A Minimal Book Example

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2022-02-02

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Preliminaries

The process to formulate the NAP

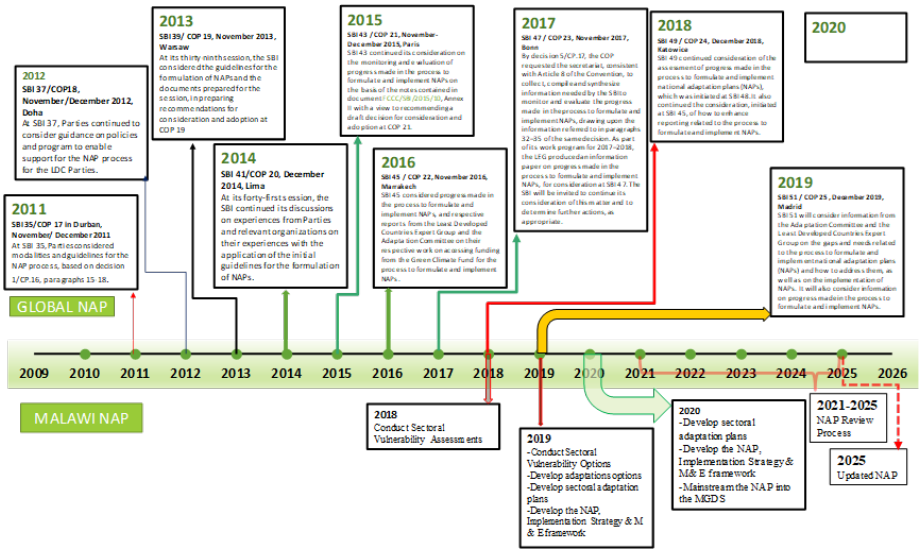

Figure 1: The NAP process

ABOUT MALAWI

Geographically, Malawi is a landlocked country situated in southern Africa bordering Mozambique, Tanzania, and Zambia (Masi 2017). The country has a total area of 118,484 km2 of which 20% is covered by Lake Malawi. The country's topography is varied. In the mountainous sections of Malawi surrounding the Rift Valley, plateaus rise generally 800 m to 1,200 m above sea level, although some rise as high as 3,000 m in the north. Malawi experiences sub-tropical

climate conditions and annual changes between wet and dry seasons. The wet season generally occurs between November and April and the dry season between May and October. Average temperatures range between 18° and 27°C, and the wet season can bring average monthly rainfall in the order of 150 mm to 300 mm (Masi 2017). Annual rainfall ranges from 500 mm in low-lying areas such as the Shire Valley to above 3,000 mm in the northern highlands (USAID 2017a).

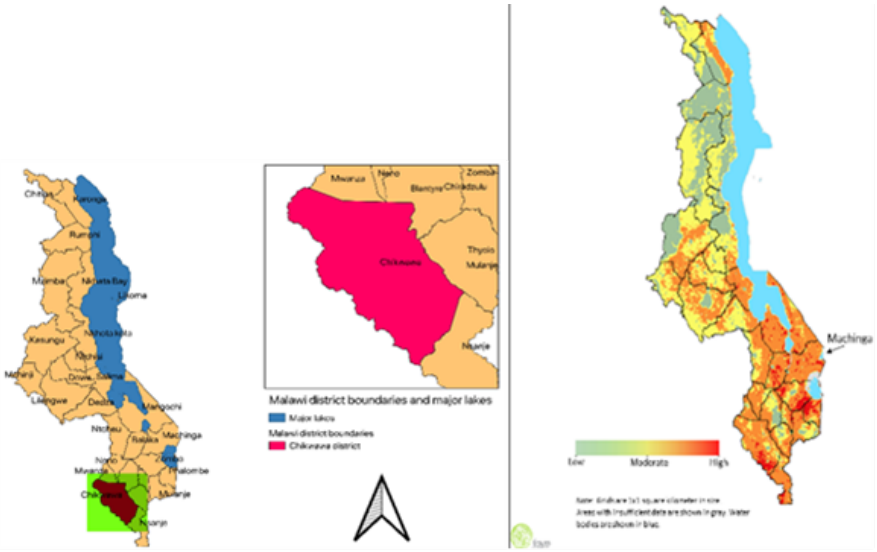

Figure 2: Left panel: District map of Malawi. Source: doi: https://doi.org/10.1371/journal.pone.0242226.g001; Right panel: Malawi Climate Vulnerability Map. Source: https://fraym.io/malawis-adaptive-capacity-to-climate-change/final_map/

Malawi is characterized by widespread poverty, and a rapidly growing population with high population density, putting pressure on land, fisheries, water and other natural resources (Masi 2017). Malawi is already experiencing some of the effects of climate change with observed rising temperatures and changes in the variability of rainfall (Masi 2017). Adverse impacts have already resulted in considerable damage, disrupted economic activity and adversely affected the lives of large number of people, particularly the poor who are the most vulnerable to weather related shocks (Masi 2017). Challenges resulting from climate change include (Masi 2017): dry spells and seasonal droughts linked to crop failures, food security and nutrition availability; intense rainfall associated with severe riverine and flash floods and damaging infrastructure including roads, bridges, schools and health facilities; soil erosion due to intense rainstorms combined with ongoing degradation of upstream catchments causing high sediment deposition loads in rivers hence massive siltation in Lake Malawi that adversely

affects hydropower energy generation; heat stress and outbreaks of livestock diseases like Newcastle disease in chickens and African Swine Fever in pigs; degraded grazing fields resulting to low fodder availability and quality; competition for resources like water and grazing land; denudation of forests and woodlands driven by biomass energy demand also causing biodiversity loss; increase in disease incidence and transmission of cholera, schistosomiasis and malaria.

Or build the book from the R console:

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bookdown::render_book()
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Chapter 1

Introduction

Malawi is experiencing climate related hazards and extreme events which are increasing vulnerability of the communities to climate change across all sectors (Irish Aid 2018) with reports of extreme weather events (that is, droughts, heavy rains, and floods) increasing from just one during the 1970s to nineteen between 2000 and 2006 (Hughes et al. 2019). Mean temperatures have risen by an average rate of 0.21°C per decade, with comparative increases in evapotranspiration (Hughes et al. 2019). Extreme weather events that occur frequently in the country include dry spells, seasonal droughts, intense rainfall, riverine floods and flash floods (Masi 2017). Impacts include the Phalombe flash floods in 1991 that killed over 1,000 people, and wiped out villages, crops, livestock and property and an intensive 2015 flood event that occurred in many districts in Malawi that left many lives and livelihoods destroyed (Irish Aid 2018). The effects of the climate changes and extreme weather events are compounded by a number of other factors. Extensive land use, including the massive cutting down of trees on the Middle and Upper Shire Valleys, has resulted in severe land degradation and soil erosion, leading to siltation of the Shire River and its tributaries, seriously affecting hydro-electric power generation, human health and fisheries (UNFCCC 2006). Soil degradation which is a major challenge in Malawi has soil losses averaged at 20 T/ha/year translating to a 4% - 25% annual yield loss (Irish Aid 2019). The average annual national soil loss rates were estimated at 29 tons per hectare in 2014, with soil erosion and nutrient depletion reported to affect more than 60% of Malawi's land area. Unsustainable farming practices, an increased demand for agricultural land and wood fuels associated with a growing population have all been attributed to cause this degradation with chemical land degradation, including soil pollution and salinization/ alkalization, leading to 15% loss in the total arable land in Malawi. Between 2008 and 2016, majority of urban households relied on biomass energy with a 35% increased charcoal demand worth more than USD 66 million in 2016 providing employment opportunities for over 235,000 people (Hughes et al. 2019). This has a huge impact on agriculture which is the main economic activity of the

country contributing to over 80% of the country's GDP.

Malawi is among the dozen most vulnerable countries globally in terms of adverse effects of climate change, especially drought, but also floods/heavy rains. Heavy dependence on rain-fed agriculture of both the national and local economies, and for the livelihoods of the majority (85%) rural population makes Malawi particularly vulnerable. The rains can start as early as October, especially in the south of the country and can end as late as May, especially in the north of the country (Malawi, 2015). This early rains and extended rains disrupt the agricultural cycle hence having a negative impact on food production in the country. Factors including high population density and poverty, small landholding sizes, and the low-input low-output farming systems exacerbate farmers' vulnerability and reduce the resilience of agricultural systems and adaptive capacity of farming communities to effectively respond to adverse CC impacts or take advantage of emerging opportunities (Zulu 2017). Malawi, with a 3.06% annual growth rate (Masi 2017), has high incidences of poverty, violence, unemployment, malnutrition, HIV and AIDS, high illiteracy rates, poor health, and psychological disorders which characterize the country's young population (MDGS II 2011-2016) (Irish Aid, 2018). About 85% of the people live in rural areas and derive their livelihoods from natural resources and agriculture (from small land holdings of between 1.0 and 5.0 ha per household of five people), with the remaining 15% residing in urban areas (Malawi Vision 2020). The changes in climate and land cover and use are exacting significant adverse impacts on the economy of Malawi. A 1-in-10-year drought event would have an estimated adverse impact of 4% on the annual GDP of Malawi, with even larger impacts for 1-in-15 and 1-in-25-year events (Malawi 2015). The Government of Malawi (GoM) has estimated that 29 metric tons of soil per hectare are lost each year, costing the country an estimated 8% of its annual gross domestic product (GDP) (GOM 2001) (USAID 2017b) and for the period 2001 to 2009, the annual costs of land degradation have been estimated at USD 244 million per year, an amount equivalent to 6.8% of Malawi's country's GDP. There has been migration from rural to urban areas (at the rate of 3.6% per year), and from densely populated to sparsely populated areas or districts over the decades from areas adversely affected by climatic hazards (especially floods and drought) to safer upland areas or other districts (MoECCM 2018) and in search of income earning opportunities (Malawi Vision 2020).

National Adaptation Plans (NAPs) are generally important in several ways. For instance, if countries fail to build resilience of people, places, ecosystems and economies to the impacts of climate change, they risk losing the hard-won sustainable development gains. The most unfortunate part is that poor countries are more vulnerable to the devastating impacts of climate with Malawi being one of the poorest countries in the world, ranked 170 of 188 countries on the global United Nations Development Programme's HDI. Given the climate related challenges faced by Malawi, a NAP will identify and provide a roadmap on key adaptation measures required to address key adaptation needs and processes to ensure that these measures are mainstreamed into the national

planning and development processes and programmes across systems and sectors. The country's Intended National Determined Contribution INDC noted the need to enhance resilience of productive sectors like rain fed agriculture to the associated negative impacts of climate change. The 2016 Malawi National Climate Change Policy noted the need to effectively manage the impacts of climate change through interventions that build and sustain the social and ecological resilience of all Malawians; with the regulation of greenhouse gas emissions to the atmosphere at a level that would prevent dangerous human-induced interference with the climate system within a timeframe that enables social, economic and environmental development to proceed in a sustainable manner. It notes that climate change needs to be integrated into planning, development, coordination and monitoring of key relevant sectors in a gender sensitive manner and through an appropriate institutional framework. The 2006 NAPA sought to increase the adaptive capacities of vulnerable communities to adverse effects of climate change through a number of initiatives, such as: improving community resilience to climate change by the development of sustainable rural livelihoods; restoring forest in Upper, Middle and Lower Shire Valleys catchments to reduce siltation and the associated water flow problems; improving agricultural production under erratic rains and changing climatic conditions; improving Malawi's preparedness to cope with droughts and floods, and; improving climate monitoring to enhance Malawi's early warning capability and decision making and sustainable utilization of Lake Malawi and lakeshore areas resources. The NAP process seeks to reduce vulnerability to the impacts of climate change by building adaptive capacity and resilience while integrating climate change adaptation into relevant new and existing national development policies, programs and activities.

Chapter 2

Framework for the NAP

As indicated in the introduction section above, Malawi's geographical characteristics and the prevailing socioeconomic conditions among the majority of its population, makes it one of the most vulnerable countries to the impacts of climate change globally. The country has been experiencing unpredictable weather patterns characterized by poor distribution of rainfall, causing dry spells, droughts and floods. Devastating droughts and floods witnessed in recent years and high temperatures cause food insecurity affecting millions of its population through low agricultural yields as a result of reduced soil moisture and inflated food prices. Drought lowers hydroelectric power production in the Shire River by reducing the flow rates in the river as a result of complete drying up of some of the tributaries that feed into Lake Malawi. Lake Chilwa, a notable wetland, is drying up. These have made agricultural production and the country's agro-based economy extremely vulnerable. Land degradation and loss of soil fertility, decreasing availability of safe water for humans and livestock as water tables recede, forest fires, floods resulting in severe crop loss and infrastructure damage including roads and the only rail line that links the south to the centre, all result in serious socio-economic disruptions, food and water insecurity, and diseases such as diarrhoea, cholera and malaria. Increased temperatures, droughts, and floods will also result in a range of direct and indirect impacts to health, with malaria being of particular concern to Malawi because as temperatures becomes warmer, it will become more suitable for breeding of mosquitoes even at higher altitudes, which historically have not been exposed to the disease. All these changes among others are depressing economic activities, with significant impact on national GDP, and diminishing the wellbeing of the large population of rural dwellers (85%) whose livelihoods depend on wetlands, livestock and natural resources, as well as the urban poor who have to contend with unemployment and inequality.

The National Adaptation Planning process which was initiated during the seventeenth session of the Conference of the Parties (COP) to the United Nations

Framework Convention on Climate Change (UNFCCC) is today an essential component of planning at all levels because climate change is an issue that has to be addressed over the long-term. The process enables developing and least developed country (LDC) parties to assess their vulnerabilities, mainstream climate change risks, and to address adaptation across all key sectors that are impacted by climate change (LEG, 2012). Further, it is essential that developing country and LDC parties integrate adaptation planning in the broader context of sustainable development planning because climate change risks disproportionately magnify development challenges in these countries as compared to developed countries (LEG, 2012). The national adaptation plan (NAP) process was, therefore, established by the COP as a pathway by which effective adaptation planning in LDCs and other developing countries can be facilitated. The Government of Malawi embarked upon the National Adaptation Plan (NAP) process to adopt a medium-term approach for reducing vulnerability to climate change impacts, and to facilitate the integration of climate adaptation into ongoing planning processes at national and subnational levels.

The agreed objectives of the national adaptation plan process are (LDC-EG, 2012): (a) To reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; (b) To facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The implementation of the NAP process is intended to: * build on existing CCA planning processes and initiatives in order to provide continuity with previous planning efforts; * build on past implementation successes; * eliminate duplication of effort; and * avoid repetition of implementation failures.

2.1 Essential functions of the NAP process

The NAP for Malawi will serve the following functions:

1. Enhanced institutional coordination- Provision of oversight on climate change activity implementation by NSCCC and the NTCCC providing a platform for efficient and effective implementation of national, regional, and global partnerships on climate change.
2. Strengthen the capacity of Malawi's government at all levels to implement a NAP process. MDAs will provide the data and information needed at various stages of the NAP process.
3. Nationally agreed adaptation targets that are mainstreamed into sectoral strategies like the MGDS III and policies which will provide for building of climate change resilience through regular development budgets. National Climate Change Investment Plan will assist the NAP process in resource mobilization.

4. A timetable and a work-plan to harmonize the main policy inconsistencies across Malawi's policy and legal frameworks that are relevant to climate change adaptation, which again will provide for building of climate change resilience through regular development budgets.
5. Incentivized government technical officers through professional development strategies. Capacity development will entail holding regular working group meetings and developing training programs for working groups based on prior training needs assessment. Working group meetings will come up with terms of reference and a training program for climate risk and vulnerability assessments, economical appraisal and design of adaptation pathways.
6. Tools and mechanisms established to promote iterative adaptation planning. Relevant institutions, individuals and organizations involved in CCA will be encouraged to adopt and use this CCA blueprint to build climate change resilience and contribute to the sustainable socioeconomic development of the country.
7. Enhanced access to adaptation finance that delivers the country's adaptation targets effectively. The National Climate Change Investment Plan and the National Climate Change Fund both have stipulated how they will manage fiduciary risks in dealing with the financial resources. Financial integrity in the NAP process will be further assured by adhering to government operating procedures on financial management and procurement as contained in Malawi's Financial Management Act. In addition, the NAP budget will be tabled by the Minister of Finance to the National Assembly during presentation of the annual government budget for approval. All NAP work-plans will be presented to the National Technical Committee on Climate Change and the National Steering Committee on Climate Change for endorsement and approval. This will ensure accountability and transparency.
8. A promotion of private sector engagement in businesses that will meet market demand for adaptation technologies and services. This will be achieved through the engagement of the Malawi Confederation of Chambers of Commerce and Industry (MCCCI) as a go-between to coordinate and facilitate private sector engagement. There will have to be a clear plan/structure for regular and sustained engagement.
9. Identify and address capacity gaps and needs to ensure that adaptation strategies are properly designed and implemented.

2.2 The NAP as the umbrella programme for adaptation

The National Adaptation Plan (NAP) addresses the effects of climate variability and climate change in Malawi with a systems approach – a departure from a sectoral approach. The framework prioritizes transformative investments for

addressing the impacts of climate change on the national economy with a focus on building the resilience of vulnerable communities. The NAP evolves from a background of experience in the National Adaptation Plan of Action (NAPA). Contrastingly, the NAPA was designed to address urgent and immediate needs of the country, created to act as a channel through which the country could access support quickly and take advantage of win-win measures that would avoid increased damages and be more expensive to implement in the future. The NAPA was designed more than 10 years ago, when the country was experiencing heightened levels of vulnerability to floods, drought, and other adverse effects of climate change. With emerging and additional science and knowledge about climate change and its impacts, this NAP provides a framework for awareness and capacity for medium- and long-term adaptation in the various systems which support national socio-economic development. The current Malawi Vison 2063 (MW2063) – aspires to embrace ecosystem-based approaches in managing the environment. With climate change, Malawi has made commitment to develop systems to break the cycle of environmental degradation and increase resilience, sustainable development and planning as well as the promotion of climate change adaptation, mitigation, technology transfer and capacity building for sustainable livelihoods through Green Economy measures. The NAP framework is a direct contribution to the UNFCCC commitment and the MW2063.

There are several development programmes and activities that are taking place in Malawi at national and local governments under national government ministries and parastatals or through bilateral arrangements and partnerships with private sector entities, which need to be buttressed to be resilient to the impacts of climate changes to effectively contribute to targeted development outcomes. Among many others, these include, for example:

- Lilongwe Water and Sanitation Project Malawi by Lilongwe Water Board jointly with Lilongwe City Council to increase access to improved water services and safely managed sanitation services in Lilongwe City;
- the Shire Valley Transformation Program in Chikwawa and Nsanje Districts in the south of Malawi to increase agricultural productivity and commercialization for targeted households and to improve the sustainable management and utilization of natural resources.
- The Social Cash Transfer (SCT), locally known as Ntukula Pakhomo Programme by the Ministry of Gender, Children, Disability and Social Welfare to cushion the poor and marginalized;
- The Public Works Programme (PWP) implemented by the Ministry of Local Government and Rural Development through the National Local Government Finance Committee (NLGFC) it provides regular payments to individuals in exchange for work, with the objective of decreasing chronic or shock-induced poverty and providing social protection.
- The School Feeding Program implemented by the Ministry of Education aims to “improve child nutrition, increase children’s’ ability to concentrate in class, promote enrolment and regular attendance”.

- The Fertilizer Input Subsidy Programme (FISP) implemented by the Ministry of Agriculture to reduce poverty and ensure the country's food security by fostering an increase in agricultural productivity levels.
- The Cement and Malata Subsidy Programme that seeks to provide affordable access to building materials by the poor.
- The Increasing Access to Clean and Affordable Decentralized Energy Services (IACADES) Project under the Ministry of Energy with funding from UNDP and GEF among other sources.
- Community Energy, an energy company funded by the Scottish government aims to help support energy-inefficient countries and to implement new energy-based programs to provide electricity to rural areas, focusing on personal electricity and solar projects, as well as hydro and cooking stoves for communities in rural areas, with 104 rural communities benefitting so far from the installation of install personal renewable energy units. Twelve districts of Malawi have so far received direction and access to these units, and each will begin to produce and regulate their own energy, with Community Energy's support.

