Mainstreaming/Integrating Climate Information and Services into Legislation, Development Policies, Plans and Practices:

Training Resources for Capacity Building for Legislators, Policy Makers and Civil society

climatechangesolutions

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report

Table of contents

LIST OF TABLES

LIST OF TEXT BOXES

LIST OF FIGURES

LIST OF ACRONYMNS

ACOMET	African Conference on Meteorology
ADAPT	Assessment and Design for Adaptation to climate change
ADB	Asian Development Bank
ALM	Adaptation Learning Mechanism
AMCOMET	African Ministerial Conference on Meteorology
APF	Adaptation Policy Framework for climate change
AWS	Automated Weather Stations
AU	African Union
BAU	Business As Usual
CC	Climate Change
CCA	Climate Change Adaptation
CDKN	Climate and Development Knowledge Network
CESM	Community Earth System Model
CI	Climate Information
CIS	Climate Information Service
ClimateFIRST	Climate Framework Integrating Risk screening tool
CMS	Coupled Model Systems
COP	Conference of Parties
CRISP	Climate Risk Impacts on Sectors and Programmes
CRiSTAL	Community-based Risk Screening tool - Adaptation and Livelihoods
DfiD	UK - Department for International Development
DRs	Disaster Risks
DRR	Disaster Risk Reduction
EBM	Energy Balance Model
EWS	Early Warning Systems
FCFA	Future Climate for Africa
FIT	Feed-in Tariffs
FONERWA	Rwanda National Fund for environment and climate change
GCMs	General Circulation Models or Global Climate Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFCS	Global Framework for Climate Services
GHGs	Green House Gases
GIS	Geographical Information Systems
IGAD	Inter-Governmental Authority on Development
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
ICT	Information Communication Technology
IT	Information Technology
KMD	Kenya National Meteorological Department
LDCs	Least Developed Countries
M&E	Monitoring and Evaluation
NAPA	National Adaptation Programmes of Action
NGOs	Non-governmental Organizations
NMHSs	National Meteorological and Hydrological Services
NMS	National Meteorological Services
OECD	Organisation for Economic Co-operation and Development
ORCHID	Opportunities and Risks from Climate Change and Disasters
PSAs	Public Service Announcements
PPP	Public Private Partnerships
RCMs	Regional Climate Model

RE	Renewable Energy
RECs	Regional Economic Communities
RMS	Risk Management Strategy
SAAGA	Seeding Center for Aeronautical Aviation
SEA	Strategic Environmental Assessment
SEI	Stockholm Environment Institute
SMS	Short Message Service
TMA	Tanzania Meteorological Authority
UK	United Kingdom
UK-CIP	UK Climate Impacts Programme
UNDP	United Nations Development Programme
UN-EHS	United Nations University Institute for Environment and Human Security
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNPEI	United Nations - Poverty-Environment Initiative
USSD	Unstructured Supplementary Service Data
USAID	United States Agency for International Development
VAs	Voluntary Agreements
WB	World Bank
WEAP	Water Evaluation And Planning
WMO	World Meteorological Organisation
WRI	World Resources Institute

BACKGROUND/PURPOSE OF MANUAL

Introduction

This guide was developed to build the capacities of decision makers in the use of Climate Information and Services for long term planning and decision making. It therefore defines Climate Information and Services, gives an overview of the types of Climate Information and its uses, categorises users of Climate Information and Services as well as the uses of Climate Information in agriculture, infrastructure, disaster risk reduction, urban and spatial development, and sectoral planning. It also gives an overview of legislation for improving Climate Information and Services, including budgeting and institutional development, and, the role of Climate Information in domesticating international agreements such as the Paris Climate Talks. Finally, it gives recommendations on how to mainstream Climate Information and Services into laws, plans and policies for better long term decision making.

Who is the Intended Audience?

This Guide has been developed to build the capacities of policy makers in key decision making portfolios in the legislature, in all sectors of government development policy making, and in relevant sectors in Regional Economic Communities and other regional bodies. It is also suitable for decision makers in municipalities and other sub-national authorities.

What is the Purpose of this Guide?

This guide therefore aims to enable decision makers to better understand the importance of Climate Information and Services in decision making. It explains what Climate Information and Services are and their uses in planning and decision making. It explains the physical structure of climate information and services, describes the global context of climate information and services and delves into the products and services available for decision makers. It also analyses the state of climate information services in Africa, and gives a comprehensive analysis on what can be done to strengthen climate information and services on the continent, by mainstreaming Climate Information and Services into laws, plans and policies.

This Guide therefore seeks to contribute towards the resolution of the limited use of climate information and services in development policies, planning and practice most of the continent, by building the capacity of decision makers and experts at all levels to develop and implement national strategies for mainstreaming CI/S into decision making.

It is divided into the following sections:

1. Introduction to Climate Information and Services
2. Types of Climate Information
3. Climate Services
4. Users and Uses of Climate Information
5. Climate Information and Services and Legislation
6. Mainstreaming Climate Information into Laws, Plans and Policies
7. Conclusions and Recommendations

STRUCTURE OF THE MANUAL

Chapter 1

Introduces the concept of Climate Information and Services. Several definitions of Climate Information and Services exist, but in this guide, Climate Information refers to data on temperature, rainfall, wind, humidity, sunshine hours and other measurable weather related factors. Climate Information services refers to the provision climate information in a way that assists decision making by individuals and organizations. Climate information is useful for long term decision making, and is important in guiding adaptation planning at various levels of government; guiding sectoral planning; supporting scenario planning, allowing consideration of future risks as well as implications on different development pathways; identifying areas with high potential for future vulnerability to climate risk; climate proof development plans and investments and; guide long-lived, large-scale infrastructure investments, such as dams, ports and roads in order to reduce likelihood of damage and negative returns on investment.

The section also introduces decision makers to the infrastructure, human skills and other requirements necessary for the production and delivery of Climate Information and Services. These include the physical requirements, which are weather stations equipped with observational equipment to capture climate data and software necessary to analyse climate data. Climate Information Services in Africa are hampered by a lack of access to reliable climate information and the lack of capacity of disseminating it due to, among other issues, a lack of climate information infrastructure; inadequate finance; limited technical capacity to manage weather information systems; systematic processes for packaging, translating and disseminating climate information and warnings and; a lack of integration with disaster management systems.

Chapter 2

Delves deeper into the types of Climate Information and Services that are available for decision making. This includes weather forecasting tools and climate scenarios, which are plausible and simplified representation of the future climate constructed from climate simulations for longer term planning. The section also elaborates on climate models, which are representations of the climate system developed to help scientists understand present climate as well as exploring possible climatic conditions in the future. Climate models help policy and decision makers in understanding the future climate risks and uncertainties, allowing them take measures to address the future economic and social impacts of climate change. Emissions scenarios are models used by scientists that attempt to project future scenarios based on projections of GHG emissions to assess the future vulnerability to climate change.

The use and interpretation of historical climate information is also discussed, focusing on the applications of data such annual rainfall totals, rain season start dates, growing season length and temperature in decision making at the policy level. This includes 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.

Chapter 3

Is dedicated to Climate Services and products. Climate products can be categorised as basic, intermediate or advanced and each are useful at various levels of decision making. Basic climate products consist tables and charts showing historical climate information stemming from observed climate data along with projected mean future changes stemming from climate models. Basic climate information is used to raise awareness, scan for present and future risk as well as for high level governance. Intermediate climate information is used to undertake vulnerability/impact studies, in order to increase resilience and facilitate the early development of adaptation plans.. Advanced climate information consist of information that is focused on projected future climate changes. Advanced climate information is often tailored specifically to their needs and will often not be relevant or usable by others. This information is used for to evaluate adaptation measures and to undertake research and development. Due to their high level of specificity, advanced climate products are usually developed on request. Communicating Climate Information is the responsibility of National Meteorological Service institutions within a country. These agencies are supported in distributing information by the media, other government agencies, the private sector and Non-Governmental Organizations. Climate Information is generally communicated through traditional media channels, information bulletins, internet, public displays and social forums, text message services, public service announcements and directly upon request for information. Stakeholders and users of Climate Information consists of farmers, local communities, policy makers, the private sector, and, government ministries and agencies.

Chapter 4

Dwells on practical application of CI in Development planning, Agricultural and Extension Services, Infrastructure and Construction, Disaster Risk Reduction, Urban and Spatial Development Planning, INDCs and sectoral Planning. Notably, this selected areas are closely linked to development hence building their resilience is imperative for economic growth. In-addition, this Chapter demonstrates how each of the aforementioned '*areas*' is impacted by Climate Change and how integrating CI can reduce their vulnerability. In-order for CI to be effective in decision-making, especially in the face of change and uncertainty, it should meet the following: (a) Respond to user needs and priorities hence of practical application to decision makers, communities and other stakeholders; (b) Downscaled – to draw effective localised conclusions for plans and policies and to clearly identify uncertainties, opportunities and barriers; (c) Accurate so as clearly define risks to be accommodated; (d) Accessible and easy to interpret by users; (e) Collected over a long period of time (historic trends) and frequently updated; (f) Cost effective – since there are limited resources to manage information systems; (g) and Tailored to respond to specific needs of users, risks, vulnerable populations and ecosystems, in order to avoid information overload.

Chapter 5

Looks at the role of legislation in strengthening Climate Information and Services. Developing and distribution of useful climate information and services that meet the needs of different users within a country requires the input of several different institutions within a country. In Africa, there are gaps in information, communication, policy, practice, and institutional capacity, compounding the difficulties of creating useful climate services within the country.

Addressing these challenges requires the design of a framework for Climate Services at the National level that would lay the foundation for effective climate information services by improving on three crucial elements as follows: Improving the quality and availability of information; strengthening collaboration between and among user and provider communities and developing enabling policies & practice that encourage the connection of data and information to policy and practice. Climate Information infrastructure in Africa suffers from underinvestment, and in order to reverse this trend and increase budgetary allocations, the value of climate information in development needs to be emphasised upon. Furthermore, institutional weaknesses need to be addressed in order to strengthen Climate Service delivery, and in some cases, there is a need to develop policy and legal frameworks to guide the provision of meteorological services, including their establishment in some countries.

Chapter 6

Focusses on Climate mainstreaming. Effective mainstreaming of CI in planning and routine incorporation of climate risk into decision-making will contribute to CC mitigation and adaptation. Three main approaches can be adopted when mainstreaming climate change into developmental policies: (a) Climate Proof Approach; (b) Climate First Approach (c) The Development First Approach. The Chapter provides approaches and guidelines to mainstreaming climate information into legislation, projects and programmes. In-addition, policy and economic instruments available to governments for incentivizing mitigation actions are also highlighted. These include: Regulations and Standards, Taxes and charges, Tradable Permits, Voluntary Agreements, Subsidies and Incentives, Information Instruments, and RE Feed-in Tariffs. Challenges facing climate mainstreaming are also discussed.

Chapter 7

Sums up the entire document by outlining the key observations, gaps, challenges and proposed recommendations. The significant effort being made by governments across Africa to mainstream CC into development planning and legislature is applauded however, challenges mentioned in chapter 6.6 still impede this process. The role of ICT in positively transforming the CI/CIS in terms of the quality, accessibility and scale of CI is also acknowledged. This chapter emphasizes the potential of CI/CIS in building Africa's resilience. One of the main constraints faced by decision makers in integrating CI into development planning is lack of information on criteria for prioritizing climate-resilient responses, this includes information on the economic costs of climate change. In addition, reluctance to integrate CI/CIS into development planning by political leaders is triggered by the fact that climate change is an unpredictable long-term issue that requires managing risks and making decisions based on considerable uncertainty, with limited and/or imperfect information. This contradicts with the political leaders' and government officials' priorities e.g., they are mainly concerned with political cycles and near-term issues since they will be in power for a short term. Notably, CIS has significantly progressed over the years however, gaps in terms of quality, coordination and analysis of the information and in its dissemination and communication need to be addressed. Key recommendations put forth include**:**

1. Tailor CI to fit into long and short term activities in political manifestos by reigning governments
2. Downscale climate products and interpret in a lay man's language e.g., Generate area specific maps and interpret the outputs. This information will guide future area members of parliament in determining development activities.
3. Central economic government institutions such as Ministry of Finance and Planning should co-ordinate climate change activities – This institutions should set a mandatory clause that requires all sectors to indicate how CI has been mainstreamed in their budgets – This will ensure climate change mainstreaming becomes a standard practice
4. Integration of CI into economic instruments such as taxes, fines, standards and regulations etc. will obligate people and companies in the government and private sector to enhance environmental integrity.
5. Widely disseminate INDCs in a lay man's language – decision makers, government officials, political leaders, private developers among others should refer to INDCs when making development decisions and development planning.
6. Raise awareness about importance of CI/CIS with emphasis on development and environmental sustainability.

1 INTRODUCTION TO CLIMATE INFORMATION AND SERVICES

1.1 Definition of Key Terms/Concepts

1.1.1 Weather

Weather is the fluctuating state of the atmosphere around us, characterized by temperature, wind, precipitation, clouds and other weather elements. Common examples of weather phenomena include fog, dust storm, hailstorm, and so on. Weather is the result of rapidly developing and decaying weather systems such as low and high pressure systems, and so on.

1.1.2 Climate

Climate refers to the average weather and its variability over a certain time-span and a specified area. The World Meteorological Organisation (WMO) suggests 30 years as a standard time span for defining climate of a region. Common examples of climate are tropical, polar, marine, Mediterranean, and so on. Measurable climate variables include: Rainfall, Air temperature, Wind, evaporation, Relative humidity, Water vapor, Atmospheric pressure, Sunshine hours

- **While weather fluctuates from day to day, climate is the average weather pattern of a given place over a longer duration.**

1.1.3 Climate Information

Climate Information is used to refer to climate data that is obtained from two sources, one from observations of the climate (such as temperature and precipitation from weather stations for example) and two, from climate model outputs. The former provides information on historical events while the latter can simulate both past and future periods. (Charron, 2014).

Climate information entails “the transformation of climate related data together with other relevant information and data into customized products such as projections, forecasts, information, trends, economic analyses, assessments (including technology assessments), counselling on best practices, development and evaluation of solutions, and other services in relation to climate or responding to climate change that are of use to society.”

