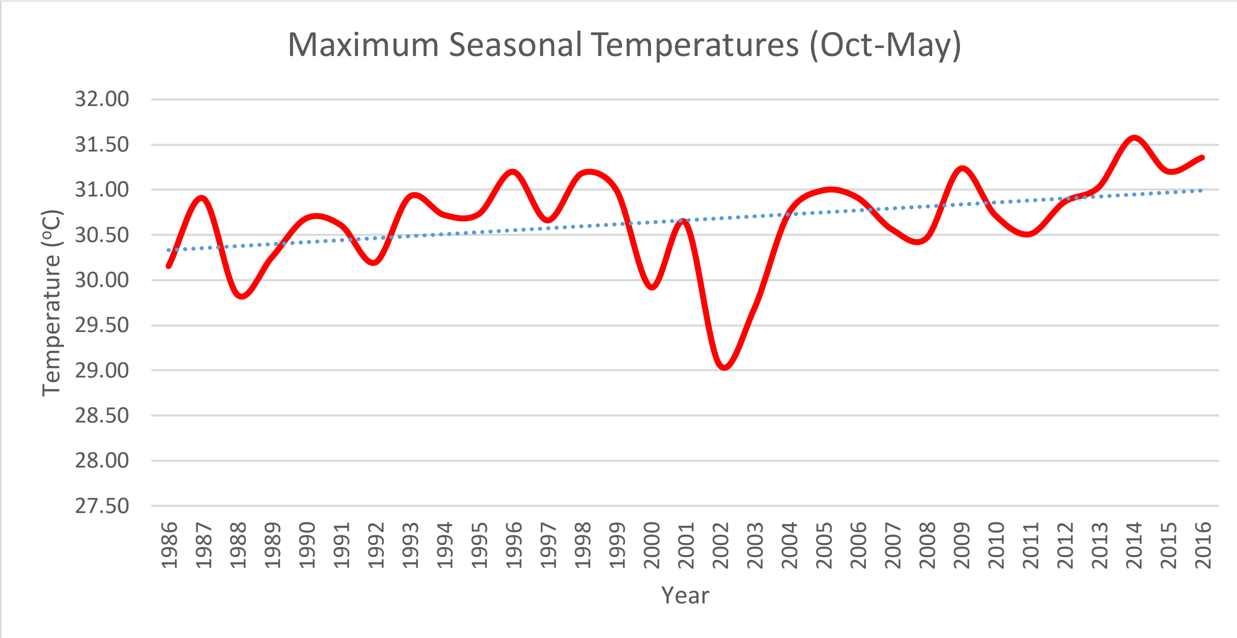

Figure 12: Seasonal Maximum temperature trends for the growing season (November to May 1986 to 2016). Source: excel output from data analysis 2018

Figure 12 shows that maximum temperatures are increasing in the district with an increase of 0.7ºC in the average T_{max}. Both T_{max} and T_{min} have a standard deviation of between 0.5 and 1 which is considerably high for temperature

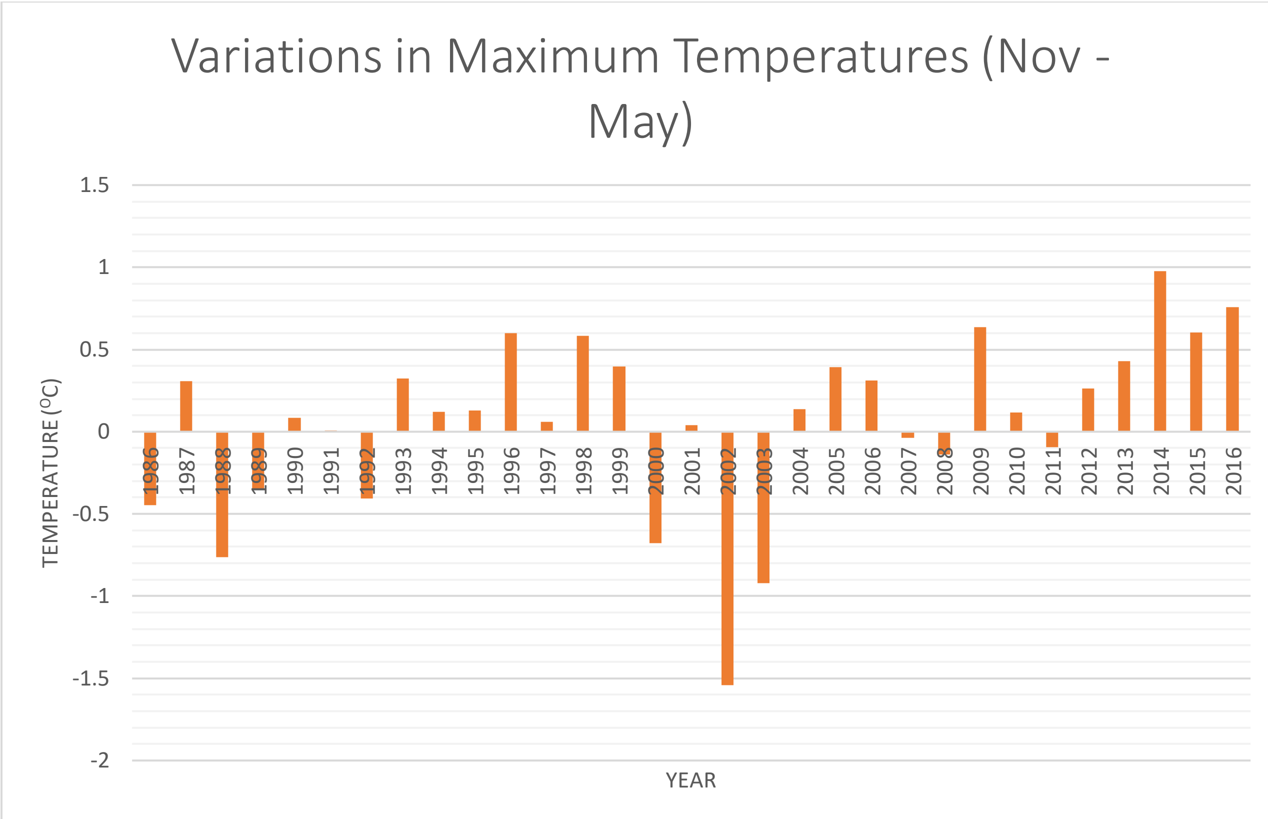

Figure 13: Maximum temperature variations from expected mean. Data from November 1986 to 2016. Source: excel output from data analysis 2018

Between 2010 and 2016, the observed annual temperatures have been above average for all but the year 2011. This coincides with observed global temperature increases with the hottest years having been recorded in the past 7 years. The climatic impacts of concern in the district therefore hail from shifting temperature averages as well as variation in rainfall events that make unreliable agricultural production hard to determine.

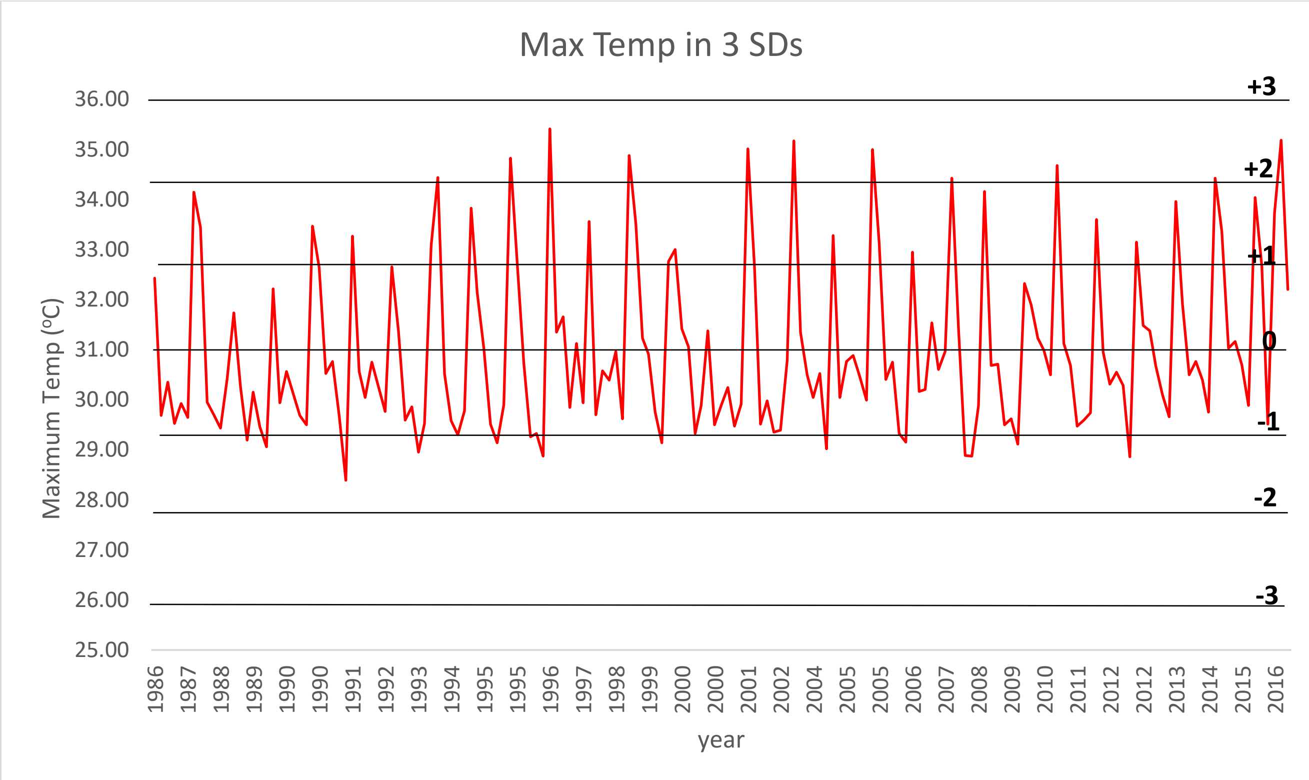

Figure 14: maximum temperature variation plotted against three standard deviations (November to May 1986 to 2016). Source: excel output from data analysis 2018.

The maximum temperatures for Karonga districts depict an increasing trend. The monthly averages are increasing beyond the +1 sigma which is the boundary of normal expected variation.

The multiple regression analysis of the weather parameters and yields had an R^2 of 0.110 which showed an insignificant level of variance in crop yields in the assessment period as a result of variation in the weather parameters.

Table 2: summary of statistics as extracted from SPSS

Values	Temp max	Temp Min	Rainfall	Total Yield	Total Rice	Total Irrigated	Total Yield Irrigated
Mean	31.14	21.94	909.61	1978.45	15778.07	4834.56	4224.24
Median	31.12	22.04	869.60	2079.85	13127.50	4989.50	4408.26
minimum	29.06	20.43	532.00	1021.81	4459.00	2200.00	2908.89
maximum	33.75	22.82	1508.50	2713.75	32337.00	6470.00	4692.59
Range	4.69	2.39	976.50	1691.94	27878.00	4270.00	1783.70
Std. Deviation	.93	.53	219.92	507.75	7647.55	1176.11	479.92

4.3 Discussion

Rice production can be affected by a range of factors for which climate variability is one (Achiase & Aninagyei, 2014). The rainfall in Karonga varies above and below a 913mm annual expected average for the assessment period. Figure 8 highlights aggregated monthly changes in rainfall in the targeted years for this assessment. An increase in rainfall extremes, particularly above a normal standard deviation of +1 and -1 sigma is observed. This potential alludes to above and below average rainfall events. Such rainfall events that affect rice production through floods and other water-related damages that are among the most common impacts of rice production (Terdoo & Feola, 2016). The variation in rainfall is a concern for rice production especially since extreme rainfall events have been associated with a reduction in production despite all other production factors (Daccache et al., 2014).

There is an increase in rice yields in the target areas as observed in Figure 6. This is attributed mainly to an increase in area under rice production. This study did not establish whether the increase in yields is sufficient for the growing demand of rice. However, impacts being experienced by as a result of climate change are captured in the 3rd objective. The comparison of trends with rainfall however shows years with extreme rainfall events (high/low) coincide with low rice production rates. A significant linear relationship was not established between rainfall and actual changes in production, (R^2 was 0.110 for multiple regression). Pearson's correlation between rainfall and total yields depicts a -0.180. This shows that an increase in rainfall causes a slight decrease of 18% in yields of rice crop during the summer seasons. Despite this being insignificant, observed shifts from the normal range were depicted in the 3 sigma graphical presentations. Unsustainable yields are a key concern for livelihood, food and nutrition security for the smallholder farmers, and can contribute to increased vulnerabilities (Oort & Zwart, 2018). Climate proofing the production through the relevant policy can therefore present an opportunity to effectively integrate climate sensitivities and reduce agricultural risks as a result of variations in climate.

The increasing trend average in annual rainfall is perceived as a desirable outcome in the face of climate change and agricultural production (Figure 6). However, the distribution of the rainfall can be a hindrance to production (Achiase & Aninagyei, 2014). Paddy rice grows well in inundated conditions (Badriyah et al., 2017). Nevertheless, this is not for the duration of the growing period and needs to be controlled. Above-average rainfall risks reducing yields by inducing crop rot after grains are mature and ripe for harvest. It can also lead to floods that wash away rice plants (Rahman et al., 2017). Figure 6 shows that some annual rice yields in the district coincide with extreme above and below-average annual rainfall in the period mapped. The impacts are however not limited to annual rainfall only. The distribution of rainfall across the season can also be a cause for variation (Achiase & Aninagyei, 2014). One of the key impacts in Malawi is the seasonal distribution of rainfall, where rainfall falls in unevenly distributed patterns that therefore affect optimal delivery of water for rice production (Jeanne Yekeleya Coulibaly et al., 2015). The variability is an issue of concern for production in the district as it affects yields and inferentially food, nutrition and livelihood security (Oort & Zwart, 2018). This hence needs to be considered in coming up with effective strategies for rice production that protect production and the human systems that rely on it.

Figure 7 shows a representation of the variation from the expected annual rainfall each year. The expected annual variation ought to be integrated in coming up with strategies that guide production so as to reduce the potential impacts on production and various human systems that rely on the production. This can be the basis for the development of appropriate water management strategies to ensure sustainable availability despite any variations.

Rice generally grows well between T_{min} of 21 °C and T_{max} of 35 °C (GRiSP, 2013). This is however subject to the region and the rice species in question. Exposure to extreme heat at the most sensitive stages of development can adversely affect yields (GRiSP, 2013). The sensitivity also includes differences in day and night temperatures and the stage of planting. The vegetative stage of rice can tolerate high temperatures of between 25 °C night temperature and 35 °C day temp degrees Celsius (Shamshiri et al., 2018). This makes it perhaps the most resilient phase of production. The transplanting stage is particularly sensitive to these shifts in temperature. These variations can result in reduced height, reduced tillering, and reduced spikelet formation. The reproductive phase is the most sensitive of the three (Olson et al., 2017). Heat stress for even just a few hours such as higher temperatures during night time can alter the productivity of the crop and negatively affect yields. High temperatures during the flowering could be negatively consequential for the flowering of the plant and therefore yields (Rathnayake et al., 2016). High temperatures exposure even for just a few hours can affect rice production by inducing sterility and therefore reduced seeding of tillers (Ghadirnezhad & Fallah, 2014). However, changes in any optimal weather conditions for rice production can affect crop productivity during the transplanting of rice from the nursery to the fields (GRiSP, 2013).

The analysis for both T_{max} and T_{min} shows a widening range of temperature ranges with an increasing T_{max} and decreasing T_{min} which is uncharacteristic of the district (8-13). Monthly T_{min} and T_{max} aggregated averages vary beyond +1 and-1 sigma which is outside what is expected of normal variation (Figure 11 and Figure 14). Such temperature variations, as is with rainfall, raises concern for production and consequently affect the lives of the smallholder farmers and the rice production chain reliant on it. Despite being seemingly minute, these are also a reason for concern as minute shifts in temperature have been known to have undesired impacts (Kim et al., 2016). A study on the sensitivity of rice to climate in the southern part of Malawi found that an increase in the frequency of hot days and an increase in high temperatures could result in a reduction of rice production by at least 50% (van Oort & Zwart, 2017).

The shifts in rainfall in the rainy season can affect winter cropping as well. A regression analysis was done for winter rice production against the rainfall in the rainy season depicted an R-value of 0.717 which shows that there is a high sensitivity of winter rice production to climatic factors mapped in this research. T_{max}, T_{min} and rainfall together explain at least 51% of the variation in rice production in the winter season. This is high given the fact that a lot of other factors determine the production of rice and maybe explained because of the sole reliance on river discharge for water. This also has implications on the adaptation strategies employed. Unsustainable water availability often leads to various water harvesting, storage, and irrigation intervention(Before et al., 2018). Adaptation strategies ought to take into consideration all impacts of climatic variables for all to avoid investment in adaptation options that remain sensitive to the climatic impact are developed.

A similar relationship was not as significant for summer cropping despite shifting climatic events with an R-value of 0.331 and the climatic factors explaining only 10 per cent of the variation (R^2 of 0.110). This is probably because of the variations in rainfall in the season, the type of cultivation fields used and also the high indirect climatic impacts on production that might not easily be captured through assessments, such as floods reducing fertility which might not be resultant in climate impacts of the particular year. Winter planting is done in somewhat controlled environments as opposed to summer cropping that is done in a variety of planting environments which might not be able to ably explain sources of variation or impacts. Reduction in yields for other areas in Malawi has however been linked to climatic impacts such as floods, drought, and dry spells that cannot be easily captured through annual trend analyses.

An additional assessment was done with beta coefficients in regression to remove possible errors that could come from variables being measured in different units. For all 3 independent variables, a certain level of impact was established. An increase in rainfall here contributes to a -0.133-standard deviation in observed yields. Increases in T_{max} and T_{min} contribute to 0.285 and -0.06 changes in the standard deviation of yields respectively. Despite these being regarded as low impacts, a study on of the future impacts of the parameters used in this thesis against rice yields showed that there are significant climatic variations in climate change are projected for Malawi which could have implications on rice production (Maganga & Malakini, 2015; Mwale & Adeloye, 2010). In addition to this, more focused research on isolated events on yields might produce different results. Some climatic impacts are therefore resulting in some changes in yields, and this poses a concern for rice production in the district.

4.4 Conclusion

Variations in the climatic variables assessed in this study have some impact on agriculture. These impacts were mapped for both the rainy and winter cropping season. The variation of temperature and rainfall beyond the optimal thresholds can result in physiological and physical stress and damage on the crop, which ultimately leads to reduced yields. This affects food, livelihood and nutrition security and is an issue of concern, particularly among vulnerable smallholder farmers. Climate proofing of agriculture policies can aid in reducing climate-based agricultural risks and therefore reduce undesirable shocks on human systems.

CHAPTER FIVE: Results and Discussions-Objective Two

The section presents results and discusses the findings for objective 2.

OBJECTIVE 2: Analyse climate-proofing inclusion in the MNAP 2016

5.1 Introduction

The MNAP 2016, as the main guiding framework for agricultural production in Malawi, ought to consider and incorporate all possible threats to agricultural production in the country. Climate change being one of the key threats to agricultural production ought to have been thoroughly considered in the policy. This objective sought to assess the degree to which the policy document is coherent with climate-proofing, and therefore answer the question of whether the policy is guiding climate proofing of the sector.

5.2 Results

QDA Part 1: Reference to Climate Change Terms

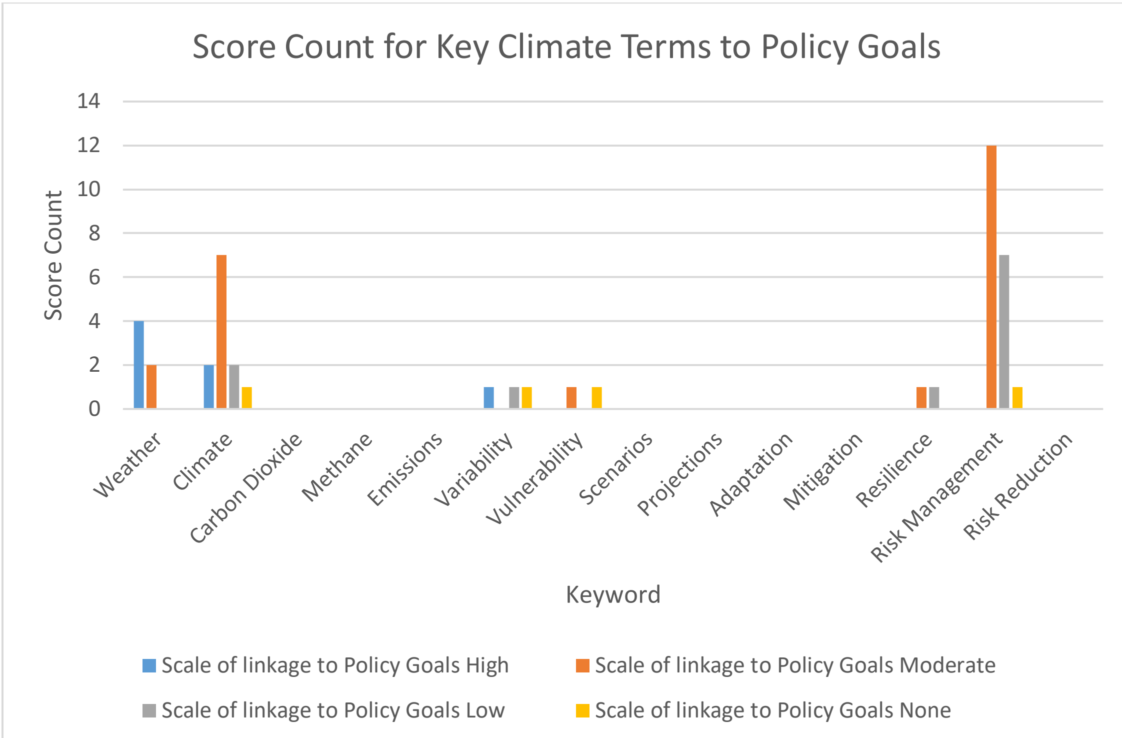

Figure 15: Score count of key words in the MNAP 2016 in comparison to their linkages to policy goals. Source: Excel output of data analysis 2018

For this assessment, 14 keywords were identified in reference to climate change. These keywords were selected from common terms used in various literature in relation to the physical basis of climate change, adaptation to climate change as well as mitigation of climate change. These are depicted in figures 15 above and 16 below. Of these keywords, only 6 appeared in the document.