Given its cross-cutting nature which includes, inter alia, considerations of adaptive capacity and resilience at systems level while considering also the individual, institutional, and systemic factors, and its mainstreaming into governance and development planning structures, the NAP offers an appropriate umbrella under which national programmes for adaptation can be jointly framed, coordinated and implemented. The NAP will present an aggregate national adaptation plan that will link to appropriate local, subnational, national, and sectoral activities and action plans, maximise on efficiencies, minimise duplication of efforts, and leverage on cost constraints to programme implementation. The NAP process shall also add value to past and current activities by identifying capacity gaps, especially for the design and implementation of medium-term climate change adaptation priorities, as well as by accessing opportunities for international funding to develop more effective climate responsive planning and budgeting. The Malawi NAP coalesces all the discrete climate change adaptation plans and programmes that are or shall be implemented in the country. It comprises of collated, synthesised and analysed data of climate change trends and its impacts, aggregated from local level and downscaled from regional analyses, as well as related peculiar vulnerabilities at scale within and across regions and systems, and identifies gaps and capacity needs that should be addressed. This information will be used to identify and prioritise adaptation options, and to put in place plans to implement the proposed adaptation options, as well as how to finance them. Finally, a monitoring and evaluation framework is determined for the different programmes to track progress and to make adjustments where necessary. Periodic updates (every four years) shall be undertaken to ensure that the NAP is responsive to new and emerging needs and offers an effective mechanism for climate change adaptation at scale.

2.3 Coherence with national development context, SDGs, Sendai and other relevant frameworks

Malawi has espoused a new ambitious development framework – the Malawi Vision 2063 (MW2063) - a successor to Vision 2020 which had the goal of Malawi becoming secure, democratically mature, environmentally sustainable, self-reliant with equal opportunities for and active participation by all, having social services, vibrant cultural and religious values and a technologically driven middle-income country by the year 2020. The predecessor to MW2063 – the Vision 2020 was implemented in a challenging global and domestic environment to the effect that, it only culminated with Malawi still lagging in realising its development potential. The MW2063 is framed on the lessons drawn from implementation of the Vision 2020 with emphasis on getting things done. The new vision is "inclusively wealthy and self-reliant nation is ringing louder across the country". MW2063 is aligned to the Sustainable Development Goals (SDGs) whose overall objective is to create a better and sustainable future for all. The MW2063 encompasses three key strategic pillars including (i) agricultural Productivity and Commercialization (ii) Industrialization, and (iii) Urbanization.

The MW2063 recognises the environment as one of the key enablers for realisation of its strategic pillars. Environmental sustainability is central in the MW2063. The underlying concern as a people is that while the country might enjoy the spoils of the environment today, the country owes it to future generations of Malawians to do so responsibly and sustainably with an ethic of care.

The MW2063 further recognises that the challenges confronting environmental sustainability including: (i) natural disasters and climate adversities; environmental degradation; weak institutional capacity and coordination exacerbated by political interference in regulation and enforcement; limited awareness of environmental best practices; data gaps and limited funding for environment sustainability initiatives. The environment and the MW2063 Vision pillars have overlapping effects on each other, with unplanned urbanization often associated with environmental downsides. The MW2063 reiterates that industrial growth has for long been associated with increased pressure and demand on land and pollution of water and air. It is also water intensive with heightened demand for fuel which is not necessarily clean. Poor Industrial waste management coupled with loss of forest cover have increased the destruction risks on flora and fauna and endangered species. Industrial activity associated with unregulated disposal. These pronouncements align with the NAP vision for Malawi of "a country with people, ecosystems and infrastructure that are resilient and have adaptive capacity to the impacts of climate change."

The government of Malawi developed the National Climate Change Management Policy 2017-2027, to assist the country achieve its long-term goal for cli-

mate change management, which is to reduce the socio-economic impacts of adverse effects of climatic change. The NCCM policy is in line with other national strategies and plans. For example, the Malawi Growth Development Strategy II 2011-2016 recognizes that climate change, environment and natural resources management as key priority areas that needs to be responded to using appropriate approaches because it contributes to lower land quality, heightens extreme weather conditions (e.g. recurrent droughts, heavy rain falls and floods) which sometimes lead to emergency relief efforts that divert much needed finances from development projects, and has significant adverse consequences for agriculture, food security, poverty and vulnerability. The process of developing the MGDS III 2017-2022 considered all the international commitments that Malawi made which include the SDGs, African Union Agenda 2063, SADC RISDP, and other regional treaties. The government advocated for alignment of the SDG to all sector and institutional programming. This guaranteed that all development intervention from the cooperating partners are well aligned towards the SDG timely tracking and reporting of all the agreed indicators. On the other hand, Malawi is also committed to implement the Sendai Framework for Disaster Risk Reduction 2015-2030 as it strives to achieve various SDGs since Malawi is suffering the impacts of disasters from climate change as well another natural causes. The commitment goes beyond the 2030 agenda as resilience building is paramount importance if the development gains being achieved in all the national efforts should be sustained. Malawi is therefore well placed to enact and mainstream a NAP to operationalize its approach to adaptation to climate change and to monitor progress towards desired outcomes.

Chapter 3

Approach/Methodologies

3.1 Guiding principles

In line with the principles established by the UNFCCC and also in line with Malawi's development goals, the guiding principles for the NAP process are as follows: developing sustainably; uplifting the poor and the vulnerable; respecting the critical role of gender; encouraging participation and ownership; incorporating traditional and Indigenous knowledge and proceeding with financial accountability and integrity.

a. A country-driven approach.	country-driven approaches inspire ownership and ensure that plans, programmes and activities are aligned with national priorities.
b. Sustainable development	Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987).
c. Uplifting the poor and the vulnerable	Poor people in Malawi, who are also the majority, are the most affected by climate change impacts and have the least means of adapting to these impacts. Rural, urban and peri-urban poor people bear the brunt of climate-related disasters such as floods because their communities suffer from weak infrastructure. When drought and famine occur, the poor can also cope because of low incomes and reliance on rain-fed agriculture. Malawi's NAP will, therefore, among other principles, be guided by pro-poor principles to ensure inclusiveness. The NAP will ensure that the poor and vulnerable, including women and children, are targeted and benefit from the planning and implementing climate change adaptation interventions. The main objective of this principle is poverty reduction. This principle is in line with Malawi's Vision 2063 and SDG 1.

a. A country-driven approach.	country-driven approaches inspire ownership and ensure that plans, programmes and activities are aligned with national priorities.
d. Gender and social inclusion, and particular consideration of marginalized groups such as women	The NAP will ensure that Malawi's Gender Policy (2015) principles—gender parity, women's empowerment and upholding women's rights—guide the process. The process will include the youth who are already engaged through various climate change youth networks.
e. Participation NAP Process and ownership	This is a critical guiding principle for the NAP. It will allow full involvement of stakeholders and beneficiaries in the NAP activities, thereby enabling information sharing and minimizing efforts' duplication. Soliciting the views of stakeholders at each step of the NAP will ensure their ownership, which will positively affect the outcomes. There are many actors in the climate change adaptation field that are already carrying out various activities. These will now be engaged with the NAP process guided by the framework, which will result in increased focus in terms of planning and funding for adaptation activities. This is important because adaptation activities have long been underfunded at both the central and district level. Stakeholder participation is necessary for buy-in, ownership, involvement in, and support of planned activities.
f. Incorporating traditional and indigenous knowledge	While scientific methods of weather forecasting have evolved in the last 100 years or so, rural communities the world over have traditionally relied on Indigenous forecasting methods. In Malawi, communities have used local Indigenous methods to predict good or bad years by using cloud observations (appearance), wind directions, stars, and the behaviour of animals, insects and plants. Indigenous local knowledge of weather forecasting is useful in decision making at the village level. The NAP process will encourage integrating Indigenous knowledge with the scientific knowledge of weather forecasting. The process requires that communities be engaged to identify knowledge integrated with science, which could then be further disseminated for use by scientists, practitioners and policymakers.
g. Financial accountability and integrity	Resources allocated to climate change adaptation programs can greatly increase over time if there is confidence that these resources will be spent prudently, be quickly accessed, and produce the intended results. This calls for good fiduciary governance of the resources. The National Climate Change Investment Plan and the National Climate Change Fund have stipulated how they will manage fiduciary risks in dealing with the financial resources. Financial integrity in the NAP process will be further assured by adhering to government operating procedures on financial management and procurement as contained in Malawi's Financial Management Act. Besides, the NAP budget will be tabled by the Minister of Finance to the National Assembly during the annual government budget presentation for approval. All NAP workplans will be presented to the National Technical Committee on Climate Change and the National Steering Committee on Climate Change for endorsement and approval. This will ensure accountability and transparency.

a. A country-driven approach.	country-driven approaches inspire ownership and ensure that plans, programmes and activities are aligned with national priorities.
g. A multidisciplinary and complementary NAP approach, building upon relevant existing plans and programmes	Multidisciplinary and complementary approaches are essential in the NAP approach because adaptation is itself multidisciplinary and cross-cutting. The country has mainstreamed climate change issues in its development plans because it has implications for employment creation and economic growth. Its impact on various economic sectors such as agriculture, health and nutrition, tourism, and natural resources has been well established.
l. Simplicity and flexibility of procedures based on the country's circumstances	Simplicity is important where actions are planned in multidisciplinary and multi-institutional/multi-agency contexts coupled with strong involvement of the public and private sector, communities and individuals. Flexibility is important, as adjustments can be made to improve different aspects of implemented programmes.
m. Alignment with the GCF country programme.	This alignment is important to improve access to funds such as the Green Climate Fund. Such alignment would include coherency with the national climate change policy and related strategies and plans, coherence with existing policies, the executing entity's capacity to deliver, and stakeholder consultations and engagement.

3.2 Guidelines used

The main guidelines used included:

- The Technical Guidelines for the National Adaptation Plan Process, UNFCCC – this was used as the primary document for framing of the structure and content of the NAP. It also requires that the NAP process: follows a country-driven, fully transparent, approach; is based on and guided by the best available science and, as appropriate, traditional and indigenous knowledge; and facilitates country-owned, country-driven action and not be prescriptive, nor result in the duplication of efforts undertaken in-country.
- Malawi National Climate Change Policy-2017-2027
- Malawi Second National Communication-2011
- The Malawi Vision 2063
- The Malawi Growth Development Strategy 2017-2022
- Malawi Intended Nationally Determined Contribution
- National Adaptation Plan of Actions-2006
- Malawi NAP Stocktaking Report 2016
- National Climate Change Investment Plan (2013-2018)
- National Environment and Climate Change Management 2012-2016
- National Strategy for Sustainable Development
- Malawi Strategy on Climate Change Learning

In addition, and following the experiences gathered from the implementation of the NAPA process, the Technical Guidelines recommend:

- using locally defined criteria for ranking vulnerabilities and prioritizing project activities, which will build confidence and buy-in across all stakeholders;
- using available data and assessments as a basis for more comprehensive assessments; and
- engaging national experts, as this will also enhance the experience and capacity of the country.

These were supported with emerging new data from the published literature. The assessment of these documents together included:

a. Process of identification/stocktaking of desirable and available information

b. Climate and socio-economic data and information

ii. Current assessments: Exploring possibilities for further assessments
iii. Policies, strategies, plans
iv. Existing initiatives on adaptation

b. Resource mobilization for the process.

3.3 A systems approach to adaptation

Systems are complex, and each system interacts to various degrees with other related systems. Sectoral interventions have not been as successful as desired because they do not consider the interactions of system components, including the fact that the mandate to manage some components of the system may lie in a different sector, and hence come under a different institutional mandate whose primary goal is not necessarily in tandem with those of another sector, and more often than not, there is very little synergy between sectoral programmes.

Urban areas, for example, are complex since many social, physical and economic systems meet and interact, with many of these extending well beyond its spatial boundaries, e.g. water and power supply systems, while other linkages may be transboundary. It is important, therefore, that National Adaptation Plans capture these systems and their interlinkages, scale and stakeholder diversity, so that appropriate and synergistic adaptation measures can be devised and implemented. Thus, the NAP process uses a systems approach which facilitates the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development

planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The framework to guide the assessment of vulnerabilities and risks included:

i. Conceptual framework of vulnerability and risk at various levels: national, system level, local level, etc.
ii. Boundary conditions for the assessment using the period 1971-2000 for baseline climate but also extended further back into time where data is available.
iii. Focus on key systems/sectors.
iv. Synergy with SDGs, Sendai Framework for DRR, and other relevant regional and national frameworks.

3.4 Other unique considerations

The emergence of the COVID-19 pandemic in early 2020 disrupted globally, established societal structures and ways of doing things, and has had devastating impacts on human health, stressed health systems and severely disrupted national economies. A UNDP 2020 study "Covid-19 Pandemic in Malawi Final Report June 2020" shows the high levels of vulnerabilities of individuals, households and the whole Malawian economy affecting negatively on almost all sectors of the economic growth in the country. The study projects that the negative impacts of COVID-19 on the economy are projected to persist for more than 10 years. The open NAP initiative in Malawi has been developed with Malawi being one of the 11 Africa-Asia-Pacific region beneficiaries of GCF funding of a mitigation-themed project named Climate Investor One. However, more funding of projects from other funding sources like LDCF, SCCF, GEF and Adaptation Fund among other sources has not been materialized perhaps due to lockdowns and poor internet access across the country affecting personnel availability to apply for funding as well as undertake the projects. It is however hoped that the situation will normalize and that COVID-19 will be properly managed so as more funding will be availed to Malawi to continue developing this NAP and more funds can be used to develop the next NAP.

3.5 Road Map

This particular process was initiated in 2016 with a stakeholder engagement workshop. Milestones in the process are illustrated in Figure 1 below, with the goal of mainstreaming the NAP into the Malawi Growth and Development Strategy (MDGS III).

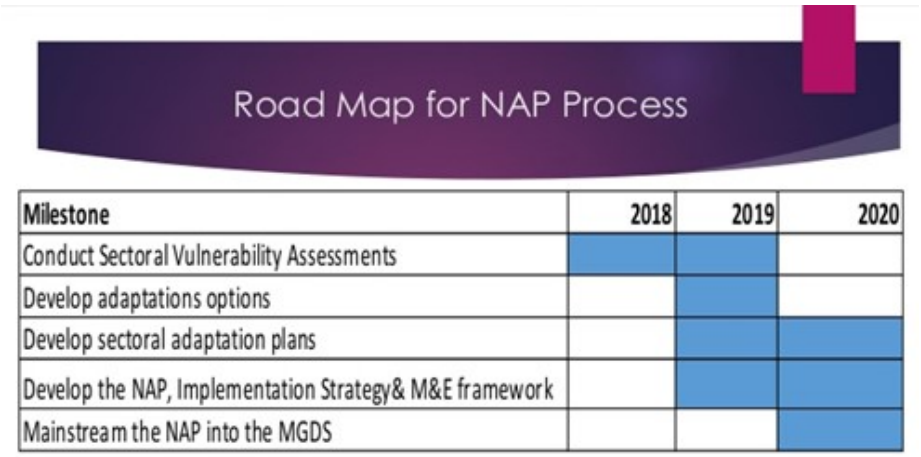


Figure 3.1: Figure 1. Roadmap for NAP Process developed in the stakeholder engagement workshops in 2018, 2019 and 2020

Chapter 4

Vision, goals and objectives of the NAP

4.1 Vision for Adaptation for the Country

The vision is "a country that is resilient to adverse socio-economic impacts of climatic change".

4.2 Goals and Objectives of the NAP

The main goal and objectives of the Malawi NAP, in line with the country's National Climate Change Management Policy, are:

Goal

- Create an enabling policy and legal framework for a pragmatic, co-ordinated and harmonized approach to climate change management. Objectives
- Effectively manage the impacts of climate change through interventions that build and sustain the social and ecological resilience of all Malawians;
- Integrate climate change into planning, development, coordination and monitoring of key relevant sectors in a gender sensitive manner
- Integrate cross-cutting issues into climate change management through an appropriate institutional framework

Chapter 5

National context

5.1 National circumstances

Environment: Malawi's landscape has a varied topography and is dominated by the Great Rift Valley, which runs north to south and contains Lake Malawi and the Shire River Valley. To the west are the central plateaus, highlands (Nyika and Viphya in the north and Shire in the south) and isolated mountains (Mulanje and Zomba) (USAID, 2017a). In the mountainous sections of Malawi surrounding the Rift Valley, plateaus rise generally 800m to 1,200m above sea level, with some especially in the north rising as high as 3,000m. To the south of Lake Malawi lie the Shire Highlands, approximately 900m above sea level. The Shire River plays a very significant role in Malawi by providing water for generating hydropower (98% of Malawi's electricity), agriculture, fisheries, transport, tourism, urban and rural water supply along its length, impacting the livelihoods of over 5.5 million people in the southern region of Malawi (Masi, 2017). Freshwater for irrigation in Malawi's plantations such as Illovo Sugar at Nchalo is obtained from the Shire River; as well as other domestic and industrial uses (UNFCC, 2006). Malawi has multiple important waterbodies including Lake Malawi, (the third largest African Rift Valley Lake), Lakes Malombe, Lake Chilwa, and Lake Chiuta (USAID, 2015). Other rivers in Malawi providing water comprise of North and South Rukuru and Songwe in the Northern Region, Linthipe, Bua and Dwangwa in the Central Region, and Shire and Ruo in the Southern Region (Global Water Partnership, 2016).

In 2005, forest area coverage was at 24.3% while cultivated land covered 33.7%, shrubs and savannah woodlands covered 19.9% and the remaining 22.1% of Malawi was covered by water. In the upper Shire River catchment, there was an 18 % increase in agricultural land in the 1989 to 2002 period (Mtilatila et al. 2020). Forests and trees impact livelihoods and the economy through the supply of biomass fuels, provision of habitats for wildlife and biodiversity,

prevention of land degradation, protection of watersheds and acts as sources of soil fertility (Hughes et al. 2019). Malawi has the highest deforestation rate in sub-Saharan Africa with the government of Malawi estimating that the annual rate of deforestation in Malawi is 1.0–2.8%. Estimation shows that the ratio of forest area decreased from 51% to 33% from 1990 to 2010 (Mapulanga and Naito, 2019). Malawi has very low greenhouse gas (GHG) emissions of around 1.4 tons CO2 equivalents (CO2e) per capita in 2015 by global standards (Hughes et al. 2019). According to Malawi's Nationally Determined Contribution (NDC), the main sectors contributing to GHG emissions are as at 2015, forestry at 78% of the emissions, agriculture at 16% and energy at 4% (Irish Aid, 2018).

Soil degradation is a major challenge with soil losses averaged at 20 T/ha/year. This translate in a yield loss of 4% - 25% annually (Irish Aid 2019). In 2014, the average annual national soil loss rates were estimated at 29 tons per hectare, and soil erosion and nutrient depletion are reported to affect more than 60% of Malawi's land area. The main causes of this degradation are unsustainable farming practices, increasing demand for agricultural land and wood fuels associated with a growing population. Chemical land degradation, including soil pollution and salinization/ alkalization, has led to 15% loss in the arable land in Malawi in the last decade alone. The annual costs of land degradation between 2001 and 2009 have been estimated at USD 244 million per year-an amount equivalent to 6.8% of Malawi's country's GDP. Between 2008 and 2016, urban household demand for charcoal increased by 35% and was worth more than USD 66 million in 2016 and provided employment opportunities for over 235,000 people (Hughes et al. 2019).

Climate: country experiences a cool tropical continental climate, characterized by two distinct seasons: a rainy season from November to April and a dry season from May to October. Annual rainfall ranges from 500 mm in low-lying areas such as the Shire Valley to above 3,000 mm in the northern highlands. Overall rainfall exhibits high inter-annual variability and is highly influenced by the El Niño Southern Oscillation (USAID, 2017a). The rains can start as early as October, especially in the south of the country and can end as late as May, especially in the north of the country (Malawi, 2015). The warm-wet season stretches from November to April, during which 95% of the annual precipitation takes place. Malawi experiences large heterogeneity in rainfall regime, and there are big differences between the North, Central and South regions. Annual average rainfall varies from 725 mm to 2,500 mm with Lilongwe having an average of 900 mm, Blantyre 1,127 mm, Mzuzu 1,289 mm and Zomba 1,433 mm (Masi, 2017). In the south of Malawi, the wet season normally lasts from November to February bringing around 150-300m per month, but rain continues into March and April in the north of the country as the ITCZ migrates northwards. Inter-annual variability in the wet-season rainfall in Malawi is also strongly influenced by Indian Ocean Sea Surface Temperatures, which can vary from one year to another due to variations in patterns of atmospheric and oceanic circulation. The most well documented cause of this variability is the El Nino Southern Oscillation (ENSO) (UNDP, n.d.).