- **For the purposes of this report, climate information** includes data ranging from short term weather-related information over days and weeks, to information that cover longer time spans.

1.1.4 Climate Information Services

Climate Information Services involve providing climate information in a way that assists decision making by individuals and organizations (WMO, 2014). A service requires appropriate engagement along with an effective access mechanism and must respond to user needs (WMO, 2014).

It is a user-driven development and provision of knowledge for understanding the climate, climate change and its impacts, and guidance in its use to researchers and decision makers in policy and business (JPI Climate 2011, 44).

1.2 Infrastructure, human skills and other requirements for the production of Climate Information and delivery of Climate Services

Weather information is generally collected from weather stations, which are facilities, either on land or sea, with instruments and equipment for measuring atmospheric conditions to provide information for weather forecasts and to study the weather and climate. The measurements taken include temperature, barometric pressure, humidity, wind speed, wind direction, and precipitation amounts. In order to gather this information, a variety of tools, briefly described below, are used:

- **Thermometers:** They measure the temperature.
- **Radar systems:** Are used to create maps of rain and snow, and measure the motion of rain clouds.
- **Barometers:** Measures the pressure in the atmosphere.
- **Rain gauges:** Measures rain fall
- **Wind vanes:** Measures wind speed. These work alongside anemometers
- **Transmissometers:** They measure visibility by shining a laser through the air and detecting how much light is lost.
- **Hygrometers:** Measures humidity (how much water the air contains)

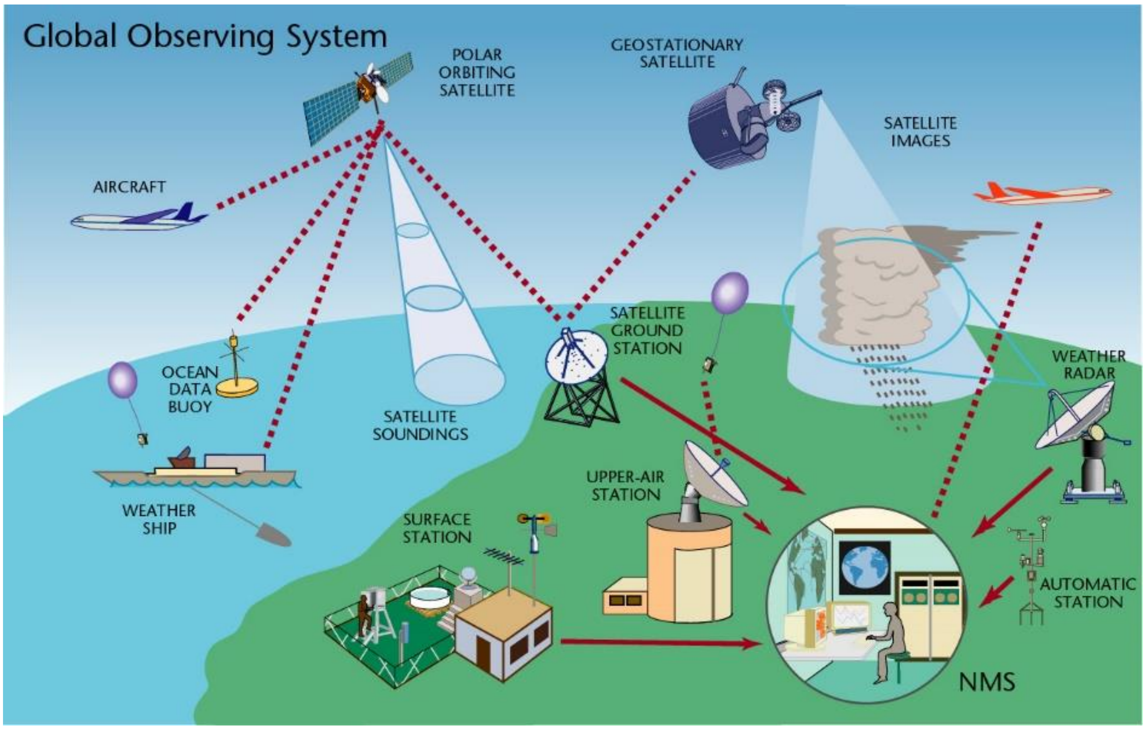

Figure 1: Global Weather Observing System

1.2.1 Dissemination of Climate Information to the public or a specific user

This requires strong partnerships among providers, such as National Meteorological and Hydrological Services (NMHSs), and stakeholders, including government agencies, private interests, and academia, for the purpose of interpreting and applying climate information for decision making, sustainable development, and improving climate information products, predictions, and outlooks (WMO, 2014)

1.3 Status of Climate Information and Services in Africa

Climate stresses and low adaptive capacity are increasing Africa´s vulnerability to climate change. Climate related shocks to the economy, vulnerable populations, ecosystems and infrastructure threaten development goals and poverty alleviation strategies. The ability of decision-makers to understand and communicate the likely impacts of climate change is of critical importance in adapting development plans to new climate realities.

However, the lack of access to reliable climate information and the lack of capacity of disseminating it prove to be significant obstacles in allowing governments and populations to develop the correct tools to address the changes that will be brought on as a result of climate change.

Lack of access to reliable climate information is due to, among other issues, a lack of climate information infrastructure; inadequate finance; limited technical capacity to manage weather information systems; systematic processes for packaging, translating and disseminating climate information and warnings and; a lack of integration with disaster management systems.

A more comprehensive SWOT analysis of the Climate Information services in Africa can be found in Annex 1. Annex 2 provides brief studies of the status of climate information services in various African countries.

1.4 Importance of Climate Information to Long Term Planning

There is a growing need to improve our understanding of climate, climate predictions and our use of climate information to serve societies needs better, particularly in the face of climate change and the need to put in place adaptation measures. Climate Information plays the following roles:-

- Effective climate services will facilitate climate-smart decisions that will reduce the impact of climate-related disasters, improve food security and health outcome, and enhance water resource management, for example.
- An understanding of climate information is essential in making informed and appropriate plans to deal with climate related impacts through adaptation, risk reduction and development actions, particularly as the future looks increasingly uncertain.
- Flexible and proactive planning enabled by climate information helps vulnerable communities, service providers and intermediaries to continuously adjust their plans as climatic stresses and shocks unfold, as well as to maximise on opportunities. This capacity results in resilience to a continually variable and changing climate.
- Guide adaptation planning at various levels (local/ national)
- Guide sectoral planning including agriculture, energy, urban planning, and, coastal management

- Support scenario planning, allowing consideration of future risks as well as implications on different development pathways
- Identify hotspots or areas with high potential for future vulnerability to climate risk. This can help authorities plan for adaptation at multiple scales, as well as climate proof development plans and investments
- Guide long-lived, large-scale infrastructure investments, such as dams, ports and roads. Information on future risk is used in the design and implementation of critical infrastructure in order to reduce likelihood of damage and negative returns on investment

2 TYPES OF CLIMATE INFORMATION

2.1 Climate Products

Climate information is collected and assessed and assembled into products that are disseminated to users, and the users in turn provide feedback on their needs for improvement of the products.

Climate information and products include an extensive array of general and user-specific information, prediction, warning and advisories that may range from general public information to customized products.

Climate service enables decision-makers and user communities to assess, and prevent or prepare for, potential impactful weather events; the weather service enables action in response to specific events as they become imminent (Charron, 2014).

To be useful, climate services should consist of:

- **Products** – identifying, generating and making available a set of user-relevant and user friendly products concerning climate variability and change that include information about the impact of these phenomena on society;
- **Support –** providing assistance in interpreting those products and, in collaboration with relevant stakeholders, helping identify a sensible set of decision options;
- **Feedback –** on-going communication between users and providers so that ways of improving products and support can be identified continually. Effective climate services will facilitate climate-smart decisions that will, for example, reduce the impact of climate-related disasters, improve food security and health outcomes, and enhance water resource management. They can provide advance warning of future potential risks and opportunities several weeks, months, years and decades ahead, depending on the nature of the risk. This advance warning can be particularly effective when integrated with weather services.

2.2 Types of Climate Information

2.2.1 Forecasting and Scale

Forecasting: Weather forecasting is a prediction of what the weather will be like in an hour, tomorrow, or next week. It involves a combination of computer models, observations, and a knowledge of trends and patterns. By using these methods, reasonable accurate forecasts can be made up to seven days in advance.

Scale: Meteorology can be divided into distinct areas that depend on both time and spatial scales. At one extreme of this scale is climatology. In the timescales of hours to days, meteorology separates into micro-, meso-, and synoptic scale meteorology. Respectively, the physical size of each of these three scales relates directly with the appropriate timescale.

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Microscale meteorology: Microscale meteorology is the study of atmospheric phenomena on a scale of about 1 kilometre (0.62 mi) or less. Individual thunderstorms, clouds, and local turbulence caused by buildings and other obstacles (such as individual hills) are modelled on this scale. (American Meteorology Society, 2000)

Mesoscale: Mesoscale meteorology is the study of atmospheric phenomena that has horizontal scales ranging from 1 km to 1000 km and a vertical scale that starts at the Earth's surface and includes the atmospheric boundary layer, troposphere, tropopause, and the lower section of the stratosphere. Mesoscale timescales last from less than a day to the lifetime of the event, which in some cases can be weeks. The events typically of interest are thunderstorms, squall lines, fronts, precipitation bands in tropical and extratropical cyclones, and topographically generated weather systems such as mountain waves and sea and land breezes.(American Meteorology Society, 2000)

Synoptic scale: Synoptic scale meteorology is generally large area dynamics referred to in horizontal coordinates and with respect to time. The phenomena typically described by synoptic meteorology include events like extratropical cyclones, frontal zones, and to some extent jet streams. All of these are typically given on weather maps for a specific time. The minimum horizontal scale of synoptic phenomena is limited to the spacing between surface observation stations. (American Meteorology Society, 2000)

Global Scale: Global scale meteorology is the study of weather patterns related to the transport of heat from the tropics to the poles. Very large scale oscillations are of importance at this scale. These oscillations have time periods typically on the order of months, such as the Madden–Julian oscillation, or years, such as the El Niño–Southern Oscillation and the Pacific decadal oscillation. Global scale meteorology pushes into the range of climatology. The traditional definition of climate is pushed into larger timescales and with the understanding of the longer time scale global oscillations, their effect on climate and weather disturbances can be included in the synoptic and mesoscale timescales predictions. (American Meteorology Society, 2000)

2.3 Climate Modelling/Scenario Building

Climate scenarios are a plausible and simplified representation of the future climate, constructed from climate simulations. They represent the difference between the current climate and a future climate. In essence, they represent a more tailored product than the output of a climate model (where the time steps are minutes long). Climate scenarios give the portrait of the future by averaging the outputs of the simulations into a temporal resolution that is better suited to impact studies (over years, or seasons, or days for example). They are arguably the climate information product most often used to evaluate the potential impacts and consequences of our changing climate. Climate scenarios are generally grouped into the following classes (Charron, 2014):

- **Synthetic scenarios** are produced by varying a particular climate variable by a realistic but arbitrary amount (such as temperature and precipitation) to obtain probable futures. They are also often called ‘what-if’ scenarios, where hypothetical futures are derived based on the best available information. They are useful for exploring limits of tolerable changes, such as finding out the maximum temperature rise permissible before crop production begin to suffer.
- **Analogue scenarios** are constructed by identifying recorded climate regimes that resemble the future climate of a given region. Depending on the type of analogue, they are useful for learning more about the relationship between ecosystems and climate change; exploring vulnerabilities and some adaptive capacities and; characterizing warmer periods from the past.
- **Climate model scenarios** are constructed using climate data output from climate models that simulate the future response of the climate to increasing greenhouse gas concentrations. Climate scenarios are useful for providing high resolution information at global/continental scales and for learning purposes.

<u>Types of climate models</u>

1. **Energy Balance Model:** EBMs are very simple models that focus on the energetics and the thermodynamics of the climate system. For example, a simple EBM can be used to estimate the surface temperature of the Earth, as well as the response of surface temperatures to external changes external (including human-induced perturbations). (Mann, 2014).
2. **General Circulation Models or Global Climate Models:** GCMS are the most advanced tools currently available for weather forecasting as well as understanding climate and projecting climate change. They are used to represent physical processes in the atmosphere, ocean, cryosphere and land surface, and integrate a variety of complex equations to simulate physical, chemical and biological conditions. Complex GCMs are used by the IPCC to summarise predictions about future climate change. (IPCC, 2013)
3. **Coupled Model Systems:** CMSs are models that combine separate models representing the atmosphere, ocean and land surface into one model. When it comes to simulating the general behaviour of the climate system over lengthy periods, however, it is essential to use models that represent, and where necessary conserve, the important properties of the atmosphere, land surface and the oceans in three dimensions. At the interfaces, the atmosphere is coupled to the land and oceans through exchanges of heat, moisture and momentum. These models of the climate system are usually known as coupled GCMs. (WMO, 2013)
4. **Regional Climate Model:** RCMs are models with higher spatial resolution than GCMs and provide more detailed simulations for a particular location. They work by increasing the resolution of the GCM in a small, limited area of

interest, such as Eastern or Southern Africa. (WMO, 2013) RCMs were developed because GCMs do not provide very detailed information at smaller scales. RCMs provide useful information that can be used for practical planning of local issues such as water resources or flood defenses in regions, countries and localities.

Climate models are not perfect, but they are doing very well and currently represent the best attempt at understanding future climate change. They pass the tests of predicting the past, and go even further. For example, scientists still do not understand what causes El Niño, a phenomenon in the Pacific Ocean that affects weather worldwide. Consequently, there is no way to program El Niños into a Global Climate Model. However, they show up because the models spontaneously generate their own El Niños, using the basic principles of fluid dynamics to simulate a phenomenon that remains mysterious to scientists today. (IPCC, 2013)

Text Box 1: How Accurate are Climate Models?