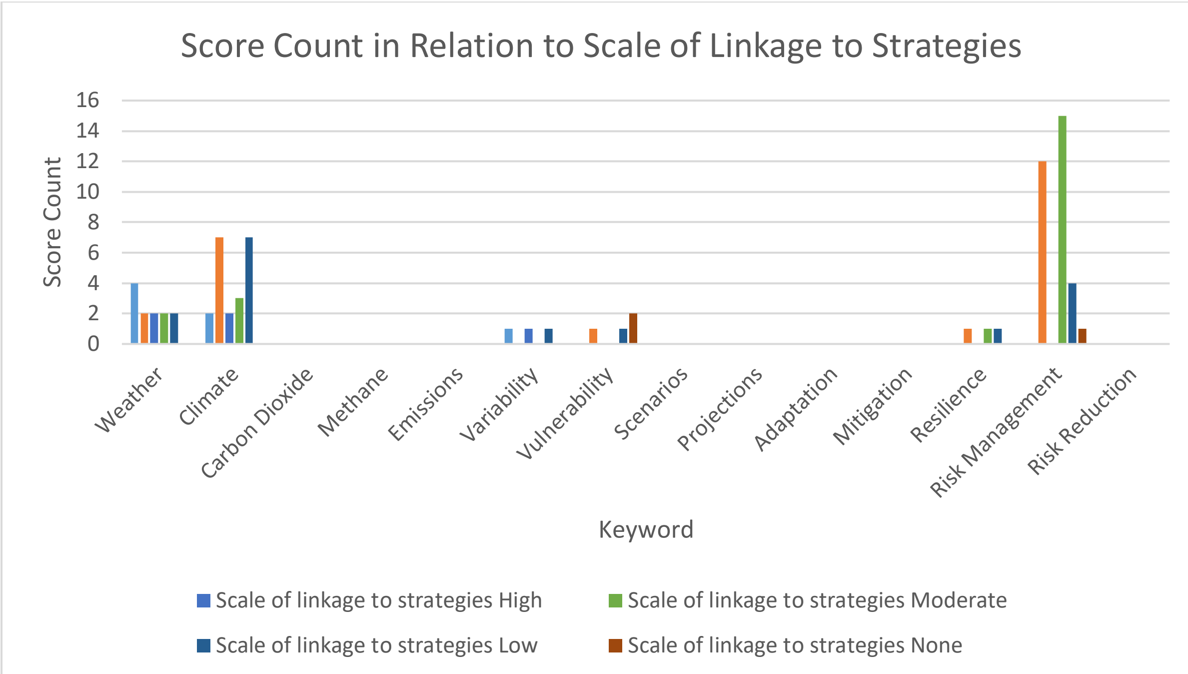

Figure 16: Score count of key words in the MNAP 2016 in comparison to their linkage to strategies. Source: excel output of data analysis 2018

Of these priority areas, keywords being evaluated only appeared in 2 of the priority areas namely: priority area 1 which focuses on Sustainable Agricultural Production and Productivity as well as in priority Area 6 which is on Agricultural Risk Management. Keyword occurrence in the two priority areas merged and the implementation outline section registered the highest values for the total occurrence of the keywords, each with 12, out of the total 54 occurrences of the keywords in the entire document. 7 of the 12 occurrences for priority areas registered moderate linkage or higher. On the other hand, 9 out of 12 of all keyword occurrences under the implementation outline scored moderate linkage or lower. Three introduction sections, despite having the second-highest presence of key words registered 7 out of the 11 occurrences being either low or no linkage to climate change-based actions. Similar trends were observed for the cross-tabulation between policy goal linkage and the section of the policy except for the introduction section which had 7 out of the 11 occurrences showing moderate or higher linkage to the policy goals.

QDA 2: Evidence of Incorporation of Climate Change.

The assessments for this QDA were done by first developing principles of climate-proofing which would be used to assess the level of integration in the strategies devised under the priority areas. The principles were developed by analysing various literature on climate proofing. The themes developed were:

Table 3: Climate proofing theme categorisation

Theme	Explanation
CCP 1: Integration of Climate Change Impacts in Planning	Reference/relation to particular climatic events and/or impacts e.g. floods, drought, temperature change, rainfall variability, low yields, etc.
CCP 2: Consideration Current Challenges of Climate Change	Relation of strategy to consideration of current climatic threats to reduce the overall impact on agriculture
CCP 3: Consideration Future Climate Change Challenges	Relation of strategy to consideration of future climatic threats to reduce the overall impact on agriculture
CCP 4: Exploitation Current opportunities of Climate Change	Relation of strategy to potential action of exploiting current opportunities presented by climate change for development and achieving policy goals
CCP 5: Exploitation Future opportunities of Climate Change	Relation of strategy to potential action of exploiting future opportunities presented by climate change for development and achieving policy goals

The policy has over 200 strategies divided among 8 priority areas. The study screened the strategies to select only 136 strategies that can indirectly or directly contribute to crop production since the case study is focusing on rice production. This section provides a brief presentation of results and discussions.

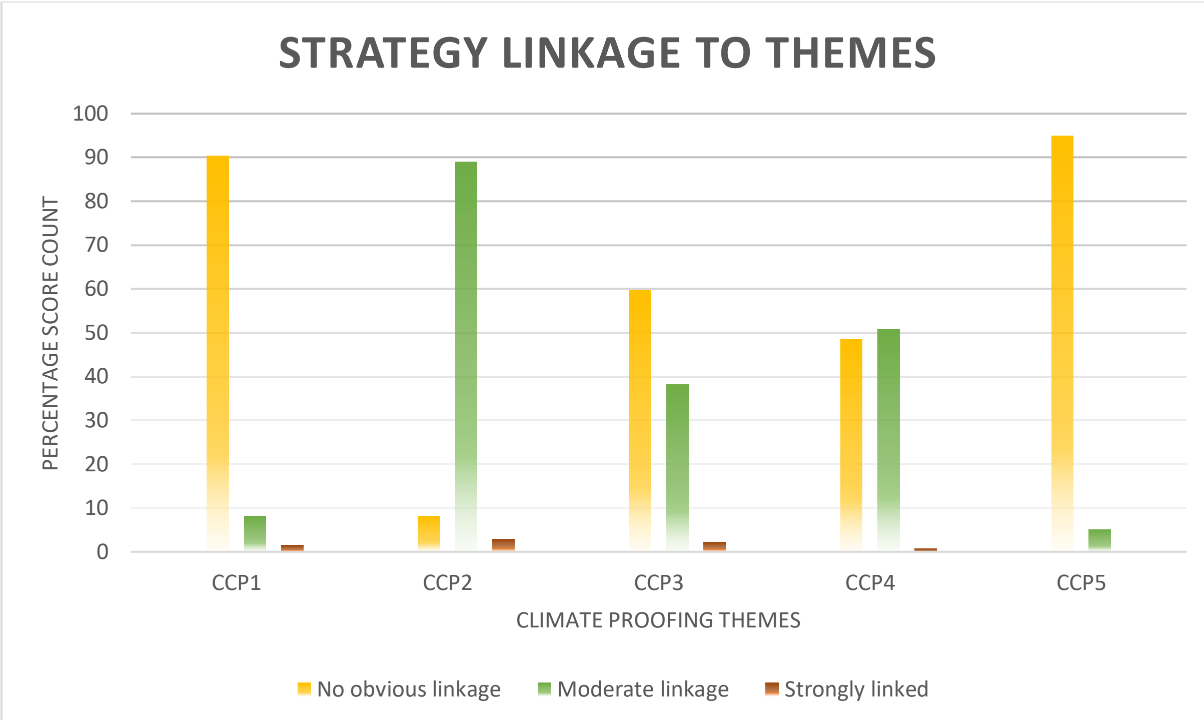

Figure 17: The percentage score of linkage between strategies in the MNAP 2016 and the climate-proofing theme. Source: excel output for data analysis 2018

As already highlighted, the policy has 8 priority areas. The number of strategies selected in each of those areas was unevenly distributed. However, the strategies with the highest linkage to any of the 5 climate-proofing themes were found in priority area 6 (Agriculture Risk Management) which registered a lower number of strategies included for this assessment. Figure 15 above provides a summary of the frequency of occurrence of the strategies categorized according to the scale of linkage under each principle.

Policy Comparison

The policies analysed in this section are those that are supposed to ideally inform climate change integration in development and also lead to reduced climatic impacts. The table below summarizes the general relationships (GoM, 2006, 2015b, 2016c, 2016d)

Table 4: Comparison of the MNAP 2016 to other key policies

Policy Name	Relation To MNAP 2016 Goals	Relation to Climate Proofing Agriculture

National Climate Change Policy	The policy has a broad goal of promoting adaptation and resilience which can broadly also include agriculture and food security. It isn't as specific as the MNAP 2016; therefore, all relations are assumed based on areas of the MNAP 2016, specifically, strategies revised which have some relation to the general focus areas of the policy	The policy outlines broad goals of achieving climate change adaptation in line with climate proofing theme number 2. Its implementation strategy, however, outlines broadly how this will be achieved for the agriculture sector.
National Resilience Policy	this policy outlines several responses under agriculture and food security such as crop diversity and sustainable irrigation which are all in line with MNAP 2016 goals	the responses outlined are aimed at dealing with various vulnerabilities, including those from climate change, therefore, depicting a relation to themes 1 and 2
Disaster Risk Management Policy	The DRM policy was implemented before the development of the MNAP 2016. The policy, however, has a broad focus area of reducing various disaster and promoting food security which is in line with MNAP 2016 Goals	The policy has a specific objective on mainstreaming disaster risk management into development and also the strategic assessment of the impact that is in line with climate proofing themes 1, 2 and 3.
National Adaptation Programme of action	The NAPA aims at reducing the food and livelihood security sensitivity to climate change. Those are in line with the sustainable agricultural production and enhancement of livelihoods focus of the MNAP 2016	The NAPA outlines strategies for reducing sensitivity to climate change in relation to climate-proofing themes 1, 2 and 3

5.3 Discussion

The first QDA showed that despite the reference to some keywords, reference to other important terms such as adaptation and mitigation was not found in the entire document. The same trend was observed when analysing the presence of the same keywords in relation to strategies. The observed reference to climate change was related mainly to reducing impacts on production or reducing the vulnerability of systems. Regard for the contribution of the sector to climate change, and reduction of future impacts on climate were only assumed in a limited number of cases where the keyword appeared in a sentence that had some actionable activities that could result in such. The mention of keywords does not automatically signify the level of regard to climate change. However, a document guiding one of the most vulnerable sectors to climate change in Malawi ought to have a more satisfactory reference to climate change.

The assessment of keywords in relation to strategies focused on whether the keywords appeared in relation to actual actions related to the key words was quantified. Climate-related keywords under risk management had the highest scale of linkage to the climate actions of the strategies compared to all other keywords. This is in contrast with the occurrence of other keywords that would appear in reference to actions not directly related to climate change such as in reference to the name of an organisation. This shows the low integration of climate-related actions in the policy.

Another element that was worth investigating was the section of the document in which the keywords were observed. All six climate-related keywords mentioned in this document appear in the introduction section. This however carries less significance as the introduction, despite having does not translate into actionable areas of the policy which are mainly in the annexes that outline specific strategies to be covered. The policy has 8 priority areas that translate into strategies in the implementation outline. From all these assessments, some form of climate integration in the policy can be assumed. The level of which is however not satisfactory. This was the basis for conducting the second QDA which explored, in more detail, whether climate change, though sparsely referred to throughout the document, was incorporated in the strategies devised under the 8 priority areas.

The second QDA showed that a proportionally lower number of strategies under the different priority areas had a strong linkage to the climate proofing themes (Figure 17). A majority of the strategies registered no linkage to any of the themes. The themes that incorporated a somewhat satisfactory level of linkage were themes 2 (89% moderate linkage in all assessments), 3 (38.2% moderate linkage in all assessments) and 4 (50.7% moderate linkage in all assessments) which focus on current and future impacts as well as current opportunities. All of the 136 strategies had at least one linkage to any of the 5 themes, however this was mostly a moderate linkage meaning that while the strategy did not implicitly integrate climate change issues, it can potentially contribute to certain desired climate action. This was however an assumption of how the policy could inform various climate action and did not account for the actual scale of implementation on the ground. Theme 2 had the highest linkages due to the policy’s orientation towards planning and implementation in the current implementation term (5 years). These policy statements generally referred to enhancing elements such as extension services and aides for implementation of extension services such as transportation, setting up of insurance schemes to support agricultural production, financing, etc. for instance a strategy statement that says *'Build capacity of farmer organizations to facilitate delivery of financial services to their members.'* speaks directly to approaches needed in order advance financial security that allows them to make sustainable investments in their agricultural production. These strategies are potentially oriented towards achieving results for the current term and are also linked to activities that are already present in the sector. The strategies also scored moderate linkage to themes because they have the potential to be utilised as tools for sensitization and information exchange on issues to do with climate change across different scales and also because they can contribute to reduction of climatic risks for the farmers.

The fact that most of the reference is moderately linked alludes to the fact that integration of climate to those strategies was not a deliberate or primary goal. An example of a strategy statement that fit all themes is '*Advocate for the establishment of an agricultural development fund or bank which is reinsured through insurance companies*.' This cannot directly speak to specific interventions on climate-based insurance, or the coverage expected, however it does have the potential of informing climate-based insurance. Climate Risk Reduction itself, has been integrated as a secondary goal or as a resultant impact of implementation of the primary goal. This might be due to the fact that most of the strategies developed seem to be focused on development of agricultural production in the short term in order to rectify current issues that agriculture production in Malawi is facing. This fails to capture the entirety of the climatic threat. *'Build capacities of existing and new water-user and water catchment management associations'*. This strategy statement for instance subtly alludes to the climate-based water risks that agricultural production faces, however, the primary goal for such a strategy is to improve management of catchments.

Theme 4 on exploiting current opportunities presented by climate change registered the second highest number of strategies in relation to the themes. The strategy *'Build the knowledge of farmers to enable the profitable irrigate production of the priority crops'* for instance relates to 4 of the key themes, despite the relation not being strong. This also argues for the orientation of the strategies towards dealing with current issues of production in the sector as opposed to both current and future issues. *'Build capacity of local stakeholders to produce or assemble appropriate* *agricultural machinery.'* this strategy speaks to the advancement of mechanisation of agriculture which relates to both current and future opportunities presented by climate change.

Less than 50 percent of the strategies are oriented to include actual climate threats, and future challenges and opportunities presented by climate change. This would mean that, though the policy might be able to inform climate proofing of the sector based on current threats, if such an approach to policy development continues, the government might spend resources it could otherwise invest elsewhere in dealing with impacts that would have otherwise been reduced, had they been incorporated in the policy plans at an earlier stage.

Another observation was that in all cases, less than 5% of all responses were strongly linked to any of the thematic areas. These included strategies on designating land for protection and conservation which was strongly linked to theme numbers 2 and 3; strategy on adoption of drought and flood tolerant crop varieties which was linked to themes 1, 2, and 3; and strategy on use of agricultural insurance as a risk mitigation measure, such as weather-index crop and livestock insurance and livestock health insurance which was potentially linked to themes 1, 2, 3 and 4. The last strategy discussed was also the only strategy with the most linkages to the themes.. These strategies do not specifically mention the pathways through which this is to be achieved, except the 3 highlighted in this paragraph, which only leaves the incorporation of climate issues as an assumption. The 3 strongly linked strategies touch on issues of climate impact resistant crops, conservation, and insurance which are only a fraction of activities required for adaptation in the production aspect of agriculture. Conservation, as highlighted in the document has the potential of reducing climatic impacts, but this is also subject to the area coverage of the conservation, as well as scale of implementation and actual enforcement of the strategy. It also has implications on the kind of synergies that are in existence with related policies such as the environmental management policy and its implementing authority. This shows that most strategies in this policy were not deliberately developed to aid climate proofing, or incorporation of climate, but this was collectively achieved as a secondary goal This was done through then investment plan which showed also superficial reference to climate change which also simply translates the strategies into actions that do not necessarily take into account climate change.

In the assessment for coherence with policies what ought to be noted is that for all the policies, there is either a duplication of responses as outlined in the MNAP 2016 or the ambiguity or non-specificity of actual activities that are both related to agriculture and climate proofing goals. The NCCMP 2016 and the DRMP 2015 are two of the national climate change frameworks ideally designed to guide the integration of climate risk into the MNAP 2016. There is however no evidence of any climate-proofing based on these 2 policies in the MNAP 2016. The NCCMP was developed after the MNAP 2016, while the DRMP 2015 vaguely touches issues to do with climate proofing agricultural production. In addition to this, both are policies and therefore are not legally binding; hence do not make it mandatory for sector-based policies to integrate climate risk into their provisions. The policy level is key to identifying and evaluating needs in assorted climate change action (Kok et al., 2008). this could potentially mean that these policies are developed independent of each other and do not necessarily take into consideration actual activities that they are meant to be guiding climate action in the agriculture sector. This raise concerns on harmonising of efforts towards climate action in a bid to increase efficiency and coordination of responses to climate change.

5.4 Conclusion

Integration of climate change in the policies seems to be more of a secondary goal, with no evidence of strategies that specifically target climate proofing of the sector. Climate action sometimes can be achieved through the same goals as other non-climatic agendas. However, climatic impacts can vary widely, hence the need for specific guidelines designed to deal with the problem in a bid to reduce the impact of climate variation and change on agriculture.

CHAPTER SIX: Results and Discussions -Objective Three

The section presents results and discusses the findings for objective 3.

Objective 3: Investigate the relevance of strategies devised by the MNAP 2016 in relation to climate-proofing of rice production

6.1 Introduction

This objective aimed to assess the level of practical integration of the policy in actual activities. Apart from actual climate sensitivity and adaptation practices, this objective also assessed the knowledge of climate change, knowledge of climate-proofing strategies and also the knowledge the strategies applied for rice and other crops and whether these were recent introductions. The target audience was government and development partners as well as smallholder rice farmers.

6.2 Results

Key informant interviews

The observed unsatisfactory coherence of the policy with climate proofing the policy is the key departure point for assessing whether the policy implementation is deliberately integrating climate issues. However, the target audience under this objective was restricted to particular sections under government ministries and non-governmental organisations that deal with activities related to climate proofing rice production. The focus was oriented towards probing the degree of practical relation to climate change of said strategies which were otherwise only assumed during QDA assessment. The assessments for this element found that some of the strategies, though not designed specifically for climate proofing of the policy, integrate some level of climate change action.

Cross-sectional Survey

The key informant interviews were followed by a survey to assess the level of integration of adaptation practices among smallholder rice farmers.