Average daily temperatures vary with seasons and elevation, with the coldest temperatures (12–15°C) in July in the highlands and the hottest (25–26°C) in October in the Lower Shire Valley (USAID 2017a). Mean annual temperature has increased by 0.9°C between 1960 and 2006, an average rate of 0.21°C per decade (Irish Aid 2018). A cool, dry winter season runs from May to August with mean daytime temperatures varying between 17 and 27°C, and temperatures falling between 4 and 10°C at night. A hot, dry season lasts from September to October with daytime temperatures between 25 and 37°C. The wet season generally occurs between November and April and the dry season between May and October. Average temperatures range between 18° and 27°C, and the wet season can bring average monthly rainfall in the order of 150mm to 300mm (Masi, 2017; UNDP, n.d.). Between 1967 and 2003, the country experienced six major droughts and incidences of flooding. 2011-12 droughts had severe effects on food security in many districts in Malawi, with approximately 2 million people affected, particularly in the southern districts. (Irish Aid, 2018). Floods in Malawi have been associated with heavy upstream rainfall resulting in too much water downstream that leads to the breaking-up of riverbanks. This is a common feature on the North Rukuru in Karonga, Likangala in Zomba, and the Ruo/Shire Rivers in Chikwawa/Nsanje. Malawi has also experienced flush floods due to prolonged torrential rains, such as the Phalombe flush floods in 1991 that killed over 1,000 people, and wiped out villages, crops, livestock and property (UNFCC, 2006). Intensive flooding in 2015 left many lives and livelihoods destroyed (Irish Aid, 2018).

5.1.1 National

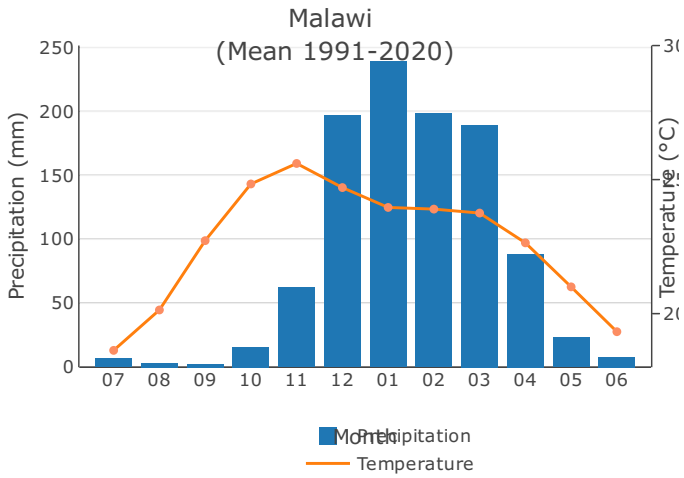
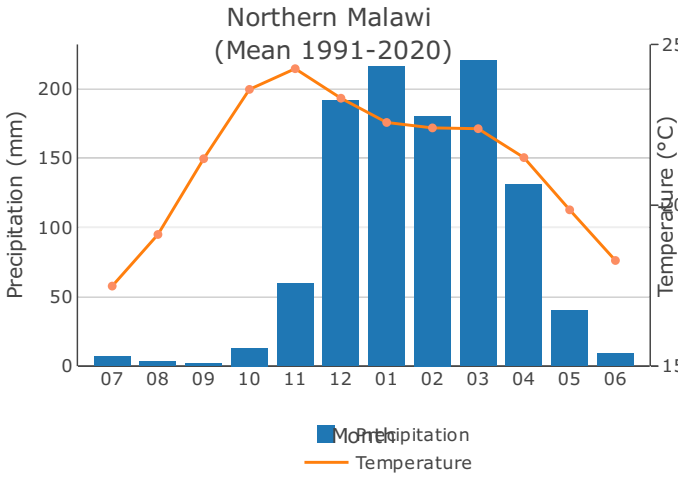
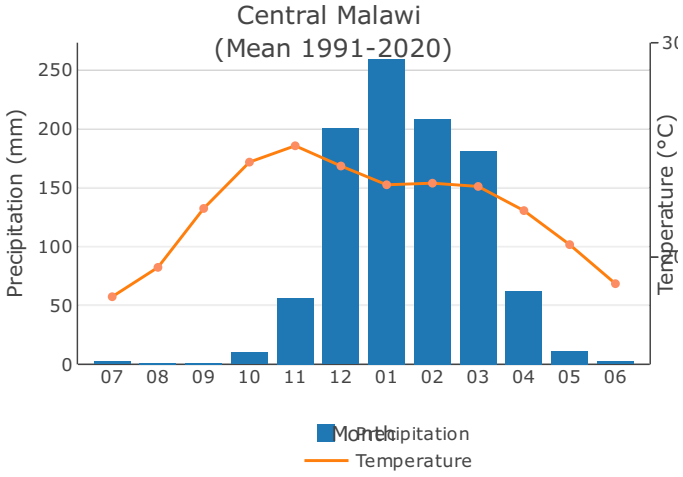


Figure 3 – Monthly Climatology of Mean-Temperature & Precipitation 1991-2020 Malawi.

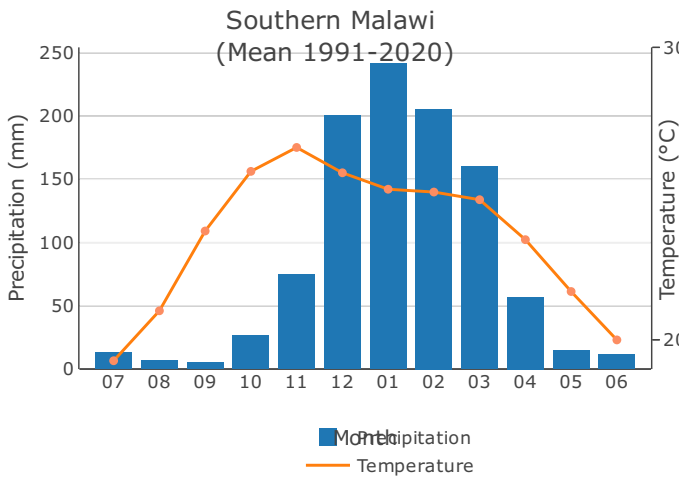
5.1.2 North



5.1.3 Central



5.1.4 South



Political context: The Republic of Malawi is a sovereign State with rights and obligations under the Law of Nations (Malawi Constitution, Chapter one). There shall be a President of the Republic who shall be Head of State and Government and the Commander-in-Chief of the Defence Forces of Malawi (Article 78). The President shall be elected by a majority of the electorate through direct, universal and equal suffrage (Article 80(2)). The National Assembly of Malawi is the supreme legislative body of the nation. The National Assembly has 193 Members of Parliament (MPs) who are directly elected in single-member constituencies using the simple majority system and serve five-year terms. Malawi is a member of the United Nations, the Commonwealth of Nations, the Southern African Development Community (SADC) (Malawi 2017), the Common Market for Eastern and Southern Africa (COMESA), and the African Union (AU). Malawi was a one-party state since attaining her independence until 1993 when it became a multi-party state (Masi, 2017).

Legislative context: The GoM prioritizes climate change, natural resources, and environmental management in its development strategy, the Malawi Growth and Development Strategy (MGDS II 2012–2016). The GoM has also invested in the Green Belt Initiative (GBI); an initiative which seeks to transform Malawi, through irrigation, from a predominantly consuming and importing country to a producing and exporting country (USAID, 2013). In 2016, Malawi made an ambitious 4.5 million hectares restoration pledge to the Bonn Challenge and the African Forest Landscape Restoration Initiative (AFR100) by 2030 estimated at a cost of approximately 279 billion MWK or approximately 62000 MWK

per hectare (USAID, 2017b). GoM in partnership with the World Bank and African Development Bank has formulated this Strategic Program for Climate Resilience (SPCR) under the Pilot Programme for Climate Resilience (PPCR) to act as a framework for addressing the challenges of climate change that impact on the national economy and community livelihoods. The SPCR will build on the available enabling frameworks and efforts in climate resilience-building programs as stipulated in the Malawi Growth and Development Strategy III, National Climate Change Management Policy (2016), National Agriculture Policy (2016), National Climate Change Investment Plan (2013), and Malawi's Nationally Determined Contribution under the UNFCCC (2015).

Malawi is a signatory to various international treaties, instruments and that cover climate change. These include the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. These treaties and instruments oblige the country to take various actions to address climate challenges including putting in place instruments such as climate change policies and legislation. Malawi is a member of the Least Developed Countries' (LDCs) Group, the LDC Expert Group (LEG), and currently has a seat on the board of the Adaptation Committee and the Green Climate Fund (GCF) Board (Masi, 2017). The Government has put in place a series of legislative sectoral frameworks and strategies to integrate environment and climate change management in socio-economic development activities. Key ones include: Malawi Vision 2063; the Malawi Growth and Development Strategies; National Environmental Policy (NEP) 2004; NAPA 2007; National Climate Change Investment Plan (2013); Malawi Energy Policy (2003); Food Security Policy (2006); Disaster Preparedness and Relief Act (DPRA) (1991); Environment Management Act (1996) and the Disaster Risk Management Policy 2015 (Irish Aid, 2018).

Social context: According to the World Population review, January 2018, Malawi has a land area of 118,484 square kilometres, with an estimated population of 18,921,352 million which ranks 61st in the world. Malawi still has a fairly low population density of 129 people per square kilometre (86th in the world). However, Malawi is growing rapidly with a 3.06% (Masi, 2017) annual growth rate. High incidences of poverty, violence, unemployment, malnutrition, HIV and AIDS, high illiteracy rates, abuse, poor health, and psychological disorders characterize the country's young population (MDGS II 2011-2016) (Irish Aid, 2018). About 85% of the people live in rural areas and derive their livelihoods from natural resources and agriculture (from small land holdings of between 1.0 and 5.0 ha per household of five people), with the remaining 15% residing in urban areas. About 48% of the population is below 15 years of age. The overall average life expectancy as of 2008 statistics was 37 years with fertility rates declining from 7.6 in 1984 to 2.8% in 2008 and later rising to 6.7 (Malawi Vision 2020). There has been migration from rural to urban areas (at the rate of 3.6% per year), and from densely populated to sparsely populated areas or districts over the decades from areas adversely affected by climatic hazards (especially floods and drought) to safer upland areas or other districts (Ministry of Environment and Climate Change Management Environmental Affairs De-

partment, 2018) and in search of income earning opportunities (Malawi Vision 2020). 33150 cases and 981 deaths were recorded in Malawi's worst Cholera outbreak. Waterborne infectious diseases are a leading cause of child mortality and contribute to forms of growth retardation, including stunting and wasting with 48 to 53 percent of children under the age of five suffering from stunted growth (Republic of Malawi, 2012). Overall, records as to disaster damage provided by Department of Disaster Management Affairs, DoDMA and the Prevention Web (by The United Nations Office for Disaster Risk Reduction, UNISDR) give critical information related to human and economic losses resulting from the disasters that have occurred in Malawi within last three decades. More than 47 natural disasters were recorded in the last three decades and these disasters range from droughts, earthquakes, epidemics, floods and storms. In these natural disasters, a total of 2,775 people was killed with an average of 90 people killed per year. Most of these (60%) died due to epidemics (National Water Resources Masterplan- Part II masterplan). Malaria is the most common disease in the lake areas, followed by respiratory infections, diarrhoea, anaemia, and bilharzia/schistosomiasis. HIV/AIDS and other sexually transmitted infections (STIs) are also common. Research conducted by Madsen et al. between 1998 and 2007 found a high prevalence of schistosomiasis in communities living along the shores of Lake Malawi. They found that the prevalence of urinary schistosomiasis ranged from 10.2% to 26.4% in inland villages and from 21.0% to 72.7% in lakeshore villages. Infection rates were higher among school age children ranging from 15.3% to 57.1% in inland schools and from 56.2% to 94.0% in lakeshore schools. The HIV infection rate in Malawi as a whole was 10.3% in 2010 (UNAIDS) (USAID, 2015).

Economic context: Agriculture is central to Malawi's economy, contributing nearly 40 percent of GDP and roughly 90 percent of the country's export earnings (USAID, 2017a). Maize is a dominant crop in Malawi, accounting for 28.8 percent of agricultural GDP. Groundnut is an important smallholder food and cash crop in Malawi contributing 1.6 percent to agricultural GDP. Soya and sunflower account for 13 percent of that sector's total intermediate input expenditure, and account for 1.9 percent of agricultural GDP (Aragie et al. 2018). The agriculture sector is the driver of Malawi's economy and provides employment to 85% of the workforce, and contributes 85 to 90% of foreign exchange earnings and 60 to 70% of raw materials for the manufacturing sector (UNFCCC, 2006). Over half (51%) of Malawi's predominantly rural (86%) population live below the national poverty line, most (85%) dependent on agriculture for livelihood, and on only 320 United States Dollars (USD) per capita per year (Chinsinga, Chasukwa and Naess 2012; World Bank 2014; Zulu 2017). Average annual headline inflation in 2016 stood at 22.6%, slightly lower than the 2015 figure of 21.0%, with rising food inflation as the main driver. Power generation reduced by 30% due to low levels in the Shire River affecting economic activities in sectors such as manufacturing, which experienced low capacity utilization. Malawi's overall GDP grew at only 2.7% in 2016, down from 2.9% in 2015. According to the poverty statistics for 2010, 70.9% of the people

in Malawi are living on less than USD1.90 a day. The people living below the national poverty line are 50.7% and the country inequality trend (GINI Index) stands at 46.1 (Irish Aid 2018). According to the United Nations Development Program's Human Development Report for 2014, about 62% of the population in Malawi lives on less than USD 1.25 a day and 89% lives below the US $2 a day threshold (USAID, 2015). Tobacco is Malawi's largest export cash crop, accounting for over half of export earnings, followed by tea and sugar (Purchase from Africans for Africa. n.d.; FAO, n.d.; and World Bank, 2012). Fishing contributes about 4% to Malawi's Domestic Product (GDP) and accounts for 60–70 percent of Malawians' animal protein intake. An estimated 1.6 million Malawians derive at least some income from fishing, fish processing, marketing and trading, boat and gear-making, and allied industries (Brummet and Noble, 1995; Andrew et al. 2003). Wildlife is a valuable tourism resource as it can contribute significantly to incomes and employment. The sector, however, faces a number of challenges including poaching, poor supporting infrastructure, and low community participation in wildlife conservation (USAID, 2013).

Malawi is one of the poorest countries in the world, ranked 170 of 188 countries on the global United Nations Development Programme's HDI. More than 70% of the population lives below the international poverty line of USD 1.90 per capita per day and GDP per capita is just USD 372 (2015). Both inequality and poverty rates are high. About 20.7% of the people are so poor that they cannot afford to eat a minimum daily recommended food intake, and at least 37% of children under five are chronically undernourished and stunted (low weight for age). Malawi's wealth per capita, USD 8,409 in 2014, is much lower than the average for other low-income countries (USD 13,629) or for Sub-Saharan Africa as a whole (USD 25,562) (Hughes et al. 2019). Real gross domestic product (GDP) grew by 5.7% in 2014, but slowed down to 2.5% in 2016 after floods in early 2015 followed by two consecutive years of drought, which has adversely affected the performance of agriculture, which accounts for about a third of the country's GDP. The country has a GDP of USD 6.4 billion (2015 data), and per capita income (2015 data) is USD 34011. Malawi is a low-income country with 74% of Malawians earning USD 1.25 per day or less. Using national poverty headcount, approximately 50.7% of the population live below the national poverty line. About 24.5% are considered ultra-poor, meaning that they cannot afford to meet the minimum standard of the daily recommended food requirement. Levels of chronic malnutrition are very high at 42%, wasting is at 4% and underweight prevalence is at 13%. The 2015 flood damage cost event estimated at US$ 335 million, equivalent to approximately 5% of GDP. Land degradation is estimated to cost the equivalent of 5.3% of GDP each year with soil degradation a significant factor that contributes between 4 and 25% to the loss of agricultural yields in Malawi (Masi, 2017).

Lake Malawi provides the main source of the country's fish production. Other important sources include Lake Chilwa, Lake Malombe and the Elephant Marsh. The sector has experienced considerable decline of commercially important fish species like Chambo (Oreochromis spp.) from around 30,000 Mt a year in the

late 20th century to about 2,000 Mt annually in recent years from Lake Malawi caused by overfishing and climatic influences which result in reduced water levels and disrupt fish breeding and nursery sites. Weak governance capacity to enforce fisheries regulations, and control of illegal fishing and destruction of habitats, contribute to reduced abundance of fish stocks and fisheries resources in Malawi (Masi, 2017). The National Human Development Report of 2001 ranks Malawi as one of the lowest in terms of Human Development Index (HDI), placing it at number 163 out of 173 countries in the world (United Nations Development Programme (UNDP)/Malawi Government (MG), 2001). It is one of the poorest countries in Africa, with about 65% of its population living below the poverty line in 1998, and 29% living in extreme poverty (MG, 1995, 2000; MoA, 2005; UNFCCC 2006). The manufacturing sector currently makes a small contribution to national income (12% of GDP) and employment and there is limited industrial diversification. In addition, there are weak inter and intra-industry linkages (Malawi Vision 2020).

Technological context: Technology is a cross-cutting feature of Malawi Vision 2063 and the country will "heavily invest in research and development to encourage innovations". A developing country such as It was recognised in Malawi Vision 2020 that the country needs information technology to achieve development in all spheres of human endeavour but in Malawi Vision 2063 the role and scope of technology in the envisaged transformation of the country has been greatly enhanced, including its application in adapting to climate changes. Greater use of geospatial technologies such as aerial surveys, satellite monitoring, and drone surveys could help address the limited human resources at field levels. Mobile phone technologies are rapidly improving communication and services with growing opportunities for informing Malawians on environmental issues (Hughes et al. 2019). The media plays a key role in raising public awareness on climate change issues especially in informing rural communities who suffer most due to adverse impacts of climate change due to their low adaptive capacity (Ministry of Environment and Climate Change Management Environmental Affairs Department, 2013-2018). The systematic use of new cell phone technologies, social media, video documentaries, radio and TV programs, and other information-communication technologies can greatly accelerate the widespread knowledge of proven restoration interventions (Ministry of Natural Resources, Energy and Mining, n.d.).

5.2 Legal frameworks

The vision of Malawi's NAP aligns with the Malawi Growth and Development Strategy III (2017-2022). MGDS III is anchored in Water Development, Agriculture and Climate Change. The NAP process will address climate change management through improved community resilience to climate change through enhanced agricultural production, infrastructure development and disaster risk

management. The MGDS III adaptation strategies for Agriculture, Water Development and Climate Change Management include increased agricultural production and productivity, increased land under irrigation; increased agricultural diversification, enhanced agricultural risk management, enhanced integrated water resources management at all levels, and improved weather and climate monitoring for early warning, preparedness and timely response. These will be the strategies the NAP will also prioritize. The MGDS III goals are premised on Malawi's long-term development aspirations, well laid out in Vision 2020 but now needing alignment to Vision 2063. Malawi has also prioritized climate change, environment and natural resources management among the priorities within priorities of the Malawi Growth and Development Strategy (MGDS II). Government of Malawi has also developed the National Climate Change Management Policy (NCCMP) whose goal is to promote climate change adaptation, mitigation, technology transfer and capacity building for sustainable livelihoods through Green Economy measures for Malawi. The policy outlines six priority areas for climate change management in the country which include: Climate change adaptation, Climate change mitigation, Capacity building, education, training and awareness, Research, technology development and transfer, and systematic observation, Climate change financing, Cross-cutting issues like gender consideration, population dynamics and HIV and AIDS.

The NCCMP policy statements are:

1. Reduce vulnerabilities of populations in Malawi and promote community and ecosystem resilience to the impacts of climate change;

2. Ensure that women, girls and other vulnerable groups are engaged and involved in planning and implementing climate change adaptation interventions; and

3. Ensure that communities are able to adapt to climate change by promoting climate change adaptive development in the long term.

4. Promote the reduction of greenhouse gas emissions; and

5. Enhance carbon sinks through re-afforestation and sustainable utilization of forest resources.

6. Build capacity in all sectors and at all levels in climate change to attain socio-economic development utilizing the principles of green economy; and

7. Address capacity gaps on investment in skills and capabilities for negotiations, mechanisms for reducing emissions while supporting prudent environmental management and sustainable economic growth.

