



Bridging Climate Information Gaps to Strengthen Capacities for Climate Informed Decision-making

CLIMATE INFORMATION AND NEEDS ASSESSMENT REPORT

CAMEROON, KENYA, MALAWI, NIGERIA AND TUNISIA

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January, 2018



Clim-Dev Special Fund

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ACRONYMS AND ABBREVIATIONS

AAP	Africa Adaptation Programme	DAMS	Directorate of Applied Meteorological Services
ABN	Niger Basin Authority	DCCMS	Department of Climate Change and Meteorological Services
ACMAD	African Centre of Meteorological Applications for Development	DGF	Forest management Service
ADPs	Agricultural Development Programmes	DGRE	Water Resource Management Service
AfDB	African Development Bank	DGS	Soils Service / Direction Générale des Sols
ANME	Agence Nationale pour la Maitrise de l'Energie	DGSAM	Air and Maritime General Management Service (Tunisia)
ANPE	National Environmental Protection Agency (Tunisia)	DMN	National Meteorological Service of Cameroon
AO	Arctic oscillation	DoDMA	Department of Disaster Management Affairs
APAL	Coastal Protection and Planning Agency (Tunisia)	DRM	Disaster Risk Management
APCC	APEC Climate Centre	DSCE	Growth and Employment Strategy Document
ATO	African Timber Organization	DWR	Department of Water Resources
BOMAs	British Overseas Management Administration	ECCAS	Economic Community of Central African States
CAFCOM	Central African Forests Commission	ECOFAC	Conservation and Rational use of Central Africa Forest Ecosystems
CARBAP	African Research Center on Bananas and Plantains	ENACTS	Enhancing National Climate Services
CBFP	Congo Basin Forest Partnership	ENRMAP	Environment and Natural Resources Management Action Plan
CBLT	Lake Chad Basin Commission	ENSO	El Niño Southern Oscillation
CBOs	Community Based Organizations	EPAs	Extension Planning Areas
CCKP	Climate Change Knowledge Portal	FAO	UN Food and Agricultural Organization
CDM	Clean Development Mechanism	FARA	Forum for Agricultural Research in Africa
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station	FEWSNET	United States Famine Early Warning Systems Network
CHWGs	Climate and Health Working Groups	GCMs	Global Climate Models
CIFOR	Center for International Forestry Research	GDP	Gross Domestic Product
CIP	Climate Information Platform	GFCS	Global Framework for Climate Services
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement	GFI	Governance Forest Initiative
CIS	Climate Information Services	GOK	Government of Kenya
CITET	Centre for Environmental Technology of Tunis	GPCP	Global Precipitation Climatology Project
CMAP	Merged Analysis of Precipitation	GPCs	Global Producing Centres
CMO	County Meteorological Office	GTZ	Gesellschaft für Technische Zusammenarbeit
CNCT	National Mapping and Remote Sensing Centre (Tunisia)	IAR	Institute of Agricultural Research
CNRM	National Center for Meteorological Research Centre	ICPAC	Intergovernmental Authority on Development Climate Prediction and Applications Centre
COP	Conference of Parties	ICRAF	World Agroforestry Centre
CPC	Climate Prediction Center	ICTs	Information and Communication Technologies
CPCs	Civil Protection Committees	IEDRO	International Environmental Data Rescue Organization
CSA	Climate Smart Agriculture	IFC	International Finance Corporation
CSAG	Climate Systems Analysis Group	IGR	Internally Generated revenues
CSIR	Council for Scientific and Industrial Research	IHA	International Hydropower Association
DADOs	District Agriculture Development Officers		
DAES	Department of Agricultural Extension Services		

IITA	International Institute of Tropical Agriculture	NDVI	Global Normalized Difference Vegetation Index
IMTR	Institute Meteorological Training and Research	NEWS	National Early Warning System
INAT	National Agronomy Institute of Tunis	NGOs	Non-governmental organisations
INC	Initial National Communication	NGOs	Non-Governmental Organization
INRAT	National Agricultural Research Institute of Tunisia	NIMET	Nigerian Meteorological Agency
INSTM	National Ocean Science and Technology Institute (Tunisia)	NIS	National Institute Statistics (Tunisia)
IRA	Institute of Arid Regions (Tunisia)	NMHSs	National Meteorological and Hydrological Services
IRAD	Institute of Agricultural Research for Development	NMS	National Meteorological Service
IRTC	UCLA International Research and Training Center in Cameroon	NTCCC	National Technical Committee on Climate Change
IUCN	International Union for Conservation of Nature	NTFP	Non-timber Forest Products
IVRS	Interactive Voice Response System	ONACC	National Observatory on Climate Change
KALRO	Kenya Agricultural and Livestock Research Organization	PPEW	Platform for the Promotion of Early Warning
KBS	Kenya Bureau of Statistics	PRESAC-10	Tenth Session of the Regional Climate Outlook Forum for Central Africa
KMS/D	Kenya Meteorological Service/ Department	PSAs	Public Service Announcements
LDCs	Least Developed Countries	RANET	Radio Network
LINK	Local and Indigenous Knowledge	RCC-RA I	Regional Climate Centre for the Region of North Africa
LST	Land-Surface Temperature	RCCs	Regional Climate Centres
MCCCI	Malawi Confederation of Chambers of Commerce and Industry	RCOF	Regional Climate Outlook Forums
MECCM	Ministry for Environment and Climate Change Management	RDPs	Rural Development Programmes
MINEP	Ministry of Environment and Nature Protection	REDD+	Reduce Emissions from Deforestation and forest Degradation in Developing countries
MINEPAT	Ministry of the Economy, Planning and Regional Development	RFE	African Rainfall Estimate
MoAFS	Ministry of Agriculture and Food Security	RMTC	Regional Meteorological Training Centre
MoIWD	Ministry of Irrigation and Water Development	SHO	Hydrographic and Oceanographic Service of the Navy (Tunisia)
MPs	Members of Parliament	SMS	Short message services
MVAC	Malawi Vulnerability Assessment Committee	SOPs	Standard Operating Procedures
NADC	National Agency for Disease Control	TCCC	Technical Committee on Climate Change
NAERLS	National Agricultural Extension and Research Liaison Services	TOESD	Observatory for the Environment and Sustainable Development (Tunisia)
NAM	Northern Annular Mode	TRMM	Tropical Rainfall Measurement Mission
NAPA	National Adaptation Plan of Action	UNDP	United Nations Development Programme
NCCAP	National Climate Change Adaptation Plan	UNFCCC	United Nations Framework Convention on Climate Change
NCDC	National Climatic Data Centre	USCSP	US Country Studies Programme
NCS	National Climate Services	WBG	World Bank Group
NDMA	National Drought Management Authority	WHO	UN World Health Organization
NDPRC	National Disaster Preparedness and Relief Committee	WII	Weather Index-Based Insurance
		WMO	World Meteorological Organization
		WRMA	Water Resources Management Authority
		WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

The impact of climate change in African countries has been widely acknowledged. Africa has made considerable efforts over the past decade in the development of regional and national strategies and institutions aimed at supporting African countries to transition towards climate resilient and less carbon-intensive economies. At the regional level, several programmes and initiatives have been to tackle the effect and impact of climate change through the provision of robust climate information and services that support decisions and strategies for climate resilient economies. One such programme is the Climate for Development in Africa (ClimDev), a joint initiative of the African Development Bank (AfDB), African Union and the United Nations Economic Commission for Africa (UNECA). Under this initiative, the ClimDev Africa Special Fund (CDSF) was established to strengthen institutional capacities of national and sub-regional bodies to formulate and implement effective climate-sensitive policies.

With financial support from the CDSF, the African Technology Policy Studies Network (ATPS) in partnership with the Stockholm Environment Institute (SEI) Africa Centre, IGAD Climate Prediction and Applications Center (ICPAC), Observatoire du Sahara et du Sahel (OSS), AGRHYMET Regional Centre (ARC), and the Regional Centre for Mapping Resource for Development (RCMRD) is implementing a project tagged “Bridging climate information gaps to strengthen capacities for climate informed decision-making in Africa”. The goal of the project is to reduce vulnerability and foster a food-secure Africa through the strengthening of African countries’ capacities to understand and deploy appropriate climate information and best practices to inform decision-making and support development planning. The project focuses on five countries (Cameroon, Kenya, Malawi, Nigeria and Tunisia), which are a representative of the five major geographical regions in Africa. The selection of each country within a region is also based factors such as being a regional hub; country that is favourably disposed to climate change policies and institutions; and vulnerability to climate change impacts; and low capacities for adaptation and planning.

This report provides an assessment of the climate information, needs and services in Cameroon, Kenya, Malawi, Nigeria and Tunisia. This is part of the activities in component one of the project that runs for 2 years till the end of 2019. These assessments were mainly conducted through desk studies where various published and unpublished documents and information were analysed. Key informant interviews were conducted to triangulate and validate the results of the desk studies. Among those interviewed were government officials drawn from the key ministries, those from the meteorological, transport, Tourism, agricultural departments among others. ATPS conducted studies for Cameroon, ICPAC for Kenya, RCMRD for Malawi, ARC for Nigeria and OSS for Tunisia. SEI was not part of this component. The reports were individually reviewed and this consolidated report prepared capturing the key issues identified in the five countries.

The aim of this assessment was to:

- i) Identify the gaps in collection, accessing, dissemination, packaging and utilization of climate information and services in five countries (Cameroon, Kenya, Malawi, Nigeria and Tunisia).
- ii) Identify the legal and regulatory framework in the countries and how those affect access, dissemination, packaging and utilization of climate information and services
- iii) Analyze the extent of utilization of climate information and services in the five countries
- iv) Examine the extent to which the various sectors are impacted by the lack of climate information and services
- v) Assess the vulnerability and adaptive capacity of the people engaged in different livelihoods across the five countries.

These countries have formulated climate change adaptation plans and strategies to assist their economies deal with climate change impacts. Recent interventions through the Intended Nationally

Determined Contributions (INDCs) set out the pledges and intentions of these countries on climate change mitigation for the post-2020 period. Despite programmes and initiatives to address climate change issues, these countries are confronted with gaps in available climate information and low capacity to collect, analyze, and use robust and reliable climate information to inform decision-making and to mainstream climate change adaptation and risk measures into national development plans and policies.

Chapter one provides a background, objectives, methodology and the definition of the key concepts used throughout the report. Chapter two provides a synopsis of the five countries with respect to their position, political, social and economic state. It also dissects the key climate information services and needs in the countries. These include the state and specific needs with regard to financial capacity, human resource capacity, technical and technological capacities, infrastructural needs and communication and dissemination of climate information and services. The various sources of climate information that exist in the five countries are also discussed in this chapter.

Climate Information Systems (CIS) in the five countries are discussed and illustrated in Chapter two. The linkage and relationships between users of climate information and products and the generators of the information are elaborated. Private sector players, research organizations, universities, government institutions (Ministries and Parastatal bodies), public users and the National Meteorological and Hydrological Services (NMHSs) relate differently and at different levels. Relationships with international bodies such as World Meteorological Organization (WMO) and other regional bodies are also elaborated for the different countries.

Chapter three highlights the specific gaps and needs in ensuring access to climate information and services in the five target countries. The various stakeholders involved in the provision and utilization of climate information and services are also identified and discussed. Some of the countries have made efforts in providing climate information and packaging it for ease of use by the various stakeholders. However, some of the countries only provide raw data or data targeting just the aviation industry with very little analysis for early warning and weather monitoring to adapt to climate change. Several gaps and needs have been identified that contribute to the poor provision of climate information and services. Among the needs identified is the low capacity of the workers to collect quality climate information which is aggravated by the fact that most weather stations in the five countries continue to use rudimentary/outdated technology/instruments in measuring some of the weather elements. Furthermore, most of the stations are ill-equipped and suffer from understaffing. In Cameroon, for example, there are about 22 major weather stations that are functional but not all of them are able to provide all the weather parameters. Data gaps are filled from modelling in most of the countries including Tunisia, Malawi and Nigeria. Kenya has made huge strides in establishing infrastructure for collecting climate information. This has been through concerted effects with various stakeholders who work with Kenya Meteorological Department (KMD). Other private organizations have set up small weather monitoring stations and transmit the data to KMD on a weekly basis. Cameroon, Nigeria, Tunisia and Malawi are part of the Regional Climate Centres (RCC) established by the World Meteorological Organization (WMO) to collect and share climate information and services. Most of these data are available in the websites of WMO and partners. The links to some of the sources of the climate information are shared in this chapter. A major gap identified in this report is the poor packaging and dissemination of climate information across all the five target countries. Most of the information is usually too raw to give meaningful actionable data. In most instances, the data is poorly analyzed and is not focussed on the end-user. Therefore, the sector players are unable to translate the data into actionable decisions or policies or plans.

Chapter four addresses the key sectors that are affected by climate change and how climate information and services availability and access can be used shield or prevent or assist the people to adapt from the severe effects of climate change if provided timely and in the correct package. This information can also be used in various sectors such as tourism and transportation sectors for safety especially in aviation industry and also for planning purposes. Analysis has been provided on how the five target countries have been able to utilize the available information in the various sectors. Cameroon for instance is using climate information in the agricultural sector where various insurance products have been developed based on climate information available. However, Cameroon is faced with difficult socio-economic conditions, insufficient institutional framework and inadequate infrastructure. Inadequate research, training and credit limit farmers' capacity to adapt to climate variation and change. In Kenya, Kenya Meteorological Department (KMD) currently provides a range of climate information both at short, medium, long range, seasonal and sub-seasonal scales. At the national level daily, 3 days, 5 days 7 day, 10day, monthly and seasonal weather forecasting and review are available for the general public. The public weather climate information are offered without charge and can be retrieved from the KMS website, and are also posted on KMS social media handles and through email request. Despite the access to this information, its utilization is still very limited and the users in the various sectors are unable to interpret the information to aid in decision making. Private players and research organizations have attempted to interpret and package this information into actionable forms for their own use or to provide early warning services. The product and services provided by various private players targeting specific users include agriculture and livestock; early warning systems with a proportion that also serve agricultural purposes; agro-weather information services in support of tactical and strategic decision making; weather forecasting; climate advisories for general government policies and decision-making and climate projections; and some providers service the insurance derivatives and transport safety advisory sectors. In Malawi, various departments within the Ministry of Agriculture and Food Security (MoAFS) use seasonal forecasts, for example they produce the Agricultural Crop Production Survey and produce information and advice for farmers. However, they also focus on the coming season and therefore, do not consider projections of what will happen in following years. MoAFS and the Ministry of Irrigation and Water Development (MoIWD) collaborate at all levels of governance on matters relating to food security. Representatives from departments within the MoIWD outlined that weather information such as rainfall, temperatures, humidity, potential evapotranspiration rates, etc. are all vital in planning and designing long-term future investments, such as irrigation projects. For Agriculture and food security sector in Nigeria, NIMET is regularly providing the seasonal climate forecast consisting of outlooks on the cumulative rainfall, mean temperature anomalies, onset of the rainfall, ending of the rainfall season, dry spells (drought). Other sectors discussed include, health: Tunisia has an approved national health adaptation strategy and has conducted a national assessment of climate change impacts, vulnerability and adaptation for health. Additionally, Tunisia is taking action to build institutional and technical capacities to work on climate change and health. Other sectors discussed in this report include energy, water resources, environment and natural resources, tourism and transport.

Chapter five analyses the existing legislation and policies in the five countries that address or touch on climate information generation, analysis, packaging and dissemination. Some of the policies and legislation discussed touch on the various efforts and progress made in addressing the challenges of climate change over the years. Most of these policies are sector specific while others are general and cut across various sectors. These policies provide a legal basis and framework for action. These countries are signatories of the United Nations Framework Convention on Climate Change (UNFCCC) and have fully complied with the agreement. They have all submitted their INDCs and are working towards achieving the goals set in the documents through the strategies prescribed.

Socioeconomic information is linked to climate information in chapter six. Livelihoods and livelihood assets are discussed together with the capacity of the people to adapt to climate change vagaries and how indigenous knowledge and practices are applied in the absence of modern climate information. Vulnerability and adaptation strategies applied in the target countries are also analyzed. In Kenya for instance, the economy is highly dependent on climate sensitive sectors including agriculture, tourism, and energy. Agriculture is the backbone of the Kenyan economy directly contributing 24% of the GDP in 2009 and another 27% indirectly. The sector accounts for 65% of informal employment in rural areas. Kenya faces major food security challenges due to the over dependence on rain-fed agriculture for food production. The number of Kenyans requiring food assistance rose from 650,000 in 2007 to almost 3.8 million in 2009/2010. Pastoral and marginal agricultural areas are particularly vulnerable to the impacts of climate change. There is reasonable level of awareness of the importance of climate information services (CIS) for climate adaptation as seen in the policy and legal framework and the efforts of engagement of stakeholders in CIS related issues. However, an outstanding challenge is the absence of a framework to properly downscale CIS to the local and county level in accordance with the decentralization initiatives. There is also a challenge to evaluate the quality of the services, effectively deliver the downscaled services, and elicit relevant feedback from end users. There is also limited coordination in the CIS field with the implication that the much needed collaboration framework to enhance CIS design and delivery; sustainably scaling up CIS based on good science; improved governance; and set up of appropriate business models is required.

Nigeria is particularly vulnerable to the impact of climate change in many fronts considering its geography, climate, vegetation, soils, economic structure, population and settlement, energy demands and agricultural activities. As a developing country, it is particularly vulnerable because a large share of its economy is dependent on climate-sensitive natural resources. Some progress has been made to avert the challenges of climate change or reduce this vulnerability by way of policy and proactive activities to enhance provision of climate information and services. But this is not enough. Malawi is vulnerable to climate-related hazards particularly floods, droughts and intermittent rainfall; and there is evidence suggesting that the frequency and magnitude of these hazards will increase in future and will be exacerbated by climate change. However, Malawi's own vulnerability to climate change arises mainly from socio-economic, demographic and climatic factors. Yet, there are no policies that directly address these issues in terms provision of quality climate services that considers the socio-economic and demographic factors.

Chapter seven analyses the challenges and constraints facing the target countries in collection, recording, analyzing, packaging and dissemination of climate information. It is evident that the major constraint is the lack of financial capacity to finance the NMHSs to procure modern equipment, establish new weather observation stations and set up infrastructure. Lack of finances also leads to under-staffing, in ability to invest in capacity building of staff or employ more qualified experts. Other challenges are also discussed in this section.

Chapter eight provides the opportunities that are available for the countries and the recommended actions going forward. Among them is to collaborate with other institutions in the production and dissemination on weather and climate information; the weather and climate services partnership will be more effective in serving the countries and individual clients if the public, private, and academic sectors collaborate and work together on the priorities and pull resources that are critical for progress. The top priority for improvement in weather and climate services is optimization and integration of the observation, modeling, and prediction system with a special focus on improved observations of water and other key variables.

There is a need to incorporate climate change considerations into development plans, and the clearest policy objective should be to prepare for the hazards of climate change by reducing vulnerability, developing monitoring capabilities and enhancing the responsiveness of the various sectors to forecasts of production variations by reducing vulnerability through improvements in research and infrastructure. For instance, agriculture in Cameroon is a risky business, not only because of inadequate infrastructure, under-capitalization and farming returns that barely exceed costs, but in large part because an essential input – climate – is variable and unpredictable. Declining growth rates in yields, losses of land from production and environmental constraints are powerful indicators for a difficult future. Since agricultural activities are sensitive to climate and weather conditions, agriculture decision makers in the country are at the mercy of these natural factors or attempting to benefit from them. The only way to profit from natural factors is to take them into account and understand their influence. Since very little land is irrigated, climate variables translate into variable production levels. There is an overwhelming and urgent need to put in place mechanisms that will promote societal adaptation to the current climate variation, and future climate change.

Malawi requires a hands-on approach to improve the climate data capture and management system at all levels. Improvements should be made in the quality and appropriateness of data collected through networking, development and use of innovative technologies and capacity building. Increased recognition of the devastating impact of climate change and the need for adaptation, innovations in information and communication technologies, and increased civil society participation in development activities are some of the opportunities that should be utilized for propagating rigorous efforts in building climate data management capacity in the country. There is also a need for institutionalizing climate data management training within all climate data collection stations, which would encompass collecting, processing, storing, updating, packaging and/or disseminating of data and information to various stakeholders. In addition, there is need to provide equipment and training for community collection of local climate data to improve access to weather data and to enhance climate projections. Recommended also is the establishing of a website for information dissemination and sharing, which would also act as a backup for the climate data. This would be coupled with utilisation of existing technologies such as Geographical Information System (GIS) and Remote Sensing. Other opportunities could be strengthening the capacities of local communities, district councils, and national agencies that usually respond to emergencies through trainings and improved emergency services. Despite the growing knowledge base built and managed by NIM and the collaboration with its national technical stakeholders, many information and knowledge gaps still need to be filled out in Tunisia.

The main challenges that need to be overcome to ensure a more efficient climate information service delivery include: the strengthening of the forecasts and alerts systems for specific events (storms, coastal surges, flooding and high winds); the setting up of a more efficient national climate modelling and forecasting service, taking into account the climate change dimension at various scales; the reinforcement of knowledge and capacities of the stakeholders (government agencies, climate sensitive sectors such as agriculture, energy, tourism and transport) in the mastering and use of climate predictions, products and information to support long-term planning on adaptation; the building of a Web-based Interactive Collaborative Environment for climate information knowledge sharing and dissemination; the reinforcement of knowledge and capacities of staff at the NMHS and the national technical stakeholders dealing with climate-based information/data; the introduction/promotion of mobile application technologies (such as *LandInfo*), for improved climate resilience; and the improved consideration of the climate change dimension in the services offered in the various sectors of agriculture, energy, tourism, among other sectors. It is also imperative to set up a dynamic and consistent collaboration network with other meteorological agencies in Africa and beyond.

Chapter nine concludes the report by providing the key findings of the study in the five countries. It also provides the way forward for the countries to bridge the gap in provision of climate information and services. Effort is needed to create a modern real-time climate system requires strengthening capacities of national and regional institutions and existing networks to use and disseminate climate information to assist development planning in the target countries. This can be enhanced through strengthening the capacity of the various ministries involved in climate data management as this will enable them deploy appropriate climate information and best practices in order to effectively implement climate-proof policies and practices that can help the countries to become more resilient and productive under changing climate.

1. INTRODUCTION

1.1 Background

The African continent remains the world's second fastest growing economy after East Asia according to African Development Bank (AfDB) financial presentation 2017 (AfDB, 2017) . Buoyed by recent investments in the resource sectors, agriculture, and growing innovations, the prospects of continued growth look good except that the impact of climate change, which has become a development imperative threatens to derail the gains made and limit African countries' pathway to sustainable development. To deal with the threat of climate change impact, several programmes and initiative has been established at the national and regional levels to deal with the growing threat of the impact of climate change. Such initiatives and programmes allow various African stakeholders to share collect and share climate information and services that would strengthen national and regional climate information systems. For example, the Climate Change and Development Africa (CCDA) conference is designed to strengthen linkages between climate science and development policy by promoting transparent discussions between key stakeholders in the climate and development community, with the ultimate goal to mainstream climate information into decision-making and strengthening capacities on climate sensitive sectors such as agriculture, food security, energy and transport. Such initiative among others are informed by the African Union's "Action Plan for Africa" and the Action Plan and Adaptation Strategy of African Development Bank (AfDB) to strengthen the capacity of member countries to address climate change risks, and to deliver sustained development benefits on the continent.

Despite the effort at the regional and national levels, many African countries continue to lack access to consistent climate and weather information to properly inform decisions on the management of climate-related risks. The density and coverage of existing African climate data observations network have generally been described in many literatures as poor and sparse (Washington et al., 2006; Parker et al., 2011). Whilst deeper analyses of the likely impacts of climate change has been carried out at the global and continental levels, there is an expressed need and recommendations made for the acquisition of more detailed climate data to inform decision-making and for improved modelling accuracy at the regional, national and local levels. Many African countries are challenged with adequate climatic data to make sound analysis and to inform decision-making. Based on the current climate change issues and development priorities identified in selected countries, this report responds to the needs through a critical review and analysis of available climate information and needs in the selected countries. With climate change increasing the frequency and intensity of disasters such as floods and droughts, it is becoming more urgent to support vulnerable countries and communities to have access to relevant climate information. Climate information is needed to characterize climate risks and to inform decision-making for effective risk management.

This report assesses the climate information and needs in Cameroun, Nigeria, Malawi, Kenya and Tunisia. These countries have formulated climate change adaptation plans and strategies to assist their economies deal with climate change impacts. Recent interventions through the INDCs set out the pledges and intentions of these countries on climate change mitigation for the post-2020 period. Despite programmes and initiatives to address climate change issues, these countries are confronted with gaps in available climate information and low capacity to collect, analyze, and use robust and reliable climate information to inform decision-making and to mainstream climate change adaptation and risk measures into national development plans and policies. It is based on this that AfDB through its ClimDev programme provided resources to African Technology Policy Studies Network (ATPS), to lead in identifying the gaps in climate information needs and services for the five countries ATPS is working with 5 other partners i.e. Stockholm Environment Institute (SEI) Africa Centre, IGAD Climate Prediction and Applications Centre (ICPAC), Observatoire du Sahara et du Sahel (OSS), AGRHYMET Regional Centre (ARC), and the Regional Centre for Mapping Resource for Development (RCMRD). These institutions have partnered based on their individual capacities as

leading institutions on climate change research, development and policy and also based on the competencies of individuals working in these institutions.

1.2 Objectives of the Assessment

The objectives of this assessment are to:

- i) Identify the gaps in collection, accessing, dissemination, packaging and utilization of climate information and services in five countries (Cameroon, Kenya, Malawi, Nigeria and Tunisia).
- ii) Identify the legal and regulatory framework in the countries and how those affect access, dissemination, packaging and utilization of climate information and services
- iii) Analyze the extent of utilization of climate information and services in the five countries
- iv) Examine the extent to which the various sectors are impacted by the lack of climate information and services
- v) Assess the vulnerability and adaptive capacity of the people engaged in different livelihoods across the five countries.

1.3 Methodology

The assessments were mainly conducted through desk studies where various secondary data were collected from published and unpublished documents. National policy documents such as National development plans, Sectoral Acts and legislations were reviewed. National annual reports from the various sectors such as energy, agriculture, environment and natural resources, water among others for the target countries were also reviewed. This was done to assess the state of the sectors, the progress made in the use of climate information and services to inform decision making and to identify the gaps that exist in collection and use of climate information.

Primary data was collected using key informant interviews to triangulate and validate the results of the desk studies. Among those interviewed were government officials drawn from the lead ministries (Environment and Natural resources, Agriculture, Water, Energy, Transport and Tourism among others in the respective target countries), those from the meteorological, research organizations, and national and international organizations that collect, use and disseminate climate information as well as private sector players. Among those interviewed were key experts and researchers in the field of climatology and weather forecasting. Key users of climate information including farmers, insurance companies, transporters, tourist/travel agents, research organizations and humanitarian aid agencies were also interviewed. The information was then organized and presented as case studies, tables and figures. Lessons, challenges and opportunities were drawn from the studies to inform future actions.

1.4 Description of Key Concepts

a) Weather

Weather is the state of the atmosphere, describing for example the degree to which it is hot or cold, wet or dry, calm or stormy, clear or cloudy etc. Weather refers to day-to-day temperature and precipitation activity, whereas climate is the term for the averaging of atmospheric conditions over longer periods of time.

b) Climate services

According to the European Commission's Roadmap for Climate Services (2015), climate services "covers the transformation of climate-related data - together with other relevant information - into customized products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices development and evaluation of solutions and any other services in relation to climate that may be use for the society at large" (European Union, 2015).

c) Climate change

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming.

d) Climate variability

Climate variability is defined as long-term averages and variations in weather measured over a period of several decades. Evidence for changes in the climate system abounds, from the top of the atmosphere to the depths of the oceans. Climate, sometimes understood as the "average weather," is defined as the measurement of the mean and variability of relevant quantities of certain variables (such as temperature, precipitation or wind) over a period of time, ranging from months to thousands or millions of years.

e) Climate information

Climate information describes data on temperature, rainfall, wind, humidity, sunshine hours, and other factors. We usually distinguish between weather, which is the situation over a short time period, and climate, which describes long-term weather patterns or 'average weather'. Climate information may be from different sources, and may combine scientific as well as traditional knowledge. Climate information may be combined with various services to help people interpret and use climate information to improve their livelihoods, in areas such as health, agriculture, energy or water. Examples of climate information are:

Short term (days to weeks)

- Observed rainfall and temperature
- Forecasts for rainfall and temperature for up to one week in advance
- Alerts on pests and diseases
- Early warning of extreme rainfall, flooding

Medium to long term (months to years and decades)

- Likelihood of seasonal rainfall and temperature conditions
- Early warning of seasonal rainfall patterns
- Information about dry spells, onset of rains, duration of rainy season
- Historical data for rainfall, temperature, wind, extreme events

f) Meteorology

Meteorology is the scientific study of the atmosphere that focuses on weather processes and forecasting. Meteorological phenomena are observable weather events which illuminate and are explained by the science of meteorology. Those events are bound by the variables that exist in Earth's atmosphere.

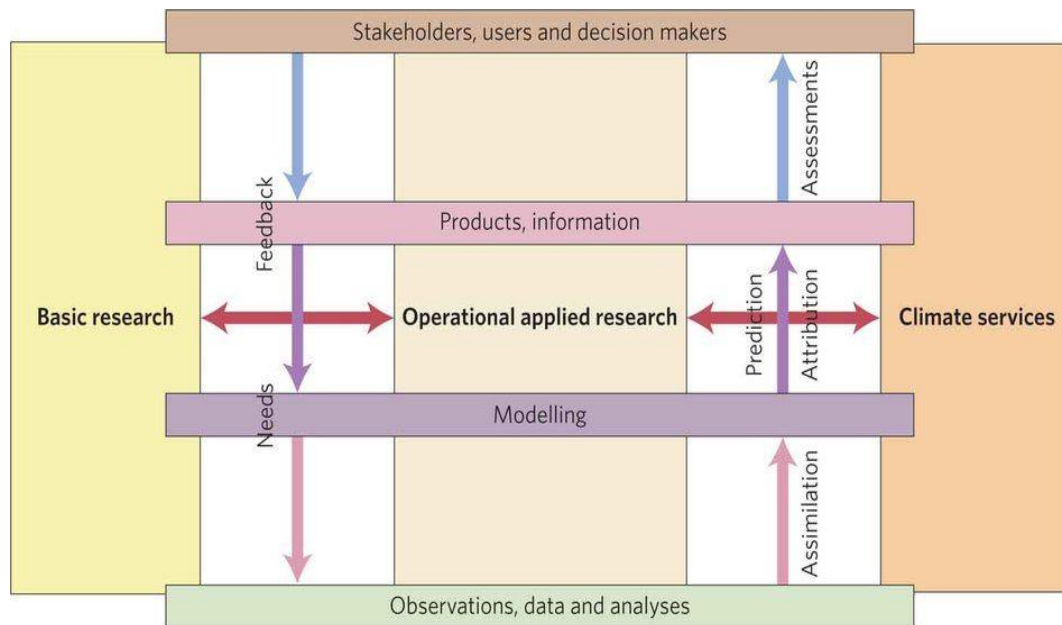
g) Climatology

Climatology also known as climate science is the study of climate, scientifically defined as weather conditions averaged over a period of time. Weather is known as the condition of the atmosphere over a period of time. Given the wide scientific and societal significance of climate and its study, the origins of the terms climate and climatology are of interest. They are traced from their earliest usages in English. The early references are in general scientific works but later climatology evolves as a science in its own right.

2. CLIMATE INFORMATION SYSTEMS

2.1 Overview

A climate information system helps inform decision-makers about what is happening and why, and what the immediate prospects are according to Trenberth (2008). Figure 1 below shows a schematic of the flow of the climate information system, as basic research feeds into applied and operational research and the development of climate services. The system is built on the climate observing system that includes the analysis and assimilation of data using models to produce analyses and fields for initializing models; the use of models for attribution and prediction and with all the information assessed and assembled into products and information that are disseminated to users. The users in turn provide feedback on their needs and how to improve information.



(Adopted from Trenberth, 2008; Trenberth et al., 2016)

Figure 1: Climate information system

The most useful types of climate data are precipitation (rainfall, snow, hail), temperature, vegetation, wind and humidity, although there are others that may be better suited for a specific decision. For each type of climate data, users may need to consider:

- a) **Historical information:** Data on past conditions and trends can be used for mapping hazards, assessing trends, identifying relationships with historical impacts (such as disease outbreaks and food insecurity), and providing a reference against which to compare current and anticipated conditions. Historical data can also be used for identifying the seasonality of climate, which can, for example, be important information for understanding the monthly distribution shifts of disease-carrying vectors, or identifying likely cropping cycles (Mason et. al., 2015).
- b) **Current information:** Data on current and recent conditions can be useful for indicating whether potentially impactful weather and climate events, such as severe storms, have recently occurred, or are under way, such as droughts.
- c) **Prospective information:** Forecasts, projections, and scenarios are useful for anticipating climate hazards, for planning operations, and for longer-term recovery and development planning. Inevitably, the proper use of such information is fraught with difficulties in fragile states, because of disruptions to the network of observations and operational climate services, as well as the lack of human resources in these contexts to generate and understand such information (Mason et. al., 2015). But even in fragile states, climate

information can be of value if its limitations are known and made explicit and climate-sensitive decisions are addressed appropriately.

2.2 Climate information system in Cameroon

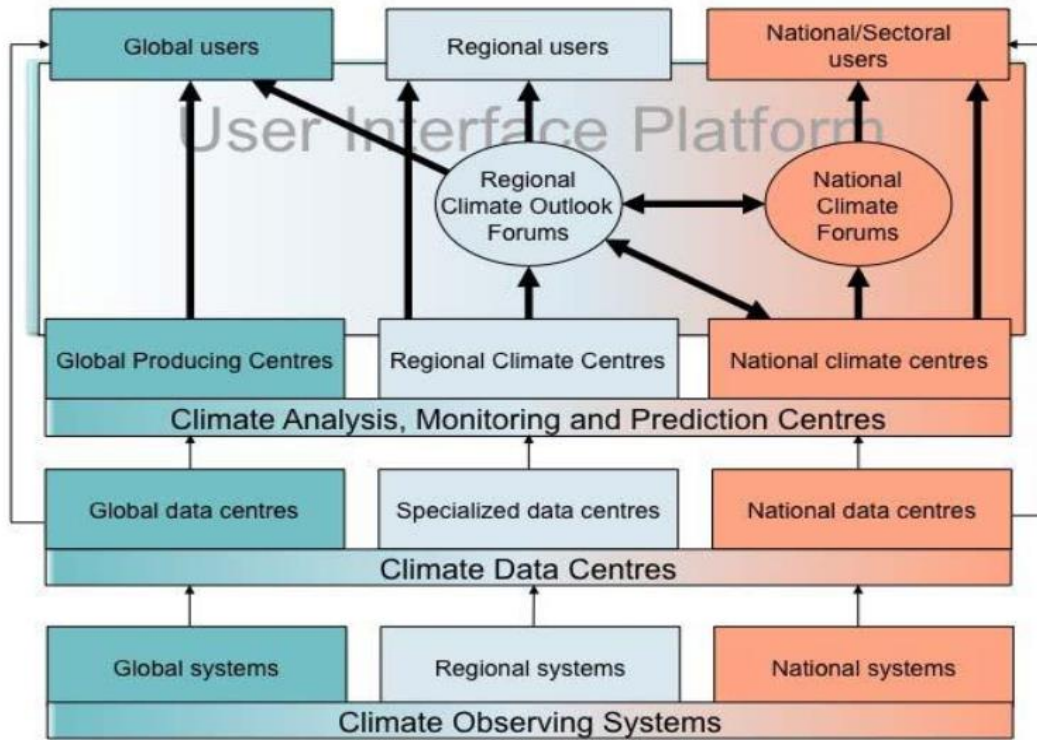
In order to be successful, adaptation strategies need to make use of the best available climate information, including assessments of recent climatic trends and projected future climate change that may be experienced in the years to come. Cameroon is still very far from achieving this. They are however making steps towards establishing systems to enhance production and dissemination of climate information. The climate information needed by local level communities and national governments includes how climate variables such as temperature and rainfall, and the timing and severity of storms and climate extremes may change. In order to be both useful and used, this information needs to be timely, high quality, relevant and accessible. Meeting these needs is the focus of an emerging field called *climate services*, which aims to bridge the gap between climate science, policy and practice for adaptation decision-making and disaster resilience.