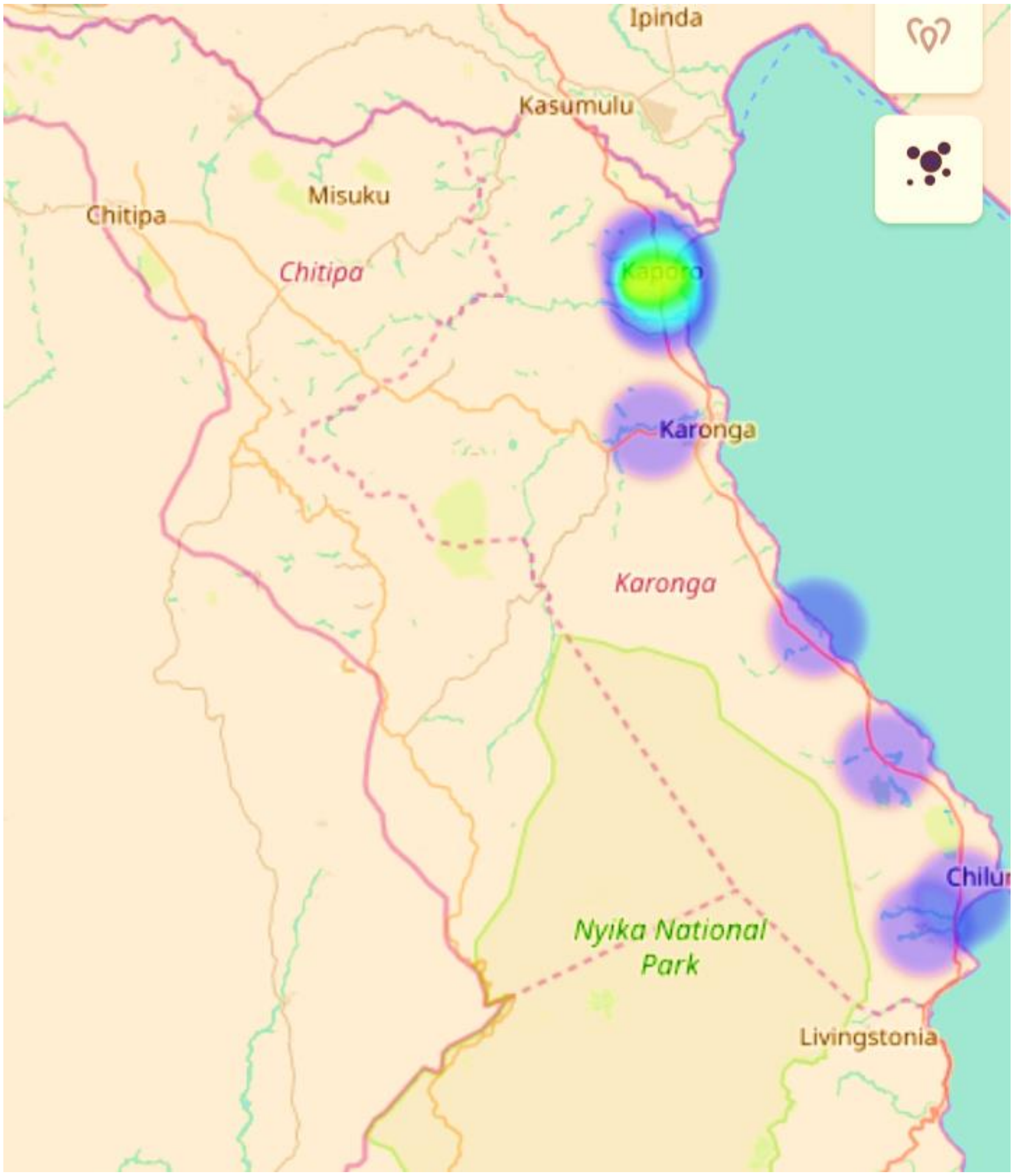

Figure 18: Data collection aggregated points across the different EPAs. Source: Extracted from Kobo Toolbox 2018

The respondents were from 5 of the 6 economic planning areas in the districts (Kaporo north, Kaporo south, Nyungwe, Vinthukutu, and Lupembe) (Figure 1818). Rice farms in Karonga are either located along dambo land where farming is predominantly rain-fed or along river basins, were in some cases irrigation schemes are located. Almost all interviewees in this study were individual smallholder farmers usually planting rice as the main livelihood source.

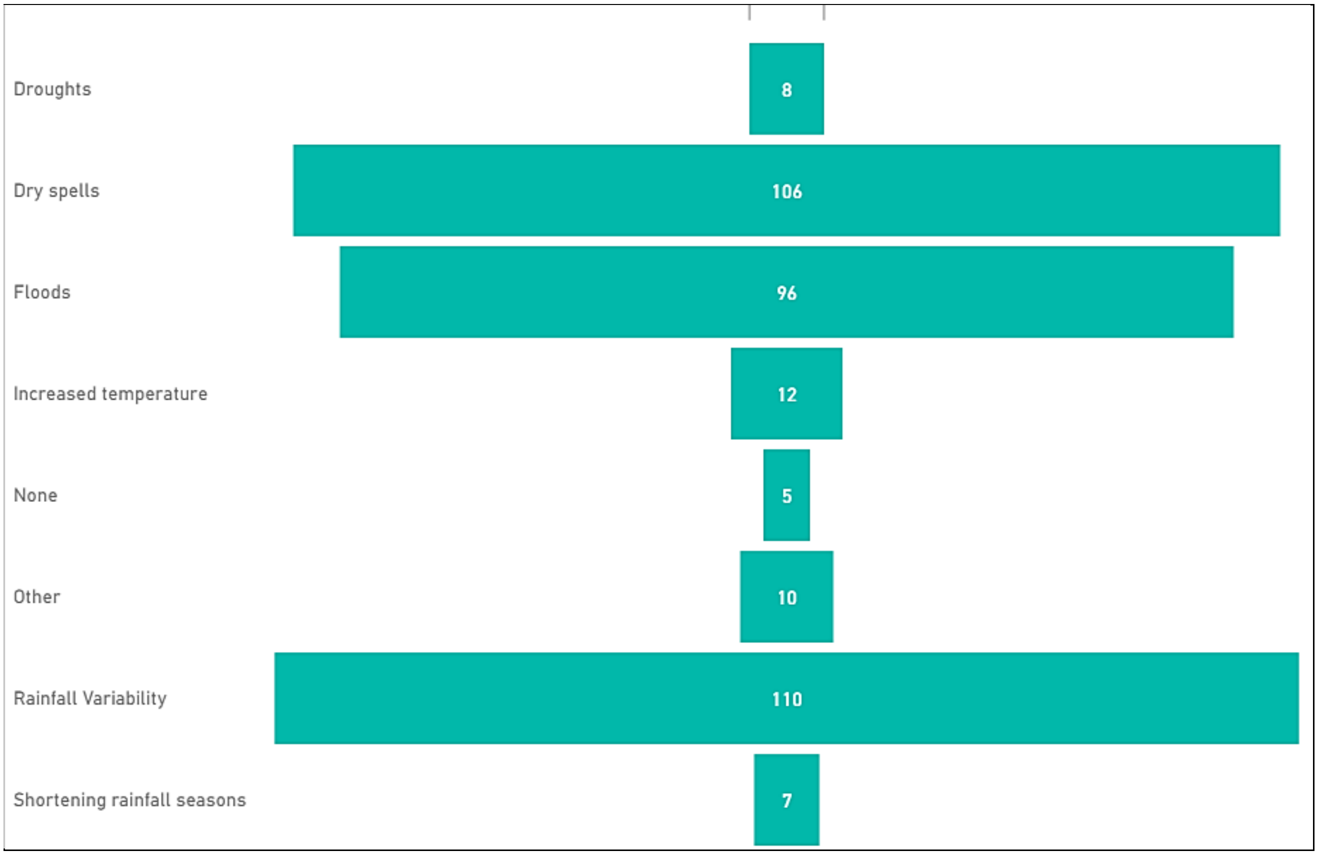

Figure 19: Tally of climatic impacts experienced by the respondents. Source: Output from Microsoft Power BI 2018

Figure 19 shows the responses from the farmers on the types of climatic impacts that they have experienced and that have affected rice production. The most common were rainfall variability, floods, dry spells and extreme rains which had coincidentally been experienced in the preceding 2016/2017 agricultural year.

The impacts experienced between schemes and regular rice fields are similar, with those in schemes experiencing lower flood impacts mainly due to properly constructed and banded water channels as shown in Figure 20 below. However, where floods are experienced in scheme environments, it was mainly as a result of another river source passing through the perimeters of the scheme, and those affected were farmers with fields along that perimeter.

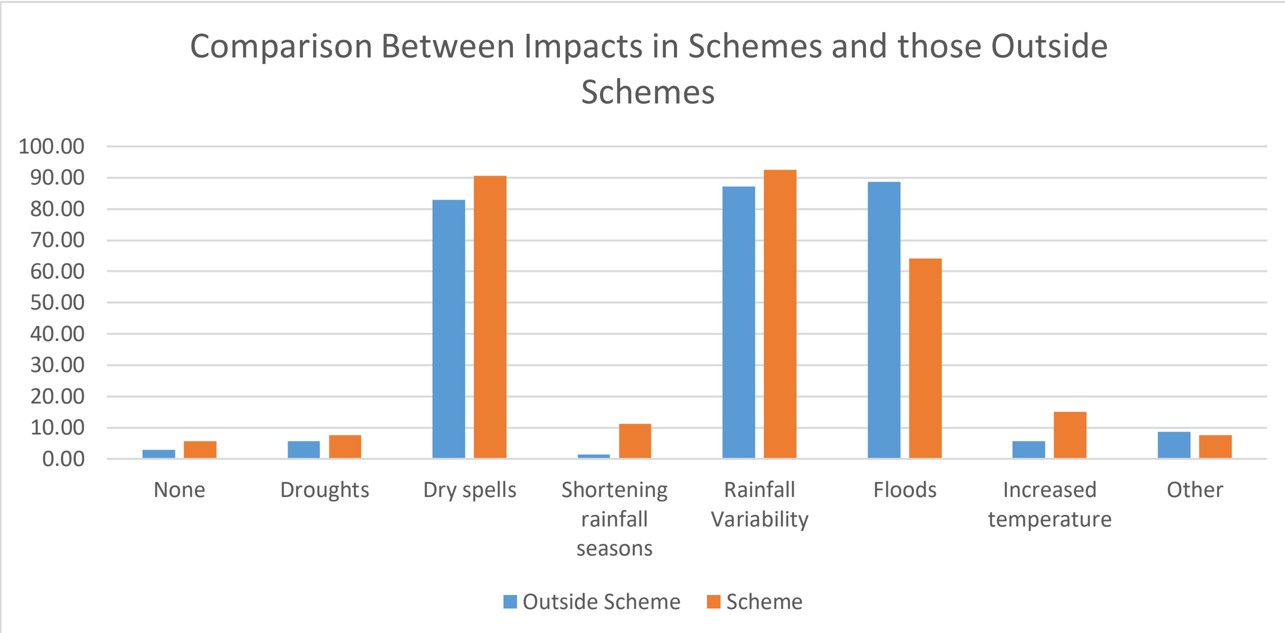

Figure 20: Comparisons of impacts experienced in the schemes and outside the schemes where yes depicts those in schemes. Source: excel output from data analysis 2018.

Over 90 per cent of the respondents had some knowledge of climate change and had experienced some kind of impact during their farming history. The respondents, based on the irrigation type, linked climatic impacts to specific crop failure activities such as physical loss of the crop, physiological stress resulting in reduced yields, reduced fertility, physical destruction of fields and an increase in the prevalence of pests and diseases.

6.3 Discussion

Objective 3 sought to establish the relationship between actual goals of the policy and its climate-proofing inclusion in the policy based on different stakeholders involved in the implementation process. Most of the respondents from government and development partner agencies agreed to a semi-deliberate integration of climate change into the different policy priority areas, where climate was a secondary concern, and its impacts were simply included based on observed past impacts. However, 65% of the respondents agreed that despite climate change being a key risk factor, its integration into the policy was not a priority, and was only considered where climate actions coincided with desired goals.

This key informant interviews also unveiled that most activities that were developed in the MNAP 2016 to deal with issues of climate change action for sustainable agricultural production are not particularly new developments, but a collection of pre-existing strategies that have been implemented to various degrees by government itself and other non-governmental organisations to deal with the issue. There was also not enough evidence of assessment of whether these strategies were assessed on their effectiveness across various scales in being able to deal with climate change issues. Retaining of pre-existing strategies would have been better integrated with the evidence of effectiveness, as this would have accounted for the deliberate consideration of climate change as a key issue, and therefore climate proofing of the policy.

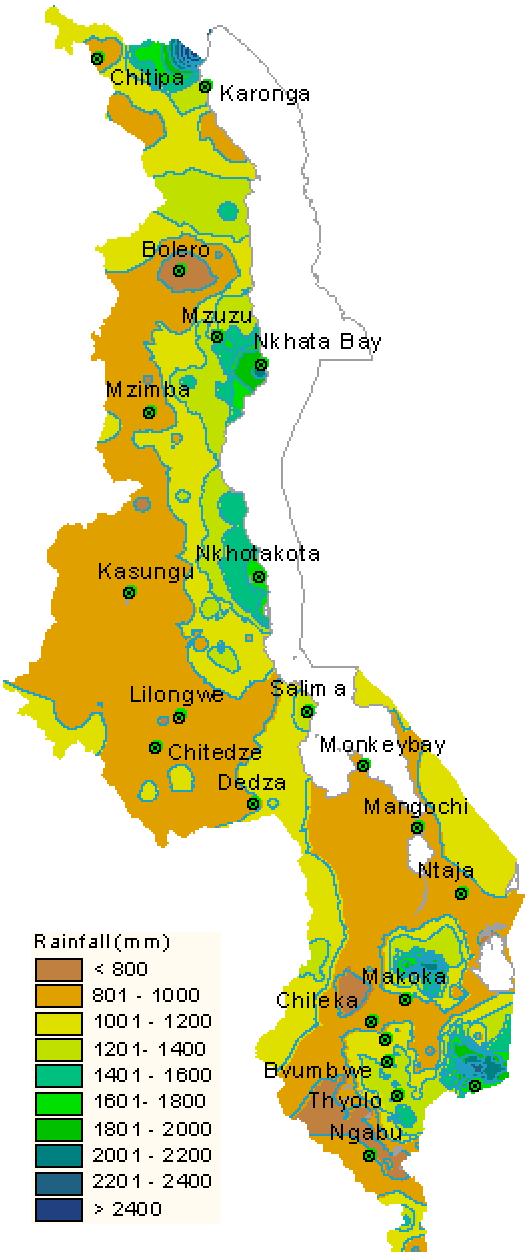

Figure 21: Rainfall distribution across Malawi. Source: Department of Climate Change and Meteorological Services, Malawi Source (Malawi Map)

The geographical expanse shows that the rainfall across the country and the study district is highly variable in expected ranges, hence the sensitivities to rice production, could vary even at district levels, and argues for the possible peril that generalised adaptation options could have on a local level. The study areas are spread across the district which can explain the variation in the how the respondents perceived key impacts. Dealing with climate sensitivities and risks therefore ought to consider this in order to effectively reduce vulnerabilities.

The assessments of the 2 districts showed that Dambo land farming faces higher sensitivity to floods and water shortages as compared to rice farming in irrigation schemes. This was usually because of disorganised channels in dambo land which made it hard to control or supplement water in the event of either floods or droughts. These differences also argue for the fact that integration strategies ought to take into account specific vulnerabilities faced in geographical locations that are downscaled as much as is feasibly possible and requires.

Rice farming in the district is not only tied to food security but is also a matter of livelihood security and has some cultural ties. These factors influence the type of varieties grown, and therefore the kind of adaptation strategies that the rice farmers are open to and their willingness to adapt. Most farmers prefer Kilombero and Faya species because of their economic value based on market sales and customer preferences. The other shorter maturing varieties such as Nanyondo, Pussa and TCG10 are grown during winter sessions and are therefore mainly adopted by farmers that have plots in schemes or those that are privileged to have rice fields along perennial streams/rivers. These shorter maturing varieties are also not adapted to summer growing conditions in dambo land, as their height makes them easy to submerge in flood waters and therefore reducing yields and destroy grain quality. The impact on yields also affects the availability of rice seeds that are reserved for seedling production in the next growing year. This imposes socio-economic vulnerabilities on the farmers. The sensitivity in irrigation schemes becomes pronounced during winter cropping when the water is rarely enough to satisfy the water demand in the schemes. An understanding of these and other dimensions would in play that could affect adaptation action is required in order to ensure that effective adaptation is implemented hence the need for climate proofing the sector through integration of all these factors into the development of a policy led intervention for climate proofing.

Figure 22 below depicts the proposed responses to climatic impacts based on the survey results. These have been matched to the corresponding climatic impacts.

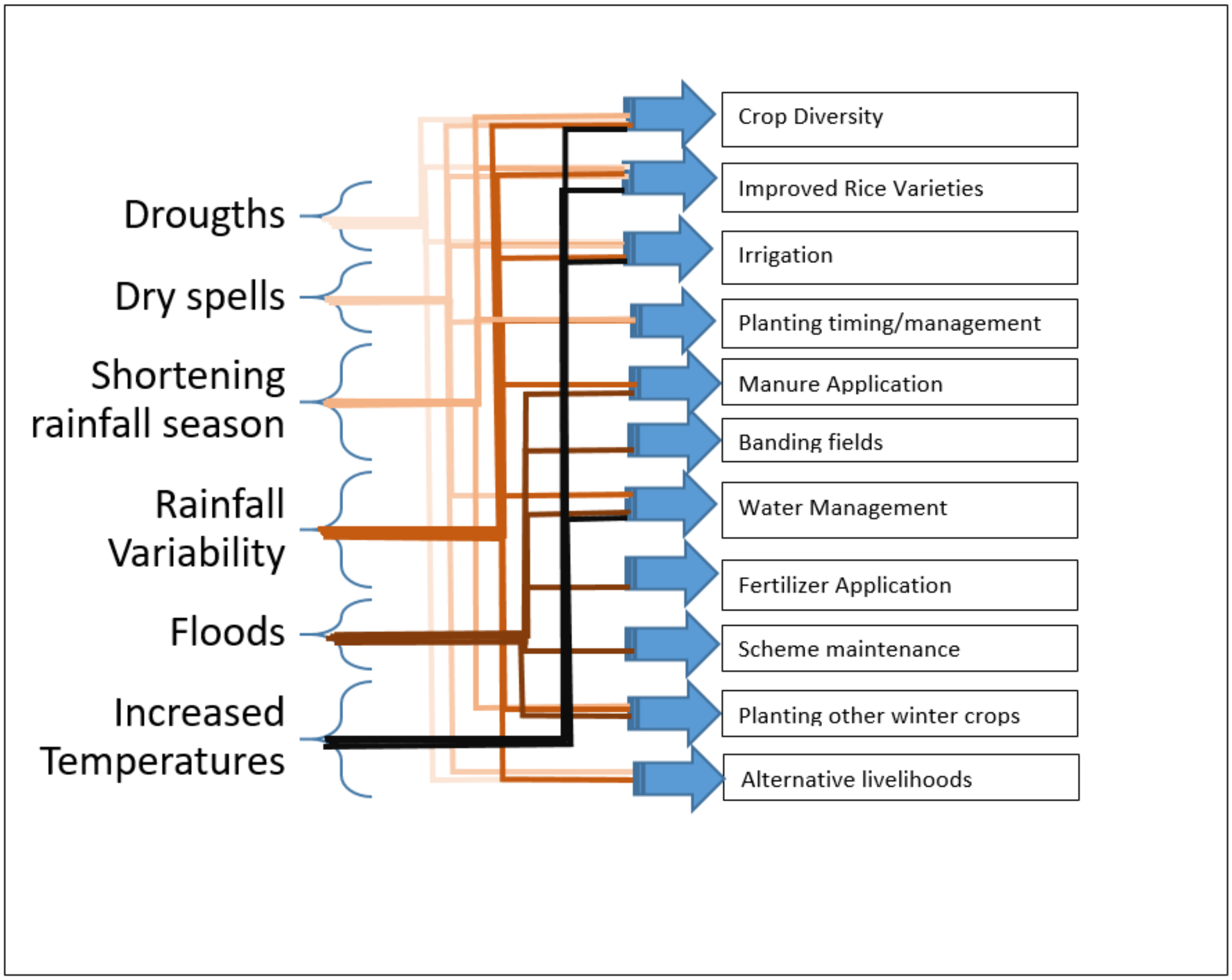

Figure 22: Linkage of climate-based impacts to adaptation practices. Source: Output developed from analysis 2018

Of all these adaptation options, only manure application is a recent introduction among the farming communities. It was mainly introduced in regular rice fields as a means of boosting production. It was however not clear whether this was motivated by the MNAP 2016 as some respondents highlighted that they had been doing it from 2014, which was two years prior to the official launch of the MNAP 2016. The other adaptation practices have been practiced by the farmers since before introduction of the MNAP 2016. Increasing fertilizer and nutrient application and altering the doses of nutrient application required for fertilization is key to reducing climatic impacts such as leeching which reduces nutrient adhesion to the soil under high rainfalls and flooding events. In Malawi, some areas can have a beneficial reaction to improved fertilization. However, where there are high temperatures and low water stress a suitable alternative would be irrigation even during rainy seasons to boost fertilizer utilisation. This just shows the diversity required to deal with climate-based impacts, and the need to develop localized solution that takes into account this diversity in applicability of solutions.

Again, limited land ownership requirement particularly in the schemes which affects yields per person in also needs to be considered when coming up with irrigation-based interventions. The land ownership in irrigation schemes is more than 50% less than that outside the schemes. Options for expanding the schemes are also not plausible since the schemes visited for this research have already reached the maximum possible water extraction level for the various rivers that feed them. The schemes in the district also collectively only cater to less than 30% of all rice farmers in the district, with expansion limited because of available water sources at an affordable cost. Other issues also affect the applicability of schemes. For instance, a scheme in Nyungwe EPA uses solar panels for water extraction. The biggest challenge is however securing enough solar power to run agricultural production in the scheme. It has limited access for locals, in both number of farmers and acreage distribution. The scheme is also not used for rice production; this is done in the dambo area outside the scheme. An irrigation scheme relying on solar energy to extract ground water was also developed in Kaporo South EPA. It however is currently non-functional due to high initial cost of implementation and low to negative profit margins for the farmers. The functional schemes in the district rely on either gravitational force or use solar power but the (using solar) are run by a development partner. Such technicalities need to be properly researched before implementation of various adaptation practices.