8. Enhance research, technology and systematic observation for climate

change management, supported by appropriate capacity development and dedicated financing

9. Encourage resource mobilization and commitment of government for the prioritized technologies.

10. Enhanced financing for implementation and coordination of climate change management activities through increased national budgetary allocation, establishment of a Climate Change Management Fund, improved access to international climate financing (both multilateral and bilateral) and private sector investments.

11. Mainstream gender and issues affecting the disadvantaged groups into all climate change strategies, plans and programmes.

12. Integrate population issues into climate change management in the development agenda through an integrated approach which would reduce poverty, protect natural resources and reduce inequality.

13. Incorporate HIV and AIDS as well as gender considerations in all climate change interventions including adaptation, mitigation, capacity building and technology development and transfer.

The Government of Malawi through their Vision 2020 and the Malawi Constitution 1995 has put in place a series of legislative sectoral frameworks and strategies to integrate environment and climate change management in socio-economic development activities. These include:

i. The Malawi Growth Development Strategies;
ii. United Nations Development Assistance Framework for Malawi (UNDAF);
iii. National Strategy for Sustainable Development 2004;
iv. National Environmental Policy (NEP) 2004;
v. National Forestry Policy of Malawi, 1996;
vi. National Land Resource Management Policy and Strategies (2000);
vii. Wildlife Policy (2000);
viii. Malawi Irrigation Policy and Development Strategy (2000);
ix. National Fisheries and Aquaculture Policy (2001);
x. National Land Policy (2002);
xi. National Environmental Action Plan 2002;
xii. National Climate Change Investment Plan (2013);
xiii. National HIV and AIDS Policy, 2003;
xiv. Malawi Energy Policy (2003);
xv. National Land Use Planning and Management Policy, 2005;
xvi. Food Security Policy (2006);

xvii. National Water Policy (2005);
xviii. Mines and Minerals Policy (2013);
xix. National Transport Policy (2015);
xx. National Construction Industry Policy (2015);
xxi. Water Resources Act (2013);
xxii. Mines and Minerals Act (1981);
xxiii. Disaster Preparedness and Relief Act (DPRA) (1991);
xxiv. Waterworks Act (1995);
xxv. Environment Management Act (1996);
xxvi. Forestry Act (1997);
xxvii. Fisheries Conservation and Management Act (1997);
xxviii. Road Traffic Act (1997);
xxix. Local Government Act (1998);
xxx. Energy Regulation Act (2004);
xxxi. National Parks and Wildlife Act (2004),
xxxii. Gender Equality Act (2013).

Table 5.1: National/sectoral policies, strategies
for adaptation

...1	Title/Type	Year
Climate	Malawi National Climate Change Policy	2016

...1	Title/Type	Ye
	Second National	20
	Communication	
	NAPA	20
	National Climate Change Investment Plan	20
	National Environment and Climate Change Management	20

...1	Title/Type	Year
Environment	National Forestry Policy of Malawi	1996
	National Environmental Policy (NEP)	2004
	National Environmental Action Plan	2002
	National Biodiversity and Action Plan	
Agriculture	Malawi Irrigation Policy and Development Strategy	2000
	Food Security Policy	2006
	Draft National Agricultural Policy	Draft
Energy	Malawi Energy Policy	2003

...1	Title/Type	Ye
Health	National HIV and AIDS Policy	20
Economic	Wildlife Policy	20
	United Nations Development Assistance Framework for Malawi (UNDAF);	20
	The Malawi Growth Development Strategy III	20
	National Strategy for Sustainable Development	20
	Mines and Minerals Policy	20
Land	National Land Resource Management Policy and Strategies	20

...1	Title/Type	Year
	National Land Policy	2002
	National Land Use Planning and Management Policy	2005
Water	National Water Policy	2005
Education	Malawi Strategy on Climate Change Learning	
		2013
Social- Cultural	Gender Equality Act	2013

...1	Title/Type	Ye
	National Gender Policy	20
Fisheries	National Fisheries and Aquaculture Policy	20
	Fisheries Conservation and Management Act	19

Table 5.2: General environmental laws and their policy rele
for adaptation

Title/Type	Year	O
Environment Management Act	2,017	Th en st m co an an Pl au M Po ac en
Energy Regulation Act	2,004	Th re an th re en re th pr
Rural Electrification Act	2,004	Th m m re

Title/Type	Year	Objective
Disaster Preparedness and Relief Act (Cap. 33:05)	1,992	This Act makes p Malawi and for di mitigation. There Preparedness an supervise the est and civil protectio materials and ser provides for the e Preparedness an
Wildlife Policy	2,000	The policy embra adequate protect biological diversit land managemen utilization conside understanding on management and issues; Create a enterprises; Facil and enforcement wildlife use; and I and institutional f without comprom

5.3 Institutional arrangements for climate change adaptation

Malawi has several existing institutional structures to support climate change mitigation and adaptation policies (Malawi & Environmental Affairs Department, 2016). The Malawi Constitution explicitly calls for environmental support, and the Malawi government has addressed climate change at the national, ministerial and departmental level (Amadu et al., 2020). Coordination between government agencies is a significant challenge for implementing the climate change policy components since climate change is a cross-cutting issue affecting most sectors, such as agriculture, human health, energy, fisheries, wildlife, water, forestry and gender (Hughes et al., 2019a). Table 3 presents the evolution of the climate change agenda.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Political milestones				President passed away (Bingu wa Mutharika)	Interim election (Joyce Banda)		New president (Arthur Peter Mutharika)			
Ministry(ies) with responsibility for climate change	Ministry of Development Planning and Cooperation (Department of Economic Planning and Development)				Ministry of Environment and Climate Change Management		Ministry of Natural Resources, Energy and Mining (Environmental Affairs Department and Department of Climate Change and Meteorological Services			
Date of adoption of key policy documents				National Climate Change and Environment Communication Strategy 2012-16	National Climate Change Investment Plan 2013-18			National Climate Change Management Policy		
Major programmes	National Climate Change Programme (under Africa Adaptation Programme 2008-12)									

Figure 5.1: Table 3: Evolution of the national climate change agenda in Malawi: policies, programmes, institutions and linkage to political leadership (Cacho et al., 2010)

Chapter 6

Climate change adaptation assessment

6.1 Observed climate impacts

The general aspects of the climate and environment of Malawi have been covered in sections 1.1 and 5.1.1 above. In this section, emphasis is on the impacts of observed climate on the identified systems, for which the impacts of climate extreme events are summarised in Table 4 below.

Table 6.1: Examples of notable past extreme c
pacts and impacted systems in Malawi

Hazard	Event Data	Impacts
Drought	1960-2014	· Increasing dro
		· Seven severe
		· The droughts c severely on agric 1991/92 -equivale for the previous fi
		· Annual loss of
		· Malawi food cr
		· Depleted food
		· Deforestation
		· Water scarcity

Hazard	Event Data	In
		.
		. th
		. M
Floods	1967-2014	. su
		. re ec
		.
		.
		.
		.
		. du
		. 19 ca
		.
		. w
		.
Heavy storms	La Niña	.
	2000/01	.
		.
Land degradation	2001- 2014	. es
		. 20 6.
Intense Heat		.

Hazard	Event Data	Impacts
		· Decreased fish
		· Dry river and r
Increased temperature	1960-2006	· Increased tem with an average r
		· Reduced hydr Micro-Hydropowe 1980–2011
Low rainfall	Mid 1980s – 2014	· Decreased pre
	El Niño 1997/1998	· Reduced surfa

Figure 6.1: Figure 2: Common shocks experienced from flooding in 2016-2017 Mzuzu town according to the IHS3 (Kita 2017)

The average temperature in Malawi ranges from 8°C in the northern highlands to 38 °C in the lowland regions around Lake Malawi and the Lower Shire Valley (Nhamo et al., 2019). Since the 1960s, Malawi has recorded an annual mean temperature rise of 0.9°C (Parrish et al., 2020). Analysed data from 1960 to 2007 showed increasing drought frequency and intensity and the variability of rainfall, contributing to regional (SADC) insecurity of food and water (Nhamo & Muchuru, 2019). Malawi suffered seven severe droughts and 19 floods between 1967 and 2014 that adversely affected smallholders' production and food security (Haug & Wold, 2017). As a result, trends in people in need of food assistance (Figure 3) have increased between 2012 and 2016 (Haug & Wold, 2017).

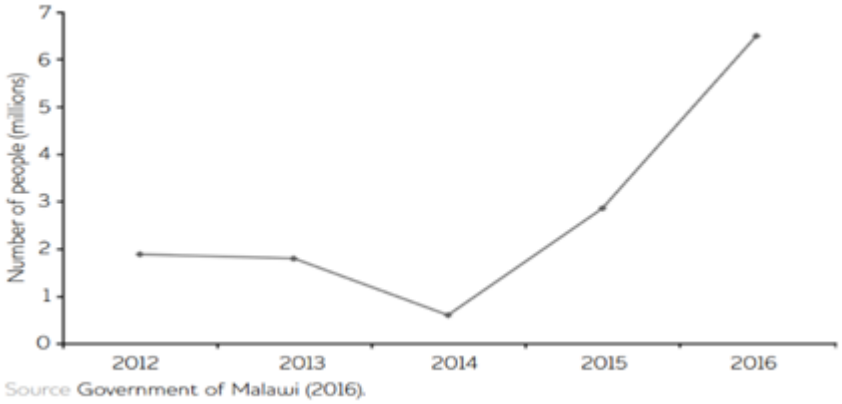


Figure 6.2: Figure 3. Trends in people in need of food assistance

Besides the severe droughts, frequent flood events remain a dominant impact of climate extremes in Malawi (Adeloye et al., 2015; IFPRI, 2020). Although local rainfall patterns are challenging to model accurately, an increase in the frequency and magnitude of drought and floods has been observed (Parrish et al., 2020). Malawi received the highest record rainfall for the country in 2015, causing severe flooding, especially in the Southern Region (Haug & Wold, 2017). According to Adeloye et al. (2015), rainfall in Shire of Malawi is about 2000 mm due to orographic influences. As a result, flooding is more prominent in the Shire valley. According to Malota and Mchenga (2019), the rural lower Shire Valley is most prone to flooding in the entire country - it registered almost three-quarters of the total flood-related economic losses in the past ten years. The Shire Basin is characterized by medium risk communities based on vulnerability and hazard - accounting for 8 of the 12 communities assessed (Adeloye, 2015). In the last decade alone, Malawi recorded an annual average loss of 12 % in maize yield production due to flood-related crop damage (Malota & Mchenga, 2019). The Mzuzu city experienced the worst floods ever recorded since its establishment in April 2016. Fifteen settlements were affected, 19,000 people were displaced, seven people were killed, and seven camps were set up to house the displaced (Kita, 2017). Figure 2 shows the percentage of households that suffered various flood-related shocks between 2016 and 2017 (Kita, 2017).

In Malawi, agriculture is the foundation of the economy (Ajefu & Abiona, 2020). It employs 85% of the workforce and generates one-third of the gross domestic product (GDP) and 90% foreign exchange earnings (Msowoya et al., 2016). Under the dominant land-use practice of ridge tillage, maize-based farming systems cultivated up to 80 % of the land area of the Lilongwe-Kasungu plains (Lark et al., 2020). Maize farming covers over 92% of Malawi's agricultural land and accounts for over 54% of the national caloric intake (Msowoya et al., 2016). In the last decade alone, Malawi recorded an annual average loss of 12 % in

maize yield production due to food-related crop damage (Malota & Mchenga, 2019). Malawi recorded a deficient national average maize production of 0.76 tons per hectare (t / ha) in 2005, 40 % below the expected average (Msowoya et al., 2016). There was also overall maize (the staple crop in the region) deficit of 5.1 million t, a 10% decrease in production compared to the previous year and a 15% drop compared to the 5-year average (Nhamo & Muchuru, 2019). The average national production growth rate in the 1980s was 3%, followed by a production decline rate of 2 % per annum from 1990 to 1994 (Msowoya et al., 2016). Figure 4a shows the agricultural contribution of Malawi to the total GDP, indicating a good correlation between the economic growth of Malawi and agricultural production. In contrast, the changes in maize production in Malawi between 1980 and 2011 are shown in Figure 4b, illustrating the instability of maize production and the steady rise in maize prices over the past decades. Because of climate change, the Lilongwe District, Malawi's largest maize growing district, may decrease by up to 14 % by mid-century, rising to as much as 33 % by the end of the century (Msowoya et al., 2016). Small- and medium-scale farmers bear the brunt of floods, with recorded average annual production losses of 2.7 and 2.2 % respectively, compared to the small gains realized by large-scale farmers (IFPRI, 2020).

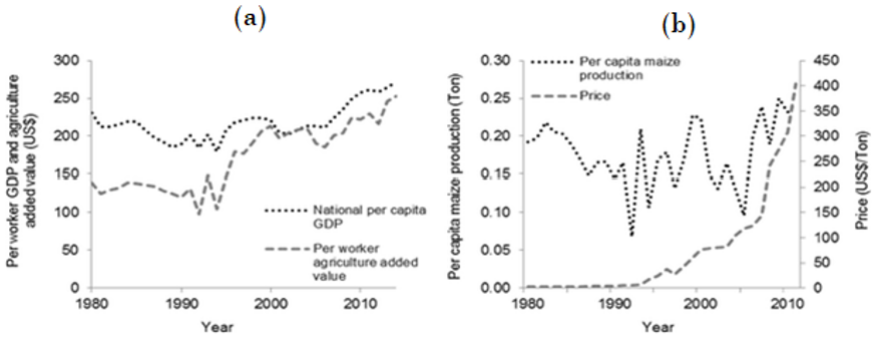


Figure 4: (a) Malawi's per worker agricultural value-added and national per capita GDP adjusted for constant 2005 prices for 1980-2008 (World Bank 2015); and (b) per capita maize production and price for the same period (Chirwa et al. 2006; FAOSTAT 201)

Climate impacts on biodiversity have also been recorded in Malawi. Declining lake levels in Lake Malawi has resulted in a subsequent decline in terrestrial and aquatic biodiversity (Aragie et al., 2018; GCF, 2017). Besides, eutrophication of lakes has led to reduced biodiversity (Hughes et al., 2019a). Malawian fisheries, particularly for most people living in rural areas, are a source of animal protein (Limuwa et al., 2018). However, between the 1970s and 2015, Malawians' fish consumption decreased by 60 % due to low fish catches (Limuwa et al., 2018).

Droughts and floods, the leading climate impacts in Malawi result in elevated poverty levels (Actionaid, 2002). On average, poverty is 1.3 % higher due to droughts and 0.9% higher each year due to floods (IFPRI, 2020). Lack of access

to water, food insecurity, and low-income levels at the household level accelerates poverty during extreme climates (Hughes et al., 2019a). Table 5 demonstrates household livelihoods' exposure to climate risks in the past ten years (Abdi et al., 2020).

Climatic shocks	Exposure	E
	Household (%)	N
Droughts	66	34
Floods	41.2	58
Crop pests and diseases	48	52
Hailstorms	33.299999999999997	66

Source: CIMMYT-led project on Sustainable Intensification of Maize and Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) (Abdi et al., 2020)

Changes in rainfall patterns are highly variable (Hughes et al., 2019a). Figure 5 presents the historical climate variability in Malawi between 1905 to 1998. Northern and Southern Malawi has experienced a drying trend since the early 2000s (Figure 6), while Malawi's centre has seen slightly increased rains. Reports of extreme weather events that is, droughts, heavy rains, and floods) increased from just one during the 1970s to between 2000 and 2006.

(Source: The International Resources Institute for Climate and Society at Columbia University, derived from the Climate Research Unit at the University of East Anglia, the United Kingdom). Note: Yellow-red shading (drought) shows the country's percentage that would experience lower than normal rainfall (to different degrees). Blue shading (floods) indicates the country's percentage that would experience higher than normal rainfall linked to floods.

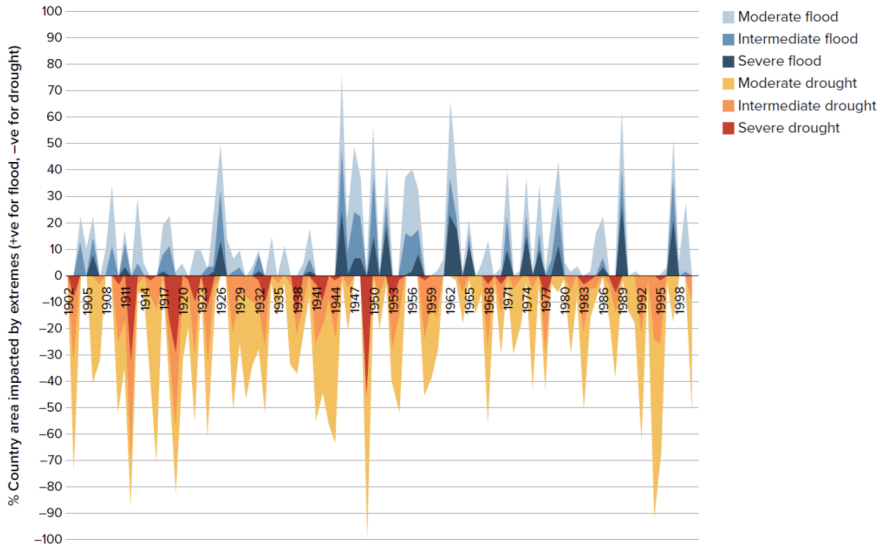
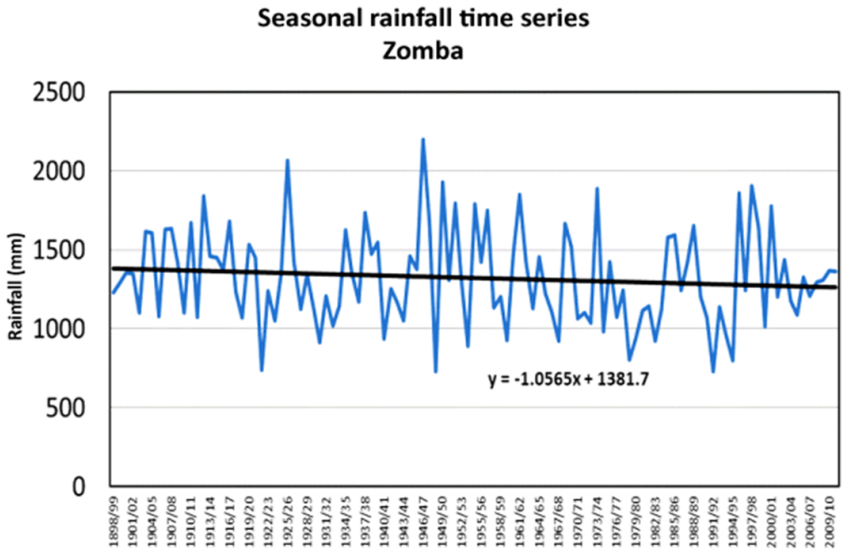


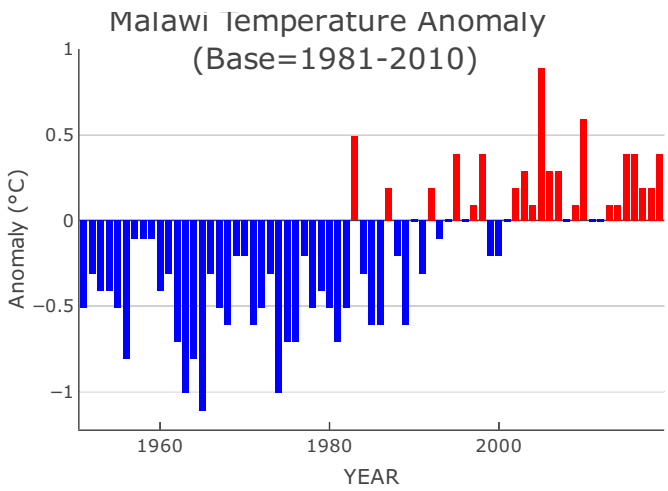
Figure 6.3: Figure 5: Historic climate variability in Malawi.