Cameroon has a total of 22 weather stations all over the country which translates to 21,611 Km² per weather station. This severely reduces affect the accuracy of data provided by the stations for areas that are more than 5Km radius from the weather station. However, according to the World Meteorological Organization (WMO), only 20 stations are enlisted (<https://www.wmo.int/cpdb/cameroon>). This could be because of inability to collect weather information effectively to the acceptable standards of WMO.

2.3 Climate information system in Kenya

KMD provides climate information services (CIS) in Kenya and to provide framework to achieve such. It derives its mandate from WMO Convention, which is to provide accurate, timely weather and Climate Information Services (CIS). Education and training including research and development are additional functions designated by WMO to KMS. The mandate of KMD is to provide meteorological, hydrological and related services in support of relevant national needs, including safety of life and protection of property, safeguarding the environment and contributing to sustainable development, as well as to meeting international commitments and contributing to international cooperation which is derived from the world meteorological organisation (WMO) convention. KMD has made steps in decentralizing climate information services to the county levels and these are aimed at providing localised and user specific information. County meteorological offices are expected to implement the mission of KMD at county level.

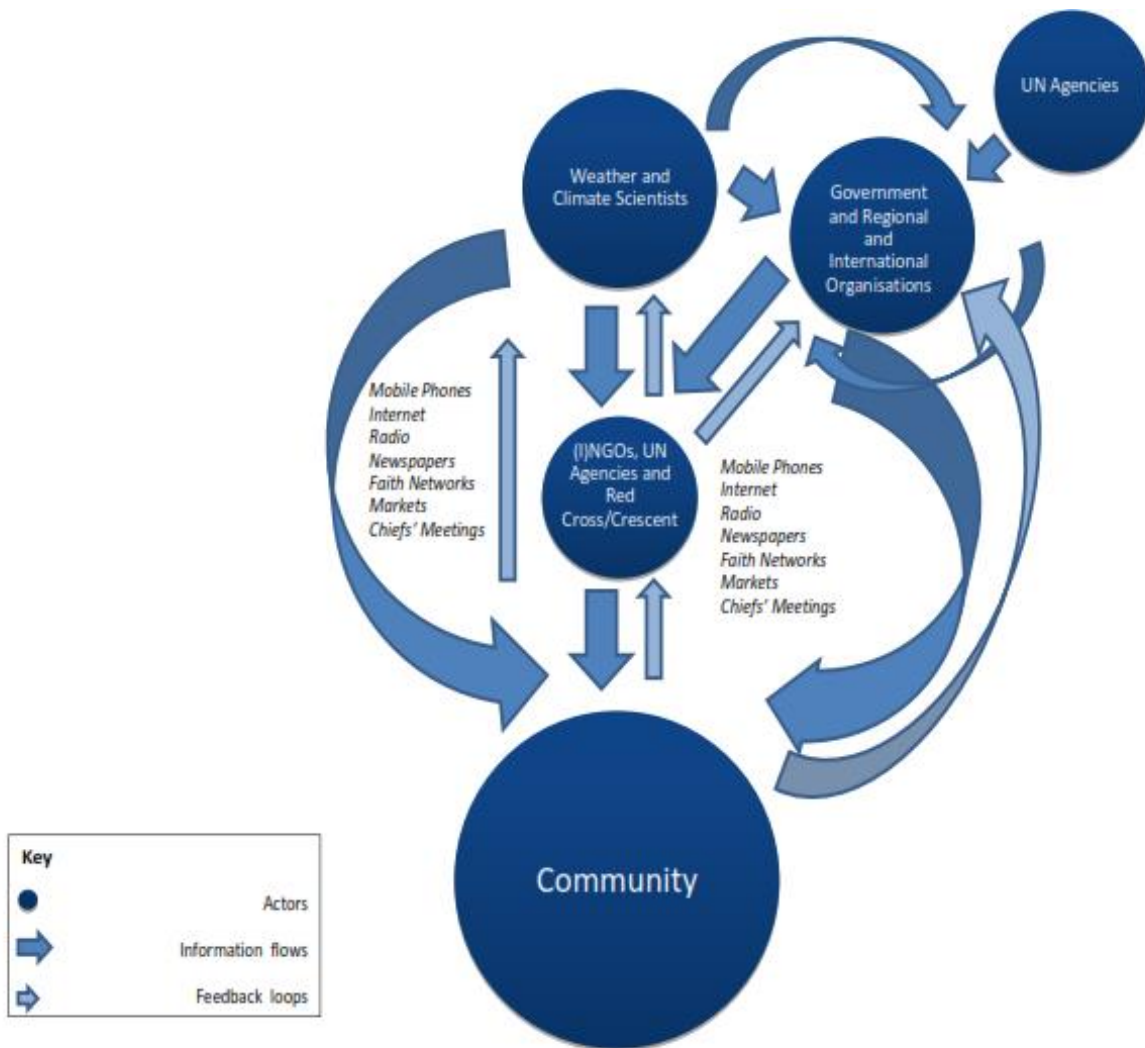
Development of weather and climate products is done at different levels, including global, regional, national and local scales. At the national level, KMS develops the products at its headquarters in Nairobi. These national-level products are released to County Meteorological Office (CMO) as needed for use at the county level. The CMO has the role of downscaling national-level products to address local needs. Weather and climate products include: probabilistic weather forecasts, ranging from short-term (daily, weekly), medium-term (monthly) and long-term (seasonal and annual); rain onset, cessation and distribution; early warning advisories; and climate summaries and normals. The CMO uses historical climate data and local knowledge of climate variability to downscale the national monthly and seasonal forecasts to develop a forecast for the county and sub-county levels.



Source: Richard Graham et al., (2015)

Figure 2: Global to National Data flows and value-added information flows

Global to National Data flows (thin lines) and value-added information flows (thick lines) into and through the entities and functions required for generating and delivering climate services



Source: Visman and Carpenter, (2012)

Figure 3: Two-way flows of weather and climate information to support community resilience

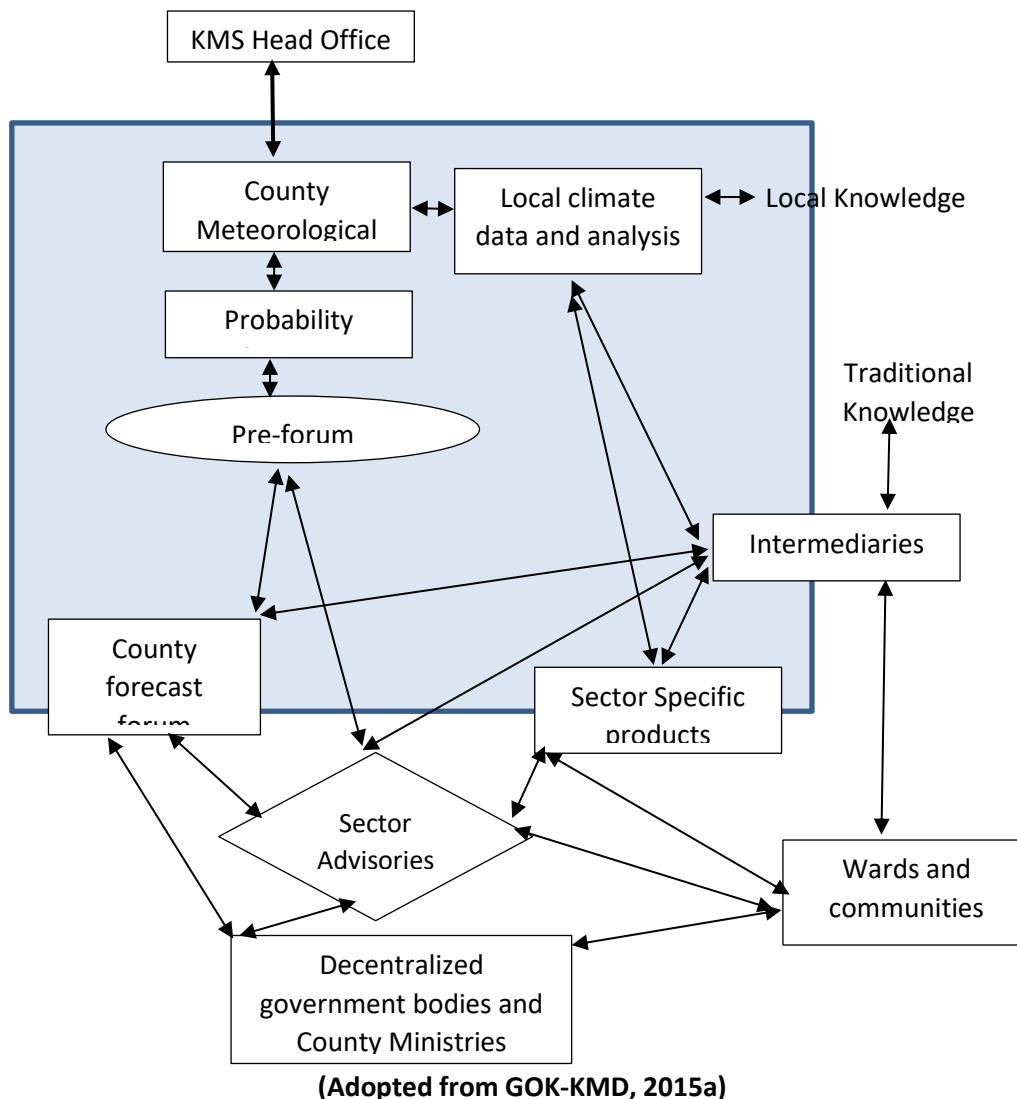


Figure 4: Proposed two way flow of decentralised climate information and seasonal forecast distribution

Education and training including research and development are additional functions designated by WMO to KMD. Institute Meteorological Training and Research (IMTR) a branch of the KMD and is one of the twenty three the WMO-Regional Meteorological Training Centre (RMTC) in the world. IMTR is responsible in training personnel in meteorology, hydrology, and related geo-sciences in the country and in the Anglophone countries in Africa. The IMTR/WMO-RMTC has two components: the IMTR located at the KMD; and the University of Nairobi college of Biological and Physical Sciences, Department of Meteorology. These two components work together in coordination of training on matters pertaining to meteorology including application, education, training, research and development. Training and research in various components of climate information services is also provided by other collaborating stakeholders such as regional institutions such as ICPAC, and climate intermediaries.

2.4 Climate information system in Nigeria

In Nigeria the climate information system follows the same model as define above (Figure 1). The data observations, collections are done by observers in meteorological stations across the country through a network. The meteorological information's are collected regularly at each station and transmitted directly to the national center of data collection. Decree in force as of 2001 allots the

meteorological service the power as the sole Organisation for developing national policies and guidelines on Meteorology as well as the sole coordinator of meteorological activities in Nigeria.

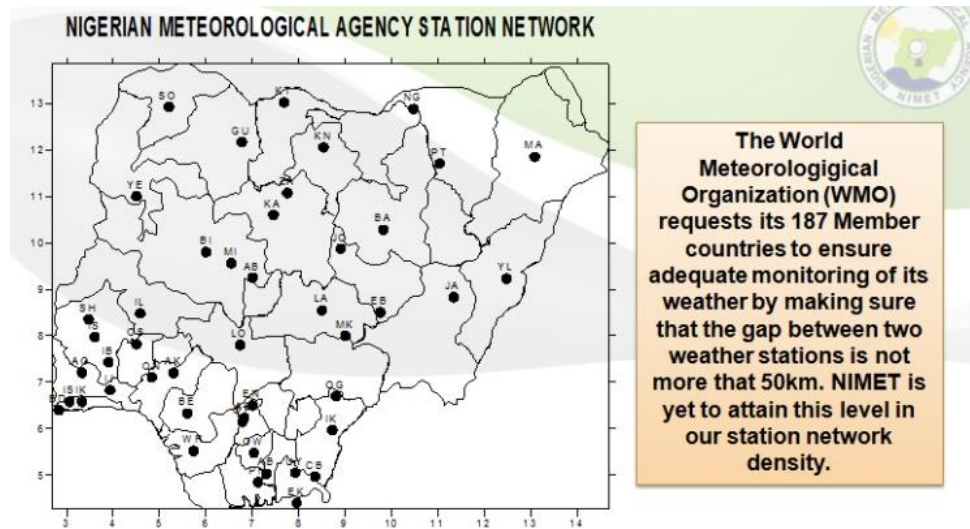


Figure 5: Operational Infrastructural Network of stations in Nigeria

The ground stations that collect data are composed of 54 stations (synoptic, agro-climatic and climatologic). At the main office where all the data converge, there are some experts to control the quality of the data and stored them in a databank through a data base management system. These data are used in models to see past evolution of the climate, to make some predictions or evaluate the impact of the climate on some socio-economics activates. The same data collected can be used for weather forecast, climate forecast (e.g. seasonal forecast,) and climate change and variabilities depending on the time scale. From the output of the models we have products that are analyzed and interpreted by climatologists and meteorologists and drag out information’s in terms of bulletins to various users. These information’s and bulletins are communicated to users, stakeholders and decision makers via different Channels. The research feed and improved the quality of need of various users of the climate information’s are done through universities, NIMET Directorate of research and training.

2.5 Climate information system in Malawi

In Malawi, the Enhancing Community Resilience Programme (ECRP) has invested in the development of climate monitoring and early warning systems through their DISCOVER¹ programme. Monitoring uses simple equipment such as rain and river gauges to collect data that is shared through an information center, specifically designed to be accessible to local community members. ECRP’s partnership with Malawi’s Civil Society Network on Climate Change (CISONECC) has allowed for PSPs to expand on the existing climate information pathway. When PSP workshops are included in the existing information pathway, climate information can be interpreted by a multi-stakeholder group that includes users and technical experts. Figure 6 and Figure 7 are graphical illustrations of: i) the current DISCOVER and ECRP climate information pathway; and ii) the role of PSPs. PSP workshops produce advisories that contain the climate forecast and recommendations for the coming rain season. Users that receive the advisories can implement the recommendations without having to interpret raw climate information. This reduces misinterpretations and leads to improved adaptive practices. In addition, the advisories are informed by technical expertise and

¹ Developing Innovative Solutions with Communities to Overcome Vulnerability through Enhanced Resilience (DISCOVER) works with local partners to deliver interventions that include *inter alia* early-warning systems, disaster risk management and climate-smart agriculture. During the January 2015 floods, DISCOVER early-warning systems reported several successes in avoiding damages and loss of life.

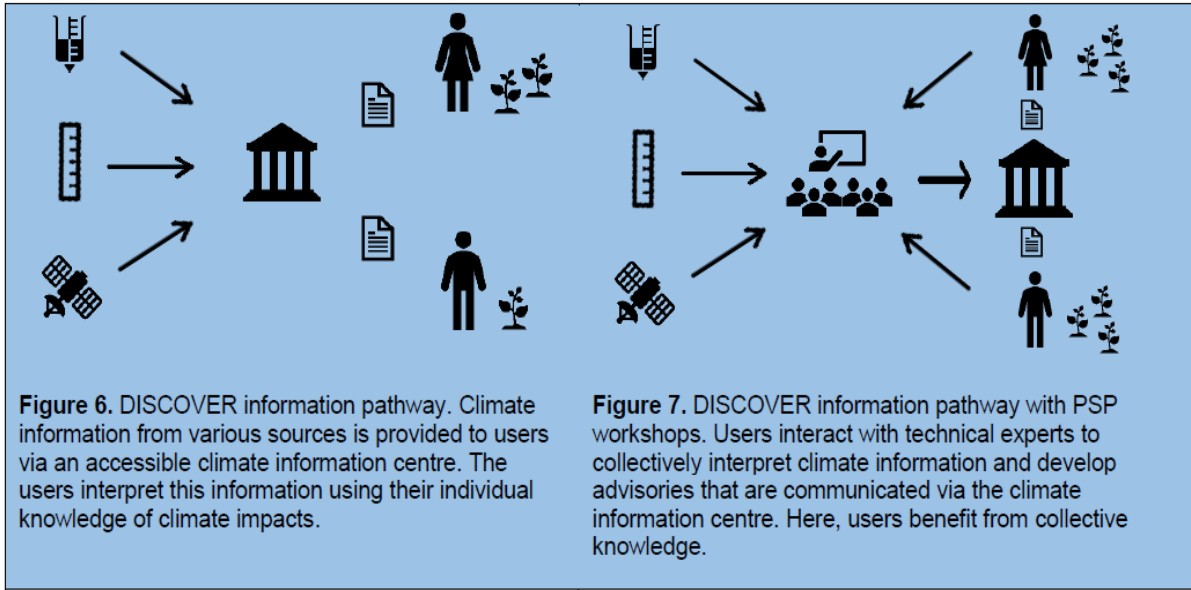


Figure 6 and Figure 7 are graphical illustrations of: i) the current DISCOVER and ECRP climate information pathway; and ii) the role of PSPs

2.6 Climate information system in Tunisia

The National Institute of Meteorology (NIM-INM) is the main government body in charge of delivering weather and climate information in support to needs of the different economic sectors in Tunisia (see Figure 8 below).

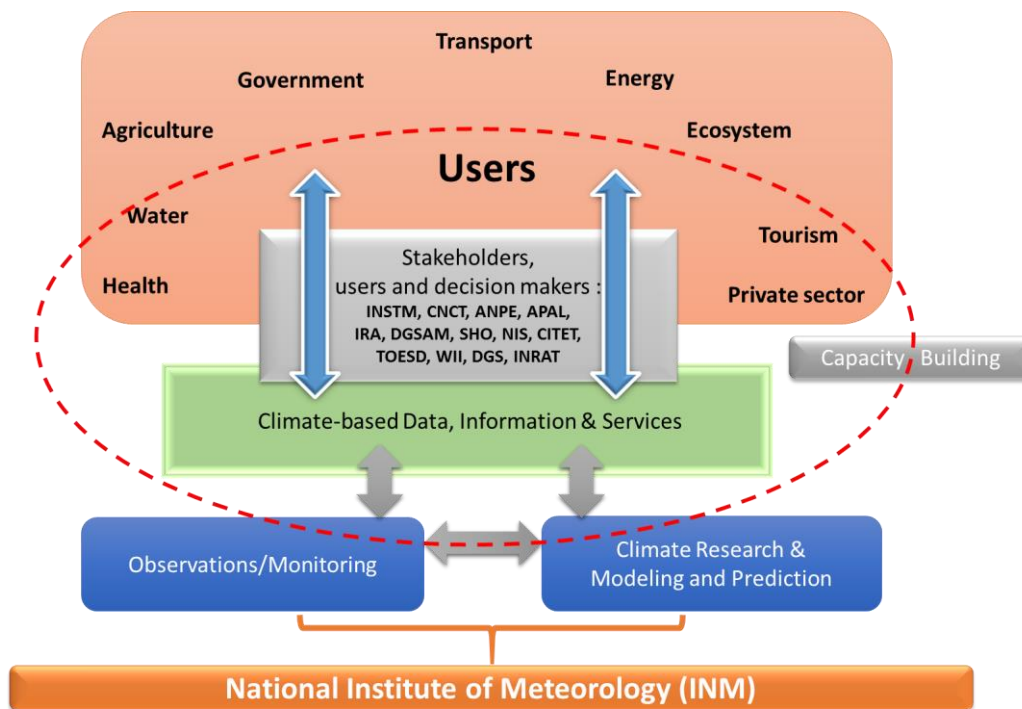


Figure 8: Basic overview on the Climate Information System in Tunisia

3. CLIMATE INFORMATION NEEDS AND STAKEHOLDERS ASSESSMENT

3.1 Overview

This section provides an overview of the five countries. It briefly describes the countries' situation with respect to the relevance and potential value of climate information and data as drivers in decision-making in the key economic sectors. It also provides a brief assessment of the state of climate information and services in the country.

3.1.1 Cameroon

Cameroon is located in central Africa and covers a land area of 475,650 km² (183,650 sq. mi). The population of Cameroon in 2016 was 24 million, with an average annual growth rate of 2.7 %. The country lies between 2 and 13° N and longitude 8° 30' and 16° 10' East. Cameroon is at the junction between Central and West Africa and is bounded by Nigeria to the North West (over 1,720 km), Chad to the North (1,122 km), to the East by Central African Republic (822 km), to the South by Congo (520 km), Gabon (298 km) and Equatorial Guinea (183 km). It opens to the Atlantic Ocean in the West with a total coastline of 400 km. Most agricultural activities are practised at the subsistence level by local farmers using simple tools. The majority of the country's poor live in rural areas and rely on rain fed agriculture and other natural resources for their living (Munang et al., 2008). According to the National Institute of Statistics of Cameroon (INS), agriculture is the dominant sector of the national economy and contributes about 52 % to GDP, 45 % of export earnings, and 15 % in public revenue (INS, 2010).

Cameroon is characterized by five agro-ecological zones with varied landscapes and climates. These are described as Zone I (Soudano-Sahelian); Zone II (High Guinea Savannah); Zone III (Western Highlands); Zone IV (Humid Forest with monomodal rainfall pattern); and Zone V (Humid Forest with bimodal rainfall pattern) (Ndi, 2014; Forum for Agricultural Research in Africa [FARA], 2015). Records on temperature and rainfall from a number of stations in Cameroon suggest a rising trend in temperature around Yaounde (Ndi, 2014; FARA, 2015). The rate of temperature change from 1900 to 1991 showed a net increase of 0.91°C during the period, higher than the global warming rate of 0.5°C over the same period. The northern region of Cameroon has a Sahelian climate with annual rainfall (RF) ranging between 300mm and 500 mm and concentrated around three to four months from July to October with average annual temperature exceeding 30°C (Nchangvi, 2004; FARA, 2015).

The Government of Cameroon's response to climate change has been mixed. The country is active at the international and regional levels in a number of processes, such as the participation in the Central African Forests Commission (CAFCOM or COMIFAC), established in 2005 as part of a commitment to sustainable forest management in the Congo Basin. Regional awareness on climate change has been established in line with the opportunities presented by emerging carbon markets and financial incentives for voluntary reductions in national deforestation rates. Through CAFCOM, Cameroon has played an important role in contributing to the development of the Reduce Emissions from Deforestation and forest Degradation in Developing countries (REDD+) option, in particular with regards to avoiding deforestation and forest degradation, and also the enhancement of carbon stocks in protected areas (COMIFAC, 2008). At the national level the government's response to climate change is much less clear. Political discourse around climate change has not yet gained a national platform in Cameroon despite the country's high level international commitments. However, increased national focus on environmental conservation and protection over the last decade has laid some of the groundwork for building a national climate change agenda, not least through the Forest and Environment Sector Programme (FESP), which the Center for International Forestry Research (CIFOR) describes as the „most tangible indication of Cameroon's efforts to meet its commitments (CIFOR REDD+ report, 2011).

One of the greatest challenges in responding to climate change is how to pin down the information needed to understand the risks and plan effective measures to address them. The sheer volume of information available in Cameroon is overwhelming; even the expert reviews and syntheses provided by the Intergovernmental Panel on Climate Change (IPCC) can fill hundreds of pages. However, sorting through it all, and finding the specific information that is relevant to the questions at hand, may be beyond the capacities and resources available to many decision-makers in Cameroon (Graham et al., 2015). There are major gaps between the questions that decision-makers may be asking, and the answers available (Graham et al., 2015).

In 2015, the agricultural sector accounted for 20% of the country's gross domestic product (GDP), approximately \$6 billion, and employed 54% of the population. Even though more than 12 million Cameroonians depend on agriculture for their livelihoods, their primary means of agricultural risk mitigation are limited to risk avoidance and other informal approaches such as under-investing in agricultural inputs. The use of climate information in other sectors such as natural resources conservation, tourism, and energy among others is very limited. In tourism for instance, short to medium range forecasts are used to advise visitors on the best days or periods to visit particular tourist attraction sites.

3.1.2 Kenya

Kenya lies on the equator with the Indian Ocean to the south-east, Tanzania to the south, Uganda to the west, South Sudan to the north-west, Ethiopia to the north and Somalia to the north-east. Kenya is a Lower Middle-Income country and the fifth-largest economy in sub-Saharan Africa. It has a Growth Domestic Product (GDP) of \$53.3 billion giving GDP per capita of \$1,246. In 2014, the economic growth rate was estimated to be 5.3%. The country has a population of more than 40 million people. The country has a warm and humid climate along its Indian Ocean coastline, with wildlife-rich savannah grasslands inland towards the capital. Nairobi has a cool climate that gets colder approaching Mount Kenya, which has three permanently snow-capped peaks. Further inland there is a warm and humid climate around Lake Victoria, and temperate forested and hilly areas in the western region. The north-eastern regions along the border with Somalia and Ethiopia are arid and semi-arid areas with near-desert landscapes. Lake Victoria, the world's second largest fresh-water lake and the world's largest tropical lake, is situated to the southwest and is shared with Uganda and Tanzania.

The agricultural sector is very critical and has been identified as the engine of prosperity, chiefly due to its direct positive impact on Kenya's rural population. It contributes approximately 24% of the nation's GDP, 60% of export earnings and about 75 % of industrial raw materials. It also accounts for 65% of the country's total export, 18% and 60% of formal and total employment respectively (<https://sokodirectory.com/2015/11/5320/>). The landscape of Kenya is distinctly divided into two halves – the eastern half which slopes gently to the coral-backed seashore, and the western portion, which rises abruptly through a series of hills and plateaus to the Eastern Rift Valley. West of the Rift is a westward-sloping plateau, and the lowest part is covered by Lake Victoria. The highest point in the country is the snow-capped peak of Mount Kenya (5,199 m), the second highest mountain in Africa. The coastline extends some 536 km from the Tanzanian border in the southeast, to the Somali border in the northeast. The main rivers are the Athi/Galana and the Tana. The major lakes are: Lake Victoria, Turkana, Baringo, Naivasha, Magadi, Jipe, Bogoria, Nakuru and Elementaita.

Extreme weather events, largely droughts and to a lesser extent floods, influence economic growth of the country and with associated devastating impacts. The frequency and intensity of severe weather events has been noted to increase, and this is expected to increase with further increase as with climate change. Frequent drought and flood events result in crop losses, livestock and wildlife deaths, spikes in food prices, increased food insecurity and malnutrition for the poor, rural

population displacement, and impact on urban water supply, and on energy generation (World Bank, 2014).

The Government of Kenya (GOK) recognizing the growing threat climate-related risks pose to its near- and long-term development prospects has developed several climate sensitive strategies and plans. For example, the Vision 2030; the First Medium Term Plan (2008–2012) and Second Medium Term Plan (2013–2017) acknowledge climate risk and the need to enhance capacity to manage it especially in reducing drought hazards. Kenya’s 2012 National Climate Change Adaptation Plan (NCCAP) recognizes the key role of improving climate information and services to strengthen the adaptive capacity of communities through ‘providing farmers and pastoralists with climate change-related information, and mainstreaming climate change into agricultural extension services. The NCCAP equally recognizes the vital importance of climate information services (CIS) to reduce ‘vulnerability to disasters by using climate risk information in development planning and policy making; taking into consideration that more than 70 per cent of natural disasters in Kenya are related to extreme climate events.

The Kenya Meteorological Department (KMD) is the national meteorological service provider with the mandate to provide climate information, coordinate and manage climate information provision framework in Kenya. The department has a nationwide network and has recently decentralised its services to the county level, in conformity with the Kenya Constitution of 2010. The County meteorological offices are expected to contribute in bringing climate services nearer to the community users, highly collaborating with county institutions, CIS intermediaries and bodies at the local levels.

Efforts to bridge climate service gaps in Kenya has brought on board several groups and agencies, and these include research and academia institutions; non-governmental organization (NGOs); governmental agencies; private sector; and regional and international organizations who play an active role in the context of CIS. In collaboration with KMD, regional climate centres such as the Intergovernmental Authority on Development Climate Prediction and Applications Centre (ICPAC) and the African Centre of Meteorological Applications for Development (ACMAD) work to generate climate information for stake holders within the region. Some of the CIS providers act as both users and producers of climate information especially those whose work evolves around community engagement and development (World Bank Group [WBG], 2016).

Although many efforts have been made in the provision of climate information in the country there are still gaps to fill especially in the technical capacity for production of user-oriented products, and communication and dissemination capacity. These can be attributed to the diversity of the CIS environment in Kenya, the lack of funding, lack of technical skills, and lack of appropriate frameworks for collaboration.

3.1.3 Malawi

The Southern African nation of Malawi contains Lake Malawi, one of Africa's largest, longest lakes, and is bordered by Mozambique to the south and west, Zambia to the east, and Tanzania to the north. It has an estimated population of 18 million (2016). With the support of the International Monetary Fund (IMF), the World Bank, and other development partners, Malawi has been able to make important economic and structural reforms and sustain its economic growth rates over the last decade. Nevertheless, poverty is still widespread, and the economy remains undiversified and vulnerable to external shocks. The macroeconomic outlook faces significant downside risks. These risks relate primarily to Malawi’s continued vulnerability to external shocks, amplified by the risks of fiscal slippages. The country (and its growth performance) is expected to remain vulnerable to climate variability for some time. Similarly, despite encouraging efforts towards fiscal consolidation,

experience suggests that Malawi has struggled to contain recurrent expenditure over the political-business cycle. Households' welfare in Malawi remains vulnerable to natural shocks such as drought and flooding, and food price inflation. Building families' resilience to shocks through investments in basic services, asset building, the improvement of early warning systems, and the revamping of safety-net programs continue to be the major challenges going forward.

Malawi experiences a subtropical climate that is largely decided by the oscillations of the Inter-Tropical Convergence Zones, the interactions between the zonal Congo air mass and the meridian south-eastern trade winds and monsoonal north-eastern winds. The ITCZ moves over Malawi late October, ranges south throughout November, reaching the likes of Mulanje late November, thereby providing the country with a tropical bimodal seasonal pattern. This pattern is influenced by the Indian Ocean's south western cyclonic weather pattern of a cool, dry westerly frontal system and – increasingly - by the ocean's surface temperature variability. The variations in altitude, as seen from its geography, lead to wide differences in climate hence seasons. From November to April, there is a wet but warmer season and almost all the annual precipitation takes place in this season (95%). This precipitation is dominant along the northern coast of Malawi with about 1630mm per year. This is pretty high because about 70% of the country averages between 750mm and 1000mm precipitation annually. A variation in the amount of rainfall is in the range of 725mm and 2,500mm. Zomba, Mzuzu and Blantyre receive 1,433mm, 1,289mm and 1,127mm of rainfall respectively. An extreme drought occurred in the period of 1991-1992 while extreme floods occurred in the period 1988-1989 and in 2014-2015. Between May and August, there is relatively cool, dry winter season, and temperatures fluctuate between 17°C and 27°C. Frost also occurs in some areas between June and July. Between September and October, there occurs a hot and dry season with temperatures fluctuating between 25°C and 37°C and humidity is at 50%. Between January and February, humidity is very high at 87%. Generally, the season can be summarized as follows: Cool season between May and mid-August; the hot season between mid-August and November; the rainy season between November and April (rains sometimes continue longer in the northern and eastern mountains); and the post-rainy season occurring between April and May (DoDMA, 2015).

In Malawi and Tanzania, WFP is one of the partners implementing the Global Framework for Climate Services (GFCS) Adaptation Programme for Africa. Under this initiative WFP's focus is on enhancing access to tailored weather and climate information for vulnerable communities. Being able to access easy-to-understand and timely information allows communities to take better decisions and to better manage climate related shocks for greater food security. For example, tailored agro-meteorological advisories are shared with food insecure communities through dedicated radio programmes and mobile phone messages. Agriculture extension workers have also been trained to interpret and communicate relevant climate information to rural audiences (WFP, 2017).

3.1.4 Nigeria

A key regional player in West Africa, with approximately 184 million inhabitants, Nigeria accounts for 47 percent of West Africa's population, and has one of the largest population of youth in the world. A federation that consists of 36 autonomous states, Nigeria is a multi-ethnic and culturally diverse society. With an abundance of resources, it is Africa's biggest oil exporter, and also has the largest natural gas reserves on the continent. The government led by President Muhammadu Buhari, identifies fighting corruption, increasing security, tackling unemployment, diversifying the economy, enhancing climate resilience, and boosting the living standards of Nigerians as main policy priorities. Nigeria's federated structure gives significant autonomy to states. Between 2006 and 2016, Nigeria's GDP grew at an average rate of 5.7 percent per year, as volatile oil prices drove growth to a high of 8 percent in 2006 and to a low of -1.5 percent in 2016. While Nigeria's economy has performed much better in recent years than it did during previous boom-bust oil-price cycles, such as in the late 1970s or mid-1980s, oil prices continue to dominate the country's growth pattern.

Moreover, the volatility of Nigeria's growth continues to impose substantial welfare costs on Nigerian households. The onset of the oil price shock in mid-2014 confronted the government with the pivotal challenge of building an institutional and policy framework capable of managing the volatility of the oil sector and supporting the sustained growth of the non-oil economy. After contracting for five consecutive quarters, the economy has returned to growth in the second quarter of 2017. With a renewed focus on economic diversification, promoting growth in the private sector and driving job growth, GDP grew by 0.6 percent (year-on-year) in the second quarter of 2017, driven by recovering oil production and some recovery in non-oil industries, too, and modest growth in agriculture. Economic growth is expected to have remained positive in the second half of 2017, averaging about 1.0 percent for 2017; driven by the continued recovery of oil production, sustained growth in agriculture, and the positive impact on investment and other private sector activities from the improved availability of foreign exchange to support imports.

As the government begins to implement the structural reforms outlined in its Economic Recovery and Growth Plan 2017–2020, growth can be expected to strengthen further in the medium term, reaching about 2.8 percent by 2019. Nigeria has made significant progress in socio-economic terms over the last 15 years. Between 2005 and 2015, Nigeria's Human Development Index value increased by 13.1 percent. However, the country continues to face massive developmental challenges, which include reducing the dependency on oil and diversifying the economy, addressing insufficient infrastructure, and building strong, and effective institutions, as well as governance issues, public financial management systems, human development indicators, and the living conditions of the population.

In Nigeria, it is the Nigerian Meteorological Agency (NIMET), which came into existence by an Act of the National Assembly who is the main institution providing climate and meteorological information's to users. Its establishment Act, enacted on 21st May 2003, and became effective on 19th June 2003 following Presidential assent. It is the Federal Government agency charged with the responsibility to advise the Federal Government on all aspects of meteorology; project, prepare and interpret government policy in the field of meteorology; and to issue weather (and climate) forecasts for the safe operations of aircrafts, ocean going vessels and oil rigs. The Act also makes it the responsibility of the Agency to observe, collate, collect, process and disseminate all meteorological data and information within and outside; co-ordinate research activities among staff, and publish scientific papers in the various branches of meteorology in support of sustainable socio-economic activities in Nigeria.

The NIMET vision is to make world standard weather predictions and services for sustainable national socio-economic development and safety of life and property. Its mission is to observe Nigerian weather and climate and provide meteorological, hydrological and oceanographic services in support of national needs and international obligations. This mission can be achieved through issuing services to human and environmental sustainability; policy development; safe operations of air, land and marine transportation; agricultural production, tourism, health, defence, education, sports construction etc., monitoring, management and mitigation of natural disasters, corporative interaction within the framework of global practice in the science of meteorology and provide weather forecasts and reports for safe operation of flights.