Current climate projections indicate that in the future (WMO, 2014):

- **Global precipitation:** Precipitation will generally increase in tropical regions (such as the monsoon regimes) and over the tropical Pacific in particular. There is projected to be general decreases in the subtropics, and increases at high latitudes. The Intensity of precipitation events is projected to increase, particularly in tropical and high latitude areas. Even in areas where mean precipitation decreases (most subtropical and mid-latitude regions), precipitation intensity is projected to increase meaning that there would be longer periods between rainfall events. There will be greater risk of drought especially in mid-continental areas during summer
- **The rate of climate change would become too rapid** for some species to move sufficiently fast, causing extinction of more than half of the species alive today
- **Crop production would be at high risk** due to desertification
- **Sea levels would rise by 1 meter or more,** causing massive displacement of people living in coastal areas and cities

2.4 What are Emissions Scenarios and why are they Important?

Emissions scenarios describe future releases into the atmosphere of GHGs, aerosols, and other pollutants and, along with information on land use and land cover, provide inputs to climate models. They are based on assumptions about driving forces such as patterns of economic and population growth, technology development, and other factors. They assist in climate change analysis, including climate modelling and the assessment of impacts, adaptation, and mitigation. (WMO, 2014)

Levels of future emissions are uncertain and thus scenarios provide alternative images of how the future may unfold. Their range reflects our current understanding and knowledge about underlying uncertainties and is consequently subject to some changes as new data emerges on the factors that drive them and as governments and the global population make choices that affect their emissions. (IPCC, 2007).

2.4.1 The Paris Agreement and Emissions Levels

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C. The agreement is due to enter into force in 2020.

Governments agreed to; a long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels; to aim to limit the increase to 1.5°C, since this would significantly reduce risks and the impacts of climate change; on the need for global emissions to peak as soon as possible, recognizing that this will take longer for developing countries; to undertake rapid reductions thereafter in accordance with the best available science.

In order to do this, countries would need to make serious efforts to reduce carbon emissions to zero by 2050, make serious investments in renewable energy and possibly develop methods of removing carbon dioxide from the atmosphere.

3 CLIMATE SERVICES

Broadly speaking, climate information comes in the form of:

- Statistical summaries of historical data
- Indices derived from such data (e.g. climatological information)
- Forecasts on various time scales (e.g. daily weather forecasts and seasonal climate outlooks).
- Warnings and Alerts

The level of sophistication of climate information can be categorised as basic, intermediate or advanced as further explained in the following sections. Generally, African NMS provide basic climate information, while regional bodies such as the Inter-Governmental Authority on Development (IGAD) Climate Prediction and Application Centre. (ICPAC) as well as international bodies such as the World Meteorological Organization provide more sophisticated information.

3.1.1 Basic Climate Information

For basic information, that is, historical climate information stemming from observed climate data along with projected mean future changes stemming from climate models

- **Synthesis table** – used to present both past and future changes
- **Climate normal** – is used to present climatic averages (e.g. 30-year)
- **Historical trends –** used to present long-term evolution of the past climate
- **Global changes –** used to present projected changes on a global scale
- **Map of projected regional changes –** used to present projected changes on a smaller spatial scale

3.1.2 Intermediate Climate Information

This category only includes information about projected future climate changes. In addition to the information communicated in the basic category, it includes a series of more complex formats that may require a more in-depth analysis of the figures.

- **Spatial analogue –** used to present where the historical climate will be in the future
- **Scatter plot** – used to show changes in climate variables for different climate simulations
- **Map of projected future values** – used to present projected future values of a climate variable
- **Evolution of future values** – used to present projected evolution of future values
- **Cumulative distribution function –** used to present the distribution of the projected future values

3.1.3 Advanced Climate Information

The climate information in this third category is focused on projected future climate changes. However, the analysis targets not only average or mean changes in a climate variable over time but also estimates changes in extreme events and for climate indices for which there is less confidence in model projections at this time.

The information given to users in this category is often tailored specifically to their needs and will often not be relevant or usable by others.

The examples used to highlight the type of information available in this category have been grouped into four examples. From the simplest to the most complex, they are:

- Specific format – used to present future changes or values using a format that is specifically tailored to the user
- Temporal series – is used to provide climate data (e.g. outputs from climate models) that are subsequently used in impact models
- Analysis of low-confidence climate indices and events

3.2 Climate Information and their uses

The table below summarises various types of climate information and their uses:

Table 1: Climate Products and their Uses

Category	Example of Goal and Purpose	Type of climate information commonly provided	Examples of common information formats
Basic	To raise awareness: • initial awareness • risk scanning • high level governance	Historical trends and future mean changes over large spatial and temporal scales and for simple climate variables	• Synthesis tables • Climate normals • Historical trends (station data, homogenized climate records) • Global changes • Map of projected regional changes
Intermediate	To evaluate vulnerability/impact study: • vulnerability assessment • impact study • increase resilience • early development of adaptation plan	Future changes or future absolute values of more complex climate variables over finer spatial scales	All formats from the basic category + • Spatial analogues • Scatter plots • Map of projected future values • Evolution of future values • Cumulative distribution function

Category	Example of Goal and Purpose	Type of climate information commonly provided	Examples of common information formats
Detailed	To evaluate adaptation options: • evaluate adaptation measures • research and development • local governance	Future changes in means, absolute values and extremes over finer spatial scales	All formats from the basic and intermediate categories + • Specific format • Temporal series • Analysis of extremes • Analysis of low confidence climate indices and events using synthetic scenarios or climate models

3.2.1 Communicating Climate Information

Generally, climate data at the local and national levels is typically the responsibility of a country's National Meteorological Service (NMS). NMS offices are mandated to continuously generate and disseminate weather and climate data from across a country's territory, as well as develop and issue forecasts and warnings. Generating these data requires functioning, well-maintained and well-distributed physical infrastructure (such as weather stations and rainfall gauges), as well as capacities within the NMS for analysing climate data and using it to model future conditions.

In Africa, the type, quality and sophistication of climate information products varies from country to country. Below is a brief cross section of climate information products in sub-Saharan Africa:

- **Zambia:** Daily weather forecasts prepared for e-mail and radio dissemination; seasonal rainfall forecasts issued in September/October; TV weather reports and forecasts issued 3 times a week on; 10-day Crop Weather Bulletin during the rainy season; aviation forecasts issued at all scheduled flight airports and aerodromes in the country; severe weather warnings issued when an event is anticipated; technical reports/publications issued periodically; Climate data supplied on request to all respective stakeholders.
- **Burkina Faso:** Bulletins with general information on the minimum and maximum temperature of the current and next day, the quantity of rainfall (mm) and the state of visibility in different geographical regions
- **Tanzania:** Seasonal precipitation forecast which is posted on its website with basic analysis of the impacts on agriculture, basic crop and livestock advice; short-term (daily) forecasts
- **Liberia:** Occasional weather and climate forecasts

Climate information is most commonly communicated to the public through:

- **Traditional media channels:** This includes television, radio and newspaper broadcasts
- **Information bulletins:** these contain more detailed information and analysis of weather forecasts

- **Internet:** This includes emails sent out to databases, NMS website and social media
- **Public displays and social forums:** This includes the use of billboards, community organizations and barazas
- **Text Message services:** this includes paid services such as Short Message Services (SMSs), Unstructured Supplementary Service Data (USSD) services, as well as free messaging services such as WhatsApp.
- **Provision of information** upon request
- **Public Service Announcement:** These are broadcasts in the media that seek to communicate a simple message to the general public. They are particularly useful for issuing early warnings as well as general advice on what to do during certain weather events (such as floods, or in case of a thunderstorm).

3.2.2 Stakeholders and Users of Climate Information

The provision of climate information services is in the hands of observers, modellers, forecasters, disseminators, intermediaries, and end users.

End users of climate information include:

- **Farmers:** This group is comprised of crop farmers, smallholder farmers, industrialized farmers, pastoralists (livestock herders), fishermen and rural enterprisers. Farmers rely heavily on weather and climate information. Climate information is important for farmers because it can save lives, contain losses, increase productivity and reduce risk. Reaching rural farmers is a challenge, because of little internet communication, low literacy levels as well as 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 provides, extension services, cooperatives and innovative last mile approaches.
- **Local Communities:** This group is comprised of community leaders, farm cooperative leaders, village leadership, regional politicians, children, teachers, parents, elders and other community members that do not work in farming, local NGOs, extension services and medium-scale local enterprisers. 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). They can be reached by email, social media, print, radio, broadcast, and advocacy. However, it has been challenging to integrate climate information into actual planning and policy making on the continent.

- **Private Sector:** The private sector benefits 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.
- **Government ministries and agencies:** Climate information is important for government ministries involved in; Disaster risk reduction and management; Water resource development and management; Forest conservation and environmental management including pollution control and management; Agriculture and Livestock development and management; Development and management of Aerodromes and Airstrips; Economic operation and safety of civil aviation industry; Financial services and banking; Economic planning including urban planning; Energy development, production, management and distribution; Health management and disease control; Ports and Harbours management; Safety of Marine Navigation, including marine and fisheries research and; Managers of wildlife and forests.

4 USES OF CLIMATE INFORMATION

4.1 Climate Information for Development Planning

Climate information (CI) can be used to build Africa's resilience to climate change through informing decision-making across social, economic, political and ecological dimensions, including legislature governing sectors within the aforementioned dimensions (African Union, 2014). By factoring CI into planning and investments, African decision makers will achieve their long and medium term development goals since CI guides sustainability and effectiveness of many long-term development objectives and minimises risk of decisions that will increase vulnerability of sectors and livelihoods (Jones et al., 2015).

In-order for CI to be effective in decision-making, especially in the face of change and uncertainty, it should (World Resources Institute, 2011):-

- Respond to user needs and priorities hence of practical application to decision makers, communities and other stakeholders.
- Downscaled – to draw effective localised conclusions for plans and policies and to clearly identify uncertainties, opportunities and barriers.
- Accurate so as clearly define risks to be accommodated
- Accessible and easy to interpret by users
- Collected over a long period of time (historic trends) and frequently updated
- Cost effective – since there are limited resources to manage information systems
- Tailored to respond to specific needs of users, risks, vulnerable populations and ecosystems, in order to avoid information overload.

Findings by Future Climate for Africa (FCFA) Programme (Implemented by The Climate and Development Knowledge Network (CDKN).

1. Why CI is not widely mainstreamed in long-term decision making

In-spite existence of many projects/programmes with long-lived impacts, Future Climate for Africa (FCFA) established that that there is minimal effort to integrate CI in these programes/projects. Several reasons were given as to why CI is not being widely mainstreamed in long-term decision making however, the following were identified as key:

i. Need to resolve pressing short-term development challenges in most sub-Saharan Africa SSA States 'forces' decision makers to focus on shorter time scales;
ii. Due to factors such as uncertainties at high-spatial resolutions and a lack of integrated assessments of climate impacts, vulnerability and adaptation across much of Africa, CI (medium and long term) is not well-placed to inform economic, social and environmental considerations that dictate investment trade-offs;
iii. Lack of clear communication between producers and users of CI. For instance, CI shared with decision makers is highly technical and could easily lead to misunderstanding of the uncertainties. In addition, the needs of decision makers are rarely communicated to climate scientists – so that they align CI with the needs of decision makers.

2. Avenues for supporting CI in Africa

Climate science, affiliated experts and institutions in Africa can be supported through the following:-

i. Support climate related technologies and build capacities of scientific institutions

ii. Improve the usefulness and relevance of climate information e.g tailor CI to respond to needs of specific sectors, users etc
iii. Identify and address political and institutional barriers
iv. Assist decision-makers to make informed decisions despite uncertainty about the future climate. This can be done through creating awareness about CI, consulting decision makers to determine their needs and priorities hence align CI in their context, simplify CI so that it is easy to interpret etc

3. Lessons learnt from approaches used by the FCFA teams

I. Long term engagement/consultation amongst donors, producers and users of CI will result to robust policy impacts
II. Climate scientists should carefully select the tools for sharing CI. For instance, findings show that in-spite workshops being the custom mode of knowledge sharing, they must be well designed and facilitated to lead to meaningful engagement among different stakeholders.
III. It is important to focus on a specific adaptation challenge

Text Box 2: Findings by the Future Climate for Africa (FCFA) Programme - DfiD

(Source: Jones et al., 2015)

4.2 Agricultural and Extension Services

Africa's economic development and environmental sustainability remains at risk due dependence on climate sensitive sectors such as Agriculture (African Union, 2014). CC and variability coupled with environmental degradation, loss of biological diversity, and poverty among others threaten environmental sustainability and human well-being (which also includes food security) (WMO, 2016).

Africa's agriculture sector is mainly rain-fed hence change or variability in frequency and quantity of precipitation and occurrence of prolonged disasters such as droughts, floods, famine, water and vector borne diseases, wild fires, pest and disease outbreaks among others could affect agricultural productivity in terms of quantity and quality of yields (e.g crop failure, livestock deaths, post-harvest loss of perishable goods since transport infrastructure is impassable), influence agricultural practices such as water use (e.g. need for irrigation), pest and disease control etc (WMO, 2016; Wikipedia, 2016). In the long run, the national economy of African states is affected negatively since agriculture contributes immensely to National Gross Domestic Product (GDP) (African Union, 2014).

In-order to cope with climate variability and change, majority of local agricultural communities world-wide have turned to climate forecasts (traditional or modern) with the objective of predicting seasonal climate behaviour (WMO, 2016). Notably, WMO notes that this is a step towards reducing vulnerability of communities and the agriculture sector to climate change effects (Ibid). For instance, increasing climate knowledge and improving prediction capabilities generates relevant information and prediction products that advise farmers' such as timing for cultivation, harvesting (Ibid). In-addition, farmers can exploit opportunities generated by weather and climate predictions by (Ibid):

- Minimizing impacts of hazards through planning how to avoid the risk or taking precautionary measures;

- Maximizing on the predicted variability such as building water storage tanks to store water for irrigation.