Crop diversification is more of an autonomous adaptation strategy for farmers with about 70% of respondents tracing it as a learned adaptation from their parents. Climate change adaptation solutions ought to understand these impacts in order to design relevant adaptation strategies. Using the same rice field to plant other winter crops during the winter season is also another adaptation practice that is adopted by farmers in Lupembe EPA and in isolated cases in the other EPAs where the conditions are favourable. The geographical setting of the rice fields in the EPA and the soil type makes it possible to alternate between rice and other crops. This argues for the need for capitalising of specific vulnerabilities and developing tailor-made adaptation practices for those cases in order to reduce climate impacts on the smallholder agricultural production.

Karonga alone has over 10 rice varieties, some that are not easily differentiated by the farmers. It was therefore impossible to map the adoption of actual new and improved varieties, as some varieties were local but previously unknown to the group of farmers that referred to them as new. However, some hybrid species such as TCG10 were introduced in the 2000s and are widely adopted by farmers especially for winter cropping. The recently introduced hybrid variety named Kayanjamalo was not recorded by any of the interviewees, possible because farmers and extension workers tend to rename new varieties to a locally agreed on name that makes it easier to adopt. The variety could therefore have been mistaken for any of the other rice species that farmers recorded as the ones that they plant. The sensitivity of the preferred rice species has been effectively mapped. This however leaves out the lesser-known species, and opportunity of reducing vulnerabilities by using qualities locally available in the country as opposed to those developed from species outside the country.

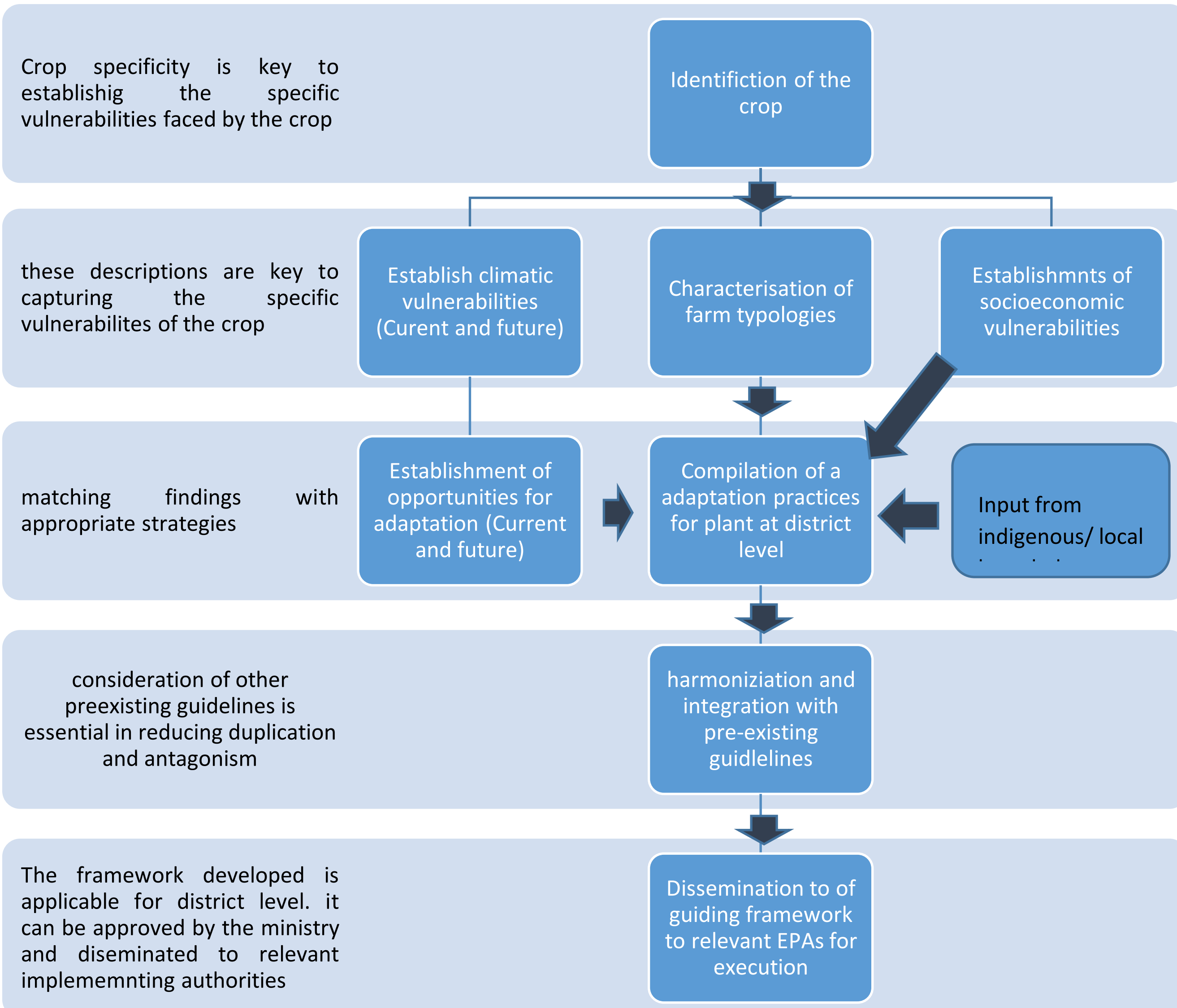

Figure 23: Proposed conceptual model for climate-proofing rice production

The relevance and applicability of adaptation options change and varies over spatial and temporal scales (Guan et al., 2017). This has to be taken into account in the development of climate change-based strategies, where any such variations are considered. This can greatly reduce vulnerabilities to climate change among the farmers but also aid in the adoption of adaptation strategies that are introduced to the communities. The generalisation of adaptation options can assume farmer needs based on expert opinions, which could result in the introduction of appropriate adaptation options which however are not accepted by the farming communities hence the key need of consulting the farmers to assess the key vulnerabilities and adaptation needs in the climate-proofing of the policy. Adoption can however also be affected by the time it takes for strategies to result into adaptation benefits (Dittrich et al., 2016). This is another key assessment area, which can be explored for the development of a set of adaptation options designed to tackle vulnerabilities at different temporal scales.

6.4 Conclusion

Tubiello, Chhetri, Dunlop, Howden, & Meinke (2007) outlined a list of criteria required for climate-proofing agriculture which include: altering inputs; efficient water management; and use of climate forecasts. There is some evidence these interventions being implemented; however, this is not in a strategic or coordinated manner. There have been development of new seed technology and introduction to farmers. However, the rice production in the district is not organized. There is record of a lot of rice varieties, but these are not well documented or known. The authorities might have knowledge of the seed varieties they provide; however, a majority of farmers use their own seed reserved after harvest. The other interventions such as water efficiency and use of climate data are also not as extensively adopted and effective at reducing climate risks mainly because they are not coordinated well. A majority of interventions being used to reduce climate sensitivity of rice are also not recent developments, therefore haven't been introduced as a result of the MNAP 2016. The NAIP, which is the MNAP 2016's implementing framework, highlights specific climate risk reduction innovations or interventions for assorted livestock, but generalises climate risk reduction interventions for crop production. This shows that the MNAP 2016 might not be contributing to climate proofing of the sector, even if it should be fully implemented. This also shows a major gap that could affect the outcome of the policy in regard to climate change adaptation. Climate risk reduction innovations that were observed are more of holistic as opposed to specific, mainly with a departure point, and heavy reference, to maize.

The MNAP 2016 therefore has not conclusively translated into specific adaptation options in the country with regards to rice production. It lacks the policy directives that are to be translated into development of relevant adaptation practices that target sustainable agricultural production. There is also no clear evidence of the development of strategies based on impacts experienced or the vulnerabilities faced by sampled rice farmers in the district.

CHAPTER SEVEN: Conclusions and Recommendations

7.1 Conclusion

The MNAP 2016 outlines a comprehensive array of strategies aimed at achieving sustainable agricultural production in the country. What lacks though is an in-depth assessment of how climate change issues have been integrated in the policy, and the extent to which the strategies, as have been devised, contribute to climate change adaptation. This more so because the MNAP 2016 has been developed at a time when climate issues are presenting unprecedented challenges ion agricultural production. This entails unjustified costs on both the development front as well as the climate change action front that could have repercussions on the country's economy. This could also affect individual smallholder farmers who rely on cultivating rice as a main source of livelihood.

Climate change issues, with respect to integration of climate change impacts on rice production, were not sufficiently integrated into the Malawi National Agriculture Policy 2016. The study established that despite clear impacts on rice production not being established, the study found that the 3 weather parameters assessed (maximum temperature, minimum temperature and rainfall) are varying beyond expected means which is potentially detrimental for the development of rice which was used as a case study in this thesis. In addition to this, the interviewed farmers also reported having been exposed to climatic impacts that have affected rice production negatively.

The MNAP 2016 is the strategic driver for integrating assorted climate impacts into the food production systems, in this case, the rice production system for Karonga. However, there was no evidence of the policy having informed specific adaptation especially in the production of rice. The policy itself also does not appear to deliberately incorporate issues to do with climate proofing of rice production.

Rice production is sensitive to deviations of assorted weather parameters, including temperature and rainfall. These impacts can differ based on geographical locations and socio-economic status. The country needs a comprehensive agricultural product-based approach to integrate climate change issues and the study has designed a conceptual framework for the study, The sensitivities to climate change vary widely among crops as well as among different farm typologies. Irrigation schemes for instance are more vulnerable during winter cropping seasons as compared to the summer cropping season. It is essential that these issues are integrated in developing appropriate current and future climate integration options in order to maximise production while also balancing this with reducing the impacts of climate variation and change. These strategies also have to take into account other socio-economic aspects that could either enhance or reduce the sensitivity of the farmers and their rice farming livelihoods. Adaptation in the agricultural sector also involves consideration of environmental factors which argues for the more focused assessment on localized areas.

Integration of the sensitivities to climate also ought to consider ways in which the said innovations are introduced to the communities and adoption of these systems of enhanced. The study found that there was low introduction of new technologies, which needs to be rectified in order to create an appropriate feedback loop between climatic impacts and relevant response. There is also needed to identify options for improving enforcement of agricultural policies and also solutions for enhancing coordination between government and various development partners in a bid to reduce duplication of efforts and antagonistic responses to the integration of the climate-based sensitivities. For future agricultural policies, climate proofing needs to be done to ensure that climate issues are explicitly taken into account

7.2 Recommendations

The MNAP 2016 is a key intervention point for climate proofing agricultural production. To achieve an effective level of climate change integration, the MNAP 2016 ought to develop a climate proofing strategy to facilitate implementation of all activities. these recommendations are primarily for the Ministry of Agriculture, Water and Irrigation Development, the custodians of the MNAP 2016. This can have the following specifications based on the findings of this research:

1. The next revision of the MNAP 2016 needs to better integrate climatic impacts. The model devised in this research can be used to integrate climate change issues in line with the specific section on strategies. This can be done by the ministry of agriculture

2. Devise strategies that integrate impacts and sensitivities on rice production in different geographical areas. This can be done using the model, and that can effectively contribute to identification of impacts and relevant adaptation strategies.
3. Conduct extensive research on the varieties of rice grown and put in place measures that direct the kind of varieties that the farmers can adopt based on weather forecasts for a specific growing season
4. Increase harmonization and coordination among various implementation partners to strengthen institutional level efforts towards climate risk integration and management
5. Document the expected level of variation in adaptation options for a particular crop across the country using the model approach
6. Devise methods for increasing regulating of agricultural interventions
7. Identified areas of further research
    a. Research on the varieties of rice grown and sensitivities to climate change in geographical zones
    b. Document the effectiveness and applicability of indigenous and other adaptation options for rice production

REFERENCES

Achiase, A., & Aninagyei, I. (2014). *Analysis of Rainfall and Temperature Effects on Maize and Rice Productionin*. *2*, 930–942.

ADB. (2005). *Climate proofing: A Risk-based Approach to Adaptation* (No. 030905). Asian Development Bank.

ADB. (2011). *Guidelines for Climate Proofing Investment in the Transport Sector*. Asian Development Bank.

ADB. (2012). *Guidelines for Climate Proofing Investment in Agriculture , Rural Deveopment, and Food Security*. Asian Development Bank.

ADB. (2013). *Guidelines for Climate Proofing Investment in the Energy Sector*. Asian Development Bank.

ADB. (2016). *Guidelines for Climate Proofing Investment*. Asian Development Bank.

Adhikari, U., Nejadhashemi, A. P., & Woznicki, S. A. (2015). Climate change and eastern Africa : a review of impact on major crops. *Food and Energy Security*, *4*(2), 110–132. https://doi.org/10.1002/fes3.61

AICC. (2017). *Geographical distribution of rice profits in malawi*.

Alam, M. M., bin Toriman, M. E., Siwar, C., & Talib, B. (2011). Rainfall variation and changing pattern of agricultural cycle. *American Journal of Environmental Sciences*, *7*(1), 82–89. https://doi.org/10.3844/ajessp.2011.82.89

Alston, J. M., & Pardey, P. G. (2014). *Agriculture in the Global Economy*. *28*(1), 121–146.

Altvater, S., Görlach, B., Osberghaus, D., McCallum, S., Dworak, T., Klostermann, J., van de Sandt, K., Tröltzsch, J., & Larsen, A. F. (2011). *Recommendations on priority measures for EU policy mainstreaming on adaptation-task 3* (Issue September).

Asfaw, S., Mccarthy, N., Lipper, L., Arslan, A., Cattaneo, A., & Kachulu, M. (2014). *Climate variability , adaptation strategies and food security in Malawi ESA Working Paper No . 14-08* (Issue 14).

AU. (2015). *Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods*.

Badriyah, N., Zaman, K., Ali, J., & Othman, Z. (2017). *Sustainable Paddy Cultivation Management : System of Rice Intensification (Sri) for Higher Production*. *6*(2), 235–242.

Bärring, L., & Andersson, B. (2017). *Tailored climate indices for climate-proofing operational* *forestry applications in Sweden and Finland*. *142*(March 2016), 123–142. https://doi.org/10.1002/joc.4691

Before, J. T., James L. Tembo, C., Mandala, D., & Nthala, L. (2018). Constraints to Rice Production in Malawi: A Case of Nkhulambe Irrigation Scheme in Phalombe District, Southern Malawi. *Rice Research: Open Access*, *06*(04), 2–7. https://doi.org/10.4172/2375-4338.1000200

Benson, T. (2016). *A Spatial Examination of Agricultural Land Use Potential in Malawi Agricultural planning and Malawi ' s geographic diversity and complexity* (Issue April).

Burton, I., Diringer, E., & Smith, J. (2006). *Advancing the International Efforts Against Climate Change*.

Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. *Nature Climate Change*, *4*(4), 287–291. https://doi.org/10.1038/nclimate2153

Chinsinga, B. (2009). *Ministries of Agriculture : Structures , Capacity and Coordination at District Level in Malawi* (Issue October).

Chinsinga, B., Chasukwa, M., & Naess, L. O. (2012). *Climate Change and Agricultural Policy Processes in Malawi* (Issue August).

Chun, J. A., Li, S., Wang, Q., Lee, W.-S., Lee, E.-J., Horstmann, N., Park, H., Veasna, T., Vanndy, L., Pros, K., & Vang, S. (2016). Assessing rice productivity and adaptation strategies for Southeast Asia under climate change through multi-scale crop modeling. *Agricultural Systems*, *143*, 14–21. https://doi.org/https://doi.org/10.1016/j.agsy.2015.12.001

Coulibaly, Jeanne Y., Gbetibouo, G. A., Kundhlande, G., Sileshi, G. W., & Beedy, T. L. (2015). Responding to crop failure: Understanding farmers' coping strategies in Southern Malawi. *Sustainability (Switzerland)*, *7*(2), 1620–1636. https://doi.org/10.3390/su7021620

Coulibaly, Jeanne Yekeleya, Mbow, C., Sileshi, G. W., Beedy, T., Kundhlande, G., & Musau, J. (2015). Mapping Vulnerability to Climate Change in Malawi : Spatial and Social Differentiation in the Shire River Basin. *American Journal of Climate Change*, *4*, 282–294. https://doi.org/10.4236/ajcc.2015.43023

Daccache, A., Sataya, W., & Knox, J. (2014). Climate change impacts on rain-fed and irrigated rice yield in Malawi. *International Journal of Agricultural Sustainability*, *13*. https://doi.org/10.1080/14735903.2014.945317

Davis-Reddy, C. L., & Vincent, K. (2015). Climate Risk and Vulnerability: a Handbook for Southern Africa. In *Introduction to International Disaster Management* (2nd ed.). CSIR. https://doi.org/10.1016/B978-0-12-801477-6.00003-4

Dittrich, R., Wreford, A., & Moran, D. (2016). A survey of decision-making approaches for climate change adaptation : Are robust methods the way forward ? *Ecological Applications*, *122*, 79–89. https://doi.org/10.1016/j.ecolecon.2015.12.006

Dohlman, E. (2012). *Policy Coherence for Development* (Vol. 33, Issue 1).

ECA. (2015). *Assessment report on mainstreaming and implementing disaster risk reduction measures in Malawi*.

Eickhof, T. (2014). *Guidelines for Climate Proofing Water Investments in the MENA region* (Issue January). GIZ.

ERI. (2014). *Climate Proofing Indian Cities : A Policy Perspective* (Issue 0).

FAO. (2014). *Review of food and agricultural policies in Malawi Country*.

FAO, IFAD, UNICEF, WFP, & WHO. (2018). *State of Food Security and Nutrition in the World 2018: Building Climate Resilience for Food Security and Nutrition*. FAO.

Fünfgeld, H., & McEvoy, D. (2013). *Framing climate change adaptation in policy development and implementation* (Issue August).

GFDRR. (2011). *Vulnerability, Risk Reduction, and Adaptation to Climate Change* (Issue April).

Ghadirnezhad, R., & Fallah, A. (2014). Temperature Effect on Yield and Yield Components of Different Rice Cultivars in Flowering Stage. *International Journal of Agronomy*, *2014*.

Giertz, Å., Caballero, J., Dileva, M., Galperin, D., & Johnson, T. (2015). *Managing Agricultural Risk for Growth and Food Security in Malawi*. *October*, 1–8.

GIZ. (2014). *Integrating Climate Change into Financial Planning: Climate Proofing Manual for Zambia*. GIZ.

GoM. (2006). *Malawi's National Adaptation Programmes of Action (NAPA)* (Issue March).

GoM. (2011). *Malawi Agricultural Sector Wide Approach* (Issue 0).

GoM. (2015a). *National Climate Change Response Framework*.

GoM. (2015b). *National Disaster Risk Management Policy*.

GoM. (2016a). *Implementation , Monitoring and Evaluation Strategy for National Climate Change Management Policy Ministry of Natural Resources , Energy and Mining* (Issue June).

GoM. (2016b). *National Agriculture Policy 2016* (p. 116).

GoM. (2016c). *National Climate Change Management Policy* (Issue June).

GoM. (2016d). *THE NATIONAL RESILIENCE PLAN : Breaking the cycle of food insecurity in Malawi*.

GoM. (2018). *2018/2019 LEAN SEASON FOOD INSECURITY*.

Gornall, J., Betts, R., Burke, E., Clark, R., Camp, J., Willett, K., & Wiltshire, A. (2010). Implications of climate change for agricultural productivity in the early twenty-first century. *Philosophical Transactions of the Royal Society*, *365*, 2973–2989. https://doi.org/10.1098/rstb.2010.0158

GRiSP. (2013). *Rice Almanac* (4th ed.). Global Rice Science Partnership.

Grist, N. (2015). *CASE STUDY: Malawi's Agriculture, Climate Change and Food Security Country Analysis and Programming Recommendations* (Issue April).

GTZ. (2010). *Climate Proofing Tool* (1st ed., Issue July).

GTZ. (2012). *Climate Proofing Tool* (2nd ed.). GTZ.

Guan, K., Sultan, B., Biasutti, M., Baron, C., & Lobell, D. B. (2017). Agricultural and Forest Meteorology Assessing climate adaptation options and uncertainties for cereal systems in West Africa. *Agricultural and Forest Meteorology*, *232*, 291–305. https://doi.org/10.1016/j.agrformet.2016.07.021

Hahn, M., & Frode, A. (2011). *Climate Proofing for Development: Adapting to Climate Change, Reducing Risk*. GIZ.

Herr, D., Himes-cornell, A., & Laffoley, D. (2016). *National Blue Carbon Policy Assessment Framework ecosystems*. IUCN.

Hjerp, P., Volkery, A., Lückge, H., Medhurst, J., Hart, K., Medarova-Bergstrom, K., Tröltzsch, J., McGuinn, J., Skinner, I., Desbarats, J., Slater, C., Bartel, A., Frelih-Larsen, A., & ten Brink, P. (2012). *Methodologies for Climate Proofing Investments and Measures Under Cohesion and Regional Policy and the Common Agricultural Policy* (Issue August).

