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The state of climate information and agro-advisory services in Africa: A regional and country-level landscape



The state of climate information and agro-advisory services in Africa: A regional and country-level landscape

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Abbreviations and acronyms

AAS	Agro-advisory services
ACCIC-ECOWAS	African Centre for Climate Information and Applications - Economic Community of West African States
ACPC	African Climate Policy Centre
ACMAD	African Centre of Meteorological Applications for Development
ACREI	Agricultural Climate Resilience Enhancement Initiative
ADF	African Development Fund
ADPs	Agricultural development projects
AfDB	African Development Bank
Afri-Res	African Resilience Initiative
AGRHYMET	Agriculture, Hydrology, Meteorology Regional Climate Center, Niamey
AI	Artificial intelligence
AICCRA	Accelerating Impacts of CGIAR Climate Research for Africa
AMCOMET	African Ministerial Conference on Meteorology
ANAM	National Meteorological Agency of Burkina Faso (Agence Nationale de la Météorologie du Burkina Faso)
ASECNA	Agency for the Safety of Air Navigation in Africa and Madagascar (L'Agence pour la Sécurité de la Navigation aérienne en Afrique et à Madagascar)
ATI	Ethiopian Agricultural Transformation Institute
AUC	African Union Commission
CSA	Climate-smart advisories
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel (Comité permanent inter-État de lutte contre la sécheresse au Sahel)
CIS	Climate information services
CNRST	National Center for Scientific Research and Technology, Burkina Faso (Centre National de la Recherche Scientifique et Technologique)
CR4D	Climate Research for Development in Africa
DACA	Digital AgroClimate Advisory
DGM	Burkina Faso Dedicated Grant Mechanism
DRM	Disaster Risk Management
ECMWF	European Centre for Medium-Range Weather Forecasts
ECOWAS	Economic Community of West African States
EDACaP	Ethiopian Digital AgroClimate Advisory Platform
EMI	Ethiopian Meteorological Institute
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EWS	Early warning systems
FAO	Food and Agriculture Organization of the United Nations
FEWS NET	Famine Early Warning Systems Network
FMAFS	Federal Ministry of Agriculture and Food Security
FONERWA	Rwanda Green Fund (Fonds National de l'Environnement du Rwanda)
FSNWG	Food Security and Nutrition Working Group
GFCS	Global Framework for Climate Services
GFS	Global Forecast System
GHA	Greater Horn of Africa

GHACOF	Greater Horn of Africa Climate Outlook Forum
ICPAC	IGAD Climate Prediction and Applications Centre
ICT	Information and communications technology
IGAD	Intergovernmental Authority on Development
ILRI	International Livestock Research Institute
INAM	National Meteorological Institute (Instituto Nacional de Meteorologia, Mozambique)
IRI	International Republican Institute
KALRO	Kenya Agriculture and Livestock Research Organization
KAOP	Kenya Agriculture Observatory Platform
KMD	Kenya Meteorological Department
LEAP	Livelihoods, Early Assessment and Protection
MASA	Ministry of Agriculture and Food Security (Ministério da Agricultura e Segurança Alimentar, Mozambique)
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government, Rwanda
MM5	Fifth-Generation Penn State/NCAR Mesoscale Model
NADMWS	NextGen Agricultural Drought Monitoring and Warning System
NAERLS	National Agricultural Extension and Research Liaison Services
NAPs	National Adaptation Plans
NARIs	National agricultural research institutes
NASRDA	National Space Research and Development Agency
NCOF	National Climate Outlook Forum
NDCs	Nationally Determined Contributions
NDMA	National Drought Management Agency
NFCS	National Framework for Climate Services
NHISA	Nigeria Hydrological Service Agency
NiMET	Nigeria Metrological Agency
NMHSs	National meteorological and hydrological services
NOAA	National Oceanic and Atmospheric Administration
RAB	Rwanda Agriculture and Animal Resources Development Board
RBDA	River Basin Development Authority
RCC	Regional climate centre
RCOF	Regional Climate Outlook Fora
RCSA	Rwanda Climate Services for Agriculture
SADC	Southern African Development Community
SARCOF	Southern African Regional Climate Outlook Forum
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development
WFP	World Food Programme
WISER	Weather and Climate Information Services
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting model



Terrace farming in Rwanda. Photo: Alliance of Bioversity CIAT/Neil Palmer.

