Assessment on Weather and Climate Services Value Chain in Kenya

[Working Document v04]

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Acronyms

ACMAD - African Centre of Meteorological Applications for Development
ADA - Adaptation Consortium
AGRA - Alliance for a Green Revolution in Africa
ASDSP - Agricultural Sector Development Support Programme
ASARECA - Association for Strengthening Agricultural Research in Eastern and Central Africa
BEAMS - British East African Meteorological Service
CCAFS - Climate Change, Agriculture and Food Security
CGIAR - Consortium of International Agricultural Centers
CHIESA - Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa
CSA - Climate-smart agriculture
EAC - East African Community
EAMD - East African Meteorological Department
FAO - Food and Agriculture Organization (of the UN)
FEWSNET - Farming and Early Warning Network
GCAP - Global Climate Adaptation Partnership
GFCS - Global Framework for Climate Services
IBLI - Index-Based Livestock Insurance
ICPAC - IGAD Climate Prediction and Applications Centre
ICRISAT - International Crops Research Institute for the Semi-Arid Tropics
ILRI - International Livestock Research Institute
IPPs - Independent Power Producers
ITIKI - Information Technology and Indigenous Knowledge with Intelligence
KALRO - Kenya Agricultural Livestock Research Organization
KFWG - Kenya Forest Working Group
KMD - Kenya Meteorological Department
MoWI - Ministry of Water and Irrigation
N-FEWS - National Flood Early Warning System
NAFIS - National Farmers Information Service
NDMA - National Drought Management Authority
NDOC - National Disaster Operations Centre
PACJA - Pan Africa Climate Justice Alliance
PPE - Public-Private Engagement
PPP - Public-Private Partnership
PPPA - Public Private Partnerships Act
PPPC - Public Private Partnerships Committee
RCMRD - Regional Centre for Mapping of Resources for Development
TAHMO - Trans-African Hydro-Meteorological Observatory
UoN-Met - Department of Meteorology, University of Nairobi
USGS - United States Geological Survey
WMO - World Meteorological Organization
WRA - Water Resources Authority
WRMA - Water Resource Management Authority

Concepts and Terminologies

Climate is usually defined as the average weather condition, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years. The World Meteorological Organization (WMO) often defines a period of 30 years. (IPCC, 2014)

Weather is the atmospheric condition in a given place, including variables such as temperature, rainfall, wind, or humidity. (IPCC, 2014)

Weather and climate services involve providing weather and 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)

1. Introduction

The climate in Kenya is a combination of various patterns, from its different topography which ranges from the lowlands along the coast to the plateaus in the highlands and the high mountains. Such diversity of the area results in a mosaic of climatic zones, such as hot and humid coastal areas, arid and semi-arid regions, cool to temperate highlands with sharply defined dry and wet seasons, and the ever-changing weather of the Great Rift Valley. However, Kenya is not spared by the worldwide trend of climate change. The nation is witnessing rising temperatures, shifting rainfall patterns, and an escalating frequency of extreme weather events, such as droughts, floods, and storms, which cast ominous shadows over various sectors.

Climate change profoundly impacts Kenya, especially its agriculture, which is crucial to the economy. This results in reduced yields, food insecurity, and economic instability, particularly in arid and semi-arid regions. Water resources are strained due to altered rainfall patterns affecting freshwater availability. Rising temperatures also expand vector-borne diseases like malaria, posing significant public health risks.

In response to these challenges, Kenya has taken steps to enhance its resilience to climate change. The National Climate Change Action Plan (NCCAP) is a crucial policy initiative that outlines the country's efforts to adapt to and mitigate the effects of climate change. These efforts encompass climate-smart agriculture practices, afforestation, reforestation initiatives, and the promotion of renewable energy sources, such as geothermal and wind power. The quality and quantity of climate information generated by Kenya Meteorological Department (KMD) has improved with advancement in technology. Furthermore, Kenya has invested in disaster risk reduction and early warning systems to mitigate the impact of extreme weather events.

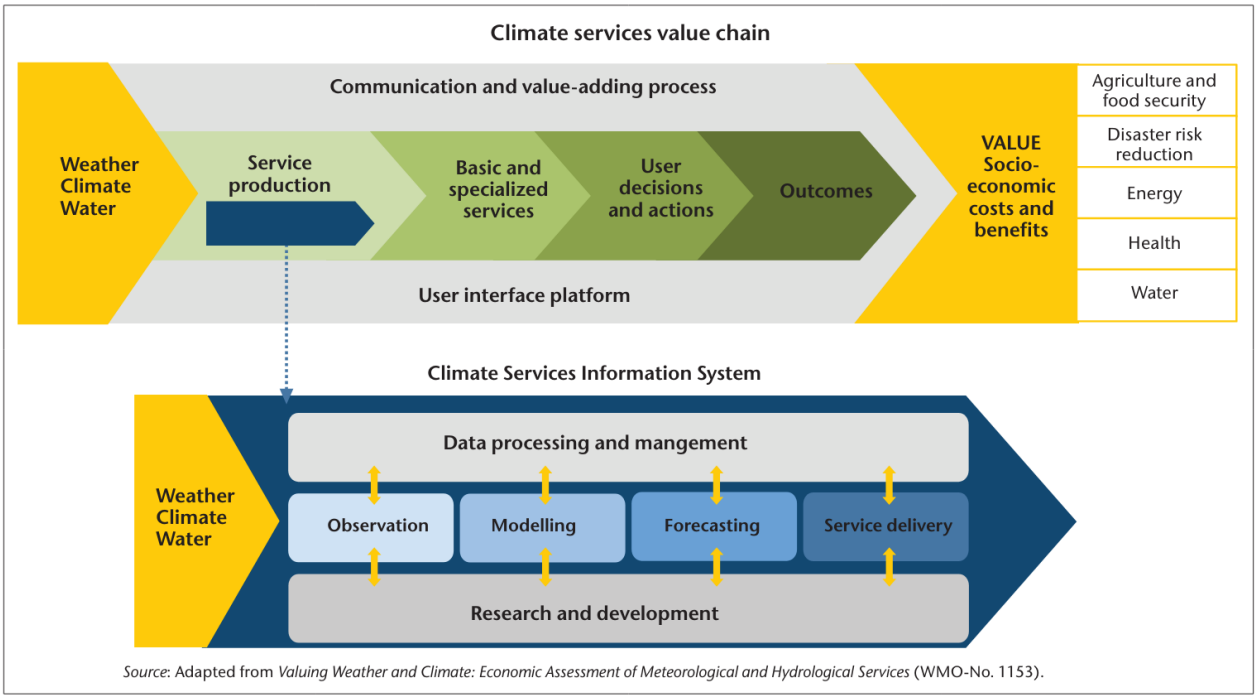
Despite these efforts, several hurdles persist. One of the major problems faced in discharging some of the functions of KMD has been lack of smart and specific climate services. In addition, Kenya faces data and information gaps, with limited access to timely and accurate climate data, especially in rural areas. Climate modelling and forecasting capabilities require further development, and institutional capacity for climate information dissemination needs strengthening. A climate service delivers climate-related data and insights tailored to aid individuals and organizations in making informed decisions" (WMO, 2014). More often the climate information sent through media does not target specific sectors but is rather general; therefore, most sector users cannot integrate the climate information into their sector plans and decision-making processes. In addition, given the limitations of the pure governmentally intervened and pure market-based WCS provision models, it is important to test new approaches.

Methodology – This report explores secondary data for the contextualized answers to the key research questions on a high-level. Key research questions are:

- Identify and map key stakeholders in the agricultural sector throughout the WCS value chain, and evaluate their access to and utilization of WCS
- Assess the national policy and regulatory environment for PPP/PPE, pinpointing gaps and opportunities (explore existing and previous PPP/PPE models that have been used to address improved service delivery in other sectors such as water, energy, and transport).

2. The Global Framework for Climate Information Services (CIS)

The Global Framework for Climate Services (GFCS) was put forward in the World Climate Conference in 2009 which focused on the need to "to strengthen the production, availability, delivery and application of science-based climate prediction and services". The GFCS implementation plan is currently targeting gaps in climate services which are crucial for priority sectors such as agriculture, water, health, and disaster risk reduction in vulnerable countries.



Source: Adapted from *Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services* (WMO-No. 1153).

2.1. Climate Information Services Principles

Various challenges confront efforts to use climate-related information to improve the lives of smallholder farmers. Critical gaps in the design, delivery, and effective use of climate-related information for risk management among smallholder farmers can be filled by paying attention to five prerequisites (Tall et al. 2013):

- **Salience** – Tailoring content, scale, format, and lead time to farm-level decision making.
- **Access** – Providing timely access to remote rural communities with marginal infrastructure.
- **Legitimacy** – Ensuring that farmers own climate services and they shape their design and delivery.
- **Equity** – Ensuring that women, poor, and socially marginalized groups are served.
- **Integration** – Providing climate information as part of a larger package of agricultural support and development assistance, enabling farmers to act on received information.

There exists the notion that the integration of weather and climatic data into decision-making is a transdisciplinary but multidisciplinary process that involves scientific components such as climate science and information services, environmental communication (driven by translational science), and issues of management to encourage the delivery and use of services by service providers. Both globally and sub-nationally there has been quite a good effort to improve the capabilities of this interlinking component and this includes pilot projects whose goal is not only to improve the interaction and understanding of the topic between climate information providers and users.

Similarly, numerous initiatives have been undertaken in recent years to enhance climate and weather information services across Africa. However, it remains evident that the availability and adoption of such information and services still lag, representing a missed opportunity for both social and economic advancement. There is an increasing consensus that the absence of a comprehensive approach and sustained long-term support for the development of weather and climate services significantly hinders progress in their adoption (Graham et al., 2015). The emergence of climate-smart agriculture (CSA) and associated programs in Kenya presents an opportunity to address the low uptake and bolster climate information services in the agriculture and food security sector.

2.2. Farmers Decision Making Under Climate Change

Farmers adapt to climate variability and change through climate advisories that reduce climate impacts. The information assists farmers in deciding which agricultural technologies and adaptation mechanisms may be most useful in responding to weather variability and climate change (Wood et al. 2014).

When it comes to agricultural decision-making, there are generally two different categories: strategic and tactical. The distinction between strategic and tactical decisions in agricultural planning is directly linked to Weather and Climate Services (WCS). Strategic decisions, which involve long-term planning and seasonal forecasting, heavily rely on WCS to anticipate weather patterns, climate trends, and potential environmental impacts. This information informs decisions such as crop selection, irrigation planning, and the timing of chemical applications to optimize yield and minimize risk.

On the other hand, tactical decisions, made within shorter time frames during the growing season, also benefit from WCS. Immediate weather forecasts help determine daily or weekly actions like irrigation scheduling, pest management timing, and harvest planning. By integrating WCS data into both strategic and tactical decision-making processes, agricultural operations can enhance their resilience, efficiency, and sustainability in response to changing weather conditions and climate variability. Thus, WCS serves as a crucial tool in aligning agricultural practices with environmental conditions to achieve optimal outcomes.