IFAD. (2011). *Addressing Climate Change in East and Southern Africa*. www.ifad.org%5Cnwww.ruralpovertyportal.org%5CnDecember 2011 �IFAD/Robert

IPCC. (1992). *UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE UNITED NATIONS* (pp. 1–33).

IPCC. (2013). Climate Change 2014: The Physical Basis of Climate Change. In T. F. Stocker, G.-K. Plattner, M. M. B. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, & P. M. Midgley (Eds.), *Fifth Assessment Report of the Intergovernmental Panel on Climate*

Change (pp. 2013–2014). https://doi.org/10.1017/CBO9781107415324.Summary

IPCC. (2014a). Climate Change 2014: Mitigation of Climate Change. In O. Edenhofer, R. Pichs-Madruga, Y. Sokona, J. C. Minx, E. Farahani, K. Susanne, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlomer, C. von Stechow, & T. Zwickel (Eds.), *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 1454). https://doi.org/10.1017/CBO9781107415416

IPCC. (2014b). Climate Change 2014. Impacts, Adaptation, and Vulnerability Part A: Global And Sectoral Aspects. In D. R. Tobergte & S. Curtis (Eds.), *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change. https://doi.org/10.1017/CBO9781107415324.004

IPCC. (2014c). Climate Change 2014 Impacts, Adaptation, and Vulnerability Part B: Regional Aspects. In R. Bott (Ed.), *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Issue 1, p. 696). IPCC. https://doi.org/10.1007/s13398-014-0173-7.2

IPCC. (2015). Paris Agreement. In *21st Conference of the Parties* (p. 3). https://doi.org/FCCC/CP/2015/L.9

IPCC. (2018). *Global Warming of 1.5°C - Summary for Policy Makers*. Intergovernmental Panel on Climate Change.

Janet, F., Mabiso, A., & Gerrard, C. D. (2016). *Agriculture Policy and Institutional Strengthening (APIS) in Malawi : A National Workshop on ASWAp II Final Report*.

Jerven, M. (2013). The Political Economy of Agricultural Statistics and Input Subsidies : Evidence from India , Nigeria and Malawi. *Journal of Agrarian Change*, 1–17.

Kaarhus, R., & Nyirenda, R. (2006). *DECENTRALISATION IN THE Policies , processes and community linkages* (Issue 32).

Kabat, P., & Vellinga, P. (2005). *Climate proofing the Netherlands*. *438*(November).

Kahsay, G. A., & Hansen, L. G. (2014). *The Effect of Climate Change and Adaptation Policy on Agricultural Production in Eastern Africa* (2014/08).

Kassie, M., Teklewold, H., Marenya, P., Jaleta, M., & Erenstein, O. (2015). Production Risks and Food Security under Alternative Technology Choices in Malawi: Application of a Multinomial Endogenous Switching Regression. *Journal of Agricultural Economics*, *66*(3), 640–659. https://doi.org/10.1111/1477-9552.12099

Khanal, U., Wilson, C., Hoang, V. N., & Lee, B. (2018). Farmers' Adaptation to Climate Change, Its Determinants and Impacts on Rice Yield in Nepal. *Ecological Economics*, *144*. https://doi.org/10.1016/j.ecolecon.2017.08.006

Kim, S., Bae, S., Kim, S., Yoo, S.-H., & Jang, M.-W. (2016). Assessing Sensitivity of Paddy Rice to Climate Change in South Korea. *Water*, *8*(12), 554. https://doi.org/10.3390/w8120554

Kwon, H., & Kim, E. (2014). Poverty Reduction and Good Governance: Examining the Rationale of the Millennium Development Goals. *Development and Change*, *45*(2), 353–375. https://doi.org/10.1111/dech.12084

Le Blanc, D. (2015). *Towards integration at last ? The sustainable development goals as a network of targets* (Vol. 1, Issue 141).

Li, T., Hasegawa, T., Yin, X., Zhu, Y., Boote, K., Adam, M., Bregaglio, S., Buis, S., Confalonieri, R., Fumoto, T., Gaydon, D., Marcaida, M., Nakagawa, H., Oriol, P., Ruane, A. C., Ruget, F., Singh, B.-, Singh, U., Tang, L., … Bouman, B. (2015). Uncertainties in predicting rice yield by current crop models under a wide range of climatic conditions. *Global Change Biology*, *21*(3), 1328–1341. https://doi.org/10.1111/gcb.12758

Ling, C. Y. (2012). The Rio Declaration on environment and development: An assessment. In *Third World Network* (Vol. 1). https://doi.org/10.1017/CBO9781107415324.004

Maganga, A. ., & Malakini, M. (2015). Agrarian Impact of Climate Change in Malawi : A Quantile Ricardian Analysis. *Intertional Conference of Agricultural Economists*, 1–29. https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&sqi=2&ved=0CCcQFjAB&url=http://www.cepa.org.mw/index.php/en/2015-02-13-13-10-21/legislation/policy-documents?task=download&id=93&ei=HeGCVcjiFYSC7gb2s4PYBg&usg=AFQjCNEp7pQ0qUW

Magrath, J., & Sukali, E. (2009). *The winds of change: Climate change, poverty and the environment in Malawi*. www.oxfam.org

Maidment, R. I., Allan, R. P., & Black, E. (2015). Recent observed and simulated changes in precipitation over Africa. *Geophysical Research Letters*, *10*(1002), 8155–8164. https://doi.org/10.1002/2015GL065765.Received

Makoka, D., German, G. M., Olson, J., Hoglund Giertz, A. M. G., Caballero, R. J., & Galperin, D. (2015). *Malawi - Agricultural sector risk assessment* (Issue 99941).

Masante, D., N McCormiclVogt, J., Barbosa, P., & Morena, C. C. (2018). *2018 – Drought and Water Crisis in Southern Africa*. European Comission. https://doi.org/10.2760/81873

McNeeley, S. M., & Lazrus, H. (2014). The Cultural Theory of Risk for Climate Change Adaptation. *Weather, Climate, and Society*, *6*(4), 506–519. https://doi.org/10.1175/WCAS-D-13-00027.1

Medarova-Bergstrom, K., Volkery, A., Schiellerup, P., Withana, S., & Baldock, D. (2014).

Strategies and Instruments for Climate Proofing the EU Budget. In *Institute for European Environmental Policy* (Issue January 2011).

Midgley, S., Methner, N., New, M., Cartwright, A., Cullis, J., Johnstone, P., Knowles, T., Midgley, G., Cole, M., & Parkins, F. T. (2016). *Western Cape Climate Change Response Framework and Impletation Plan for the Agriculture Sector - 2016*.

Montmasson-clair, G. (2016). *A Policy Assessment : Climate Change Adaptation and Agriculture in South Africa*.

Msowoya, K., & Madani, K. (2016). Climate Change Impacts on Maize Production in the Warm Heart of Africa. *Water Resources Management*, 5299–5312. https://doi.org/10.1007/s11269-016-1487-3

Mulwa, C., Marenya, P., Rahut, D. B., & Kassie, M. (2017). Response to climate risks among smallholder farmers in Malawi: A multivariate probit assessment of the role of information, household demographics, and farm characteristics. *Climate Risk Management, 16*, 208–221. https://doi.org/10.1016/j.crm.2017.01.002

Mwale, F. D., & Adeloye, A. J. (2010). *Quantifying flood vulnerabilty, hazard and risk of rural communities in sub-saharan Africa: the case of the Lower Shire valley, Malawi*. 1–32.

Ng'ang'a, S. K., Van Wijk, M. T., Rufino, M. C., & Giller, K. E. (2016). Adaptation of agriculture to climate change in semi-arid Borena, Ethiopia. *Regional Environmental Change*, *16*(8). https://doi.org/10.1007/s10113-016-0940-4

Nkhoma, P. R. (2016). *Constituting Agricultural and Food Policy in Malawi : The Role of the State and International Donors in the Farm Input Subsidy Program (FISP)*.

NSO. (2019). *2018 Malawi Population and Housing Census-Main Report* (Issue May).

OECD. (2011). *Risk management in agriculture: what role for governments? November*, 8. https://doi.org/http://dx.doi.org/10.1787/5k94d6fx5bd8-en

Oliver, K., Lorenc, T., & Innvær, S. (2014). New directions in evidence-based policy research : a critical analysis of the literature. *Health Research Policy and Systems*, 1–11. https://doi.org/10.1186/1478-4505-12-34

Olson, J. M., Alagarswamy, G., Gronseth, J., & Moore, N. (2017). Impacts of Climate Change on Rice and Maize, and Opportunities to Increase Productivity and Resilience in Malawi. In *Global Center for Food Systems Innovation Technical Paper*. *Michigan State University*.

Ongugo, P. O., Langat, D., Oeba, V. O., Kimondo, J. M., Owuor, B., Njuguna, J., Okwaro, G., & Russell, A. J. (2014). *A review of Kenya ' s national policies relevant to climate change adaptation and mitigation Insights from Mount Elgon* (No. 155).

Oort, P. A. J. Van, & Zwart, S. J. (2018). *Impacts of climate change on rice production in Africa and causes of simulated yield changes*. *September 2017*, 1029–1045. https://doi.org/10.1111/gcb.13967

Oort, P. A. J. Van, Zwart, S. J., van Oort, P. A. J., & Zwart, S. J. (2017). Impacts of climate change on rice production in Africa and causes of simulated yield changes. *Global Change Biology*, *July 2017*, 1029–1045. https://doi.org/10.1111/gcb.13967

Pauw, K., & Seventer, D. Van. (2010). *Droughts and Floods in Malawi Assessing the Economywide Effects*. *April*.

Perez, C., Jones, E. M., Kristjanson, P., Cramer, L., Thornton, P. K., Förch, W., & Barahona, C. (2015). How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. *Global Environmental Change*, *34*. https://doi.org/10.1016/j.gloenvcha.2015.06.003

Pervin, M., Sultana, S., Phirum, A., Camara, I. F., Nzau, V. M., Phonnasane, V., Khounsy, P., Kaur, N., & Anderson, S. (2013). *A framework for mainstreaming climate resilience into development planning* (Issue November).

Powell, J. P., & Reinhard, S. (2016). Measuring the effects of extreme weather events on yields. *Weather and Climate Extremes*, *12*, 69–79. https://doi.org/10.1016/j.wace.2016.02.003

Rahman, A., Kang, S., Nagabhatla, N., & Macnee, R. (2017). Impacts of temperature and rainfall variation on rice productivity in major ecosystems of Bangladesh. *Agriculture & Food Security*, 1–11. https://doi.org/10.1186/s40066-017-0089-5

Rathnayake, W. M. U. K., Silva, R. P. De, & Dayawansa, N. D. K. (2016). Assessment of the Suitability of Temperature and Relative Humidity for Rice Cultivation in Rainfed Lowland Paddy Fields in Kurunegala District. *Tropical Agricultural Research*, *27*(4), 370–388.

Ray, D. K., Gerber, J. S., Macdonald, G. K., & West, P. C. (2015). Climate variation explains a third of global crop yield variability. *Nature Communications*, *6*. https://doi.org/10.1038/ncomms6989

Rosenzweig, C., Elliott, J., Deryng, D., Ruane, A. C., Müller, C., Arneth, A., Boote, K. J., Folberth, C., Glotter, M., Khabarov, N., Neumann, K., Piontek, F., Pugh, T. A. M., Schmid, E., Stehfest, E., Yang, H., & Jones, J. W. (2014). Assessing agricultural risks of climate change in the 21st century in a global gridded crop model intercomparison. *PNAS*, *111*(9), 3268–3273. https://doi.org/10.1073/pnas.1222463110

Schipper, L., & Pelling, M. (2006). Disaster risk , climate change and international development : scope for , and challenges to , integration. *Disasters*, *30*(1), 19–38.

Schlenker, W., & Lobell, D. B. (2010). Robust negative impacts of climate change on African Agriculture. *Environmental Research Letters*, *014010*. https://doi.org/10.1088/1748-

9326/5/1/014010

Shamshiri, R. R., Ibrahim, B., Ahmad, D., Man, H. C., & Wayayok, A. (2018). *An Overview of the System of Rice Intensification for Paddy Fields of Malaysia*. *11*(May), 1–16. https://doi.org/10.17485/ijst/2018/v11i18/104418

Sonwa, D. J., Dieye, A., El Mzouri, E.-H., Majule, A., Mugabe, F. T., Omolo, N., Wouapi, H., Obando, J., & Brooks, N. (2017). Drivers of climate risk in African agriculture. *Climate and Development*, *9*(5), 383–398. https://doi.org/10.1080/17565529.2016.1167659

Sovacool, B. K., Linnér, B., & Goodsite, M. E. (2015). The political economy of climate adaptation. *Nature Publishing Group*, *5*(7), 616–618. https://doi.org/10.1038/nclimate2665

Stern, N. (2015). *Growth , climate and collaboration : towards agreement in Paris 2015 Policy paper December 2014 Centre for Climate Change Economics and Policy Grantham Research Institute on Climate Change and*. *December 2014*, 1–24.

Terdoo, F., & Feola, G. (2016). The Vulnerability of Rice Value Chains in Sub-Saharan Africa: A Review. *Climate*, *4*(3), 47. https://doi.org/10.3390/cli4030047

Thorlakson, T. (2012). Reducing subsistence farmers' vulnerability to climate change: evaluating the potential contributions of agroforestry in western Kenya. In *Agriculture & Food Security* (Vol. 1, Issue 1). https://doi.org/10.1186/2048-7010-1-15

Trinh, M. Van, Vaas, I. A. E., Vaas, N. V. B., & Minh, H. G. (2014). *Climate change and impacts on rice production in Vietnam : Pilot testing of potential adaptation and mitigation measures A benchmark report characterizing the three project areas and rice farming systems in the three provinces*. *June*.

Tubiello, F. N., Chhetri, N., Dunlop, M., Howden, S. M., & Meinke, H. (2007). Adapting agriculture to climate change. *PNAS*, *104*(50), 19691–19696.

Tubiello, F., Schmidhuber, J., Howden, M., Neofotis, P. G., Park, S., Fernandes, E., & Thapa, D. (2008). *Climate Change Response Strategies for Agriculture : Challenges and Opportunities for the 21st Century Strategies for Agriculture*.

UN-OHRLLS. (2009). *The impact of climate change on the development prospects of the least developed countries and small island developing states*.

UNISDR. (2005). *Hyogo Framework for Action* (Issue January 2005).

UNISDR. (2015). *Sendai Framework for Disaster Risk Reduction 2015 - 2030*.

Urwin, K., & Jordan, A. (2008). Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environmental Change*, *18*, 180–191. https://doi.org/10.1016/j.gloenvcha.2007.08.002

van Oort, P. A. J., & Zwart, S. J. (2017). Impacts of climate change on rice production in Africa and causes of simulated yield changes. *Global Change Biology*, *July 2017*, 1029–1045. https://doi.org/10.1111/gcb.13967

Vincent, K., Dougill, A. J., Mkwambisi, D. D., Cull, T., & Stringer, L. C. (2014). *Analysis of Existing Weather and Climate Information for Malawi*. *April*, 1–18.

Wach, E., Ward, R., & Jacimovic, R. (2013). Learning about Qualitative Document Analysis. *Institute of Development Studies Practice Paper in Brief 13*, *2008*(August), 1–10. https://doi.org/www.ids.ac.uk

Wang, X., Ciais, P., Li, L., Ruget, F., Vuichard, N., Viovy, N., Zhou, F., Chang, J., Wu, X., Zhao, H., Wang, X., Ciais, P., Li, L., Ruget, F., & Vuichard, N. (2017). *Management outweighs climate change on affecting length of rice growing period for early rice and single rice in China during 1991 – 2012 To cite this version : HAL Id : hal-01417186*.

Webber, H., Gaiser, T., & Ewert, F. (2014). What role can crop models play in supporting climate change adaptation decisions to enhance food security in Sub-Saharan Africa? In *Agricultural Systems* (Vol. 127). https://doi.org/10.1016/j.agsy.2013.12.006

Williamson, L. E., Connor, H., & Moezzi, M. (2009). *Energy Systems*.

World Bank. (2019). *Malawi Country Environmental Analysis*.

Yoshida, S., Oryza, P., In, L., & Environment, A. C. (2012). *Soil Science and Plant Nutrition Effects of temperature on growth of the rice plant (Oryza sativa L .) in a controlled environment*. *0768*. https://doi.org/10.1080/00380768.1973.10432599

Zinyengere, N., Crespo, O., Hachigonta, S., & Tadross, M. (2015). Crop model usefulness in drylands of southern Africa: an application of DSSAT. *South African Journal of Plant and Soil*, *32*(2), 95–104. https://doi.org/10.1080/02571862.2015.1006271

Zulu, L. (2017). *Existing Research and Knowledge on Impacts of Climate Variability and Change on Agriculture and Communities in Malawi*.

APPENDIX

Appendix 1: Climate Data Used

Year		Nov	Dec	Jan	Feb	Mar	Apr	May
1986	Temp_Min	23.54	22.33	22.38	22.14	22.47	21.72	20.75
	Temp_Max	32.43	29.68	30.35	29.53	29.93	29.65	29.51
	Rain_Fall	9.3	390.4	74.2	260.1	248.9	146.9	22.80
1987	Temp_Min	23.95	24.38	22.46	22.48	21.99	21.88	20.15
	Temp_Max	34.15	33.45	29.95	29.69	29.43	30.42	29.25
	Rain_Fall	14.4	98.1	214	135	269.6	33.3	0.10
1988	Temp_Min	22.73	22.24	21.23	21.30	20.92	20.64	19.85
	Temp_Max	31.74	30.26	29.19	30.15	29.46	29.06	28.99
	Rain_Fall	67.7	141	133.8	93.5	149.3	194.4	7.30
1989	Temp_Min	22.49	21.92	21.74	21.70	21.36	21.20	19.82
	Temp_Max	32.22	29.93	30.56	30.12	29.69	29.50	29.74
	Rain_Fall	79.7	106.7	110.2	162.8	218	119.9	6.00
1990	Temp_Min	23.05	23.15	22.08	22.24	21.96	20.41	20.61
	Temp_Max	33.46	32.64	30.53	30.77	29.69	28.39	29.32
	Rain_Fall	10.7	43	208.3	118.9	144.8	221.8	10.60
1991	Temp_Min	23.13	22.52	22.08	21.78	22.33	21.46	20.68

	Temp_Max	33.27	30.57	30.05	30.75	30.26	29.77	29.59
	Rain_Fall	0.5	201	214.9	84.8	244.7	193.3	14.20
1992	Temp_Min	22.83	22.76	22.16	21.88	21.44	21.60	19.93
	Temp_Max	32.66	31.36	29.59	29.86	28.96	29.53	29.40
	Rain_Fall	118.4	117.5	137.5	130.2	135.6	217.3	45.10
1993	Temp_Min	24.13	24.62	22.84	22.01	21.91	21.79	20.28
	Temp_Max	11.4	8.9	120	167.4	222.2	75.5	1.40
	Rain_Fall	33.09	34.44	30.52	29.58	29.30	29.78	29.76
1994	Temp_Min	23.93	23.80	22.52	21.86	21.73	21.79	20.57
	Temp_Max	33.83	32.15	31.03	29.52	29.15	29.89	29.48
	Rain_Fall	0	52.8	155.7	265.3	411	56.9	0.60
1995	Temp_Min	23.72	23.88	22.49		21.88	21.32	20.99
	Temp_Max	34.82	32.75	30.72	29.26	29.33	28.88	29.35
	Rain_Fall	0	102.4	148.9	138.4	57.7	178.8	1.20
1996	Temp_Min	23.64	22.84	23.09	22.07	22.87	21.75	19.52
	Temp_Max	35.41	31.35	31.66	29.85	31.12	29.94	29.06
	Rain_Fall	0.1	82.6	95.3	155.9	116.6	81.5	65.70
1997	Temp_Min	24.62	22.40	23.26	22.99	23.09	22.09	19.88
	Temp_Max	33.56	29.69	30.58	30.39	30.96	29.61	29.82

	Rain_Fall	31.9	479.5	248.3	152.9	323.7	272	0.00
1998	Temp_Min	23.68	23.94	22.69	22.50	21.49	21.17	20.09
	Temp_Max	34.88	33.52	31.23	30.91	29.76	29.13	28.85
	Rain_Fall	0.2	135.6	115.4	62.8	320.5	235.1	15.50
1999	Temp_Min	23.18	23.16	22.79	22.47	21.65	21.61	19.58
	Temp_Max	32.76	33.00	31.41	31.05	29.33	29.89	29.55
	Rain_Fall	21.9	49.1	94.1	69.5	320.5	190.1	24.90
2000	Temp_Min	22.84	22.00	21.70	22.21	21.29	21.85	19.84
	Temp_Max	31.38	29.50	29.88	30.25	29.47	29.92	29.05
	Rain_Fall	127.8	244.6	187.9	90.9	343.6	110.1	0.00
2001	Temp_Min	23.47	23.45	21.53	21.96	21.49	21.40	18.85
	Temp_Max	35.02	32.66	29.51	29.98	29.35	29.39	28.56
	Rain_Fall	0	187	228.1	243.4	544.9	108.7	53.20
2002	Temp_Min					21.57		20.18
	Temp_Max			30.77	29.32	28.63	27.68	28.89
	Rain_Fall	53.9	191.3	254.9	133	113.9	167.4	0.00
2003	Temp_Min			22.84	16.74	22.60	21.49	18.49
	Temp_Max			30.49	30.04	30.52	29.02	28.33
	Rain_Fall	0	126.1	185.7	211.1	193.3	497.8	2.10