4.3 Infrastructure and construction

The infrastructure and construction sector remains vulnerable to CC and variability (African Union, 2014). Precipitation, temperature and wind are the major weather parameters that affect infrastructure and Construction sector (USAID-East Africa, 2016). For instance (USAID-East Africa, 2016):

- **Precipitation:**
  - Floods, for example flush floods, river floods, mudslides, landslides and silting destroy/wash away buildings, roads, bridges as well as top soils and structural engineering which support roads, tunnels, and bridges. In addition, siltation can hamper railway transport and shipping
  - Decrease or increase in sea level affects ship and boat docking, increase in sea level sub-merges buildings, roads etc
  - Mist/fog impair visibility e.g. road, air, water transport)
- **Winds** (strong wind speeds) and sand storms pose danger to road, air and water transport, destroy buildings, drainage facilities
- **Temperature:**
  - Very high temperatures cause melting and buckling of metal on buildings, railway lines and other infrastructure, melting of tarmac etc.
  - Freezing temperatures cause metal contraction hence loosen joints in infrastructure, loosen road particles etc

Resultant effects of CC and variability on the construction and infrastructure sector directly affect the national economy since other key economic sectors (such as agriculture, tourism, energy, health, water and supply) depend on this sector to function effectively (Nemry and Demirel, 2012). For instance, transport of tourists, transport of medicine, hospitals, office buildings and other general infrastructure, transport of agricultural produce, drainage systems, dams, electricity poles, among others. In-addition, budget allocations for frequent repairs and re-construction of infrastructure also affects the economy since this money would have been channelled to other developmental initiatives (Nemry and Demirel, 2012).

Scenario building is a key way of using CI to climate proof infrastructure (African Union, 2006).For instance, combining a range of scenarios and historic trend analyses can inform long-term infrastructure planning and many policy and investment choices since understanding of future trends and uncertainties would have been built (Ibid)

4.4 Urban and Spatial Development Planning

CI can be integrated into development applications by using Geographical Information Systems (GIS) since these systems explore relations and create maps (African Union 2006). For instance (Ibid);

- By incorporating climatic and non-climatic data into statistical or rule-based decision models, maps showing agro-ecological zones, disease risks, vulnerable communities, hazard risks etc can be developed. Such maps can assist in the following ways:-
  - Indicate what policies are appropriate;
  - What investments should be made;
  - Land zoning and urban planning;
  - Hazard and vulnerability inform decision making e.g plan for climate proof infrastructure depending on the nature of hazard identified, channel more funds to Disaster management etc
  - Where research and intervention should be targeted
  - Indicate the current status of the season or indicators of changes in risk especially when they incorporate near real time weather and possibly climate forecast data e.g. malaria early warning models are driven by seasonal changes in weather-related risk.

4.5 Disaster Risk Reduction (DRR)

Majority of disasters[1] experienced in Africa are weather or climate driven (Africa Union, 2014). For instance, weather parameters such as rainfall and temperature directly correlate with natural disasters such as floods, vector and waterborne diseases, pest outbreaks, storms, heat wave, famine, wild fires, land-slides among others (IPCC, 2014; IPCC, 2007).

Frequency and intensity of weather related hazards[2] is projected to increase in the coming decades due to escalating global temperatures and alterations in frequency and quantity of precipitation (WMO, 2014; IPCC, 2014; Africa Union, 2014). It is therefore important to underscore the fact that CC and variability increase Disaster Risk[3] (IPCC, 2014; IPCC, 2007). For instance;

a) CC alters the magnitude and frequency of extreme events hence increases vulnerability of the community in-that, coping, response and planned disaster mechanisms based on past vulnerability will not be sufficient (Sperling and Szekely, 2005)
b) Change in average climatic conditions and variability generates ‘new’ risks and threats - which the affected community may not know how to address or not sufficiently equipped to address (Ibid)

Occurrence of climate extremes coupled with rapid environmental degradation[4] and other socio-economic factors such as poverty, rapid population growth and poor health care systems also increase Disaster Risks (Nehren et al., 2014).

[1] **UNISDR defines Disaster** as “A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Exposure X Hazard”
[2] **UNISDR defines Hazard as:** A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
[3] **UNISDR defines Disaster Risk (DR)** as “The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.”
[4] **UNISDR defines Environmental Degradation** as “The reduction of the capacity of the environment to meet social and ecological objectives and needs.”

Subsequently, The World Risk Report (2012) points out that "Environmental degradation is a significant factor that reduces the adaptive capacity of societies to deal with disaster risk in many countries" (UN-EHS, 2012).

In the current state where the environment is rapidly being degraded world-wide whilst GHGs continue to be emitted, it is projected that intensity and frequency of weather related hazards and DRs will also increase significantly (WMO, 2014; IPCC, 2014; Africa Union, 2014; Nehren et al., 2014; Sperling and Szekely, 2005). This means that the resulting effects of future weather related hazards will be magnified in terms of scope and losses (UNISDR, 2014). As a result, building disaster resilience of communities remains a key priority (Ibid).

DRR[5] is one of the approaches being adopted world-wide to reduce vulnerability of communities to disasters hence build their resilience (UNISDR, 2014). This is so because DRR aims to reduce the damage caused by natural hazards (Ibid). However, in-spite DRR's potential to contribute to sustainable development, its integration into development planning remains a challenge (Ibid).Nevertheless, it should be emphasized that, inclusion of climate change and variability into development planning and budgeting processes will establish mechanisms of reducing vulnerability and treat risks as an integral part of the development process (Nehren et al., 2014).

In-order for DRR to achieve its objective, there is need to "use meteorological, hydrological and CI as part of a comprehensive multi-sector, multi-hazard, and multi-level (local to global) approach" (WMO, 2014). For instance, through forecasting, combined with proactive DRR policies and tools, including contingency planning and early warning systems DRs will be drastically reduced (Ibid). Specifically, CI can be used in the following ways to reduce disaster risks (Ibid):-

- **Quantitative Risk[6] Assessment:** Involves combining information on Hazards with Exposures[7] and Vulnerabilities[8] of the community or property (e.g., agricultural production, infrastructure and homes, etc). Information provided under hazards will include historical climate data and forward looking modelling and forecasting about environmental conditions e.g., rainfall, temperature, soil moisture and hill slope stability, river basin hydrology etc. Socio-economic data will be provided under Exposure and Vulnerability.
- **Development of Risk Management Strategy (RMS):** Using the Risk information accrued above, a Risk Management Strategy can be developed using Early Warming Systems (EWS)[9]. It is important to note that EWS reduce damages inflicted by meteorological hazards. Notably, climate

[5] **UNISDR defines Disaster Risk Reduction/Disaster Reduction**: "The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events."
[6] **UNISDR defines Risk as:** "The combination of the probability of an event and its negative consequences"
[7] **UNISDR defines Exposure as:** "People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses"
[8] **UNISDR defines Vulnerability as:** "The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard."
[9] **UNISDR defines Early Warning System (EWS) as:"**The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss."

prediction provides opportunities to increase the lead times of early warnings. For instance, seasonal climate forecasts assist in prediction and management of excessive or deficient precipitation. On the other hand, historical climate data is used for analysis of hazard patterns however, in the face of climate change and variability "weather and climate services with hourly to seasonal forecasts will be needed to inform long-term investments and strategic planning" e.g. coastal zone management, development of new building codes and the retrofitting of infrastructure to withstand more frequent and severe hazards.

- Early Warning and Emergency response Operations: In-order to reduce disaster risks, EWS (WMO,2014):-
  - Detect, monitor and forecast hazards
  - Analyse risks and incorporate risk information in emergency planning and warnings
  - Disseminate warnings that are timely and authoritative
  - Contribute to community planning and preparedness.

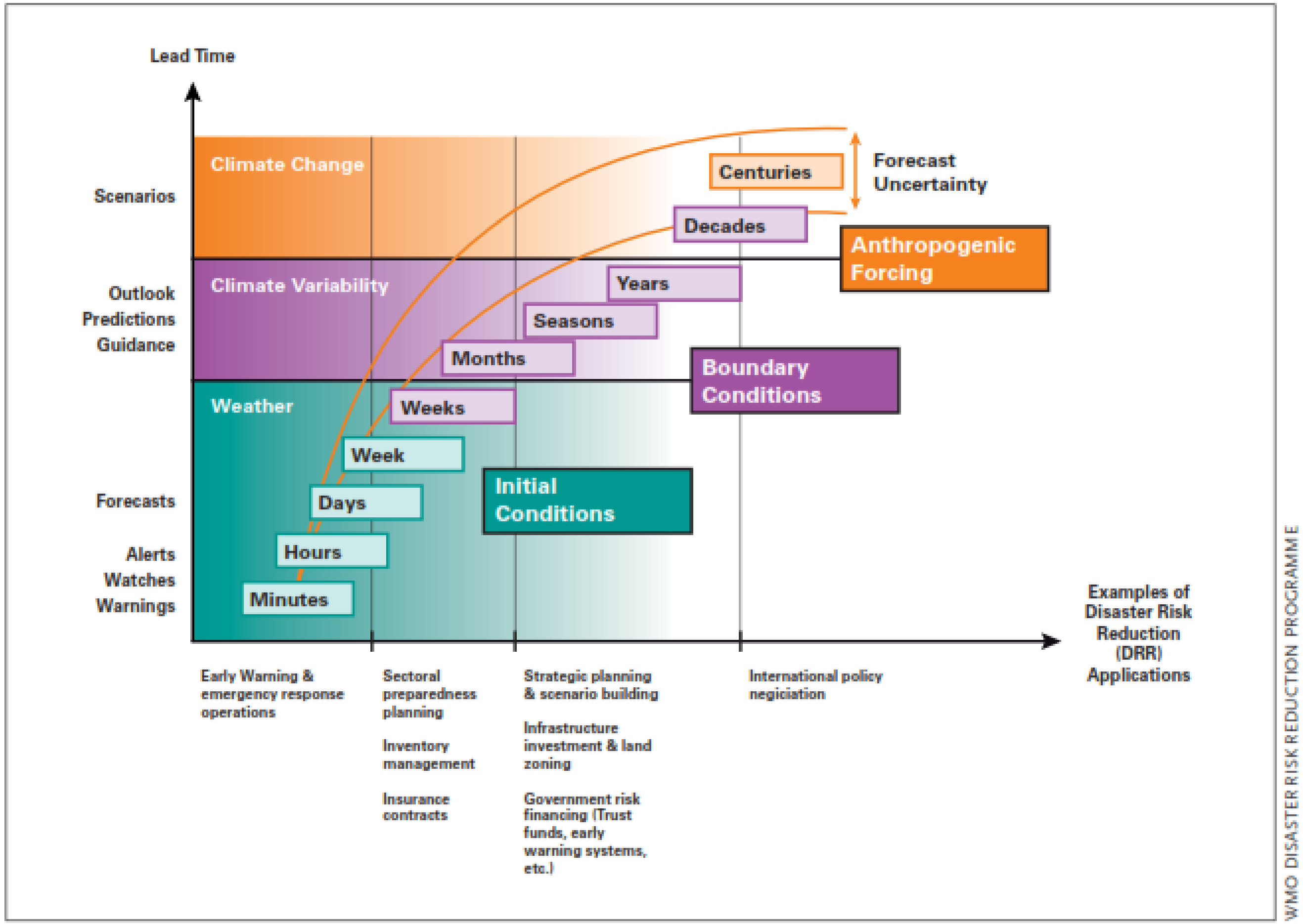

Figure 2: Hydro-meteorological and climate services for various risk management applications

(Source: WMO, 2014)

4.6 Intended Nationally Determined Contributions and Sectoral Planning

Intended Nationally Determined Contributions (INDCs) is a terminology used under the United Nations Framework Convention on Climate Change (UNFCCC) to refer to efforts that signatory States intend to implement so as to reduce GHG emissions (UNFCCC, 2013; Climate Policy Observer, 2016).

Development of INDCs commenced after the 19th Conference of Parties (COP 19) held in Warsaw (UNFCC, 2013). This was in preparation for COP 21 (Held in Paris, 2015) whose core aim was to generate an International Climate Agreement (World Resources Institute, 2016). Notably, INDCs (UNFCCC, 2013; World Resources Institute, 2016):-

- Provide a means in which governments communicate internationally, how they intend to address climate change nationally (in their respective countries);
- Reflect each country's ambition towards reduction of GHGs;
- Show how each country intends to adapt to climate change, what support they need to do so and what support they will provide to other nations to adopt low-carbon pathways and build climate resilience.

Following COP 21, which yielded the Paris Agreement, signatory countries to UNFCCC are expected to publicly declare their post 2020 low carbon actions through INDCs. The INDCs should be in line with the Paris Agreement. It is important to note that INDCS play a significant role in guiding the world towards a low-carbon and climate resilient future (World Resources Institute, 2016).

The World Resources Institute notes that a "well designed" INDC should show what the country is doing to address CC and limit future risks (World Resources Institute, 2016). In-order to do so, both climate and non-climate information is crucial (Ibid).

5 CLIMATE INFORMATION AND SERVICES AND LEGISLATION

5.1 Legislating for Investment in CI and Services

Developing and distribution of useful climate information and services that meet the needs of different users within a country requires the input of several different institutions within a country. Most African countries do not have national climate information frameworks that guide the development and distribution of climate information at the national level. Consequently, there are gaps in information, communication, policy, practice, and institutional capacity, compounding the difficulties of creating useful climate services within the country.

The generation of climate services within a country is beyond the capacity of any single institution, it therefore, calls for collaboration among various sectoral institutions across administrative, functional, and disciplinary boundaries. (WMO, 2014)

Furthermore, maintaining weather observation systems requires significant human and financial resources yet governments do not always recognize this as investments and therefore do not allocate adequate resources. As a result, the condition of observation networks in some areas of the world is on the decline, and unable to implement modern observing systems, such as radars, radiosonds and drifting buoys. (WMO, 2014)

Addressing these challenges requires the design of a framework for Climate Services at the National level that would lay the foundation for effective climate information services by improving on three crucial elements (IRICS, 2012):

- **Improving the quality and availability of Information:** Climate services depend fundamentally on quality data and information.
- **Strengthening collaboration:** Effective climate services are built on sustained communication and interaction between and among user and provider communities.
- **Developing enabling Policies & Practice:** Climate services must connect data and information to policy and practice in order to see impacts on the ground.

5.1.1 Budgeting and other Statutory Provisions

Despite covering a fifth of the world's total land area, Africa has the least developed land-based observation network of all continents, and one that is in a deteriorating state, amounting to only 1/8 of the minimum density required by the WMO. Most services have a stagnant pool of human and financial resources, and obsolete technologies limiting their capabilities to produce the best services needed by policy makers and other decision-makers. (ACOMET, 2014)

Underinvestment in Climate Infrastructure results in low quality and unreliable data for making management decisions related to climate change induced disaster risks, and limits a country’s ability to plan for slow-onset climate hazards that will require a transformational shift in economic development and risk reduction efforts. A climate information and EWS is an important part of adapting to climate change-related impacts, as it increases the resilience to future changes in these climate/weather-related hazards.