Time scales for tactical and strategic agricultural management decisions

Decision Type	Climate System (Years)
Logistics (for example, scheduling of planting/harvest operations)	Intraseasonal (> 0.2)
Tactical crop management (for example, fertilizer/pesticide use)	Intraseasonal (0.2–0.5)
Crop type (for example, wheat or chickpeas)	Seasonal (0.5–1.0)
Crop sequence (for example, long or short fallows)	Interannual (0.5–2.0)
Crop rotation (for example, winter or summer crop)	Annual/biennial (1–2)
Crop industry (for example, grain or cotton, phase farming)	Decadal (~10)
Agricultural industry (for example, crop or pasture)	Interdecadal (10–20)
Land use (for example, agriculture or natural system)	Multidecadal (20+)
Land use and adaptation of current systems	Climate change

Source: Meinke and Stone 2005.

3. Overview of Kenyan Weather and Climate Services

3.1. Geographical and Climatic Characteristics

Climate change is having significant adverse effects including flooding, erratic rainfall patterns, sea level rise, droughts, soil erosion, and lower crop productivity on the African continent (Dube et al. 2016; Coulibaly et al. 2020). These effects exacerbate food insecurity and poverty and threaten the livelihoods of millions of people across Africa (Atiah et al. 2022). This has necessitated the search for solutions to moderate the effects of climate change across Africa (Pachauri et al. 2014). Climate variability and change pose significant challenges not only to Sub-Saharan Africa but to societies worldwide. The impacts of climate change and variability on agriculture are large particularly in sub-Sahara Africa where rainfall is the main source of water for farming (Forch et al., 2011; Kristjanson et al., 2012).

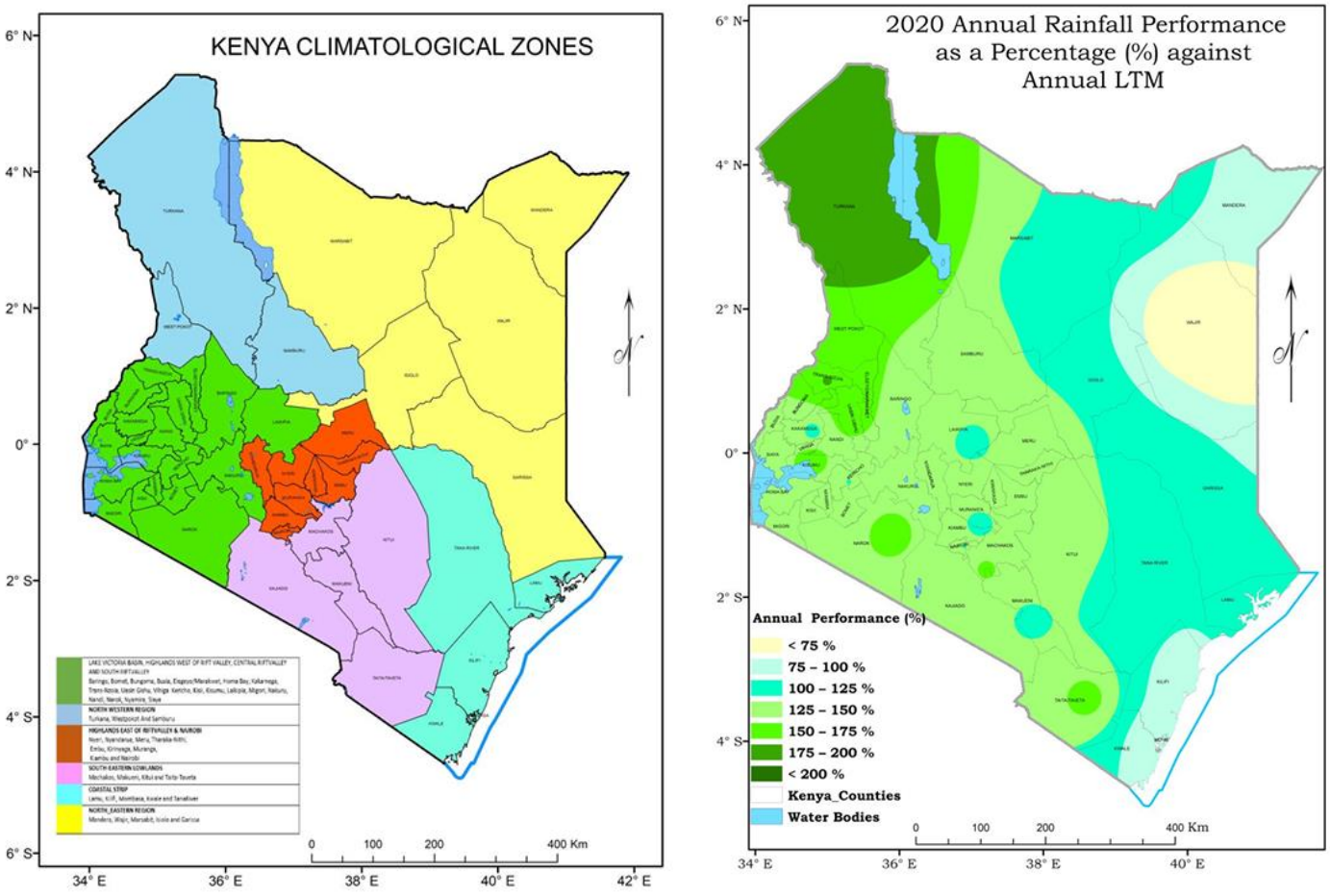
Kenya's climate varies considerably across the country, heavily influenced by its varied topography and the north-south migration of the zonal arm of the Intertropical Convergence Zone (ITCZ). The country's geographical location makes it prone to cyclical droughts and floods. The climate has exhibited increasing variability and change as evident in the long data (over 50 years) on rainfall and temperature at various stations in Kenya (KMD, 2020).

Extreme weather events have become common in Kenya. Largely droughts and to a lesser extent floods, influence economic growth of the country and with associated devastating impacts. The frequency and intensity of severe weather events have been noted to increase, and this is expected to increase with further increase as with climate change. Frequent drought and flood events result in crop losses, livestock and wildlife deaths, spikes in food prices, increased food insecurity and malnutrition for the poor, rural population displacement, and impact on urban water supply, and on energy generation (World Bank, 2014).

Droughts and floods are more frequent in Kenya and the region in the last decade (Bunyasi, 2012; Huho and Kosonei, 2013; Mugalavai and Kipkorir, 2013; Yvonne et al., 2016). Climate change presents one of the most significant challenges to Kenya's horticulture sector due to extreme events such as droughts, floods, and temperature increases (Patrick et al., 2020). Most of the disasters that affect the country are climate-related and therefore exacerbated by climate change. This threatens Kenya's socioeconomic development since the economy depends on climate-sensitive sectors such as agriculture, health, energy, and tourism.

Global Climate Model (GCM) data indicates that Kenya's mean annual temperature is projected to increase between 0.8 and 1.5°C by the 2030s and between 1.6°C and 2.7°C by the 2060s. GCMs suggest with greater confidence that the proportion of annual rainfall that occurs in heavy events will increase.

The coastal region has a tropical climate, which is suitable for crops like coconuts, cashew nuts, and cassava. In contrast, the arid and semi-arid lands (ASALs) in the interior are suitable for livestock rearing and drought-resistant crops.



Adopted from KMD 2020

Climate information services have become an important tool for mitigation of the impact of risks associated with climate change and weather variability. Smallholder farmers' access to timely, affordable, and accurate agro-weather advisories is key to empowering farmers' decision-making for increased adaptive capacity, greater agricultural productivity, household income, and food security (Ngigi, M. W., & Muange, E. N., 2022).

3.2. Potential Impacts of Climate Change in Kenya

Kenya's diverse geography and climate have a significant impact on its agricultural sector. The country's agriculture is mostly rain-fed, highly dependent on the rainfall patterns, making farmers vulnerable to the impacts of weather variability and climate change.

Climate change poses a major threat to Kenya's agriculture. Changes in temperature and rainfall patterns, as well as extreme weather events like droughts and floods, have significant impacts on crop production. For instance, the ongoing Horn of Africa drought, the worst in 40 years, has severely affected the ASALs, where agriculture is the main source of livelihood. According to the World Bank, climate change will likely have major implications for maize production in Kenya, with losses estimated

at US$100–200 million annually by 2050. Similarly, other crops and livestock will suffer heavy losses with serious implications as a result of climate change.

Most Climate-affected Areas

The Kenyan Government recognizes that arid and semi-arid areas are the most vulnerable to climate-related risks with huge impacts on livestock and smallholder farming, which are the dominant sources of livelihood in these areas (Jarvis et al., 2011). The food security situation in Kenya's Arid and Semi-Arid Lands (ASALs) counties deteriorated sharply due to the poor performance of the October-December 2021 short rains season, leaving an estimated 2.8 million people in Crisis (OCHA, 2021).

Livestock deaths due to the drought are reported to have surpassed 1.4 million in 2021, including due to long trekking distances and depleted pastures. In marginal agricultural areas, crop production will be an estimated 70% below-average, marking the third consecutive below-average season. The poor rains also significantly reduced agricultural wage labor income for poor households, constraining access to food (OCHA, 2021).

24 counties are considered prone to drought, according to Kenya's National Drought Management Authority (NDMA). These include counties like:

Counties in ASAL with largest number of affected population	Counties in ASAL with large number of affected population
Garissa, Kilifi, Turkana, Wajir, Kitui, Kajiado, Mandera, Kwale, Marsabit	Baringo, West Pokot, Tana River, Laikipia, Isiolo, Samburu, Lamu, Taita Taveta
These counties are highly vulnerable to climate change facing floods and prolonged droughts due to their arid or semi-arid conditions, and their agriculture and livestock production is often severely affected by droughts. ASALs makes up over 80% of the country's land mass (OCHA, 2021).	

3.3. Importance and Provision of Climate Information Services (CIS)

Kenya's economy is highly dependent on agriculture, which employs over 75% of the population and accounts for more than 25% of GDP. However, the sector is highly vulnerable to climate change, with increasing temperatures, erratic rainfall, and more frequent extreme weather events posing significant challenges.

Kenyan farmers are adapting to climate change in several ways (CIMMYT, 2023, World Economic Forum, 2015; Simotwo, H. K., Mikalitsa, S. M., & Wambua, B. N. (2018).):

- **Using Climate Information Services (CIS)**: Farmers are using CIS to adapt to climate variability and change. These services provide weather forecasts and advisories, information about new seeds and technologies, and market developments.
- **Growing Indigenous Crops**: Some Kenyan farmers are adapting to extreme weather by growing indigenous crops. These crops are often more resilient to local pests and diseases, and they can better withstand extreme weather conditions compared to exotic and commercial vegetables.
- **Planting Drought-Tolerant and Early Maturing Crops**: Many farmers are planting drought-tolerant crop varieties and early maturing crops. These crops can survive in harsh conditions and mature quickly, reducing the risk of crop failure due to unpredictable weather patterns.
- **Diversifying Crops and Income Sources**: Diversifying crops and income sources is another major adaptation strategy used by Kenyan farmers. By growing a variety of crops and diversifying their income, farmers can reduce their vulnerability to climate change.