3.1.5 Tunisia

Tunisia is situated in North Africa, covering an area of some 164,000 km² and with a 1,300 km coastline on the Mediterranean Sea. The climate is particularly arid and variable, with precipitation ranging from 800 mm per year in the north to 150 mm per year in the south. The population growth rate has steadily been dropping, reaching 1 per cent per year during the past decade. Tunisia had some 11 million inhabitants in 2014, whereas it had 9.9 million in 2004. Tunisia is considered to be

one of the countries most exposed to climate change in the Mediterranean (Tunisia INDC, 2015). The main risks which it is likely to confront are temperature increases, reduced precipitation, rising sea levels and escalating extreme weather phenomena (floods and droughts). These risks are likely to result in major environmental and socio-economic vulnerability. Tunisia is aware of these challenges and has adopted a proactive policy of fighting climate change, both in terms of mitigation and adaptation. Moreover, as Tunisia actively supports international efforts to combat climate change, it has delivered on all of its commitments to the United Nations Framework Convention on Climate Change (UNFCCC), the last of which was the submission of the first biennial report in December 2014 (Tunisia INDC, 2015). In addition, in the wake of the political changes triggered in December 2010, Tunisia adopted a new constitution on 26 January 2014, which incorporated the fight against climate change as a permanent feature. Under Article 44 of the new constitution, the State shall “*provide the means necessary to guarantee a healthy and balanced environment and contribute to the climate’s integrity*” (Tunisia INDC, 2015).

Tunisia faces large fiscal and external deficits. The central government deficit (excluding grants) reached 6.1 percent of GDP in 2016, up from 5.6 percent of GDP in 2015. As a result public debt has risen to 62.9 percent of GDP in 2016, up from 57.2 percent in 2015 and from 45.5 percent in 2012. In 2016, the current account was estimated at 8.4 percent; combined with the deterioration of the capital and financial accounts, this is eroding the country’s foreign reserves buffer. The national unity government—a coalition of the main political parties, the largest worker’s and trade union formed a year ago—has set its priorities as strengthening security, improving the business environment, ensuring macroeconomic stability, fiscal sustainability and restarting growth. While the new government was expected to lead to greater political stability due to its inclusive composition, it has undergone two cabinet reshuffles involving key ministries, such as finance, investment, and education. Unemployment has declined from its peak of 19 percent in 2011 to 15.5 percent in 2016 (15.3 percent in second quarter (Q2) of 2017) despite a low labour force participation, at about 50 percent, mainly due to a very weak participation of women (26 percent). Most of the unemployed are low-skilled workers, but university graduates have the highest unemployment rate, which increased from 15 percent in 2005 to 23 percent in 2010 and to 31.6 percent in 2016 (31.2 percent in Q2 of 2017), while female graduate unemployment reached 40.4 percent. Unemployment rates are also much higher in the hinterland compared to coastal regions.

As in many parts of the world, Tunisia is experiencing the effects of climate change through higher temperatures, land and water scarcity, flooding, drought and displacement, which negatively impacts on agricultural production and causes breakdown in food systems (WHO, 2015). These situations may cause high environmental and socio-economic vulnerabilities in the country. Aware of these issues, Tunisia has identified a set of tools and resources which are adapted to the national specificities and to the challenges that the country is facing, particularly on the environmental level. A national Agenda 21 has been put in place, supported by local Agendas 21, so as to face local and national environmental concerns, and to establish the practical foundations of the sustainable development. A National Strategy on Climate Change has been established since the adoption of the UNFCCC, to ensure the best adaptation of agriculture and ecosystems to climate change. The production and provision of relevant climate-related data and services became an important stake.

The importance of relevant climate-related information, data and tools in the decision-making process in Tunisia is undeniable, particularly with regard to the economic activities and natural resources management. Decision-makers at several levels need access to the most relevant and reliable information available in connections between climate and the key sectors of the economy (Tunisia INDC, 2015). In this regard, specific and constant observation service was established in Tunisia since 1974 to ensure the monitoring of usual climate parameters, and to satisfy the information requests from the various sectors of activity, including policymakers, researchers, practitioners, farmers, private sector actors, etc.

The production and dissemination of climate information/data at the national scale in Tunisia is done by the National Institute of Meteorology - NIM (Institut National de la Météorologie, INM) affiliated to the Tunisian Ministry of Transportation. The NIM is connected to regional branches in the country, constituting a network that ensures regular meteorological observations over the entire territory. The NIM manages the climate heritage of Tunisia and offers the essential of meteorological and geophysical dataset through an observation network equipped with several types of stations (synoptic, climatological, agrometeorological, etc.). The NIM is working closely with RCC-RA I, the Regional Climate Centre Network (RCC-Network) for the region of North Africa, whose members are Morocco, Algeria, Tunisia, Libya and Egypt. RCC-RA I is a centre of excellence that assists members in terms of climate services production to meet national needs and capacity building. In Tunisia, there is also the observation network of the National Observatory of Agriculture which is as well involved in terms of climate-based information/data provision. The development of Remote Sensing with Earth Observation technologies and the internet technologies has improved the easy and cost-effective access to climate information/data on the entire earth. Several reference information systems are currently dealing with climate issues and taking into account Tunisian context exist [i.e. World Bank, FAO, IPCC, WMO, WorldClim, WCDMP, ACMAD, etc.].

Generally, considerable efforts have been made to ensure access information about the classical climate variables including seismic activity, astronomical phenomena, weather reports, etc. While several achievements have been recorded, significant challenges still remain.

3.2 Application of Climate Information and Services

Climate information has not been used effectively wherever and whenever it is available in many African countries. This is partly because of the low capacity to collect, interpret and package it usefully for use by farmers, conservationists or the policy makers. This has therefore led to low appreciation of the value of the information generated in the various weather stations in the country. Various sectors in the country continue to suffer from risks that could have been prevented or mitigated against if the people responsible had the climate information packaged usefully and on time. There are a few instances where the information is beginning to be put in valuable use in a few sectors such as Agriculture, conservation and Tourism.

Some of the key literature as well as ongoing initiatives were recently reviewed by Wilby (2014); he highlighted (i) a low but growing research output on climate from African institutions (presently 3 % of the global share of publications), (ii) significant regional variations in research outputs and (iii) major research gaps recognised by African scientists in urban populations and migration, built environment, clean energy, coastal zone, and mainstreaming of science into practice (in agreement with findings from Edwards, 2013).

Cameroon

Climate information has been used in Cameroon for climate change vulnerability and adaptation studies. Like other Sub-Saharan African countries, Cameroon is vulnerable to climate change which constitutes a serious threat to its natural resources which is the source of livelihood for the majority of its population. Before dealing with climate change risks and associated vulnerability, experts started by studying natural risks in each agro-ecological zone and made a cartographic comparison between natural risks and climate change risks. Availability of past climate data and their impact on the population and natural resources has enabled climate projections within vulnerability studies. This shows that the northern Sahelian zone is the most variable, followed by the coastal zone.

As agriculture in Sub-Saharan Africa becomes increasingly vulnerable to the vagaries of climate change, a new kind of approach to insurance, called "index-based insurance", has been developing

over the years as a response. Contrary to more classic models of agricultural insurance, which defines rates in function of the probability of loss and the yields of the previous year, index-based insurance uses meteorological indices such as humidity, rainfall, temperature, and collects satellite data to anticipate and manage risk. In order to develop this innovative tool, which has the advantage of being more affordable for farmers and can accelerate the settlement of claims without sending an expert, the Government of Cameroon requested the World Bank and the International Finance Corporation (IFC) to conduct a feasibility study to improve the knowledge and understanding of the market opportunity for index insurance in the agriculture sector (<http://www.worldbank.org/en/news/feature/2017/01/17/index-insurance-feasibility-study-workshop-in-cameroon>). The findings were unveiled in Douala on December 15, 2016, at a workshop jointly organized by the World Bank Group and the Association of Insurance Companies of Cameroon (ASAC). The event was another milestone for Cameroon's agricultural sector, which is increasingly experiencing shocks due to climate change. In 2015, the sector accounted for 20% of the country's gross domestic product (GDP), approximately \$6 billion, and employed 54% of the population. Even though more than 12 million Cameroonians depend on agriculture for their livelihoods, their primary means of agricultural risk mitigation are limited to risk avoidance and other informal approaches such as under-investing in agricultural inputs.

Recognizing an opportunity in the agro-insurance space in Cameroon, the World Bank Group focused the feasibility study on value chain mapping in order to assess index insurance opportunities along the value chains for cotton, maize, livestock, and sorghum. It also sought to catalyze and reinforce the development of a sustainable market for agricultural insurance products. Additionally, the findings are also expected to complement two World Bank projects in Cameroon: the Agriculture Investment and Market Development Project (<http://projects.worldbank.org/P143417/?lang=en&tab=overview>) and the Livestock Development Project (<http://www.projects.worldbank.org/P154908?lang=en>).

"Agriculture index insurance will mitigate the risks of climate change for both farmers and those who finance them," says Alphonsus Achomuma, World Bank Senior Financial Sector Specialist. "This will encourage the use of optimal investment in agricultural inputs & methods, and encourage banks and micro finance institutions to provide financing to farmers," he emphasized.

Use of climate information in other sectors such as natural resources conservation, tourism, and energy among others is very limited. In Tourism for instance, short to medium range forecasts are used to advise visitors on the best days or periods to visit particular tourist attraction sites.

Kenya

In Kenya, the user needs for climate information vary and are very dynamic. It is not a situation of one size fits all in especially for most of the country. The sectors of concern for majority of CIS providers vary and are focused on agricultural and livestock, water and water resources, financial/planning, environmental and natural resources, energy, research and development, health, media, construction/infrastructure, and disaster management (WBG, 2016). The service and product portfolio for CIS in Kenya also varies focusing around climate predictions, early warning system, weather forecasting, agro-weather advisory, climate projections, government policies, transport safety advisories, Insurance/weather derivatives, and airspace weather forecasting. Much of the CIS providers are involved with agriculture related sector and have services and products that focus on agro-weather advisories. This can be attributed to the importance of agriculture to the country and the impact of climate variability to agriculture.

A study conducted by the World Bank in 2016 (WBG, 2016) on climate service providers in Kenya indicated that a total of CIS for 11 different sectors are spread all over the country, out of which,

Eighty-three percent of them focus on agriculture and livestock; Approximately eighty percent of them offer early warning systems as their primary services—a proportion of which also serve agricultural purposes. Seventy-two percent offer agro-weather information services to support tactical and strategic decision making. Half of the CIS providers surveyed engage in weather forecasting. Some forty one percent of the CIS providers give climate advisories for general government policies and decision-making and climate projections, whereas twenty eight percent of the providers service the insurance derivatives and transport safety advisory sectors.

Malawi

The existing use of weather and climate data in Malawi remains extremely limited. A planner in the Ministry of Local Government and Rural Development stated that they only use immediate weather information in their planning while the Department of Disaster Management Affairs (DoDMA) and departments in the Ministry of Irrigation and Water Development (MoIWD) use weekly/ 5-10 day forecasts for planning purposes with daily updates of, for example, extreme weather events. During the season, 10 day bulletins are provided by the DCCMS and then distributed to relevant ministries. From the literature review and interviews conducted, it was found that DoDMA does not have long-term plans based on long-term climate scenarios due to resource constraints and according to the MoIWD, because there is no advance forecasting capability within the Department of Climate Change and Meteorological Services (DCCMS) (Vincent et al., 2014).

Nigeria

The climate of Nigeria has shown considerable temporal and spatial shifts in its variability and change. Extreme climate and weather events (drought, flood, heatwaves, ocean surges, etc.) have become more regular. The impacts of extreme weather and climate may be gradual but they are destructive to lives and property, negatively impact on the economy. Floods have become a perennial challenge with increasing intensity each year, leaving colossal losses and trauma. To reduce the effects of these climate variability, change and extreme event on population and properties in Nigeria some services are developed by NIMET. These services includes the:

- Daily weather forecast for general public
- Seasonal climate prediction: producing every year the Seasonal Rainfall Prediction (SRP) in fulfilment of its responsibilities to provide critical climate information and advisories in support of science based decisions in the climate-sensitive sectors such as the agricultural, water resources management, environment, health, disaster risk management, tourism and the communication sectors.
- Aviation meteorology through air traffic management: providing aviation weather services and issues weather reports to contribute to safety improvement and efficiency of air navigation.
- Flood forecasting services: providing flood forecasting services which include flood warning and advisories to help meet the comprehensive need to protect life and property.
- Marimet or Marine operations: providing oceanographic information for marine users both at sea and along the coast. Thereby making the decision-making process during weather sensitive operations more efficient.
- Oil and gas tailored forecast: supplying tailored forecasts to the oil and gas industry in both terrestrial and offshore environment assisting with risk management and daily operations.
- AGROMET service to agriculture: by providing basic information and issues early warning on drought, crop-pests and diseases within the agricultural sector.
- Weakly and annual climate review: provides more incisive information on observed extreme weather and climate events such as flooding, drought, dust storms and heat waves in Nigeria. These extreme weather phenomena have significant negative impact on sustainable socio- economic development of the country, as well as the wellbeing of Nigerians. In addition, other meteorological variables such as thunderstorm occurrence,

hailstone, surface pressure and winds, derived from observations from network of weather stations are highlighted. Most of the analyses show that Nigerian climate continues to be highly variable and this impacts on the economy especially on agriculture, energy, environment, health, transportation and water resources. There is therefore growing concern about the adverse impacts of climate variability and change on these key sectors of the economy of the Country.

In addition to the above services and information provided to users, NIMET produces some specific bulletins for specific users such as quarterly weather bulletin, MESA LandThema bulletin. The publications discuss the typical weather and climate variable from the eye of the synoptic weather developments, temperature and rainfall variations, and socio-economic implications in some of the key sectors of the economy.

Tunisia

Applications about climate information and services in Tunisia are performed by the National Weather Service (NIM), whose products and services are destined to two major customers/users: aeronautical sector and other (professionals and general public related to marine, tourism, agriculture, energy, etc.). The NIM's activities are related to two major fields: Meteorology and Geophysics/astronomy.

Aware of the key role of observation in meteorological activity, particularly for weather forecasting, climatology, and applied meteorology, the NIM is thoroughly managing a nationwide meteorological observation network that comprises:

- Synoptic network (26 stations)
- Agro-meteorological network (31 stations)
- Climatologic network (58 stations)
- Rainfall network (208 stations)
- Radar network (1 Radar)
- Seismologic network (15 stations).
- Measurement of bottom pollution network (1 station)
- Marine station network (7 stations)

Moreover, Tunisian NIM is involved in the RCC-RA I, the Regional Climate Centre Network (RCC-Network) for the region of North Africa, through which each country member (Morocco, Algeria, Tunisia, Libya and Egypt) contributes or leads in the performance of the respective RCC functions for the entire North African region. Tunisia ensures the role of a co-lead in climate Monitoring and the role of Lead with Egypt in the function of training.

Another important and longtime partner of the NIM has been Météo-France, a partner with whom several initiatives have been experimented and executed. Among these, there was the "ALADIN² TUNISIA's Numerical Weather Prediction Project", which was aiming at establishing a numerical weather prediction chain at NIM.

3.3 Climate Information Gaps

One of the greatest challenges in responding to climate change is how to pin down the information needed to understand the risks and plan effective measures to address them. The sheer volume of information available in Cameroon is overwhelming; even the expert reviews and syntheses provided by the Intergovernmental Panel on Climate Change (IPCC) can fill hundreds of pages.

² ALADIN : Aire Limitée, Adaptation dynamique, Développement InterNational. The ALADIN project was launched by Météo-France in 1991 with the objective of building mutual cooperation in the field of Numerical Weather Prediction (NWP) (<http://www.meteo.tn/htmlen/developpement/aladin.html>).

Sorting through it all, and finding the specific information that is relevant to the questions at hand, may be beyond the capacities and resources available to many decision-makers in Cameroon and most African countries. There are major gaps between the questions that decision-makers may be asking, and the answers available (Graham et. al., 2015). The purpose of climate services is to bridge those gaps: to identify users' needs and connect them to the relevant information. However, these services are not available in Cameroon.

Significant gaps of relevance to Africa include shortcomings in atmospheric observations due to the inability to maintain networks, lack of training and capacity and inadequate communications systems; incomplete or missing observations of vital land-surface parameters such as river discharge and lake levels; restrictive data policies and ineffective information infrastructures; and the need to rescue, digitize and develop historical climate data sets (WMO, 2014). International reviews of the state of NMHSs report that capacity is very poor, with more than 50 National Meteorological and Hydrological Services (NMHSs) in Africa needing transformative modernization following 15-20 years of underfunding, low visibility, economic reforms and in some instances military conflict (Rogers and Tsirkunov, 2014).

There is a growing consensus that a lack of a holistic approach and long-term support of the development of weather and climate services is a major contributing factor that limits progress in uptake (Graham et al. 2015). A gap analysis published by the International Research Institute for Climate and Society (IRI) and the Global Climate Observing System (GCOS) in 2005 explored the challenges in the application and user of climate information in detail and identified four key gaps: (i) gaps in integration of climate into policy; (ii) gaps in integration of climate into practice at scale; (iii) gaps in climate services; and (iv) gaps in climate data. Though this information was a while ago, the gaps it highlighted are still relevant today. However, availability of relevant and reliable climate information, particularly throughout rural Africa, is substantially limited in terms of availability and quality, and where available there is lack of awareness on the availability or application of such information (FAO 2008; Washington et al., 2006; IRI 2005; Dinku et al., 2011).

Institutions addressing disaster risk management (DRM) and climate-related activities in Malawi suffer from a lack of inter-sectorial coordination. The planning and management of climate change and disaster management is currently conducted on a sectorial basis, and the involvement of relevant stakeholders, including local community members, is limited. The absence of an integrated planning and management strategy gets in the way of successful adaptation. There are also limited skills and resources at the local level to implement new policies (Dyoulgerov et al., 2011).

There is very limited direct contact of the providers of this information with the rural farmers. Even when the contact is established, there is low level of understanding or communication either because of the limitations of the middlemen (such as the extension workers) in the knowledge technical terms used or as a result of language problem following the low literacy level of most of the rural farmers. It is also apparent that the level of involvement of farmers' organization, as well as that of state government leaves much to be desired. This no doubt further slows down contact with the rural farmers. Another gap is absence of follow-up exercises by the ADPs' officials and the extension workers, who often complained of lack of vehicles to disseminate the vital information to the rural farmers. The final gap, in the non-implication of media in the formatting and dissemination of climate information produce by scientists to end users. This implication should include translating the information to the local and digest language that common users can understand.

Despite the growing knowledge base built and managed by NIM (the National Weather Service) and the others technical stakeholders (INSTM, CNCT, ANPE, APAL, IRA, DGSAM, SHO, NIS, CITET, TOESD,

WII, etc.), important information and knowledge gaps still need to be filled out. These may be related to:

- The non-availability of more precise downscaled local level dataset.
- The setting up of a national climate modelling and forecasting activities at the NIM.
- The reinforcement of knowledge and capacities of the stakeholders (government agencies, climate sensitive sectors such as agriculture, energy, tourism and transport) in the mastering and use of climate predictions, products and information to support long-term planning on adaptation.
- The inexistence of Web-based Interactive Collaborative Environment for climate information knowledge sharing and dissemination.
- The difficulties in publishing the results of researches the engineers from NIM.
- The introduction/promotion of mobile application technologies (such as LandInfo) in agriculture, for improved climate resilience.
- The better consideration of the climate change dimension in the services offered to professionals in the various sectors of agriculture, energy, tourism, and the general public, etc.

2.3.1 Technical Capacity

Cameroon faces challenges in its technical capacity to collect, analyse communicate and use climate information. While there have been a few success stories, in too many developing countries the outcomes have been poor. The results obtained over the last three decades from substantial investments—particularly when viewed from the lens of long-term sustainability and adaptation to climate change—have been discouraging (World Bank, 2011). In many cases, government agencies, private sector businesses, and the general public are still unable to access critical local climate information to make better informed decisions. This localized weather and climate information is essential for protecting lives, sustaining and improving livelihoods, and building local and national resilience. Given these decades of mixed outcomes at best, there is a need to investigate on-the-ground situations and determine the root causes of why the desired outcomes have not happened, to appreciate the short- and long-term impacts of restrictions in local capacity, and to update approaches to ensure that future efforts yield better results.

The arising issues of climate change and such concepts and idea as smart agriculture as well as development of new technology for monitoring climate information and for communication, has created a need that should be addressed for effective application of climate information. The knowledge on climate change issues although available but the skills especially in climate change adaptation and impact assessment are still limited. Climate change also bring with it opportunities in CIS provision especially in green technology implementation There is rise in new technology and sensors and these should be addressed as to calibration and test for quality. Some other areas of interest would be in improving the knowledge for the validation and testing of CIS information, and also in the improvement on development of CIS information including downscaling to the required user decision level.

Malawi recognizes and appreciates the need for technology development and transfer as well as research in climate change management. To this effect, Malawi has already produced and identified technology transfer needs. However, financial resources for addressing the identified needs such as the development of climate change research agenda and enabling environment for the application of science and technology are inadequate. Key areas include promotion of rain water harvesting technologies, development of dykes and levees in flood prone areas, adoption of climate smart agriculture, development of drought tolerant crop and livestock technologies, and promotion of energy saving technologies, renewable energy technologies, and development of technologies in river course management (GOM, 2016).

In order to achieve its mandate NIMET is structured into different directorates including administration and supply, applied meteorological services, engineering and technical services, finance and accounts, legal services, research and training, weather forecasting services. Most of the technical works and services delivery to different users are done by applied meteorological services, engineering and technical services, research and training and weather forecasting services. The Directorate of weather forecasting services is responsible for the generation of weather data and information and accurate forecast for navigational safety. It also provides forecasts for search and rescue to aid the activities of the Accident Investigation Bureau (AIB) of the Aviation Ministry and the National Emergency Management Agency (NEMA) during disasters. The Directorate of Applied Meteorological Services (DAMS) is one of the operational sub-systems of NIMET. There are three Divisions that make up the Directorate of Applied Meteorological Services via Agro meteorology, Hydrometeorology and Marine Meteorology Divisions. The Directorate is also in charge of NIMET's Remote Sensing and Geographic Information Centre. The Directorate is sub-divided into Agromet division, Marine divisions and hydromet division.

The Directorate of Engineering and Technical services of the Agency services all other Directorates of the Agency, the Nigerian Public and other meteorological Agencies within and outside West African Sub-region. Its mission is to design, fabricate, install and ensure sustainability of all Meteorological infrastructure, data collection and dissemination, movable and immovable. This Directorate of research and training is responsible for the long term weather management and plans as well as the training and retraining of the manpower resources for the Agency. The Directorate is made up of two divisions – Research and Training divisions. In terms of technical capacity for the collecting data, production of climate services, the agency has its headquarter in the airport of Abuja, and regional offices in the Federal States. Technology used to derive the information is based on MESA station, PUMA, CLIDATA, WEBEX, MSG-RETIM systems.

The NIM activities are mainly focused to two major fields in Tunisia: Meteorology on the one hand, and Geophysics and Astronomy on the other hand. In terms of Meteorology, the NIM has the full skill and ability to perform:

- The data collection, processing and, exchange.
- The weather forecasting.
- The climatology and applied meteorology (Agro-meteorology and Hydrometeorology).

Concerning the activities dealing with Geophysics and Astronomy, The NIM ensures:

- The measurement of seismic activity, applied geophysical studies.
- The observation of the lunar crescent, eclipse and lunar calendar elaboration.
- The measurement and processing of different types of solar radiation

The NIM maintains good cooperation with the CNRM of METEO-France. In terms of equipment, since 2004, NIM has acquired a super calculator which, since 2013, has been equipped with a high resolution model coupled version ARPEGE-CLIMAT. Besides, the NIM represents an important node on Climate Monitoring and Watch for the North Africa Regional Climate Centre Network (RCC-RA I). In collaboration with RCC-RA I, the NIM is currently providing some basic climate diagnostics including analysis of climate variability and extremes such as drought.

2.3.2 Human Resource Capacity

Keeping NMHSs staff skills up to date is a challenge in most African countries. Staff training and professional development are seldom available locally, making them expensive both in terms of time and money (Snow et al., 2016). Sending an individual for training not only incurs the cost of the training and travel, but also often results in complaints by others in an office already thinly staffed. Further, as the skill sets required for meteorologists, climatologists and supporting technical staff are often readily transferable to higher-paying positions in the local private sector, or in the NHMS or

private sector of another country, the retention of skilled staff is an issue (Snow et al., 2016). These factors have become disincentives for the leadership of an NHMS in a least developed country to significantly invest in staff training and development. There is also a very understandable human element at play here. New automated systems, internal politics, protectionist stances (both for the ownership of data and the assignment of responsibilities), and a lack of incentives to change create roadblocks, limiting the willingness of many staff and even senior managers to depart from the status quo (Snow et al., 2016).

There is qualitative and quantitative insufficiency of personnel in Cameroon in the required skills or competencies in spite of the effort of training and development of capacities started by the government with the support of development partners. Some training possibilities are offered at the national level. However, the structures available are in general not well equipped and the programs that are compatible with climate change or climate information services are not well developed and are not updated because of a qualitative and quantitative deficit of teachers.

KMD has a diverse array of human resource specialised and focussed on various aspect of CIS provision. However from huge initiative to decentralise CIS to county level, and with 47 counties to be covered across the nation, this has created a challenge in the availability of human resource at the county levels, with many of the county offices not having adequate number of employees recommended for the provision of climate service. There is need to train CIS intermediaries on methods of application and generation and dissemination of user oriented climate information; and also to train volunteer observers and county climate officers on appropriate methods and techniques for collecting and dissemination of climate data and information. Human capacity has to be developed in such areas as the systematic observations of climate change using the existing National and county network including volunteer observers and community data monitors. With newer demands rising for climate change information, there is need to train on new technologies for climate data acquisition, monitoring, analysis and modelling, and dissemination and user outreach. This also comes from the rise of such new technologies as Smart Agriculture Initiatives which require specialised information. Therefore there is need to develop knowledge on climate change related issues, and sensitize such including development of urban emission inventories and carry out urban climate studies, air pollution modelling, monitoring and forecasting. The majority of climate scientists have the general knowledge of climate change. There is need for specialized training in aspects such as: Climate variability and change studies specialized training on climate change in areas such as impact assessments etc.; Climate change model development and application; specialized equipment maintenance and any other relevant courses.

Malawi has few specialised trained staff in climate change management and specialised training programmes are not available in local universities. Primary and secondary school education curricula are still devoid of climate change issues. This is affecting programming efforts at national level as there is limited expertise to design and implement serious climate change programs which usually require high levels of technical expertise, however ,the Government of Malawi through the Ministry of Environment and Climate Change Management, academic institutions and NGOs have conducted several training sessions intended to build capacity in climate change in the country: training for Members of Parliament (MPs) and the Technical Committee on Climate Change (TCCC), training local communities in Machinga and Nsanje districts in the basics of climate change, short courses on climate change for the media etc. Through the Africa Adaptation Programme (AAP), the Malawi Government has trained 10 professionals at Master of Science degree level in climate change. Therefore the development of the Climate Change Learning Strategy is a timely complement to the draft National Policy on Climate Change and the draft Climate Change Investment Plan. https://www.unclearn.org/sites/default/files/sg4_24_national_climate_change_learning_strategy_of_the_republic_of_malawi.pdf

In order to accomplish its mission, Nigeria's NIMET has about 1,300 staff composed of 5 PHD, 50 Masters, over 600 graduates and over 300 observers and technicians. But one of the problems regarding the staff is the professional cadres to master the production and dissemination of the climate related information is understaffed. Majority of the staff are administrators rather than technical staff (meteorologists, climatologists, computer scientists, etc.).

As a Public Non Administrative Establishment (EPNA) in Tunisia, the Staff in NIM is composed of:

- Engineers: 7%
- Frameworks (function and administration): 10%
- Press: 0.3%
- Technician/Typist: 59%
- Administrative officers and workers: 22%

2.3.3 Financial Capacity

The financial capacity of Cameroon just like many African countries is low. Despite being an oil mining country and have the potential to improve on their annual economic growth, very little is being invested in the provision of quality climate information and services. The climate observation networks and systems are poor and where networks and infrastructure do exist, many are in decline. Lack of sufficient funding has resulted into compromises in quality (Skill-set and motivation) and quantity (Number of staff) of human resources. Investment in new and updated technology has also been limited by the lack of finances.

Most of the CIS providers in Kenya can be categorised based on five business-operating models in order of increasing autonomy, namely, public departmental unit; public body; private but not profit oriented; private and profit oriented; and international organizations. The major sources of funding for CIS providers are Grants, Public funding, users pay, private funding. Considering that climate information is primarily an international public good and governments have a central role in its management. KMD which is operate under the direct control of the government ministries. It has no autonomy and is primarily financed by the state budget, and delivers non-commercial services to citizens or other public sector bodies. Government entities that are not accustomed to paying for services from other government departments will likely refuse to pay for meteorological and hydrological information, even though it may be essential for their operations. The main barrier to satisfactory implementation of the program is that KMD may not have adequate financial resources to establish stations in many areas of the country where communities can benefit most. This is due to lack of alternative sources of revenue and adequate funding to support capital and recurrent expenditures. Limited and unreliable public financing make long-term investment decisions difficult, and could create a downward spiral that results in reduced staffing, inability to maintain observation networks, a limited capacity to innovate, low organizational incentives, and poor service delivery (Rogers and Tsirkunov, 2013; WBG, 2016).

The service providers that operate in the public body model face less political and hierarchical influence and have more operational and managerial freedom. They supplement state budgets with grants and some earn revenues from service delivery. Although there is some autonomy compared with a public department. There are also the CIS providers are private but not profit oriented, majority of which are climate adaptation projects sponsored from abroad with limited life span. Some of these projects are meant as pilots, targeting a limited number of beneficiaries, with limited scope that are specific to the project goals (WBG, 2016).

Privatized companies (profit oriented) are also involved in CIS provision in the country, and these operate in the market and generate their own revenues. Even though privatized companies enjoy a high degree of autonomy, certain economic activities are controlled by government regulations. Given the public good nature of CIS benefits, full privatization may not provide optimal solution for

effective CIS delivery. Purely market-based approaches are subject to low to moderate penetration, and can place a higher emphasis over commercial compared with technical criteria. Majority of international and regional players in the CIS provision in the country obtain funding from principally from subventions from member organizations and other grants, and they do not generate revenues from CIS activities.

Malawi is among the most vulnerable countries to climate change because its economy is predominantly agro-based and largely rain-dependent. Considering that the rural population, which is in majority, is poor and directly depends on natural resources for its livelihood, the bulk of this population lacks the capacity to proactively finance climate change adaptation, mitigation and climate proofing activities. There is therefore, need for more predictable and reliable financing mechanisms from local and international sources (GOM, 2016).

The financial capacity of the NIMET is provided mostly by the government and internally Generated revenues (IGR) through services provided to some specific users of the information. However some project can contribute to the capacity of the agency through providing support to achieve targeted tasks.

As a public institution (EPNA) under the Ministry of Transport in Tunisia, most of NIM financial resources are provided by the Tunisian State. Generally, these resources are allocated to 4 categories:

- Management (26%)
- Interventions (1%)
- Investments (5%)
- Remuneration (68%)

2.3.4 Communication/dissemination mechanisms

Cameroon uses different modes of communication ranging from print media to radio and television. There is also a good internet coverage and mobile network across the country. The main official languages are English and French. A large majority of the NMHSs in Africa (90%) have not made any efforts to assess the economic value and benefit of the use of information provided in the agrometeorological bulletins (Snow et. al., 2016). About 70% of the agrometeorological units do make efforts to issue specific bulletins of a special nature to address extreme events such as droughts, floods and forest fires (Snow et. al., 2016). Besides the NMHSs, ACMAD, a regional institution, also disseminates a variety of products to various users. One example is the climate prediction for Western Africa, Chad and Cameroon which is disseminated through its website.

In his analysis of the problems faced by the clientele for agrometeorological services in Africa, Isabirye (2004) attributed them to lack of ability to understand raw data and its interpretation for the relevant action, language technicalities, lack of awareness of the importance of the agromet information and lack of timeliness to meet the early warning aspects. The different categories of users include the farming community, the research community, governmental bodies, private sector, public sector and international agencies. It is important for the NMHSs to recognize that the content of information varies with the end user. Depending on its purpose, the content of information can be related to special advisories provided to farmers through the national or state extension services, general advisories accessed by farmers directly through the electronic media, early warning advice to prevent famine crisis and the development of agricultural planning policies (Snow et. al., 2016). Most often, agrometeorological information provided by the NMHSs is not comprehensive. In many cases, it refers only to the 'meteorological' component (i.e. weather conditions, forecasts of future weather events, analyses of past weather) (Snow et al., 2016).

In Kenya, the most common medium is bulletin/newspaper, work well in project-type service provision, but adoption may be negligible beyond the pilots. Radio is the next most common medium, followed by the use of intermediaries. Intermediaries refer to brokers between scientists/service providers and farmers, translating and adding value to agronomic and economic information of use in agricultural management decision making. KMD has established Radio Network (RANET) for dissemination of information at the local languages. It has been established that this intermediary model is the most effective mode of disseminating climate information. Short message services (SMS), website, and radio network and interactive voice response system (IVRS) are also employed. The relatively low frequency of SMS, websites, and IVRS suggests significant opportunity to expand the use of modern information and communication technologies (ICT) for higher market penetration (WBG, 2016). Brokers can then be encouraged to use them as sources of the information they disseminate. Public *Barazas* are face-to-face public community gatherings instigated by village officials for the purpose of attentive discussions. The primary purpose is public awareness creation, targeting specific groups and communities. Through *Barazas*, the communities become aware and informed about their vulnerability and the measures they can take to proactively adapt to climate change. Public *Barazas* tend to increase enthusiasm and support, stimulate community action, and mobilize local knowledge and resources. KMD is implementing the concept of 'climate intermediaries' who are themselves users and also act as a bridge between the final users and the climate information provider. Intermediaries receive forecasts through SMS and provide a network for dissemination of information and feedback on the services provided. Intermediaries are selected from across institutions and agencies with existing extensive reach including County Administrations and the Ministries of Agriculture, Livestock and Cooperation, as well as religious and community leaders and NGOs. Involvement of government agencies, such as the extension services, in dissemination of agro-weather information, has been found to legitimize the content owing to the authority conferred on government officers. CARE International and the Adaptation Consortium are employing participatory scenario planning (PSP) which help in building capacity to interpret seasonal forecasts and disseminate climate information and services in a more user-friendly manner.

Feedback is the part of the receiver's response that is communicated back to the sender and takes a variety of forms. Feedback provides the sender with a way of monitoring how the message is being decoded and received by the target audience. It is the final link in the chain of the communication process. Service providers should be interested in the feedback from the end user so that the services can be improved. SMS, meetings, and call centres are the primary feedback mechanisms employed by the CIS providers. CIS providers also use e-mails and IVRS. Most of the CIS providers do not have an effective mechanism with which to track their users. Under this condition, providing feedback to enhance the utility of climate information is critically curtailed. The fact that the majority of the CIS providers do not use any feedback mechanism suggests the absence of bidirectional information exchange between providers and users to optimize recommendations, advisories, and alerts (WBG, 2016).

In Malawi, the dissemination and communication of early warning messages is normally done through the following tools as spelt out in the National Disaster Risk Management Communication Strategy (2014-2018): print media (newspapers, magazines, newsletters, leaflets, brochures, pamphlets, road banners, roll-up banners, posters, bill boards, Tactile-Braille, Large print); electronic media/broadcast (radio, TV, documentary, interactive website, social media, texting using mobile phones); direct stakeholder engagement (meetings, workshops, symposia, drama, dances, songs, storytelling, poetry, exhibits/displays, road shows, school clubs); social marketing and advertising (newspapers, radio, TV); sign language/video clips; extension workers; and beating of drums, blowing whistles, shouting, and using megaphones (GOM, 2015).