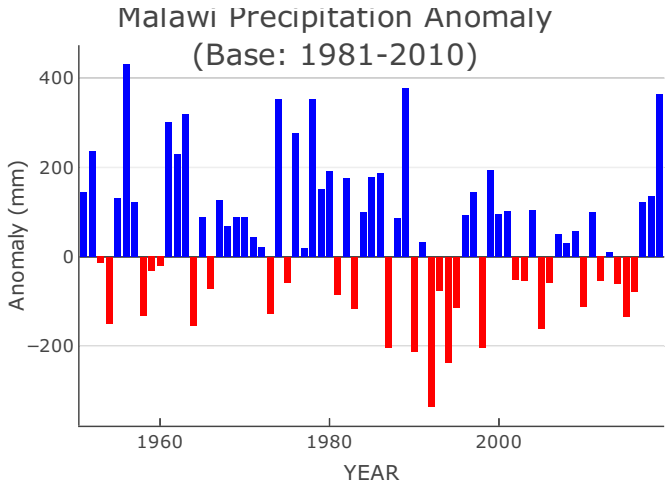
Source: (Jørstad & Webersik, 2016)

Temperature and Precipitation Anomalies in Malawi from 1950 to present (based on climatological period 1981-2010)

Temperature Anomaly



Precipitation Anomaly



Severe floods have been reported to damage infrastructure in Malawi (Hughes et al., 2019a). For example, the 2015 floods highlighted the transport sector's vulnerabilities with severe damage caused to the infrastructure. For the transport

sector, the total damages and losses due to the disaster were approximately USD 60 million, while the cost of recovery was approximately USD 130 million, the highest among all the sectors. Flood events have also reduced electric generation from hydropower energy (Mtilatila et al., 2020). Malawi is close to the bottom of the United Nations Human Development Index league, and one of the world's lowest electricity access rates (Dauenhauer et al., 2020) exacerbates its extreme poverty levels. An estimated 16 million Malawians currently live without electricity or 91 % of the country's population (Dauenhauer et al., 2020). Reduced hydropower generation at the Lujeri Micro-Hydropower Scheme in southern Malawi during 1980–2011 was attributed to increased temperature (Mtilatila et al., 2020).

Malawi has recorded 4,901,344 confirmed malaria cases and 3,614 deaths due to the disease were reported by the World Health Organization in 2017 (Frake et al., 2020). Areas with the highest risk of infection are concentrated in the Shire River valley along the Lake Malawi lakeshore and the central plains, which are characteristically hotter and wetter than other parts of the country. According to Frake et al. (2020), for Anopheles gambiae s.s., 7.25 % of Malawi exhibits suitable water conditions (water only), approximately 16 % for water plus another factor, and 8.60 % is maximally suitable, meeting thresholds of suitability for water presence, terrain features, and climate conditions. Almost 21% of Malawi is suitable for breeding based on land characteristics alone, and 28.24% is suitable for breeding based on climate and land characteristics alone (Frake et al., 2020).

6.2 Projected future climate

The temperature is anticipated to continue to rise by 1.1 to 3.0 C by the 2060s and by 1.5 to 5.0 C by the 2090s (Jørstad & Webersik, 2016). On the other hand, by the 2090s, annual rainfall is projected to decrease throughout Malawi by -14% (Future Climate for Africa, 2019a; GCF, 2017; Msowoya et al., 2016). Modelling of climate change scenarios predicts significant medium- and long-term changes to Malawi's climate, in terms of both temperature and rainfall (Jørstad & Webersik, 2016). Extremes in temperatures (that is, hot and very hot days) are also more likely to occur more frequently (Hughes et al., 2019a). Figure 7 shows the potential highs and lows Malawi may face during the 2030s and 2040s. These extremes in temperatures can negatively affect the vulnerable, such as the old, the young, people living in poverty, and those with health issues. Extreme temperatures can also reduce water quality, cause surges in algal growth, and negatively affect aquatic ecosystems, including fish. Further, it has been observed that an increase in temperature by 5 °C can reduce the lake level by 1.42 m (Mtilatila et al., 2020). Analysis of 34 climate change models projecting up to 2090 suggests more frequent dry spells and a reduction in the number of rainy days and the amount of rainfall each day (Figure 7). It also shows a greater likelihood of flooding. During floods, agricultural losses are

estimated at 3.5 to 8.2 % of GDP during RP5 and RP50 floods, respectively (IFPRI, 2020). These changes are likely to threaten livelihoods, increase the risk of food insecurity, and negatively affect economic growth.

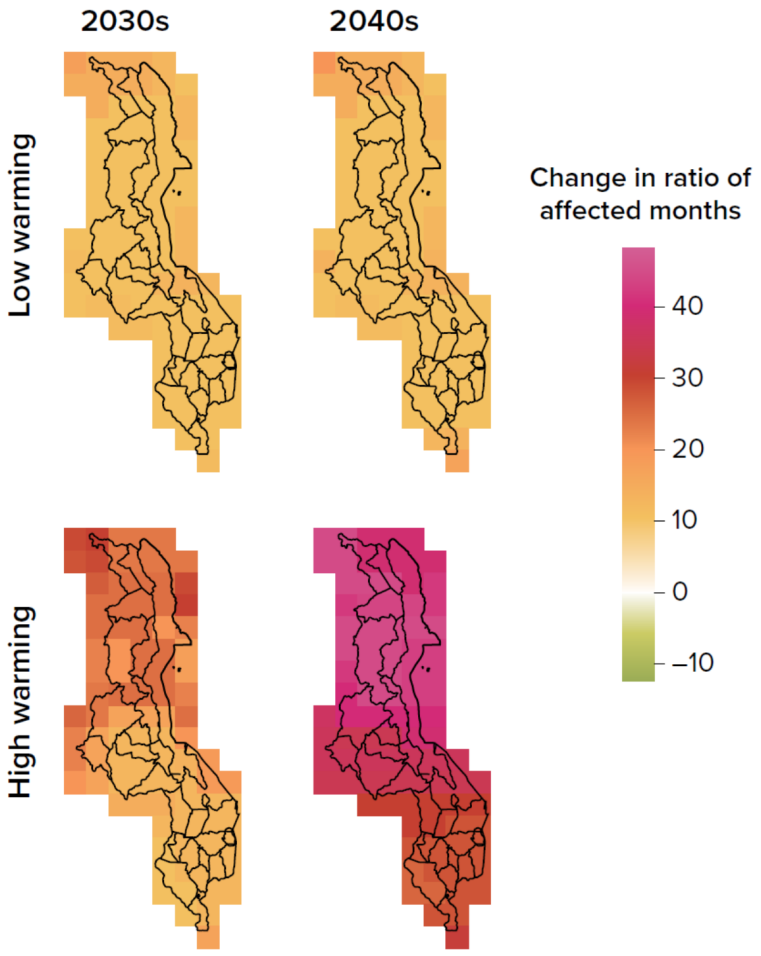


Figure 6.4: Figure 7: Changes in heat extremes in the 2030s and 2040s (Source: World Bank. 2017(c). Multi-Sectoral Investment Plan for Climate and Disaster Risk Management in Malawi)

Mean Temperature change 2021-2040 based on climatological mean 1971-2000

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Scenario: SSP5 - Fossil-fueled Development

National
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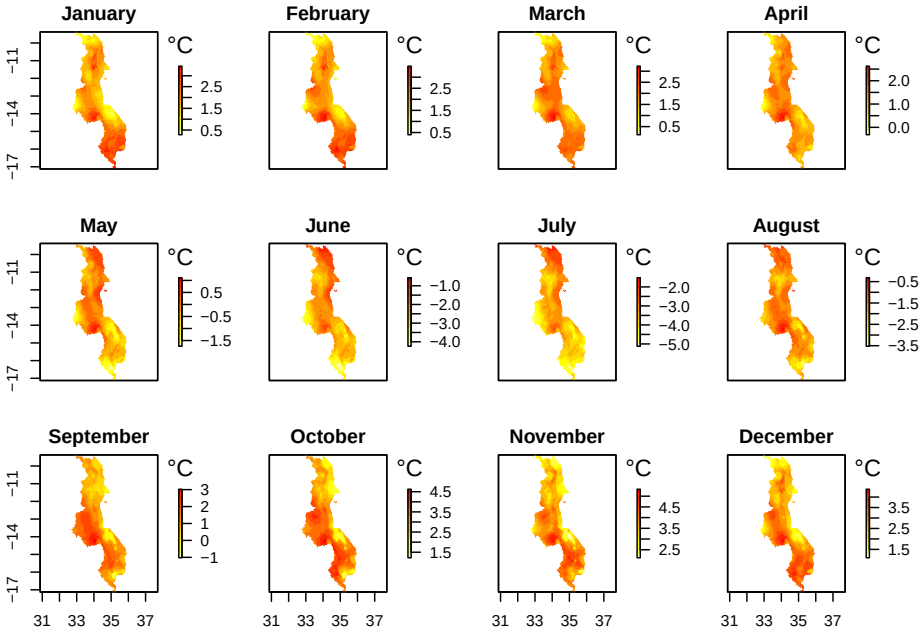
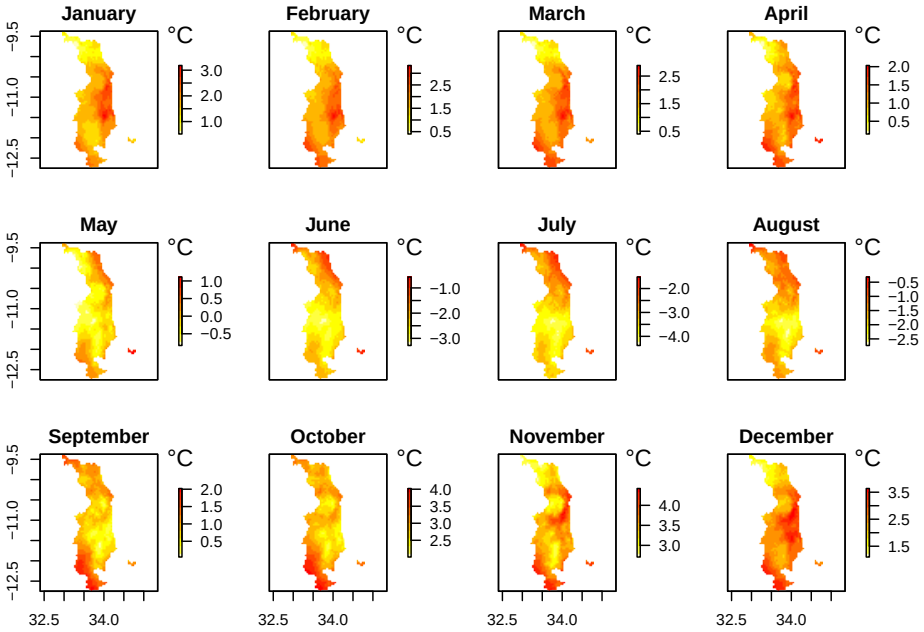
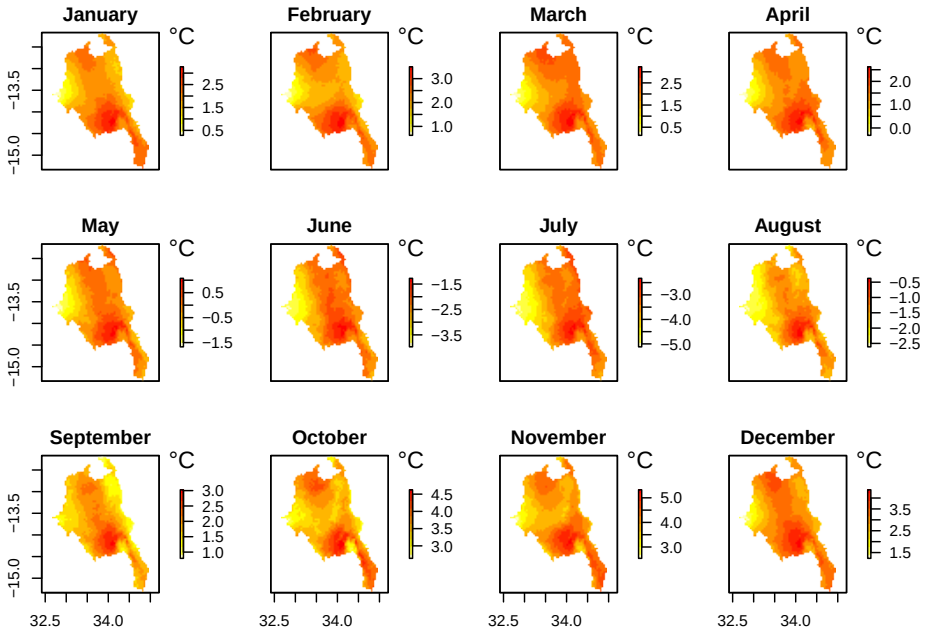


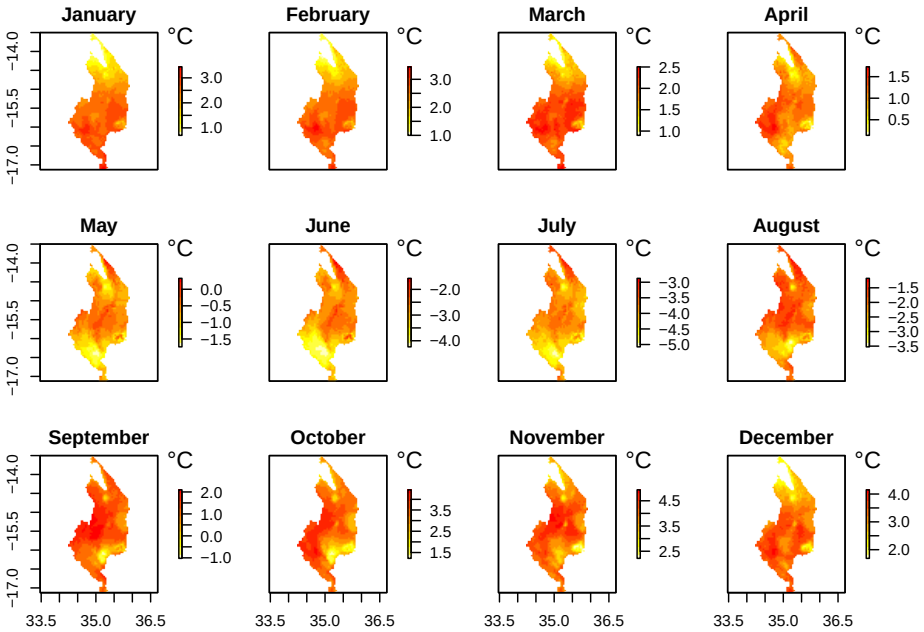
Northern Malawi



Central Malawi



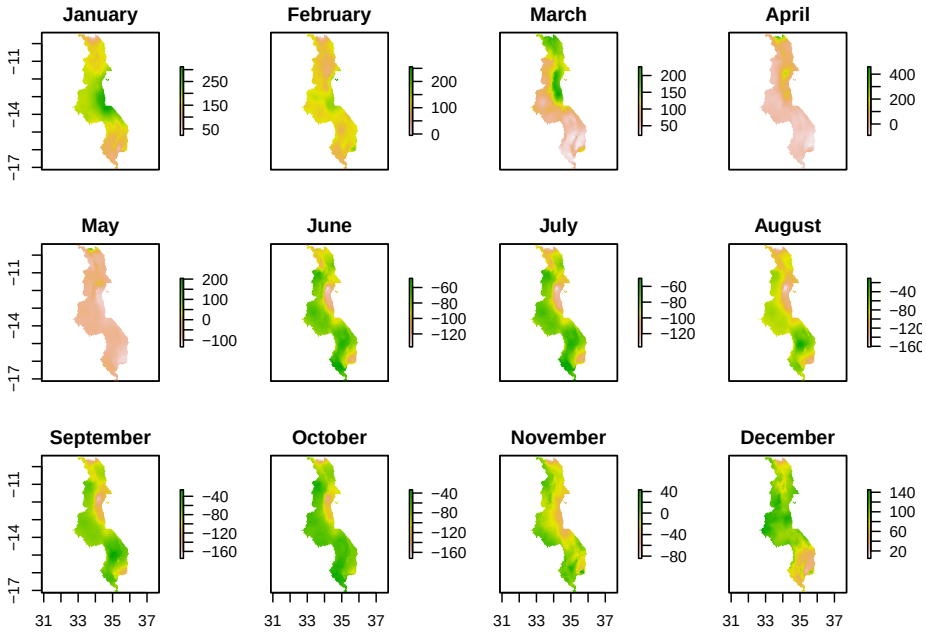
Southern Malawi



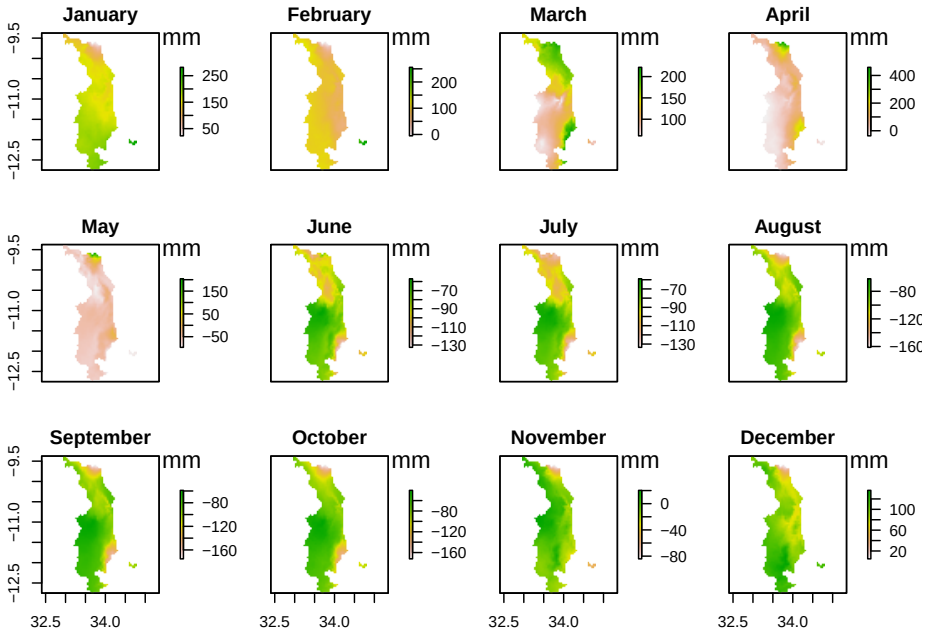
Precipitation change 2021-2040 based on climatologial period 1971-2000