- **Community-Based Adaptation Projects**: Community-based adaptation projects, such as the Isiolo adaptation pilot project, are helping pastoralists manage drought better and protect their animals, incomes, and families. These projects are often backed by international organizations and encourage community members to identify investments that would build their resilience to climate change.
- **Improved Veterinary Care**: Improved veterinary care is helping to control diseases that can spread more easily due to climate change. For example, in northern Kenya, migration during drought periods exposes animals to diseases as they converge on remaining grazing land and watering points.

These strategies are helping Kenyan farmers build resilience and adapt to the challenges posed by climate change. However, the effectiveness of these strategies can vary depending on local conditions and resource

Focus on CIS to adapt to climate change

The government of Kenya recognizes the growing threat climate-related risks pose to its near- and long-term development prospects. Vision 2030 (GOK, 2007a) and Kenya's First Medium Term Plan (2008–2012) (GOK, 2008), Second Medium Term Plan (2013–2017) (GOK, 2013) acknowledge climate risk and the need to enhance capacity to manage it, especially in reducing drought hazards (GOK, 2010).

Kenya's National Climate Change Adaptation Plan (NCCAP) recognizes the key role of improving climate information and services to strengthen the adaptive capacity of communities through 'providing farmers and pastoralists with climate change-related information, and mainstreaming climate change into agricultural extension services. The NCCAP equally recognizes the vital importance of climate information services (CIS) to reduce 'vulnerability to disasters by using climate risk information in development planning and policy making; taking into consideration that more than 70% of natural disasters in Kenya are related to extreme climate events.

CIS play a crucial role in helping farmers adapt to climate variability and change. These services provide weather forecasts and advisories, information about new seeds and technologies, and market developments.

An important step toward improving the ability to manage climate-related hazards is the timely availability and usage of climate information services (Vaughan and Dessai 2014; Antwi-Agyei et al. 2021a,b). Climate information services are the ways in which climate information is made available to and useful for decision-makers across different sectors and at different scales (WMO 2018). Climate information services provide institutions and people with timely, contextualized climate information to lessen climate-related risks as well as protect lives, properties, and livelihoods (Vaughan and Dessai 2014; Nkiaka et al. 2019).

Such services include weather forecasts and climate predictions. Weather forecasts predict the state of the atmosphere over a short period of time and is dependent on the initial state of the atmosphere, while climate prediction or climate forecast is an attempt to produce a most likely description or estimate of the actual evolution of the climate in the future, for example, at seasonal, interannual, or decadal time scales (Infrastructure for the European Network for Earth System Modelling 2020). While seasonal forecasts are routinely issued in some regions, climate predictions at longer time scales are still at an early research stage.

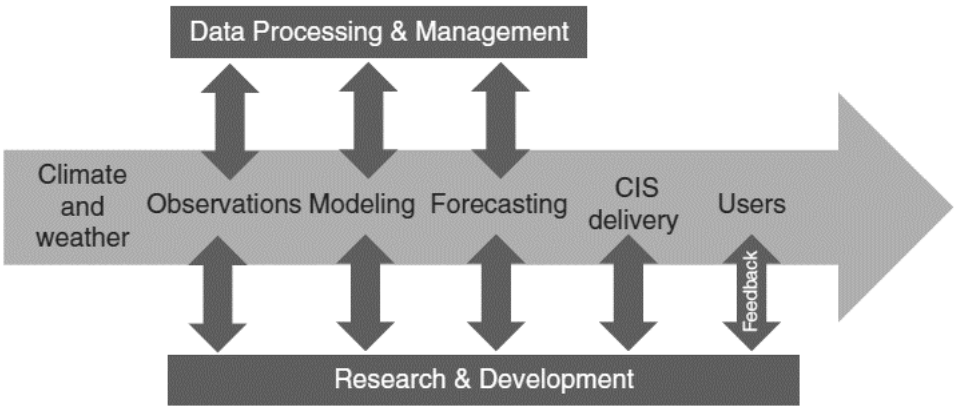
There are a number of sectors including agriculture, marine, aviation, forestry, and utility companies with their own specific needs for weather and seasonal forecasts. For instance, farmers (the end users) make farm management decisions including irrigation, application of fertilizers and pesticides, and drying of crops based on weather and seasonal forecasts (Antwi-Agyei et al. 2021a).

4. Contextualized Analysis of the Kenyan CIS Value Chain

The concept of those who provide services concerning climate evokes a state of permanent relationship intermediaries like observers, modelers, forecasters, disseminators, and end users where the users especially the farmers will have the ability to forecast the deviations climate change will trigger. The value of the information is only realized at the end of the chain in which decisions are made based on the information provided.

There are three main reasons climate and weather services must be viewed as a value chain:

1. A weakness in one aspect of this chain will have consequences with respect to the usefulness of the information, products, and services provided.
2. It helps to reinforce the idea that inputs in the form of weather and climate events must be translated into user-specific products that aid climate-resilient decision-making.
3. In the past, much investment in weather and climate services was not integrated, resulting in inefficiencies and a lack of sustainability in the ability of the system to perform in the medium and longer term.



4.1. Mapping the Kenyan WCS Providers

The field of climate information in Kenya has attracted a vast array of participators, some are CIS producers, some intermediaries, and others are end users.

Meteorological observations in Kenya commenced in 1896 at the former Mombasa Old Observatory, Port Reitz. However, organized meteorological services were formally instituted in 1929 under the British East African Meteorological Service (BEAMS). This entity underwent a renaming in 1947/48 to become the East African Meteorological Department (EAMD), later falling under the jurisdiction of the East African Common Services in 1965. Following the dissolution of the East African Community (EAC) in 1977, the Kenya Meteorological Department (KMD) was established as a department within the Ministry of Power and Communications. Over time, it has been housed within various ministries and currently operates as a department within the Ministry of Environment, Climate Change, and Forestry.

KMD is the mandated central institution for providing weather and climate information services. This mandate is anchored on executive orders on the structure and organization of the Government of Kenya and the World Meteorological Organization Convention. The Convention also recognizes the National Meteorological Service to be the single and authoritative voice and source on matters of severe weather and extreme climate events among WMO's member states (KMD).

There are other institutions which provide climate information services (CIS), early warning (EW) services and platforms. Traditional and community based EWS, for example the Nganyi Group and the Pokot Community EWS bring into play broad forecasting knowledge bases in their own localities. There is also the Information Technology and Indigenous Knowledge with Intelligence (ITIKI), an app based innovative drought early warning system anchored on a novel framework that integrates indigenous and scientific drought forecasting approaches, and the National Flood Early Warning System (N-FEWS) which provide flood forecasting and management, through collaboration of Ministry of Water and Irrigation (MoWI), KMD, the Water Resources Authority (WRA) and the United States Geological Survey (USGS).

Institutions providing climate related information in Kenya

Service Providers (not exhaustive)	
Kenya Meteorological Department (KMD)	Esoko
Agriculture and Climate Risk Enterprise Ltd. (ACRE)	aWhere
Upande Ltd	Water Resource Management Authority (WRMA)
Global Climate Adaptation Partnership (GCAP)	Kenya Forest Working Group (KFWG)
National Drought Management Authority (NDMA)	Airtel Kilimo
Regional Centre for Mapping of Resources for Development (RCMRD)	National Disaster Operations Centre (NDOC)
Trans-African Hydro-Meteorological Observatory (TAHMO)	IGAD Climate Prediction and Applications Centre (ICPAC)
Geo Enviro Ltd	Adaptation (ADA) Consortium
Famine Early Warning Systems Network (FEWSNET)	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Index-Based Livestock Insurance (IBLI)	Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa (CHIESA)
Cereal Growers Association	Pan Africa Climate Justice Alliance (PACJA)
University of Reading/Maseno University	National Farmers Information Service (NAFIS)
Department of Meteorology, University of Nairobi (UoN-Met)	CARE International (Adaptation Learning Programme)
Kenya Agricultural Livestock Research Organization (KALRO)	Climate Change, Agriculture and Food Security (CCAFS) of the Consultative Group on International Agricultural Research (CGIAR)
Agricultural Sector Development Support Programme (ASDSP)	

For detailed stakeholder mapping refer to Excel – Annex

4.2. Analysis of WCS Providers Functions and Focus

Climate information is primarily an international public good and governments have a central role in its management (Lúcio and Head 2012). Consequently, the Kenya Meteorological Department (KMD) is the national meteorological agency mandated to collect and store climate data in the country. KMD is also charged with coordinating and managing the climate information provision framework.

In Kenya, the user needs for climate information vary and are very dynamic. It is not a situation of one size fits all in especially for most of the country. The sectors of concern for the majority of CIS providers vary and are focused on Agricultural and livestock, Water and water resources, Financial/Planning, Environmental, and natural resources, Energy, Research and development, Health, Media, Construction/infrastructure, and Disaster Management (WBG, 2016). The service and product portfolio for CIS in Kenya also varies focusing on Climate predictions, early warning systems, weather forecasting, agro-weather advisories, climate projections, government policies, transport safety advisories, Insurance/weather derivatives, and airspace weather forecasting. Many of the CIS providers are involved with agriculture-related sectors and have services and products that focus on agro-weather advisories. This can be attributed to the importance of agriculture to the country and the impact of climate variability on agriculture.

Nature of WCS Providers	WCS Types	Sectoral Focus of WCS Providers
○ Private Sector ○ NGOs/CBOs ○ Government/Government Agencies ○ Research & Academia ○ International Organizations	○ Early warning systems and predictions (stand out as the major services offered by majority of the WCS providers) ○ Agro weather information services (more than half of the providers offer this) ○ Climate predictions ○ Agro-weather advisory ○ Weather forecasting ○ Government policies ○ Climate projections ○ Insurance/weather derivatives ○ Transport safety advisories ○ Airspace weather forecasting	○ Agricultural and livestock ○ Financial/planning ○ Water and water resources ○ Environmental and natural resources ○ Research and development ○ Energy ○ Health ○ Disaster management ○ Construction/infrastructure

~70% of the CIS providers are private sector, NGO, and Government agencies.

The WCS providers serve a diverse community of users with sector-specific climate information. They cover diverse sectors with majority focusing on agriculture and livestock. This is reasonable because agriculture is one of the sectors most affected by climate change.

A study conducted by the World Bank in 2016 on 29 climate service providers in Kenya indicated that a total of CIS for 11 different sectors are spread all over the country:

- 83% focus on agriculture and livestock;
- ~80% offer early warning systems as their primary services—a proportion of which also serve agricultural purposes

- 72% offer agro-weather information services to support tactical and strategic decision making.
- Half of the CIS providers surveyed engage in weather forecasting.
- 41% of the CIS providers give climate advisories for general government policies and decision-making and climate projections
- 28% of the providers service the insurance derivatives and transport safety advisory sectors.