For example, the Kenya National Meteorological Department (KMD) has seen a large decline in staff numbers, since the government put in place a hiring freeze in 1995. Kenya's meteorological department shrank from 1 563 employees in 1995 to 669 in 2005, representing a decline of more than 50% of their initial capacity. This loss of technical skill and institutional memory certainly weakened the KMD's capacity to deliver CI and services. (KMD, 2016)

Currently, the Tanzania Meteorological Authority (TMA) has a budget of USD 6.7 million. However, the TMA's Five Year Plan for Enhancement of Meteorological Services for Sustainable Socio-economic Development in Tanzania (2010-2015) foresees an additional 35 million US$ over five years to enhance the services and infrastructure of the TMA. Of this amount, only 15% has been funded to date (TMA, 2010)

Climate information and services are expensive to produce but relatively cheap to reproduce and are therefore considered a public good.

However, by linking Climate Information and Services can directly contribute to national development goals, such as the linkage between CI and services with early warning systems, food security, water resources management, health risk management and terrestrial and coastal ecosystem resilience, the case for increasing the national budget for CI and services can be made.

It is vital for Africa's governments and policy makers to take on board the contribution of NMHSs to socio-economic planning and development, integrate them in national development programmes and accord the necessary financial support; In so doing, all weather dependent organizations, institutions and individuals have appropriate range and level of meteorological services as per their requirements.

The African Ministerial Conference on Meteorology (AMCOMET), was established as a high-level mechanism for the development of meteorology and its applications in Africa. Ministers in charge of meteorology unanimously committed to strengthen and sustain National Meteorological and Hydrological Services (NMHS) by providing them with the necessary resources and adequate institutional frameworks to enable them to fully perform their roles as a fundamental component of national development infrastructures. As a key joint initiative of the African Union and the WMO, AMCOMET leads the planning and response efforts, through the Integrated African Strategy on Meteorology (Weather and Climate Services) (the Integrated African Strategy), to ensure that National Meteorological and Hydrological Services in Africa can better address climate variability and change.

The strategy aims to ensure that at NMHs are allocated at least 5% of the national budget. The strategy seeks to cultivate long term partnerships with traditional finance mechanisms such as development banks; remain abreast of bilateral and multilateral funding mechanisms; actively engage the private sector; strengthen partnerships with international scientific and technical partners and; strengthen collaboration with existing initiatives.

5.1.2 Public Private Partnerships (PPPs)

One way to boost investments and increase funding for NMIs is through Public Private Partnerships (PPP). A PPP is a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance. (PPP Knowledge Lab, 2015). PPPs offer a way to bring expertise, capital, and a profit-driven approach to delivery of public services and are useful in a time of rapid evolution in technologies.

5.1.3 Climate Services as a Business Model

Climate services have been established with the assumption that an active market of users and stakeholders is in place to rapidly benefit from science-based information. Unfortunately, the market has only been partially established and the relation between climate services and potential stakeholders remains weak or ad-hoc in many cases. The explanations for the lack of connection involve several factors [Vaughan and Dessai, 2014]:

- Insufficient awareness by some societal actors of their vulnerability to future climate change
- Lack of relevant and timely products and services offered by the scientific community,
- Inappropriate format in which the information is provided
- Inadequate business model adopted by the climate services.

The challenge for climate services is therefore to analyze their potential market and to narrow the gap between information providers and prospective users. These four challenges highlight the fact that the market for climate services is not yet fully developed, especially regarding adaptation to climate change; the initial assumption that the income of climate services would soon be generated by the products delivered to users has appeared to be incorrect. Climate services still serve public good and therefore best funded in large part by the taxpayer.

5.1.4 Institutional Development for CI/CIS

Climate Information and Services are limited also in part because of weak institutional coordination between institutions leading to limited packaging, translating and disseminating weather and climate information and warnings. Some reasons as to why this is the case include:

- Lack of effective mechanisms for collaboration between public and private sectors and across scientific disciplines and technical domains;
- Weak institutional arrangements between agencies responsible for generating Climate Information
- Absence of policy and legal frameworks to guide the provision of meteorological services
- Limited appreciation and use of meteorological services by other sectors of the economy.
- Weak organisational structures and capacity for effective weather and climate monitoring and/or early warning generation and dissemination

- Lack of legal frameworks for establishment of NMHSs in many Member countries;
- Lack of a defined framework for mainstreaming meteorology in national development;
- Non-existent, obsolete or inadequate observation infrastructure (ACOMET, 2014)

AMCOMET recognises the challenges that NMHs face in carrying out their mandate. One of the pillars of the AMCOMET strategy is to increase political support and recognition of NMHSs and related WMO Regional Climate Centres through the integration of meteorological services' contribution to various economic sectors and in national development programmes. It further aims to increase the active participation of relevant inter-governmental officials and other stakeholders in establishing adequate weather and climate services, both at the national and regional levels, aligned with policies that address development challenges and opportunities. The strategy seeks to formulate policies and provide legislation to ensure that NMHSs are more semi- autonomous; ensure that they develop strategic plans and charters aligned with national development plans; facilitate regular meetings with policy makers to demonstrate relevance and; facilitate close cooperation from Regional Economic Communities to support the production and delivery of weather and climate services.

5.2 Climate Information and Services in domesticating international climate and environmental agreements

5.2.1 The Global Framework for Climate Services (GFCS)

The Global Framework for Climate Services aims to enable society to manage the risks and opportunities arising from climate variability and change better, especially for those who are most vulnerable to such risks.

The GFCS was established after the World Climate Conference-3, an UN-led initiative spearheaded by WMO to guide the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors.

The GFS focuses on four priority areas, namely: Agriculture and Food Security (including fisheries and aquaculture); Disaster Risk Reduction; Health, and; Water. The Framework has five overarching goals:

- Reducing the vulnerability of society to climate-related hazards through better provision of climate information
- Advancing the key global development goals through better provision of climate information
- Mainstreaming the use of climate information in decision-making
- Strengthening the engagement of providers and users of climate services
- Maximizing the utility of existing climate service infrastructure

The Framework includes the following eight Principles for guiding successful achievement of its over-arching goals, namely that All countries will benefit, but priority shall go to building the capacity of developing countries vulnerable to the impacts of climate change and variability; The primary goal will be to ensure greater availability of, access to and use of enhanced climate services for all countries; Activities will address three geographic domains: global, regional and national; Operational climate services will be the core element; Climate information is primarily an international public good provided by governments, which will have a central role in its management; Promote the free and open exchange of climate-relevant data, tools and scientifically based methods while respecting national and international policies; The role of the Framework will be to facilitate and strengthen, not to duplicate and; The Framework will be built through user–provider partnerships that include all stakeholders.

The Framework is built upon the following five components, or pillars:

- **User Interface Platform:** a structured means for users, climate researchers and climate information providers to interact at all levels;
- **Climate Services Information System:** the mechanism through which information about climate (past, present and future) will be routinely collected, stored and processed to generate products and services that inform often complex decision-making across a wide range of climate-sensitive activities and enterprises;
- **Observations and Monitoring:** to ensure that climate observations and other data necessary to meet the needs of end-users are collected, managed and disseminated and are supported by relevant metadata;
- **Research, Modelling and Prediction:** to foster research towards continually improving the scientific quality of climate information, providing an evidence base for the impacts of climate change and variability and for the cost-effectiveness of using climate information;
- **Capacity Development:** to address the particular capacity development requirements identified in the other pillars and, more broadly, the basic requirements for enabling any Framework related activities to occur.

The Framework's long-term high-level outcomes and benefits are that user communities make climate-smart decisions and that climate information is disseminated effectively and in a manner that lends itself more easily to practical action. While long-term, these outcomes need to be tackled at an early stage in order to demonstrate the usefulness of the Framework to decision-makers, providers and potential funders. Effective development and use of climate services will be of great value for decision-making in many economic and social sectors, value that has not yet been properly assessed by providers or users.

The Framework will be implemented through activities and projects that will be enabled by mobilizing the necessary resources, including funding. The objectives of the Framework will evolve as its implementation matures and initial successes are realized, but after six years it is expected that improvements to climate services in these priority areas will be measurable and that activities in other areas will be initiated as new priorities emerge. After ten years there will be access to improved climate services throughout the world and across all climate-sensitive sectors

5.2.2 African Ministerial Conference on Meteorology

The AMCOMET was established in 2010, during the Nairobi Ministerial Declaration from the First Conference of Ministers Responsible for Meteorology in Africa, as a high level mechanism for the development of meteorology and its applications in Africa.

African Ministers recognized that weather and climate are central to the socio-economic development of any country, and as such deserve strong support at the highest possible level of government. Ministers recognized that sound governance of the science of meteorology and its related applications must be streamlined in national development agendas to promote cooperation, security, socio-economic development and poverty eradication on a pan-African level. By establishing AMCOMET, the Ministers committed themselves to:

- Strengthen and sustain National Meteorological Services by providing them with the resources and appropriate institutional frameworks to enable them to execute their functions, particularly in observations, forecasting and applications;
- Recognise the role of meteorological services as a fundamental component of the national development infrastructure and ensure that meteorological information is a permanent parameter and feature in national current and future plans, programmes and policies in the key sectors of the country's economy
- Regard national meteorological services as strategic national assets which contribute to national security, principal of which are transport, food, water, energy and health in addition to being vital to sustainable development particularly poverty reduction efforts, climate change mitigation and adaptation and disaster risk reduction; and
- Ensure that all sub regions of the continent are active and are adequately resourced.

5.2.3 Nationally Determined Contributions

The Paris Climate Agreement includes "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2" as the Global Adaptation Goal, which is linked to the Agreement's temperature goal.

Adaptation is defined as strategies, policies, programmes, projects or operations aimed at enhancing resilience or reducing vulnerability to observed or plausible changes in climate. It includes activities implemented to create changes in decision environments as well as actual adjustments to address climate risks (Adger et al., 2007).

In the Paris Agreement, Parties are requested to strengthen regional cooperation on adaptation where appropriate and, where necessary, establish regional centers and networks, in particular in developing countries;

Parties are also bound to strengthen their cooperation on enhancing action on adaptation, taking into account the Cancun Adaptation Framework including:

- Information sharing such as best practices, lessons learnt, and, experiences
- Strengthening institutional arrangements
- Strengthening scientific knowledge on climate
- Providing support to developing nations in identifying effective adaptation practices, adaptation needs etc
- Improving the effectiveness and durability of adaptation actions.

Climate services will have to monitor the efficacy and relevance of these INDCs. International collaboration is therefore key for strengthening the local and regional capacities in developing countries, and specifically for building resilience and catalyzing adaptation to social and environmental change of marginalized populations.

Furthermore, climate information services can help to meet the following goals of the Paris Climate Agreement; assessing adaptation needs with a view to assisting developing countries and; strengthening regional cooperation on adaptation where appropriate and, where necessary, establish regional centers and networks, in particular in developing countries.

5.2.4 Monitoring and Evaluation

At present there is considerable experience in many of the technical, practical, and institutional aspects of climate services. However, this knowledge has not been consolidated in the form of standards and guidance for climate service providers, communities of practice, and policy makers. Furthermore, it is necessary to improve the general understanding of the role and contribution of climate services in decision making and managing climate related risks. Given this reality, monitoring and evaluation of climate information is still in its early stages, without a solid M&E framework. However, a monitoring and evaluating climate information services can be based on the following:

- **Problem identification and the decision-making context:** Climate services are developed to improve decision making in specific contexts, and naturally involve certain assumptions about those contexts. Access, comprehension, and adoption rates are all important determinants of the distributional impacts of climate services. Identifying methods to assess the extent to which climate services address tractable problems, and do so in a way in which benefits target users should be examined more closely. (Vaughan & Dessai, 2014)
- **Characteristics, Tailoring, and Communication of the Climate Information:** The success of a climate service depends on the quality of the climate information that under-pins it. Assessing the extent to which information is appropriately tailored is important to understanding the efficacy of climate services. Three important aspects of this tailoring process are: the relevance and perceived relevance of the information; the accessibility of the information; and the distributional impact of various groups, including those who may be more or

less well-off. The extent to which climate services are able to provide information is an important attribute of their effectiveness. (Vaughan & Dessai, 2014)

- **Governance, Process, and Structure of the Climate Service:** The range of actors involved, and the range of issues that must be addressed, in the development and delivery of climate services requires the development of structures that can facilitate interactions between dispersed institutional and administrative mechanisms, projects, and financial resources; it may suggest a role for private-sector services to fill the gap. In this con-text, the structure and governance of a climate service are important determinants of the effectiveness of the service itself. The perceived objectivity of the process by which the information is shared also determines the extent to which users will engage with information. While the range of funding mechanisms underwriting the climate service operations described above is diverse, many rely either on public funds; others rely on project funding and have no permanent source of support. This more precarious situation is seen to limit their effectiveness over time. (Vaughan & Dessai, 2014)
- **Socioeconomic Value of the Climate Service:** Assessing the effectiveness of a climate service should involve some assessment of its economic value. Part of the difficulty associated with this is related to challenges of methodology. Determining just how to assess the value of a service is complicated, involving a range of different methodologies for assessing perceived local-level and aggregated impacts; valuation information must also be put in context so that impactful climate services targeted to low-income users are not dismissed as 'low value'. User surveys, case studies, contingent valuation methods, and empirical modeling have been used to assess the economic value of different forecast types in different decision systems and environmental and policy contexts. (Vaughan & Dessai, 2014)

Monitoring the effectiveness of climate information services is still in its early stages. At the moment, there is no agreement on the metrics or methodologies that should be used to evaluate climate services. Establishing effective metrics and methodologies for analysis in particular contexts, and with particular goals in mind, will be an important step in measuring the value and effectiveness of climate information services.