Scenario: SSP5 - Fossil-fueled Development

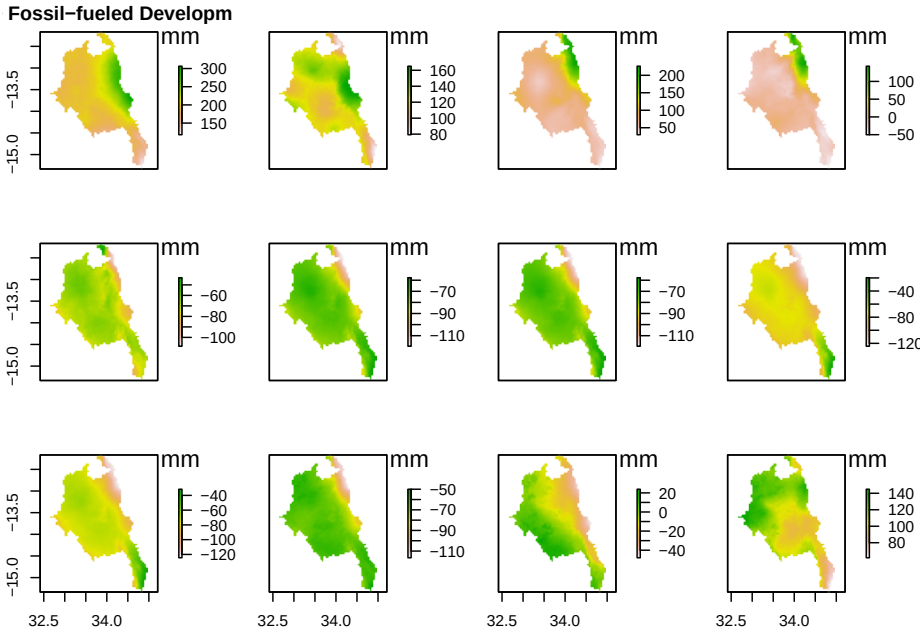
National



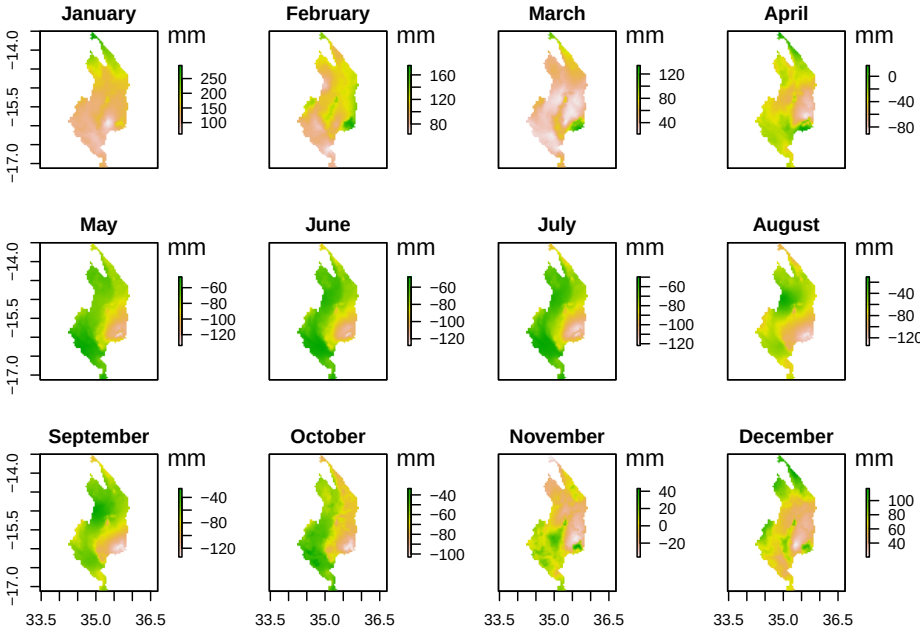
Northern Malawi



Central Malawi



Southern Malawi



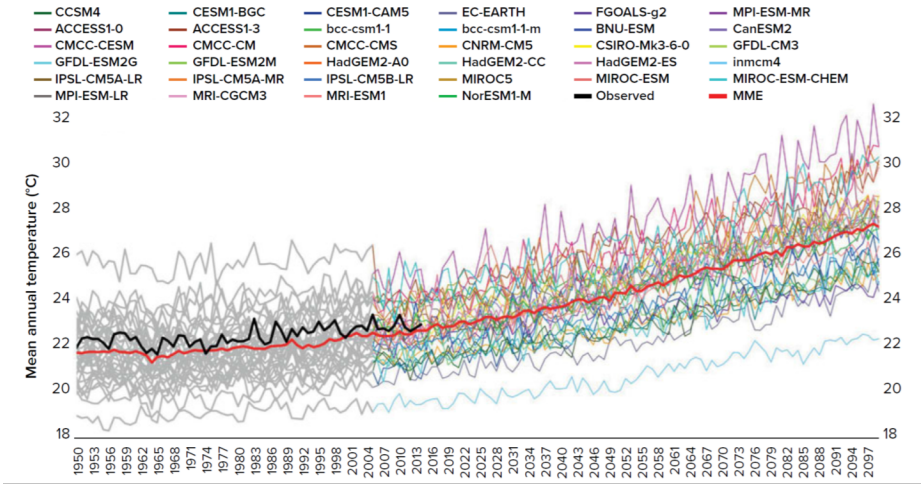


Figure 6.5: Figure 8: Time series of mean annual temperature (°C) for 34 CMIP models (Source: UMFULA. 2017. Malawi Country Climate Brief: Future Climate Change Projections for Malawi). Note: CMIP = Climate Model Intercomparison Project

Rain-fed agriculture contributes 90 % of Malawi's food production. However, the incidence of extreme droughts and floods and extreme heat events is expected to increase (Hughes et al., 2019a). According to Cacho et al., (2020), crop yields are expected to be below the no climate change reference scenario for most crops by 2050, with average yields as low as 0.83 compared to 2010 Table 6. For the period 2020-2050, climate change's total cost to smallholders is $1.6 (± 1.3) billion in present-value terms (Cacho et al., 2020).

	RCP*		
Crop	**2.6**	**6.0**	**8.5**
	Malawi		
Maize	0.966 ± 0.085	0.937 ± 0.090	0.918 ± 0.097
Groundnut	0.901 ± 0.082	0.864 ± 0.094	0.832 ± 0.102
Beans	0.932 ± 0.022	0.905 ± 0.024	0.882 ± 0.014
Soybean	0.903 ± 0.050	0.868 ± 0.064	0.825 ± 0.033
Rice	0.914 ± 0.027	0.877 ± 0.039	0.846 ± 0.017
Tobacco	0.966 ± 0.086	0.938 ± 0.090	0.919 ± 0.097

Figure 6.6: Table 6: Relative yield projections in 2050 for main crops grown by smallholders in Malawi expressed as the ration of yields under each RCP to yields under no climate change reference scenario with CO2 fertilizer (± SD)

Climate change impacts on infrastructure have been projected to reduce the growth rate of Malawi's GDP. Based on a comprehensive analysis using median climate scenarios directly related to changes in temperature and precipitation up to 2050, it has been estimated that, without adaptation measures to the

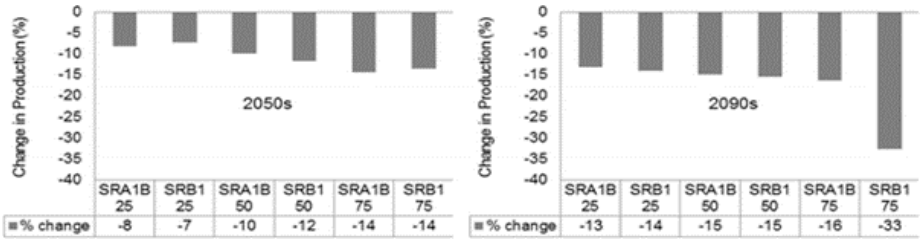


Figure 6.7: Figure 9: Average changes in the Lilongwe District's mid-and late century maize yields(%).Compared to the baseline period (1971-2000), the average maize yield reduction ranges for the 2050s and 2090s are 7%-14% and 13% -33%, respectively.Source: Msowoya et al., 2016

planning, construction and maintenance of ad infrastructure, Malawi faces a potential annual average total cost of USD 165 million. The capacity installed and electricity generated at the hydropower plants in Malawi account for 80.2% and 98%, respectively, of the country's total electricity power (Mtilatila et al., 2020). Reduction in annual hydropower production between 1% (RCP8.5) and 2.5% (RCP4.5) during 2021–2050 and between 5% (RCP4.5) and 24% (RCP8.5) during 2071–2100 has also been projected (Mtilatila et al., 2020).

Table 6.3: Sub-national climate projection dat
period

Hazard	**Northern Malawi**	**Central and Sou**
Temperature	Extreme temperature increase	Temperatures are baseline by betwe 2.5 °C by 2055 u Pathways (RCPs

Hazard	Northern Malawi	C
Total Monthly Rainfall	· Drying is pronounced in all the seasons in northern Malawi. · A prolonged drying trend has occurred in December to February	· I · I
Drought	Below normal crop yields between 2045-2090	· I · I
Floods	Increased frequency of flood events	In · · · pe flo

6.3 Assessment by key systems

There are a number of key systems in Malawi (Table 8 and Figure 13) below on Malawi Systems. Each of these are addressed below and interlinkages between them are explored. Local and national economic development in Malawi depends on livelihoods from natural resources and food security. Systems that provide for livelihoods are vulnerable to the impacts of climate change and overexploitation due to growing demand from rapid population growth. The NAP has been designed to capture the need to adapt in the critical subsystems of food production including crop, livestock, fisheries, and water resources. The food production system is strategically linked with economic value chains as broader market interventions at the macro level. The fisheries subsystem is complements with crop and livestock in livelihoods - as a source of income as well as a source of nutrition. Water resources support both agriculture (crop and live-

stock) and fisheries and has strong linkages across productivity and adaptation needs. Other systems under consideration include health, the hydropower, the sewage and waste, urban planning and development, and transport (Table 8).

Identified Systems	**Key System Stressors/Weaknesses**	**Key Interacting/**
Crop production	Rising temperatures	Water resources
	Increased intensity and frequency of heavy rainfall	Livestock produc
	Increased frequency of droughts and length of dry spells.	Marketing and Tr
	High costs of inputs	Forests
	Low adoption of agriculture technologies.	Fisheries
	Limited access to efficient markets.	Ecosystems and
	Limited irrigation systems.	Energy
	Poor land management practices.	Health
		Social-cultural
		Governance
Livestock production	Limited pasture due to human population pressure	Water resources
	Inadequate storage and breeding technologies in feed and breeding programs – unavailability of artificial insemination services	Rangelands
	Insufficient health support infrastructure and services such as dip tanks.	Crop production
	Increasing temperatures	Market and trans
	Diseases and high cost of drugs	Health
	Low milk prices	Ecosystems and

Identified Systems	Key System Stressors/Weaknesses	K
	Poor markets for milk	S
	Land degradation	G
		E
Agriculture Markets and Trade	Over reliance on rainfed agriculture and limited irrigation infrastructure	C
	Limited access to inputs and services	Li
	Low productivity	W
	Post-harvest losses	Tr
	Poor or lack of processing and weak marketing strategies	
	Inadequate and/or lack of domestic markets	
	Poor credit repayment discipline.	
	Low prices for some crop produce	
	High transportation costs	
Fisheries	Unsustainable fishing practices - Overfishing	W
	Increased surface water temperatures.	E
	Increased frequency and intensity of heavy rainfall events.	F
	Increased drought conditions	C
		M
		H
		S
Forestry	High human population growth – increased biomass energy demands	W
	Agriculture expansion.	C
	Tobacco farming – which requires significant number of trees for curing	Li

Identified Systems	Key System Stressors/Weaknesses	Key Interacting/
	Brick burning	Health
	Urbanization	Social cultural
	Inadequate funding	Energy
	Poor law enforcement - corruption	Market and trade
Water Resources	Deforestation in catchment areas.	Crop production
	Rising temperatures.	Livestock produc
	Increased intensity and frequency.	Energy
	Increased drought conditions and dry spell length.	Health
		Tourism
		Fisheries
		Forests
		Ecosystem and B
Rural water supply	Inadequate human resources to ensure an adequate and sustainable water supply.	Crop production
	Cultivation along riverbanks and streams threatens the quality of water supplied to rural households and communities.	Livestock produc
	Land cover changes due to deforestation causes drying up of some streams and rivers.	Forests
	Droughts	Ecosystem and B
	Increased use of agro-chemicals.	Social Cultural
Urban water supply system – Lilongwe City	Rapid human population growth.	Crop production
	High rates of urbanization	Livestock produc
	The increased emergence of low-income areas and informal settlements – make it difficult for Lilongwe Water Board (LWB) to improve water on water service coverage.	Forests

Identified Systems	Key System Stressors/Weaknesses	K
	Deforestation of the Lilongwe River catchment.	E
	Inadequate infrastructure	S
Urban water supply system – Mzuzu City	Rapid human population growth – High demand for water	C
	Inadequate storage capacity of the Lunyangwa dam	Li
	Over-reliance on loans for expansion of services – results in loss of revenue.	F
	Interrupted power supply – which causes machines to fail to pump water at times.	E
		S
Urban water supply system – Blantyre City	Poor governance/management practices – lack or low incentives to workers.	C
	Low tariffs collection – due to illegal connections, and vandalism	Li
	Rapid rates of urbanization	F
	Inadequate finances to expand the water supply system.	E
	Power outages	S
	Droughts and low rainfall	
Energy – Hydroelectricity generation system	Encroachment of hydro- power dams for sand winning – Affect stability of dams.	W
	Low water levels due to inadequate and/or erratic rainfall.	E
	High maintenance costs.	M
	Operational losses due to power theft or informal power connections	
Energy – Electricity distribution infrastructure	Low distribution capacity.	M
	Poor transmission infrastructure	Tr

Identified Systems	Key System Stressors/Weaknesses	Key Interacting/
	Wildfire burning high transmission poles in forests	Governance
	Windstorms pulling down transmission lines	Forests
	Bushfires causing explosion of transformers.	
	Increasing air temperatures affecting carrying capacity and transmission potential.	
Urban waste management system - Landfills	Poor public attitude towards waste disposal.	Health
	High rates of urbanization which have increased demand for landfills.	Water resources
	Lack of proper waste management plans.	Crop production
	Low frequency of waste collection by the city assembly due to limited number of vehicles.	Livestock produc
	Lack of machinery for digging trenches and compacting waste in landfills.	Social cultural
	Poor effluent discharge into rivers.	
	Agriculture chemicals	
	Heavy rains and /or floods which washes waste from an around landfills into river systems	
Medical waste management	Rapid human population growth which has increased amount of waste generated.	Health
	High maintenance cost for medical waste disposal systems.	Water resources
	Expansion of health facilities has resulted in high-cost biological waste disposal	
Sewage waste management systems	Generation of high amounts of sewage beyond the capacity of treatment plants – due to high human population growth.	Health
	Heavy rains which flood sewer reservoirs.	Water resources

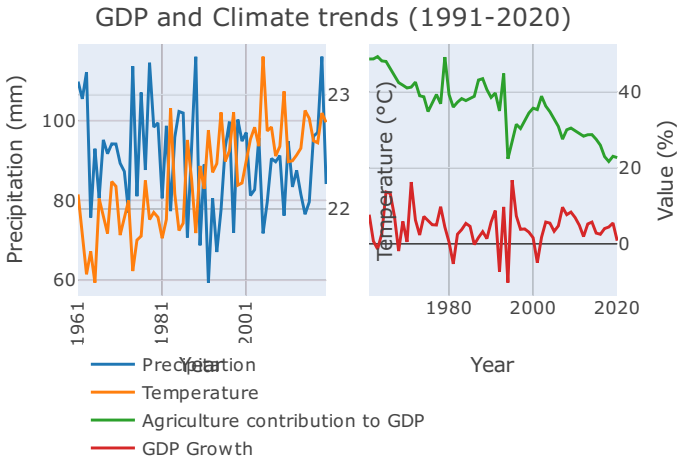
Identified Systems	Key System Stressors/Weaknesses	K
	Rapid expansion of urban settlements	C
		Li
		S
Transport system	Inadequate road networks	W
	Inadequate freight and rail capacity	E
	Inadequate financial resources	M
	Delayed maintenance of various roads	
	Heavy rains – which cause floods or increased runoff which degrade roads	
	Poor road surface conditions	
	Weak enforcement of town planning regulations.	
Riverbank flood planning	Extensive deforestation	W
	Heavy rainfall	E
	High poverty levels	A
	Limited funding	H
	Limited community participation	
	Over-reliance on aid and lack of ownership by local communities of flood management projects	
	Increased settlements in flood prone areas	
	Lack of flood protection infrastructure	
Urban flood planning	Poor drainage systems	W
	High human population density – difficult to install or modify drainage systems	E

Identified Systems	Key System Stressors/Weaknesses	Key Interacting/
	Lack or untimely maintenance of drainage systems	Agriculture
	Informal settlements	Health
Ecosystems	Land use/cover change due to deforestation	Forests
	Rising temperature	Water resources
	Erratic rainfall	Crop production
	Increased drought conditions	Livestock produc
		Crop production
		Market and Trade
		Health
		Social cultural
		Tourism
		Energy
Social-Cultural System	Over-exploitation of natural resource for housing, clothing, medicine, energy, livelihoods	Ecosystems and
	Socio-cultural importance of livestock ownership	Forestry
	Chronic poverty	Crop production
	Low adaptive capacities	Livestock produc
		Fisheries
		Rangelands
		Water resources
		Energy
		Tourism
		Cities and humar

Identified Systems	Key System Stressors/Weaknesses	K
		H
Health	Rising temperature	C
	Increased heavy rainfall events – cause floods	Li
	Increased drought conditions	E
	Increased human population	W
	Low number of health workers	F

6.3.1 Food Production Megasystem

The Food Production System in Malawi is complex – highly fragmented and dependent on many small-scale producers who are often non-market oriented and vulnerable to climate change. This is on a background of many environmental risks that impose limits to systems productivity. A recent report on the Malawi's Agri-food System (White, 2019) demonstrates the country's agri-food system's complexity in two fundamental ways (i) the country's agri-food system comprises 80% of the population of about 18.1 million people consisting of smallholder farmers and many who work as food retailers, transporters, and small-scale processors. (ii) the country's food production system operates in a complex policy debate about the role of subsidies such as the Farm Input Subsidy Program (FISP) against priorities for Greenhouse Gas (GHG) mitigation. For the purpose of the National Adaptation Plan (NAP), this section limits description of the country's food production system within the scope of crop, livestock and the fisheries and aquaculture subsystems from climate change adaptation context.



The performance of agri-food system in Malawi is vulnerable to a high degree of uncertainty and volatility compounded with limited adaptive capacities, especially among smallholder farmers. This is because, the country's agri-food system relies on rainfed annual agriculture production thriving in highly variable climate, compounded with the fall armyworm (Spodoptera frugiperda). Many people, both urban and rural are perpetually vulnerable to an annual hungry season when the previous year's harvest has been poor. Trends have shown that, malnutrition was steadily declining from a high of 26.3% in 1998, down to 12.1% in 2009, back up to 16.7% in 2014, with undernourishment in 2015 staggering at 20.7% and declines remained slow in recent years.

The volatility and precarity of the agri-food system is exacerbated by the combined impacts of poor infrastructure, uneven and deteriorating power access, expensive fuel, and poverty. Across the region, climate change is yet, expected to have widely variable impacts that generally exacerbate variability and extremes. The future impacts of the agri-food system can be reflected in the response of other subsystems such as energy and infrastructures (Tables 7 and Table 8).

Sector	Observed climate impacts	Global impact ra
AGRICULTURE	Reduced crop yield associated with heat and drought stress.	Low-High

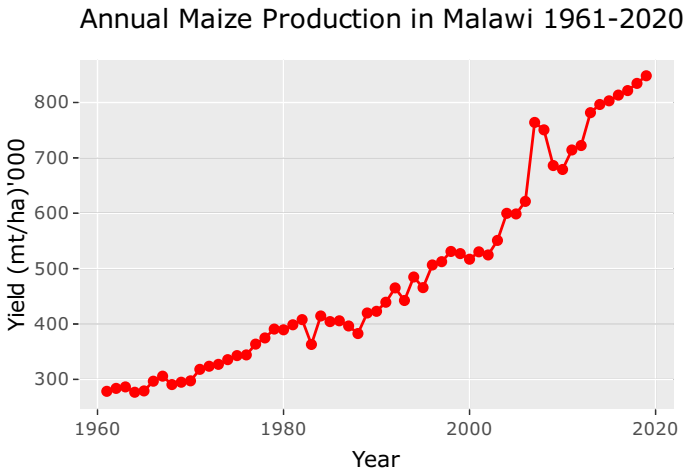
Sector	Observed climate impacts	G
Crops	Changes in crop suitability due to shifts in agroecological zones.	M
	Economic losses due to severe reductions in crop yields caused	
	by frequent floods and droughts.	
Livestock	Increased animal mortality associated with intense heat, frequent droughts and floods.	Lo

Sector	Projected climate impacts	In
Agriculture	Declining yield among all types of crops in all parts of the country except in the northern region.	M
Energy	Hydropower production negatively affected by high rainfall variability.	M
Built Infrastructure	Increased damage to infrastructure and human settlement due to intense flooding.	Hi

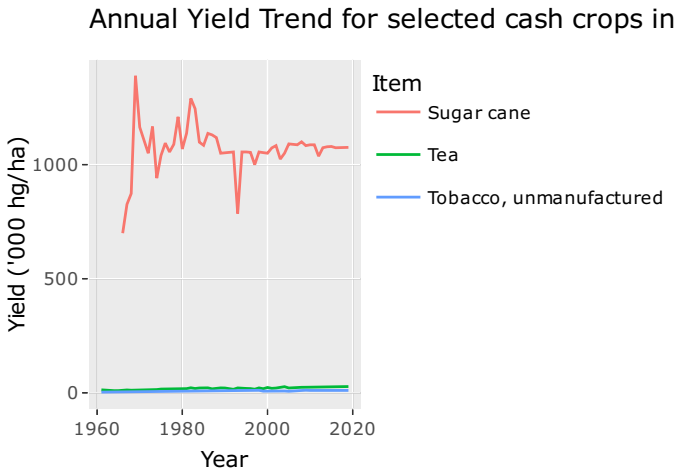
Source: CLICC Phase 2 Project (2019).