KMD and the National Drought Management Development Authority (NDMA) provide services for all 11 sectors.

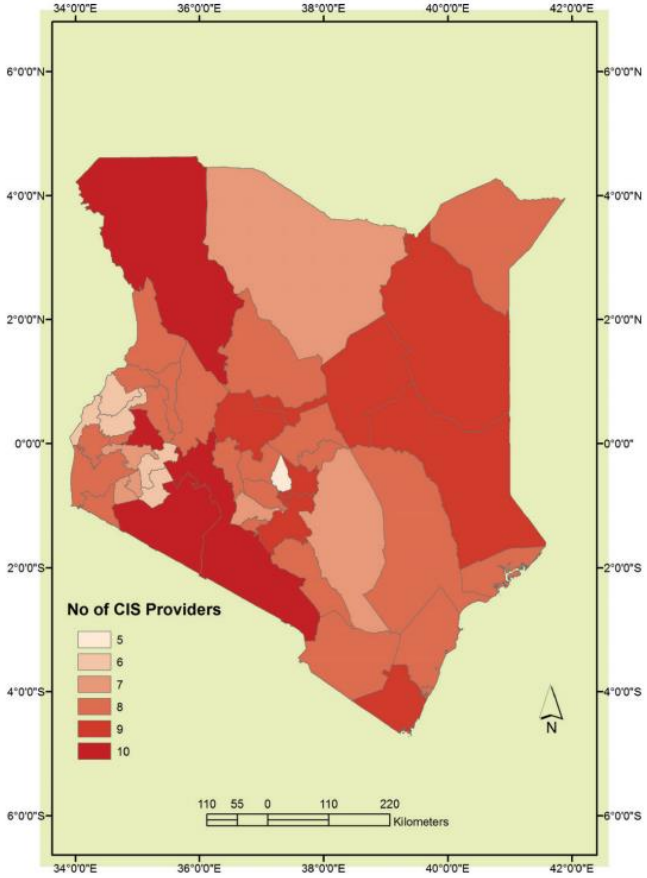
Although many efforts have been made in the provision of climate information in the country there is still gaps to fill especially in the technical capacity for production of user-oriented products, and communication and dissemination capacity. These can be attributed to the diversity of the CIS environment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

4.3. WCS Coverage

The CIS intermediaries and providers are distributed all over Kenya with a minimum of about five working within each of the 47 counties. However, the spatial depth of their engagement varies.

All Kenya counties are covered by at least five WCS providers. Kajiado, Narok, Nandi, and Turkana counties are covered by a maximum of 10 WCS providers. Six WCS providers cover Bomet, Bungoma, Busia, Kakamega, Kericho, Kirinyaga, Nyandarua, and Nyeri counties. Some seven to nine WCS providers cover the remaining counties. Only two WCS providers (KMD and RCMRD) cover all the counties. (World Bank Group Report, 2016)

However, it's important to note that the existence of WCS providers within a county does not guarantee that all farmers requiring services are effectively reached or can access them. Furthermore, the mere presence of providers does not ensure the delivery of relevant services of satisfactory quality to users.



4.4. WCS Data Collection and Processing

Currently, KMD undertakes data collection through its own climate observing stations and also through collaboration with other institutions and volunteer observers. However, in the context of WCS there are other producers, for example, the Intergovernmental Authority on Development Climate Prediction and Applications Center (ICPAC) and the African Centre of Meteorological Applications for Development (ACMAD). Some other organizations are producers and as well as users: the Food and Agriculture Organization (of the UN) (FAO), Alliance for a Green Revolution in Africa (AGRA), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Farming and Early Warning Network (FEWSNET), International Livestock Research Institute (ILRI), Index-Based Livestock Insurance (IBLI), Consortium of International Agricultural Centers (CGIAR), Climate Change,

Agriculture and Food Security (CCAFS), and International Crops Research Institute for the Semi-Arid Tropics (WBG, 2016).

Weather and Climate Services (WCS) rely on data sourced from both observations and numerical modelling. The foundation for generating reliable climate information for end-users begins with obtaining weather, climate, and sector-specific data with suitable spatial and temporal resolution. When this data is processed and combined with local knowledge, it becomes invaluable for decision-making by end-users.

The WCS providers use three basic data types;

- Radar,
- Satellite data (highly common), and
- In situ weather stations (highly common) or a combination of these.

The majority of Weather and Climate Services (WCS) providers in the country are either directly partnering with the Kenya Meteorological Department (KMD) to co-develop climate information services/products or indirectly utilizing data produced by KMD. Additionally, due to their regional nature, other providers naturally collaborate with KMD in the joint development of climate services.

Satellite data emerged as the preferred source or initial step in product development among major consulting climate information service providers. The availability of these data for free contributes to expedited development times for climate information products and services. However, index-based insurance service providers view satellite-based weather data as less accurate compared to station-based weather data. This discrepancy results in higher premiums for station-based weather-sourced index-based insurance coverage.

As per the study done by World Bank in 2016, CIS providers use data owned by various organizations:

- 59% of the data used are owned by KMD
- International organizations and CIS providers each own 45%

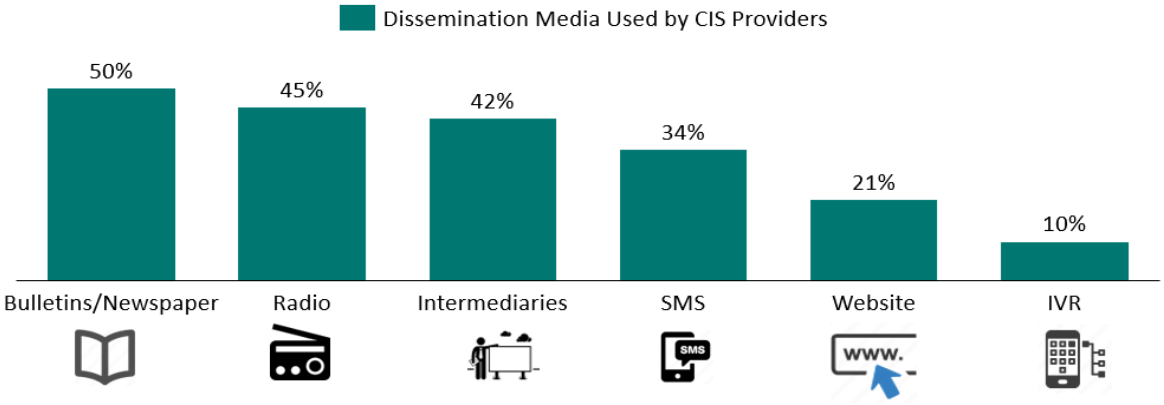
55% of the CIS providers are purveyors that do not produce their climate data but add value to data already available from other sources.

Data collected undergo a variety of processing to yield sector-specific information. The processes involved differ depending on the required outputs. The WB study showed that CIS providers generally use more than one source in the processing of data; expert consultation (79%), stakeholder consultation (66%), focus group discussion (55%), and modelling (52%).

There lacks a structured framework for assessing the quality of data utilized by providers and the Weather and Climate Services (WCS) derived from such data. Providers of WCS do not consistently label their products or specify the methodologies employed in their development. Consequently, it becomes challenging for farmers, who are not climate experts, to gauge the quality and potential value of the information used for decision-making (WBG, 2016).

4.5. WCS Dissemination

The CIS environment is vast and varies and therefore each climate information producer aims at providing information to the user in the appropriate form. The choice of the media should always be end user centred, taking into consideration vulnerable groups, especially women, people living with disability, the elderly, and nomads in remote areas. Ignoring the roles, activities, and relationships of the end user at all stages may leave potential users underserved.



Adopted from WBG, 2016

- Weather and Climate Services (WCS) providers utilize various media channels to disseminate their services. The most prevalent medium is bulletin/newspaper, employed by over 50% of providers. While this method is effective for project-type service provision, its adoption may be limited beyond pilot projects. Radio serves as the next common medium followed by the use of intermediaries (WBG, 2016).
- Intermediaries, acting as liaisons between service providers and farmers, play a crucial role in translating and enhancing the agronomic and economic information essential for agricultural management decision-making. Research such as Nyasimi M, et al, 2016 indicates that this intermediary model is the most effective means of disseminating climate information. Thus, there is a policy implication to integrate "climate extension" into existing extension services.
- The relatively low usage of SMS, websites, and IVRS suggests significant potential to expand the utilization of modern information and communication technologies (ICT) for broader market penetration. Encouraging brokers to utilize these technologies as information sources could further enhance dissemination efforts.

Feedback constitutes the portion of the receiver's response communicated back to the sender, manifesting in various forms. It serves as a means for the sender to monitor how the message is being interpreted and received by the intended audience, representing the final link in the communication process chain. As per the 2016 study by the World Bank Group, SMS, meetings, and call centers emerge as primary feedback mechanisms utilized by WCS providers. The prevalence of WCS providers without any feedback mechanism (~42%) suggests a lack of bidirectional information exchange between providers and users, hindering the optimization of recommendations, advisories, and alerts.

4.6. Why is KMD Data Used by Majority of the WCS Providers?

Weather and Climate Services (WCS) providers utilize data sourced from a variety of organizations. According to the World Bank survey of 2016, approximately 60% of the data used is owned by the Kenya Meteorological Department (KMD) and international organizations, while WCS providers themselves own 45%. Consequently, 55% of WCS providers act as distributors rather than producers of climate data, enhancing the value of data sourced from external entities.

KMD data is used for the following three reasons:

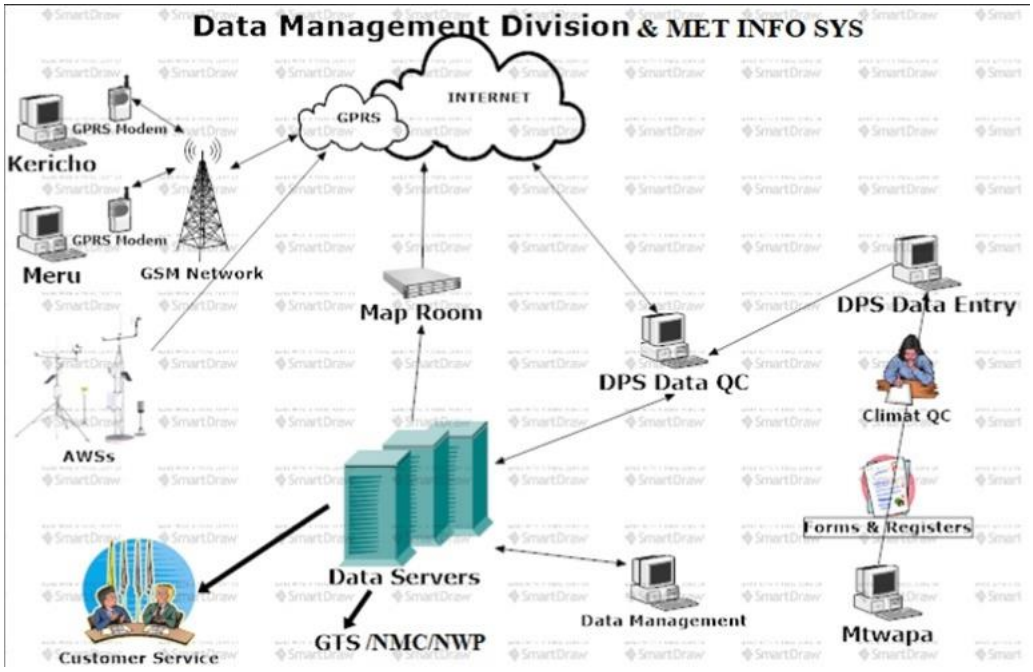
- Users express significant trust in the ground truth data supplied by KMD.
- KMD serves as the primary reference point for climate data within the country, as it is legally mandated to archive station-based climate data.
- Certain providers possess limited technical capabilities in the processing and analysis of satellite data.