5.2.5 Investment Assessments

"Climate proofing" is a process that aims to identify risks that an investment project may face as a result of climate change, and to reduce those risks to levels considered to be acceptable, and a measure aimed at mitigating the climate risk to which a project is exposed. (ADB, 2015)

Climate proofing an investment is based on an economic analysis that seeks to address questions of the following nature:

- What are the impacts of projected climate change on the costs and benefits of the investment project?
- Is climate proofing the investment project desirable or should the project proceed without climate proofing?

- If there are multiple technically feasible and economically desirable climate-proofing measures, which of these should be recommended?
- Should co-benefits associated with some climate-proofing measures, such as ecosystem-based approaches, be included in the economic analysis?
- If climate proofing is desirable, when is the best time to undertake such investment over the course of the lifetime of the project?
- Should climate proofing be postponed until better information becomes available and allows the use of actual and observed climate conditions instead of uncertain climate projections (ADB, 2015)

However, it should be noted that uncertainties in climate change projections do not invalidate conducting an economic analysis of an investment project in order to undertake climate proofing measures. While it would be ideal to have more accurate information, the economic analysis of investment projects and of their climate proofing does not demand accuracy and precision from climate projections (ADB, 2015)

Undertaking an economic analysis of an investment can result in one of three options on climate proofing: (i) climate proof now; (ii) make the project climate-ready; or (iii) wait, collect information and data, and revise if needed.

6 TOOLS AND APPROACHES FOR MAINSTREAMING CLIMATE INFORMATION AND SERVICES INTO LAWS, PLANS AND POLICIES

6.1 Understanding the concept of Climate Change Mainstreaming

There is no universally agreed definition of climate change mainstreaming concept. Most definitions refer to mainstreaming as a process and indicate – either explicitly or implicitly – that the components of and entry points to mainstreaming will depend on the level that is under consideration. For instance, there are a number of reports and literature on mainstreaming climate change adaptation, but very little on mainstreaming climate information. In this report we have adopted three definitions of mainstreaming, which are widely used:

1. "Mainstreaming means integrating climate concerns and adaptation responses into relevant policies, plans, programs, and projects at the national, sub-national, and local scales." (USAID, 2009).

2. Incorporating climate change risks and adaptation into:
    - National policies, programmes and priorities: ensuring that information about climate-related risk, vulnerability, and options for adaptation are incorporated into planning and decision-making in key sectors, such as agriculture, water, health, disaster risk management and coastal development, as well as into existing national assessments and action plans, including Poverty Reduction Strategies and Priorities.
    - Development agency programmes and policies: ensuring that plans and priorities identified in development cooperation frameworks incorporate climate change impacts and vulnerability information to support development outcomes.
    - Ideally, integration should become a systematic process rather than a one-off process of utilizing climate information in decisions" (UNDP, 2009).

3. "Mainstreaming involves the integration of policies and measures that address climate change into development planning and ongoing sectoral decision-making, so as to ensure the long-term sustainability of investments as well to reduce the sensitivity of development activities to both today's and tomorrow's climate" (Klein et al., 2007).

6.2 General approach for legislators on the mainstreaming of CI/S into legislation and policy

Bearing in mind the above definitions, this section seeks to provide a practical illustration (tools, guidelines and approaches) on how climate information can be mainstreamed into policies, legislation, programmes and projects. The general approach is schematically illustrated in the figure 3 below and includes the following steps:

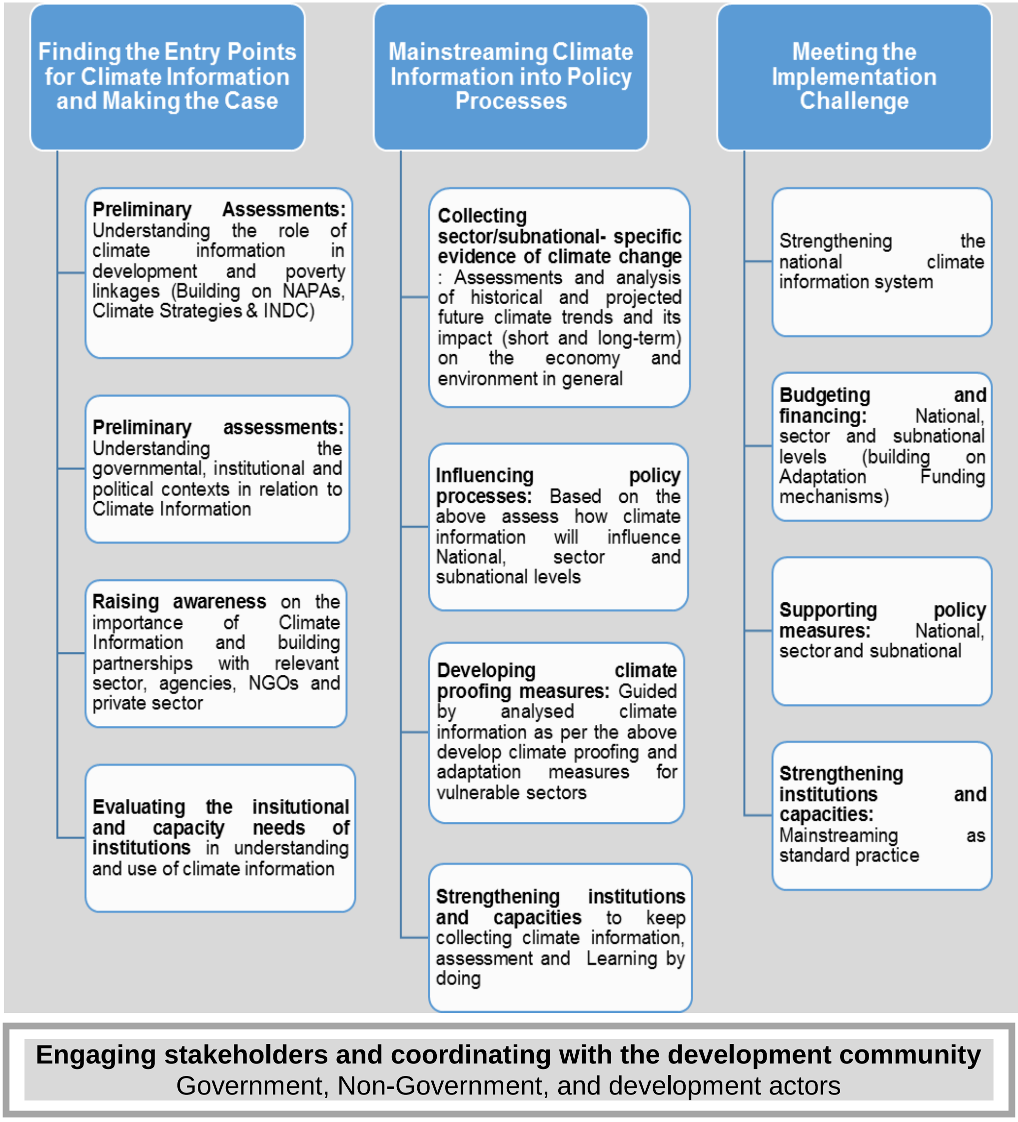

Figure 3: General approach to mainstreaming climate change/ climate information into legislation, projects and programmes

The steps in figure 3 above are discussed below;-

1. **Understand the concept of Climate Information and relation to climate change**

Legislators need to understand the concept of climate information and how it relates to climate variability and its long-term and short-term effects on development, economy, human well-being and ecosystems in a business as usual scenario (BAU) vis-à-vis scenarios when mitigation and adaptation initiatives are implemented. Climate information should be the main evidence of determining climate impacts and hence the type of adaptation measures that need to be put in place. Legislators need to understand the role of CI/S in building the country's resilience to climate change and variability. Further, legislators need to understand that strong CI/S infrastructure is very crucial to a country's economic growth, ecological integrity and human wellbeing. Some activities that can be implemented to achieve this understanding and awareness include: -

- Continuous and widespread climate change awareness e.g., capacity building workshops, mandatory quarterly and yearly circulation of brief and simplified CI leaflets to legislators by CI/S institutions;
- Dissemination of simplified climate information to legislators. For instance, disseminate CI that is easy to understand and tailored to respond to government priorities e.g., climate scientists need to show how sectors, development, economy, communities among others are being (will be) affected in a BAU scenario vis-à-vis scenarios when mitigation and adaptation initiatives are implemented;
- Encourage frequent interaction between legislators and climate scientists from relevant climate change institutions through quarterly or annual workshops, meetings etc.

2. Find the Entry Points for Climate Information and make a case

In order to mainstream CI/S, there is need to find a suitable entry point, which provides one or more opportunities for incorporating specific climate change adaptation considerations into a given policy, plan, programme, or project. Notably, in-order to establish entry points in policy and legislation, reviews and policy analyses must be undertaken to establish gaps and this could involve the following activities: -

a) Undertaking Preliminary Assessments to:
    - Understand the role of climate information in development and poverty linkages, building on existing climate national adaptation plans of action (NAPAs), National communications, Climate Change Strategies, Nationally Determined Contributions (NDC), climate policies, etc.
    - Understand the governmental, institutional and political contexts in relation to Climate Information. How strong are the meteorological departments? How resources are they?
    - Understand historical climate trends by studying available climate information data in order to make sense of the current and future climate risks in various sectors at national level and the role of climate information in addressing these risks
    - Understand current and future climate risks at community level and the role of climate information in addressing these risks

b) Raising awareness on the importance of Climate Information and building partnerships with relevant sector, agencies, NGOs and private sector

c) Evaluating the institutional and capacity needs of institutions in understanding and using climate information. This is very crucial as some sectors are not even aware that CI/S are important in this age.

3. Mainstreaming Climate Information into Policy Processes

This step involves legislators understanding that sustainable development can only be achieved if climate information is central in monitoring the weather, monitoring climate variabilities and climate change, and how it can lead to better development decisions based on reliable forecasts. There is need for meteorology departments or CI providers to make available data that can be easily used in the form of historical statistical summaries, indices derived from such data (climatological information; forecasts on various time-scales – weather forecasts and seasonal outlooks; early warning and alerts. Such information provided to water resource management, forest conservation, agriculture and livestock programmes; transport; energy development production, management and distribution; health management and disease control, aviation, ports and harbours; marine navigation including marine fisheries research and insurance and banking, etc., will lea d to better economic planning at sector and national level and aide in budgeting for such services. Mainstreaming cannot be said to have occurred unless budgets have been provided for ensuring the production and generation of such climate information.

This is consistent with the 4th Assessment Report (IPCC, 2007) highlights the following with regard to integrating climate change/climate information into legislature: -

- Sustainable development can be achieved if climate change policies are integrated with other development policies;
- Whilst integrating climate change/climate information into policies, there is need to ensure that the policy (policies) is (are) tailored to respond to local context;
- In-order to improve their effectiveness, the selected instruments for climate change/climate information mainstreaming should be updated over time. In-addition, continuous monitoring and evaluation of these instruments should be undertaken.

It is imperative that country specific evidence on economic costs of climate change and benefits of climate change and adaptation is generated and understood. This information can be generated through impact, vulnerability and adaptation assessments, socio-economic analysis, demonstration projects etc.

Mainstreaming Climate Information into Policy processes involves the following activities: -

a) *Collecting sector/subnational- specific evidence of climate change:* Assessments and analysis of historical and projected future climate trends and its impact (short and long-term) on the economy and environment in general
b) *Influencing policy processes:* Based on the above, assess how climate information will influence National, sector and subnational levels
c) *Developing climate proofing measures*: Guided by analyzed climate information as per the above, develop climate proofing and adaptation measures for vulnerable sectors
d) *Strengthening institutions and capacities to keep collecting climate information*, assessment and learning by doing.

These are some of the main activities but not exhaustive. In addition, various policy instruments can be adopted to address issues established from the above activities. Examples of policy instruments that can be used to mainstream climate information into legislation, projects and programmes include:

- **Regulations and Standards:** In addition to bench-mark emission levels by e.g., providing the minimum requirement for pollution output, set technology standards etc. (IPCC, 2007), further regulations can be enacted to guide climate information collection and sharing by institutions to enable early warning systems, alerts, etc.

- **Taxes incentives:** Tax incentives on private sector involved in climate information gathering could encourage private sector to share data with government sector and other organizations. Various instruments exist for doing this, such as the below:
- **Voluntary Agreements (VAs):** This refers to agreements made between the government and one or more private parties with the aim of promoting environmental integrity – VAs go beyond regulated obligations (IPCC, 2007) and could include climate information and services by private entity.
- **Subsidies and Incentives:** Refers to rewards given by the government to an entity for undertaking a specific action. This may be in the form of direct payments, tax reductions, price supports or the equivalent (IPCC, 2007). Tea, sugar and other cash crop companies have been collecting data for hundreds of years, and can be given these kind of subsidies to share some of the massive data they have in their archives.
- **Information Instruments:** Obligation to publicly disclose information relating to environmental matters e.g., labelling programmes and rating and certification systems (IPCC, 2007). Various Country's constitution have clauses on 'rights to information.' Kenya is one of them.
- **RE Feed-in Tariffs (FIT):** Policy instrument that seeks to catalyze investment in renewable energy technologies through offering long term contracts to RE producers based on the generation cost of each technology (IPCC, 2007). Such FIT could embolden the obligatory use of CI/S in RE projects development.