Executive summary

Access to climate information services (CIS) and agro-advisory services (AAS) remains a challenge for millions of people, especially smallholder farmers and livestock keepers across Africa. These services are critical for improving agricultural productivity, climate resilience and food security. The updated CAADP Strategy and Action Plan (2026–2035) explicitly prioritizes Climate Information Services (CIS) as part of its broader climate resilience agenda, emphasizing the development of climate-smart infrastructure, adaptation and mitigation institutions, and increased climate finance for agriculture. CIS is also embedded in the CAADP Biennial Review process, which monitors the proportion of farmers with access to climate information and early warning systems, reflecting a strong commitment to informed decision-making and sustainable, climate-resilient agriculture across Africa.

However, the gap in accessing these essential services continues to constrain the ability of agricultural value chain players to effectively manage climate risk and adapt to climate change. To design context-specific interventions to enhance the delivery of these services, it is important to understand the landscape and the institutional arrangements present at the regional and country levels in Africa. This report assesses the roles played by regional, national and subnational organizations relevant to CIS and AAS services, and the operationalization of context-specific interventions in Africa. Focusing on key actors and stakeholders, it presents insights from Burkina Faso, Ethiopia, Kenya, Mozambique, Nigeria and Rwanda, and highlights the challenges of and opportunities for strengthening CIS and AAS to enhance resilience and climate adaptation.

Though there is a strong collaboration between regional and national bodies across Africa in delivering Climate Information Services (CIS) and agro-advisories, the level of coordination and effectiveness varies by country. These partnerships are crucial, as climate systems operate beyond national borders, requiring regional forecasts to be downscaled and tailored for local use. Climate Outlook Forums like GHACOF, SARCOF, and PRESAO serve as key platforms where regional climate centers (e.g., ICPAC, AGRHYMET, SADC, ACMAD) and national meteorological services jointly develop and interpret seasonal forecasts. These efforts are complemented by training, technical support, and joint research to strengthen national capacity and enhance the relevance of climate information for agriculture.

Collaborative initiatives such as WISER and ENACTS promote the co-production of CIS and agro-advisories, ensuring regional data is translated into practical, farm-level guidance. Data sharing platforms and harmonized standards support real-time exchange and improve forecast quality, while regional institutions work with governments to align CIS with frameworks like CAADP, AAI, and NAPs.. However, challenges remain, including inconsistent coordination, limited capacity in some national services, downscaling, including last mile delivery and issues with data interoperability and sustainable funding.

The common challenges encountered across these countries include human and institutional capacity constraints, lack of high-performance computing infrastructure necessary for climate modelling and downscaling, and absence of partnerships/linkages among national meteorological agencies, agricultural research organizations and farmer-facing entities. There is also a need for weather station networks and data collection systems that generate granular agrometeorological data necessary to provision context-specific CIS and early warning systems. This report makes several recommendations to strengthen CIS and AAS services by addressing these challenges. They include:

1. **Capacity-building:** Enhancing the technical expertise of meteorologists, agronomists and extension workers is essential to improve the effectiveness of CIS and AAS. Training programmes should focus on methodologies to improve the accuracy of forecasts across timescales, use of climate models, and application of bias-corrected/downscaled global forecasts. Training should also focus on translating climate information into actionable farm-level advisories using process models (e.g. DSSAT, APSIM) and decision-support tools (e.g. iSAT) that consider local agricultural conditions. Capacity-building initiatives for national meteorological and hydrological services (NMHSs) should equip staff with the skills required for forecasting and analysing extreme weather risks and events at relevant scales. Personnel in public and private extension services should be trained to effectively communicate climate-related information to farmers, livestock keepers and stakeholders for effective climate risk management.
2. **Infrastructure development:** Strengthening infrastructure is critical to improving climate forecasting and advisory services. Expanding the network of weather stations, modernizing meteorological equipment and investing in high-performance computing facilities will enhance the accuracy and accessibility of climate information. Robust data-sharing platforms will facilitate collaboration among climate scientists, agronomists and policymakers, enabling more effective use of climate data for agricultural decision-making.
3. **Financial sustainability:** A stable and sustainable funding mechanism is essential for the long-term viability of CIS and AAS. It is imperative for governments to allocate dedicated annual budgets to these services and reduce reliance on external donors. Exploring innovative financing mechanisms such as climate adaptation funds and private sector investments, and establishing self-sustaining models can generate revenues to support these services. Strengthening public-private partnerships can attract investment, facilitate infrastructure development and enhance the sustainability of climate services.

4. **Stakeholder coordination:** Effective delivery of CIS and AAS requires vigorous collaboration among government agencies, research institutions, private sector players and end users. Establishing structured platforms for knowledge exchange and joint planning, and organizing regular consultations during the national and regional climate outlook fora (NCOF and RCOF) as well as co-production of climate services will improve efficiency and reduce duplication of effort. Strengthening multistakeholder partnerships and implementing the National Framework of Climate Services (NFCS) in each country and at each regional climate centre will enable development and dissemination of climate services to meet the diverse needs of agricultural communities.
5. **Technology adoption:** Digital innovations such as mobile phone applications, use of citizen science, artificial intelligence (AI) and remote sensing can significantly enhance the reach, efficiency and accuracy of CIS and AAS. These technologies can be leveraged to provide real-time and localized climate advisories that are accessible to farmers. Additionally, multilingual dissemination strategies using radio, SMS and digital platforms (e.g. agDatahubs) will help bridge communication gaps and ensure that climate information is delivered in user-friendly formats to diverse communities.
6. **Inclusivity and equity:** Ensuring that CIS and AAS are inclusive and accessible to all, particularly women, youth and marginalized groups, is crucial for equitable climate resilience. Gender-responsive approaches should be integrated into climate advisory frameworks, and decision-making platforms should be developed to promote the active participation of under-represented groups.
7. **Public-private partnerships:** The private sector can play a crucial role in strengthening CIS and AAS by contributing technical innovation, financing and expertise. Private sector involvement can help ensure that the services are demand-driven and aligned with market needs. Partnerships among governments, the private sector and local communities, and publicly accessible data and information will foster innovation and new business models. Innovative business and partnership models that facilitate data collection using citizen science, village based advisors or local rural enterprises can be transformational for data collection as well as dissemination of CIS and agro-advisories.
8. **Access to data:** Access to reliable climate and agricultural data will enable better decision making. Governments and other stakeholders should prioritize open data policies that allow greater access to climate data, satellite imagery, weather forecasts and agricultural research. Data-sharing platforms, collaborative research networks and improved data collection systems will enhance access to accurate and relevant information.

1. Context

Africa is warming faster than the global average for land and ocean combined. This accelerated warming has caused rapid shifts in weather patterns, exposing millions of vulnerable people across the continent to climate extremes. In September 2021, many countries including Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Ethiopia, Kenya, Niger, Nigeria, Senegal, Somalia, South Sudan, Sudan, Togo, and Uganda reported loss of life or major population displacements due to severe flooding. Most of these countries experienced extended drought conditions either before or after flooding, highlighting the recurrent and increasingly intense cycles of drought and floods being witnessed in Africa. By 2030, some 118 million extremely poor people (i.e. those living on less than USD 1.90 a day) in the continent are projected to be exposed to drought, floods and extreme heat if adequate climate adaptation and mitigation measures are not adopted.