Communication and dissemination of climate and weather information in Nigeria is done periodically, on daily, through couple of days, weekly, monthly to seasonal and yearly basis. The channels employed include NIMET's website (www.nimet.gov.ng), Mailing list of some key stakeholders such as contact-persons of the Federal and States' Ministries of Agriculture and those of their Agricultural Development Programmes (ADPs), Agricultural Extension Officials, Agricultural Research Institutes and organizations such as the Institute of Agricultural Research (IAR) and the National Agricultural Extension and Research Liaison Services (NAERLS), the print and electronic media, (e.g. the daily TV weather forecast), issuance of alerts/EWSs on emerging extreme/hazardous weather, Public presentation of the Seasonal Rainfall Prediction and its subsequent distributions to States' ADPs and other relevant stakeholders by NIMET's State/Zonal Meteorological Inspectors (SMIs/ZMIs). An electronic version of the SRP, (i.e. the e-SRP) has also been developed in recent years to further ease the public's access to the SRP. Also, the NIMET developed an Environmental Information Systems to improve quality of information that farmers receive and use in crop production.

In Tunisia, the National Institute of Meteorology (NIM-INM) is the main government body in charge of delivering weather and climate information in support to needs of the different economic sectors. With regard to the seasonal weather forecast information, basic related documents (Monthly, seasonal and annual Bulletin) are made available, freely accessible from the Tunisian NIM website. The native data have been obtained from the National Climatic Data Centre (NCDC). For all the 4 seasons (autumn, winter, spring and summer) the two major parameters (Temperature and Precipitation) are covered. The climate information and services needs for the five countries are summarized in Table 1 below:

Table 1: Summary of climate information needs and services for 5 countries

	Need	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
		Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
a)	Climate Information availability and access	-Available at the various met stations and online for those who have access to internet -Available at the ministry in charge of environment	-Need for more coverage of weather stations - Need to make climate information at all levels of the various sectors and institutions	-Available at various time scales and at national and county level. -Information includes unique weather events and warning advisories, forecast at different time steps, trends and climatology are available. Much of the information at shorter time scale are yet to be implemented in many of the county offices -Are accessed through bulletin, radio, SMS, website and social media, email, phone call, television, intermediaries and extension officers Limited tools for integrating climate information and local knowledge -Lack of clear guidance on process of data acquisition and lack of use of modern ICT for accessing of data especially for public access	-Need to establish modern integrated information system for information assessment, and dissemination. -Develop framework for sharing of climate information and data among local producers -Create tools and framework for integrating local climate knowledge and climate information services, and allowing easy access	-Available at a bigger extent/level	-Down scaling the climate information available and its accessibility to smaller level	-Data is available and access to data is on request subject to the approval of the DG. Products (Daily weather forecast, seasonal climate prediction bulletin, Agromet bulletin, Drought and Flood bulletin, Climate review) are available on the internet (nimet.gov.ng) and printed for end users	-The use of mobile phones and media (Radio)	-Provision and management by NIM (in collaboration with RCC-RA I). Existence of others regional/international sources (WMO, World Bank Climate Change Knowledge Portal, etc.) -Online access (websites and Facebook social network), free or Formal request for specific users. - Data often under the governance of the Ministry of Defence, etc., limiting data. - Insufficient data. - Not linked to impact analysis.	-Densification of the number of weather stations in the country (particularly the southwest and interior). -Strengthening of the forecasts and alerts systems for specific events (storms, coastal surges, flooding and high winds). - Make climate data available, by the civil authority in charge. - Data rescue and expansion of the number of weather stations. - Ensure data are readily available to policy makers and researchers for analysis.
	• Analysis and	-Met data has been collected and	-Need for deeper analysis and	-Use of a variety of tools and methods	-Develop a framework for downscaling of	-Data were recorded by	-Improve the capacities of	-Use of a variety of	-Need for modern	-Collection, validation,	Improving the real-time data

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Need	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
	recording	<p>recorded over the years but very little analysis has been done or made available for users.</p> <ul style="list-style-type: none"> - Site specific climate data is unavailable or inaccurate depending on the proximity to the weather station -No sector programmes for climate change nor have there been systematic efforts to mainstream climate change across different sector programmes. -Private sector not yet a player in climate change 	<p>packaging of information for various users</p> <ul style="list-style-type: none"> -need to mainstream climate change across different sectors. 	<p>for generation of climate information</p> <p>No common operational procedure for the generation of climate information especially at the local level.</p> <p>In the process of implementing ENACTS integrated framework</p> <ul style="list-style-type: none"> -No current set up framework for monitoring performance of climate information -Majority of CIS users and providers are either in direct partnership with KMD in co-developing climate information services/products or are indirectly using the data produced by KMD. -By virtue of being regional bodies, others are by default working with KMD in jointly developing climate services. 	<p>climate information for local needs, and for monitoring the performance of the services.</p> <ul style="list-style-type: none"> -Develop procedures and implement tools for generation of user oriented climate information at the local level -Provide tools for easy integration of climate information to enable decision making -There was no framework for the evaluation of data quality used by providers and the CIS derived from the data. CIS providers do not label -Develop product and service catalogue and information including methods and data used in analysis 	<p>administrators at the British Overseas Management Administration (BOMAs), missionaries, farmers and a few interested individuals. Thus the station network then reflected the logistics of the recorders or owners of the stations rather than technical aspects hence there was no consistency in data collection, processing and utilisation.</p>	<p>data analysis, archiving and Recording through coordinated trainings</p>	<p>rudimentary tools and methods for generation of climate information</p>	<p>Climate monitoring tools and soft wares required</p>	<p>storage and processing by NIM.</p> <ul style="list-style-type: none"> -Data from 1950 onward is available and managed by an information system equipped with analysis tools. Basic online dynamic climate Monitoring and Watch service. Online access to annual bulletin (2013, 2014 and 2015), etc. 	<p>exchange tools between the main technical stakeholders (INSTM, CNCT, ANPE, APAL, IRA, Air and Maritime General Management Service / Direction Générale des Services Aériens et Maritimes (DGSAM), Hydrographic and Oceanographic Service of the Navy / Service Hydrographique et Océanographique de la Marine Nationale (SHO), Observatory for the Environment and Sustainable Development (TOESD), Centre for Environmental Technology of Tunis/Centre International des Technologies de l'Environnement de Tunis (CITET), National Institute of Statistics (NIS), etc.</p>
	• Weather monitoring	-Not adequately done and therefore information is not always forthcoming	-Need to set up reliable weather monitoring stations that will	-There are scarce rainfall distribution in some areas especially in arid	-Improve the station network especially in arid and semi-arid lands	-Limited technical and human capacity for monitoring and	-Capacitating specific officers only dedicated for Monitoring	-Drought and Flood Monitoring -54 stations	-Extreme Temperature, High Intensity	-Forecasts are established for periods of a few hours up to 6	-Training on climate-based information/data modelling (new

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Need	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
		or it comes when it is too late to mitigate against the effects of the extreme weather conditions -Only 15 weather stations across the country	provide timely early warning and alerts -Need more weather stations for monitoring especially in rural areas.	and semiarid lands Data rescue from obsolete media which lie at the local or private observers No framework for regular remittance of volunteer observer station -Lack of appropriate skills for local climate officers and volunteer observers to ensure standards in observation	Conduct data rescue to convert data from obsolete media to usable form Collect and provide means for training of volunteer community climate observer Revitalize local station and increase monitoring network Explore the use of satellite derived data sets and build capacity of climate users to use such	forecasting extreme weather and climate change	of extreme weather events.		rainfall -720 stations required	days by NIM. Online access of three-decade (1981–2010) averages of climatological variables including temperature and precipitation, etc.	downscaling processes and Uncertainties). Training on modelling and mapping of atmospheric pollution. Access to relevant climate dataset at local level, etc.
b)	Technical Capacity (Skills)	-Low capacity of staff in terms of skills for collection, recording and analysis of climate data -Technical expertise on key topics related to national communications is relatively limited; -lack of mid and long term sectoral planning	-Train staff on the modern and efficient climate information collection, recording and analysis to provide usable products to end users -	-KMD limited computing facility computer used for numerical weather prediction. -Limitation of computing capacity at the county and sub-county level -Limited technical knowledge on new technology such as modern weather centres and tools. -Limited knowledge on climate change information especially for impact assessment needs	-Train on use and maintenance of modern equipment -Training on methods including modelling -Training in climate modelling, impact assessment and analysis including application of appropriate tools	Inadequate technical capacity	Training must continue for enhancing capacity of individuals and organizations to mainstream climate change issues into their activities and effectively adapt and mitigate to the impacts of climate change.	5 PhD, 50 MSc, 600+ Graduates, 300+ Observers and Technicians	More Professional staffs (meteorologists, climatologists, etc.)	In meteorology: Data collection, processing and exchange. Weather forecasting. Climatology and applied meteorology (Agrometeorology and Hydrometeorology) In geophysics and astronomy. Measurement of seismic activity, applied geophysical studies. Observation of the lunar crescent, eclipse and lunar calendar	-Reinforcement of the data exchange communication system -Improving the real-time data exchange tools. -Improvement of the observation and forecasting capacity Reinforcement of weather monitoring equipment to support alert generation Technical assistance, capacity building

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Need	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
										elaboration. Measurement and processing of different types of solar radiation	
c)	Human Resource Capacity (<i>Enough workforce</i>)	-The number of staff deployed are not sufficient hence reduced efficiency of data collection recording and analysis -Lack capacity building actions in the national expertise plan, institutional development, research, systematic observation and technological development;- -Qualitative and quantitative shortage of national technical expertise -	-Need to employ more staff or automate some of the systems to increase efficiency -Operational capacity building for institutions and experts; -Information and education of the public	Number is limited especially at the county level Limited skills on new technology and on development of new technology A large no. of the skilled staff is expected to retire in the recent year which is likely to increase the skill gap.	Support the engagement of more meteorologist and support staff especially at the county level Improvement of skill and knowledge on climate and weather related activities especially on new technologies, for production, and dissemination of climate information. Improve skills on climate change impact assessment Train staff on downscaling methods	Lack of trained met observers is a huge gap in fulfilling climate data requirements for the basins in the country such as Lake Chilwa Basin as quality is compromised.	Need for trained Met observers	No. of staff is 1,300	The Professional cadre are understaffed	Staff composed of: Engineer: 7% Frameworks (function and admin): 10% Press: 0.3% Technician/Typist : 59% Administrative officers and workers: 22%	Capacity building (specifically the engineers). Assistance in terms of scholarship for research and involvement in Master and PhD. Programs. Possibility of publications of the results of various works and research and simulations. Diversification of the coloration (basically CNRM and METEO-France).
d)	Financial Capacity	-Low financial capacity and low funding	-Need for more funds especially for upgrading equipment and training of staff on the new technology	Most government institutions have no autonomy Much depended on government funding for provision of public services Some interagency climate services are not paid for by the government recipient institution	Framework for valuation of CIS government and clear guidelines on cost Increase autonomy to allow space for alternative sourcing of funds and flexible decision making especially for long-term plans	Financial constraints are a major contributing factor towards inadequacies in climate data capture and management in the country	Need for more predictable and reliable financing mechanisms from local and international sources	Government and Internally Generated Revenues (IGR)		Main provider is the Tunisian State. Others contributions through implementation and coordination of projects.	Need of financial capacity increase. Need of diversification of financial sources.
e)	Infrastructural needs	-Relatively poor or obsolete infrastructure	-Need for upgrade of roads and communication	Only three upper air monitoring station available and only	Support the development, revitalization an	Despite upgrades to hydro-meteorological	There is a need for government to support	Inadequate infrastructure	-Need to have more synoptic	-The NIM head office The six regional	-Need for improvement of infrastructure

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Need	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
		especially for communication	technology to increase accessibility and ease of communication	one in operation	expansion of monitoring facilities across the country	observation networks, the existing infrastructure remains insufficient to monitor climate and weather across the full extent of Malawi. For example, the automatic rain gauges and weather stations are concentrated in the western half of the country, while many of the lakeshore areas do not have reliable rainfall and weather data collection facilities	Department of Climate change and Meteorological Services (DCCMS), Department of Water Resources DWR and Department of Disaster Management Affairs (DoDMA) in developing an updated and upgraded comprehensive multi-hazard national EWS, which will encompass warnings of floods, drought and strong winds.		observation stations	representations of NIM (Tunis, Jendouba, Sousse, Sfax, Tozeur et Medenine).	
f)	Technological needs (Tools, equipment, software)	Obsolete equipment and poor infrastructural development and networks	-Need to upgrade and improve network and infrastructure across the country	Has a single mainframe computer used for numerical weather prediction There are limited computing facilities at the county level	Higher computing system for modelling and analysis Better integrated climate information monitoring system Improvement of the user of different ICT technology especially for communication of data and climate information	Technological Development such as the development of climate change research agenda and enabling environment for the application of science and technology has been hindered by financial resources -Limited	The Capacity and Training Needs Assessment Report will be updated periodically to cater for new developments	-Use of a variety of rudimentary tools and methods for generation of climate information	-Need for modern Climate monitoring tools and software to enhance capacity to collect, analyze and disseminate climate information	-Existence of nationwide meteorological observation Stations (Synoptic, Agro-meteorological, Climatologic, Rainfall, etc.). -Existence of a super calculator (2004). -Installation of a high-resolution coupled version	Real-time data exchange issue and technology. Equipment for the storage; More performant calculators and modelling software. Performant Internet technology Geographic information system unit.

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Need	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
						computational equipment, software (model code and associated routines),etc.				of ARPEGE-CLIMAT.	
g)	Policy and regulatory needs	-Weak and inadequate policies -"climate change" dimension has not yet been taken into account in some national development and strategies	-Need to strengthen policies to cover issues of provision and utilization of quality climate information to advice planning and development	Established decentralisation plan CIS in Kenya have been handled without a coordinated CIS policy, legal and institutional framework and lack of standard operating procedures	No legal / institutional framework for collaboration in CIS management. Need to integrate "climate extension" into the current extension service/system	Limited protocols and agreements and related Standard Operating Procedures (SOPs) for DoDMA, DCCMS and DWR at regional, national and local levels with regards to weather, hydrological and information collection, exchange, analysis, interpretation and early warning dissemination.		The NIMET Agency was established for related matters by ACT 2003 No. 9. Of the 19th June, 2003. In addition to that the Nigerian government put in place some National Climate Policy Development Framework - Climate-relevant Policies, Strategies and Plans in Nigeria	Need to develop robust policies to enhance production and dissemination of climate information	In process of being elaborated	In process of being elaborated
h)	Early warning Systems and monitoring of extreme events	-Inadequate, ill-equipped and ineffective	-Need to set up/upgrade early warning systems and monitoring systems for extreme weather events	-Availability of early warning information through the efforts of CAP. -Does not support much all are used for dissemination, especially ICT related avenues	-Promote the use of modern technology ICT -Improve the early warning to the grassroots -Expand the user-reach and also engage and improve the skills of local users	-End-users are unable to understand the inherent uncertainty in the information and that advice resulting from it cannot be relied upon as the	-End-users are unable to understand the inherent uncertainty in the information and that advice resulting from it cannot be relied upon as the	-Seasonal Rainfall Prediction, Drought and Flood Monitor are available and disseminated through media and	Disaster Risk Reduction and early warning systems are required	Forecasts regularly performed by NIM (the National Weather Service). Long-term climate variability monitoring through (NIM /	Real-time data exchange mechanism between the technical stakeholders (NIM, INSTM, National Mapping and Remote Sensing Centre

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
Need	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	
				Based on inter-agency forums such as the Food security	Create awareness of the availability of the early warning information	absolute truth.	absolute truth.	Agromet Bulletins		RCC-RA I). Provision and management by NIM (in collaboration with RCC-RA I). Existence of others regional/international sources (WMO, World Bank Climate Change Knowledge Portal, etc.).	(CNCT), National Environmental Protection Agency (ANPE), Coastal Protection and Planning Agency (APAL) Standard communication protocol to generate and disseminate timely alerts.
i)	Dissemination mechanisms (from producers to users/End-users)	-Ineffective and inefficient mechanisms in dissemination of climate information	-Need to re-establish, modernize and equip systems of climate information based on the end user needs	-Many mechanisms are employed for CIS communication mainly through newsletters and bulletin, RANET, SMS, RVT, meetings and through CIS intermediaries -The current platform is based on agency intervention and interaction	-Need to explore more channels especially the use of ICT platform. -Engage users in the design and implementation of CIS especially defining the specific-user needs. Allow for Implement a platform that allows for effective, interaction, monitoring and user feedback	Improve on the dissemination mechanisms	Improve on the dissemination mechanisms	Dissemination is through media and Agromet Bulletins, Internet,	-Develop a platform for sharing climate information	No standard communication protocol	-Establishment of a standard communication protocol to generate alerts and disseminate them in a timely manner to civil protection authorities and ultimately to local communities -Establish a central bureau Holding and disseminating data sets to concerned sectors on observed climate, socioeconomic characteristics, land use, and climate change scenarios.

3.4 Climate observations, sources of data and analysis

Following the release of the IPCC 4th Assessment report in 2007, there has arisen an unprecedented commitment amongst people, societies, agencies and governments to take appropriate steps – to cope with climate variability, and to be ready to adapt to climate change (IPCC, 2007). As such, there is an increasing demand for climate information of all kinds for decision-support systems and climate risk management in all socio-economic sectors. For instance, Cameroon has teamed up with other African countries in Central and West Africa to initiate programmes for climate services.) Within the framework of the implementation of the Global Framework of Climatological Services (WCMC) in Central Africa, the African Centre of Meteorological Applications for Development (ACMAD) in collaboration with the WMO, the Meteorological Services and NMHSs and their partners, organized the Tenth Session of the Regional Climate Outlook Forum for Central Africa (PRESAC-10). The PRESAC-10 took place in Douala-Cameroon from 21 to 25 August 2017 and was supported by WMO and other donors through the ACMAD centre. The forum was organized to consensually identify the most likely climatic hazards expected between September and December 2017 and their potential impacts in order to inform the actors of the sub-regional platform for disaster risk reduction in Central Africa. This activity thus contributes to the implementation of the strategy of the Economic Community of Central African States (ECCAS) / the United Nations Office for Disaster Risk Reduction (UNISDR) for disaster management and adaptation to climate change. It is also a contribution to the start-up phase of the activities of the Regional Climate Centre of Central Africa (UNISDR, 2011).

The WMO which consists of 188 members represented by their NMHSs. WMO works in close collaboration with research communities, universities, the private sector, other government agencies and various space agencies as well, to systematically observe the climate system. The information collected is archived and managed in climate databases such as those in the NMHSs of WMO's Members (WMO, 2008). These data, critical to our understanding of the climate system, feed dynamical and statistical computer models, to predict and project future states, and to develop useful information, products and services for decision-makers in all walks of life. All the member countries, to serve their public and users whose activities are climate-sensitive, need to understand and to provide for their climate-related needs. This will require climate observations, management and transmission of data, various data services, climate system monitoring, practical applications and services for different user groups, forecasts on monthly, seasonal and inter-annual time scales, climate projections, through to policy-relevant assessments of climate variability and change, and the research that makes all of this possible (WMO, 2008). The five target countries do not have sufficient individual capacity to cope with this on their own. The situation is exacerbated by the reality that some of these countries are severely affected by climate extremes and climate change, and societal and economic vulnerability is at the highest levels (WMO, 2008). WMO members have recognized the need. WMO's technical experts in climatology, regional cooperation, service delivery and product development and transmission are working with the WMO Secretariat to establish mechanisms to improve our institutional capacity for climate around the world. One accomplishment, following years of research and development, is that WMO has designated a number of Global Producing Centres for Long-range Forecasts (GPCs), after a careful assessment of needs, capabilities and optimal designation criteria. The products developed and shared by these centres are extremely valuable global-scale information (WMO, 2008).

Available climate information gathered as part of this National Communication in Cameroon included national relevant data from the initial studies of agriculture; livestock; fishing and aquaculture; forestry, silviculture and wildlife; water and sanitation; health; energy; mines; industries; public works; urban development; tourism, and also from the United Nation Development studies in Cameroon. Experts started by studying climate in each agro-ecological and compare with past climatic data. The spatial scale at which these global products are provided is currently approximately 200 km by 200 km resolution. Some national and local applications would

benefit from products at smaller spatial scales (e.g. 50 km by 50 km). Appropriate strategies are required to develop and implement downscaling of the global products for such applications. To address this, and other information needs for adaptation to climate variability and change, WMO members have established Regional Climate Centres (RCCs) to help fulfil the need for more regionally focused climate services. While most members understand the potential benefits of RCCs in their regions, they have, however, not taken full advantage of the services provided by these centres.

3.5 Availability and access to climate information and services

Climate information in Cameroon is available at the weather stations and the NMHS. However, Cameroon is a member of WMO and has networks with regional organizations that provide climate information. Some of the information is freely available online through their websites. Area specific weather data are available at the twenty two (22) weather stations.

The KMD is the institution mandated to collect and store climate data in Kenya. Data collection is undertaken through the climate observing stations operated by the institution and also through collaboration with other institutions and volunteer observers. The data exchange is achieved through the Global Telecommunication System (GTS). Kenya hosts the Regional Telecommunication Hub (RTH) responsible for data collection and exchange in Eastern and Southern Africa. The major cause of non-availability of data from the region and country is the poor performances of telecommunication links. These limitations affect climate monitoring and prediction, not only for the country or region, but also for the entire global community. The KMD through the decentralization plan has identified the need to expand its observation network in all of the counties and this will involve the enrolment of Community Climate Observers and the application of Automatic Weather Stations, however these require funding. KMD operates thirty six (36) surface climate observing stations countrywide (Synoptic Stations) which provide information on rainfall, minimum and maximum temperatures, wind speed and direction, air pressure, soil temperature, solar radiation, sunshine duration, relative humidity, evaporation and cloud cover. Over three thousand rainfall stations are registered by KMD and are operated by volunteer observers who mainly record rainfall data but some include temperature, however this number is still small as the optimum recommended number is ten thousand. 24 Automatic Weather Stations (AWSs) which automatically record climate data and transmit it to receiving stations at KMD. Most of these stations have enough data that can be used for climate trend analysis; however care needs to be taken when using the volunteer stations as due to concerns of not adhering to recommended standards for observation.

The KMD also operates 3 upper air stations located at Dagoretti Corner, Garissa and Lodwar. Of these only Dagoretti is currently operational and is making one ascent instead of two ascents per day as required due to inadequate resources for purchasing consumables. Four (4) marine tidal gauges with automatic meteorological sensors, which monitor ocean tides and waves as well as Tsunamis are available. The data collected is used to study sea level rise associated with global warming. This data is crucial in providing information to support decision making in adaptation planning for coastal zone management. Three (3) Airport Weather Observing Systems (AWOSs) at Jomo Kenyatta International Airport, Wilson airport and Mombasa International Airport. These systems are able to detect and monitor hazards associated with extreme weather events. Four (4) lightning and thunderstorm detection systems at Nairobi, Mombasa, Kisumu and Eldoret. These systems are used to provide severe weather warnings especially for aviation safety. Data on water and river gauge are mainly obtained from the Ministry of Water and Irrigation or Water Resources Management Authority (WRMA) which is the institution that is responsible for maintaining and operating flow gauging stations. In total there are four hundred and fifty five (455) river gauging stations operated by WRMA well distributed in the 5 drainage basins. In addition, KMD recently installed seventeen (17) hydro-meteorological automatic weather stations in the major water catchments for

measurements of surface discharge and weather parameters. Monitoring of river discharge characteristics enables us to assess the impacts of climate on the water resources, planning in the water sector, especially discharge data used for monitoring of hydro-power generation.

In collaboration with such institutions as the Kenya Agricultural and Livestock Research Organization (KALRO) 14 Agro-meteorological stations have been installed at the stations. These have daily recording of normal meteorological parameters conveyed to the Agro-meteorological division at the KMD headquarters, Dagoretti Corner, after every ten days for analysis and generation of advisory bulletins for the farming community. The agro-meteorology observations include: air temperature; soil temperature at five, ten, twenty, thirty, fifty and one hundred centimetre; depths; sunshine duration; solar radiation; wind speed; relative humidity; pan evaporation; and rainfall in millimetres per day. In addition, crop data is also obtained from the agro-meteorological stations, and these include: variety of the grown crops; stage of development attained by the crops; general assessment of crop performance; damage by pests, diseases and adverse weather; state of weeding in the farm; and plant density. This data and complimentary information is used to undertake assessment of crop performance under different climate conditions and to predict seasonal yields of the various crops and hence to assess food security. The information on the assessment is disseminated to the public through Agro-meteorological Bulletins which are published every ten days for early warning.

The starting point in the development of credible climate information for the end user is in receiving weather, climate, and other sector-specific data of appropriate spatial and temporal resolution that, when processed and integrated with local knowledge, can prove vital for decision making by the end users. Much of the socio-economic information is obtained from other partners including government ministries and agencies such as KALRO, National Disaster Management Authority (NDMA), Kenya Wildlife Service (KWS), Kenya Forest Service (KFS), Kenya Bureau of Statistics (KBS), Department Resource Surveys and Remote Sensing (DRSRS), Water Resources Management Authority (WRMA), National Environment Management Authority (NEMA); from research institutions; and from international and regional agencies [FAO, United States Famine Early Warning Systems Network (US-FEWSNET)]. These includes information on wildlife and livestock population, surface water variability, crop performance, land use and land use change, forest cover, urbanization and human settlements, economic variables.

Satellite data are available and accessible from three satellite receiving stations, two for Meteo-Sat Second Generation (MSG) and one for National Oceanic and Atmospheric Administration (NOAA) satellites data and also from the RCMRD and Department of Resources Survey and Remote Sensing (DRSRS), there are also established PUMA and EUMESAT e-station at the KMD. The satellite data help in observing systems that drive the local climate systems such as global sea surface temperature fields. This data is crucial for predicting seasonal rainfall performance with sufficient lead time for early warning and preparedness. It is therefore a key component of contingency adaptation planning. These datasets helps in improving coverage and also in estimating and filling gaps in data scarce areas and some of the satellite data and derivative products can downloaded from online data repositories. However the downside is usually the lack of insufficient skills required to use and apply them and the limited technical capacity of the user institutions needed to handle the data. Part of satellite derived information include the Normalized Vegetation Index (NDVI), rainfall derived information, cloud information, atmospheric profile, temperature and humidity profiles.

The Department of Climate Change and Meteorological Services (DCCMS) is the main agency responsible for weather and climate services in Malawi. It is located within the Ministry for Environment and Climate Change Management (MECCM). Significant capacity-building attempts have taken place to support the generation of more robust weather and climate information in

Malawi. For example, the World Bank funded a major “training of trainers” initiative based on a capacity building needs assessment led by the University of Cape Town (UCT) in 2013 (Daron, 2013). UCT is also providing on-going support to DCCMS in the development of their climate atlas, which is still underway. DCCMS monitors crop growing season using:

- Observations from a network of weather stations and rain gauges scattered over the country
- Satellite information - NOAA Rainfall estimates (RFE) and NDVI with 8km resolution, or high resolution Spotvgt – 1.1km
- FAO Crop Specific Water Balance model which relies information on weather, climate, crop and soil water holding capacities and fortnightly crop reports
- 10-day Rainfall and Agro meteorological Bulletin
- Weather forecasts and updates
 - ✓ Short (up to 3 days)
 - ✓ Medium (5 – 10 days)
 - ✓ Seasonal (up to 6 months)(Vincent et. al., 2014)

The most accessible source of climate data on Malawi is the Climate Information Platform (CIP) hosted at the Climate Systems Analysis Group (CSAG). This portal has historical records of TRMM satellite rainfall, namely total monthly rainfall, total monthly rainy days, and total monthly heavy rain days (useful to identify particular climate events such as floods or droughts, as well as observing long term variability and trends and observed average seasonality) covering Malawi from 1998 to 2012. Observational records from Lilongwe International Airport (LIA) are available from 1982 to 2000 and include total monthly rainfall, total monthly rainy days, total monthly heavy rain days (>10mm), average maximum temperature, and average minimum temperature. (Vincent et al. 2014) Satellite images from the METEOSAT satellite are a fundamental component of the weather monitoring and forecasting processes. The Malawi Meteorological Services has a satellite receiver that receives data from the METEOSAT second generation series of satellites. (<http://www.metmalawi.com>)

Climate observations in Nigeria are done through observatories in meteorological synoptic, agro-climatic and climatological stations, as well as with radars and earth observation systems like satellites and models. All of these systems collect data and send them back to the main station (at the NIMET headquarters). The quality of these data are controlled, and stored in a data base management system. After that, experts are using the data to do some analysis and provide products to specific users. The observed weather parameters such as temperature, rainfall, humidity for the periods (day, week, dekad, season, year, etc.) are compared with the average for the 30-year base (or reference). This method of analysis is in line with international scientific practice prescribed by WMO. The analyses presented shows that Nigerian climate continues to be highly variable and these impacts on the economy especially on agriculture, energy, environment, health, transportation and water resources. There is therefore growing concern about the adverse impacts of climate variability and change on these key sectors of the economy of the country. It is also in line with this, and in response to the statutory responsibility of NIMET to continue to provide climate information to assist stakeholders in adaptation and mitigation, impacts of climate variability and change on key sectors of the economy.

In Nigeria climate data and information comes mainly from NIMET and some international collaborators through the:

- Weather stations observations and archived data,
- Satellite data,
- Trans-African Hydro-Meteorological Observatory (TAHMO),
- National Aeronautics and Space Administration (NASA),
- National Oceanic and Atmospheric Administration (NOAA),

- National Environmental Satellite,
- Data and Information Service,
- National Climatic Data Centre,
- Data portals, mapping Tools and Information systems and
- Weather simulation models.

Climate data is available in Nigeria on daily basis at the weather stations. These data can be converted to decadal, monthly, seasonal, etc. for usefulness of short medium to long term development of products.

There are two ways (sources) to have access to climate data and information in Tunisia.

- The official climate-based data are collected, processed and delivered by the Tunisian National Institute of Meteorology (NIM) including the RCC-RA I. Free validated public data can directly be accessed through the website of NIM. But demand for specific climate products and services can be submitted as well to NIM through a user service.
- The national complementary sources, representing others national structures which use/provide information/data that are derived from climate-based data, and which could also provide specific kind of processed climate information information/data (INSTM, CNCT, ANPE, APAL, IRA, DGSAM, SHO, NIS, CITET, TOESD, WII, etc.). These may be gathering and processing climate-based information according to various formats.

There are external sources which represent the regional and international data repositories providing various climate-based data according to various formats including archived weather stations and satellite data. The most considered include:

- World Meteorological Organization (WMO) Country Profile Database Portal
- World Bank Group Climate Change Knowledge Portal (CCKP)
- Trans-African Hydro-Meteorological Observatory (TAHMO),
- International Consortium for Agricultural Systems Applications (ICASA)
- ICASA Data Exchange (IDE)
- National Aeronautics and Space Administration (NASA)
- National Oceanic and Atmospheric Administration (NOAA)
- National Environmental Satellite Data and Information Service,
- National Climatic Data Center, etc.

At the national level, the climate information available in the country can be broadly classified as followed:

- **The short range** climate-based information, which are :
 - Hourly and daily weather information.
 - Hourly and daily weather forecasting information/data
 - Monthly weather information and Annual weather information.
- **The mid-range** climate-based information representing the seasonal weather forecast information (through monthly bulletin). Information on Temperature and Precipitation parameters are provided for all the 4 seasons (autumn, winter, spring and summer).
- **The long-range** climate-based information representing historical annual and monthly weather information (temperature, precision, sea surface temperature, sea level pressure and drought).

Access to quality weather and climate data is essential for policy makers. Without reliable data on temperature and precipitation levels, it is difficult to assess the current climate and make reliable weather forecasts and climate predictions that will allow for the design of effective policies, the implementation of early warning systems, and adaptation within key sectors upon which the economy depends. Tunisia has regular climate data collection with a high concentration of weather

stations in the northeast of the country as well as in Djerba and other highly developed regions. There are however, low concentrations of weather stations in the southwest and interior of the country. Climate data is currently documented using SDCLIM version 1.0. This is based on individual meteorological elements, which facilitate automatic inputs, but there is some difficulty in the system in terms of introducing new elements or parameters. The system has also only been developed in French, which limits some forms of international and national data sharing (Ben Mansour 2011; (WMO, 2002). In the short and medium term, the collection and monitoring of climate data could be improved by expanding the number of weather stations, and by collaborating with other countries in the region to improve the coverage and comparability of data. This effort should be combined with a push to link climate data to impact analysis by making climate data available to policy makers and researchers. Some efforts in this direction have already started. Tunisia is part of the European Climate Assessment and Dataset (ECA&D) project. This project, which aims to combine collation of daily series of observations at meteorological stations, conduct quality control, analyze extremes, and disseminate both daily data and analysis results, is gradually being extended across the Middle East and North Africa. Water is scarce in Tunisia and likely to become scarcer due to climate change. Information on current and future water availability and quality is therefore critical for designing adaptation responses (Verner Dorte, 2013). This requires information on river runoff, groundwater levels, and water quality including salinity. While information on hydrology is included in the Climdata system used by Tunisia, in many parts of Tunisia coverage of this data is poor and will need to be upgraded (Verner Dorte, 2013). Capacity is also required to monitor and analyze long-term trends in hydro-meteorological data, link it with the climate data, and develop downscaled climate change models.

Some of the sites that weather and climate information for all the target countries can be accessed include:

- <https://www.iamat.org/country/cameroon/climate-data>
- <http://worldweather.wmo.int/en/city.html?cityId=257>
- http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical
- <https://www.weather-forecast.com/maps/Cameroon>

3.6 Stakeholders, users and decision-makers

End users for climate information and early warning systems include farmers, communities, policy makers and the private sector. Actors to reach these stakeholders include telecoms/electronic media, NHMS, community leaders, first responders, NGOs, education, health, early warning centre, brand ambassadors, country projects, partner agencies, CIRDA, United Nations Development Programme (UNDP) and the community of practice, rural radio... and the list goes on. Understanding stakeholders is not an easy process, especially as regional linguistic, cultural, media and political variations create nuances from country to country for both end-users (communities and farmers) and policy makers. End users include:

Farmers

This target group is comprised of crop farmers, smallholder farmers, industrialized farmers, pastoralists (livestock herders), fishermen and rural enterprisers. This target group has multiple needs for weather and climate information. It can save lives, contain losses, increase productivity and reduce risk. Reaching rural farmers is a challenge, Internet communication is virtually impossible, literacy is low, and there are regional and village-level cultural and linguistic differences. Primary methodologies for reaching this group include: rural radio, SMS, trainings and informational meetings hosted at the community level, billboards, outreach from schools and health organizations, NGOs, pamphlets and other advocacy methods. They can also be reached through value-added service providers, extension services, cooperatives and innovative last mile approaches such as Human Network International's 3-2-1 Service.

Local Communities

This group is comprised of community leaders, farm cooperative leaders, village leadership, regional politicians, children, teachers, moms, elders and other community members that don't work in farming, local NGOs, extension services and medium-scale local enterprisers. Reaching this group is a little easier. Villages will often have access to television, radio, and may even have access to the Internet. Primary vehicles to reach them include Public Service Announcements (PSAs), TV, training, radio, policy dialogue (learning routes), print media, social media (growing but still limited), community meetings, school and hospital outreach, SMS and engagement with extension services. Some communities have enabled communications tree within the leadership to ensure messages are disseminated rapidly once generated.

Policy Makers

This group is comprised of national leaders in the NHMS, Senate, House of Representatives, executive branch, ministries, media, large private-sector enterprise (telecommunications, banking, mining, etc.), universities, think tanks, and regional cooperation entities (i.e. African Union). Reaching them should be the easiest of all. They can be reached by email, social media, print, radio, broadcast, and advocacy. However, impacting their opinions and policies is a whole other ballgame. In order to reach them and sway opinion and policy, you first need to reach their constituencies (farmers and communities), empower product champions, and foster learning opportunities.