6.3.1.1 Crop Production Subsystem

Approximately, 90% percent of the crops are rainfed, and most farmers cultivate on small parcels of land of approximately 0.5 to 1.5 ha, although Lea & Hanmer (2009) note that many farmers in some parts of the country leave portions of their plots fallow, which is partially due to labour constraints (Bezner-Kerr & Patel, 2014). It is estimated that 11% of farmers are landless and only 13% of households cultivate on more than 2ha (Mangelsdorf, Hoppe, Kirk, & Dihel, 2014). Household land farms vary across the country – larger in the northern region than further south due to lower population density. Maize occupies at least 60% of cultivated land and is farmed by 97% of farming households. It makes up 60-70% of total food intake and 48% of protein consumption (Kampanje-Phiri, 2016). Average maize yields in Malawi are around 1.2 MT/ha, which is lower than the average for Africa, 1.8 MT/ha, also considered far below the average potential (Abate et al., 2017; Mango et al., 2018).



Total cultivatable land is not fully explored in Malawi. Currently total land cultivated is about 2.5 million hectares (Agriculture policy) but total suitable area for agriculture is about 4.7 million hectares. The cash crops like, tobacco, tea, sugarcane, and macadamia are cultivated in estate subsector. The estate subsector also provides contract farming opportunities for smallholder farmers. Out of the cultivated land 90% is under rain fed agriculture despite that there are 407, 862 hectares of land that have the potential for irrigation farming. Out of the 400,000 hectares of land suitable for irrigation, only 14,000 hectares are under smallholder farmer irrigation while 48,000 hectares are under estate irrigation. This indicates a huge gap that can be addressed through investment.



With quantitative data available for eight soil and terrain factors, a recent study (Li et al., 2017) has indicated that highly suitable, moderately suitable, marginally suitable, and unsuitable agricultural areas account for 8.2%, 24.1%, 28.0%, and 39.7% of the total land area, respectively. The majority of suitable lands are currently used for agriculture, but more than half (57.4%) of Malawi's total cropland exists on marginally suitable or unsuitable land categories and is likely a candidate for rehabilitation through sustainable agricultural practices, if the crop production subsystem is to adapt to climate change.

Over the years the government has implemented agricultural input programs to improve agriculture production in the country amidst of the challenges. Most of these input programs have focused on Maize production the staple food. The main aim of these programs has been to improve the productivity of the smallholder maize farms so as to ensure food security. Since the early seventy's the government has implemented six agricultural input programs which include:

- Agricultural Input Subsidy Programme: – subsidized seed and fertilizer for smallholder farmers (1970-1995)
- Supplementary Input Programme: – Input kit distribution to vulnerable households (1995-1997).
- Starter Pack Programme: – Universal distribution of fertilizer and seed (1998-99).
- Targeted Input Programme: – Targeted fertilizer and seed distribution (2000-04).
- The 2005 Extended Target Input Programme: – Expanded targeted fertilizer and seed distribution.

- Farm Input Subsidy Programme: – Targeted voucher based maize seed and fertilizer subsidies (2006 to present).

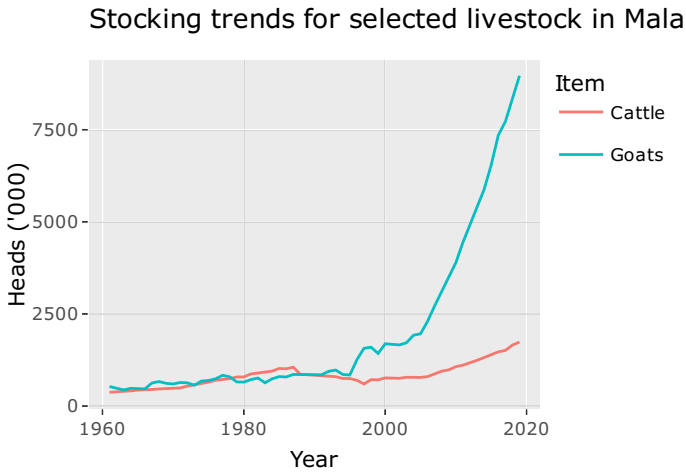
The main aim of these programs has been to improve the productivity of the smallholder maize farms so as to ensure food security. However, some of these programs did not achieve the intended goals hence they were phased out. For instance, despite having the Targeted input programme (2000-04) and the 2005 extended target input programme the country still experienced severe food crises in 2002 and 2005. Currently, the Farm Input Subsidy Programme (FISP) is being implemented where smallholder famers are provided with coupons which allow them to purchase hybrid maize seed and fertilizers at relatively low prices. The FISP programme has positive impacts on maize production and net crop income but limited impact on food consumption and household income (references). Furthermore, weaknesses of the programme have been pointed out including its financial sustainability and identification of beneficiaries (IFPRI, 2013), as there is high support to the middle income than the poorest.

The constraints to expanding irrigation for agricultural production have been:

- Focusing of the agricultural economy on rainfed agriculture and existing irrigation schemes, where emphasis was on funding extension activities.
- Reluctance of donors to fund irrigation development.
- Replacement of irrigation services under the Ministry of Agriculture, which has focused on rainfed agriculture.
- Price setting for crops not viable for irrigation.
- Almost no irrigation technology training facilities within the country.
- A poorly funded and understaffed Department of Irrigation.

6.3.1.2 Livestock Production Subsystem

The livestock industry in Malawi is underdeveloped and contributes only 8% of total GDP and about 36% the value of total agricultural products. Both smallholders and estate farmers are involved in livestock production, but due to various production bottlenecks, intensive livestock production systems are largely dominated by estate farms. Despite that, livestock provides food, income, manure, animal traction and social security to some smallholder farmers. Considering all this, livestock may account more than 11% to Gross Domestic Production. Major livestock production comprises beef, dairy, goat, sheep, pigs, chicken and eggs, with registered small increases in recent years. Population of cattle has been increasing by 3% annually. In 2014 there were over 1.3 million cattle and over 6.3 million goats in the country. Livestock production experiences varying challenges including: (i) limited pasture due to human population pressure (ii) inadequate production and storage technologies in feed and breeding programmes (iii) Insufficient health support infrastructure and services such as dip tanks.



Spatial coverage of floods responsible for economic losses are generally localized in watershed areas. This limited coverage creates localized impacts such as crop and soil losses; hence the rating is medium. However, the impacts are felt on the national economy hence the rating is high. For example, on average, Malawi loses USD9 million or 0.7% of the GDP each year due to floods in the southern region of the country. Taken together, drought and floods cost the Malawian economy about 1.7% of its GDP every year. This is equivalent to almost US$22 million.

Available literature agrees on the devastating impacts of frequent and severe floods and droughts on the agriculture sector in Malawi. The sector suffers the greatest losses, effecting declines in GDP ranging from 1.1 to 21.5% during Return Period of 5 years (RP5) and Return period of 25 years (RP25) for droughts, respectively. Furthermore, the literature and experts agree that low agriculture productivity resulting from climate change result in food shortages, cause domestic grain prices to rise while grain imports increase rapidly to cover the shortfall. Maize imports, for example, increase by between 6 and 256% during RP5 and RP25 droughts, respectively. The possibility for high rating of the impacts implies that spatial coverage is at times wide, and frequency of the impact increases to high. For example, maize is by far the dominant crop produced in Malawi, occupying more than 70 per cent of available agricultural land and is critically important to livelihoods. The average land holding size per household for smallholders in Malawi in the period under consideration was 1.2 hectares. Over 90% of the total agricultural value-added came from about 1.8 million smallholders who on average owned only 1 hectare of land. Flooding in low-lying areas where productivity is inherently high affected almost the whole

country in terms of food availability stability and accessibility. The alternation with droughts in the high areas complicates crop productivity. Floods wash away livestock in the low-lying areas.

6.3.1.3 Agriculture Markets and Trade Subsystem

Malawi is an export-led economy and agriculture comprises 80% of exports, with major export crop being tobacco, but sugar, tea, and coffee. The role of tobacco as an export crop is continuously declining. Smallholder rainfed maize production dominates and comprises about 25% of the agricultural GDP, of which agriculture as a whole makes up around 30% of the overall GDP (Pauw, Beck, & Mussa, 2016). At the farm level, net revenue varies widely and may be influenced by multiple factors such as soil conditions, farm size, infrastructure, distance to market, composition of the household, education levels, agro-climatic variability, and other variables.

Transportation of agricultural produce/seeds and agriculture markets constitutes one of the components of the food production system. Agriculture produce is transported differently from the farm to the storage facilities or from the farm to the market depending on distance to be covered and on the financial capacity of the farmer. Among the modes of transport employed are; transportation by foot, bicycle, oxcarts and vehicles. Cereal crops are sold in different ways some are sold to the Malawi government through the Agricultural Development and Marketing Corporation (ADMARC). The ADMARC sells and buys produce from farmers at standardized prices. Other farmers who do not prefer to sell their crop produce to ADMARC usually sell at local markets or sell to vendors who usually move around villages searching for crop produce to buy. For cash crops like tobacco the government has established structures like the Tobacco Control Commission which regulate the sales of tobacco and facilitates exports of the produce.

Sales of livestock and fish are usually done at local markets. For African smallholder farmers to sustain the yield increases they seek, they are reliant on a seed industry. On the other hand, a hybrid-based maize sector also requires large-scale commercial seed enterprises whose profits can be sustained only by strong seasonal demand by farmers for renewing their seed (Haggblade & Hazell, 2010). Leading Seed Companies in Malawi Multinational seed companies carry out seed breeding, production, multiplication, processing, and distribution of mainly hybrid maize. Local seed companies are involved only in seed multiplication and distribution. Malawi's main seed companies are Seed Co, Monsanto (Bayer), DowDuPont (Pannar), Demeter, and MUSECO.

The Country Vision on Trade.

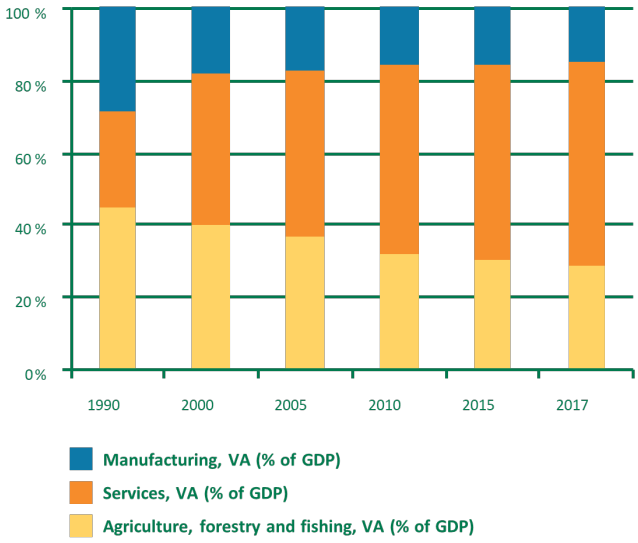
The Malawi Vision 2063 shows the country's commitment to have an agricultural development and marketing entity running on commercial principles, promoting the commercialization of agriculture and providing local and interna-

tional structured market linkages farmers. The parastatals shall operate under a strong alliance with the private sector, in a transparent and accountable manner and independent of political interference.

Malawi is a member of WTO since 1995 and, in recent years has targeted trade-led development through trade expansion instruments, including regional trade agreements. The country also a Member State of the Common Market for Eastern and Southern Africa4 (COMESA) and the Southern African Development Community5 (SADC), with each one accounting for less than a quarter of the country's trade. Malawi is primarily a resource exporting country and features in the lowest quartile among its regional trade agreement (RTA) partners in terms of GDP per capita – in 2017, the COMESA average was US$2,900 and the SADC average was US$3,720. It is also a Signatory Party to the Protocol on Free Movement of Persons of the Kigali Declaration (2018) and to the 2018 African Continental Free Trade Agreement (AfCFTA).

This active regional trade policy is remarkable and provides several trade-led opportunities for development. However, a variety of challenges and constraints continue to impede trade, such as licensing requirements and a system of trade permits.6 Efforts, such as single window, are underway to simplify border or certification procedures but, overall, there is a great deal of paperwork and specific certification regulation. In addition, standards-related regulations, and implementation, notably Sanitary or Phytosanitary measures (SPS) and other Technical Barriers to Trade (TBT), can also be an impediment to the export of agricultural and agriculture-related products. Malawi also faces several infrastructure-related constraints including poor transport links and lack of access to electricity for a large proportion of the population - only 10 per cent have access - mirroring a trend in many African countries. On the other hand, over half of the population have access to radio and mobile phone services.

Figure 10 displays the value-added breakdown of the Malawian GDP. The significant change in the aggregate economy since 2017 is characterized by a decline in the share of the industrial sector from 29% in 1990 to 15% in 2017 and an increase in the share of the services sector. from 26% in 1990 to 56% in 2017. The former can be explained by the small size of the sector and the relative expansion of world demand for certain basic agricultural products, which has led to a shift towards greater specialization in raw or semi-processed products. The increase in the contribution from services is striking at first, given that the sector's predominance in generating value -added is generally a phenomenon of developed countries. The most dynamic over the past decade have been construction and sub-sectors such as wholesale and retail trade, real estate, information and communication and financial services. Growth in the services sector is believed to be driven by government expenditure as well as development assistance.3 The share of agriculture as a percentage of GDP has also seen a steady decline from 45% in 1990 to about 28% in 2017.



Source: UNCTAD secretariat calculations based on World Bank World Development Indicators data

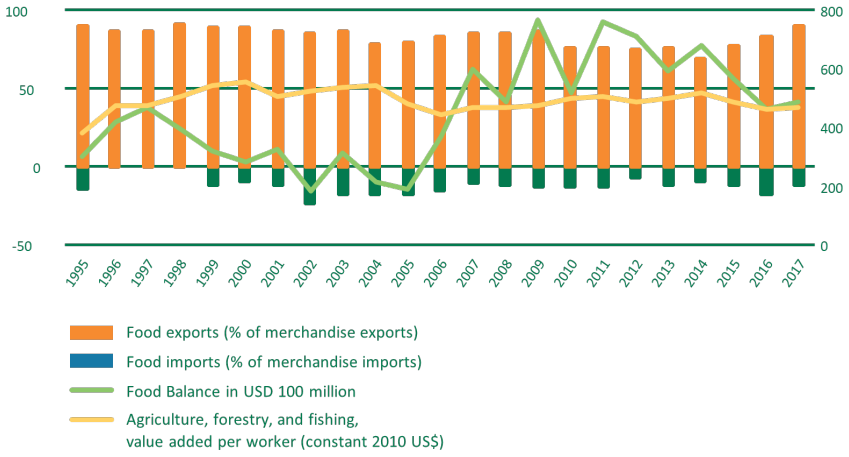


Figure 6.8: Figure 11: Food trade calculations for exports and imports between 1995 and 2017. Source: UNCTAD secretariat calculations based on World Bank World Development Indicators data

6.3.1.4 Ecosystems

Ecologically sensitive and fragile ecosystems are facing threats due to poor land use practices and deforestation. Habitat fragmentation and loss threaten biodiversity. Deforestation is leading to the loss of mechanisms for adaptation from the increased impacts of severe flooding and excessive heat waves. Table 11

shows selected ecological systems of special significance in Malawi.

Table 6.7: Selected ecological systems of special significan
Malawi

Name	Type	B
Chongoni Rock Art Area	UNESCO world heritage site	Li ab Ba st
Lake Malawi National Park	UNESCO world heritage site	Be gl di
Mulanje Mountain Biosphere Reserve	UNESCO site	G Ul of co Bi
Lake Chilwa Wetland Biosphere Reserve	UNESCO site	D la po
Nyika National Park	National Park	Ny ce ec re
Vwaza Marsh Wildlife Reserve	Wildlife Reserve	Co ha ne sn
Dzalanyama Forest Reserve	Forest Reserve	It ec m bi
Thuma Forest Reserve	Forest Reserve	G es co co ba wl
Kasungu National Park	National Park	It ar w fa ar
Nkhotakota Wildlife Reserve	Wildlife Reserve	Is co th H ab

Name	Type	Brief description
Liwonde National Park	National Park	Established in 19 the Big five. In re in the number of elephants were tr Nkhotakota wildli bird species; harb
Majete Wildlife Reserve	Wildlife Reserve	It is a big five res Malawi. Nearly 5, reintroduced inclu cheetah, sable an elephants
Lengwe National Park	National Park	It was designated open deciduous f Nyala antelope

The Lake Malawi ecosystem is particularly an area of high freshwater biodiversity that plays a crucial role in the local economy of people living around the lake. It is however also under increasing threat from development, deforestation, hydropower development, oil exploration and multiple other interconnected factors. There is currently a lack of information and awareness of freshwater biodiversity within the region so existing conservation actions fail to recognize its importance and vulnerability.

The country is committed to protection of ecosystems and the services. The national parks, wildlife reserves, and forest reserves cover 18% (1.7 million hectares) of the land mass of Malawi and a substantial proportion of the Shire Valley. Effective protection of these resources will continue to contribute significantly to address the drivers of climate change. Degraded ecosystems need restoration to maintain carbon storage and sequestration, and through best practice land management to combat degradation. Currently, forests are being lost and degraded at alarming rate, driven by a range of factors, including conversion for agriculture, overharvesting of firewood, cutting for charcoal production and increasing frequency of forest fires. Consequently, the country is experiencing unprecedented loss of habitat and their biodiversity. These factors are likely to intensify as population pressures continue to grow. Remnant forests decline in both quality and coverage and as changing climatic factors influence regeneration, forest fire frequency etc. Investing in the sustainable management and conservation of these remaining natural habitats, with strategies and interventions that are informed by climate modelling, offers a potentially cost-effective way of protecting ecosystem services and contributing to resilience. The Government of Malawi has developed a National Biodiversity Strategy and Action Plan to deal with threats to biodiversity including ecosystems.

6.3.1.5 Fisheries System

Malawi is endowed with wild fish resources with fish farming is predominantly based on finfish for both commercial and non-commercial purposes. The fisheries and aquaculture provide essential nutrition, support livelihoods and contribute to national development in Malawi. The aquaculture sector is important to the country's economic growth and will remain so in many years to come. As the human population grows so too will the demand for animal protein. Fish provides over 70 per cent of the dietary animal protein intake among Malawians and 40 per cent of the total protein supply. Fish also provides vital vitamins, minerals and micronutrient. Much of the fish is consumed in rural areas thereby contributing significantly to daily nutritional requirements to some of the vulnerable groups such as HIV and AIDS victims, orphans and the poor (Economic Report, 2011). Fishing is the main source of livelihood to 37,089 out of 3,984,981 households in Malawi (NSO, 2018). The sector directly employs nearly 59,873 fishers and indirectly over 500,000 people who are involved in fish processing, fish marketing, boat building and engine repair. Furthermore, nearly 1.6 million people in lakeshore communities derive their livelihood from the fishing industry. The main provision of the fishery resource comes from capture fisheries. Sustainable fisheries contributes 3 percent to the national GDP, and government has set a target of 3.8% to be achieved by 2022 in partial fulfilment of MGDS Key Priority Area 1: To achieve sustainable agricultural transformation that is adaptive to Climate Change (GoM, 2017).

Over the past few years, the sector has displayed signs of growth . Total annual production volumes reached an all-time high of 164,940 tonnes in 2016, up from about 81,400 tonnes in 2005 and 100,900 tonnes in 2010. While the bulk of fish caught, sold and consumed has traditionally been produced by capture fishery, capture fishery production has declined in some years. This has been particularly the case for the commercially-oriented, high-value species such as the Oreochromis karongae - locally known as 'chambo' – the average annual production of which declined from more than 10,000 tonnes between 1980 and 1990 to around 4,000 tonnes between 2000 and 2015 . The annual fish production under aquaculture increased from about 800 tonnes in 2005 to about 4,900 tonnes in 2015 and 7,672 tonnes in 2016. The bulk of fish produced by aquaculture are commercially oriented, high-value species, which are being caught less by capture fishery (Table 12).

Year	Capture (tonnes)
2,005	80,609
2,006	72,929

Year	Capture (tonnes)	
2,007	67,818	
2,008	75,867	
2,009	76,045	
2,010	98,300	
2,011	82,336	
2,012	120,328	
2,013	109,889	
2,014	116,289	
2,015	144,315	
2,016	157,268	

Source: Department of Fisheries

Lake Malawi has potential for fisheries expansion. The various targeted species found in Lake Malawi alone have an estimated catch potential in the range of 120,000 to 200,000 tonnes, as estimated by the ODA/SADC Pelagic Resources project (M. Banda, pers. comm.). Potential sites of aquaculture investment in Malawi are presented in Figure 12.

Other water bodies are overfished (Lake Malombe), prone to desiccation (Lake Chilwa) or threatened by water hyacinth, Eichhornia crassipes (Lower Shire). Identified virgin stocks in Lake Malawi, however, require expensive deep-water trawls. It is unlikely that these developments will benefit small-scale operators and economic viability remains to be demonstrated. Malawi is now a net importer of fish to supplement its needs. It all suggests that there remains unexploited potential increasing productivity in the aquaculture subsector to meet the growing demand.