Collected data undergoes diverse processing methods to generate sector-specific information, with processes varying based on the desired outputs. WCS providers typically employ multiple data sources during processing. According to a 2016 survey conducted by the World Bank, around 80% of WCS organizations engage in expert consultations. Additionally, more than half of the WCS providers utilize modeling techniques in their processes.

[*]Experts are those called in to consult based on their qualifications in the particular field, for example, agro-meteorologists, who can help interpret certain information received; stakeholders are those organizations or groups that have an interest in the same information that will be derived from the data for similar or other uses.

5. KMD as a Major WCS Player

The Kenya Meteorological Department (KMD) plays a crucial role in the collection, processing, analysis, and dissemination of climate information for agricultural use in Kenya.



KMD collects climate data from various meteorological observation systems, including those owned by KMD and its partners. The Climate Data Management Services Division (CDMS) is responsible for managing this data, received through paper forms, email, and the internet from Automatic Weather Stations (AWSs). The data undergoes initial quality control and is then entered into an electronic database for further checks before archival. CDMS ensures the processed data is archived and accessible to users.

Additionally, KMD disseminates early warnings, forecasts, advisories, and alerts for severe weather and extreme climate events. CDMS manages the KMD-ENACTS Maprooms, a dedicated Climate Information Service (CIS) web portal available 24/7. These Maprooms integrate station data with satellite estimates to provide climate information, aiming to enhance data availability and accessibility on both long-term and daily bases. Users can access climate information specific to counties or wards as needed.

- KMD works with various partners to enhance its services. For instance, scientists at the University of Leeds and the National Centre for Atmospheric Science (NCAS) worked in partnership with KMD to develop the Forecasting African STorms Application (FASTA), which enables meteorologists to provide accurate forecasts of storm weather.
- The CIS is used in the agricultural sector to make informed decisions about farming practices. For example, farmers can use weather forecasts to plan their planting and harvesting schedules34. In addition, climate data can help farmers choose the right crops to grow based on the expected weather conditions.

5.1. KMD Decentralization

(KMD, ATPS 2017)

Kenya Meteorological Department has a nationwide network and has recently decentralized its services to the county level, in conformity with the Kenya Constitution of 2010. The county meteorological offices are expected to contribute a lot in bringing climate services nearer to the community users, highly collaborating with county institutions, CIS intermediaries and bodies at the local levels.

- The KMD is implementing the concept of 'climate intermediaries' who are themselves users and also act as a bridge between the final users and the climate information provider. Intermediaries receive forecasts through SMS and work with the CDM to provide a network for the dissemination of information and feedback on the services provided.
- Intermediaries are selected from across institutions and agencies with existing extensive reach including County Administrations and the Ministries of Agriculture, Livestock, and Cooperation, as well as religious and community leaders and NGOs.
- The aim is to establish a network of approximately one intermediary for every 500 people in each county. Involvement of government agencies, such as the extension services, in dissemination of agro-weather information, has been found to legitimize the content owing to the authority conferred on government officers. CARE International and the Adaptation Consortium are employing participatory scenario planning (PSP) which help in building capacity to interpret seasonal forecasts and disseminate climate information and services in a more user-friendly manner.

Development of weather and climate products is done at different levels, including global, regional, national, and local scales. At the national level, KMD develops the products at its headquarters in Nairobi. These national-level products are released to the County Meteorological Office (CMO) as needed for use at the county level. The CMO has the role of downscaling national-level products to address local needs.

Weather and climate products include: probabilistic weather forecasts, ranging from short-term (daily, weekly), medium-term (monthly), and long-term (seasonal and annual); rain onset, cessation, and distribution; early warning advisories; and climate summaries. The CMO uses historical climate data and local knowledge of climate variability to downscale the national monthly and seasonal forecasts to develop a forecast for the county and sub-county levels.

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

Cost-benefit Analysis: Kenya Meteorological Department (KMD) decentralizing service provision, offers disaggregated, contextualized, and more easily understandable localized weather and seasonal information products relative to national level equivalents. A study by Sam B, et al 2020 uses household productive income (2014–2015) across Kitui County to model the economic value of KMD's local seasonal forecast and advisory products. The findings suggest that, after controlling for alternative explanations, households receiving KMD's local advisories and seasonal forecasts have marginally higher income levels compared to the counterfactual of using national level equivalents. When marginal appreciations in productive income are compared to the costs of establishing and maintaining KMD's decentralized provision, the investment is economically viable and comparable with similar initiatives within and outside Kenya.

5.2. KMD Transition to a Semi-Autonomous Agency

As per Tuya the Cabinet Secretary for Environment, Climate Change and Forestry, Kenya has started the process of converting the Kenya Meteorological Department into a semi-autonomous government agency.

"Semi-autonomous" refers to an organization or agency that has some degree of independence but is not entirely self-governing. It typically means that the agency has the authority to make decisions and manage its operations and generate income without direct control from higher authorities, but it still operates within a framework set by the government or parent organization. This allows for more flexibility and responsiveness to specific needs while still maintaining alignment with broader goals and regulations.

The objective is to improve the incorporation of early warning weather and climate information technology within the institution. The directive is also anticipated to generate new revenue streams for the government. And to make KMD contributes much more to the socioeconomic progress of our country by playing a more pronounced role in hunger and poverty reduction, improvement of human health and wellbeing, ensuring clean water, as well as clean and affordable energy.

Kenya is proactively and progressively reforming the Kenya Meteorological Department to make it more responsive to its growing importance as a critical safeguard of Kenya's socioeconomic well-being and sustainability. The government has invested and is continuing to invest substantially in the revitalization of KMD, including the modernisation of equipment and capacity building of staff. This will strategically reposition KMD to take advantage of emerging and available opportunities to enhance the quality and efficiency of service delivery.

The ministry is pursuing public-private partnership opportunities that will transform the Kenya Meteorological Department from a cost-center, as currently set up, into a thriving, profitable institution capable of supporting itself and contributing directly to Kenya's country's GDP.

5.3. Limitations to the delivery of climate services at the national level

The National Framework for Climate Services (NFCS) Report, 2023 outlines the key limitations observed across the WCS delivery:

Lack of national policy, regulatory, and institutional frameworks

The provision of climate services is hindered by the absence of comprehensive national policies, regulatory frameworks, and institutional structures, leading to a lack of strategic direction. Consequently, there is inadequate control and coordination of operations and programs, contributing to the rapid proliferation of unregulated institutional and individual providers. This proliferation may result in the dissemination of sub-standard products and services, leading to confusion among stakeholders and users.

Limited institutional visibility and public awareness and support

The level of public awareness and understanding of the role and importance of climate services is relatively low among the Kenyan populace. This has led to a perceived negative attitude towards and limited support for the provision of climate services.

Inadequate observation networks, and monitoring and early warning systems

Observations, communication networks, and monitoring systems operated by various partners, sectors, independent institutions, and traditional providers have not been synchronized into a national grid. This lack of harmonization restricts both the quantity and quality of data available for the development of climate services products.

Despite efforts in data generation, digitization, homogenization, rescue, integration, and access, among other related capacities, there are still inadequacies. Current monitoring systems face limitations in functions such as analyzing extreme events, climatic trends, and climate change scenarios due to gaps in data and information. Furthermore, deficiencies exist in staff technical competencies, equipment, support, and empowerment for the production, tailoring, and communication of climate information.

Moreover, the absence of a national coordination mechanism between the Kenya Meteorological Department (KMD) and relevant monitoring institutions, such as those in water, agriculture, disaster management, energy, and health sectors, hinders the outputs, including early warning services.

6. Operating Models of WCS Providers

Weather and Climate Services (WCS) providers derive their main sources of income from grants, public funding, user payments, and private funding. The cost structure of WCS includes expenses such as data acquisition, weather infrastructure, data processing, system maintenance, and dissemination. Costs vary between public and privatized entities, with dissemination accounting for a larger share in the public sector (due to a larger audience), and data processing being more prominent in the private sector (due to more targeted, specific, and tailored services).

This suggests that while privatized entities may spend less on data acquisition and weather infrastructure, they allocate a significant portion of their resources to enhancing the value of their products and services. However, there appears to be a disconnect, in both cases, between processing and dissemination, which warrants further investigation (WBG, 2016).

Most of the CIS providers in Kenya can be categorized based on five business-operating models in order of increasing autonomy, namely, public departmental unit; public body; private but not profit-oriented; private and profit-oriented; and international organizations. The major sources of funding for CIS providers are Grants, Public funding, users pay, private funding (WBG, 2016).

Characteristics	Public Departmental Unit	Public Body	Private but not Profit Oriented	Private and Profit Oriented	International Organization
Government control	Directly controlled	Indirectly controlled	Indirectly controlled	Indirectly controlled	No, Host country agreements
Own legal entity	No	Partially or fully separate	Yes	Yes	Yes
Legal basis	Public law	Public law	Private law	Private law	Convention
Financing	State budget, grants	State budget, grants, own revenues	Grants, own revenues	Own revenues	Grants
Control mechanism	Direct political	Statutes, laws	Regulation	Regulation	Host country agreements
Ministerial responsibility	Yes	Partial	No	No	No
Autonomy	No	Yes	Yes	Yes	Yes
CIS Providers	KMD, NDMA, WRMA	ASDSP, KARLO, NDOC, NAFIS, UoN-Met, Maseno University/ University of Reading	CHIESA, KFWG, PACJA, ADA Consortium, UON-ICCA, CGA, ILRI (IBLI), CGIAR (CCAFS), FEWSNET, CARE International, TAHMO	ACRE, Upande, GCAP, Geo Envigro, Airtel Kilimo, Esoko, aWhere	RCMRD, ICRISAT, ICPAC

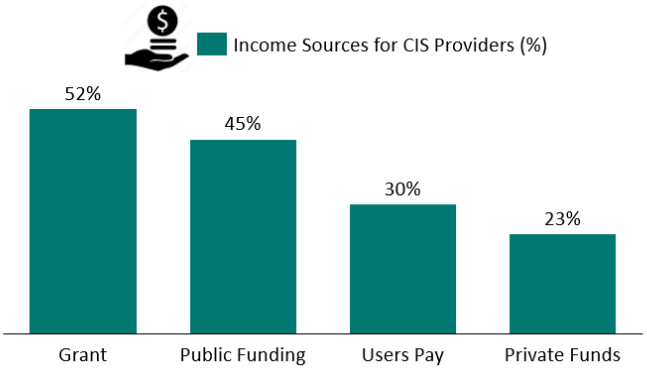
- The service providers that operate in the public body model face less political and hierarchical influence and have more operational and managerial freedom. They supplement state budgets with grants and some earn revenues from service delivery. Although there is some autonomy compared with a public department.
- There are also the CIS providers are private but not profit oriented, majority of which are climate adaptation projects sponsored from abroad with a limited life span. Some of these projects are meant as pilots, targeting a limited number of beneficiaries, with limited scope that are specific to the project goals.
- Privatized companies (profit-oriented) operate in the market and generate their own revenues. Even though privatized companies enjoy a high degree of autonomy, certain economic activities are controlled by government regulations.