Private Sector

Not only do private sector enterprises benefit from tailored weather information – to protect human and physical resources and make climate-smart business decisions – they can also play a role in disseminating messages. Telecommunications firms can site AWS and serve as go-betweens to send early alerts, mining companies can be tapped to leverage corporate social responsibility dollars, or pay for tailored weather information, media can be used to share early alerts and PSAs. In order to engage the private sector, you need to create a narrative that underscores your specific value to them and to their consumers. They need to understand you are creating a valuable product that they can trust.

International Organizations

A number of international research institutions have country offices and research stations in Cameroon. Examples of these institutions and their research domains are presented below.

- International Institute of Tropical Agriculture (IITA): cassava, banana, plantain, maize, cocoa, entomology and social studies;
- The World Vegetable Center (AVDRC): vegetables;
- Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD): food security, agroforestry systems, agro-industrial plantations, aquaculture systems and cotton cropping systems;
- World Agroforestry Centre (ICRAF): agroforestry systems;
- Biodiversity International: agricultural and tree biodiversity;
- Center for International Forestry Research (CIFOR): forest management, gender, climate change, food and biodiversity, forest policy, products and trade, and landscape;
- UCLA International Research and Training Center in Cameroon (IRTC): conservation, ecology and evolution, infectious diseases, and biodiversity;
- GIZ (Cameroon-German partnership). The GIZ is a major funder of agriculture and environment activities in the country;
- Forum for Agricultural Research in Africa (FARA) which, through other organizations like IITA and AVRDC, has been putting efforts to set up innovation platforms and support their activities;

- The African Research Center on Bananas and Plantains (CARBAP) has been playing an important role by carrying out research on bananas and plantains

National Organizations

The public agricultural research organization is the Institute of Agricultural Research for Development (IRAD), which was established in 1996 to conduct agricultural research with mandates around annual and perennial crops, livestock and fisheries, forest and environment, farming systems, economics and rural sociology. IRAD works in collaboration with many local and international research institutions and development partners. Some government and private universities are also involved in agricultural research in Cameroon. These include: University of Dschang, University of Ngaoundere, University of Yaounde I, University of Buea, University of Bamenda, Catholic University of Cameroon, Cameroon Christian University, and Catholic University Institute of Buea.

The field of climate information in Kenya has attracted a vast array of participants, some are CIS producers, some intermediaries, and others are end users. However the chain of information flow links all and considering the importance of user feedback for improvement of CIS quality, the concept of end user become rather obscure. A study conducted by the World Bank in 2016 (WBG, 2016) on climate service providers in Kenya indicated that the climate service providers came from various association. Twenty-seven percent of the CIS providers covered in the study were private sector operators; twenty-one percent were government agencies; together, nongovernmental and community-based organizations (NGOs and CBOs) made up 21 percent of CIS providers; seventeen percent of the providers surveyed were in research and academia; and another 14 percent were international organizations. Some of the service providers also double as producers of climate information. Therefore it is good to note that CIS providers include Government, Non-Governmental Organizations, Private Sector players, Research institutions, farmers organisations and SACCOs, media, religious organization, county government, regional and international bodies, and UN organizations.

Three key departments play various roles in the provision of Climate Change and Disaster Risks related early warning in Malawi. These are i) the Department of Disaster Management Affairs (DoDMA) in the Office of the President and Cabinet (OPC); ii) the Department of Climate Change and Meteorological Services (DCCMS) in the Ministry of Environment and Climate Change Management (MoECCM); and iii) the Department of Water Resources in the Ministry of Irrigation and Water Development (MoWDI) (UNDP, 2013). DoDMA is a Government agency in the OPC, which is mandated to coordinate and oversee disaster risk management programs and projects being implemented by various stakeholders in the country with the aim to build and improve resilience of households, communities and the nation to disaster risks. The Department was established in 1994 by the DPR Act (1991), which was enacted after the Phalombe floods catastrophe to coordinate and implement measures to alleviate effects of disasters. The Act emphasized establishing the institutional functions required for the coordination of disaster risk management programmes and activities in the country, comprising: i) the Secretary and Commissioner for Disaster Management Affairs in the Department of Disaster Management Affairs (DoDMA); and ii) the National Disaster Preparedness and Relief Committee (NDPRC), Civil Protection Committees (CPCs)(UNDP,2013).

The private sector is an important stakeholder when it comes to economic growth and job creation in the country and therefore must play an active role in climate change management. The private sector is critical in achieving a low carbon emission development for Malawi through investing in cleaner technologies and provision of green jobs. Government can provide incentives for this and promote public-private partnerships to take this forward. Furthermore, the private sector should take an active part in decision making on climate change initiatives. This can be achieved through

representation in the National Technical Committee on Climate Change (NTCCC) through the Malawi Confederation of Chambers of Commerce and Industry (MCCCI) as a platform for providing their input and participating in climate change management in the country. In particular, the private sector can take an active role in participating in projects for carbon emissions trading including CDM, low carbon development, offsetting their emissions and investing in renewable energy (GOM, 2016).

NGOs, FBO and CBOs have an important role to play as they work closely with communities and can influence communities' response to climate change adaptation and mitigation as they have the necessary resources to do projects at that level. It is important for this group of stakeholders to realize that mainstreaming of climate change and disaster risk reduction into their activities will help climate proof and sustain their activities for the longer term (GOM, 2016).

The media has an important role of creating awareness on climate change issues amongst stakeholders at all levels including at community level. The dissemination of information should be evidence based and in this regard there is need to promote journalism that focuses on environment and natural resource. Messages disseminated by media in a timely manner will empower communities to take necessary action on climate change adaptation, mitigation and disaster risk reduction (GOM, 2016). The need for more research and training in climate change issues in Malawi cannot be overemphasized. Training and research institutions have a pivotal role to play. Training in climate change issues must be enhanced in order to build the capacity of individuals and organizations to mainstream climate change issues into their activities and effectively adapt and mitigate to the impacts of climate change. Furthermore, home grown research must be promoted. Scientific knowledge from research must be used for decision making and practical solutions that are user friendly and sensitive to local needs must be recommended (GOM, 2016).

In Nigeria, NIMET advises the government on all aspects of related to climate and meteorology; project, prepare and interpret government policy in the field of meteorology; and to issue weather (and climate) forecasts for the safe operations of aircrafts, ocean going vessels and oil rigs. In the face of climate change challenges in Africa, increased dissemination of climate information services which involves acquisition, processing, packaging and delivery of weather and climate data and its subsequent uptake by users is important for developing climate impact mitigation strategies, to assist resilience planning for climate vulnerable users, for early warning of weather related hazards etc. That way many partners are involved in the dissemination of the climate and weather information to users. These partners include some government agencies such as Agriculture and those of their Agricultural Development Programs, Agricultural Extension Officials, Agricultural Research Institutes and organizations and the National Agricultural Extension and Research Liaison Services and the TV through daily weather forecast. Also NIMET developed an Environmental Information Systems (CIS) to improve quality of information that farmers should receive and use in crop production in line with the Federal Ministry of Environment in term of early warning systems and the Platform for the Promotion of Early Warning. To quickly and effectively reach the end users some Non-Governmental organizations, civil society and media are involved in dissemination of the climate related information's.

Nevertheless, for a variety of reasons, it will be difficult for African governments to efficiently deliver CIS to users in the foreseeable future. Thus, outsourcing CIS delivery task to private sectors is one of the best approaches for enhanced dissemination and uptake of climate information to users. As they are driven by profit and competition, outsourcing climate information system delivery task to private sectors will result in fast dissemination and uptake. This in turn will result in increased application of weather and climate information in all development sectors and by climate vulnerable users, increased adaption and mitigation to climate change, increased resilience of vulnerable societies to climate impacts, increased economic and social developments, increased job creation and

entrepreneurship so on. However, policies, legal frameworks, guidelines and modalities that enable establishment and administration of private CIS delivering firms, responsibilities and accountabilities of private sectors, etc. should be drafted and approved by government. Moreover, roles and responsibilities of government and relevant stakeholders with respect to outsourcing CIS delivery tasks to private sectors should also be defined. Details of approaches and mechanisms required for outsourcing CIS delivery to private sectors are described in this project proposal.

4. ANALYSIS OF SECTORS AND CLIMATE INFORMATION NEEDS

There are several sectors that are sensitive to the effects of climate change. The progress report for the UNDP study (2011) identified eight sensitive sectors: agriculture, livestock, fishery and aquaculture; biodiversity; water; energy and mining; industry; sanitation and health; urban development and public works, and, last, human development (UNDP, 2011). This report will discuss seven sectors across the five countries. They include: Agriculture and food Security, Health, Energy, Transport, Tourism, Water resources and Environment and Natural Resources.

4.1 Agriculture and Food Security

It has evidently been shown that food security; pastoralism, agricultural productivity and marine fisheries are sensitive to weather and climate variability. These forms the keys sectors of concern for majority of CIS providers in Cameroon. Agricultural users of weather and climate services in typically require weather and climate products on a combination of timescales, including historical observations, monitored information throughout a growing season, daily/weekly weather forecasts, monthly outlooks, seasonal predictions, and decadal climate change projections (Tall et. al., 2014).

There is a decrease in agricultural activities due to climate change and an extension of agricultural activities toward the lowlands in Cameroon (Sasson, 2012). Given that Cameroon depends heavily on agriculture, the effects of global warming and climate change on the agricultural sector are likely to threaten both the welfare of the population and the economic development of the country. Cropland under different crops has generally been increasing steadily since 1961 (FAOSTAT, 2012). Notwithstanding this increase in cropland, food production has not been increasing sufficiently to meet the rising demand (Sasson, 2012). From 2008 to 2009, Cameroon suffered a major food price crisis, which led to several weeks of social unrest (with a total of 40 fatalities officially reported) in some main cities (Lagi et al., 2011).

The review of the literature reveals significant potential for climate change to affect crop and livestock production, hydrologic balances, input supplies and other components of the agricultural systems. The nature of these biophysical effects and human responses are complex and uncertain. For instance, crop and livestock yields are directly affected by changes in climatic factors such as temperature and precipitation and the frequency and severity of extreme events such as droughts, floods and wind storms. To add to this, Cameroon is faced with difficult socio-economic conditions, insufficient institutional framework and inadequate infrastructure. Inadequate research, training and credit limit farmers' capacity to adapt to climate variation and change.

The diversified climate however, offers immense potential for the development of a wide range of crop production systems (Westphal et al., 1985; de Graaff et al., 2011; Yengoh et al., 2011). Farming practices, however, have not been generally effective in conserving and ameliorating soil nutrients (MINLAPDAT, 2005; Kanmegne, 2006) hence soil fertility decline has been reported as an important problem of food production in the country (Kanmegne, 2006). Local level analysis of constraints to food crop production can guide the development of carefully targeted responses that are adapted to local realities (Lobell et al., 2009; Bindraban et al., 2012).

The necessary adjustments such as changing crops, introducing irrigation or modifying farm management methods are too costly for many farmers to implement. These changes entail costly capital investments, and the resulting lower yield potential (production) from drought tolerant crops does not compensate for the direct costs incurred. Desertification in the north is also strongly linked to food insecurity. Combating desertification and promoting development are virtually one and the same owing to the social and economic importance of natural resources and agriculture. Food security can be put at risk when people already living on the edge face severe drought.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3906480/>

Some of the agro-climatic advisories available in the Kenya include: Planting window/varieties selection, land preparation, harvest, postharvest, input application rate, timing of input application, input stocking, input procurement, financing arrangement, and market information (WBG, 2016). Currently much of the climate information is provided for at 10 day, monthly and seasonal scale by KMD and usually at the national level. However, there has been some initiatives to improve the uptake of CIS information at the local scale these include: the decentralization of climate services to the county level; Christian Aid SALI project promoting enhanced community engagement in the uptake of CS through the co-development of community-based adaptation strategies through appropriate, 'localized' interpretation of weather and climate products from NMHSs (Christian Aid, 2011; Christian Aid, 2012); the Adaptation Learning Programme (ALP) for Africa by CARE, that develops community-based risk-management strategies, involving participatory engagement of rural communities to assist with designing agricultural advisories based on probabilistic seasonal forecast information from NMSs (CARE ALP Brochure, 2011). Some tools are being employed in downscaling of climate information to the local level such as 'FIT Interpretation Tool' (Brown, 2008), developed by the Famine Early Warning Systems Network (FEWSNET – associated with USGS and USAID).

Already, Kenya has an established a consortium of several stakeholders through the Kenya Food Security Committee and the technical component of Kenya Food Security Working Group who are concerned with issuance of advisories and briefs on the food security situation. Some of the identified gaps and needs for the climate service in the country include: Strengthening of Regional, national and subnational Climate Outlook Forums and integration with wider government frameworks and plans (WMO, 2014b); Further development of tools for downscaling of climate information to produce local information and forecasts (Brown, 2008); Further research into how local indigenous knowledge can be combined with climate services and support climate information (Masinde, 2014); Scaling up of successful climate services projects in the food security sector, which address the key criteria identified in recent studies (e.g. Tall et al., 2014); Developing tailored forecasts to meet user needs, including the use of local languages and a wide range of communication channels (Tall et al., 2014; Lumbroso et al., 2014); Provision of simple weather and hydrological monitoring equipment to local communities to raise awareness, promote dialogue and data exchange.

The cross-sectoral Malawi Vulnerability Assessment Committee (MVAC) that monitors food security only look ahead to the coming season, and therefore decisions are currently based on observations, rather than modelling or projections. Various departments within the Ministry of Agriculture and Food Security (MoAFS) use seasonal forecasts, for example they produce the Agricultural Crop Production Survey and produce information and advice for farmers. However, they also focus on the coming season and therefore, do not consider projections of what will happen in following years. MoAFS and the Ministry of Irrigation and Water Development (MoIWD) collaborate at all levels of governance on matters relating to food security. Representatives from departments within the MoIWD outlined that weather information such as rainfall, temperatures, humidity, potential evapo-transpiration rates, etc. are all vital in planning and designing long-term future investments, such as irrigation projects. Weather information (temperature; potential evapo-transpiration rates; rainfall) based on past averages for the same times of the year are also used in the operation of irrigation projects. However, current planning and decision- making are based not on model projections but rather on linear regression of past averages- observations from the past (provided by DCCMS) are used to predict what will happen in the future. Such linear modeling, which is also used by other ministries, is potentially problematic as it assumes that the future will mirror the past, which may not be the case under projected climate change (Vincent et al., 2014).

For Agriculture and food security sector in Nigeria, NIMET is regularly providing the seasonal climate forecast consisting of outlooks on the cumulative rainfall, mean temperature anomalies, onset of the

rainfall, ending of the rainfall season, dry spells (drought). Some specific needs that will enhance the making of necessary decisions to reduce the impacts of drought includes timely generation and dissemination of some useful information on climate and weather for people whose livelihoods are mostly affected including rainfall intensity forecast, drought forecast as well as crop yield forecast and potential area at risk. The suggested recommendations are:

- Capacity building programmes relevant to climate change and agriculture should be organized by the government at all levels through the appropriate ministries, agencies and departments to train extension agents and educate farmers to boost their capacities for effective and sustainable adaptation to climate change
- stakeholders in the generation of climate change information such as the Nigerian Meteorological Institute (NIMET) should ensure the timely generation and dissemination of relevant information on climate change (e.g. weather forecast) which should cover all the areas of need indicated by the farmers to enable them make decisions which will enhance their adaptation to climate change;
- Curriculum for training prospective extension personnel should be reviewed to incorporate the identified areas of information need for adaptation to climate change; and
- Interventions and advocacies in climate change should be guided by the identified socio-economic characteristics that determine the information needs for proper adaptation.

In livestock production, NIMET provides information on drought and floods but some complementary is needed by herders in terms of livestock comfort index, pests and diseases forecast. Climate change and variabilities may have impacts on the distribution of disease vectors. Some diseases are associated with water, which may be exacerbated by flooding and complicated by inadequate water access. Droughts may force people and their livestock to move, potentially exposing them to environments with health risks to which they have not previously been exposed. While the direct impacts of climate change on livestock disease may be relatively muted there are considerable gaps in knowledge concerning many existing diseases of livestock and their relation to environmental factors, including climate.

Due to climate change, many climate hazards and extreme weather events, such as heat waves, heavy rainfall and droughts, could become more frequent and more intense in many parts of the world. Human health is profoundly affected by weather and climate. Climate change threatens to exacerbate today's health problems – deaths from extreme weather events, cardiovascular and respiratory diseases, infectious diseases and malnutrition – whilst undermining water and food supplies, infrastructure, health systems and social protection systems. To reduce the effect of climate on health NIMET is providing some information related to the outlook of season in term of rainfall predictions (deficit or excess rainfall) but there is still need for temperature forecast and prediction. Droughts caused by climate change will particularly affect rain-fed cereal farming interests, which would decrease from a current average land area of 1.5 million hectares to about 1 million hectares in 2030, i.e. a reduction of approximately 30 per cent. Agricultural GDP following the reduction in land area, given yields identical to the reference situation, would fall by 5 to 10 per cent by 2030. In the event of successive extreme droughts, the land area used for cereal crops and arboriculture (mainly regions in the centre and the south) will decrease by 200,000 and 800,000 hectares respectively. Lastly, the livestock population would decrease by about 80 per cent in the centre and the south, and 20 per cent in the north, owing to the loss of rough grazing areas.

The actions planned are essentially capacity-building and institutional development measures:

- Adapting irrigated crops in the central regions,
- Adapting mixed farming-livestock production to climate change in vulnerable regions,
- Updating the agricultural map to take into account the impacts of climate change,
- Introducing a climate monitoring and early warning system, as well as an insurance mechanism against climatic hazards due to climate change,

- Conserving and exploiting genetic heritage to adapt cereal crops to climate change, developing innovative systems for arable crops.

A number of countries in North Africa, including Tunisia already face semi-arid conditions that make agriculture challenging, and climate change will be likely to reduce the length of growing season as well as force large regions of marginal agriculture out of production. Projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected (Boko et. al., 2012). The region relies on sparse winter rainfall and short rainy seasons to grow cereals, legumes and low-yield arboriculture as well as raises sheep and goats on fragile grazing land. The extremely arid areas in the south depend almost entirely on crop irrigation but are devoid of any major river systems. Irrigation plays the most crucial role in the arid regions, which are characterized by low rainfall or evapotranspiration exceeding precipitation most of the year and high inter-annual rainfall variability. Accordingly, water scarcity related to climate change is expected to have negative consequences on agriculture (El-Shaer et al., 1997). Water and land resources in Tunisia are primarily used for agriculture. The decrease in annual precipitation that is predicted for Northern Africa in the 21st century will exacerbate these effects, particularly in semiarid and arid regions that rely on irrigation for crop growth (Hulme et al., 2001). IPCC (2007) reported that agricultural production in many African countries is projected to be severely compromised by climate variability and change. Yields from rained agriculture in Africa could be reduced by up to 50% by 2020, and the projected sea-level rise will affect low-lying coastal areas with large populations, which will require a total cost of adaptation that could amount to at least 5-10% of GDP. Model results are inconsistent regarding future changes in crop yields and agricultural growing seasons in North Africa, and we do not know whether variations in temperature, precipitation, or atmospheric CO₂ will be the dominant factor.

4.2 Health

One of the major constraints in African countries for addressing health challenges and climate change challenges in particular is the limited number of trained health workers to ensure the health system's full functionality at all levels. Weaknesses in disease control and climate surveillance and reporting systems make it difficult to obtain the long-term data sets on climate and disease that are necessary for the development of early warning systems in Africa (WHO, 2005). Due to scarce resources, African governments allocate grossly inadequate funding to health research. Health research is mostly supported by bilateral and multilateral organizations with limited participation of scientists from the home countries, resulting in donor-driven research agendas. Research is conducted fragmentally in separate ministries, sectors and institutions and there are no overarching inter-sectoral or inter-institutional mechanisms for collaboration, exchange of information and knowledge and addressing health priorities. Ministries are unaware of each other's research projects, a situation that contributes to the lack of clearly defined national health research priorities. In addition, priorities for individual research institutions are set internally, rather than in collaboration with other institutions. Furthermore, health practitioners and communities have limited understanding of the effects of climate change on health to undertake appropriate climate change adaptation actions. The health systems in African countries are pyramidal with three levels: central (strategic), intermediate (technical) and peripheral (operational). Stakeholders are local government health institutions, the private sector, NGOs, bilateral and multilateral partners and the communities. The health systems of most of the countries are suffering from shortage of quantitative and qualitative human capital for proper implementation of health strategies. In many cases, communities are not involved in the implementation strategies of health policies. There is poor coordination between the stakeholders, and climate change adaptation strategies are not precisely defined and integrated into health policies.

In Cameroon, the health sector is primarily funded by the national budget, households (cost recovery and other direct payments), external funding and to a lesser extent local government authorities and private health insurance. North-South cooperation is predominant and is carried out through the main specialised agencies of the UN system, the European Union, the World Bank, the African Development Bank and the Islamic Development Bank. Bilateral cooperation is dominated by France's AFD and Germany's KfW Entwicklungsbank and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

Weather and climate conditions on all timescales have both direct and indirect effects on public health and safety through extreme events such as heat waves, floods and droughts, as well as the prevalence and severity of infectious, vector- and water-borne diseases such as meningitis, malaria, and diarrhoea (WMO, 2014a) and cholera (de Magny et al., 2007). Rapid urbanisation with a lack of modern drainage systems and wastewater systems has the potential for increasing the prevalence of water-borne diseases. While the impacts of weather and climate on public health are widely recognised, the uptake and implementation of climate services to inform policy and decision making activities within the health sector is relatively low (Jancloes et al., 2014; WMO, 2014a). This could be attributed to factors such as: limited capacity to effectively use and understand climate services; the apparent inability to manage and monitor the risks of climate variability and change on public health; lack of access to the relevant datasets, and an institutional disconnect between the public health community and other sectors which consider public health as a downstream priority such as food security and water resource management (Jancloes et al., 2014; WMO 2014a).

Kenya has already developed national level partnerships through the implementation of Climate and Health Working Groups (CHWGs), which has established strong national partnerships between the climate and health communities for the conduct of research, education and data exchange (Rogers et al., 2010). Key outcomes of the CHWGs has been improved service delivery and increased capacity of NMSs, through sustained partnerships, increasing cross-sectorial collaboration. There is still a limitation in the development of decision-support tools that is relevant to the health sector, and the cooperative development of weather and climate advisory services for practical use in the health community (Connor et al., 2010).

Ways to improve the effective integration of climate services into the decision-making in the health sector include: promoting two-way dialogue channels and strengthened partnerships between CS providers and the health community; investing in human resource and institutional capacity development activities while promoting interdisciplinary research into the potential effects of climate variability and change on public health; and improving the access, understanding and relevancy of both climate monitoring and health surveillance datasets (Connor et al., 2010; Clim-Health Africa, 2013; Jancloes et al., 2014; WMO, 2014a).

Tunisia has an approved national health adaptation strategy and has conducted a national assessment of climate change impacts, vulnerability and adaptation for health. Additionally, Tunisia is taking action to build institutional and technical capacities to work on climate change and health. Climate change, through higher temperatures, land and water scarcity, flooding, drought and displacement, negatively impacts agricultural production and causes breakdown in food systems (Verner Dorte, 2013). These disproportionately affect those most vulnerable people at risk to hunger and can lead to food insecurity. Vulnerable groups risk further deterioration into food and nutrition crises if exposed to extreme climate events. Without considerable efforts made to improve climate resilience, it has been estimated that the global risk of hunger and malnutrition could increase by up to 20 percent by 2050. In Tunisia, the prevalence of stunting in children under age 5 was 10.1% in 2012, the prevalence of underweight children and wasting in children under age 5 was 2.3% and 2.8%, respectively, in 2012 (Verner Dorte, 2013). In Tunisia, by 2030, an estimated 250 annual

premature deaths due to outdoor air pollution may be avoided and near-term climate change mitigated by implementing 14 short lived climate pollutant reduction measures (Verner Dorte, 2013).

The effects of climate change on health in Tunisia will take the form of:

- The resurgence and proliferation of certain vector-borne diseases, such as malaria, leishmaniasis or dengue,
- Respiratory diseases caused by the rise in temperature,
- Water-borne diseases caused by degradation of the bacteriological, physical and chemical quality of water resources.

The measures here for dealing with these problems essentially dwell on capacity-building and institutional support:

- Risk assessment and prevention of a proliferation of respiratory pathologies linked to climate change,
- Introduction of a network to monitor epidemics of the principle vector-borne diseases,
- Implementation and strengthening of the entomological monitoring network and efforts to fight mosquitoes and sand flies,
- Introduction of a programme to adapt the health system to climate change, especially through protection against water-borne diseases.

4.3 Energy

Total electricity produced in Cameroon in 2015 was 628 ktoe with 75 per cent of it from hydroelectricity. In 2015, electricity consumption was 526 ktoe; industry consumed 43.3 per cent of this. Cameroon has 18.8 million hectares of forest, amounting to the third largest biomass potential in sub-Saharan Africa (FAO, 2015). Deforestation is a major issue occurring at a rate of 220,000 ha/yr between 1990 and 2015, with less than 2 per cent of that being replanted annually. Primary uses for biomass in the country include heating and light for the majority of the rural population. Use of palm oil for biodiesel is also a viable prospect for the country. However, this contributes to deforestation, as forests are often cleared to make way for palm oil farms. In 2010, estimates indicated that palm oil is grown on about 190,000 ha of land. (https://wedocs.unep.org/bitstream/handle/20.500.11822/20487/Energy_profile_Cameroon.pdf?sequence=1&isAllowed=y).

With at least 23GW of unexploited hydropower, Cameroon has Africa's second largest potential after DRC. Only 3% of this potential has been harnessed at present with around 800MW of installed capacity according to the International Hydropower Association (IHA). The main three operating projects are Edea (264 MW), Songloulou (398 MW) and Lagdo (72 MW) (IHA, 2013). For decades, poverty eradication has been given priority over investments in the energy sector, but in recent years policy-makers have reconsidered the role of reliable electricity services in bringing socio-economic development. To meet growing domestic electricity needs, there are now three additional hydropower projects under construction: Lom Pangar, Memve'ele and Mekin. The 56MW Lom Pangar project is planned upstream of Edea and Songloulou. By serving as a regulating dam to reduce seasonal variability, it will increase year-round production at the downstream projects and respond to water service needs in the region. The project will also reserve 30MW for rural electrification (IHA, 2013). It is scheduled to be fully operational in 2016. Cameroon has also recently conducted studies of its solar and wind energy potential finding that northern regions have high solar potential, while wind is abundant in the west. In 2012, the country partnered with China to electrify 1,000 villages through solar power plants. The country is preparing a renewable energy policy to attract partners to develop the existing potential. Renewable technology development may have implications for how hydropower is operated in the future (IHA, 2013).

Cameroon will increasingly rely on renewable energy as it moves towards its goal of “economic emergence” by 2035, the government announced. Energy supply has been the main hurdle in Cameroon’s path towards economic growth according to the Minister of Water and Energy Resources. He said the country uses less than one percent of its renewable energy potential.

The Government of Cameroon appealed for help in establishing CDM project based on converting biogas into electricity. This is in line with the Kyoto Protocol, which aims to cut climate-changing emissions, the CDM allows developing nations to sell carbon credits earned by carrying out emissions reduction projects. The credits can then be bought or traded by richer nations to meet part of their own requirements to meet emissions reduction targets. According to a report by the Africa Development Bank, despite Cameroon’s abundance of energy resource resources – including oil, gas hydropower and solar – only 18 percent of people in the country had access to those energy sources in 2013, a rate experts said is low for Africa (AfDB, 2015). The report says currently 60 percent of the country’s installed electricity generating capacity of 1,400 MW is based on hydropower, which fluctuates greatly during the dry season, forcing Cameroon to rely on expensive emergency thermal units, or fossil fuel power. To carry out its Energy Sector Development Plan—which aims for a 75 percent electrification rate by 2030—and reach its economic goals, Cameroon needs more and more reliable energy. The country also needs new energy grids to reach rural areas and other development infrastructure such as roads. It is also critical that there are mechanisms in place to ensure that energy generation is sustained by planning for future climatic changes that may jeopardize the generation of hydropower, wind or solar energy.

About 60% of electric energy that is generated in Kenya is from hydro-power dams in the major rivers. The country has been experiencing power shortages associated with the recurrent droughts. The risk of serious power shortages and resultant slowing down of economic growth will be even higher as droughts increase in frequency and intensity. KENGEN is the organization mandate to see the generation of electricity in Kenya. KENGEN has collaborated with KMD to apply use of climate knowledge especially for energy planning at seasonal and for long-term implementations in the hydroelectric power plants, climate information has also been useful in the planning of wind and solar energy plants. Unfortunately, lack of such datasets as wind and solar energy, create a challenge in application of such green sources of energy. However, the potential of application of satellite energy for such information is viable and available and this needs to be tested and applied. The application of green energy for climate mitigation and the need for planning of energy generation will continue to require climate information, especially on hydrological fluctuations, wind, and solar viability, and also on risk such as storm and lightening surges.

The main energy source in Malawi is primarily hydroelectric power from the Shire River. The hydroelectric power generation has been negatively affected by the droughts and floods. The water flow disruptions in rivers have been exacerbated by siltation caused by poor and unsustainable agricultural practices, deforestation, and noxious weeds, such as water hyacinth. And therefore through the climate information availability most of these problems can be tackled.

Energy planning and operations in Nigeria in general are markedly affected by meteorological events. Although this is certainly the case for renewable sources such as wind, solar and hydropower and for electrical distribution and transmission systems, the more traditional energy sources can also be severely impacted by extreme weather climate events. Thus, by properly taking into account weather and climate information, energy systems can considerably improve their resilience to weather extremes, climate variability and change. Climate services can also support increased development and use of renewable energy sources. In Nigeria, only the seasonal rainfall forecasts are provided to the sector. The expressed needs for the sector are the rainfall intensity forecast and the drought forecast. For oil and gas fields, NIMET supplying tailored forecasts to the oil and gas

industry in both terrestrial and offshore environment is assisting with risk management and daily operations. There are strong needs to benefit from forecast of the weather extreme events, and having correct risk estimation of dangerous phenomena.

The policy of fighting climate change in Tunisia is particularly emphasized in the energy sector. It is the case that, despite Tunisia's efforts to manage its energy over the past three decades, the energy system is today facing significant challenges:

- Energy supply security issues due to the growing energy balance deficit and the heavy reliance on conventional energy;
- Economic sustainability issues associated with fluctuations in global energy prices and their implications regarding the balance of payments and public finances.

To meet these challenges, the Tunisian authorities have decided, since 2013, to forge ahead with an energy transition process based on an unprecedented strengthening of the energy management agenda and its two pillars of energy efficiency and renewable energies. This transition agenda aims for a reduction in primary energy demand of 30 per cent by 2030 compared to the baseline scenario, and a penetration rate of 30 per cent for renewable energies in electricity production (Tunisia INDC, 2015).

Tunisia is stepping up its efforts to mitigate greenhouse gas emissions in several sectors. For instance, in the energy sector, there is a mitigation plan in place that aims to intensify the promotion of energy efficiency in all consumer sectors and for all energy usages. Around 20 energy efficiency actions have been included in the calculation of avoidable emissions, covering the entire industrial, building, transport and agricultural sectors. This should allow primary energy demand to decrease by some 30 per cent by 2030, compared to the baseline. The plan also advocates increasing the use of renewable energies, not least through the Tunisian Solar Plan (PST). This will raise the share of renewable energies in electricity production to 14 per cent in 2020 and to 30 per cent in 2030, whereas it stood at only 4 per cent in 2015. To achieve this, the plan will aim to achieve an installed renewable energy capacity of 3,815 MW in 2030, including 1,755 MW for wind power, 1,610 MW for solar photovoltaic (PV) and 450 MW for concentrated solar power (CSP). With regard to solar heating, Tunisia intends to triple the solar water heater distribution rate, which will exceed 220 m² of collectors per 1,000 inhabitants in 2030, compared to 73 in 2015.

In this sector, some of the international financial support should serve to bolster the Energy Transition Fund (FTE). This fund was established by the Tunisian State in 2014 as a central instrument for implementing its energy transition agenda. The Energy Transition Fund replaces the National Energy Management Fund (FNME), increasing its resources through a tax on energy consumption, diversifying its intervention strategies and extending the range of eligible actions. Finally, the international effort will also focus on the funding of capacity building and technology transfer programmes (Tunisia INDC, 2015).

4.4 Transport

Adverse and extreme weather events and climate change and variations can affect transport systems and have significant impacts on society. Adverse weather conditions such as storms, icing, high winds, and poor visibility have immediate effects on day-to-day operations, often disrupting large portions of a transportation network. Extreme weather events such as floods, droughts, hurricanes, and tornadoes also have immediate effects, disrupting transportation and creating large clean-up and rebuilding costs. Expected climate change and variations, such as increasing temperatures, a growing number of droughts and floods, more intense hurricanes and precipitation events, and rising sea level, have long-term impacts on all aspects of transportation. In order to develop appropriate planning, response, and adaptation strategies, it is important to have

information on how weather and climate trends affect the various modes of transportation. Some of the challenges of climate/weather on the transport sector include:

- Rising temperatures and extended heat-wave periods increasing the problems of rail buckling, pavement deterioration and thermal comfort for passengers in vehicles.
- Weather extremes generating floods or landslides leading to delays, interruptions and detouring needs.
- Sea-level rise threatening harbours and other transport infrastructure and services in coastal areas.
- Air transport challenged by changing wind patterns, flooding of airport infrastructure and other weather events.

The NIMET provides assistance to the aviation and marine industries through air traffic management and marine operation. It provides the aviation weather services and issues weather reports to contribute to safety improvement and efficiency of air navigation by assisting pilots with some tailored products like the Terminal Aerodrome Forecast (TAF), en-route and Destination Weather Forecasts & Trends; Briefing of Pilots and Airmen on expected weather at various points; Provision of route weather reports of points of departure, en-route and destination by radio transmission; Significant Weather Reports (SIGMET) which is a vital tool for flight routing during movement, etc. For marine operations, NIMET provides oceanographic information for marine users both at sea and along the coast. This makes the decision-making process during weather sentinel operations more efficient.

4.5 Water resources

Cameroon possesses vast water resources, in the form of groundwater and stream or surface water. In the well-watered southern region, which has metamorphic and igneous rocks, the resources are mostly surface water, while in the semi-arid less watered northern lowlands they are mostly groundwater, owing to the permeability of the sedimentary rocks. There are two major and two minor catchment areas. These two major ones are the Adamawa high plateau and the western highlands, which are collectively referred to as the Cameroon Volcanic Line. The volcanic watershed cuts across the country almost diagonally and provides the drainage divide between the two major river systems of Central and West Africa. Water is led out of this huge drainage divide through tectonic depressions such as the Mbo, Ndop and Tikar Plains and the Mbere graben (an usually elongated depression between geologic faults) through which flows the River Mbere, a tributary of the Logone. The two minor catchment areas are mainly feeders to major rivers radiating from the Adamawa high plateau and the western highlands. These are the Mandara Mountains in the Far North feeding the Chad and the Benue basins and the Guimbisi mountains to the east of Abong Mbang on the southern plateau, a radial type drainage pattern from which flow the headwaters of the rivers Ngoko and Nyong.