Current observations indicate that the aquaculture sector in Malawi is vulnerable to the impacts of climate change, but smallholder fish farmers have limited capacity to adapt. Recent field observation shows that fish farmers in the country have been experiencing climate change in many ways depending on geographical location. In Blantyre the Chambo Fisheries Limited has been experiencing extreme cold temperatures which eventually affect fish production and fingerling growth. Contrastingly, in Salima and Balaka, observations have shown that farmers are increasingly facing extreme hot weather conditions resulting in water shortages and drying up of dams before harvesting the fish stocks reach harvesting stage.

Atmospheric warming could change water temperatures, which might impact

Figure 6.9: Figure 12: Potential sites of aquaculture investment in Malawi. source:

production. Droughts could decrease the availability of freshwater to fill ponds or tanks. In other areas such as Mzimba, Rumphi and Phalombe, farmers face torrential rains which at times result in heavy flooding of fishponds, and consequently losing fish stocks. In March 2019, for example, floods triggered by Cyclone Idai washed away two Chonona Fish Farms fishponds, along with catfish stock that was about to be harvested, resulting in significant sunk costs. Generally, the Lower Shire valley has significant potential in aquaculture production, but the region is vulnerable to extreme climatic events which alternately occur between floods and droughts. The seasonal impact on production depends on the specific weather conditions in agroecological zones. For instance, farmers in high-altitude areas such as the northern region city of Mzuzu are not able to produce fingerlings during the cold months from May to July, which also restricts the production of grow-outs to a single cycle per year. On the other hand, fingerling production and production of grow-out fish can be undertaken throughout the year in low-altitude warm areas such as the Lower Shire and most of the Lake Shore districts of Nkhatabay, Nkhotakota and Salima.

Projections indicate also that climate change will invariably heighten risks and vulnerabilities to existing levels of variability of temperature and rainfall. Even with the levels of uncertainty linked to climate modelling, all recent studies of Malawi's future climate broadly agree that over the next decades: temperatures will rise, causing higher evaporation and consequent water stress, and; high levels of rainfall variability will remain. While there exists less confidence in the exact future patterns of extremes, there is higher likelihood of dry spells and higher likelihood of intense rainfall events.

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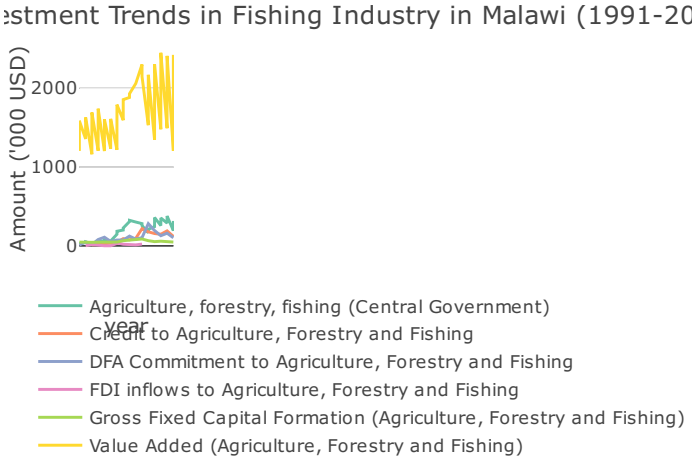

6.3.1.6 Forestry System

Forest cover in Malawi has declined significantly over the past years mainly due to charcoal production and agriculture expansion. The remnant forests face pressures from human population increase and climate changes. Corrupt practices among the forestry officials also pose a threat to the survival of the remaining forests (Table 11). Planting more trees, reducing charcoal production and curbing corrupt practices will ensure the sustainability of these forests.

6.3.2 Water Resources Megasystem

[Subsystems: Riverbank flood planning; Urban flood planning]

Malawi relies on both surface- and ground-water sources, with an extensive river system covering 20 percent of the country's surface area, comprising the Shire, Ruo, Bua, Rukuru, and Songwe Rivers, and numerous lakes such as Malawi, Chilwa, Chiuta, and Malombe. Water resource distribution exhibits dramatic spatiotemporal variation. Approximately, 90 percent of the runoff in major rivers occurs between December and June. The country's vast network of streams, rivers and lakes provide water for various uses including drinking and agriculture. Lake Malawi plays a particularly important role in surface-water supply in the socio-economic development of the country, but decreased water levels adversely affect power generation from hydro power plants and water supply in towns. These water resources have been affected by droughts,

erratic rainfall and poor agriculture practices, affecting the quantity and quality of available water (Table 1). Topographically low-lying areas and cities are increasingly faced with severe flash floods; more generally, floods in Malawi occur widely and cause huge economic losses. The main causes of these floods have been heavy rainfall and poor catchment management practices. With climate change projected to increase incidences of heavy rainfall these floods are expected to increase. In urban areas, poor drainage systems and the rapid increase of informal settlements have contributed to an increase in the frequency of floods. Frequent floods and droughts are the most severe effects of climate change in Malawi which highly impact the water system. Apart from causing the lack of access to water supply (Table 13), drought derails the economic progress for communities.

WATER	**Impact**	**High...3**
Water supply	Water quantity and quality disrupted by increasing frequency of droughts and floods.	High
Water treatment	Increased sediment, nutrient, and pollutant loadings from heavy rainfall and floods and droughts.	High
Water collection	Damage to water infrastructure and contaminated ground and surface water sources	High
Surface water management	Increased frequency and magnitude of floods associated with torrential rains.	High
	Reduction in water flow in major rivers of the country due to reduction in rainfall	

A study by Adhikari and Nejadhashemi (2019) examined climate change impacts on water resources in Malawi. Downscaled outputs from six general circulation models, for the most extreme Representative Concentration Pathway (RCP 8.5), were used as inputs to the soil and water assessment tool to assess the impacts of climate change on evapotranspiration, surface runoff, water yield, and soil moisture content at the country, watershed, and sub-basin levels by the 2050s. At the country level, the results showed a –5.4%–5.4% to +24.6%+24.6% change in annual rainfall, a −5.0%−5.0% to +3.1%+3.1% change in annual evapotranspiration, from –7.5%–7.5% to over +50%+50% change in annual surface runoff and water yield, and up to an 11.5% increase in annual soil moisture. At the watershed level, results showed an increase in annual rainfall and evapotranspiration in the north and a gradual decline towards the south. Sub-basin-level analysis showed a large probability of increase in the annual precipitation, sur-

face runoff, water yield, and soil moisture, especially in the north. Overall, the northern region was found to be more prone to floods, while the southern region was found to be more prone to droughts.

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6.3.3 Water Supply Megasystem

Subsystems: Rural water supply; Urban water supply system – Lilongwe City; Urban water supply system – Mzuzu City; Urban water supply system – Blantyre City

Malawi is water stressed and the per capita water availability continues to decline due to human population growth especially in the urban and peri urban areas (World Bank, 2007); thus, water withdrawal for agriculture/irrigation as well as for municipal purposes has been rising concurrently with population growth. However, in the past decades Malawi has made significant progress in increasing water supply coverage. In 2015 WHO/UNICEF Joint Monitoring Programme (JMP) estimated that coverage for improved water supply was 90% nationally; 89% in rural areas and 96% in urban areas (WHO/UNICEF, 2015), surpassing its Millennium Development Goal water supply target. In 2014 over 80% of people had access to improved water sources within a distance of 200 m for urban and 500 m for rural areas and 93% had an average time to collect drinking water (return trip) of less than 30 minutes (MoIWD, 2014). In rural areas water source options include piped water and community hand pumps as well as household point of -use water treatment (Holm et al 2016). Nevertheless, water supply is being affected by climate change as evidenced by the increased frequency of droughts and floods (Pauw et al 2010; Chidanti-Malunga et al., 2011). However, the water supply services in the country experiences several challenges which makes water access in the country not equitable. One of the main challenges is the low functionality of the rural water supply services; with

an estimate of about 25% water points not working at a given time (MoIWD, 2014).

Piped water supply in Malawi falls under water boards; the Northern Region Water Board (NRWB), Central Region Water Board (CRWB) and the Northern Region Water Board (NRWB). These regional water boards cater for the northern, central and southern region of Malawi. However, cities like Lilongwe and Blantyre have other water boards namely the Lilongwe Water Board (LWB) and the Blantyre Water Board (BWB) which aim at catering for the needs of population of their respective cities. The water boards in all parts of the country experience similar challenges which are a result of increasing human population which result in increased demand for water. Most of the water treatment plant built in different districts were designed for a smaller human population than the current population. Hence, in recent years the country has been experiencing water intermittent water supply. Some water boards have made an effort to construct water storage infrastructure and dams to meet the growing demand for water. Even though these initiatives will solve water challenges in the short run, there is still need for more funding to the various water board to prepare for long term challenges.

6.3.4 Energy megasystem

Subsystems: Hydroelectricity generation system; Electricity distribution infrastructure

Most of the energy demands in Malawi are met by biomass energy, with biomass energy satisfying over 90% of the energy needs. The increasing human population in the country is exerting huge pressure on biomass energy sources like forests. This has led to wide spread deforestation in the country. Climate change which has increased the frequency of droughts also poses a threat to energy needs in the country. Droughts imply that the regeneration potential of trees is lowered due to inadequate water. Further, droughts result in lower water levels in rivers consequently affecting hydro-power production.

6.3.5 Waste management megasystem

Subsystems: Urban waste management system - Landfills; Medical waste management; Sewage waste management systems

Increased human population has led to an increase in waste generated, for instance Lilongwe city accumulates over 200 tons of waste per day. These wastes are usually dumped in landfills around residential areas and markets waiting for the city/town assembly to collect them. However, due to inadequate finances, the collection by the city/town assembly is irregular resulting in accumulation of wastes. consequently, the wastes produce bad smell and sometimes find their way into water bodies; thus, posing a high risk of causing diseases.

In Major Cities of the country, councils are responsible for waste collection, transportation, and disposal at designated dumping sites. However, the quantity of solid waste collected remains smaller than solid waste generated. In most areas of the cities where settlement is unplanned, waste collection is absent leading to environmental hazards in the form of air pollution from burning, direct contact and vermin. The system of waste management remains rudimentary in the urban areas. Many townships of Malawi dispose waste in pits dug within their plots, while some throw waste on the roadside, the riverside and very few utile community skips. As there are no properly designed sanitary landfills, waste collected by cities is dumped in the designated open dumpsites with huge implications on health for those living adjacent these sites.

It is clear that waste management, pollution, inadequate access to sanitation services and poor urban conditions are some of the major challenges to development in Malawi. The MW 2063 recognizes that the environment and the Vision pillars have overlapping effects on each other, with unplanned urbanization often associated with environmental downsides. Industrial growth has for long been associated with increased pressure and demand on land and pollution of water and air. It is also water intensive with heightened demand for fuel which is not necessarily clean. Poor Industrial waste management coupled with loss of forest cover have increased the destruction risks on flora and fauna and endangered species. Industrial activity associated with unregulated disposal of waste.

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6.3.6 Health

Climate change has the potential to worsen the health situation in Malawi by increasing infant mortality, and waterborne diseases, as well as increase pest and diseases that affect the crop and livestock production systems, resulting in low yields which contribute to food insecurity. With increase in temperatures incidences of Malaria are expected to increase and spread to higher altitudes. Increased incidences of heavy rainfall and floods are likely to put vulnerable communities under poor sanitation and great risk of diseases like cholera. Additionally, climate change has the potential to increase incidences of malnutrition due to low agriculture productivity which affects food availability.

The Second National Communication assessed the associations between weather and malaria, cholera, diarrhoea, and undernutrition, with additional climate

change expected to increase the levels of risk. Undernutrition is one of the most important health and welfare problems facing Malawi. Agriculture is predominantly subsistence, so droughts and floods (regular occurrences) severely reduce crop yields and food security. There is a significant relationship between climate change and undernutrition - which has been described as a 'hunger risk multiplier'. Climate change exacerbates existing rates of undernutrition through three causal pathways: (i) impacts on household access to sufficient, safe and adequate food; (ii) impacts on care and feeding practices; and (iii) impacts on environmental health and access to health services. Declines and variability of crop yields could have significant negative implications for nutrition and stunting, and even when calorie consumption is adequate there can still be micronutrient deficiencies. There is a strong relationship between temperature and diarrhoea, where the incidence is related to food-borne diseases caused by high temperatures. In addition, diarrheal outbreaks are frequently associated with the aftermath of floods, due to contamination of water supplies. As an example: WHO analysis suggests that, under a high emissions scenario, diarrheal deaths attributable to climate change in children under 15 years old is projected to be about 10.6% of the almost 5,800 diarrheal deaths projected in 203069. Although diarrheal deaths are projected to decline to about 3,100 by 2050 the proportion of deaths attributable to climate change will rise to approximately 14.9%. Cholera epidemics have been occasionally reported, with the 2001/2 epidemic associated with over 33,000 infected and over 1,000 deaths. These epidemics occurred more often in dry years when people are forced to rely of contaminated water, although it can also be exacerbated by floods, when these contaminate water sources. Malaria is increasingly being reported in high altitude plateaus and hilly areas that were malaria free four to five decades ago. In part this is due to changes in rainfall patterns and increase in temperature, although socio-economic determinants also account for spatial variations in malaria risk. Temperature was not associated with malaria incidence over the period 1974-2006, and there was a negative relationship between rainfall and malaria.

Currently, Malawi operates a three-tier health system. The first tier is primary healthcare. This sector is in effect to meet the needs of general medical care, which includes community and rural hospitals and maternity units. The second tier consists of district hospitals. These see patients who receive a referral from their primary care physician to receive specialized services. This includes laboratory work and rehabilitation services. The final tier is tertiary care provided by central hospitals. This tier covers extreme conditions that require highly specialized care such as treatment for specific diseases. The linkage for these services comes through an elaborate referral system that trickles down the health system. Although the 2008 doctrine worked to lay out different measures to ensure the quality of health service delivery in Malawi, major health concerns still persist. HIV/AIDS continues to be the number one cause of death in Malawi: 21.7 percent of deaths in 2012 were linked to HIV/ AIDS. Acute Respiratory Infections account for 8.6 percent of deaths, while Malaria accounts for 40 percent

of hospitalized individuals.

The government of Malawi developed The Health Sector Strategic Plan II (2017-2022), whose goal is to achieve universal health coverage of quality, equitable and affordable health care with the aim of improving health status, financial risk protection and client satisfaction. HSSP II has one of the objectives being to reduce environmental and social risk factors that have direct impact on health. The MW2063 envisions a healthy population with improved life expectancy working towards the socioeconomic transformation of Malawi. The goal is to attain universal health coverage with quality, equitable and affordable health care for all Malawians. This will be achieved by providing a comprehensive health care system through interventions that will address shortfalls in the recruitment, distribution and retention of health workers; strengthening reproductive, maternal, neonatal, child and adolescent health; improving the availability and quality of health infrastructure, medical equipment, medicines and medical supplies; and exploring innovative and sustainable financing for health while focusing on efficiency enhancing measures such as strengthening governance, among other interventions. Every constituency in the country shall have well-equipped and staffed hospitals and health centres with commensurate investment in public health and medical health programmes, including E-health. Malawi shall have a health sector with advanced data capturing and management systems to support decision-making and policy formulation. Malnutrition has a significant bearing on our children's future development and health with wider implications on socio-economic development.

6.3.7 Transport System

The transport system in Malawi comprises two key players the private transport and public transports. Public transport is dominated by minibus and buses. The transport system plays a key role in the economy of the country, Nevertheless, it is characterized by several challenges like the poor road network and inadequate finances for road construction and maintenance. These challenges are worsened by increased frequency of floods which washes some bridges and roads resulting to high maintenance costs.

The Malawi Vision 2063 envisages an integrated transport system that will not only support domestic economic activity but also build global linkages for the national economy. The country has a multi-modal but underdeveloped transport system consisting of road, rail, air and inland water transport.

- Road transport subsystem: The country's transport system is dominated by roads which carry more than 70 percent of internal freight and close to 90 percent of international freight. The Malawi Vision 2063 further strives to have a world-class, well maintained and expanding road network connecting the urban and rural areas to local and international markets.

This will be done through development of transport masterplans at the national, city, town and council levels and adhered to.

- Rail transport subsystem: Experience has shown that efficient rail and water transport is cheaper than road transport, especially for bulk freight over long distances. However, the country has a rail route which remains unreliable because of poor infrastructure and water transport is not fully developed with dilapidated ports infrastructure. The MW2063 commits to have an expanded and modernized railway system as an attractive alternative transport mode.
- Air transport subsystem: In terms of aviation the MW 2063 commits to create an aviation sector that is internationally competitive and expanded to attract more competition from global players.
- Water transport subsystems: To facilitate trade, the country shall have a water transport system that is expanded to generate wealth for the economy.

6.3.8 Social-Cultural System

Culture in Malawi is embedded in the dominant modes of production, consumption, lifestyles and social organization that give rise and relevance to adaptation to climate change. For example, the belief in disasters linked to anger of spirits has been culturally embedded in many traditions. This has implications on adaptive responses.

The large proportion of the Malawi population leaves in the rural areas depend on natural resources for livelihoods. Culture plays a critical rural in natural resources management. The preservation, promotion and retention of our cultural values that promote sustainable natural resources management will remain vital for adaptation to climate change. Upcoming generations must be encouraged to patriotically embrace our culture and tradition, especially those values that promote sustainable natural resources management.

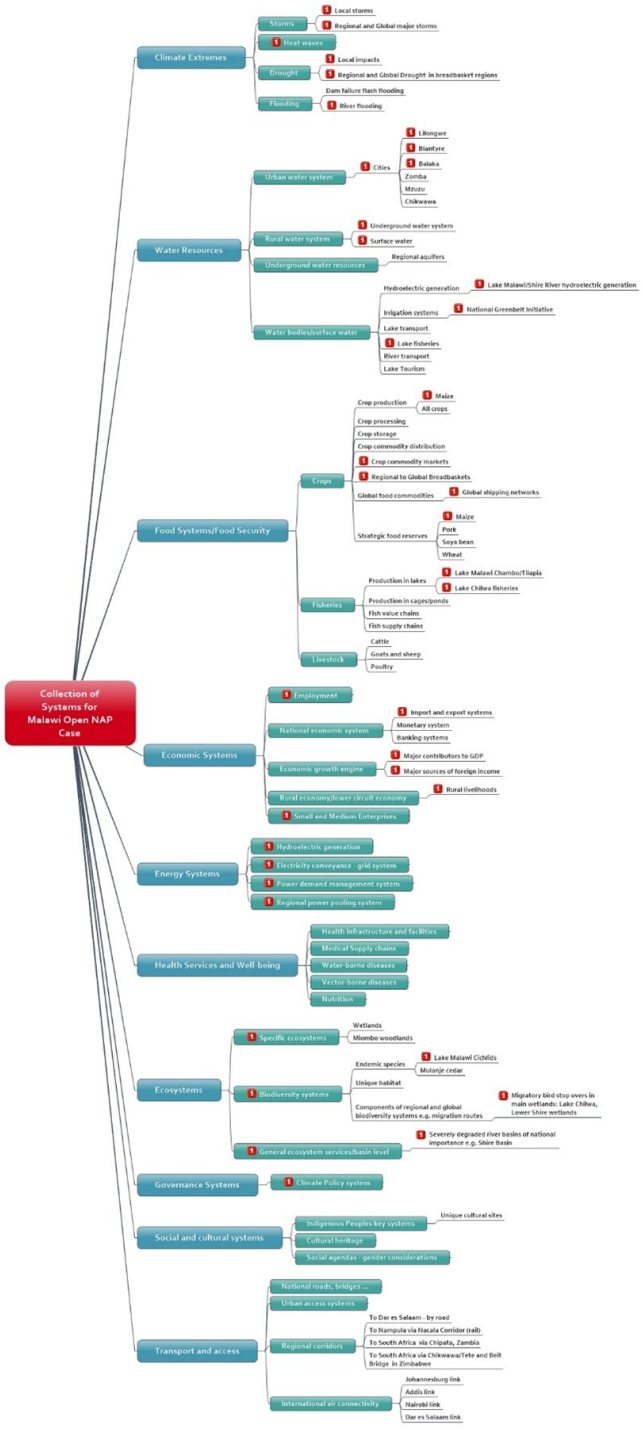

Figure 6.10: Figure 13: Malawi systems August 2020 LEG map.