4. Meeting the Implementation Challenge

There are various challenges at implementation stage. To overcome some of the common challenges, the first step will be to understand how the end user communities want to use the weather or climate information. CI/S providers and the intermediary can then tailor such information in an understandable form to the end user, explaining all scientific terms and avoid uses of technical jargon in communicating meteorological data. Agencies mandated with collecting and disseminating CI/S could also work with the Ministry of Education to educate learners on weather and climate variability expectations, providing charts, maps or other learning materials. This is a long term strategy that has implication on implementation and climate adaptation. CI/S agencies can also ensure that National Weather forecast are downscaled at devolved level through the intermediaries and interpreted in local languages. Having multi-stakeholder platforms where users interact with providers and intermediaries to assess the data but also understand and interpret it into user responsive information is essential. To ensure that downscaled information is working, monitoring activities could be put in place to ensure that end users are getting the right kind of information for users and also provides an opportunity to profile needs of communities to tailor information and send it via various media including social media such as SMS via mobile phones to ensure they reach wider audience. By integrating/ partnering with platforms that reach wider audience, CI/S providers have an opportunity to initiate a localized "peer model" to ensure small holder farmers access knowledge. Peer to peer information model could provide an easy way to understand and interpret data summaries and provide a platform that is accessible and convenient to everyone. Also the need to openly indicate at what level is the information required is no longer free of charge or requires specialists. In summary to ensure the wider use of climate information at local level

- Decentralising services to county level and making information simple and livelihood applicable by incorporate indigenous traditional systems and using local language to disseminate information
- Provide a platform that is accessible to everyone and a contact person at the local region who can interpret the climate information through an application programming interface
- Translate the information in a local language and ensure follow up of the understanding of the information by users
- Partner with private enterprises to process the content and package it and also through pastoral networks for dissemination
- Openly indicate at what level the information required is and that it is no longer free of charge as it requires specialists to interpret
- Work with existing local structures such as provincial administration, county governments, etc.,

UNDP-UNEP, 2011 have summarized implementation challenges faced when mainstreaming climate change and climate information into policies, projects and programmes, and provided examples of these challenges and way forward. These are highlighted below:

1. Complexity of Climate Change: Climate change is a complex subject with significant links to development. Notably, addressing impacts of climate change cannot be done exclusive of development and poverty eradication. As a result, the key bottleneck remains how to make climate change and climate information a relevant issue to the government, legislators and other development stakeholders.
    - In-order to address this, understanding linkages between poverty reduction and pro-poor economic growth must be built. This involves clearly identifying potential economic costs of climate change impacts using climate information as evidence in a Business as Usual Scenario vis a vis when climate change adaptation is mainstreamed in development planning
2. Implementation challenge: Implementation of policies in terms of financing, measuring the impact of policy measures among others remains a key challenge – In this case, policies that have successfully integrated climate aspects.

    - Strengthening the national climate information system through equipping resources in meteorology departments

- Budgeting and financing: National, sector and subnational levels (building on Adaptation Funding mechanisms)
- Supporting policy measures: National sector and sub-national
- Strengthening institutions capacities: make mainstreaming a standard practice
- The outcome of a policy is usually felt after a period of time hence persistence is key to overcoming the policy implementation challenge.

3. Despite climate change being a long-term issue, political leaders and government officials find it difficult prioritizing it due to its unpredictable nature. For instance, addressing climate change requires managing risks and making decisions based on "considerable uncertainty, with limited and/or imperfect information". Notably, this contradicts with the political leaders and government official's priorities e.g., they are mainly concerned with political cycles and are in power for a short term.
    - There is need to ensure political will through widespread advocacy and packaging climate information in a manner that is easy to interpret and responds to the needs of political leaders e.g., short term and long term

4. Climate change matters are usually designated to the Ministry of Environment hence minimal attention is given to it by Governments during national development planning and budget allocation.
    - Making climate change a central issue in government requires that a key economy wide or high level Ministry such as planning or finance coordinates the process of mainstreaming climate change adaptation. This step will inevitably ensure budget allocation for climate change mainstreaming across sectors and development planning.

5. Lack of a clear link between National responses and other sub-national levels: -
    - Need to link national responses with local and grass root levels. In addition, need to scale down national projections to area specific. This can be achieved through active involvement of stakeholders from all levels and economic sectors.

6. Inadequate capacities of institutions at various levels impede policy implementation e.g., limited technical know-how, limited funds etc.
    - Need to sustainably strengthen capacities of institutions at various levels in terms of widespread climate change advocacy, increasing number of technical experts, increasing budget allocation etc.
    - Making mainstreaming a standard practice across sectors ensures sustainability of this initiative. This can be done through integrating CI into sector mandates, coordination mechanisms, and procedures among others.

6.3 Guidelines to successful mainstreaming of climate information into policy, legislation, projects and programmes

The key steps to successful mainstreaming of climate information into legislature, projects and programmes are discussed below: -

1. **Advocacy and awareness raising:** Climate information plays a key role in building resilience to climate change and promoting green growth. Hence there is need to ensure frequent gathering of quality climate data, recording, analysis, storage and dissemination of up-to-date climate information. In-addition, there is need to invest in advanced technology, training of climate experts and continued capacity building of climate scientists. Based these reasons, it is imperative that government officials, legislators/decision makers, donors and local community understand importance of investing in technology and experts that ensure quality climate data is gathered, recorded, analyzed, stored and disseminated. This therefore calls for widespread advocacy and awareness raising about importance of climate information.

2. **Enabling environment:** The role played by climate information in promoting resilience and green growth is indisputable. As a result, it is important that governments and legislators treat climate information as one of the key priority development areas. This step will create a conducive environment for generation of quality climate data and adequate use of climate information. For instance, acknowledging the role of climate information in promoting green growth will lead to investing in climate information infrastructure including human resource and foster integration of climate information into legislation. Unfortunately, governments and legislators do not accord climate information the importance it deserves. Therefore, it is imperative that donors and development partners continually incentivize and encourage governments and legislators to create an enabling environment for climate information.

3. **Development of tools:** Legislators should be provided with summaries of climate risk and vulnerability assessment reports conducted on sectors, areas, communities and projects. These reports will provide guidance to legislators/decisions makers on issues to consider when formulating policies and budget allocation. Climate proof legislation and adequate budgets for vulnerable areas, sectors, communities and individual projects will build their resilience. Subsequently, relevant government institutions should ensure that climate risk and vulnerability assessments are frequently conducted on areas, sectors, communities and individual projects and appropriate DRR tools adopted so as to guarantee appropriate risk reduction measures are implemented.

4. **Training and technical support:** Governments and development organizations need to build capacities of legislators and human resources through provision of relevant training and technical support for the integration of climate information concerns into development and legislation.

5. **Change in operational practice:** In-order for mainstreaming of climate information into legislation, projects and programmes to be effective,

legislators/decision makers need to restructure the manner in which they operate in terms of policy-making, budgeting, implementation and monitoring at national, sector and subnational levels. This will include incorporating the following elements into their day-to-day operations: -

- *Early Assessment:* Climate information service institutions (especially government institutions) need to share key environmental assessment reports with legislators/decision makers. These reports should communicate key messages that need to be taken into consideration during policy formulation and budget allocation. This therefore calls for frequent up-date of climate information and timely circulation to legislators/decision makers.
- *Adequate supporting information/Adequate climate information infrastructure*: Climate information service providers need to ensure they compile valid and up-to-date climate information so as to build a substantial case when they approach legislators/decision makers to integrate climate information into policies. Legislators should note that, in-order for there to be quality climate information, there is need to invest in climate information infrastructure e.g., strengthen already existing climate infrastructure; purchase or build modern climate infrastructure; build capacities of climate scientists through training among others.
- *Cost minimisation:* Integrating climate information into country policies, projects and programmes should be undertaken at minimum cost. Partnerships between governments and development community can minimize the cost of integrating climate information into country policies, projects and programmes. For instance, governments and development organizations can share climate data and work together to improve climate information infrastructure.
- *Transparent, inclusive and accountable consultation:* Climate scientists should ensure that the process of collecting climate data is participatory (involves relevant stakeholders and local communities) - especially when undertaking risk and vulnerability assessments. Notably, when communicating with legislators, climate scientists should ensure that legislators understand how mainstreaming climate information into legislature and projects will reduce vulnerability of poor and marginalized groups.
- *Measuring progress/Monitoring and Evaluation:* Legislators/decision makers should incorporate climate information and services into their national legislative blue prints, sector strategies/plans and INDCs. This will create an enabling environment for climate information and services and provide a road map for governments and development organizations against which progress in mainstreaming climate information into legislation and development projects can be measured.

6. **Learning, experience sharing and networking:** Climate information Service providers in the government and private sector should continually build their capacities through continuous learning, experience sharing and networking amongst themselves. In-addition, decision makers and climate scientists

should make an effort to have frequent forums where they can discuss, learn and share experiences in mainstreaming climate information and services into legislature and development.

In conclusion, United Nation Poverty and Environment Initiative (UNPEI 2011) have provided three general levels of intervention through which climate change mainstreaming can take place (UNPEI, 2011):

- **Strengthening the development base:** Consciously/intentionally implement development initiatives that aim to reduce vulnerability (not necessarily to climate change). The various stages of the project cycle (identification, appraisal, design, implementation and monitoring & evaluation) provide natural entry points for mainstreaming at the project level.
- **Promoting mainstream adaptation measures:** Incorporate climate change into government decision-making. By doing so, climate change will be mainstreamed in legislative frameworks resulting to (a) climate proof policies and (b) addressing emerging adaptation needs.
- **Promoting specific adaptation measures:** Address issues that have not been tackled by the two levels above though enacting specific adaptation policy measures.

A recent paper published by the International Institute for Environment and Development (IIED) outlines the following approaches to mainstreaming climate change/climate information into developmental policies, projects and programmes (Pervin et al., 2013):

1. **Climate-proofing Approach:** This approach seeks to climate-proof development initiatives that have been planned without considering climate change and variability. It seeks to do so by increasing their capacity to cope and recover from effects of climate change and variability. This approach is suitable for nations that use project-based approaches to development planning. As result, the entry point is project-based interventions. An example of this approach is highlighted in the USAID guidance (USAID 2009), which aims to integrate climate resilience into the design of its country assistance development portfolio.
2. **The Climate-first Approach:** This approach seeks to increase a society's ability to cope with resultant effects of climate change and variability. As a result, the society's preparedness and ability to withstand increased effects of climate extremes is enhanced. The entry point for this approach is stand-alone climate change policies/strategies. Examples of this Approach are provided in the: initial National Adaptation Programmes of Action (NAPA) and Pilot Program for Climate Resilience (PPCR) guidance documents, which allow Least Developed Countries (LDCs) to identify priority activities and projects that responded to their urgent and immediate climate adaptation needs.
3. **The Development-first Approach:** This approach ensures climate resilience is incorporated in all development initiatives – from decision making to implementation to the outcome of the development initiative. The entry point for integration is often a national, local or sectoral development planning framework.

7 RECOMMENDATIONS AND CONCLUSION

CI/CIS has potential to build Africa's resilience to climate change impacts (*refer to section 4 above*), **however, decision makers and political leaders are yet to fully embrace its role in development planning**. Notably, climate change is a complex matter with strong linkages to development - considering majority of African economies are dependent on climate sensitive sectors such as Agriculture, Tourism, Water, Energy, Health, Transport and Infrastructure among others.

Various studies have reported increased climate mainstreaming efforts by governments across Africa (e.g., mainstreaming in existing development planning priorities, sector legislative frameworks etc.) however a couple of challenges still hinder this process. Examples of this challenges and way forward are discussed under section *6.6 above.*

The Information Communication Technology (ICT) sector has significantly contributed in the positive transformation of CI/CIS. For instance, the quality, accessibility and scale of CI has significantly improved over the years. This is attributed to transition from analogue computer systems to sophisticated computer programs e.g., able to project the impact of climate change on sector productivity etc. In-addition, by using information systems, planners are able to integrate relevant CI and responses into existing development planning systems.

One of the **main constraints faced by decision makers in integrating CI into development planning is lack of information on criteria for prioritizing climate-resilient responses** this includes information on the economic costs of climate change. In addition, a report by Pervin et al., 2013 noted that "**Monitoring and evaluation frameworks that support periodic reviews and feedback loops-based learning are yet to be developed and applied."**

Other **key challenges facing integration of CI/CIS in Africa include**:

- Weak implementation of environmental and climate change legislature
- Limited access and sharing of climate data amongst states
- Limited incorporation of CI into national/regional development planning or in disaster reduction strategies
- Limited human resource in the Climate service - human resource to produce, analyse and interpret and disseminate climate data
- Limited weather observation infrastructure, limiting the ability to generate enough accurate data in a timely manner for decision making
- Limited investments in CI infrastructure, leading to outdated or obsolete stations that cannot generate accurate CI

It is important to acknowledge the fact the CIS has significantly progressed over the years however, **gaps in terms of quality, coordination and analysis of the information and in its dissemination and communication are still existent.**

Other gaps that need to be filled so as to ensure effective climate resilience mainstreaming include:

- Need to establish adequate financial management, accounting and reporting systems (Pervin et al, 2013)

- Need to assess development effectiveness of climate investments by creating national evaluative frameworks (Pervin et al, 2013)
- Need to develop guidelines for formulation of climate change response plans and budgetary allocation for use by ministries, development agencies and the private sector (Pervin et al, 2013)
- Need to streamline the integration process by increasing use of medium-term expenditure and budgetary frameworks and sector plans
- Need to make investments into CI infrastructure in order to modernize equipment and improve spatial coverage for the generation of more accurate data

Reluctance to integrate CI/CIS into development planning by political leaders is triggered by the fact that climate change is an unpredictable long-term issue that requires managing risks and making decisions based on considerable uncertainty, with limited and/or imperfect information. This contradicts with the political leaders and government officials' priorities e.g., they are mainly concerned with political cycles and near-term issues since they will be in power for a short term.

Some of the ways in which political leaders can be persuaded to prioritize CI/CIS include:

1. Tailor CI to fit into short and long term activities in political manifestos by reigning governments
2. Downscale climate products and interpret in a lay man's language e.g., Generate area specific maps and interpret the outputs. This information will guide future area members of parliament in determining development activities.
3. Central economic government institutions such as Ministry of Finance and Planning should co-ordinate climate change activities – This institutions should set a mandatory clause that requires all sectors to indicate how CI has been mainstreamed in their budgets – This will ensure climate change mainstreaming becomes a standard practice
4. Strengthen institutional co-ordination in addressing climate change issues since climate change impacts trigger a ripple effect across sectors hence addressing the issues unanimously saves time and costs and prevents overlapping actions
5. Build a clear link between National and other sub-national levels e.g., provide guidance on how institutions at the local level can incorporate CI generated at the National level. Frequent stakeholder meetings are imperative.
6. Integration of CI into economic instruments such as taxes, fines, standards and regulations etc. will obligate people and companies in the government and private sector to enhance environmental integrity.
7. Widely disseminate INDCs in a lay man's language – decision makers, government officials, political leaders, private developers among others should refer to INDCs when making development decisions and development planning.
8. Stakeholders in the climate sensitive sectors should identify their needs and priorities and closely engage with the service providers to ensure that, together, providers and users of climate information can substantially improve

development decision-making. Platforms for this engagements should be created.