Africa is not adequately prepared for the impacts of climate change, including extreme weather events such as heatwaves, heavy rain, flooding, tropical cyclones and prolonged drought. Given this context, digital climate advisory services can help farmers and governments in navigating the complexities of climate change by providing accurate and timely weather information, customized short- and long-term agronomic and management recommendations, early warnings, and assist in implementing climate-smart practices by leveraging advanced climate advisory tools. However, given the multiple players and competing narratives involved in climate change adaptation, the gaps present in local knowledge, and the limitations affecting climate advisory services at the country level, the provision and use of advisories and climate solutions has become ad hoc and less impactful. Inconsistencies and lack of coordination in the development and use of climate advisory services are evident at the regional as well as continental levels.

Furthermore, there is a lack of context-specific climate information that can inform policy and climate action. Indigenous knowledge and the need for gender inclusivity are rarely recognized, creating barriers to the adoption of climate knowledge relevant to services and applications. The absence of a structured and coordinated approach to using climate information services limits how climate services are applied in agriculture and food systems, which in turn inhibits investment and innovation in climate change adaptation in food systems. Climate information services can only be useful when they are timely and relevant, and if the targeted users at various levels can incorporate them into their decision making.

To design interventions that improve the delivery of climate agro-advisories, it is important to understand the landscape and the institutional arrangements available for these services at the regional and country levels. Toward that objective, the following sections present (i) profiles of regional climate centres (RCCs) and (ii) country profiles of Kenya, Ethiopia, Rwanda, Burkina Faso, Nigeria and Mozambique.

2. Regional climate centre profiles

This section analyses the work of regional and continental climate institutions operating in Africa, focusing on the climate information products and services they offer, the operational challenges they face, and the capacity gaps that constrain them. We also make some recommendations to address these key gaps.

This assessment relies on qualitative data collected from face-to-face interviews, emails, phone calls and stakeholder consultations that were designed to include diverse perspectives. The four institutions assessed in this section, the African Climate Policy Centre (ACPC), the African Centre of Meteorological Applications for Development (ACMAD), the AGRHYMET Regional Climate Center, and the IGAD Climate Prediction and Applications Centre (ICPAC), play a pivotal role in providing climate services, generating climate forecasts, and delivering critical climate data to support decision making in various sectors such as agriculture, disaster management and water resources (Figure 1).



Figure 1. The jurisdictions of regional climate centres offering climate information services in Africa

An overview of the key climate information products and services offered by each of these institutions, highlighting the types of data and services available as well as their relevance to different sectors and user groups, is presented in Table 1.

Table 1. Climate service products offered by regional climate centres in Africa

Climate service product	Organization
Seasonal climate forecasts and EWS	ACPC, ACMAD, AGRYHMET, ICPAC
Research publications addressing climate change issues	ACPC
Tools and knowledge for mainstreaming climate adaptation	ACPC
Improved meteorology and hydrology infrastructure	ACPC
Nowcasting weather services	ACMAD
Continental-scale daily forecasts, dekadal and severe-weather bulletins	ACMAD
7-day rainfall and maximum temperature monitoring bulletins	ACMAD
Monitoring hydroclimatic risks and water levels for agriculture	AGRYHMET
Crop monitoring and protection services	AGRYHMET
Pastoral information services (herd health, watering points)	AGRYHMET
Medium- and long-range forecasts	ICPAC
Weekly rainfall and temperature anomaly maps	ICPAC
Seasonal rainfall onset forecast	ICPAC
Climate-smart guidelines to improve farm-level practices	ICPAC
Capacity building	ACPC, ACMAD, AGRYHMET, ICPAC

2.1 African Climate Policy Centre

Headquartered in Addis Ababa, Ethiopia, ACPC was established in 2010 as a specialized centre of the United Nations Economic Commission for Africa (UNECA) to help develop policies, strategies and frameworks that address climate change impacts across Africa. The centre focuses on supporting African governments, institutions and stakeholders as they integrate climate change policies into their development planning with a view to enhancing resilience.