- Given the public good nature of CIS benefits, full privatization may not provide the optimal solution for effective CIS delivery. Purely market-based approaches are subject to low to moderate penetration and can place a higher emphasis on commercial compared with technical criteria. The majority of international and regional players in the CIS provision in the country obtain funding from principally from subventions from member organizations and other grants, and they do not generate revenues from CIS activities.

6.1. Income Sources and Cost Structures

CIS providers' income sources

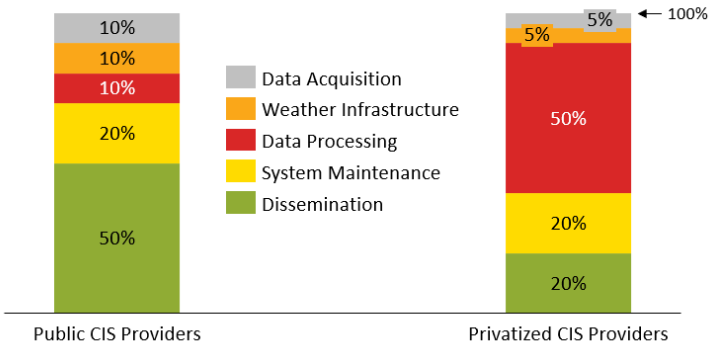
The cost structures and income sources for public and private Climate Information Services (CIS) providers reveal notable differences.



Adopted from WBG, 2016

Cost structures for public and private CIS providers

A closer look at the cost structures reveals different priorities for public and private CIS providers. For the public department model, half of the total running costs are expended on CIS dissemination, whereas for the privatized company these costs go to data processing.



Adopted from WBG, 2016

This suggests that although the private entity invests less in data acquisition and weather infrastructure, it concentrates resources on enhancing value addition through data processing for its products and services. Interestingly, there appears to be a "reverse disconnect" where the emphasis on processing does not align with the dissemination costs for both models, warranting further scrutiny of this potential discrepancy.

6.2. End-User Uptake, Willingness to Pay and Decision-Making

New findings from the Feed the Future ALL-IN-funded study (2023), led by the Tegemeo Institute of Agricultural Policy & Development at Egerton University, show there is demand for agro-weather advisories among smallholder farmers in Kenya. Further, findings also demonstrate that the scale of farming, engagement in agriculture as a business, and self-employment drive farmers' demand for weather-related advisories.

Kenyan Farmers' Willingness to Pay (WTP) to Agro-Weather Advisories

- **Willingness to Pay (WTP)**: Most Kenyan farmers, specifically 51% on average, express a readiness to invest in agricultural weather advisories. Notably, this willingness is more pronounced among farmers with smaller land holdings. This trend suggests that smaller-scale farmers may perceive a higher value or more immediate benefits from these advisory services, possibly due to their increased vulnerability to weather fluctuations or limited access to alternative information sources.
- **Pricing Structure**: The study reveals that farmers are willing to pay an average of 91.0 Kenyan Shillings (Ksh) per month for agro-weather advisories, which is equivalent to approximately USD 0.7. When considering a full growing season, this translates to Ksh 364. This pricing point indicates a significant perceived value of the service among the farming community, balancing affordability with the potential benefits of improved weather-informed decision-making.
- **Financial Sustainability**: Analysis suggests that setting a subscription price at the average WTP rate of Ksh 91.0 per month could potentially cover the operational costs of the agro-weather service if farmers subscribe under their stated willingness to pay. This finding is crucial for the long-term viability of such services, as it indicates a potential path to financial self-sufficiency without relying heavily on external funding or subsidies.
- **Implications**: These findings have significant implications for both service providers and policymakers. They suggest a viable market for agro-weather advisories, particularly among smaller-scale farmers. The data also provides a basis for pricing strategies that could balance accessibility for farmers with the financial sustainability of the service. Furthermore, this information could guide targeted marketing efforts and potential subsidy programs to increase adoption rates, especially among farmers who may benefit most from these services but are currently unwilling or unable to pay.

The uptake of climate information services (CIS) by Kenyan farmers is influenced by several factors, and it varies across different regions and farming communities. Here's a general overview:

Relevance to Farmers' Needs

- Access, consistency, reliability, and relevance of the climate information to farmers' needs are fundamental for integrating CIS into household decision-making (Simon B, James A., et al, 2021).
- A major challenge is the disconnect between farmers' perceptions and needs, and the information provided by CIS producers. Co-production of CIS with farmers can enable better decisions if the forecasts are reliable (Frontiers in Climate, 2021).
- Many CIS apps and projects fail due to a technology-push approach rather than assessing and addressing farmers' latent demand (AICCRA, 2024).

Language and Communication Barriers

- Kenya has around 68 local languages, but most CIS content is provided in English, limiting reach to smallholders. Verbal communication of CIS is crucial as the average farmer age is 60, and illiteracy is common in rural areas (Simon B, James A., et al, 2021).
- Effective use of CIS can increase agricultural yields by 5% to over 75% (Amwata. D. A, Omondi P. O and Kituyi. E, 2018). Even though information and data are available, farmers and extension workers agents are often not well informed about the effects of climate change and how to adapt because the information is not usable and understandable for them (Findlater et al., 2021).

Socio-Economic Factors

- Gender, age, education levels, and household sizes influence the use of CIS in farm decisions (Amwata. D. A, Omondi P. O and Kituyi. E, 2018).
- Investment in adult literacy and women's empowerment is key to increasing CIS adoption for productivity gains.

Delivery Modalities and Digital Platforms

- Collaborations with call centers like iShamba enable tailored, timely agro-weather advisories for smallholders (AICCRA, 2024).
- Integrating weather segments into popular agriculture TV shows like Shamba Shape-Up has reached millions of viewers (AICCRA, 2024).

In summary, addressing language barriers, involving farmers in co-production, considering socio-economic factors, utilizing appropriate delivery channels, and demonstrating productivity benefits are crucial for increasing the adoption of climate information services among Kenyan farmers.

7. Sectoral Analysis of WCS Provision

The National Framework for Climate Services (NFCS) Kenya, 2023, conducted a sectoral analysis to thoroughly understand the weather and climate services (WCS) sector. The primary aim of NFCS is to create an institutional mechanism that coordinates, facilitates, and enhances collaboration among national institutions. This effort is geared towards improving the co-production, customization, delivery, and utilization of science-based climate predictions and services.

7.1. Policy, Economic, Sociocultural, Technological, Legal and Environmental Analysis

Politically, Kenya is active in international and regional climate service provision agreements and has several national policies derived from these commitments. However, funding for WCS and meteorological programs faces bureaucratic bottlenecks and no regulation in the WCS arena.

Economically, the increasing demand for climate services, spurred by extreme climate events and technological advances, offers avenues for revenue generation, but there are challenges in positioning key sectors to tap into this potential.

Socio-culturally, extreme climate events have strained the diverse Kenyan society, and the perception of WCS remains suboptimal.

Technologically, Kenya's rapid ICT growth offers climate-sensitive socio-economic sectors, a chance to integrate innovative solutions, but there is a need to embrace newer technologies like Big Data and IoT more extensively.

Environmentally, Kenya's heavy reliance on environmental goods and services is challenged by changing weather patterns, land degradation, and other climate-induced threats.

Legally, while Kenya adheres to international standards in provision of climate services, there's a pressing need for a domestic legislative framework to solidify its mandate and enhance its service delivery.

7.2. Strengths, Weaknesses, Opportunities & Threats (SWOT) Analysis

SWOT analysis on Kenyan institutional provision of climate services:

Strength

The Kenyan WCS space has several strengths in the provision of climate services, including:

- A well-established and decentralized national meteorological service. The existence of a regional training and research center for climate services
- National-level prioritization of climate-sensitive sectors as vital drivers of social-economic development,
- Presence of an active wide range of multi-sector WCS providers and well-trained staff across the sectors. These strengths place KMD in a unique position to lead the country in the implementation of the NFCS.

Weakness

Several notable weaknesses need to be addressed:

- Current systems lack robust methods for efficient data sharing and exchange, hindering collaborative efforts and timely access to information.
- The management of climate services is hampered by bureaucratic red tape, resulting in delays and reduced effectiveness.