9. Raise awareness about importance of CI/CIS with emphasis on development and environmental sustainability.

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ANNEX

Annex 1: SWOT Analysis of Climate Information Services in Africa

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
There have been significant advances in explaining the dynamics of African climate variability, which has led to a growing confidence in climate forecasts while seasonal outlooks have gained greater importance in managing climatic risks.	Sub-Saharan Africa's climate observation networks and systems are poor. Where networks and infrastructure do exist, many are in decline.	Increase the quality and quantity of climate observation networks and infrastructure in sub-Saharan Africa.	Lack of capacity and/or willingness among potential users to access, understand the probabilistic nature of climate information, process and act upon the available information.
	Low quality and limited accessibility of climate data.	Recover unarchived historical data that has not been digitized yet and therefore, it has been inaccessible to researchers.	Political and socioeconomic factors may be inimical to the uptake of climate information in decision making processes with long term consequences.
Climate forecasts can help those who depend on agriculture with decisions such as: whether or not to plant, when to sow, which seeds or crop varieties to choose, herd migration, livestock sale or slaughter, what pest protection alternative is best and whether or not to apply inorganic fertilizers. Additionally, forecasts can also help anticipate the emergence of certain types of pests, fungi and	Sparse data coverage and temporal gaps. In some locations, time series data have been, and continue to be, disrupted by natural disasters and/or conflict.	Address barriers to the uptake of climate information, including institutional mandates, hierarchical structures and the lack of adequate incentives.	Limited capacity to identify needs for training on climate change and its potential impacts, as well as on how to integrate medium- to long-term information into existing policies and decision making processes.
	The development and refinement of climate models typically take place outside of Africa.	Promoting the usefulness of climate information in ways that decision-makers value most. There is a need to help them understand what climate information should and should not	The role of communicating climate information is usually given to formal scientific bodies and the information that reaches end users is usually overly technical, ill-matched to their demands and easily leads to misunderstanding of the

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
smuts. Climate forecasts can increase farmers' preparedness and lead to better economic and environmental outcomes in the long run. Climate information can improve resource management and enhance the welfare of agricultural and rural populations, which also represent the bulk of people living in poverty. Climate information helps to mitigate risk, which is a documented reason for the weak performance of sub-Saharan countries. The inherent uncertainty arising from natural climate variability is challenging since farmers must take many critical and climate-sensitive decisions	Packaging skills are lacking, making it difficult to reach end-users effectively. Climate information is not sold to the private sector on a large scale.	be used for, and to encourage more systematic and evidence-based approaches to decision making under uncertainty. Farmers will increase their demand for accurate climate forecasts as climate change renders their traditional information sources and experiences less reliable. Break poverty cycles**.** By having access to seasonal forecasts, for instance, subsistence farmers can adapt their strategies accordingly and avoid losses or complete crop failure. Success, however, hinges on farmers having access to adaptation options. Partner with the health sector. Most infectious diseases can be better managed if climate information is readily available to predict changes in rainfall,	uncertainties associated with it. Lack of effective communication and engagement between the users and producers of climate information, which leads to misunderstandings about the merits and limitations of its use. There is a mismatch between the capacity of climate scientists to produce policy-relevant information, and the decision-makers' unrealistic expectations about the information they could receive. Sometimes religious beliefs clash with the concept of being able to predict the weather and the use of climate information is consequently reduced.

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
months before the impacts of climate are realized. Climate forecasts can help contain disasters and also capitalize on temporarily favourable states of nature.		temperature and humidity. Fostering economic development via better informed sectors, such as agriculture, forestry, fishing, mining, water resources, energy, transportation, aviation and tourism. In addition, national hydromet services can also supplement their resources by packaging and selling information to the private sector.	

Annex 2: Challenges in the provision of Climate Information in Africa

Examples of challenges facing provision of Climate Information in Africa include:-

1. **Inadequate Infrastructure**

Many countries in Sub-Saharan Africa have not made adequate investments in their climate and weather information infrastructure, resulting in equipment that is old, obsolete, damaged, missing, or, in some cases, completely destroyed by years of civil unrest. The result is that in many countries, observation stations do not cover spatial variability to adequately cover the countries' climate zones, and unable to generate enough accurate data in a timely manner for decision making.

For example:

- In 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.
- In Tanzania, the Ministry of Agriculture maintains a network of manually observed rainfall stations. Although though the data is not transmitted regularly for all sites, when it is transmitted, it is sent to the Ministry by mail and arrives too late to enable any proactive analysis, early warning or short-term planning.
- Generally, countries have few Automated Weather Stations (AWS). For example, Tanzania has 11 AWS covering the country, while Zambia has 2. Although Sao Tome & Principe has 10 AWS, only 3 are functioning.

As a consequence of poor coverage with inadequate equipment, the accuracy of weather forecasting over Africa is compromised. This includes coverage by international systems, due to the low density of coverage of "ground-truthing" weather stations. Consequently, Africa is not adequately linked to international weather and climate systems, with limited contribution to international weather and climate studies/forecasts.

2. **Inadequate Finance**

The maintenance of monitoring equipment, the human capacity to use and repair this equipment, process data and develop early warning packages, all require constant income streams and annual budgets.

Unfortunately, little investment goes into infrastructure and capacity for the Meteorological departments, given that many of these countries have other priorities perceived to be more pressing, and choose to invest in other sectors such as infrastructure that have a more tangible effect and return.

- In Burkina Faso, insufficient budgeting has led to the inability of the Radar and Cloud Seeding Center for Aeronautical Aviation (SAAGA) to cover maintenance costs for the radar in Ouagadougou and approximately 40% of the hydrological equipment in the country to become non-operational.
- In Malawi, currently, there is inadequate funding for disaster risk management and hydro-meteorological services – in particular Early Warning Systems– in the national budget. As a result, there has been i) a steady decline in the

state of the hydro-meteorological observation networks in Malawi over the last 20-30 years; and ii) inadequate allocation of the Department of Disaster Management Affairs' funding to fulfil its core mandate in a collaborative manner with the Department of Climate change and Meteorological Services and the Department of Water Resources.

Therefore, the state of climate information infrastructure in many countries is in decline, and Meteorological departments often have to operate with inadequate resources, including software, manpower and machines that are obsolete. This not only has an impact on staff morale, but it also has an impact on the quality and accuracy of data generated.

3. **Limited Technical Capacity to Manage Weather Information Systems**

The scientific and technical capabilities required to effectively identify hazards and forecast their potential impacts on vulnerable communities in many countries is weak. This is largely a result of a lack of infrastructure (i.e. computational equipment), software (model code and associated routines), and human capacity/skills to program and run the software required to generate forecasts. Running forecast models is a highly skilled task and requires many years of education and training.

- In Zambia, the meteorological service has approximately 160 staff, with approximately 50 at the head office in Lusaka and approximately 110 at meteorological stations and at provincial offices. There are approximately 95 staff in the forecasting division country-wide. This number is not enough for a country as large and as diverse as Zambia.
- In Uganda, due to limited human resources and skills, there is insufficient use of satellite data for predicting rainfall or monitoring convective systems that result in severe storms; providing information for regions not covered by meteorological and hydrological stations; and monitoring environmental variables related to agricultural and hydrological risks, such as satellite-based vegetation monitoring to assess crop performance or flood mapping.

As a result of the poorly coordinated state of the sub-sector and thus low institutional capacities and insufficient funds, well-trained forecasters are often not able to use their skills effectively and are often lured overseas or into more lucrative work. This has resulted in limited manpower especially skilled forecasters, technicians and IT specialists.

4. **Non-existence of systematic processes for packaging, translating and disseminating climate information and warnings**

Many countries do not have a systematic process for packaging, translating and disseminating climate information and warnings. Therefore there is limited packaging of climate information and warnings and inappropriate communication to different sectors and end-users. This is largely a result of weak institutional arrangements, absence of policy and legal frameworks to guide the provision of meteorological services, and limited appreciation and use of meteorological services by other sectors of the economy. For example:-

- In Zambia, there is no organisational mechanism between government, business and civil society for effective cross-sectoral early warning against climate variability and climate change in the country.
- Although Malawi has a Flood Early Warning System, there are several weaknesses that result in delays in sending out early warning messages, including: i) limited training at a district level on what to do when an early warning message is received; ii) limited standardization in communication of early warning messages; and iii) limited cross-border cooperation with Mozambique regarding tropical cyclones, flooding, Mwera winds and drought. A clear system of communicating weather, hydrological and climate information to the communities is non-existent. Warnings are issued at national level, passing through a number of bureaucracies and many departments. Processing information between numerous departments causes delays, failing to achieve the intended purpose of early warnings.

5. Weak Institutional Coordination

Challenges arising from inadequate infrastructure and skill are further compounded by ill-defined institutional coordination and communication amongst agencies that share climate monitoring responsibilities. This results in duplication of costs, delays in transmission of data, and weakened analysis of data as it is often fragmented and stored in different departments. Furthermore, poor inter-sectoral coordination at a departmental and ministerial level results in the available climate, agriculture and environmental data and information not being adequately combined and/or translated for key messages to be easily understood by users. For example:

- In Tanzania, the Meteorological Agency, Ministry of Water, and Water Basin Authority currently maintain their own networks of stations and station monitors, which leads to duplication and high costs. Further, there is no unified and database on weather, climate and hydrology that can be accessed by relevant sectoral users at a central or local level, and therefore no source of information that can serve as a credible basis for long-term planning.

Annex 3: Tools for Climate Change Mainstreaming

Table 2: Properties and Uses of Decision-Support Tools for Climate Change Adaptation/Climate Screening Tools

	Title of tool/ guidance	Organization/ institution	Target Audience	Approach	Summary	Level	Costing exercise included	Practical application
1	Assessment and Design for Adaptation to climate change – A Prototype Tool (ADAPT)	World Bank	Policy makers, Development project planners and managers	Software-based approach integrating climate databases and expert assessments	Carries out risk analysis at the planning and design stage, through a five level flag classification and proposes options to minimize risks + guides project designers to appropriate resources. The focus thus far is on agriculture, irrigation and bio-diversity	Project	No	Agriculture and Natural Resource Management in South Asia and Sub-Saharan Africa. Tool available for Africa and India
2	Adaptation Wizard	UK Climate Impacts Programme (UKCIP)	Planners and managers, UK	User-friendly info- and structuring computer-based tool following a risk-based approach	5-step process to assess vulnerability to climate change, and identify options to address key climate risks. Needs to take developing country context into consideration in order to be of real use for developing countries	Organization	Yes	UK
3	Climate Framework Integrating Risk screening tool (ClimateFIRST)	Asian Development Bank (ADB)	Development project planners/ managers	Risk Assessment	Climate risks screening software tool for rapid assessment of projects/programmes risk potential.	Project & programme	N/A	Tool in draft stage
4	Climate Risk Impacts on Sectors and	DfiD	Policy makers, project/ programme	Sector-based climate risk assessment	Structuring framework developed for the portfolio screening of DFID activities	Programme & sector	Yes	Kenya

	Title of tool/ guidance	Organization/ institution	Target Audience	Approach	Summary	Level	Costing exercise included	Practical application
	Programmes (CRISP)		managers	methodology	in Kenya. Assesses climate impacts at the sector level.			
5	The Community-based Risk Screening tool - Adaptation and Livelihoods (CRiSTAL)	SDC, IISD, World Conservation Unit (IUCN), Stockholm Environment Institute (SEI) and Inter-cooperation	Development project planners and managers	project planners and managers Participatory and vulnerability based approach , step-by-step, computer based method	User-friendly conceptual framework, aimed at raising awareness on climate change adaptation and facilitating the identification and organization of an adaptation strategy	Project	No	Mali, Tanzania, Sri Lanka, Nicaragua
6	Disaster Risk Reduction Tools	ProVention Consortium	Policy makers, project planners/	Disaster risk reduction (DRR) approach	Provides guidance on different DRR mainstreaming tools	Various	Yes, guidance note	N/A
7	Opportunities and Risks from Climate Change and Disasters (ORCHID)	DfiD	Development project planners / managers	Portfolio risk assessment method based on pilot studies	Basic framework including a 4-step generic approach to portfolio screening for climate risks.	Project	Yes	India, Bangladesh and China
8	Screening Matrix	Danida	Development project planners/ managers	Pre-screening of activities	Simple climate change screening matrix, which establishes sector programme support sensitivity	Programme & Sector	No	Kenya, Cambodia, Bhutan, and Nepal

Source: Olhoff and Schaer, 2010

Annex 4: Examples of policy measures given general policy objectives and options to reduce GHG emissions from the energy-supply sector

POLICY OBJECTIVES /OPTIONS	ECONOMIC INSTRUMENTS	REGULATORY INSTRUMENTS	POLICY PROCESSES		
			Voluntary Agreements	Dissemination of information and strategic planning	Technological RD&D and deployment
Energy efficiency	• Higher energy taxes • Lower energy subsidies • Power plant GHG Taxes • Fiscal incentives • Tradable emissions permits	• Power plant minimum efficient standards • Best available technologies prescriptions	Voluntary commitments to improve power plant efficiency	Information and education campaigns.	Cleaner power generation from fossil fuels
Energy source switching	• GHG taxes • Tradable emissions Permits • Fiscal incentives	Power plant fuel portfolio standards	Voluntary commitments to fuel portfolio changes	Information and education campaigns	Increased power generation from renewable, nuclear, and hydrogen as an energy carrier
Renewable energy	• Capital grants • Feed-in tariffs • Quota obligation and permit trading • GHG Taxes • Carbon capture and storage • Radable emissions permits	• Targets • Supportive transmission tariffs and transmission access	Voluntary agreements to install renewable energy capacity	• Information and education campaigns • Green electricity validation	Increased power generation from renewable energy sources
Carbon capture and storage	• GHG taxes • Tradable emissions permits	Emissions restrictions for major point source emitters	Voluntary agreements to develop and deploy CCS	Information campaigns	•Chemical and biological sequestration •Sequestration in underground geological formations

Source: The 4th Assessment Report (IPCC, 2007)

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