2.1.1 Strategic partnerships and programmes

ACPC's climate information and agro-advisory programmes and initiatives are delivered through collaborations with partners to promote climate resilience and sustainable development in Africa. The centre collaborates with the African Union Commission (AUC) on aligning climate governance in the continent with Agenda 2063 and global frameworks like the Paris Agreement. Partnerships with regional economic communities such as the Economic Community of West African States (ECOWAS), the Southern African Development Community (SADC), and the Intergovernmental Authority on Development (IGAD) help enhance regional strategies in climate-sensitive sectors including agriculture and water management. ACPC also works with the African Ministerial Conference on Meteorology (AMCOMET) to strengthen meteorological capabilities and services in the continent. Collaboration with the World Meteorological Organization (WMO) and the Global Framework for Climate Services (GFCS) is focused on improving the generation and application of climate information, and supporting decision-making across sectors like disaster risk reduction and agriculture.

Additionally, ACPC's flagship Climate for Development in Africa (ClimDev-Africa) programme, jointly implemented with the African Development Bank (AfDB) and AUC, strengthens climate services and integrates climate considerations into development planning. These partnerships collectively enhance capacity, provide technical support and drive climate-smart initiatives across the continent.

2.1.2 ACPC agro-advisory services

Although ACPC does not directly provide AAS, it plays a crucial role in supporting and enhancing the delivery of climate information and agro-advisory services across Africa through various strategic initiatives and programmes. These include ClimDev-Africa to strengthen climate resilience policies, the Weather and Climate Information Services (WISER) programme to improve access to high-quality weather data, and the African Resilience Initiative (Afri-Res), which integrates climate resilience into infrastructure investments. Additionally, ACPC collaborates on the Sweden Climate Resilience Program and African Development Fund (ADF) projects, both of which support climate adaptation and sustainable agriculture. Further, by participating in the Climate Research for Development in Africa (CR4D) initiative, ACPC contributes to promoting climate research aimed at enhancing policy and practice. A summary of ACPC's initiatives and achievements in advancing AAS delivery across Africa is presented in Table A1 of the Appendix.

2.1.3 Reflections

As an institution that is driving Africa's transition to climate-resilient development, ACPC has extensive experience in climate policy development. It facilitated the creation of key policies such as the African Union's Strategy on Climate Change and Resilience, and supported the integration of climate change into national plans such as the NAPs. Over the years, the centre has built solid partnerships through programmes like ClimDev-Africa, WISER and Afri-Res and thus widened access to up-to-date climate science and knowledge. It continues to provide substantial technical support through workshops and studies aimed at strengthening African climate policy, finance, and adaptation strategies. Additionally, ACPC plays a crucial role in mobilizing climate finance, helping African countries access international climate funds for implementing their NDCs through initiatives such as the African Adaptation Initiative. The centre takes up evidence-informed advocacy that is supported by data and research—including climate vulnerability studies and economic analysis. This helps create effective and feasible climate policy interventions across Africa.

However, ACPC's efforts are constrained by several challenges that hinder its effectiveness in delivering climate services and supporting decision-making processes. These challenges include:

- weak institutional capacities occasioned by limited resources and coordination;
- lack of reliable and accessible climate data;
- lack of trained personnel in the NMHSs;
- inadequate funding, which is partly due to ACPC's reliance on project-based funding which limits its ability to sustain long-term initiatives;
- fragmented stakeholder engagement; and
- political instability among member countries.

2.1.4 Recommendations

For enhanced engagement with NMHSs, researchers, policymakers and other stakeholders, ACPC should continue to:

- provide specialized training programmes that support the development of legal frameworks for integrating climate change into national policies;
- invest in digital climate data platforms and develop tailored decision-support tools to assist key sectors such as agriculture, energy and disaster risk reduction;
- offer technical support to African governments in developing bankable climate projects, strengthening engagement with the private sector, and mobilizing funding from global climate finance mechanisms;
- expand the CR4D programme to foster interdisciplinary research collaborations, promote data-driven policy recommendations, and create knowledge-sharing platforms for climate scientists, policymakers and practitioners; and
- increase outreach to relevant stakeholders through capacity-building initiatives and improve community participation in climate resilience programmes.