The major catchment areas as well as the river courses have been modified significantly. This modification has come from land use intensification and the construction of dams along river courses. Such transformations have disrupted the regular pattern of flow of most rivers in this part of the country and this has equally affected other human activities. The Western highlands and the Mandara Mountains have all been modified over time through land uses such as deforestation for various purposes, overgrazing, reforestation and urbanization. The impact of forest clearance on hydrological processes has been controversial. Whereas some argue that deforestation is likely to contribute to enhanced runoff and consequently stream discharge, others claim it would lead to a fall in discharge. Whatever the case, everything depends on the depth of rooting of the plants. In situations where deforestation entails cutting down of deep-rooted trees, discharge will be increased as this is followed by more runoff and reduced deep percolation of water channelled by the long roots. In the western highlands of Cameroon, massive deforestation on the Bamenda

highlands for agricultural purposes has contributed to increasing seasonality of streams. This is because forest clearance has reduced infiltration and consequently the recharge of groundwater. Delayed recharge of groundwater has widened the flow gap between low and high waters of streams. Closely linked to this is the element of grazing, especially in the cattle grazing area of the Adamawa which is the main watershed of Cameroon. Most water points for cattle have disappeared over the years and the streams have become highly seasonal because of increased evaporation. The trampling effect of grazing animals makes the soil less porous, and thus less able to absorb water, especially during rainy season (Lambi, 2001). This means that the groundwater does not get sufficiently recharged, and so there are fewer springs. A strong indication of this situation is the fact that most springs which have been observed flow erratically and are not permanent. Another factor affecting water is urbanization. The increased concentration of houses and paved surfaces in urban centers, such as Bamenda, Kumbo and Nkambe in the Western highlands, Ngaoundere, Banyo and Meiganga in the Adamawa, and Mokolo on the Mandara mountains, has contributed to the canalization of water into well-defined channels. This has reduced the recharging ability of groundwater, especially with the onset of the early rains, resulting in pronounced seasonality in the flow regimes of rivers.

Kenya is generally categorized as “water scarce country”. Information needs for water sector involve water planning for industrial and domestic use including surface and underground water, and also issues that relate to drought and floods risk management. Drought affect water availability within the country, and many urban areas in the country are already facing water shortage, with Increasing urbanization of semiarid and dry lands, there is serious competition for the available water. Kenya has already made many efforts in the development of integrated water resource management, with information on flood and drought early warning being provided by KMD. WRMA, working with KMD and other stakeholders they generate water supply information, especially for key water areas such as urban water and hydropower generation. However there is still a limitation in the use of tools that enable real-time monitoring of basing flow and provision of decision-making tools that are accessible to some local users. The supply of the information required for Integrated Water Resource Management (IWRM) implementation in parts of the country is a major challenge owing to poorly developed and/or the deteriorating state of climate services. (World Water Council, 2003; Kadi et al., 2006; Adeaga, 2007; ClimDev-Africa, 2013) many decisions ranging from policies to design of infrastructure are based on unreliable information which can result in the unsustainable management of water resources.

Improving water management through the use of climate services will require identifying relevant climate services which include climate predictions products, seasonal climate, outlooks, downscaling products at various levels and different downscaling methodologies. Flood risk assessment requires information of peak flood flows for infrastructure design and floodplain mapping as well as flood forecasting and warning services. Climate information needs to be combined with vulnerability data for many applications. For drought risk management there are similar requirements for design and operational climate services. For water resources management climate and hydrological data are required to estimate resource potential, sustainable yields and allocation of resources through licensing or permitting at the catchment scale. Application of climate information for IWRM will require: a stronger enabling environment to support capacity building and international, regional and national collaboration in water management; building national capacity in national hydro-meteorological services from data observation and retrieval through application of necessary tools that allows easy access of information by users; improving the hydro-meteorological monitoring network and data management and improving the collection and exchange of climate data including IT infrastructure to support remote access to data; Enhancing application of satellite observation data and application of modern technology.

In Nigeria, water resources management, there is a dedicated agency responsible for providing flood forecasting services (Drought and Flood Bulletin) which includes flood warning and advisories to help meet the comprehensive need to protect life and property. As mentioned earlier, there is a need to invest in more equipment and river observation systems.

With some 385 m³ of renewable blue water resources available per year and per capita, Tunisia is already experiencing water scarcity (Verner Dorte, 2013). This situation is due to be exacerbated by climate change over the coming years, with the decrease in conventional water resources estimated at about 28 per cent by 2030 (Verner Dorte, 2013). The decline in surface waters would be approaching 5 per cent by the same year. Furthermore, following the expected rise in the sea level, losses through the salinization of coastal aquifers due to this rise in sea level would account for about 50 per cent of the current resources of these aquifers by 2030, amounting to almost 150 million m³.

4.6 Tourism

Even though most tourism demand studies focus on economic variables (Crouch, 1994; Lim et al., 2008), climate has been identified as a key driver for tourism and an important destination attribute (Hu & Ritchie, 1992). Climate is either the main tourism resource, for example in the case of beach destinations (Kozak et al., 2008), or it acts as a facilitator that makes tourism activities possible and enjoyable (Gómez Martín, 2005). The importance of climatic attributes for tourist destinations is reflected in advertising materials (Gómez Martín, 2005) as well as destination image construction (Pike, 2002). Studies show that besides destination choice, climate is also an important factor for the timing of travel (Lohmann and Kaim, 1999; Hamilton and Lau, 2005). Seasonality has been described as one of the main challenges of tourism's viability. Tourism's seasonality is not only driven by climatic conditions at the destination and tourists' home countries, but also by institutional factors such as school holidays (Butler, 2001). There has been a longstanding desire to capture or assess the climatic suitability of a potential or existing tourist destination. Factors that seem to be important include climatic elements such as temperature, wind chill effects, humidity and radiation. Other measures, such as wind speed or snow depth may also be important for specific recreational activities. The climatic parameters can be aggregated to a single index that gives some indication of a place's suitability for specific touristic activities.

Given the importance of climate to tourists in their decision making as well as holiday experience one would expect that tourists actively seek climatic information. Indeed, Hamilton and Lau's (2005) study found that 73% of interviewed German tourists had acquired information on the climate of their holiday destinations, usually on more than one aspect, but most often temperature. As Scott and Lemieux (2009) note climate information is available by many types of providers and media, for example travel agents, tourism marketing organisations, guide books, the internet, television, radio, newspapers, and hand-held devices. In a summary paper for the World Meteorological Organisation, Scott and Lemieux (2009) comment that tourism marketing materials and web sites provide limited climate information to potential travellers, with the most common practice being to provide only average monthly temperatures. Average conditions, however, are possibly of limited value to tourists who are more likely to be interested in the probability of experiencing certain (extreme) conditions such as hot temperatures or sunshine hours during specific periods of the year (de Freitas, 2005). Such kind of specific information would be particularly valuable in areas where weather could pose a real health or safety risk for tourists, for example in alpine areas, hot destinations or tropical zones. Different types of information are required at different stages of the trip planning process. There is no research done in Cameroon to support or dispute the above.

Tourism in Tunisia essentially revolves around its image as a beach and seaside resort, which means that it is particularly sensitive to the summer climate, rising sea levels and coastal erosion. The rise in

temperature will make the heat in summer more severe, affecting humans' climate comfort and making heatwaves unbearable for the human body. The water stress already experienced by Tunisia will intensify, which will have repercussions on tourist facilities in terms of operating costs and health and safety. Concerning coastal erosion, the annual losses to the tourist sector resulting from the retreat of the beaches due to the rising sea level are estimated at around 5 per cent of the sector's added value.

The main measures planned in the area of tourism can essentially be summarized as:

- Restoration of the Tunisian touristic sea coast and protection of tourist areas against the advance of the sea,
- Definition of climatic and touristic regions and adaptation of the division of eco-touristic circuits,
- Development of a range of services that are at once alternative and complementary to seaside tourism, particularly in terms of health, culture, sport and environment.
- Launch and promotion of the concept of ecological hotels,
- Optimization of the management of water resources by the tourist sector and installation of mini seawater desalination plants using renewable energies.

4.7 Environment and Natural Resources

Cameroon is a country blessed with natural resources but it is heavily dependent on revenues generated from oil, timber, and agricultural products which could undermine sustainable growth in future if alternative economic activities are not sought. The country also has other unexploited mineral resources such as bauxite, natural gas, iron and cobalt. Climate change affects Cameroon's development because of its consequences which will change the fate of many generations to come and particularly its impact on the poor if no appropriate measures are taken. The adverse effects of climatic change to which Cameroon is exposed to are already exerting considerable stress on important sectors from which revenue for development is generated such as agriculture and exploitation of natural resources. This poses a serious threat to national development and poverty reduction.

The climate of Cameroon has been heavily variable over the last several decades often with very high amplitudes. Climatic factors in Cameroon already limit the availability of freshwaters which causes decreased crop yields, land degradation, poor economic growth, and large social problems such as the spread of diseases. To overcome these climate change challenges, unprecedented efforts are needed based on insights in natural, social, economic, political, and health sciences. The support of decision-making processes based on a thorough understanding of all related processes is mandatory to overcome this pressing problem.

Cameroon is 5th among the richest African countries in terms of biodiversity. The country's forests host 40% of African animal species representing 48% of mammals, at least 54% of bird species, 50% of the continent's known amphibians, 30%-75% of reptiles, 42% of identified African butterflies, and at least 21% of its fishery resources. Cameroon has two main types of climate: the equatorial and tropical climate which is influenced by altitude and the monsoon winds. Cameroon also exhibits all major climates of the African continent popularly known as "Africa in miniature".

Being the single most important water catchment in Malawi, the Shire Basin (inclusive of Lake Malawi) is a natural asset of national importance. Through a range of ecological services the Shire Basin supports key economic sectors in Malawi and further downstream, including food production, transport, energy, tourism, agriculture, fisheries and industries. In order to maintain the vital role of the Shire Basin in contributing to the health and prosperity of Malawi, the Government of Malawi and cooperating partners decided to develop a long-term Environment and Natural Resources

Management Action Plan (ENRMAP) which provides a sustainable solution to managing the basin and upper catchments. LTS prepared a comprehensive ENRMAP for the Malombe East and Malombe West catchments based on an integrated ecosystem services approach that considered the social, economic, and environmental dimensions of land use and resource management problems in the Upper Shire with the primary objective of identifying and prioritising specific interventions to promote more sustainable land use practices.

Weather and climate influences our environment every day, every season, every year. One extreme weather event can affect wildlife or habitats for many years. In Nigeria, seasonal rainfall prediction, flood and drought information are produced for environmental and natural resources managers at all time scale but the gaps to fill are in the area of rainfall intensity and drought forecast.

Concerning ecosystems, as well as water resources, the major effects may be observed in forests and pastoral ecosystems. As temperatures and the inflammability of the biomass rise in Tunisia, the risk of large forest and bush fires also increases. It is estimated that 180,000 hectares of forest will have been lost by 2030. In the north of the country, such a risk will have an impact on the availability of water resources, and on the population and its heritage. The steppe ecosystems of the centre and south of the country will see their pastoral functions decline in central Tunisia, and even cease in the south. The herds will fall back to the rough grazing areas in the north, burdening these further and thereby increasing the extent of overgrazing. In the event of climate change, if no action is taken to improve the production of rough grazing areas, the contribution of steppe ecosystems is likely to have ceased by 2050.

A number of measures are planned for adapting ecosystems, which may be summarized as follows:

- Rehabilitation of forest nurseries and the expansion of indigenous and multi-use species,
- Holistic management of cork oak forests in zones at high risk of fire in the north-west of the country,
- Management of the degraded rough grazing and esparto areas in the central and southern regions, - Conservation of the ecological functions of low-lying coastal areas,
- Integrated rural development of vulnerable drainage basins, sub-drainage basins and flood control,
- Biological consolidation of work to combat silting in the south of Tunisia and support the implementation of regional action plans to counter desertification.

Table 2 below provides a summary of the climate information needs in various sectors for the 5 target countries.

Table 2: Summary of Sector based Climate Information needs and services for the 5 countries

	Sector	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
		Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
a)	Agriculture and food security	<ul style="list-style-type: none"> -Climate information services not widely used to inform planning in agriculture -Low capacity of extension agents to interpret and provide useful information to the farmers -Early warning systems are not well developed or equipped -No disaster prevention measure in climate disaster prone areas 	<ul style="list-style-type: none"> -need for capacity building and training on collection, recording and interpretation of climate information -Need to modernize the climate information collection systems and infrastructure -Need of disaster prevention strategy in cultivated areas prone to climatic disaster 	<ul style="list-style-type: none"> Provision of climate information for agriculture including onset, cessation rainfall distribution, produced at seasonal and update on 10 day basis Kenya Food Security Committee and the technical component of Kenya Food Security The sector with most stakeholders concern 	<ul style="list-style-type: none"> Integrated information for agro-climatic information provision Not all crops and regions are served 	<ul style="list-style-type: none"> -Most of the departments in this ministry use seasonal rainfall only to focus on coming season and not projections. 	<ul style="list-style-type: none"> Climate change knowledge (science, impacts and response) GHG inventory, including soil carbon stock Adaptation technologies (Climate Smart Agriculture - CSA) Crop weather insurance Crop Models for V&A studies e.g. Maize Model, Ceres Model.- Economic Models 	<ul style="list-style-type: none"> Seasonal Rainfall Prediction, onset prediction, Dry spell forecast 	<ul style="list-style-type: none"> Rainfall intensity forecast, Drought forecast Crop Yield Forecast 	<ul style="list-style-type: none"> -Availability of a variety of products available: Weather bulletins for agriculture (regular): - Agrometeorological ten-day bulletin (with 26 raw and synthesized parameters: evaporation, humidity, cumulative rainfall, sum of temperatures, PET, etc.). -Ten-day rainfall bulletin (10-day, monthly, annual cumulations of rainfall recorded in 42 stations, number of rainy days, monthly normal, etc.). -Daily agrometeorological bulletin (covering 26 cities). -Special weather report, on request. -Meteorological data (according to demand) 	<ul style="list-style-type: none"> -More advanced equipment -Better control and involvement of information and communication technologies for access to localized climate information (areas of early warning and agri-consulting). - Production levels/yields for Indicator crops. - Main food supply chains, models of how they operate, and how they will be affected by climate change. - Imports and exports of key crops as well as food storage. - Operation of safety nets. -Better involvement and mobilization of civil society
b)	Health	Heath Ministry	-Low capacity to use	Awareness of the	Information on	Climate change	Climate change	Drought/	Livestock	-Insufficient data.	-Occurrence

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Sector	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
		largely does not use climate information for planning or mitigation of potential health hazards	climate and weather information to make informed decisions -Capacity building and awareness of health officials on the usefulness of climate information	association climate and vector related diseases such as malaria and also on water related diseases such as diarrhoea	temperature related heat stress are not available, i.e. no platform for regular update for health risk Much of the information are limited to the national scale and at seasonal level or at a local scope Identify local climate risk for related to health	resulted in infant malnutrition and chronic ailments.	knowledge (science, impacts and response) Adaptation technologies Health related Models for V&A studies	Flood bulletin, Seasonal rainfall forecast	comfort index Pest and disease, impact of the seasonal climate forecast on health 'human and animal), Temperature Forecast	-Insufficient linking of climate and health data. -Lack of data information systems for monitoring climate and health trends. -Inadequate tracking of vulnerable groups.	and magnitude of climate change-related health outcomes, linking those to environmental and meteorological indicators.
c)	Energy	Low or no utilization of climate information services to inform decision making and planning	-Low capacity to use climate and weather information to make informed decisions -Capacity building of energy operators in usage of climate information in planning and decision making	-Awareness of the impact of climate variability on energy generation Seasonal and continual monthly contingency planning for river flow and dams for energy production is available Long-term assessment of energy potential is available but limited especially looking at green energy sources such as wind, and solar -Limited knowledge of energy consumption	-Information on alternative green energy potential such as solar radiation potential Wind energy potential -Improve monitoring and research of climate aspects for application of green energy sources -Technical capacity for assessment of energy audits and variation with climate change especially for cooling days and warming days	-River Shire act as the source of the hydroelectric power for the country	Climate change knowledge (science, impacts and response) GHG inventory Energy Models for V&A studies e.g. LEAP & MESSAGE models Clean Development Mechanism	Seasonal Rainfall Prediction - Supplying tailored forecasts to the oil and gas industry in both terrestrial and offshore environment assisting with risk management and daily operations.	Rainfall intensity forecast, Drought forecast	-Weather report for energy (regular) Quantitative forecast for 13 weather stations concerning. considered parameters: -The minimum temperature expected for the next 24 hours (09:00 to 09:00). -The maximum temperature expected for the current day. -The maximum temperature for the next day. -State of the sky expressed in octats for the current day. -Maximum wind (Maximum strength and	-Gaps in access and / or use of climate information on energy. -Detailed information / data on the impacts of climate change in the energy sector. -Dynamism of mitigation implementation strategies in energy policy. -Development of renewable energies -International financing opportunities to seize for the revitalization of renewable energy development

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Sector	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
										direction of wind, from 09:00 to 09:00. -Special weather report (on request)	strategies.
d)	Transport	Low or no utilization of climate information services to inform decision making and planning -Climate information mainly used for air transport	-Low capacity to use climate and weather information to make informed decisions - Capacity building and creation of awareness of the stakeholders.	-Provision of aviation meteorology by KMD Early warning of floods also provided but at a larger scale -Lack of real-time access to traffic information especially on risk or usability of roads -Limited climate information for lake transport	-Need for localised flood early warning especially for road transport -Need for tools of informing on local flood risk and state of traffic especially during bad weather -Provide and improve information for safety for lake transport in the country -Need to strengthen use of climate information in planning especially for roads, buildings and rails, drainage etc	-Climate information mainly used for air transport	Climate change knowledge (science, impacts and response) Adaptation technologies Infrastructure Models for V&A studies	Aviation Terminal Aerodome, En-route and Destination Weather Forecasts & Trends; Briefing of Pilots & Airmen on expected weather at various points Provision of rout the clock weather report of points of departure, en-route and destination by radio transmission. Significant Weather Reports– Vital tool for flight routing during movement, etc. Marine met Forecast	-Modernisation of the existing infrastructures -Building more synoptic weather stations	-Products and services to the aeronautical sector are provided according to international standards and norms. -Meteorological assistance continuously supplied to the country's airports. Aircrews are provided with the necessary documentation and all required meteorological information (flight file with aviation meteorology maps and messages: TEMSI, charts of wind and temperature in altitude, METAR messages, SPECI, TAF of departure, destination, and alternative airports, and SIGMET messages of observation of	-More advanced and modern equipment -Capacity building

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Sector	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
								oceanographic information		or forecast about meteorological phenomena that could affect the safety of the aircraft).	
e)	Water resources	-Low or no utilization of climate information services to inform decision making and planning	-Low capacity to use climate and weather information to make informed decisions -Capacity building and creation of awareness of the stakeholders. -finalize the national IWRM planning process and to ensure integration of early warning systems for water related disasters in the national water policy document.	-Information on river discharge, ground water mapping, Reservoir monitoring for urban water supply is available. Seasonal contingency planning based on seasonal forecast Modelling of water is limited -Limited information on future water needs especially with current urbanization of arid lands	-Some stations have data gaps due to lack of volunteer observers -Information on ground water availability and recharge is not comprehensive Increase capacity for water modelling, and integrated water information service Limited platform for access of water resource information, weakness in enforcement of water regulations -Lack of platform for access of information on potential for rain water harvesting for adaptation	Increasing droughts and floods seriously disrupt water availability	Climate change knowledge (science, impacts and response) Adaptation technologies Water Balance Models for V&A studies, e.g., WatBal, WEAP models	Drought and Flood Bulletin	More equipments and rivers observation systems		
f)	Tourism	Minimal utilization of climate information to advise Tourists on the best periods to visit certain attraction sites	-Need to incorporate climate information of specific touristic sites during site advertisement	Climate information is not adequately used in the tourism sector although weather is a critical component in deciding where and when to visit the various sites -Provision of public weather on daily to weekly timescales	-Need to package the relevant climate information to be useful for this sector. -Need for effective means of access to climate information especially through use of modern ICT tools					-Meteorological bulletin for regular tourism (on Tunisia and other foreign cities): parameters considered: dominant phenomenon, air temperature, the temperature of the sea water (on	-Better involvement / contribution of community radios (urban and rural) in access to localized climate information for awareness and early warning. -Revitalization

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Sector	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
				-KMD works with KWS in the application of climate information for species balance and community access to wildlife reserves -Knowledge of climate influend on forest fire risk by KMS however there is limited awareness for the public due to lack of appropriate communication especially in fire risk seasons						the coast), the wind (direction and strength), and Special observations. -Special weather report (on request): meteorological assistance to an event (evening, competition, outing, event, etc.).	of digital solutions strategies for smartphones and social networks.
g)	Environment and Natural Resources	Low utilization of climate information services to inform decision making and planning	-Low capacity to use climate and weather information to make informed decisions -Capacity building and creation of awareness -More research on local climatic effects on natural resources -enhance of research on management options that monitor climate change	Recognition of the risk of climate related disasters Establishment of multiagency framework for coordination of disaster management. KMD in the process of implementation of CAP although challenges is in the translation of information and dissemination especially	Need for decision support tools for ease of collaboration of participating agencies Improve on the dissemination of CIS early warning especially using modern ICT technology	Malawi faces more pressure on its land resources now than before.	Management of CDM and REDD+ projects Procedures for measuring carbon stocks in forest stands	Seasonal Rainfall Prediction, Flood /Drought	Rainfall intensity forecast, Drought forecast		-an integrated management approach to agroecosystems and associated natural resources, particularly water and soils will be required. There will also be a need for diversification of production systems, providing communities with alternative income sources.

5. LEGISLATION/POLICIES ON CLIMATE INFORMATION AND SERVICES

5.1 Cameroon

Faced with convincing evidence on the reality of climate change in Cameroon and its devastating effects on the environment, national economy and livelihood of the average Cameroonian, the government of Cameroon has taken measures at the institutional and policy level to address environmental degradation and Climate Change.

Environmental Policy

Between the years 1960 to 1992, forest conservation and wildlife protection had not yet gained importance in Cameroon. The forest was managed by the Ministry of Agriculture (MINAGRI), and wildlife was managed by a special department in the Ministry of Tourism.

In 1987, under the Structural Adjustment Program, forestry was given more consideration as a priority area. The year 1992 marked a turning point in Environmental Policy in Cameroon after the United Nations Conference on Climate Change in Rio de Janeiro (Brazil) in 1992. After the Rio conference, Cameroon created the Ministry of Environment and Forestry which became two separate ministerial departments in 2004: The Ministry of Forestry and Wildlife and the Ministry of Environment and the Protection of Nature. In 1993, a new Forest Policy was passed and in 1994, Cameroon adopted a new Forest Code and a law on forest, wildlife and fishery regulation. An Environmental Code was published in 1996 including an outline law voted on the political and strategic framework on the environment, conservation and sustainable development (Cameroon RIO+10 Assessment, 2002).

In 1999, Cameroon organised the first Central African Head of States Summit on the Sustainable Management of Dense and Humid Forest Ecosystems in Central Africa. Today the forestry sector in Cameroon has been restructured to include a regulatory board during the award of deeds, transparency through the introduction of three levels of independent observers, the development of a zoning plan- the first case in the sub-region, progress towards forest certification, limitations to forest resources by neighbouring populations, community forest and hunting zones run by communities (Ministry of Environment and Nature Protection [MINEP], 2012). Cameroon has equally engaged in regional agreements between countries in the Sub-Saharan region and the Congo Basin Eco region

- The Commission for the Forests of Central Africa (COMIFAC)
- The Congo Basin Forest Partnership (CBFP)
- The Lake Chad Basin Commission (CBLT)
- The Conservation and Rational use of Central Africa Forest Ecosystems (ECOFAC)
- The Niger Basin Authority (ABN).

As well, bilateral arrangements with developed countries collaboration on technical assistance and strategy elaboration and implementation that help in pushing policy, conservation, Climate Change adaptation and mitigation such as REDD and National Adaptation Plan of Action (NAPA).

Agreements also exist with The World Bank, European Union, Japan, and the Common Wealth etc, International organizations like GIZ, International Union for Conservation of Nature (IUCN), the Food and Agricultural Organization (FAO), the World Health Organization (WHO), the African Timber Organization (ATO), the African Development Bank (ADB), the World Wide Fund for Nature (WWF).

Cameroon submitted its First National Communication in 2005, under the direction of the Ministry of Environment and Forests. The Government of Cameroon is establishing a countrywide approach to adaptation that would particularly test adaptation measures in the different eco-zones, taking a poverty reduction focus and integrating gender-sensitive approaches. The government has also

established a body called the Cellule Nationale des Changements Chmatiques, CCPNCC (cell coordinating the National program on change climate) is headed by the Focal Point, which is mandated to:

- Create an inventory of national greenhouse gas emissions and adaptation measures,
- Put into place an information system and database on climate change, and to establish an online home for information to ensure accessibility and dissemination;
- Design sectorial projects addressing priority actions for climate change prevention, mitigation and adaptation; and,
- Evaluate the impacts and policies associated with adaptation and mitigation (Cameroon Ministry of Environment and Forests [CMEF], 2005).

Climate change adaptation and mitigation considerations have also been integrated into the country's National Plan for Environmental Management (Plan National de Gestion de l'Environnement PNGE). With Cameroon's high vulnerability to sea level rise, coastal adaptation strategy will be included under the plan (CMEF, 2005).

National Policies on climate change

National agriculture sector policies and strategic documents: Agriculture sector policies which are formulated by MINADER aim at enhancing agricultural productivity by increasing cultivable areas, irrespective of whether or not these affect climate change. Climate change adaptation and mitigation considerations have been integrated into the country's National Environmental Management Plan which aims at drastically reducing GHG emissions, and which has identified coastal zone management for fisheries, mangrove and coral reef protection as a major component. The Government of Cameroon has also established a regional Climate Change Observatory (ONACC), an institutional home for climate change-related research and information for the sub-region (CMEF, 2005), and has plans to establish a country-wide multi-sectorial approach to adaptation, including agricultural adaptation, in the different agro-ecological zones, taking a poverty reduction focus and integrating gender-sensitive approaches (Mbua et al., n.d).

The Government of Cameroon has been active in integrating climate change into national environmental strategies (such as the National Plan for Environmental Management) and formulating a country-wide approach to adaptation (Crawford et al., 2011). It has also submitted its Initial National Communication to the UNFCCC.

The Forest Law of 1994

Cameroon aims to "develop the total area of permanent forests to at least 30% of the national territory and represent the national ecological diversity" (article 22 of the 1994 Forest Law). Cameroon is concerned about both land tenure and forest tenure. The latter includes all forest ownership rights and thus covers forest spaces and resources. These rights define the legal and customary relationship of the people with the forest (Governance Forest Initiative [GFI], 2009). It is difficult to dissociate forest tenure from land tenure because of the legal principle that establishes that ownership of the land overrides ownership of what is on the land (article 552 Cameroonian Civil Code). Five categories of law can be applied to forestlands: land ownership, customary-user rights, environmental protection, self-defence connected to certain conservation rights, and forest-products exploitation rights (Bomba, 2004). In principle, and according to the ordinance of 6 July 1974 defining the conditions of access to land ownership and setting out the modalities for the application of the land tenure regime in Cameroon, the forests are owned by the State, the communes, the customary communities and individuals (article 7 of the 1994 Forest Law). Also, in principle, all unregistered land belongs to the State but local populations can request that they be allocated as private property if they can prove that the land in question was being developed before 5 August 1974. Failing such proof, a concession awarding procedure is applied.

Considering the present condition of the Cameroonian legal system, it is difficult to explain how one can have access to the land, but not to the forests on the land. But the State is always the legal owner of the community forests (Penelon, 1995); they are not owned by the village communities, for whom they have been created. The community forests are part of the national domain, and the local populations have rights based on participatory and beneficial forest management decisions (Bigombe Logo, 2007). The main recognized user right is the right to cut timber for home use. Little attention is given to other land uses such as agriculture. Despite the aforementioned rights, there is a risk of expropriation (article 8(3) of the 1994 Forest Law) for purposes of exploitation or conservation, under conditions that have not been unanimously approved (Bomba, 2004; Bigombe Logo, 2007).

Climate and Forest policy

Cameroon's official position has not yet been set out in legal documents, other than its international commitments. Cameroon is participating in the negotiations on the UNFCCC, which it signed on 16 June 1992 and ratified on 29 August 1994, and the Kyoto Protocol, which it joined on 23 July 2003. Several national legal instruments have been developed in connection to these conventions. Until 2011, the 2005 Initial National Communication (INC) was the only source of information on climate change in Cameroon. Under the INC, discussions were often held on GHG reduction mechanisms such as the Clean Development Mechanism (CDM). Decree 2011/2582/PM of 23 August 2011 to lay down rules for the protection of the atmosphere was Cameroon's first legal document specifically devoted to air. Although it does not refer to climate change per se, it identifies a certain number of air pollutants that it says are "under control," including CO₂ (article 4). The decree subjects the use of "all new sources of air-polluting emissions" to an environmental permit [article 8(1)] whose terms and conditions are spelled out by the minister in charge of the environment [article 8(2)], and specifies that the following activities, inter alia, shall be subject to a permit: "forest exploitation and wood preparation," the "sawmills" and the "wood preservation industries" (annex to the decree). Since there is no application decree, this legal document has not yet entered into force, and thus the fight against climate change still falls under the 1996 framework law on environmental protection and other sectoral documents.

In the document on Cameroon's vision for 2035, the government recognizes a certain number of risks to the country's natural resources, especially the risk of overexploitation (Ministry of the Economy, Planning and Regional Development [MINEPAT], 2009). The related working document says: "Cameroon should develop appropriate strategies for coping with other threats such as deforestation, loss of biodiversity..." (MINEPAT, 2009). Similarly, points 119 and 206 of the Growth and Employment Strategy Document (DSCE) on the assets of the country and on natural resources management states that Cameroonian forests must be managed in a sustainable manner. Research has produced national figures that do not reflect this position. The amount of timber removed by the informal sector is equivalent to, or even greater than the amount that is removed legally (Cerutti and Tacconi, 2006). Hence any short- or medium-term development strategy that neglects the informal sector may jeopardize the fulfilment of conservation and sustainable exploitation goals. Similarly, since the decree of 23 August 2011 on the protection of the air has not been applied, it is debatable whether it contributes to the fight against climate change. Last, as concerns forest management, it is important to discuss the procedure for obtaining access to land ownership and to clarify the question of the ownership of planted trees in order to stimulate initiatives in private forestry and agroforestry. Such initiatives could contribute to the fight against climate change.

In the Cameroonian position paper on climate negotiations, "Cameroon proposes that:

- the Reduce Emissions from Deforestation and forest Degradation (REDD) projects be prefunded;
- REDD be applied in the arid zones;

- indigenous knowledge be taken into account, optimized and promoted under the REDD mechanism;
- REDD be adapted to meet the problems of community forestry, and
- the carbon evaluation capacity be developed as part of REDD” (MINEP 2009)

The National Observatory on Climate Change (ONACC) was created by a decree of 10 December 2009, to fulfil a promise that the President of the Republic made in his speech before the 62nd United Nations General Assembly in New York on 26 September 2007. The purpose of the Observatory was to monitor and evaluate socioeconomic and environmental impacts, to take measures for the prevention of, the mitigation of and/or the adaptation to the harmful effects and the risks connected to climate change.

5.2 Kenya

Kenya has made strides in acknowledging the importance of climate information for development. In the current available Government of Kenya policies, plans, strategies and initiatives that provide a supportive framework for implementing information system, the need of climate information is well established. However, there is still not a framework or policy that unifies climate information especially to allow for managed production and access. Some of the policies and laws include:

The Constitution of Kenya (2010)

The Constitution provides ground for the formulation of adaptation and mitigation legislation, policies and strategies by guaranteeing the right to a clean and healthy environment under the Bill of Rights and also offers the opportunity for services to be moved closer to the citizens at the county and sub-county (constituency) or community/grassroots levels. This opportunity, in turn, calls for a concerted effort by KMD to strengthen its infrastructure and services to reach and have the desired influence upon the community or grassroots level of society, where the most severe impacts of climate variability and climate change are realized.

Vision 2030

Vision 2030, the national development blue print encapsulates flagship programmes and projects with aspects of adaptation and mitigation. This include: provides for transport solutions that have relevance to climate change mitigation, and recognition of development through improvement of climate sensitive sectors.

The National Policy for the Sustainable Development of Northern Kenya and other Arid Lands

This policy focuses on climate resilience requiring Government to find solutions to address climate challenges and to come up with measures to manage drought and strengthen livelihoods. The policy also focuses on an enabling environment for accelerated investments in “foundations” to reduce poverty and build resilience and growth. The establishment of the National Drought Management Authority (NDMA), the National Disaster Contingency Fund and the Council for Pastoralists education are provided for in the policy.

The National Disaster Management Policy, 2012

The policy institutionalizes disaster management and mainstreams disaster risk reduction in the country’s development initiatives. The policy aims to increase and sustain resilience of vulnerable communities to hazards. It also recognizes the impact of climate hazard and the need for building resilience through climate information.

Climate change Act, 2016

Provides for legal framework for coordination and implementation of climate change issues including public participation

National climate change response strategy (NCCRS) 2010 and the National Climate Change Action Plan (NCCAP) 2013-2017

Promotes the development of adaptation plans which contribute to development of climate information sharing and knowledge management systems; strengthen collaboration between MoA, KMD and others; and enhance capacity for agro-meteorological information provision and ensure effective service delivery mechanisms including climate smart extension.

Environmental Management and Coordination Act (EMCA, 1999)

The Act is the principle instrument of Government for the management of the environment and provides for the relevant institutional framework for the coordination of environment management including the establishment of the National Environment Management Authority (NEMA) which is the Designated National Authority (DNA) for Clean Development Mechanism (CDM) and the National Implementing Entity (NIE) for the Adaptation Fund.

Water Act, 2002

The EMCA 1999 and the Water Act of 2002 provide the overall governance of the Water Sector. The regulations and strategies following on from this Act, recognizes the climate change implications on health, sanitation and water.

The Energy Policy and Act

Kenya's energy policy of 2004 encourages implementation of indigenous renewable energy sources to enhance the country's electricity supply capacity. The policy is implemented through the Energy Act of 2006, which provides for mitigation of climate change, through energy efficiency and promotion of renewable energy.

The Agricultural Sector Development Strategy 2010-2020

This is the overall national policy document for the agricultural sector. The strategy promotes sustainable food production and agroforestry. There are also broad implications for the forestry sector that are detailed in one of the six sub-sectors of the agriculture sector.

The Kenya Forestry Master Plan 1995-2020

Provides for an overarching framework for forestry development in the country for the 25 year period up to 2020 and was the blue print for reforms in the sector, including the Forest Act of 2005 and Forest Policy of 2007. It recognizes the environmental role of forests including water values, biodiversity values, climate change values through carbon sequestration and other environmental services.

5.3 Malawi

Malawi signed and ratified the UNFCCC in 1992 and 1994 respectively. Since then the country has implemented a number of activities that bear testimony to its commitment to the objectives of the UNFCCC as spelt out in Article 2. These include: producing the V&A Assessment Report in 1997 with funding from the US Country Studies Programme (USCSP); signing the Kyoto Protocol in December 1997; publishing the Initial and Second National Communication to UNFCCC in 2002 and 2011 respectively; developing the NAPA in 2006; and producing the State of the Environment and Outlook Report for Malawi 2010. Implementation of some of the activities highlighted above involved human and institutional capacity building. (https://www.unclearn.org/sites/default/files/sg4_24_national_climate_change_learning_strategy_of_the_republi_of_malawi.pdf)

5.4 Nigeria

The Nigerian Meteorological Agency was established for related matters by ACT 2003 No. 9. of the 19th June, 2003. Also an Agency Governing Board consist of a part-time chairman; one representative of the Federal Ministry of Aviation; one representative of the Federal Ministry of Agriculture and Rural; one representative of the Federal Ministry of Transport; one representative of the Federal Ministry of Water Resources; one representative of the Federal Ministry of Environment; two other persons to represent public interest and who shall be persons and the Director-General of the Agency.