- Limited technical capacity in data collection and user-oriented product development at County, sub-county, ward, and village level, inadequate computing, and Meteorological infrastructure to observe, run models, and disseminate (i.e., private sector WCS providers have limited reach compared to KMD)
- National and cross-sector funding for climate services is insufficient, limiting the scope and quality of services provided
- Existing observation networks, monitoring systems, technical facilities, and user interface platforms are unstructured, weak, and inadequate, impeding accurate and comprehensive data collection and analysis
- There are limited mechanisms for coordination and collaboration among national and cross-sector institutions, leading to fragmented efforts and inefficiencies
- Significant gaps exist in the national and institutional legal, policy, and regulatory frameworks, creating challenges in standardizing and regulating climate services

Opportunities

There are significant opportunities within the Weather and Climate Services (WCS) ecosystem:

- There is a growing demand for reliable climate services
- There is potential for enhanced collaboration with private sector actors, as well as regional and international climate centers, to leverage their expertise, resources, and innovative approaches
- Opportunities exist to improve data availability and sharing through the enhancement and networking of observation networks, and the integration of monitoring systems, leading to more comprehensive and accessible climate information

Threats

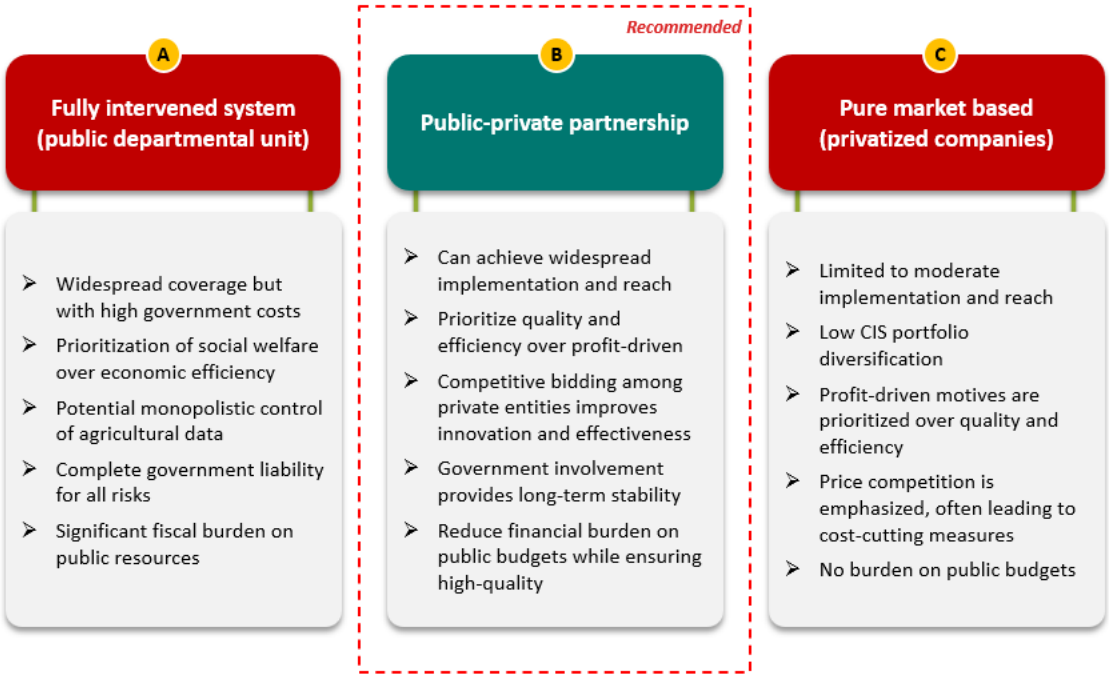
There are also threats identified within the Weather and Climate Services (WCS) ecosystem:

- There is a lack of public awareness and understanding of the value and importance of climate services, which can hinder their adoption and support
- The rise of unregulated climate service providers poses risks to the credibility and reliability of climate information, potentially leading to misinformation and reduced trust in WCS
- Users may be slow to adopt new technologies and methods in climate services operations, which can impede the implementation of innovative solutions and limit the effectiveness of WCS
- Uncertainty and variability in funding sources can jeopardize the continuity and sustainability of climate service projects and initiatives

7.3. Creating Sustainable Public-Private Partnership

To address these challenges, the sector proposes creating sustainable public-private partnerships. These partnerships would focus on:

- Collaboration for co-production and co-design of solutions
- Complementary funding of activities
- Shared investment in human resources for data collection, processing, and dissemination



Given the limitations of both purely governmentally intervened and purely market-based Weather and Climate Services (WCS) provision models, it is crucial to explore new approaches through carefully crafted public-private partnerships (PPPs). These partnerships involve long-term collaboration between at least one public and one private entity for jointly executing WCS projects, facilitating the exchange of expertise, and sharing of risks in fulfilling public tasks. Such collaborations aim to address challenges such as underinvestment, poor infrastructure, deficient services, low visibility, and inadequate funding that pose a threat to national meteorological services.

PPPs have the potential to deliver more efficient services by leveraging synergies and complementarities derived from both public and private strengths. They could also enhance the image of existing government models, such as the Kenya Meteorological Department (KMD). However, transitioning from a fully government-driven to an effective public-private agency requires a significant shift in institutional culture and operational mechanisms. Despite the challenges, the benefits, such as fostering a culture of service delivery and enhancing user engagement, are substantial.

8. Regulatory and Policy Landscape for CIS in Kenya

Current Government of Kenya policies, plans, strategies, and initiatives that provide a supportive framework for implementing information systems include:

- The Constitution of Kenya (2010) provides ground for the formulation of adaptation and mitigation legislation, policies, and strategies by guaranteeing the right to a clean and healthy environment under the Bill of Rights and also offers the opportunity for services to be moved closer to the citizens at the county and sub-county (constituency) or community/grassroots levels. This opportunity, in turn, calls for a concerted effort by KMD to strengthen its infrastructure and services to reach and have the desired influence upon the community or grassroots level of society, where the most severe impacts of climate variability and climate change are realized.
- Vision 2030, the national development blueprint encapsulates flagship programmes and projects with aspects of adaptation and mitigation. This include: provides for transport solutions that have relevance to climate change mitigation, and recognition of development through improvement of climate sensitive sectors.
- The National Policy for the Sustainable Development of Northern Kenya and other Arid Lands focuses on climate resilience requiring Government to find solutions to address climate challenges and to come up with measures to manage drought and strengthen livelihoods. The policy also focuses on an enabling environment for accelerated investments in "foundations" to reduce poverty and build resilience and growth. The establishment of the National Drought Management Authority (NDMA), the National Disaster Contingency Fund and the Council for Pastoralists education are provided for in the policy.
- The National Disaster Management Policy, 2012 institutionalizes disaster management and mainstreams disaster risk reduction in the country's development initiatives. The policy aims to increase and sustain resilience of vulnerable communities to hazards. It also recognizes the impact of climate hazard and the need for building resilience through climate information.
- Climate change act, 2016: provide legal framework for coordination and implementation of climate change issues including public participation.
- National climate change response strategy (NCCRS) 2010 and the National Climate Change Action Plan (NCCAP) 2013-2017: promotes adaptation plans which "Contribute to development of climate information sharing and knowledge management systems; strengthen collaboration between MoA, KMD and others; and enhance capacity for agro-meteorological information provision and ensure effective service delivery mechanisms including climate smart extension."
- Environmental Management and Coordination Act (EMCA, 1999): The Act is the principle instrument of Government for the management of the environment and provides for the relevant institutional framework for the coordination of environment management including the establishment of the National Environment Management Authority (NEMA) which is the Designated National Authority (DNA) for Clean Development Mechanism (CDM) and the National Implementing Entity (NIE) for the Adaptation Fund.
- The Agricultural Sector Development Strategy 2010-2020 is the overall national policy document for the agricultural sector. The strategy promotes sustainable food production and agroforestry. There are also broad implications for the forestry sector that are detailed in one of the six sub-sectors of the agriculture sector.
- The Second National Environment Action Plan (NEAP, 2009-2013) provides a broad framework for the coordination of environmental activities by the private sector and Government to guide the

course of development activities, with a view to integrating environment and development for better management of resources.

- The NDMA is a statutory body established under the NDMA Act, 2016. The Act gives the NDMA the mandate to coordinate all matters relating to drought management, including the implementation of policies and programs, and drought response initiatives undertaken by other actors. The NDMA is also tasked with promoting the integration of drought management in development policies, plans, and programs. (GoK, 2016a)
- County Drought Contingency Plan: Drought contingency plans have been developed in 23 ASAL counties to address drought-related challenges across various sectors. The plans encompass a variety of interventions based on different drought scenarios and are intended to facilitate timely and coordinated response.
- County Environment Action Plans: These plans address environmental issues across various sectors in an integrated manner and discuss their significance in development planning. They propose a strategy for achieving sustainable development in line with the SDGs and the Kenya Vision 2030 Medium Term Plan.

9. Policy and Regulatory Environment for PPP Models in Kenya

9.1. Legal and Institutional Framework

The Public Private Partnerships Act of 2013 serves as the cornerstone for PPP projects in Kenya. Before the enactment of this legislation, there were already existing PPP projects, notably in the energy sector involving Independent Power Producers (IPPs). The government has outlined various sectors for priority PPP development, which include transportation, water, sanitation, and healthcare.

Based on the Government of Kenya PPP Policy Statement, the foundation of Kenya's PPP framework is a series of legal and institutional reforms. The government enacted several laws promoting private sector participation, including the Water Act (2002), Privatization Act (2005), and Energy Act (2006). Existing laws were also amended to enable PPPs in specific sectors like transportation and telecommunications.

Kenya's PPP framework is guided by several key principles. These principles ensure value for money for the government and citizens while leveraging private sector expertise and innovation. Long-term affordability and risk allocation are prioritized, along with increased access to quality public services and balanced regional development. The framework also emphasizes social and environmental safeguards, transparency, and accountability throughout the PPP process.

Kenya expects significant benefits from PPPs. These include faster more efficient, and cost-effective project delivery. Taxpayers will benefit from optimal risk transfer and management, while efficiency gains are expected through integrated design and construction. Collaboration between the public and private sectors is expected to create added value, alleviating capacity constraints within the economy. Furthermore, PPPs are expected to increase competition, construction capacity, and innovation in service provision, ultimately leading to the effective utilization of state assets for public benefit.

9.2. Management of Public-Private Partnerships in Kenya

The Public-Private Partnerships Committee (PPPC) plays a central role in Kenya's PPP framework. This committee is responsible for formulating PPP policy guidelines, approving projects, monitoring and evaluating their progress, and ensuring efficient implementation of project agreements.

Previously, a PPP Unit handled these tasks. However, the Public-Private Partnerships Act (PPPA) established a PPP Directorate in its place. This Directorate acts as the lead institution for implementing PPP projects under the PPPA.

The Public-Private Partnerships (PPP) Directorate, which is headed by a Director–General, is the technical arm of the PPP Committee and is mandated to facilitate the implementation of the Public Private Partnership Programme and Projects in Kenya. (Kenya national treasury and economic planning, 2021). The Directorate is responsible for the systematic coordination of all the PPP projects review and approval process, which is geared towards promoting the flow of bankable, viable, and sustainable projects that further Kenya’s National Policy on PPPs. It serves as a centre of PPP expertise. (Njoroge Regeru & Co. Advocates).

9.3. Challenges and Gaps of Kenya's PPP

While PPPs offer many benefits, they also come with risks (cytonn, 2022)

A. **Inadequate Planning for PPP Projects:** There is a challenge in identifying suitable projects and gauging the risks involved, as well as testing the likelihood of success. In addition, selecting the most qualified project developer for a specific project has always been a tricky task when the pool of investors with capacity for PPPs is limited. PPP projects without sound plans have therefore led to lack of value for money due to ineffective implementation.

B. **Lengthy and Irregular Procurement Processes:** Part of the delays in the PPP process are as a result of delays in the procurement of transaction advisors, which eventually affects the kicking off of projects. Additionally, cases of corruption and irregular awarding of tenders raise speculation, hence causing a loss of public confidence in the contracted parties.

C. **Insufficient Bulk Infrastructure Required to Support Development:** Kenya has limited supporting bulk infrastructure, e.g. insufficient sewer lines and drainage systems and poor road networks in areas where the development projects are being undertaken, meaning that developers often have to incur costs to develop the infrastructure themselves and this discourages the private sector due to the huge amount required.