2004	Temp_Min	23.59	22.52	22.23	22.48	22.17	21.63	20.09
	Temp_Max	33.28	30.05	30.77	30.89	30.46	29.99	29.73
	Rain_Fall	222.5	199	226.1	200.7	175.8	53.4	2.00
2005	Temp_Min	23.78	23.62	21.92	22.52	21.70	20.98	20.27
	Temp_Max	35.01	33.14	30.41	30.75	29.33	29.15	29.16
	Rain_Fall	5	167.4	242.6	59.1	289.9	298	1.40
2006	Temp_Min	23.78	22.51	22.58	22.56	22.05	22.04	20.70
	Temp_Max	32.95	30.17	30.21	31.54	30.61	30.97	29.94
	Rain_Fall	52.5	262.7	204.5	87.5	133.3	55.8	1.40
2007	Temp_Min	24.42	22.99	21.43	21.63		21.39	20.15
	Temp_Max	34.42	31.43	28.88	28.87		29.89	29.87
	Rain_Fall	2.3	160.2	187.1	95.4	411.4	26.2	33.40
2008	Temp_Min	23.88	22.77	22.26	21.57	22.04	21.15	19.83
	Temp_Max	34.16	30.68	30.71	29.49	29.61	29.12	29.47
	Rain_Fall	10.9	171.6	258.1	390.7	89.3	110.1	4.40
2009	Temp_Min	23.95	23.53	22.79	23.08	22.26		21.29
	Temp_Max	32.32	31.90	31.23	30.99	30.49		30.47
	Rain_Fall	76.7	124.7	129.9	451.2	0	2	0.00
2010	Temp_Min	24.30	23.14	22.47	21.47	21.19	21.52	20.76

	Temp_Max	34.68	31.12	30.69	29.47	29.60	29.74	29.73
	Rain_Fall	130		200.1	164.6	475.3	0	75.10
2011	Temp_Min	23.86	22.46	21.87	21.01	20.77	20.30	19.15
	Temp_Max	33.14	31.48	31.37	30.67	30.09	29.65	29.63
	Rain_Fall	0	156.8	197.9	215.2	176	92.8	0.00
2012	Temp_Min	23.03	22.86	22.23	21.58	21.29	20.55	19.16
	Temp_Max	33.14	31.48	31.37	30.67	30.09	29.65	29.63
	Rain_Fall	13.6	152.3	160	244.5	387.3	146.9	0.00
2013	Temp_Min	22.48	22.26	21.88	21.47	20.77	20.17	19.80
	Temp_Max	33.96	31.91	30.50	30.76	30.40	29.75	29.92
	Rain_Fall	40.3	82.5	75.1	165	311.6	151.3	197.90
2014	Temp_Min	22.91	23.49	21.48	21.64	21.45	20.40	19.43
	Temp_Max	34.43	33.36	31.03	31.16	30.70	29.89	30.45
	Rain_Fall	5.9	70.7	177.4	104.1	110.3	94.1	1.10
2015	Temp_Min	23.42	23.44					17.98
	Temp_Max	34.05	32.67	30	32	31	30	29.51
	Rain_Fall	3.5	69.4	173.2	100.4	60.7	294.6	
2016	Temp_Min	23.67	23.26					
	Temp_Max	35.19	32.20	31.10	30.00	31.00	30.00	30.00

	Rain_Fall	17.9	125.9	290.6	133.6	224.5	259.4	

Appendix 2: Crop Data

Year	Total Rice	Yield	Irrigated Total	Irrigated Yields
1987	10414	2094.108	-	-
1988	11497	2065.577	-	-
1989	13911	2575.157	-	-
1990			-	-
1991	13228	2450.991	-	-
1992	10104	2420.12	-	-
1993	19071	2487.089	-	-
1994	13164	2052.385	-	-
1995	9956	1608.401	-	-
1996	16412	2153.241	-	-
1997	5857	1021.807	-	-
1998	9773	1495.715	-	-
1999	12217	1871.763	-	-
2000	8590	1358.532	2200	3.52
2001	10420	1503.608	3800	3.95010395

2002	13091	1501.434	3676	3.894067797
2003	4459	1023.646	3865	3.943877551
2004	5419	1254.689	3895	2.908887229
2005	4459	1534.215	-	-
2006	11526	1394.893	-	-
2007	10268	1599.377	4344	4.263002944
2008	20512	2255.801	4508	4.432645034
2009	22159	2565.293	4934	4.568518519
2010	23514	2517.828	5045	4.582198002
2011	25116	2537.226	5274	4.273905997
2012	24651	2359.625	5322	4.383855025
2013	32337	2713.746	5588	4.466826539
2014	29037	2399.554	5666	4.493259318
2015	18924	1937.743	6309	4.568428675
2016	28387	2364.795	6457	4.692587209
2017	26691	2255.832	6470	4.644651831

Appendix 3: QDA 1 Data

Objective 2: Qualitative Document Analysis Part 1 - Evidence of Climate Change Integration in the MNAP 2016

Assessment Scale

3 - High Linkage - Provides clear and detailed linkage of key words to climate change and the policy plans/strategies

2 - Moderate linkage - Mentions Key word but does not provide detailed linkage to climate change and policy plans/strategies

1 - Low linkage - Key word mentioned in relation to climate change with no obvious linkage to the policy plans or strategy

0 - No linkage - word mentioned but not in direct relation to climate change.

Key Word	Document Section	Scale of linkage to Policy Goals	Significance of Influence and Importance	Scale of linkage to strategies	Significance of Influence and Importance
Weather	**Preface**	2	general reference to climate based impacts and there reference to policy goals but not specific on the means to achieving said goals	**1**	no reference to specific strategies that will be used to achieve climate change management
	Introduction: 1.2 Agriculture in Malawi	2	specific reference of climate based impacts but implied relation to goals	1	no reference to specific strategies that will be used to achieve climate change management

	Introduction: 1.2.1 Structure of the Agriculture Sector	3	specific reference of climate based impacts but implied relation to goals	2	general reference to climate based interventions but not specific activities
	Policy Priority Area 6: Agricultural Risk Management	3	specific reference of climate based impacts but implied relation to goals	2	Strategies can contribute directly to climate based interventions
	Implementation Outline	3	a strategy that relates to climate change as well as contributes to achieving policy goals	3	Strategies can contribute directly to climate based interventions
	Implementation Outline	3	a strategy that relates to climate change as well as contributes to achieving policy goals	3	Strategies can contribute directly to climate based interventions
Climate	**Preface**	1	Reference to climate change not specifically but as part of a range of other issues	1	no reference to specific strategies that will be used to achieve climate change management
	Introduction: 1.1 Overview	1	Mentioned as part of the policies with links to the MNAP 2016 but no specific reference to areas of linkages	1	no reference to specific strategies that will be used to achieve climate change management
	Introduction: 1.2.2 Agricultural Production and Productivity	2	reference to agroforestry as a solution to climate change shows some linkage to climate change goals but there isn't such clear linkage to the policy goals	3	the statement is backed by production strategies outlined in the implementation section of the policy
	Introduction: 1.4 Rationale and Justification of MNAP 2016	2	climate change referred to as one of the key reasons behind development of the MNAP 2016 but no specific reference to impacts of climate that are a challenge for the sector and how the MNAP 2016 aims to rectify those	1	no reference to specific strategies that will be used to achieve climate change management
	Introduction: 1.4 Rationale and Justification of MNAP 2016	2	climate change referred to as one of the key reasons behind development of the MNAP 2016 but no specific reference to impacts of climate that are a challenge for the sector and how the MNAP 2016 aims to rectify those	1	no reference to specific strategies that will be used to achieve climate change management
	Policy Priority Area 1: Sustainable Agricultural Production and Productivity	3	part of priority area that specifically refers to a climate based intervention	2	despite this being an activity in a priority area, the specific interventions that are going to be invested in are not mentioned
	Policy Priority Area 6: Agricultural Risk Management	2	reference to climate change as one of the key threats to agricultural productivity but not specifically	1	no reference to specific strategies that will be used to achieve climate change management

	Policy Priority Area 6: Agricultural Risk Management	2	reference to climate change as one of the key threats to agricultural productivity but not specifically	1	no reference to specific strategies that will be used to achieve climate change management
	Policy Priority Area 6: Agricultural Risk Management	3	direct linkage of climate change to impacts and proposed solution	3	specific mention of some strategies towards climate change management
	Implementation Outline	2	reference to climate change interventions as part of responses to a number of issues with interventions not necessarily coming about because of climate change without specifying which interventions	2	reference to climate interventions as part of a larger solution to various problems not specifically
	Implementation Outline	0	reference to implementing authority	1	no obvious linkages
	Monitoring and Evaluation Plan	2	reference to climate change interventions as part of responses to a number of issues with interventions not necessarily coming about because of climate change	2	reference to climate interventions as part of a larger solution to various problems not specifically
Carbon Dioxide	**No Mention**	0	N/A	0	N/A
Methane	**No Mention**	0	N/A	0	
Emissions	**No Mention**	0	N/A	0	N/A
Variability	**Introduction: 1.2.1 Structure of the Agriculture Sector**	3	reference to weather impacts of concern and these are in relation to the policy goals	3	reference to a specific intervention to be applied in dealing with weather based impacts
	Policy Priority Area 6: Agricultural Risk Management	1	reference to weather variability as one of the impacts resulting into interventions with no specific reference to said weather impacts to policy goals	1	no reference to specific strategies that will be used to achieve climate change management
	Implementation Outline	0	key word mentioned but not in relation to climate change	0	key word mentioned but not in relation to climate change
Vulnerability	**Introduction: 1.2 Agriculture in Malawi**	2	Strong relation to climate change impacts on the sector despite assumed relation to goals	1	no mention of specific strategies on how to deal with the said vulnerabilities
	Implementation Outline	0	reference to implementing authority	0	no obvious linkages
	monitoring and Evaluation Plan	0	reference to implementing authority	0	no obvious linkages
Scenarios	**No Mention**	0	N/A	0	N/A
Projections	**No Mention**	0	N/A	0	N/A
Adaptation	**No Mention**	0	N/A	0	N/A

Mitigation	**No Mention**	0	N/A	0	N/A
Resilience	**Introduction**	1	key word mentioned but not in clear relation to climate change or linkage of climate change management and policy goals	1	no reference to specific strategies that will be used to achieve climate change management
	Policy Priority Area 6: Agricultural Risk Management	2	the reference is not specifically linked to climate change resilience but it states elements that lead to resilience to climate based impacts	2	specific strategies stated that are supposed to contribute to resilience mentioned though not directly linked to climate change
Risk Management	**Introduction: 1.1 Overview**	1	reference to key word but not in direct relation to climate change.	2	key word itself is part of strategies to deal with unsustainable agriculture which can relate to climate change adaptation, but no mention of specific activities in relation to climate change
	Introduction: 1.3 Evolution of Agricultural Development Policy in Malawi	0	key word used in relation of a different policy	0	key word in relation to other policy
	Policy Priority Area 6: Agricultural Risk Management	2	part of a policy priority area to achieve policy goals. But only general relation to climate change	1	mention of strategies that can contribute to climate change management
	Policy Priority Area 6: Agricultural Risk Management	1	no clear relation to climate change	1	no reference to specific strategies that will be used to achieve climate change management
	Policy Priority Area 6: Agricultural Risk Management	1	reference to key word but not in direct relation to climate change	2	general reference to types of interventions to manage risk, but not in direct relation to climate change
	Policy Priority Area 6: Agricultural Risk Management	2	although not specifically mentioned, climate change can be explained from stated impacts and this is also in relation to policy goals	2	an approach not specifically designed by climate change but can contribute to climate change management.
	Policy Priority Area 6: Agricultural Risk Management	1	no clear relation to climate change despite relation to goals	2	a strategy that can contribute to climate change but no clear mention of the specific strategies or exact climate change linkage

	Section 4 .1.14 Statutory Corporations, Trusts, Councils and Boards	2	mention of roles of an organization that plays a role in policy implementation with no specific means	1	no reference to specific strategies that will be used to achieve climate change management
	Implementation Outline	1	although there is a relation to goals, no specific reference to climate change	2	an approach not specifically designed by climate change but can contribute to climate change adaptation.
	Implementation Outline	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	relates to strategies that can generally contribute to climate change management with no mention of specific actions
	Implementation Outline	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	relates to strategies that can generally contribute to climate change management
	Implementation Outline	1	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	relates to strategies that can generally contribute to climate change management
	Implementation Outline	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	relates to strategies that can generally contribute to climate change management
	Implementation Outline	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	an approach not specifically designed by climate change but can contribute to climate change management.
	monitoring and Evaluation Plan	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	an approach not specifically designed by climate change but can contribute to climate change management.
	Monitoring and Evaluation Plan	1	no clear relation to climate change	2	an approach not specifically designed by climate change but can contribute to climate change management.
	Monitoring and Evaluation Plan	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	1	no clear linkage to how climate change as a problem will be dealt with

	monitoring and Evaluation Plan	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	an approach not specifically designed by climate change but can contribute to climate change management.
	Monitoring and Evaluation Plan	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	an approach not specifically designed by climate change but can contribute to climate change management.
	Monitoring and Evaluation Plan	2	a policy statement that covers strategies that can contribute to climate change management in relation to policy goals but not necessarily developed for that specific purpose	2	an approach not specifically designed by climate change but can contribute to climate change management.
Risk Reduction	**No Mention**	0	N/A	0	N/A

Appendix 4: QDA 2 Data Summary Tables

Priority area	Policy Statement	Strategy	Evidence of Climate Proofing		
			Theme	Coherence	Justification of Influence and Importance
3.1: Sustainable Agricultural Production and Productivity	Policy Statement 3.1.1	1	CP 1	0	no obvious linkage
			CP 2	1	transport increases availability of extension services which could increase dissemination of climate information
			CP 3	0	strategy focused on current implementation cycle
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		2	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage
			CP 3	0	no obvious linkage
			CP 4	1	coordination can improve service delivery in the agriculture sector thereby improving state of agriculture in the country
			CP 5	0	no obvious linkage
		3	CP 1	0	no obvious linkage
			CP 2	1	potential to increase efficiency of delivery of climate information therefore cushion production
			CP 3	0	no obvious linkage
			CP 4	0	an opportunity to enhance agriculture development based on current threats
			CP 5	0	no obvious linkage
		4	CP 1	0	no obvious linkage
			CP 2	1	improved service delivery within government therefore potential improving climate service delivery
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		5	CP 1	0	no obvious linkage
			CP 2	1	potential to increase information exchange and boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage

			CP 4	1	opportunity for enhancing agriculture development in relation to current climate threats
			CP 5	0	no obvious linkage
		6	CP 1	0	no obvious linkage
			CP 2	1	potential for improving effectiveness of climate-based interventions
			CP 3	0	no obvious linkage
			CP 4	1	intervention can contribute to a more effective agricultural system
			CP 5	0	no obvious linkage
		7	CP 1	0	no obvious linkage
			CP 2	1	potential to increase delivery of climate information and therefore reduce impacts
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		8	CP 1	0	no obvious linkage
			CP 2	1	potential for improving effectiveness of climate-based interventions
			CP 3	0	potential to reduce climatic impacts
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		9	CP 1	0	no obvious linkage
			CP 2	1	potential to increase delivery of climate information and therefore reduce impacts
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		10	CP 1	0	no obvious linkage
			CP 2	1	potential to increase delivery of climate information and therefore reduce impacts
			CP 3	0	no obvious linkage
			CP 4	0	opportunity for enhancing agriculture development in relation to current climate threats
			CP 5	0	no obvious linkage
		11	CP 1	0	no obvious linkage
			CP 2	1	potential to improve agricultural production in the country

			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		12	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.1.2	13	CP 1	0	no obvious linkage
			CP 2	1	potential of cushioning production and contributing to cc adaptation
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		14	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		15	CP 1	0	no obvious linkage
			CP 2	1	potential to deal with impacts resent by current climate variations
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		16	CP 1	1	potential to accurately inform production and boost agricultural production and reduce cc impacts
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		17	CP 1	0	no obvious linkage

			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		18	CP 1	0	no obvious linkage
			CP 2	1	potential to meet agricultural needs based on current climatic impacts
			CP 3	1	potential to meet agricultural needs based on current climatic impacts
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		19	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	future climatic impacts can potentially be abated by such an innovation
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		20	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		21	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.1.3 fingerlings.	22	CP 1	0	no obvious linkage
			CP 2	1	potential of boosting agricultural production and reducing cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to contribute to agricultural development
			CP 5	0	no obvious linkage

		23	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		24	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		25	CP 1	0	no obvious linkage
			CP 2	1	opportunity to boost production and reduce cc impacts
			CP 3	0	strategy focused on current implementation cycle
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.1.4	26	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		27	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		28	CP 1	0	no obvious linkage
			CP 2	1	Such initiatives can reduce impacts presented by current climatic threats
			CP 3	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 4	1	an opportunity to enhance agriculture development based on current threats

			CP 5	0	no obvious linkage
		29	CP 1	1	potential for domesticating climate based instruments
			CP 2	0	no obvious linkage
			CP 3	1	When domesticated, such instruments can contribute to sustainable agro-production
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		30	CP 1	1	designating such areas can help reduce the impacts of cc on production
			CP 2	2	designating such areas can help reduce the impacts of cc on production
			CP 3	2	designating such areas can help reduce the impacts of cc on production
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		31	CP 1	0	no obvious linkage
			CP 2	1	potential for reducing current climatic threats through diversified agricultural production
			CP 3	0	strategy focused on current implementation cycle
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		32	CP 1	1	CC impacts on diversity, hence programme can contribute to species being preserved despite climatic shocks
			CP 2	1	Characterization of diversity now would shade light on vulnerable species in need for conservation
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		33	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		34	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change

			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		35	CP 1	0	no obvious linkage
			CP 2	1	agricultural production can be shielded from impacts of climate change
			CP 3	1	agricultural production can be shielded from impacts of climate change
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		36	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	potential to reduce impacts from climate change
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.1.5	37	CP 1	0	no obvious linkage
			CP 2	1	potential of cushioning production and contributing to cc adaptation
			CP 3	1	potential of inclusion of future climate information in reviews
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		38	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	increasing investments can contribute to enhancement of agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.1.6	39	CP 1	0	no obvious linkage
			CP 2	1	funding can increase investments in agriculture and eventually contribute to reduced vulnerability in the sector
			CP 3	1	funding can increase investments in agriculture and eventually contribute to reduced vulnerability in the sector
			CP 4	1	climatic threats can be used as a justification for setting up such funding opportunities and hence contribute to agricultural development

			CP 5	1	climatic threats can be used as a justification for setting up such funding opportunities and hence contribute to agricultural development
		40	CP 1	0	no obvious linkage
			CP 2	1	funding can increase investments in agriculture and eventually contribute to reduced vulnerability in the sector
			CP 3	1	funding can increase investments in agriculture and eventually contribute to reduced vulnerability in the sector
			CP 4	1	climatic threats can be used as a justification for setting up such funding opportunities and hence contribute to agricultural development
			CP 5	1	climatic threats can be used as a justification for setting up such funding opportunities and hence contribute to agricultural development
		41	CP 1	0	no obvious linkage
			CP 2	0	Financial services can increase access to inputs relevant to boost and cushion agricultural production in the face of cc
			CP 3	1	designing such schemes can help reduce future climatic impacts
			CP 4	1	such schemes can improve the agricultural system in Malawi and boost productivity
			CP 5	0	no obvious linkage
		42	CP 1	0	no obvious linkage
			CP 2	1	reduction of vulnerability of most at-risk groups as far as cc is concerned
			CP 3	1	such innovations could reduce the number of people in need of aid as a result of cc impacts going into the future
			CP 4	1	such an innovation can make use of current opportunities presented by climate change to introduce improved agricultural production
			CP 5	0	no obvious linkage
		43	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	opportunity for enhancing agriculture development in relation to current climate threats
			CP 5	0	no obvious linkage
	Policy Statement 3.1.7	44	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage

3.2: Sustainable Irrigation Development	Policy Statement 3.2.1 Framework.	45	CP 1	1	such studies can result into in-depth consideration of climatic events
			CP 2	1	such studies can lead to implementation of projects with consideration of actual threats
			CP 3	1	such a trend can lead to increased incorporation of actual cc impacts going into the future
			CP 4	1	such an innovation can make use of current opportunities presented by climate change to introduce improved agricultural production
			CP 5	0	no obvious linkage
		46	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	opportunity for enhancing agriculture development in relation to current climate threats
			CP 5	0	no obvious linkage
		47	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		48	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	possibility to reduce future climatic impacts
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.2.2	49	CP 1	0	no obvious linkage
			CP 2	1	coordination of resources can ensure more efficient implementation of irrigation plans and therefore reduce cc impacts
			CP 3	1	Systems put in place can ensure coordination even going into the future
			CP 4	1	coordination can improve service delivery in the agriculture sector thereby improving state of agriculture in the country
			CP 5	0	no obvious linkage
		50	CP 1	0	no obvious linkage
			CP 2	1	reducing impacts by boosting production
			CP 3	0	no obvious linkage