The Agency:

- advises the Federal Government on all aspects of meteorology;
- projects, prepares and interprets Government policy in the field of meteorology;
- issues weather forecasts for the safe operation of aircrafts, ocean going vessels and oil rigs;
- promotes the services of meteorology in agricultural, drought and desertification activities;
- provides meteorological services in operational hydrology and water resources activities;
- provides weather services in marine, environmental pollution and biometeorology for climatic and human health activities;
- is subject to regulation by the Nigerian Communications Commission, provides and operates telecommunications systems for meteorological purposes only;
- proffers advice to the Federal and State Government on seismological activities;
- collects, processes and disseminates all meteorological data and information within and outside Nigeria;
- keeps in safe custody all meteorological records in the National Meteorological Archive;
- ensures uniform standards of observation of all meteorological phenomena in Nigeria;
- ensures that international standards and practices in meteorological operations are maintained;
- trains, conducts and undertakes research particularly in the field of tropical, agricultural, hydro and marine meteorology and other related areas of meteorology;
- provides consultancy services to the public on meteorology;
- monitors meteorological components of environmental pollution and ozone concentration;
- calibrates, develops and fabricates meteorological conventional equipment for export and internal use;
- is the sole authority that approves and establishes meteorological stations for meteorological observations; and
- carries out other activities as are necessary and expedient for the full discharge of any of its functions under or pursuant to this Act.

Without prejudice, the Agency prescribes the climatic requirements for all sectoral activities including aviation, defense, finance, agriculture, construction works, environment, industries, marine, natural disaster and relief management, water resources, power and steel, transport, science and technology.

There is an established fund for the Agency into which shall be paid and credited:

- all subventions and budgetary allocations from the Federal Government;
- gifts, loans, grants-in-aid from national, bilateral and multilateral agencies;
- fines payable for violation of meteorological regulations;
- returns on investments made by the Agency;
- 10 percent of landing charges from the Federal Airport Authority of Nigeria;
- 10 percent of en-route and over flight charges from the Nigerian Airspace Management Agency;
- 10 percent of the 5 percent sales tax surcharged on tickets by the Nigerian Civil Aviation Authority;
- fees, charges and funds, approved by the Board in respect of services provided by the Agency in the following

- rendering of climatic information;
- provisions of agricultural, marine and aeronautical meteorological services;
- exhibition and sale of meteorological equipment;
- production and sale of books, pamphlets, bulletins, etc., on meteorological services;
- provision of consultancy services on meteorology;
- rents and fees received from the use of properties owned by the Agency; and
- such moneys as may be received by the Agency in the course of its operations or in relation to the exercise by the Agency of any of its functions under this Act.

The Agency is exempted from the payment of income tax on any income accruing from investments made by the Board for the Agency or otherwise howsoever. The provisions of any enactment relating to the taxation of companies or trust funds do not apply to the Agency or the Board. It is a Federal Government agency charged with the responsibility to advise the Federal Government on all aspects of meteorology and to issue weather (and climate) forecasts. The Act also makes it the responsibility of the Agency to observe, collate, collect, process and disseminate all meteorological data and information within and outside; co-ordinate research activities among staff, and publish scientific papers in the various branches of meteorology in support of sustainable socio-economic activities in Nigeria.

In addition to the NIMET implementation's the Nigerian government put in place some National Climate Policy Development Framework - Climate-relevant Policies, Strategies and Plans in Nigeria. These could be adapted and implemented in anticipation of climate change to reduce its potential adverse effects:

National Environment Policy: Towards meeting the challenges of addressing the key environmental problems and challenges of land degradation (deforestation, desertification and coastal and marine environment erosion), and air and water pollution, urban decay and municipal waste, as well as hazards of drought, coastal surges, floods and erosion, the Nigerian government elaborated a *National Environmental Policy* in 1989. The policy was revised 1999 to accommodate new and emerging environmental concerns. The goal of the revised the policy is to achieve sustainable development in Nigeria and, in particular to (i) secure a quality of environment adequate for good health and wellbeing; (ii) promote the sustainable use of natural resources; (iii) restore and maintain the ecosystem and ecological processes and preserve biodiversity; (iv) raise public awareness and promote understanding of linkages between environment and development; and (v) cooperate with government bodies and other countries and international organizations on environmental matters. Nigeria has also enacted a number of specific policies and action plans for the implementation of the National Environment Policy. These policies that could be adapted to support national climate change mitigation and adaptation response efforts include (i) National Policy on Drought and Desertification; (ii) Drought Preparedness Plan; (iii) National Policy on Erosion, Flood Control and Coastal Zone Management; (iv) National Forest Policy; and (v) National Biodiversity Strategy and Action Plan.

Otherwise, Nigeria has many laws and regulatory measures to promote sustainable environmental management in many sectors of the economy. Some of the critical laws that may have influence on climate change response, particularly as they relate to ecosystem adaptation, include (a) *National Park Service Act* – retained as Cap N65 LFN 2004 (for conservation and protection of natural resources (wildlife and plants) in national parks; (b) *Endangered Species (Control of International Trade and Traffic) Act*- retained as Cap E9 LFN 2004 (conservation of wild life and protection of threatened and endangered species).

The **National Policy on Drought and Desertification**, in particular, recognizes that climate change could intensify drought and desertification in the part of the country that are very prone to these environmental problems. Thus the policy emphasized the need to equip relevant agencies,

institutions and citizens adequately to collect, analyze and use climate data effectively to ameliorate and combat drought and desertification. Specific implementation strategies for the policy include: (i) strengthening of agencies, institutions and facilities for the collection and analyses of meteorological and hydrological as well as for dissemination of information; (ii) upgrading the existing national early warning facilities for more efficient service delivery; (iii) developing appropriate awareness programmes for formal and informal education to enhance knowledge on climate and environment issues; and (iv) encouraging appropriate land use that enhances carbon dioxide sequestration, such as afforestation, reforestation and agro-forestry. This also reduces soil erosion and increase crop productivity for economic development.

The **National Forest Policy** is geared towards ensuring sustainable forest management, promoting participatory process of development, facilitating private sector – forestry development and adopting an integrated approach to forestry development. Government is currently embarking on a number of afforestation programmes. Under the guidance of the African Union Commission, Nigeria is keying into the project on the “Green Wall Initiative” in which a “green wall” of trees (40 million trees annually in the next 10 years) will be planted across the dry-land area of Nigeria to not only push back deforestation and secure agriculture and livelihoods across the Sudano-Sahelian zone of the country, but also enhance the carbon sequestration of biological diversity resources in the region for climate change mitigation.

The **National Biodiversity Strategy and Action Plan** is to develop appropriate framework and programme instruments for the conservation of Nigeria’s biological diversity and enhance its sustainable use by integrating biodiversity considerations into national planning, policy and decision-making processes. It provides frameworks for addressing (i) biodiversity conservation, (ii) sustainable use of biological resources, (iii) equitable sharing of benefits, (iv) conservation of agrobiodiversity, (v) biosafety, and (vi) biodiversity-industry interface, all of which should improve the quality of the country’s biological ecosystems to play the essential role of moderating the global carbon cycle and, therefore, climate.

The **National Erosion and Flood Control Policy** is to ensure coordinated and systematic measures in the management and control of the climate-related hazards and risks of erosion and floods to reduce their impacts on the people and the environment. Key strategies for the implementation of the policy are to: (i) evolve a mechanism for forecasting, monitoring and control of erosion and floods; (ii) review the land use laws and regulations; (iii) promote and strengthen training at all levels in erosion and flood prevention, management and control; (iv) creating public awareness to encourage participation; (iv) protection of the marginal lands by limiting utilization to their carrying capacity; (v) subjecting resources users and developers to guidelines in order to reduce the vulnerability of the environment to flood and erosion-related disasters; and (vi) providing early warning systems to avert the escalation of flood and erosion hazards. All these would have significant implications for climate change adaptation measures that would need to be adopted to increase people resilience.

Agricultural Policy: The main objectives of the 2001 Nigerian Agricultural Policy include: (i) the achievement of self-sufficiency in basic food supply and the attainment of food security; (ii) increased production of agricultural raw materials for industries; (iii) increased production and processing of export crops, using improved production and processing technologies; (iv) generating gainful employment; (v) rational utilization of agricultural resources, improved protection of agricultural land resources from drought, desert encroachment, soil erosion and flood, and the general preservation of the environment for the sustainability of agricultural production; (vi) promotion of the increased application of modern technology to agricultural production; and, (vii) improvement in the quality of life of rural dwellers. A key feature of the policy is to reduce risks and

uncertainties in agriculture by reducing the natural hazard factor (*which may include climate change*) militating against agricultural production and security of investment. The policy framework covers many issues that may be impacted by climate change. They include (i) crops, livestock, fisheries and agro-forestry production, (ii) pest control, and (iii) water resources and irrigation.

Water Policy: The National Water Policy seeks to improve on the nation's water resources management including the management of hydrological risks and vulnerabilities. Emphasis is for the assessment of water resources is to improve real time forecasting of hydrological phenomena, a major adaptation measure required to reduce societal vulnerability to the impacts

Coastal Resources: Nigeria has no clear policy directed at coastal zone management, and there has been persistent call for the country to have in place an integrated approach to coastal zone management. However, Nigeria is participating in the implementation of the UNDP/UNE/UNIDO/GEF project on *Combating coastal area degradation and living resources depletion in the Guinea Current Large Marine Ecosystem (GCLME) through regional actions*. A major output of this project implementation is the development of *Strategic Action Programme to address sustainable management of the environment of the sub-region*. Some of the remedial actions to address priority transboundary problems in the project portend good opportunity for anticipatory adaptation response to climate-induced changes to the coastal environment in Nigeria.

Energy: Nigeria envisions a peaceful and prosperous nation driven increasingly by renewable energy. By the middle of the century, sustainable and affordable renewable energy will provide half of the country's total energy demand, thereby contributing to the country's efforts to keep GHG at barest minimum. It has the specific objectives:

- Expanding access to energy services and reducing poverty, especially in the rural areas;
- Stimulating economic growth, employment and empowerment;
- Increasing the scope and quality of rural services, including, schools, health services, water supply, information, entertainment and stemming the migration to urban areas;
- Reducing environmental degradation and health risks, particularly to vulnerable groups such as women and children;
- Improving learning, capacity-building, research and development on various renewable energy technologies in the country; and
- Providing a road map for achieving a substantial share of the national energy supply mix through renewable energy, thereby facilitating the achievement of an optimal energy mix.

The Current National Development Plan - Vision 20:2020: Government have proposed a ten-year plan for stimulating Nigeria's economic growth and launched the country onto a path of sustained and rapid socioeconomic development. The blueprint was known as Vision 20:2020, articulates Nigeria's economic growth and development strategies for the period between 2010 and 2020, and has been implemented using a series of medium term development plans. The goal of Nigeria's Vision 20:2020 is to position the country to become one of the top 20 economies in the world by 2020. A major objective of the vision is to stimulate economic growth and launch the country onto a path of sustained and rapid socioeconomic development. It aims, among others, to reduce the impact of climate change on socio-economic development processes in the overall context of reserving the environment for socio-economic development. In that regard, it would:

- (i) strengthen environmental governance;
- (ii) promote environmental education; and
- (iii) optimize economic benefits from sustainable environmental management.

The Vision 2020 policy document was proposed to be legislated before the potential of mainstreaming climate change concerns into it can be realized.

5.5 Tunisia

Tunisia has currently a number of assets that led to the elaboration of its national climate policy, developed in 2012. Indeed, both at the level of mitigation and adaptation, draft of strategies and sectorial plans dealing with Climate Change (CC) issues start to emerge in Tunisia, but their implementation remains partial, sometimes inconsistent, lack of intra- and inter-sectorial consultation, etc. Finally, a number of shortcomings hamper the effective implementation of the Climate Policy.

Existing analyses are also available and include a national action plan for climate change adaptation for the agricultural sector and agro-ecosystems. The action plan is centred on three principal axes: (1) overcoming short term crisis management through a risk adaptation strategy linked to climate change, (2) integrating climatic volatility within agricultural and economic policies, and (3) managing the socio-economic consequences set to impact the agricultural sector in an integrated manner between economic sectors.

Other technical ministries have also developed adaptation strategies and corresponding action plans for the health and tourism sectors. The agriculture sector adaptation strategy is itself complemented by three studies on early warning systems to manage the risk of extreme events. The tourism adaptation strategy is complemented by three studies on the development of ecotourism. These sector strategies and actions plans will be integrated into the forthcoming National Climate Change Strategy mentioned above and a multi-sectoral adaptation project portfolio. Project categories under the portfolio will respond to the following priority areas: (1) water resources, (2) agriculture, (3) biodiversity and ecosystems, (4) industry and energy, (5) wastes, and (6) health.

Despite the undeniable achievements in terms of environmental governance, Tunisia does not seem to have a legislative structure to efficiently tackle the issue of CC. There is a lack of ownership of climate issues due to a lack of stakeholder involvement, too centralized and too formal national dialogue and a weak awareness of civil society to climate issues. The lack of a national structure that explicitly deals with CC also exacerbates the compartmentalization of strategies at work, hinders the establishment of effective institutional arrangements (early warning systems) and contributes to a lack of knowledge of opportunities offered at international level (UNFCCC financing, synergies between the 3 Rio conventions in particular). Moreover, apart from the energy sector, there are no structured monitoring and evaluation mechanisms in other sectors, whether from the point of view of mitigation or adaptation. Yet, this type of device is essential for the design and adjustment of any climate change policy. It is also a necessary condition for obtaining any international support under the UNFCCC.

The second gap concerns the state of knowledge on the issues of climate change in Tunisia, despite the work already done. There is a lack of synergy between vulnerability studies to overcome this isolated approach and to build sectorial and cross-cutting capacities in the management and dissemination of climate change knowledge, thereby overcoming the current gaps (collection, sharing, and dissemination knowledge between sectors). Finally, it is essential to reflect on the training of researchers, on the mechanisms and tools of observation, on the strengthening of national research programs and international scientific cooperation and on the means of federating research and private initiatives. The goal is to provide climate information needed by the different sector to take into consideration the CC dimension and to elaborate reliable scenarios and strategies.

At the legislative and regulatory level, although the existing legal framework is relatively complete and diversified at the sectorial level, there is sometimes a lack of controls on the implementation of certain laws (control of water resources, forest management, and Industrial Carbon emission).

However, relying on existing mechanisms and strengthening their control, is undoubtedly a useful starting point for the adaptation strategy, still insufficiently exploited in Tunisia. This need became even more urgent after the revolution of 14 January 2011, because sometimes confusions are made between freedom and free access to natural resources. To this must be added the needs identified by the various studies to evolve existing regulatory and normative tools to take into account vulnerabilities to CC. These include, for example, urban development plans, (ALCOR-TEC 2012– SNCC 10/165) schemes for regional development, port infrastructure construction standards, power stations, dams, etc. Undoubtedly, one of the major challenges that seem to emerge is the integration of climate change into the overall Tunisian spatial planning process.

In the context several challenges face to current and future global climate change, it has become essential to consider mainstreaming the NIM climate information and services into new and more adapted legislation and policy. It is also noted that the present legislation and policies on climate information and services are being redefined and fine-tuned.

6. LINKING SOCIO-ECONOMIC DATA TO CLIMATE INFORMATION

In order to provide climate information that is effective, it has to be user centred and focused on addressing the user needs. This requires not only climate information but other socio-economic and livelihood information. Much of the socio-economic information is obtained from other government agencies such as NDMA, WARMA, NEMA, KFS, KWS, KBS in Kenya and from government ministries; regional and international organization such as FAO, US-FEWSNET, UN organizations; and research institutions such as universities.

6.1 Livelihood Systems and Livelihood Assets

Livelihood covers the capacities, goods and activities needed to survive (Warner, 2000). Cameroon's forest populations are vulnerable to climate change, which creates the need for new survival techniques, over and above agriculture, hunting and the gathering of wild plants. The vulnerability of both the sedentary and the nomadic forest populations has been acknowledged. The Cameroonian government and its development partners are seeking to cope with this problem by sedentarizing the Pygmy populations and training them in agriculture, since NTFP are becoming increasingly scarce and more lands are becoming protected areas, thus limiting the forest dwellers' access to the forest resources. Unlike the vulnerability approach, the livelihood approach can offer the country's forest populations the resources for sustainable livelihood. Livelihood becomes sustainable when the people are given the ability to adapt to difficulties, cope with adversity and maintain or improve capacities and goods (natural, physical, financial, social and human capital) either in the present or in the future, without compromising the natural resources base (Carney, 1998). Forests are an important natural capital and as such contribute to sustainable livelihoods; yet it is very difficult to quantify their potential. In general they contribute to increasing income and food security (Byron and Arnold, 1999), reducing vulnerability and ensuring a more sustainable use of the natural resources base (Arnold, 1998). It is noteworthy that the analysis of the Cameroonian context does not emphasize the sustainable livelihood approach. Moreover, development sectors that are sensitive to climate change may contribute to the vulnerability of the livelihood of their target populations. However, in the Cameroonian situation the livelihood approach seems appropriate because of the forest populations' strong dependence on the forests. When applying this approach, the related analyses can be used to draw up the most fitting policies for tackling the real constraints of climate change in the forest context.

The climate change initiatives in Kenya highlight the importance of climate information for development and the adaptation and mitigation actions as well as the vulnerability assessment highly depends on an array of information from both the climate and other sectors. Streamlining climate information into people centred development will further increase resilience. The country's economy is highly dependent on climate sensitive sectors including agriculture, tourism, and energy. Agriculture is the backbone of the Kenyan economy directly contributing 24% of the GDP in 2009 and another 27% indirectly. The sector accounts for 65% of informal employment in rural areas. Kenya faces major food security challenges due to the over dependence on rain-fed agriculture for food production. The number of Kenyans requiring food assistance rose from 650,000 in 2007 to almost 3.8 million in 2009/2010. Pastoral and marginal agricultural areas are particularly vulnerable to the impacts of climate change. Extended periods of drought erode livelihood.

Climate change impacts are mostly felt by those whose livelihoods depend on natural resources as characterised by many African population of which South Africa is not exempted and this therefore, creates a need for supportive policies that can aid adaptation among farmers (Stringer et. al., 2009). In Malawi access to climate information can be a major driver of the decisions to adopt the adaptation practices. Various sources of extension information significantly inform adoption decisions. Key among these is government extension and information accessed through the media. Awareness of climate change and measures to mitigate its effects is thus depicted as a key hurdle in

the adaptation process. Climate information constraints are a key impediment to adaptation. Resource availability enables farmers to implement adaptation decisions, the lack of which presents the household with a significant challenge of adopting the adaptation measures. Credit-constrained households are still able to adopt these beneficial practices when provided with climate change related information. Therefore lack of information is the most important deterrent to climate change adaptation by the farm household.

Rural livelihoods in the semi-arid tropics often depend on agriculture, yet present diversity across regions, communities and between households. These livelihoods systems are vulnerable because they are exposed to various dryland stresses such as lack of rainfall and high temperatures. In Nigeria, the Livelihood Zone Map sketched out by FEWSNET (2014) shows area within which people share broadly the same pattern of livelihood, including options for obtaining food and income and market opportunities. A livelihood zoning provides geographic orientation of livelihood systems to inform food security analysis and assistance targeting, the basis for identifying geographically relevant food security monitoring indicators and sampling frame for future on-the-ground assessments. Livelihood patterns clearly vary from one geographic area to another, which is why the preparation of a Livelihood Zone Map is a logical first step for livelihoods-based analysis.

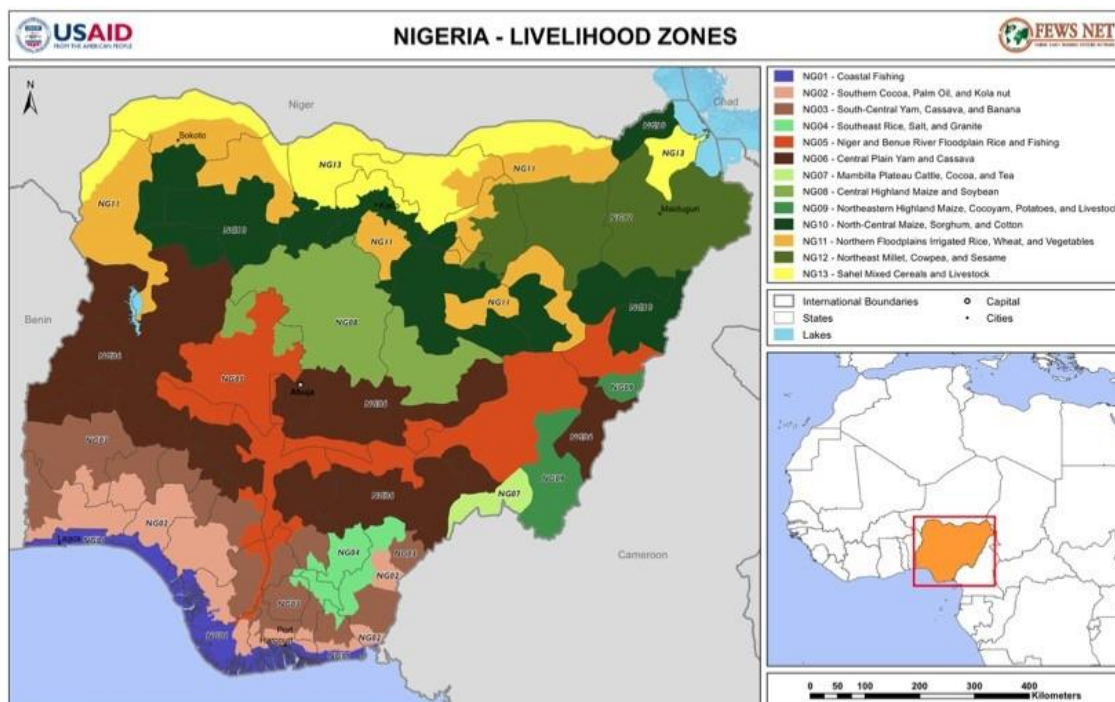


Figure 9: Livelihood Zone Map of Nigeria illustrating the country by zone, showing areas where people generally have the same options for obtaining food and income and engaging in trade

Sustainable livelihood especially among rural dwellers is one of the prerequisites for the envisaged agricultural development and much talk about revenue diversification in the country. Sustainable livelihood itself is conditioned by the quality, quantity, accessibility and sometimes affordability of the identified five principal assets including; physical, natural, human, social and financial assets. Hence, sustainability in livelihood of farmers is hinged on the balance in these assets, and its degree of resilience to shock or stress. Therefore, a study conducted by Udoh et. al., (2017) revealed the composition of these assets among farming households in one local community in Nigeria. The study showed that human capital is the least acquired asset among farming households in the country. Also, financial capital is a serious constraint among respondents.

At present in Tunisia, *ad hoc* studies have been undertaken (Verner Dorte, 2013) (for example public health studies linking climate and health information). There is not, however, a systematic collection and analysis linking socioeconomic and climate data. The data types needed for effective climate policy making include household data, census data, and other economic data such as labor market and production data. In national, sectoral and local data collection, it is important that social and economic information is collected at a disaggregate format to reflect location, gender, age, and socioeconomic status, as these factors greatly affect exposure to and ability to cope with climate risks. Ideally, micro-data series should be continuous so development over time can be tracked closely. Collecting data and analyzing it is an important step, but equally important are the mechanisms for disseminating these data and making them available, so that awareness can be raised and people begin to shift behavior and act or adapt as a result of the information received.

6.2 Local Perceptions of risks associated with lack of Climate Information

As risk perception has itself been found to be specific to culture and place (Weber and Hsee, 1999), it is also to be expected that public perceptions of the threat posed by climate change, and support for adaptation policies, will vary across countries.

According to Din et al., (2016) who assessed the local perceptions on climate change and adaptation in the coastal areas of Cameroon reported that more than 55% of the 425 people interviewed have heard about climate change with 20% hearing it from radio, followed by television (17.7%) and newspapers (15%). The effects of the climatic changes felt are the rise of the temperatures (78%) and the rise of precipitations (67%). These effects have been felt for more than 10 years (72.7%). Contrary to scientific predictions, populations observed an increase of precipitations accompanied with the rise of floods frequency. In accordance with the past and present climatic risks usually observed in the locality, the populations have adopted various types of behaviours to fit one's surroundings. According to recorded events, the reactions achieved ranged from common panic to the abandonment of site. (Din et al., 2013). Perception on climate change and sea level rise is already felt by local populations except the appreciation on rainfall. Observations varied significantly by age and sex. The increase in frequency of floods and their impacts are the relevant indicators for populations to refuse predicted rainfall deficits in the area. Expected extension of the dry season could affect the natural regeneration and the structure of mangrove forests. No efficient and continuous endogenous measure of adaptation has been recorded. Considering the importance of woody species in the local economies, the urban demographic pressure, the lack of appropriate actions and adaptation measures will lead to the total degradation of mangrove ecosystems around cities.

In Kenya, much of the information for a while has been produced at a scale that is not applicable for the local users making the users feel that the information was general and did not reflect the actual variability at the ground level. The information is sometimes in a form that is not well understood by the end users and requires extra knowledge to interpret, such as probabilistic information. Hence that form and scale of the climate information sometimes creates a situation of increased mistrust by the users. However that has led to initiatives to improve the climate information to different forms, and also to increase awareness of the availability and of CIS information and also to engage end users in the generation of information so as to have a more user oriented CIS.

From the study of Ayanlade et al., (2017), it was noticed that the majority of farmers in Nigeria know about the changes in the patterns of rainfall and temperature over time. Based on farming experiences, it was easy to examine the adaptation strategies employed by the farmers, their interest in other adaptation strategies, and an assessment of the willingness of these farmers to pay for access to those adaptation strategies. Therefore, the farming experience was used to analyze of their perception, knowledge level, attitudes, and understanding regarding climate

change in the selected communities. The result indicates that the perception of the farmer in term of climate change varies, 72.8% of the farmers responded in the affirmative, 14.9% responded in the negative while 12.3% expressed uncertainty. As for the adaption to climate change and extreme weather events, the result shows that the majority of the farmers engaged in new planting pattern, with adjustment of the planting date to the climatic event. There is a need, therefore, for agricultural reformation. This will include better government policies that provide more financial aid to farmers during and after crop loss due to climate change and other extreme climatic events. Farmers need this kind of supports to cope with crop losses caused by climate change. This resilience can be built up by the provision of insurance plans for farmers which are tailored to their needs. There is a need to improve accessibility to government loans and subsidies, especially, during extreme weather events. Above all, farmers should be encouraged to plant drought resistant varieties of crops in areas which are susceptible to water shortages and dry spells. This can be achieved by improving local research which can lead to the breed of appropriate drought resistant seed varieties. Locality-specific adaptation strategies need to be developed to breed drought-resistant varieties of crops, which can cope with extreme weather events in the tropical region. There is no doubt that development of drought resistant varieties of crops is a promising method of adaptation to climate change.

According to a World Bank report, individuals reported a growing awareness of a changing climate in Tunisia (Verner Dorte, 2013). There was, however, a limited understanding of the linkages between this knowledge and effective climate change adaptation, how this related to the national or international policy dialogue, and how support, for example in developing alternative livelihoods or improved agriculture for drought conditions, could be accessed. Education has been a priority of the Government of Tunisia (GOT) and the country's education system has ranked as one of the best in the Middle East and North Africa in the Human Development Index as well as in Organization for Economic Co-operation and Development (OECD) and UNDP studies. Tunisia has even been one of the few non-OECD countries to participate in the OECD Program for International Student Assessments. Environmental issues have been incorporated into school curriculums through the Sustainable Schools Program.² This is a program administered by the Ministry of Environment aimed at environmental education as well as the creation of environment clubs, installation of renewable energy technology in schools, and other environmental conscious activities such as the establishment of eco-gardens. Climate change could usefully be incorporated into this program as well as into core school curriculums. Main ways of perception of local risks in a context of lack of climate information in Tunisia may be summarized as:

- The comparison of changes in past and current seasonal cycle and rainfall pattern.
- The comparison of the frequency of droughts episodes.
- The perception of average increase in temperature in the summer while winter has shortened.
- The increased variations in rainfall, dry spells, temperature and drought occurrences, affecting production.

6.3 Indigenous knowledge Practices and Strategies

The term local endogenous measures is analogous to terms such as Local and Indigenous Knowledge (LINK), local knowledge, traditional ecological knowledge, indigenous technical knowledge, endogenous knowledge. These measures can be categorized in four groups: i) perceptions and understandings of climatic changes and related natural phenomena (prediction of storms based on observations of the sky, sea and wind); ii) livelihood sustainability practices (livelihood diversification); iii) survival, coping and mitigation strategies (migration to higher ground, construction of houses using local materials); iv) cultural belief systems (traditional rituals and ceremonies). All these categories have been encountered in the investigation. The third group seems to be the most frequent situation which is normal in the context of poverty. On the other hand, the

migrations found in this survey area must be considered as a temporary measure of adaptation since populations always tend to return to their land after the end of the manifestations from an extreme climatic event.

Different communities use different types of climate and weather information to support local adaptation actions (Luseno et al., 2003; Mittal, 2012; Tall et. al., 2014a). The vast majority of Semi-Arid Region (SAR) communities rely on their traditional indigenous knowledge. This indigenous climate information is valued and preferred due to: its ability to predict localised events such as when the rains will start and end, and where it will fall; its relevance to livelihood practices e.g. when to plant or to migrate; its ease of accessibility e.g. by being passed down from father to son and through traditional weather men/diviners; because it originates from trusted sources such as diviners and weather-men who are known members of the community; and because it is easily understood by the community i.e. communicated in local dialects, using local environmental indicators (Luseno et al., 2003; Anandaraja et al., 2008; Speranza et al., 2010; Mittal, 2012).

Such traditional climate information mainly includes information about current and near-future climate events such as when the rains will start and end, expected changes in seasons with regard to events such as drought and floods, among others (Anandaraja et al., 2008; Luseno et al., 2003; Mpandeli and Maponya, 2013). Pastoralists, for instance, use various traditional indicators such as: 'observation of clouds, lightening, wind; studying animal intestines; observing and studying the behaviour of plants or animals' to predict seasonal changes and to align their livelihood practices based on these changes (Luseno et al., 2003). However, while traditional climate information support uptake of adaptation actions, its ability to predict future climate change is increasingly being limited and undermined by the increased variability and uncertainty in climatic conditions (Luseno et al., 2003; Anandaraja et al., 2008).

To compliment traditional climate information and indigenous knowledge, local communities increasingly use modern seasonal forecasts from meteorological departments (ALIN, 2013; Tall, et al., 2014ab). For instance, Speranza et al., (2010) showed that households that have access to mass-media (e.g. radios) use modern seasonal forecasts alongside traditional forecasts. Other authors noted that these modern seasonal forecasts are sometimes co-produced and interpreted in combination with the traditional forecasts, or are used when traditional forecasts fail or become less consistent due to increased climate variability (Speranza et al., 2010; Luseno et al., 2003; Mpandeli and Maponya, 2013). Such modern climate information mainly provides information about future climatic events e.g. seasonal forecasts (Nderitu and Ayamga, 2013). The use of modern climate information is mostly common among communities who have access to communication channels such as radio and television; those who are more educated; those engaged in trade and among those who have access to intermediaries such as extension workers and non-governmental project staff (Luseno et al., 2003).

In several areas especially where CIS is not available in Kenya, users depend on the indigenous practices for application. The challenge has however risen due to climate change and factors such as reduction of soil fertility, and hence in some places the continued dependency on indigenous practices along leads to reduced productivity. Studies have shown that the existence of indigenous knowledge if well improved and supported by CIS increases productivity abundantly. It also creates a structure for easy adoption of climate information services.

Integrating indigenous knowledge into climate change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable. Adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas. Such strategies will include the adoption of efficient

environmental resources management practices such as the planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall declined. However, incorporating indigenous knowledge into climate change concerns should not be done at the expense of modern/western scientific knowledge. Indigenous knowledge should complement rather than compete with global knowledge systems.

Local farmers in Africa have been known to conserve carbon (C) in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques. Natural mulches moderate soil temperatures and extremes, suppress diseases and harmful pests and conserve soil moisture. Before the advent of chemical fertilizers, local farmers largely depended on organic farming, which also is capable of reducing GHG emissions. It is widely recognized that forests play an important role in the global carbon cycle by sequestering and storing carbon. Local farmers are known to have practiced the fallow system of cultivation, which encouraged the development of forests. It may be argued that with the growth in population, lengths of fallow have been reduced to the extent that the practice no longer exists in certain areas. However, one must not forget that the importance of forests have been recognized by traditional institutions to the extent that communal forest reserves were very common in traditional societies (Ajani et al., 2009).

In Nigeria, adaptation strategies perceived by farmers as appropriate include: crop diversification using different crop varieties, varying the planting dates, harvesting dates, increasing the use of irrigation, increasing the use of water and soil conservation techniques, shading and shelter, shortening the length of the growing season and diversifying from farming to non-farming activities. Some strategies that serve as an important form of insurance against rainfall variability are: increasing diversification by planting crops that are drought tolerant and/or resistant to temperature stresses, taking full advantage of the available water and making efficient use of it, and growing a variety of crops on the same plot or on different plots, thus reducing the risk of complete crop failure since different crops are affected differently by climate variabilities. Such farm-level adaptations aim at increasing productivity and dealing with existing climatic conditions and draw on farmers' knowledge and farming experience.

“Indigenous knowledge adds value to climate change studies in the following ways. First, indigenous knowledge systems create a moral economy. It identifies a person within a cultural context, therefore providing decision-making processes or rules of thumb to be followed based on observed indicators or relationships within events. Members of communities act within these rules to maintain security and assurance or risk isolation from their community. In an uncertain and biased world, these rules provide people with a sense of community belonging and stability. Second, indigenous knowledge is increasingly exhibiting a resemblance with scientific methods as many ideas in indigenous knowledge that were once regarded as primitive and misguided, are now seen as appropriate and sophisticated. Third, indigenous knowledge systems provide mechanisms for participatory approaches. A major requirement for the sustainability of any project is that the local population must be seen as partners in the project with joint ownership. This is best achieved when the communities effectively participate in the design and implementation of such projects. Fourth, indigenous knowledge systems share the same guiding principles with sustainable development framework with 3E concerns-Economy, Equity, and Environment. The essence of most climate change projects is to reduce poverty and ensure sustainable development. This can be facilitated by the integration of indigenous knowledge into climate change policy. Fifth, indigenous knowledge systems can facilitate understanding and effective communication and increase the rate of dissemination and utilization of climate change adaptation options. Sustainable land and water management combined with innovative agricultural technologies could help farmers adapt to climate change impacts” (Ajani et. al., 2013).

6.4 Extreme Climatic Events and Impact on Population and Economy

Cameroon is essentially an agricultural economy since approximately 73% of its active population is employed in the agricultural sector. The diversity of ecological zones in Cameroon affects agricultural output in two ways. In the well-watered southern regions, agricultural production flourishes. But in the progressively dry and arid north where evapotranspiration is high, agricultural output is adversely affected. Farming in the Sudano-Sahelian zone of Cameroon largely depends on the amount of rainfall received. Ecologically, the north is the most fragile zone in Cameroon, with a Sahelian climate and vegetation in the Far North Province. Barren soils constitute some 25–30% of the surface area of this province. Erosion is a serious threat to agriculture in this northern part of Cameroon. Consequently, agricultural production is vulnerable to climatic variability. Problems with crop cultivation, livestock, wildlife and fuelwood are very pronounced in this part. Agriculture is expanding as more land is being brought into farming; cattle rearing or livestock production is damaging crop cultivation. Worse still, most of Cameroon's natural parks and wildlife sanctuaries are located in the north, a marginal precipitation zone. The gathering of fuelwood, annual bush fires and the high population growth rate all contribute to deprive this fragile environment of the vegetation cover it needs. This high demand makes the northern part of Cameroon a potential catastrophe zone for agriculture.