D. **Differing Goals Between the Private and Public Sector:** While the private sector mainly focuses on obtaining a return on investment, the public sector's main interest is on protecting the interests of its citizens by enacting regulations and engaging in projects that benefit the public.

E. **Bureaucracy and Lengthy Approval Processes:** Bureaucracy in government systems has led to delays in approvals as applications require to go through different channels. In addition, some delays in responding to bidders are blamed on the failure to achieve quorum at the various levels required to provide approval, which hampers expeditious decision-making.

F. **Inadequate Risk Mitigation Strategies:** There is no specific project implementation team tasked with handling PPP projects from start to finish hence the ineffective monitoring and auditing of finances in PPP projects in Kenya has led to a lack of accountability for allocated funds and imprudent utilization of finances as funds end up being spent without consideration of the budgetary allocations.

10. Conclusion and Recommendations

The report evaluates Kenya's Weather and Climate Services (WCS) essential aspects of the value chain, across data collection, processing, and dissemination. The Kenyan Meteorological Department (KMD) is pivotal in supplying crucial climate data for sectors such as agriculture. Additionally, various private entities and development agencies contribute to Kenya's WCS.

Overall, CIS is a critical tool for Kenyan farmers to adapt to climate change and ensure the sustainability of the agricultural sector. The findings underscore notable strengths, challenges, and opportunities for improving climate information services (CIS). Key institutional weaknesses in Kenya's climate services include inefficient data-sharing systems, bureaucratic hurdles in management, inadequate technical capacity at local levels, insufficient funding, poorly structured infrastructure for data collection and analysis, lack of coordination among institutions, and incomplete legal and regulatory frameworks.

To address these gaps, there is an opportunity to utilize sustainable public-private partnerships (PPPs) to capitalize on the strengths of both public and private actors within the value chain:

- Public-private partnerships (PPPs) in climate information services offer a balanced and often superior (i.e., innovative) solution by leveraging the strengths of both sectors while mitigating their weaknesses. This model combines the stability and reach of KMD involvement with the efficiency and innovation of private enterprise. KMD's role in adding stability to the system helps ensure widespread coverage and protects against market failures, particularly in high-risk or underserved areas. Meanwhile, the private sector contributes technical expertise, operational efficiency, and innovative approaches to risk assessment and management.
- This collaboration leads to a well-diversified CIS portfolio, balancing technical and commercial criteria in decision-making. The competition for service among private providers within the PPP framework drives improvements in quality and efficiency, while KMD oversight maintains a focus on public interest goals. Additionally, PPPs can often achieve reasonable fiscal costs by sharing financial risks and responsibilities between public and private entities.
- By fostering this synergy, PPPs can achieve higher penetration rates than pure market systems while avoiding the monopolistic tendencies and high fiscal costs often associated with fully intervened systems. This approach also allows for more flexible and tailored WCS products that can adapt to changing agricultural practices, climate conditions, and market dynamics, ultimately providing better protection for farmers and contributing to the overall stability of the agricultural sector.

Next Areas to Explore

- Public-Private Partnership (PPP) Models for CIS
  - Overview of PPP Models in CIS (local and/or best practices) – long list
  - Comparative Analysis of Different PPP Models
- Proposed PPP Model for Kenya
  - Tailored PPP models with Rationale and Justification
  - Key Components of the Proposed PPP Model
  - Stakeholder Roles and Responsibilities

References

- Centre for Development Policy and Research (CDPR). (2011). Prospects Of Non-Traditional Sources Of Development Finance In Ethiopia. MOFED and UNDP.
- Cytonn “Public Private Partnerships (PPPs) in Kenya”
- Government of Tanzania, and Abbott Fund. “Public-Private Partnership for Health Care in Tanzania.”
- Graham, R., Mortazavi, M., Davidsen, P.I., and U'Hassan, J.G. (2015)
- Kenya Country Report ‘’Impact Assessment on Climate Information Services for Community Based Adaptation to Climate Change’’.
- Lúcio, F.F. and Head, D. (2012)
- National Framework for Climate Services (NFCS) Kenya, 2023
- National Treasury and Economic Planning. “Directorate Public Private Partnerships”.
- Meinke and Stone, 2005. “Agricultural Management Decisions and Climate Systems that operate at various time scales.”
- Primerus “The growing trend of public-private partnerships in Kenya”.
- Rogers, D. P., and V. V. Tsirkunov. 2013. “Weather and Climate Resilience: Effective Preparedness through National Meteorological and Hydrological Services.”
- Tall, A., Hansen, J.W., Ines, A.V.M., Ndiaye, O., Grace, K., Wijk, M.T. Van, Moussa, A.S., Zougmore, R., Saeed, F., and Ouattara, I. (2013)
- United Nations Development Programme (UNDP).(2015). Prospects of Public-private Partnership (PPP) in Ethiopia. UNDP
- World Bank Report ‘’Climate Information Services Providers In Kenya’’, 2016
- WMO (World Meteorological Organization). 2011. Climate Knowledge for Action: A Global Framework for Climate Services—Empowering the Most Vulnerable.
- World Meteorological Organization (WMO) (2014) “Implementation Plan of the Global Framework for Climate Services (GFCS).”
- World Bank 2015. “Kenya: Agricultural Sector Risk Assessment.”

Annex 1

Fact Sheet – KMD Operations

- *KMD operates thirty-six surface climate observing stations countrywide (called Synoptic Stations) which provide information on rainfall, minimum and maximum temperatures, wind speed and direction, air pressure, soil temperature, solar radiation, sunshine duration, relative humidity, evaporation and cloud cover. Over three thousand rainfall stations are registered by KMD and are operated by volunteer observers who mainly record rainfall data but some include temperature, however this number is still small as the optimum recommended number is ten thousand. Twenty four Automatic Weather Stations (AWSs) which automatically record climate data and transmit it to receiving stations at KMD. Most of these stations have long enough data that can be used for climate trend analysis, however care needs to be taken when using the volunteer stations as due to concerns of not adhering to recommended standards for observation.*

- *KMD also operates three upper air stations located at Dagoretti Corner, Garissa and Lodwar. Of these only Dagoretti is currently operational and is making one ascent instead of two ascents per day as required due to inadequate resources for purchasing consumables. Four marine tidal gauges with automatic Meteorological sensors, which monitor ocean tides and waves as well as tsunamis are available. The data collected can be used to study sea level rise associated with global warming. This data is crucial in providing information to support decision-making in adaptation planning for coastal zone management. Three Airport Weather Observing Systems (AWOSs) at Jomo Kenyatta International Airport, Wilson airport and Mombasa International Airport. These systems are able to detect and monitor hazards associated with extreme weather events. Four lightning and thunderstorm detection systems at Nairobi, Mombasa, Kisumu and Eldoret. These systems are used to provide severe weather warnings especially for aviation safety.*

- *Data on water and river gauge are mainly obtained from the Ministry of Water and Irrigation or Water Resources Management Authority (WRMA) which is the institution that is responsible for maintaining and operating flow gauging stations. In total there are four hundred and fifty five river gauging stations operated by WRMA well distributed in the five drainage basins. In addition KMD recently installed seventeen hydro-meteorological automatic weather stations in the major water catchments for measurements of surface discharge and weather parameters. Monitoring of river discharge characteristics enables us to assess the impacts of climate on the water resources, planning in the water sector, especially discharge data used for monitoring of hydro-power generation. There are long periods of observations available in many of the hydrological.*

- *In collaboration with such institutions as the Kenya Agricultural and Livestock Research Organization (KALRO) fourteen Agro-meteorological stations have been installed at the stations. These have daily recording of normal meteorological parameters conveyed to the Agro-meteorological division at the KMD headquarters, Dagoretti Corner, after every ten days for analysis and generation of advisory bulletins for the farming community. The agro-meteorology observations include: Air Temperature; Soil Temperature at five, ten, twenty, thirty, fifty and one hundred centimetre; depths; Sunshine duration; Radiation; Wind Speed; Relative Humidity; Pan Evaporation; and Rainfall in millimetres per day. In addition crop data is also obtained from the agro-meteorological stations, and these include: Variety of the grown crop; Stage of development attained by the crop; General assessment of crop performance; Damage by pests, diseases and adverse weather; State of weeding in the farm; and Plant density. This data and complimentary information is used to undertake assessment of crop performance under different climate conditions and to predict seasonal yields of the various crops and hence to assess food security.*

The information on the assessment is disseminated to the public through Agro-meteorological Bulletins which are published every ten days for early warning.

- *The starting point in the development of credible climate information for the end user is in receiving weather, climate, and other sector-specific data of appropriate spatial and temporal resolution that, when processed and integrated with local knowledge, can prove vital for decision making by the end users. Much of the socio-economic information is obtained from other partners including government ministries and agencies such as KALRO, NDMA, KWS, KFS, KBS, DRSRS, WRMA, KFS, NEMA; from research institutions; and from international and regional agencies (FAO, US-FEWSNET). These includes information on wildlife and livestock population, surface water variability, crop performance, land use and land use change, forest cover, urbanization and human settlements, economic variables.*

- *Satellite data are available and accessible from three satellite receiving stations, two for Meteo-Sat. Second Generation (MSG) and one for National Oceanic and Atmospheric Administration (NOAA) satellites data and also from the Regional Center for Mapping (RCMRD) and Department of Resources Survey and Remote Sensing (DRSRS). These stations receive global data on large scale systems such as sea surface temperatures and wind fields in cooperation with other international climate centers. The satellite data help in observing systems that drive the local climate systems such as global sea surface temperature fields. The satellite data is provided through the use of global observing satellites that transmit the data to the global climate centers which in turn process and transmit the same to the national climate centers. This data is crucial for predicting seasonal rainfall performance with sufficient lead time for early warning and preparedness. It is therefore a key component of contingency adaptation planning. Part of satellite derived information include the Normalized Vegetation Index (NDVI), rainfall derived information, cloud information, atmospheric profile, temperature and humidity profiles. These datasets helps in improving coverage and also in estimating and filling gaps in data scares areas and some of the satellite data and derivative products can downloaded from online data repositories. However the downside is usually the lack of insufficient skills required to use and apply them and the limited technical capacity of the user institutions needed to handle the data.*

- *Kenya Meteorological Department runs a Numerical Weather Prediction Model for generation of short-term forecast. The outputs of which are applied in the generation of climate advisories and reviews. However considering the computing needs and the technical capacity required to conduct long term climate modelling for climate change scenario generation, has caused a reliance on information from Global Producing centres. Currently there are several available modelling centres around the world running various models and downscaling of model information, the most widely used in the country include the WMO global producing centres Global Circulation Models (GCMS); the Coupled Model Inter-comparison Project (CMIP) under the World Climate Research Programme (WRCP) who deal with atmosphere-Ocean General Circulation Models; and the Coordinated Regional Climate Downscaling Experiment (CORDEX) also under the WCRP. Much of these data can be found on online repositories and also with through ICPAC repositories.*