2.2 African Centre of Meteorological Applications for Development

The African Centre of Meteorological Applications for Development (ACMAD) is a specialized institution that supports the advancement of meteorological, climate and environmental services across Africa. Its mandate is to enhance the capacity of African nations to monitor and understand climate variability and change with emphasis on providing actionable information for sustainable development in sectors such as agriculture, water, health and disaster risk reduction. Based in Niamey, Niger, ACMAD organizes the African Regional Climate Outlook Fora (RCOF) where experts from different African countries come together to present seasonal climate outlooks for different regions of the continent. These fora help disseminate the climate outlooks to stakeholders in the agricultural, water, health and disaster management sectors.

2.2.1 Strategic partnerships and programmes

ACMAD collaborates with key continental and international organizations to enhance climate services, disaster risk reduction and sustainable development across Africa. As a continental reference centre, it works closely with WMO and the national meteorological and hydrological services (NMHSs) to improve meteorological infrastructure and forecasting capabilities and strengthen climate resilience at the national and regional levels. ACMAD's partnerships with AUC and UNECA enable it to align its initiatives with continental strategies such as Agenda 2063 and the African Strategy on Meteorology, ensuring that climate services contribute to long-term development goals. Additionally, the centre engages with the Intra-ACP (Africa, Caribbean, Pacific) Climate Services and Related Applications Programme (ClimSA) to develop climate information products tailored for key sectors including agriculture, water management and disaster risk reduction. Its collaboration with ECOWAS enhances early warning systems in West Africa while partnerships with the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP) promote sustainable agricultural and environmental management practices. These strategic alliances enable ACMAD to expand its reach, improve service delivery and support climate-informed decision-making across Africa.

2.2.2 ACMAD's agro-advisory services

ACMAD's agro-advisory services are designed to support farmers, agricultural policymakers and extension service providers by delivering climate-smart guidance tailored to their needs (Table 2). The centre employs diverse communication channels to effectively deliver its agro-advisories. These channels include mobile platforms and SMS alerts providing real-time farming advice to smallholder farmers and rural communities; radio broadcasts targeting remote areas with forecasts and pest warnings; and ICT tools like the Mukau system, a web application aimed at progressive farmers and extension officers. Additionally, ACMAD partners with local stakeholders such as agricultural ministries and farmer organizations to ensure that its advisories are relevant to local conditions.

2.2.3 ACMAD's key achievements

- It established a continental multihazard advisory centre.
- It enhanced meteorological infrastructure by installing four regional advanced retransmission systems (RARS) for low earth orbiting satellite data, a high-performance computing system, a data server and a power generator to stabilize energy supply.
- The capacities of CIS experts from at least 22 African countries were strengthened through various capacity-building initiatives.
- Standard operating procedures (SOPs) were developed for forecasting, optimizing operational processes and enhancing the accuracy of weather predictions.
- In collaboration with RCCs and NMHSs, it organized the African Continental Climate Outlook Forum (ACCOF) to harmonize methods, tools and climate outlook products at the continental level.
- It contributed to climate research and policy by publishing the annual State of Climate Reports for Africa which provide valuable insights to policymakers and stakeholders.
- It digitalized historical meteorological data, preserving invaluable climate records and enhancing data accessibility for research and analysis.