The agricultural agenda and capacity to grow enough food for households depends on climatic stability. Any change in the weather conditions could have negative impacts on crop yields and farm outputs. A change in climate would imply some slight alteration of the agro-ecological zones. Such a shift would call for a change in the types of crops cultivated, towards grain crops or cereals which require less rainfall and have a short growing season. This could mean that maize yields will dwindle in favour of sorghum and millets which are hardy plants with relatively low water requirements. The dry season sorghum in this case will be much favoured. The annual rainfall minimums for the various crops in this northern zone of the country have been established. These rainfall crop minima are 700–800mm for cotton, 500–700mm for groundnuts, 500mm for sorghum and 250mm for millet. The reliance on rain-fed agriculture would have to give way to more irrigation. In order to maintain crop yield levels, the agrarian communities of North Cameroon would cultivate more land under dryland condition than would be the case under a wetland situation. This sort of extensive cultivation would only further expose an already ecologically fragile zone to the caprices of climatic conditions.

6.5 Current Vulnerabilities

Vulnerability varies with natural region. The main climate change risks were evaluated for each natural region. The northern region is characterized by drought, violent winds, floods and landslides and slips, to which erosion can be included. In the Adamawa, a region naturally exposed to seismic and volcanic risks, landslides caused by heavy rains and the existing relief energy (gravity) constitute the most recurrent risk. To this can be added the risk of erosion caused by over grazing. The Western highlands for their part are characterized in literature by the risk of gas emissions from lakes, Monoun and Nyos, due to heavy rainfall and the sheer seriousness of the same climate risks as those in the Adamawa plateau. The South Cameroon plateau, on the contrary, will witness heat waves resulting from global warming. These shall be added to flooding, landslides and erosion. Lastly, in the coastal region, intense and abundant rainfall will cause recurrent flooding, mass movements and erosion. Based on all the information collected and analyzed, the northern part of Cameroon seems to be most vulnerable to climate change in the country, followed by the coast and the Western highlands. The South Cameroon plateau appears to be the least affected, but care must still be taken because of deforestation, forestry and mining which jeopardizes conservation and can accelerate the above mentioned threats.

The agricultural sector in Cameroon due to its high sensitivity as a result of availability of water, erosion and flooding, it shall be the most affected by climate change in Cameroon. Similarly, energy production is entirely dependent on the hydrological system and considering the influence of the availability of energy resources on the other development sectors, the vulnerability of the main rivers' regimes will have a major impact on the development of the country as a whole. As a concern especially to human groups; the main vulnerability factor is poverty in peri-urban areas, in addition to mass exodus from rural areas to urban areas which already face a huge demographic pressure from youths and vulnerable classes seeking better living conditions. The forest sector is also of great economic importance, second only to oil production. However, unregulated logging in some areas is contributing to the effects of climate change and causing irreparable environmental damage. As temperatures continue to rise, these impacts are expected to become more profound throughout the century. There is low adaptive capacity amongst the poorest populations in areas sensitive to climate change like in the Sudano-Sahelian zone and the coastal areas are already struggling to cope with current extreme weather events and climate variability. The greater frequency and severity of climate shocks is repeatedly eroding coping capacity in most of these areas.

In Kenya, rainfall varies very much in space and time, most of the areas receive bimodal kind of rainfall which some receive unimodal kind of rainfall. Rainfall distribution amounts also varies in different regions with the higher altitude areas recording more amounts, however local variation still occurs, Temperature is also much varying with the months of June to August recording the lowest temperature in most parts. There are frequent occurrences of extreme weather conditions such as droughts and dry spells, high winds, extreme rainfall, and floods and even landslides. Droughts and floods affect the highest number of people and with increasing population, the number of affected people is also rising. Such as the 1995/6 affected 1.41 million, 1999/2000 affected 4.4 million and 2004-2006 affected 11 million (GOK, 2006b). The 1997/98 floods, on the other hand, are estimated to have affected about 1 million people, costing the economy US\$0.8-1.2 billion in terms of damage to infrastructure (roads, buildings and communication systems), public health effects and loss of crops. Other losses amounting to US\$9 million arose from flooding, property destruction, soil erosion, mudslides and landslides, surface and groundwater pollution and sedimentation of dams and water reservoirs. There has been observed a general increasing trend in temperature in most parts of the country. Rainfall trends show mixed signals with some locations indicating trends towards wetter conditions in recent years, but the majority of locations are not showing any significant trends. The annual rainfall shows either neutral or slightly decreasing trends due to a general decline in the long rains season that extends from March to May. The short rains season between October and December, on the other hand, shows a positive trend in some locations. The nearly 80% of the country is covered by arid and semiarid land, with around 7.8% being arable land. Much of the agricultural practice is rain-fed, with two rainfall seasons from March to May and October to December, with some areas experiencing a single growth period from June to December. The country is generally categorised as water scarce. The energy sector has largely depended on hydro-power which contributes about 50% of the total national energy production. This sector has been most impacted by droughts and unreliable rainfall.

Malawi is vulnerable to climate-related hazards particularly floods, droughts and intermittent rainfall; and there is evidence suggesting that the frequency and magnitude of these hazards will increase in future and will be exacerbated by climate change (GOM, 2011). Malawi's own vulnerability to climate change arises mainly from socio-economic, demographic and climatic factors. Recent climate trends show a temperature increase of 0.9°C between 1960 and 2006. Furthermore, projections of future climate from Global Circulation Models (GCMs) show that temperature will increase by 1.1 to 3.0°C by the 2060s, and 1.5 to 5.0°C by the 2090s (McSweeney et al., 2008).

Nigeria is particularly vulnerable to the impact of climate change in many fronts considering its geography, climate, vegetation, soils, economic structure, population and settlement, energy demands and agricultural activities. As a developing country also, Nigeria is a particularly vulnerable because a large share of its economy is dependent on climate-sensitive natural resources. Climate change will affect everyone. Both the rich and the poor stand to lose. Those already affected by poverty, malnutrition and disease will face displacement and new hardships. All sectors of our socio-economic development, including the natural ecosystems, are vulnerable to climate change. In general, climate change presents significant threats to the achievement of the Millennium Development Goals especially those related to eliminating poverty and hunger and promoting environmental sustainability.

Tunisian ecosystem's exposures to vulnerabilities related to climate change issues are numerous. The main factors that highlight these situations are: the real variability in temperature and precipitation conditions, the sea levels rising, droughts, floods, soil degradation phenomena, etc. The degree to which Tunisia is getting affected by climatic stresses is appreciable through specific aspects such as water scarcity, coastal salinization and its physical vulnerability (due to rising of sea levels and various direct and indirect socio-economic causes), agriculture vulnerability due to drought and reduction in land area, tourism sector vulnerability due to unbearable heatwaves, health issues due to resurgence and proliferation of certain vector-borne diseases, ecosystems concerns due to forests degradation and pastoral ecosystems impacts, etc.

The physical vulnerability of the Tunisian coastline to rising sea levels has various direct and indirect socio-economic consequences:

- Loss by submersion of approximately 16,000 hectares of agricultural land in low-lying coastal areas, - Loss by submersion of approximately 700,000 hectares of built-up areas,
- Loss by salinization of approximately 50 per cent of the resources currently available in coastal aquifers,
- Indirect loss of the potential for approximately 38,000 ha of irrigable land by 2050, i.e. 10 per cent of currently irrigated land,
- Decline in the activities of seafront hotels, which have a total capacity of approximately 30,000 beds, owing to retreating beaches,
- Decline in port and shore infrastructure.

The loss of productive capital caused by this damage is in the order of 2 billion US dollars. Losses in annual production are estimated at approximately 0.5 per cent of current GDP, mainly in the areas of tourism (55 per cent) and agriculture (45 per cent). It is estimated 36,000 job losses, mainly in agriculture and tourism.

6.6 Adaptation Strategies

The climate's direct impact on sustainable livelihood forces farmers to adopt new practices and coping strategies in response to the altered conditions. Farms and rural households adapt in various ways to lessen the adverse effects of climate variation on crop yield, farm profit and household income. In general, according to Molua and Lambi (2007), the repertoire of strategies to confront unstable changing climate includes the following:

- (i) shifting crop mix to more drought tolerant and short season varieties,
- (ii) reducing the area planted initially, then increasing it gradually, depending on the nature of the season,
- (iii) staggering planting dates (early or late planting),
- (iv) increasing plant spacing,
- (v) maximizing the use of clay soils where these are available, since clay soils have a high water holding capacity,

- (vi) implementing soil water conservation techniques (pot-holing, weeding),
- (vii) adjusting level and timing of fertilizer, and
- (viii) undertaking traditional and religious ceremonies.

Table 3 below summarizes the current socio-economic aspects existing in the 5 target countries and the specific needs relating to climate information and services.

Table 3: Summary of the socio-economic aspects, existing situation and specific needs in 5 countries

Socio-economic aspect	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
a) Livelihood systems	Highly vulnerable to climate change with very low adaptive capacities	-Need to diversify livelihoods	Reliance of climate sensitive livelihood systems such as rain-fed agriculture, livestock, tourism, and energy. Awareness of the influence of climate on livelihood systems	-Lack of climate information for adaptation especially at the local level. Limited technical capacity for mainstreaming climate information to development initiative	Approximately 80 percent of Malawians depend on renewable natural resources for livelihoods	Fund local strategies that can address climate change	Livelihood Zone Map (Figure 9) illustrates the country by zone, showing areas where people generally have the same options for obtaining food and income and engaging in trade	- Enlightenment of communities, -Involvement of Media,	Climate-based information not much used in communication technology such as mobile handsets, etc.	Better introduction/promotion of mobile application technologies (such as LandInfo) in agriculture, etc.
b) Local Perceptions	The people are largely aware of the changes in climate and have their own indigenous mechanisms of mitigating against it	-Need to document the indigenous knowledge and build capacities of the people on the modern ways of mitigating and adapting to the vagaries of climate change	Much of the climate information is generally not understood or in the right format. Lack of trust on the climate information	Interpretation of CIS information. Outreach and awareness of use and application of CIS. Participatory approach in the application of CIS	?	?	From the study of Ayanlade et. al., (2017), it is noticed that the majority of farmers knows about the changes in the patterns of rainfall and temperature over time. Based on farming experiences, it was easy to examine the adaptation strategies employed by the farmers, their interest in other adaptation strategies, and an assessment of the willingness of these farmers to pay for access	agricultural reformation: better government policies that provide more financial aid to farmers during and after crop loss due to climate change and other extreme climatic events	Empirical comparison of changes in past and current seasonal cycle and rainfall pattern. Empirical comparison of the frequency of droughts. Remarks/perception of average increase in temperature in the summer while winter has shortened. Remarks/perception on the increased variations in rainfall, dry spells, temperature and drought occurrences, affecting	Capacity building on modern/numerical easy way of perception. Facilitation on the access on climate information through mobile phones and cellular network. Capacity building on Information and communication technologies management

Socio-economic aspect	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
							to those adaptation strategies		production.	
c) Indigenous knowledge and practice	-Not well documented -Prediction of future climate change is limited.	-Needs to be well captured and documented -Need to be used alongside the modern methods especially when it comes to prediction of future climate.	High dependency on indigenous knowledge especially in places with no access to CIS Highly susceptible to climate change and causes reduction in productivity	Integration and improvement of indigenous knowledge into the CIS provision	The planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall declined.	Indigenous knowledge need to be incorporated when developing climate related policies.	-indigenous knowledge systems : create a moral economy; is increasingly exhibiting a resemblance with scientific methods as many ideas in indigenous knowledge that were once regarded as primitive and misguided, are now seen as appropriate and sophisticated; indigenous knowledge systems provide mechanisms for participatory approaches; share the same guiding principles with sustainable development framework with 3E concerns- Economy, Equity, and Environment; share the same guiding principles with sustainable development framework with	Need to improve adaptive Capacities of the people	The use of an approach on rules-of-thumb monitoring of dry spells and their likely impact on crop production, livestock and fisheries. Adoption of proactive autonomous strategies.	Capacity building on different adaptation strategies of agriculture. Different strategies of agricultural orientations. Facilitation on the access on climate information through mobile/public devices.

		Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Socio-economic aspect	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
								3E concerns-Economy, Equity, and Environment			
d)	Vulnerability										
	<ul style="list-style-type: none"> Exposure 	People are highly exposed to extreme climate events	-Need to diversify livelihoods	-Increase in temperature over much of the country, with cases of heat waves being reported. -Extreme low temperature and frost have been reported and has led to loss especially agriculture sector -Increase in drought frequency, intensity and impact in recent years -Increase in the impact of flooding especially in urban areas Disaster risk and climate hazard maps available	?	Exposure maps exist Developed by Department of Disaster Management Affairs (DoDMA) in 2015 and produced by RCMRD using: inter-seasonal precipitation trend(1981-2014) Inter-seasonal co-efficient of variation in precipitation(1981-2014) Inter-seasonal Temperature trend(2002-2014) Flood frequency(1999-2007) Forest fires(2002-2012) Drought physical exposure(1980-2001)	Need for a recent vulnerability assessment Mapping	Exposure map exist: The relative exposure of the various parts of Nigeria to climate change shows that the southwest is the least exposed while the most exposed are the northeast and southeast zones. Clearly, exposure to the challenges of climate change is not a purely regional phenomenon in terms of north/south divide. Rather, it is a wholly national phenomenon, which implies that exposure factors should be addressed in the various parts of the country.	Information/ Training	<p>Temperature: Average annual temperature increase across the entire country of +2.1°C until 2050.</p> <p>Precipitation: by 2050, a drop of between 10 and 30 % in the annual precipitation rate compared to the current situation.</p> <p>Droughts and floods: an increase in the frequency and intensity of the extreme weather phenomena.</p> <p>Rising sea levels: By 2050, the sea level is expected to have risen on average by 30 to 50 cm, causing the beaches to shrink by 20 to 135 cm per year, depending on the coastline and the region.</p>	<p>Specific climate-based information and dataset and maps dealing vulnerability to climate, namely:</p> <p>Map of vulnerability or sensitivity</p> <p>Map of the various exposure phenomena</p> <p>Map of temperature change severity index</p> <p>Map of precipitation severity index</p> <p>Map of CC severity index</p>
	<ul style="list-style-type: none"> Sensitivity 	Livelihood systems are highly sensitive to	-Need to diversify livelihood	-Kenya is a water scarce country covered mainly	-Information on the impact of land use change on	Sensitivity maps exist Developed by Department of	Need for a recent vulnerability assessment	Sensitivity map exist. The north central has the	Information/ Training	Water scarcity (renewable blue water).	Water resources: adaptation, the

Socio-economic aspect	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
	climate changes	systems	with arid and semi-arid lands. -Much of the arid and semiarid land undergoing land use changes especially through agriculture and urbanization -Limited climate monitoring network especially arid lands which are most vulnerable -There is high reliance on rain-fed systems such as agriculture, tourism, pastoralism and livestock	water needs especially in arid lands -Application and information of new technology especially in agricultural varieties and increase use of irrigation -Increase monitoring network and improvement of climate information especially in arid lands	Disaster Management Affairs (DoDMA) in 2015 and produced by RCMRD using: Soil Organic Carbon/Soil quality (1950-2005). Poverty levels (2010-11). Malaria suitability (2010). Population density (2012). Infant mortality rate (2008). Wall building material (201-11). Female headed households (2010-11)	Mapping	lowest sensitivity, while the south-south has the highest. The relatively higher value of sensitivity in the north-western zone compared with the other two zones in the north is associated with presence of large human-made water bodies that are used for irrigation in the zone		Salinization of coastal aquifers due to this rise in sea level. Coastline: rehabilitation of coasts and the prevention of coastal erosion, protecting existing infrastructure. Agriculture: capacity-building and institutional development measures, introducing a climate monitoring and early warning system, as well as an insurance mechanism. Ecosystems: adaptation of ecosystems by managing of the degraded rough grazing areas, rehabilitation of forest nurseries and expanding indigenous and multi-use species, assure integrated rural development, etc. Tourism: restoration of	transfer and reuse treated wastewater. Coastline: rehabilitation of coasts and the prevention of coastal erosion, protecting existing infrastructure. Agriculture: capacity-building and institutional development measures, introducing a climate monitoring and early warning system, as well as an insurance mechanism. Ecosystems: adaptation of ecosystems by managing of the degraded rough grazing areas, rehabilitation of forest nurseries and expanding indigenous and multi-use species, assure integrated rural development, etc. Tourism: restoration of

Socio-economic aspect	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
									<p>vulnerability of forests and pastoral ecosystems; biomass inflammability and increase of risk of large forest and bush fires</p> <p>Health: resurgence and proliferation of certain vector-borne diseases, such as malaria, leishmaniasis or dengue, Respiratory diseases, Water-borne diseases.</p> <p>Tourism: vulnerability due to heatwaves unbearable for the human body, intensification of water stress, coastal erosion).</p>	<p>the Tunisian touristic sea coast and protection of tourist areas against the advance of the sea, promotion of the concept of ecological hotels, etc.</p> <p>Health: capacity-building and institutional support for: risk assessment and prevention of a proliferation of respiratory pathologies linked to climate change, implementation and strengthening of the entomological monitoring network, introduction of a programme to adapt the health system to climate change, especially through protection against water-borne diseases.</p>

	Cameroon		Kenya		Malawi		Nigeria		Tunisia	
Socio-economic aspect	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps	Existing situation	Specific needs/gaps
<ul style="list-style-type: none"> Adaptive capacity 	Very low adaptive capacities	-Need to diversify livelihood systems	-Existence of climate change adaptation policy and action plan Establishment of Climate Change Information Centre.	Monitoring of the implementation of adaptation plans and the emerging climate change risks -Continues sensitization on climate risk especially at the local level, and also research and provision of climate information for the integration of climate change into development plans at the county level -Need to diversify livelihood systems to increase adaptive capacity -Need to put measures focusing on adaptation in the key sectors	Adaptive maps exist Developed by Department of Disaster Management Affairs in 2015 and produced by RCMRD using: Education Level of mother (2010-11). Market accessibility (travel time to major cities/towns; 2008). Health infrastructure Index (2015). Anthropogenic biomes (2001-2006). Irrigated areas (1990-2000). Literacy levels (2008)	Need for a recent vulnerability assessment Mapping	-Five indices (wealth, farm inputs, availability of infrastructures and institutions, irrigation potentials, and literacy level) influencing rural people adaptive capacity to climate change were selected; and a Five point Likert scale was used to assess the adaptive capacity to the changing climate. The results revealed the adoptive capacities are classified into categories, (High, medium and low).	-Need for increased Resources/Trainings	-A raft of measures focusing on the adaptation of six key sectors and ecosystems which are among the most vulnerable to the adverse effects of climate change has been prepared. These sectors are: Water resources, Coastline, Agriculture, Ecosystems, Tourism, and Health	-Need to put measures focusing on adaptation in the key sectors

Malawi is improving infrastructural development such as transport, investing in alternative energy sources such as geothermal, wind, solar; Increased access to information through investment in communication infrastructure; investing in initiatives such as irrigation, research in livestock and crop for the improvement of resilient breeds and alternative in agriculture such as smart agriculture initiatives; Encouraging of basic education, and engagement in several initiatives that are geared towards reduction of poverty.

The impacts of climate change are a function of exposure to hazards and perturbations and sensitivity of the affected environment. They are also mediated by the human characteristics of the society in which they occur. The adaptive capacity of society is correlated with various social factors, including gender, ethnicity, religion, class and age. Together these social factors tend to give rise to differences in human capital (such as levels of education and status of health), financial capital (wealth) and access to governance and institutions, which in turn affect ability to anticipate, cope with, and respond to change). Since these all vary on the micro scale, this is particularly important when working at sub-national level. It may be the case, for example, that an entire sub-region will be exposed to the same climate parameter or hazard, such as a cyclone. The physical environment in the sub-region may be such that its sensitivity is similar across the whole area for example in the case of a coastal location. But even so, the cyclone is likely to affect different members of the sub-region in different ways, depending on their adaptive capacity (DoDMA, 2015).

In Nigeria the adaptive capacity of rural people to climate change with particular reference to some selected communities can give idea. For the study, five indices (wealth, farm inputs, availability of infrastructures and institutions, irrigation potentials, and literacy level) influencing rural people adaptive capacity to climate change were selected; and a five point Likert scale was used to assess the adaptive capacity to the changing climate. The results revealed the adaptive capacities are classified into categories, (High, medium and low). The study recommends the development of climate change policies that would enhance the adaptive capacities of rural communities at both the state and local government levels. These policies should be specifically geared toward low adaptive capacity areas with emphasis on poverty reduction.

The adaptive capacity should include all matter related to infrastructure, poverty, education index, health expenditure, access to improved water, subscription to cellular network, travel time to nearest city, market, etc. The actual strategies include: Provision of accurate and timely weather forecasting, Enhancing agricultural extension services, Expanding and optimizing existing irrigation infrastructures; Adoption of drought-tolerant and early maturing varieties of crops; Diversifying livelihoods to improve income; Increasing and upgrading crop storage facilities; Control of pests – insects and birds; Growing more cover crops like potatoes and melon to protect soils from erosion; Stabilizing gullies and erosion sites; Improving the monitoring and evaluation of agricultural activities with realistic and measurable indicators; Helping farmers to secure agricultural insurance; Provide frequent artificial flooding downstream of earth dams; Switching to short-lived hardy crops; Recharging wetlands, digging boreholes & providing additional irrigation water; Improving transportation between the rural areas and urban centers (Adesina et al., 2011).

Faced by the challenges of climate change, Tunisia has developed and INDCs which was submitted to the Conference of the Parties to the UNFCCC. Tunisia has striven to include the issue of adaptation to climate change in the development planning process at global and sectoral levels. A raft of measures focusing on the adaptation of six key sectors and ecosystems which are among the most vulnerable to the adverse effects of climate change has been prepared. These concerned sectors are: Water resources, Coastline, Agriculture, Ecosystems, Tourism, and Health.

Tunisia has sought an international support to cover all of the additional costs for the adaptation of these sectors and fields. With its engagement with the GCF, Tunisia has the opportunity to access significant resources to finance the implementation of its National Strategy on Climate Change (SNCC) and its INDCs, especially through the Climate Finance Readiness Programme.

7. CHALLENGES IN COLLECTION, ANALYSIS AND DISSEMINATION OF CLIMATE INFORMATION AND SERVICES

i) Lack of sophisticated climate tools

The technical and computing facilities and also lack of good network of data hinder the application of some tools which would improve climate information generation. Climate tools are also not available for local scales and especially for climate downscaling purposes. Some of the technologies including satellite based systems are in limited use by CIS providers, due to lack of technical capacity to apply them. Limitation in financing has also contributed to the low pace of adoption of technology and necessary tools especially integrated climate information system.

ii) Quality

There are many players in the CIS environment in Kenya, providing various climate information services and products. However there are common frameworks for sharing of CIS information or procedures of operation directly defining the generation of user oriented climate information products. Most CIS providers have no feedback structure and also a review and documentation for the processes of the generation of their products. The CIS field in Kenya is also not fully coordinated however various service producers work in close. These hinder the process of review of the climate products and services products so as to define and justify quality.

iii) Appropriateness of scale

Different climate users have different information needs and these vary in temporal, spatial and even in form. The efforts to decentralise climate information to the county level, has open up the field for diverse demand for climate services that are appropriate for user level decisions making. Although the national level products are expected to be downscaled to the county level, the different local levels creates demands for unique products some which needs to be regenerated at the local scale. There is lack of tools to support such downscaling and the procedures are also not well developed and documented. There should be a system and tools that can enable downscaling of climate information at the local levels and also generating and retrieval of climate information at the local level to promote user required information.

iv) Communication

The diversity of user needs in the country, and also the difference in culture and language, literacy level are key challenges in the development and communication of climate information. These are compounded by lack of the right technology which allow for equal access to information to all who need it. Most climate information come in a form that might not be readily applied for user level decision making either because they are technical or the method of dissemination become a challenge hindering accessibility and applicability.

v) Interpretation

The application of climate information needs an understanding of both the technical aspect of the information and the applicative needs of the users. This requires the effort of interpreters who understand the technical aspect of the content of the climate information and can also the user applicative needs. However this is usually not the case, mainly because some of the CIS come in technical language, or may not be have the right content or form recommended for applicability. There is also the challenge of translation which considering that there is ethnical diversity in the local climate users in Kenya, and this has been one of the great challenges in developing content especially for some media being applied such as RANET, and SMS and bulletin.

vi) Lack of manpower

Most of the county/stations offices have below the recommended number of workforce, and because the provision of CIS requires some level of understanding of processes and concepts and also because of the diverse needs of the climate users at the local grounds, the human resources cannot be enough to cover all users. Even with the inclusion of various agencies and stakeholders in the CIS field in Kenya, the demand for workers has not been met. There are challenges also in the lack of tools to assist in the processes necessary for achieving an integrated climate information system.

8. OPPORTUNITIES AND RECOMMENDATIONS

i) Improve technical, technological and institutional capacity

There is a need for institutional reforms in the NMHSs to enable them to adjust to the new demands arising from changes in climate. There is a need to strengthen the legal and regulatory frameworks in the countries for climate information collection, dissemination and use operations. This includes the implementation of appropriate business and operation models that promote public private partnerships. With the changing demands caused by climate change and the opportunities that arise from it is important to enhance the capacity of the staff to be able to support such needs, and also employ various ways to avail enough human resources such as community climate observers and train them so as to increase their capacity to tackle the demand for appropriate climate services. Support should be given to establish, rehabilitate, upgrade and equip meteorological and hydrological networks so as to have enough coverage that will enable for better data for climate service provision such as downscaling of information.

There is need to increase capacity to use satellite products and also the need for strengthening capacity in climate modelling, application of modern monitoring technology including maintenance of equipment, quality control of data and calibration of the facilities. The capacity to apply ICT technology and all possible avenues in communication and transmission and dissemination of climate information should be improved, this should focus on provision of user interface that can allow for feedback process and encourage interaction between stakeholders. Efforts should be put in place to support further research on climate information and application especially in generation of climate input and in the understanding of climate systems including climate change issues.

There is also a need for institutionalizing climate data management training within all climate data collection stations, which would encompass collecting, processing, storing, updating, packaging and/or disseminating of data and information to various stakeholders. In addition, there is need to provide equipment and training for community collection of local climate data to improve access to weather data and to enhance climate projections. Recommended also is the establishing of a website for information dissemination and sharing, which would also act as a backup for the climate data. This would be coupled with utilisation of existing technologies such as Geographical Information System (GIS) and Remote Sensing. Other opportunities could be strengthening the capacities of local communities, district councils, and national agencies that usually respond to emergencies through trainings and improved emergency services.

ii) Improve coordination of CIS provision

An effective service delivery strategy should be established that includes a platform that provides forecasts of the weather's impact on the basis of information available from numerical weather predictions, observations, and risk assessments, and user specific products. The strategy should define a proper coordination mechanism for the various ongoing CIS processes. The platform can include a web-based information portal for climate service providers, service and product portfolios including methods of generation, and encourage of continuous interaction of various stakeholders and user. There is also a need to develop a digital library of all climate-relevant information from all sectors to make the services more user-oriented.

A formal framework that will allow networking of CIS providers and key stakeholders, and provision of standard operation procedures for products generation and dissemination. An approach to protect data ownership and equally eliminate barriers for effective exploitation of climate information is needed.

iii) Establish CIS quality management system

At present there is no framework for the evaluation of climate services and climate information content, which might make it difficult for users to identify high-quality climate services. An

accreditation and quality management system geared toward appropriate definition of climate services, setting standards, labelling, and validation is required. There should be put in place standard procedures for evaluating climate data and products and also offer. Encouragement of establishment of effective and interactive user feedback mechanism can also provide avenue for evaluation and improvement of climate information products and services.

iv) Foster partnerships of CIS

There is greater need to collaborate in the production and generation of climate information products especially in co-designing of climate products with end users and providers, more gap in the provision of climate information can be bridged through such effort. Promoting the adoption of effective CIS will require well-designed, inclusive, and innovative systems with clear quality checks and balances. Priorities include strengthening farmers' knowledge of CIS benefits and facilitating their use in decision making. This will result in more robust CIS systems and user-led approaches. The use of co-learning and co-management strategies involving providers and users should be encouraged. Trans-disciplinary, multidisciplinary research to support co-development of weather and climate services is also needed to enhance CIS knowledge integration. CIS providers and users working closely together will, in turn, lead to mutual accountability.

There should also be creation of increased awareness on available climate information and also on potential and emerging climate information products and services.

v) Promote integrated CIS into ongoing initiatives

Although NMHSs retain its central role in climate information management, giving priority to the provision of forecasts and warnings of severe weather, floods, and droughts to the private sector can contribute particular competencies in the form of innovative technology, design of resilient infrastructure, development and implementation of improved information systems, and the management of complex projects. A legal framework that includes data policy as a key element should be established to guide public-private partnership. A clear guideline is required on what should be provided as public goods service and what should be cost-recoverable services. The private sector can also produce and deliver valued added weather, climate, and environmental products and services, and promote their widest and most productive commercial application to enhance the efficiency of sectors that are sensitive to weather and climate variability.

Improvements should be made in the quality and appropriateness of data collected through networking, development and use of innovative technologies and capacity building. Increased recognition of the devastating impact of climate change and the need for adaptation, innovations in information and communication technologies, and increased civil society participation in development activities are some of the opportunities that should be utilized for propagating rigorous efforts in building climate data management capacity in the countries.

Finally, developing advanced partnerships between the government and private sector is a solution where government investment in meteorological services is likely to remain a small part of overall spending. National consortia involving a wide group of stakeholders with mutual interests in weather and climate information can collectively fund, maintain and utilize observing networks. However, a framework is needed to ensure that all socially-relevant information is exchanged freely and remains freely available in the public interest. The top priority for improvement in weather and climate services is optimization and integration of the observation, modeling, and prediction system with a special focus on improved observations of water and other key variables.

- Collaborate with others institutions in the production and dissemination on weather and climate information; the weather and climate services partnership will be more effective in serving the country and individual clients if the public, private, and academic sectors focus together and collaboratively on the priorities and resources that are critical for progress.

- Search for funds to strength the capacity of staff (developing institutional capability to provide more effective climate information) and users in the collection, analysis, generation and interpretation of weather and climate data and information;
- Build strong climate information system by establishing strong interactions between information providers, researchers and users (policy makers, stockholders, and end-users);
- Climate Services serves as a means of communication, dialogue and exchange platform between researchers, operational practitioners, stakeholders and end-users;
- Using the new technology approach, it will be an opportunity to use mobile phone and media (radio) in the communication of weather and climate service;

9. CONCLUSION

At present climate data is little used in development processes in the target countries because of weaknesses in both demand for, and supply of, pertinent climate services. However, climate variability and change are posing significant challenges to societies and timely communication of climate information will help prevent the economic setbacks and humanitarian disasters that can result from climate extremes and long term climate change (UNECA, 2011). Climate information plays a crucial role in national development planning, for managing development opportunities and risks and for mitigation and adaptation. Efficient application of climate services requires the integration of climate information into the policies of various sectors. Climate services include, among others, the dissemination of climate information to the public or a specific user. Strong partnerships among providers, such as NMHSs, and stakeholders, including government agencies, private sectors, and academia, for the purpose of interpreting and applying climate information for decision making, sustainable development, and improving climate information products such as predictions and outlooks are necessary.

The state of the existing facilities for collection, recording and analysis of climate is deplorable and continue to deteriorate over the years. Continuous record of climate data for 30 years is only found in few stations. Due to lack of investment and the brain drain, meeting of demand, the level of technical expertise able to support climate monitoring network, climate data processing, and the current level of activity are generally low. As a result of these problems, government institutions, developmental practitioners and service providers engaged in climate sensitive sectors of the economy are rarely oriented to plan or manage climate risks. In Cameroon for instance, there are only 22-24 functioning weather stations with only 20 submitting weather readings to WMO. The funding for the provision of climate services by the government is very low and this has exacerbated ability to access quality climate information and products. There have been efforts by various organizations and donors to help bridge the gap in capacity needs but a lot more needs to be done. Delaying actions by governments might increase both the rate and magnitude of damage from climate change and hence the costs of adaptation and repairing damage. The lack of risk management policies has been due to inadequate means to predict climate conditions with sufficient skill and lead time. A seasonal forecast of rainfall has not been properly developed in Cameroon. With a marked record of droughts in the north, high inter-annual variability of rainfall in the south and its largely agricultural economy, Cameroon could benefit immensely from seasonal forecasting. Research on how to disseminate information and ensure its applicability both at the farm and household level would be crucial. There is need to ensure good forecasts on climate and production. This will ensure early responses to climate problems, bolster sustainable livelihoods, and promote adaptations. This could be coupled with an intensification of effort to disseminate other information, for example, price forecasts and technology and management information, and ensure it is disseminated at the farm level. Explicit information would enhance the nature and speed of the farmers' response.

The government of Kenya is well aware of the consequences of climate change and the need for climate information. Climate change provides emerging challenges and opportunities for CIS provision which needs to be explored. There are various challenges caused by limited technical capacity, human resource needs, financial challenges, and general operation environment for CIS provision. These challenges hinder provision of climate information especially at the grassroots and level, considering the recently established decentralization initiative for establishment climate information to the county level by the KMD. These challenges should be overcome but most of all a framework for the collaboration and integration of CIS activities needs to be established so as to properly coordinate climate service within the country.

Nigeria needs to adopt a more comprehensive and coordinated approach to the issues of climate change within its national development context than what currently obtains. Significant national efforts are needed to ensure that climate change concerns are properly integrated into the country's Vision 20:2020, which currently constitutes the country's blueprint for sustainable rapid socio-economic development. Up-to-date data that is critical for climate change analysis and information dissemination, as well as improve understanding of the climate problems in the context of sustainable national development, is not readily available in Nigeria in a coherent and accessible manner. There have been recent efforts by NIMET to package climate information with explanation for possible impact on agriculture. Initially, NIMET only concentrated in providing daily forecasts for the aviation industry only. There is therefore need to reinforce its efforts at putting in place a comprehensive climate change information management system that is updated periodically and readily accessible.

Approximately 85% of Malawi's population lives in rural areas, with over half in poverty and most engaged in smallholder agriculture. Addressing a huge challenge as this requires detailed acquisition, synthesis and analysis of data and the distribution of understandable climate information to policymakers as well as improving climate databases, and also enhancing and scaling-up climate information sharing. Efforts to create a modern real-time, climate system requires strengthening capacities of national and regional institutions and existing networks to use and disseminate climate information to assist development planning. This can be enhanced through strengthening the capacity of the various ministries involved in climate data management as this will enable them deploy appropriate climate information and best practices in order to effectively implement climate-proof policies and practices that can help them become more resilient and productive under changing climate.

Tunisia is fairly advanced in the process of production and dissemination of climate-based information and services for decision-making. The NIM (the National Weather Service) is the reference service in charge of processing and provision of climate-based information/data and services in Tunisia. Its products and services are destined to two major customers/users: aeronautical sector and other (professionals and general public related to marine, tourism, agriculture, energy, etc.). The NIM has maintained a good cooperation with the CNRM of METEO-France. In terms of equipment, since 2004, NIM has acquired a super calculator which has been equipped with a high resolution model coupled version ARPEGE-CLIMAT. Various climate models have been used to generate illustrative scenarios related to the Tunisian climate context: CORDEX simulations models and ENSEMBLES project simulations models applied to climate change scenarios. Despite the growing knowledge base built and managed by NIM and the collaboration with several technical stakeholders important information and knowledge gaps still need to be filled out.

There is increasing need to collect high quality climate information, analysis and packaging into products that target specific users and disseminated using appropriate channels to reach the users promptly in order to make timely decisions. However, for this to happen, countries have to invest in modern efficient technology, recruit and train staff on how to use the upgraded technology and how to package and disseminate the information so as to make sense for the end users. To achieve all these, it will be important and necessary for governments to partner with the private sector as well as solicit support from donors, researchers and other stakeholders.

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