			CP 4	1	innovations can be driven based on opportunities presented by climate change
			CP 5	0	no obvious linkage
		51	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.2.3	52	CP 1	0	no obvious linkage
			CP 2	1	opportunity to boost production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	climatic threats can be used as a justification for setting up such funding opportunities and hence contribute to agricultural development
			CP 5	0	no obvious linkage
		53	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.2.4	54	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	such expos can fuel adoption of climate sensitive innovations aiding agricultural development
			CP 5	0	no obvious linkage
	Policy Statement 3.2.5	55	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	enhancing development based on current opportunities presented by climate change
			CP 5	0	no obvious linkage
		56	CP 1	1	Irrigation is a form of response to climatic impacts

			CP 2	1	Increased production would reduce current climatic impacts
			CP 3	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 4	1	Increasing irrigation development improves farming status in the country
			CP 5	0	no clear linkage to how said capacities can be developed even for future impacts
	Policy Statement 3.2.6	57	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		58	CP 1	0	no obvious linkage
			CP 2	1	capacities to manage water catchments can potentially reduce current CC threats
			CP 3	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 4	1	building capacities can enhance development in the face of cc
			CP 5	0	no obvious linkage
	Policy Statement 3.2.7	59	CP 1	0	no obvious linkage
			CP 2	1	monitoring of potential irrigation sources can improve sustainability of irrigation activities
			CP 3	1	monitoring of potential irrigation sources can improve sustainability of irrigation activities
			CP 4	1	action can potentially improve agricultural development as a result of opportunities presented by climate change
			CP 5	0	no clear linkage to how said capacities can be developed even for future impacts
		60	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	security of innovations going forward
			CP 4	1	enhancing development based on current opportunities presented by climate change
			CP 5	0	no obvious linkage
		61	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage

	Policy Statement 3.2.8	62	CP 1	0	no obvious linkage
			CP 2	1	potential to meet agricultural needs based on current climatic impacts
			CP 3	1	potential to meet agricultural needs based on current climatic impacts
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	1	potential to enhance agricultural development in the country
3.3: Mechanisation of Agriculture	Policy Statement 3.3.1	63	CP 1	0	no obvious linkage
			CP 2	1	consolidation of land can increase land area under agriculture and also help cushion from cc impacts
			CP 3	1	consolidation of land can increase land area under agriculture and also help cushion from cc impacts
			CP 4	1	potential to change the of agricultural development by shifting from traditional agricultural system. Motivation to reduce vulnerability to cc
			CP 5	0	no obvious linkage
	Policy Statement 3.3.2	64	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	enhancing development based on current opportunities presented by climate change
			CP 5	0	no obvious linkage
		65	CP 1	0	no obvious linkage
			CP 2	1	potential to cushion farmers and reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		66	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.3.3	67	CP 1	0	no obvious linkage
			CP 2	1	ensure current agricultural production is fully effective
			CP 3	0	no obvious linkage

			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
3.3: Mechanisation of Agriculture	Policy Statement 3.3.4	68	CP 1	0	no obvious linkage
			CP 2	1	Ensuring meeting of production goals through maximised efficiency therefore reducing impacts
			CP 3	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 4	1	building capacities can contribute to a more organised agriculture system as far as water management is concerned and can be motivated from climate change
			CP 5	0	no obvious linkage
	Policy Statement 3.3.5	69	CP 1	0	no obvious linkage
			CP 2	1	research can probably result into more effective ways of production under climatic impacts
			CP 3	1	if future impacts are considered, research can probably result into more effective ways of production under climatic impacts
			CP 4	1	Research is one of the key entry points for driving development, and this can be motivated by current climatic threats
			CP 5	1	research can uncover innovative mechanization that can improve agricultural production in the future
		70	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage
			CP 3	1	innovative curricula can identify better ways of dealing with future climatic threats or boosting production in the face of.
			CP 4	1	such an innovation can make use of current opportunities presented by climate change to introduce improved agricultural education
			CP 5	0	no obvious linkage
	Policy Statement 3.3.6	71	CP 1	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 2	1	building capacities can increase agricultural production reduce impacts
			CP 3	0	no obvious linkage
			CP 4	0	a need to adapt to current threats can motivate achieving and implementing such strategies
			CP 5	0	no clear linkage to how said capacities can be developed even for future impacts
		72	CP 1	0	no obvious linkage
			CP 2	1	building capacities can increase agricultural production reduce impacts
			CP 3	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 4	0	a need to adapt to current threats can motivate achieving and implementing such strategies

			CP 5	0	no clear linkage to how said capacities can be developed even for future impacts
3.4: Agriculture Market Development, Agro processing and Value Addition	Policy Statement 3.4.1	73	CP 1	1	potential to boost agricultural production and reduce cc impacts
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	opportunity for enhancing agriculture development in relation to current climate threats
			CP 5	0	no obvious linkage
		74	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.4.4	75	CP 1	0	no obvious linkage
			CP 2	1	potential to increase efficiency of delivery and incorporation of climate information therefore cushion production
			CP 3	1	research element can promote the integration of climate information on a more complex level
			CP 4	0	no obvious linkage
			CP 5	0	opportunity for enhancing agriculture development in relation to current climate threats
	Policy Statement 3.4.6	76	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	1	potential to contribute to agricultural development
			CP 5	0	no obvious linkage
		77	CP 1	0	no obvious linkage
			CP 2	1	opportunity to boost production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		78	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage

			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.4.7	79	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage
			CP 3	1	potential to enhance agricultural development in the country
			CP 4	0	can potential motivate climate action based on impacts and lead to development
			CP 5	0	no obvious linkage
	Policy Statement 3.4.8	80	CP 1	0	no obvious linkage
			CP 2	1	potential of cushioning production and contributing to cc adaptation
			CP 3	1	potential of cushioning production and contributing to cc adaptation
			CP 4	1	an opportunity to enhance agriculture development based on current threats
			CP 5	0	no obvious linkage
		81	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	0	an opportunity to enhance agriculture development based on current threats
			CP 5	0	no obvious linkage
	Policy Statement 3.4.9	82	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		83	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		84	CP 1	0	no obvious linkage

	Policy Statement 3.4.10		CP 2	0	no obvious linkage
			CP 3	1	potential to reduce impacts from climate change
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
3.5: Food and Nutrition Security	Policy Statement 3.5.2	85	CP 1	0	no obvious linkage
			CP 2	1	ability to contribute to reduced climatic events
			CP 3	1	potential to reduce impacts from climate change
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		86	CP 1	0	no obvious linkage
			CP 2	1	potential to cushion vulnerable groups from the impacts of climate change
			CP 3	1	potential to cushion vulnerable groups from the impacts of climate change
			CP 4	1	empowering poor farming households to be able to be more productive
			CP 5	0	no obvious linkage
	Policy Statement 3.5.6	87	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change (reduction of nutritional value of crops)
			CP 3	1	potential to reduce impacts from climate change (reduction of nutritional value of crops)
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
3.6: Agricultural Risk Management	Policy Statement 3.6.1	88	CP 1	1	potential to strengthen response to climatic events of concern
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	Current threats can be part of motivation for action**
			CP 5	0	no obvious linkage
		89	CP 1	1	potential to strengthen response to climatic events of concern
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	Current threats can be part of motivation for action**
			CP 5	0	no obvious linkage

		90	CP 1	2	reference to actual climatic events
			CP 2	2	strategy incorporates known climatic impacts to reduce vulnerability
			CP 3	2	strategy incorporates known climatic impacts to reduce vulnerability
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		91	CP 1	2	climate impacts motivation for risk-based insurance
			CP 2	2	strategy incorporates known climatic impacts to reduce vulnerability
			CP 3	2	strategy incorporates known climatic impacts to reduce vulnerability
			CP 4	2	Agricultural development in the country can be enhanced
			CP 5	0	no obvious linkage
	Policy Statement 3.6.2	92	CP 1	1	potential to strengthen response to climatic events of concern
			CP 2	2	strategy can potentially incorporate known climatic impacts to reduce vulnerability
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		93	CP 1	0	no obvious linkage
			CP 2	1	strategy can potentially incorporate known climatic impacts to reduce vulnerability
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
	Policy Statement 3.6.4	94	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		95	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage

			CP 5	0	no obvious linkage
		96	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	possibility of reducing future impacts from pests
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		97	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	possibility of reducing future impacts from pests
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
3.7: Empowerment of Youth, Women and Vulnerable Groups in Agriculture	Policy Statement 3.7.1	98	CP 1	1	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		99	CP 1	0	no obvious linkage
			CP 2	1	reduction of vulnerability of most at-risk groups as far as cc is concerned
			CP 3	1	reduction of vulnerability of most at-risk groups as far as cc is concerned
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		100	CP 1	0	no obvious linkage
			CP 2	1	reduction of vulnerability of most at-risk groups as far as cc is concerned
			CP 3	1	reduction of vulnerability of most at-risk groups as far as cc is concerned
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		101	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage

			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.7.2	102	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		103	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		104	CP 1	0	no obvious linkage
			CP 2	1	potential to incorporate a highly specified level of climate integration
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	1	potential to enhance agricultural development in the country
		105	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	1	potential to enhance agricultural development in the country
		106	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	1	potential to enhance agricultural development in the country
		107	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts

			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.7.3	108	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.7.4	109	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		110	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
3.8: Institutional Development, Coordination and Capacity Strengthening	Policy Statement 3.8.1	111	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		112	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	potential to inform agricultural development
			CP 5	0	no obvious linkage
		113	CP 1	0	no obvious linkage

			CP 2	0	no obvious linkage
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.8.2	114	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		115	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		116	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		117	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to reduce future climatic years
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		118	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	1	potential to reduce impacts from climate change
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage

		119	CP 1	0	no obvious linkage
			CP 2	1	Financial services can increase access to inputs relevant to boost and cushion agricultural production in the face of cc
			CP 3	0	no clear linkage to how said capacities can be developed even for future impacts
			CP 4	1	a need to adapt to current threats can motivate achieving and implementing such strategies
			CP 5	0	no obvious linkage
	Policy Statement 3.8.3	120	CP 1	0	no obvious linkage
			CP 2	1	potential to increase exposure and dissemination of climate based information
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		121	CP 1	0	no obvious linkage
			CP 2	1	potential to increase exposure and dissemination of climate based information
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		122	CP 1	0	no obvious linkage
			CP 2	1	potential to increase exposure and dissemination of climate based information
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		123	CP 1	0	no obvious linkage
			CP 2	1	potential to increase delivery of climate information and therefore reduce impacts
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		124	CP 1	0	no obvious linkage
			CP 2	1	potential to increase delivery of climate information and therefore reduce impacts
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country

			CP 5	0	no obvious linkage
	Policy Statement 3.8.4.	125	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	potential to boost agricultural production and reduce cc impacts
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		126	CP 1	0	no obvious linkage
			CP 2	0	strengthening dissemination of climate information possible
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
	Policy Statement 3.8.5	127	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		128	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		129	CP 1	0	no obvious linkage
			CP 2	0	no obvious linkage
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		130	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage

			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		131	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	possibility of reducing future climatic impacts
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		132	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		133	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	1	possibility of reducing future climatic impacts
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		134	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change
			CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage
		135	CP 1	0	no obvious linkage
			CP 2	1	potential to boost agricultural production and reduce cc impacts
			CP 3	0	no obvious linkage
			CP 4	1	potential to enhance agricultural development in the country
			CP 5	0	no obvious linkage
		136	CP 1	0	no obvious linkage
			CP 2	1	potential to reduce impacts from climate change

	Policy Statement 3.8.6		CP 3	0	no obvious linkage
			CP 4	0	no obvious linkage
			CP 5	0	no obvious linkage

Appendix 5: Questionnaire

Questionnaire

Informed Consent

This is a questionnaire that is part of an academic research project for a Masters in Climate Change and Adaptation at the University of Nairobi. The project aims to develop a crop-specific climate-proofing model for streamlining adaptation in the agriculture sector using rice as a case study. This will be based on strategies employed under the implementation of Malawi's National Agricultural Policy. For the project to achieve its goals, the perceptions that farmers have on the ability of the various practices implemented under the Malawi National Agricultural Policy will be assessed. This will be to be done to analyse whether the practices are contributing to climate change and establish gaps and opportunities for enhancing the climate-proofing of the policy through strategy development. You have been randomly selected to partake in this survey with your consent. Be assured that the research prioritises your right to safety, confidentiality and autonomy to make decisions and that the information that will be solicited from you shall be used for purposes of this survey alone. I thank you for your participation.

Questionnaire No.: ____

Interviewer Details: ____

Date: ____________/______________________________/___________________

Section A: General Information

1. Name of respondent____
2. Economic Planning Area

	Kaporo South
	Kaporo North
	Nyungwe
	Vinthukutu
	Lupembe
	Mpata

3. Section:

4. Education background

	None
	Primary
	Secondary
	Certificate
	Diploma
	Degree
	Masters and other
	Other

5. Income source

	Employment
	Farming (Crop)
	Farming (Livestock)
	Other non-agricultural business

	Casual labour

6. Farming type

	Smallholder (self)
	Cooperative (smallholder farmers)
	Medium scale farm

7. Years Farming rice:

	0-10
	11-20
	21-30
	30+

8. Rice species farmed:

	Local
	Faya
	Pussa
	TCG10
	Kilombero
	Other

9. Hectares

____

10. Frequency of Cultivating rice

	Yearly
	Almost every year
	Once every 5 years
	Random??

11. Other crops farmed:

	Maize
	Cassava
	Groundnuts
	Sorghum
	Millet
	Irish potato
	Other

12. Type of farming

	Rain fed
	Irrigation
	Both

13. Knowledge of climate change

	Yes
	No

If yes, level of knowledge

	3: Very Knowledgeable	Physical basis, causal effect relationships, impacts experienced
	2: Moderately Knowledgeable	Causal-effect relationships, impacts experienced
	1: Basic knowledge	Impacts experienced
	0: no knowledge	Based on word of mouth

14. Which climatic events have been experienced? (Please tick all that apply)

Tick	Event
	Floods
	Drought
	Rainfall variability
	Shortening rainfall seasons
	Increased temperature
	Dry spells
	Other:

15. Climate change impacts relating to rice production (Please tick all that apply) *

	Impact	Associated Climate **
	Increase production	
	Reduced soil fertility (nutrient leaching)	
	Loss of fertile soil cover	
	Low grain weight	
	Water stress	

*List to be refined based on findings from objective 1.
**Key: 1 = Reduced rainfall, 2 = Rainfall variability, 3 = Weather unpredictability, 4 = drought, 5 = dry spells, 6 = increased temperature
Other, please specify in space provided below.
____
____
____

Section B: Basic Knowledge of Governing Strategies

16. Have you heard about the MNAP 2016?

	Yes
	No

If yes, please specify the level of knowledge

	3: Very Knowledgeable	Knowledge of MNAP 2016 and functionality
	2: Moderately knowledgeable	Knowledge of the MNAP 2016
	1: Basic knowledge	Heard about it

17. Do you know about other governing policies apart from the MNAP 2016?

	Yes
	No

If yes, please specify level of knowledge

	3: Very Knowledgeable	Knowledge and functionality of 3 or more policies
	2: Moderately knowledgeable	Knowledge of at least 3 governing policies

	1: Basic knowledge	Knowledge of one of the policies

Section C: Effectiveness of the Strategies

18. Knowledge of strategies devised under the MNAP 2016 with regards to sustainable rice production

	1: Yes
	0: No

If yes, please list
____
____
____
____
____

Other strategies/practices not implemented as part of the MNAP 2016

	1: Yes
	0: No

If yes, please list
____
____
____
____
____

19. Strategy assessment: (List based on assessment of impacts in objective 1 & 2 of the study)

Practices under strategies for Rice production. Strategies ranging from 1 to **N.**

NB: Adaptation in this case refers to allowing average or above average yields despite assorted climate change challenges

Strategy 1:

Practice*	No. of years of practice use	When was the practice introduced? (0 = Practice pre-existing and been employed before 1 = Practice modified after the MNAP 2016 2 = Practices a new introduction (as a result of MNAP 2016 strategies or post-implementation of the MNAP 2016)	CC adaptation Effectiveness (0 = hasn't contributed to adaptation 1 = average yields despite CC events 2 = above average yields despite CC events)	Deliberateness for CC adaptation (0 = practice was not developed to deal with CC impacts 1 = Practice developed to partial deal with climate problem 2 = Practice developed solely for experienced climatic event)	Ability to boost production (0 = Practice contributes to low yields (1 = practice hasn't contributed to obvious yield changes 2 = practice has contributed to increased yields)	Resource intensity (0 = High resource intensity 1 = medium resource intensity 2 = low resource intensity)	Affordability of practice (0 = high implementation costs 1 = Medium implementation costs 2 = low implementation costs)	Institutional support (0 = extension and financial services not available 1 = only extension services available 2 = extension and financial services both available)

Challenges faced while using practices

____

____General views on strategies

____

____

Alternative strategies

____

____

*e.g.: soil management practices, land management practices, water management practices

Practices under strategies for other crop s. Strategies ranging from 1 to **N**

Strategy 1:

Practice*	No. of years of practice use	When was the practice introduced? (0 = Practice pre-existing and been employed before	CC adaptation Effectiveness (0 = hasn't contributed to adaptation	Deliberateness for CC adaptation	Ability to boost production	Resource intensity (0 = High resource intensity	Affordability of practice (0 = high implementation costs	Institutional support

		1 = Practice modified after the MNAP 2016 2 = Practices a new introduction (as a result of MNAP 2016 strategies or post-implementation of the MNAP 2016)	1 = average yields despite CC events 2 = above average yields despite CC events)	(0 = practice was not developed to deal with CC impacts 1 = Practice developed to partial deal with climate problem 2 = Practice developed solely for experienced climatic event)	(0 = Practice contributes to low yields (1 = practice hasn't contributed to obvious yield changes 2 = practice has contributed to increased yields)	1 = medium resource intensity 2 = low resource intensity)	1 = Medium implementation costs 2 = low implementation costs)	(0 = extension and financial services not available 1 = only extension services available 2 = extension and financial services both available)

*e.g.: input mixture, changes in planting time, changes in varieties, introduction of new crop species

Challenges Faced

____
____

General views on strategies

____
____

Alternative strategies

____
____
____

20. Concluding Comments
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Appendix 6: Interview Guide

Institutional Coherence

Informed consent

This is an interview that is part of an academic research project for a Masters in Climate Change Adaptation at the University of Nairobi. The project aims to develop a crop-specific climate proofing model for streamlining adaptation in the agriculture sector using rice as a case study. This assessment will be based on strategies employed under the implementation of Malawi's National Agricultural Policy. For the project to achieve its goals, the practical climate proofing coherence of the implementation activities based on the Malawi's National Agricultural Policy will be assessed. This information will be used to identify gaps and opportunities that can be exploited to enhance climate proofing of the sector through policy. You have been randomly selected to partake in this interview with your consent. Be assured that the research prioritises your right to confidentiality and autonomy to make decisions and that the information that will be solicited from you shall be used for purposes of this research alone. Thank you for your willing participation. This interview should take about 15-20 minutes to complete

Questionnaire No.: ____

Interviewer Details: ____

Date: __________/___________________________/_________________

Questionnaire

Section A: General Information

1. Name: ____
2. Contact details (email and phone): ____
____
3. Organization Name: ____
4. Organization Type *(please tick):*

Tick	Type
	1. Governmental
	2. Non-Governmental
	3. Other:

5. Organization Classification ***(please tick):***

Tick	Classification
	1. Research
	2. Extension Services
	3. Capacity building
	4. Other:

6. Position: ____
7. Gender: ☐ Male
☐ Female
8. Role in implementation of the Malawi's National Agricultural Policy:

(Please tick all that apply)

Tick	Role
	1. Policy advocacy
	2. Designing implementation activities
	3. Interventions in rural community
	4. Coordination of various aspects of policy directives
	5. Other:

Section B: Climate Proofing Knowledge

For the purposes of this study, climate proofing shall be defined as ***'A methodological approach aimed at integration of climate change impacts and increasing awareness of the challenges and opportunities presented by climate change'***

9. Knowledge of climate proofing
   i) Do you have any previous knowledge of the climate proofing concept?
      ☐ Yes
      ☐ No

If yes continue with questions 9(ii)-(iii)

   ii) Are you aware of how the concept is being applied in the climate proofing of the Malawi National Agriculture Policy 2016?
      ☐ Yes
      ☐ No

   iii) Do you think the climate proofing concept was applied in the development of the Malawi's National Agricultural Policy? *(Please tick ONE appropriate response)*

Tick	Factor
	0 = Not certain
	1 = Somewhat certain
	2 = Very certain

10. Which of the following best describes the importance of the Malawi's National Agricultural Policy in the sector? *(Please tick, multiple answers allowed)*

Tick	Goal
	Food security
	Livelihood security
	Economic development
	Climate change adaptation
	Climate change mitigation

11. Do you think climate proofing was integrated in the following policy outcomes? (*Please tick ONE appropriate response)*

Tick	Increased agricultural production and productivity
	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

Tick	Increased diversification of agricultural production and marketed surpluses

	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

Tick	**Increased use of irrigation in crop production.**
	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

Tick	**Increased mechanisation of farming and agro-processing activities.**
	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

Tick	**Increased agro-processing and value addition of agricultural products, particularly by women and youth**
	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

Tick	**Increased access by producers and consumers to well-functioning agricultural markets – input, output, and consumer retail markets.**
	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

Tick	**Increased engagement by women, youth and vulnerable groups in agriculture policy processes and programs.**
	0 = Not deliberate
	1 = Semi deliberate (climate-related issues partially goal in outcome)
	2 = Deliberate (climate-related issues main goal for outcome)

12. Based on your opinion, how does climate proofing affect achievement of Malawi's National Agricultural Policy goals based on specific outcomes listed in the policy document?

____
____
____

13. Have the following factors (based on Malawi's National Agricultural Policy's outcomes) changed since implementation of the Malawi's National Agricultural Policy?
Please select from the scores below, pick one score per factor:
0 = Negative impact
1 = Unsure of Impact
2 = Positive Impact

Score	Proposed Outcome
	Food production and productivity
	Mechanisation of farming
	Agro-processing activities
	Market access
	Irrigation intensification
	Climate adaptation
	Livelihood security
	Sector-based Economic Development Contribution

What are the possible conflicting issues of climate proofing the Malawi's National Agricultural Policy?

____
____
____

14. What activities are being implemented or have been implemented by your organisation as a result of the Malawi's National Agricultural Policy?
For responses, please use the score below, and fill in appropriate timeframe.
1 = Implemented
2 = Being Implemented
3 = Scheduled for implementation
4 = Implementation Delayed
5 = Other

No.	Activity Name	Time Frame

15. Using the activities listed in question 14, please score the relation of the activities to the climate proofing themes listed in the table below.

For responses, please use the ranking score below, tick ONE appropriate response. The key to themes is provided after the table.

0 = Not deliberate (activity was designed to achieve an overly different goal),

1 = Semi-deliberate, (activity was designed to partly deal with theme)

2 = Deliberate (activity was specifically in relation to theme)

Activity	i. Integration of Impacts*	ii. Consideration of Current CC Challenges*	iii. Consideration of Future CC Challenges*	iv. Consideration of Current CC Opportunities*	v. Consideration of Future CC Opportunities*

* Key to Climate Proofing Themes

i. Climate proofing involves the deliberate integration of climate change and climate change action into policy.

ii. Climate proofing involves consideration of current challenges faced with regards to climate change. These include increase in the frequency of climatic events such as floods.

iii. Climate proofing involves consideration of future challenges faced with regards to climate change. These include projected shifts in agro-ecological zones based on climatic changes.

iv. Climate proofing involves consideration of current opportunities faced with regards to climate change. These include developing climate-smart systems like irrigation networks that also contribute to other socio-economic goals.

v. Climate proofing involves consideration of future opportunities faced with regards to climate change. These include changing farming systems and practices to reduce future vulnerabilities while also enhancing future agricultural production.

Please kindly list any relevant partners in implementation

____
____
____
____
____

16. Concluding Remarks

____
____
____
____
____

Appendix 7: Climatic Impact Assessment Summaries

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
Total_Yield	1978.4503	507.75013	30
Temp_Max	31.1680	.93486	30
Temp_Min	21.9547	.52988	30
Rainfall	913.3567	222.67342	30

Correlations

		Total_Yield	Temp_Max	Temp_Min	Rainfall
Pearson Correlation	Total_Yield	1.000	.304	.149	-.180
	Temp_Max	.304	1.000	.522	-.166
	Temp_Min	.149	.522	1.000	-.044
	Rainfall	-.180	-.166	-.044	1.000
Sig. (1-tailed)	Total_Yield	.	.051	.216	.171
	Temp_Max	.051	.	.002	.191
	Temp_Min	.216	.002	.	.408
	Rainfall	.171	.191	.408	.
N	Total_Yield	30	30	30	30
	Temp_Max	30	30	30	30
	Temp_Min	30	30	30	30
	Rainfall	30	30	30	30

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method

1	Rainfall, Temp_Min, Temp_Max[b]	.	Enter

a. Dependent Variable: Total_Yield

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.331[a]	.110	.007	506.01668	.110	1.066	3

Model Summary[b]

Model	Change Statistics	
	df2	Sig. F Change
1	26[a]	.380

a. Predictors: (Constant), Rainfall, Temp_Min, Temp_Max

b. Dependent Variable: Total_Yield

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	819120.708	3	273040.236	1.066	.380[b]
	Residual	6657374.937	26	256052.882		
	Total	7476495.645	29			

a. Dependent Variable: Total_Yield

b. Predictors: (Constant), Rainfall, Temp_Min, Temp_Max

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-2446.126	4176.532		-.586	.563
	Temp_Max	154.847	119.570	.285	1.295	.207
	Temp_Min	-5.725	208.242	-.006	-.027	.978
	Rainfall	-.302	.428	-.133	-.705	.487

Coefficients[a]

Model		95.0% Confidence Interval for B		Correlations			Collinearity Statistics
		Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance
1	(Constant)	-11031.110	6138.858				
	Temp_Max	-90.933	400.627	.304	.246	.240	.707
	Temp_Min	-433.772	422.323	.149	-.005	-.005	.725
	Rainfall	-1.183	.578	-.180	-.137	-.131	.970

Coefficients[a]

Model		Collinearity Statistics
		VIF
1	(Constant)	
	Temp_Max	1.415
	Temp_Min	1.379
	Rainfall	1.031

a. Dependent Variable: Total_Yield

Coefficient Correlations[a]

Model			Rainfall	Temp_Min	Temp_Max
1	Correlations	Rainfall	1.000	-.050	.167
		Temp_Min	-.050	1.000	-.523
		Temp_Max	.167	-.523	1.000
	Covariances	Rainfall	.184	-4.482	8.576
		Temp_Min	-4.482	43364.670	-13019.190
		Temp_Max	8.576	-13019.190	14297.027

a. Dependent Variable: Total_Yield

Collinearity Diagnostics[a]

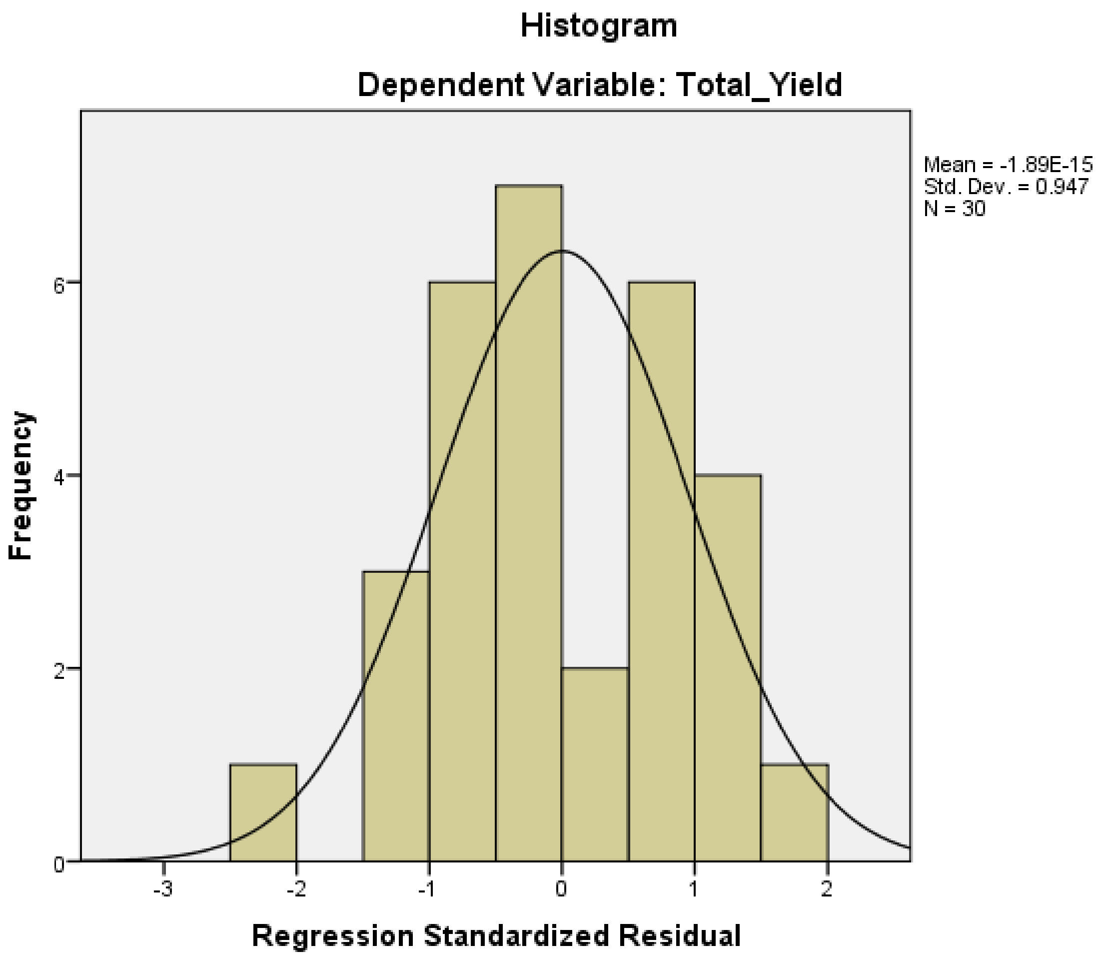
Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	Temp_Max	Temp_Min	Rainfall
1	1	3.957	1.000	.00	.00	.00	.00
	2	.042	9.700	.00	.00	.00	.95
	3	.000	96.841	.41	.88	.04	.05
	4	.000	121.783	.59	.12	.96	.00

a. Dependent Variable: Total_Yield

Residuals Statistics[a]

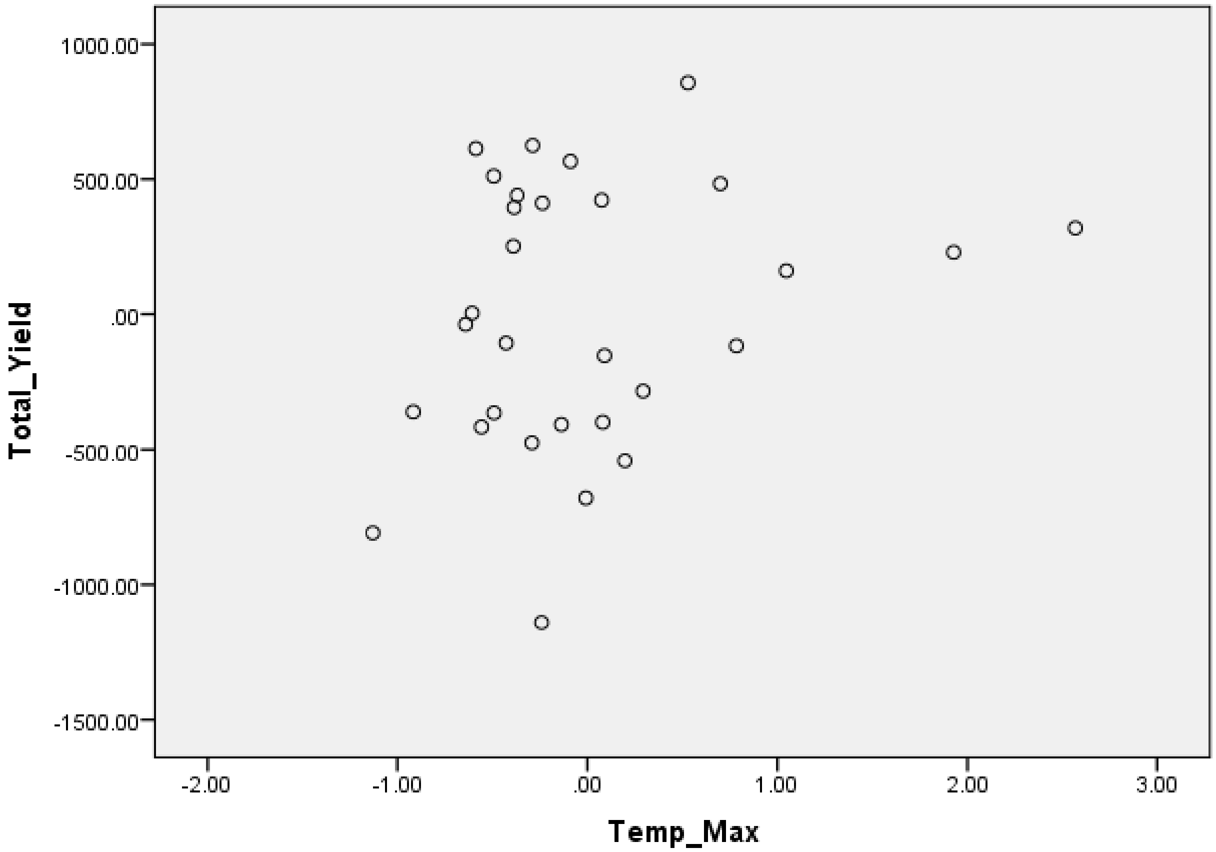
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1657.8694	2442.9114	1978.4503	168.06410	30
Residual	-1103.30908	775.32568	.00000	479.12906	30
Std. Predicted Value	-1.907	2.764	.000	1.000	30
Std. Residual	-2.180	1.532	.000	.947	30

a. Dependent Variable: Total_Yield


Histogram
Dependent Variable: Total_Yield
Mean = -1.89E-15
Std. Dev. = 0.947
N = 30
Frequency
0
2
4
6
-3
-2
-1
0
1
2
Regression Standardized Residual

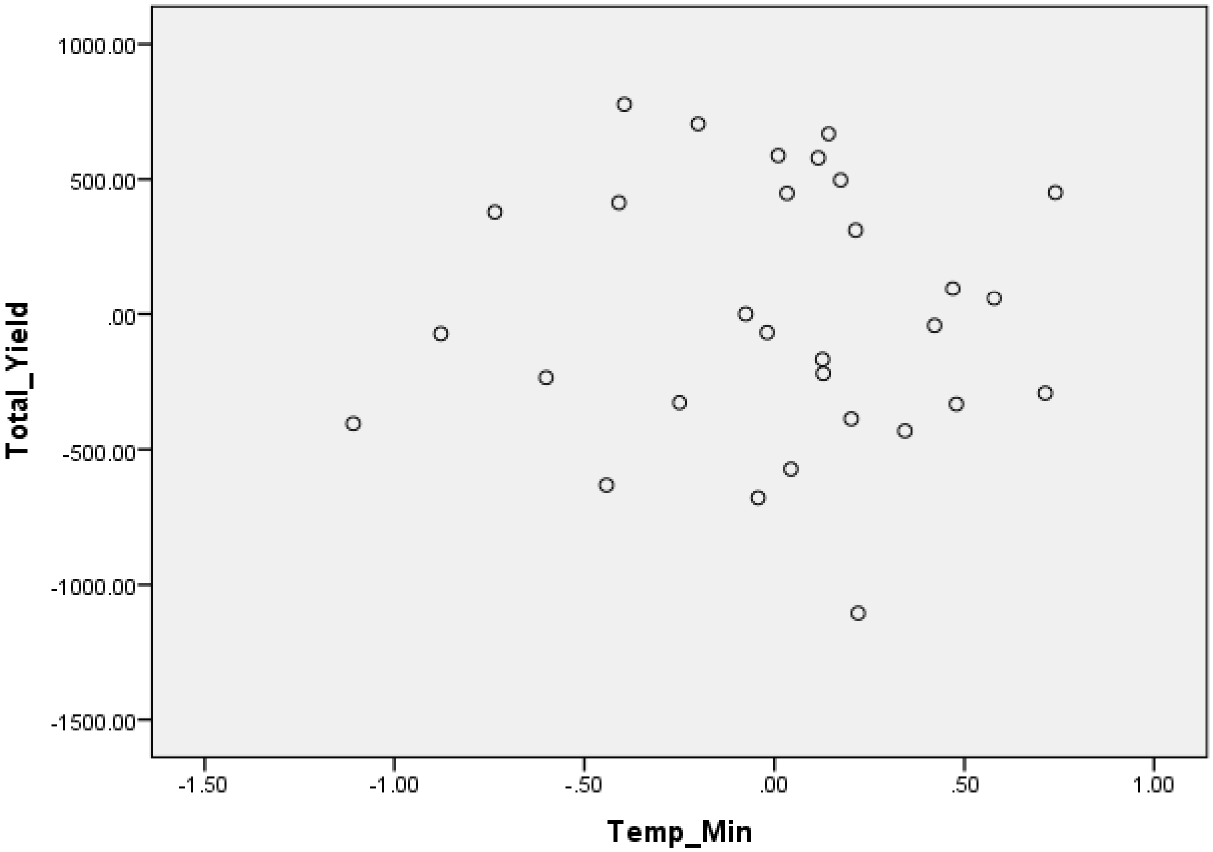
Partial Regression Plot

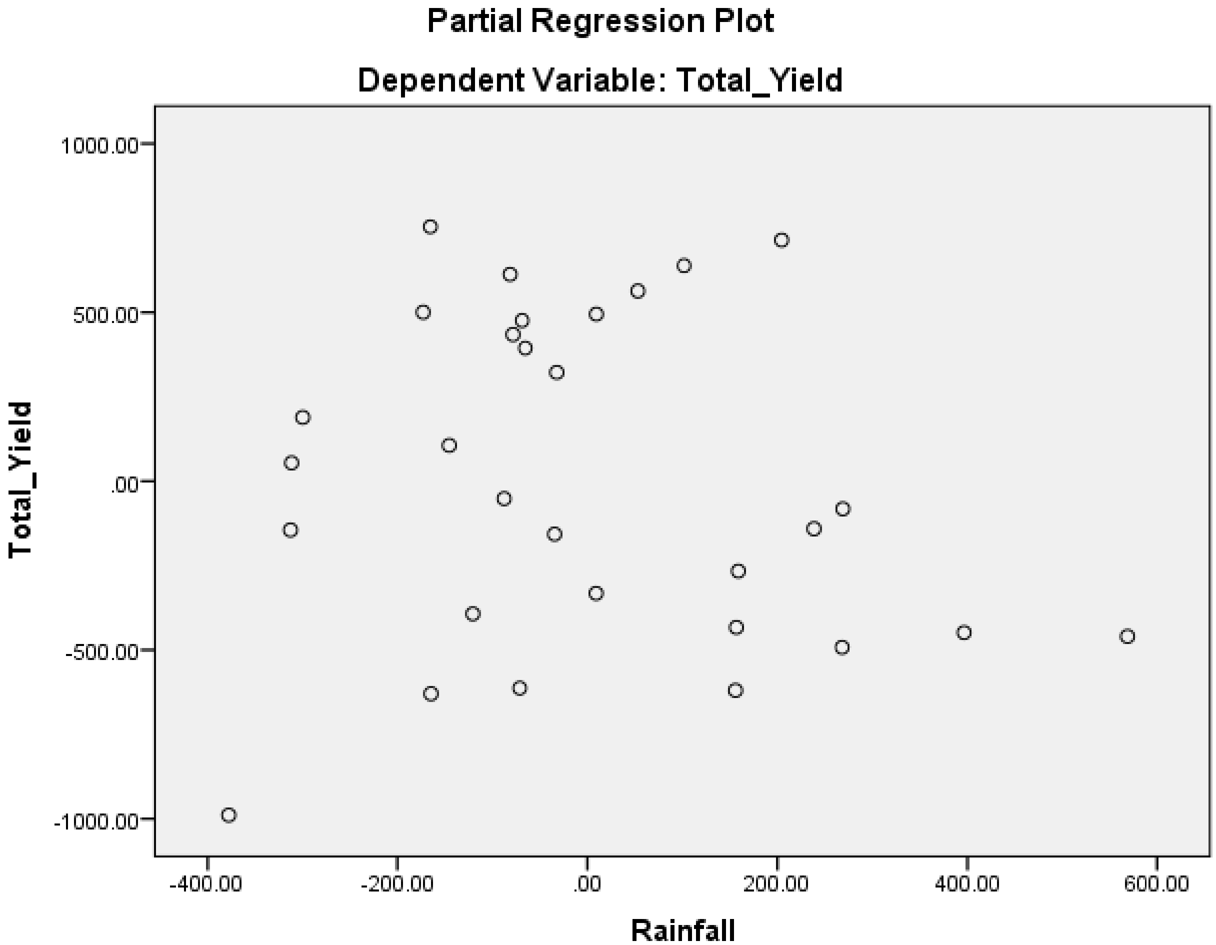
Dependent Variable: Total_Yield



Partial Regression Plot

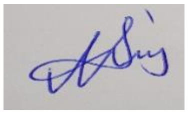
Dependent Variable: Total_Yield




Partial Regression Plot
Dependent Variable: Total_Yield
1000.00
500.00
.00
-500.00
-1000.00
Total_Yield
-400.00
-200.00
.00
200.00
400.00
600.00
Rainfall

Appendix 8: Plagiarism Excerpt

Signed:



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