Table 2. Agro-advisory services offered by ACMAD

Agro-advisory service	Target audience	Content	Frequency
Agricultural climate advisory systems	Smallholder farmers, cooperatives, rural communities	Optimal planting dates, irrigation schedules, drought-resistant crop varieties	Seasonal (before planting season)
Climate-smart agriculture (CSA) guidance	Smallholder and commercial farmers	Sustainable land and water management, soil conservation, pest control	Regular (monthly or as needed)
Real-time agro-advisory messages	Farmers, agribusinesses, extension service providers	Weather updates, extreme weather warnings, pest/disease alerts	Daily to weekly, depending on urgency
Policy-integrated AAS	National agriculture ministries, policymakers	Integration of CSA into national policies, climate risk assessment	During policy reviews
Disaster risk reduction and climate resilience	Local government, extension officers, rural communities	EWS for floods, droughts and extreme weather events	As needed (before/during major climate events)

2.2.4 Reflections

ACMAD's integrated approach of leveraging both climate data and local knowledge positions it as a key player in building resilience in Africa's agricultural systems. Through strategic collaborations and innovative solutions, the centre empowers communities to adapt to the changing climate while fostering sustainable agricultural development. However, ACMAD faces several challenges, which include:

- insufficient human resources, which limits its capacity to deliver timely and accurate CIS;
- infrastructure deficiencies such as unreliable power supply, weak Internet bandwidth, limited processing capacity and outdated software tools;
- limited last-mile service delivery owing to a shortage of intermediaries capable of translating complex climate information into actionable recommendations for key development sectors such as agriculture, food security, water and energy; and
- lack of sustained funding, which limits the centre's ability to expand services, upgrade infrastructure and strengthen partnerships with NMHSs and development organizations.

2.2.5 Recommendations

To enhance its services further, ACMAD should:

- strengthen its technical capacity by training staff and recruiting additional experts;
- improve ACMAD's data processing, storage and connectivity capacities while integrating the centre with global climate data systems;
- develop tailored services for key sectors such as agriculture, water, health and energy;
- promote open data-sharing policies and create user-friendly tools to effectively translate climate data into actionable insights; and
- ensure financial stability by eliciting contributions from member states while also exploring public-private partnerships and engaging with international donors.

2.3 AGRHYMET Regional Climate Center

The AGRHYMET Regional Climate Center for West Africa and the Sahel is a specialized institution based in Niamey, Niger. It is involved in research, training and operational application in the fields of climate, hydrology, agriculture, pastoralism, natural resource and environmental management, plant protection, market monitoring, and food and nutritional security. The center contributes to the mandate of the Permanent Inter-State Committee for Drought Control in the Sahel (Comité permanent inter-État de lutte contre la sécheresse au Sahel, CILSS) to achieve an ecological balance that strengthens the adaptation and resilience of production sectors and populations to climate change. AGRHYMET provides information on climate and weather variations to decision makers including government officials, agribusinesses and individual farmers.

2.3.1 Strategic partnerships and programmes

AGRHYMET collaborates with various regional, international and national partners to address climate and disaster challenges in West Africa and the Sahel. A key partnership is the one with ECOWAS, which has

designated AGRHYMET as an RCC to implement hydrometeorological policies and capacity building, reinforcing its role in climate data processing and dissemination. Collaborations with organizations like the Niger Basin Authority (NBA) and Volta Basin Authority (VBA) focus on strengthening early warning systems and hydrological data management. International partnerships with entities such as WMO, AfDB and the United Nations Development Programme (UNDP) provide financial and technical support for initiatives like the Global Framework for Climate Services and the Food Systems Resilience Program, which are aimed at developing climate services, improving agricultural resilience and managing disaster risks. AGRHYMET also plays a pivotal role in fostering food security and irrigation management through initiatives like the Regional Support to the Sahel Irrigation Initiative. Collectively, these collaborations position AGRHYMET as a critical player in addressing climate vulnerabilities and advancing sustainable development in West Africa and the Sahel.

2.3.2 AGRHYMET agro-advisory services

AGRHYMET provides several agroclimatic services to its member countries, partners and clients (Table 3). Its CIS offers include data collection and analysis of meteorological, climatic and bioclimatic variations/changes, and their impacts on sensitive vital sectors. These services involve the analysis of rainfall, temperature, wind, relative humidity and seasonal forecasts. AGRHYMET has also established the Centre Climatique Régional pour l'Afrique de l'Ouest et du Sahel (CCR-AOS), a regional support programme on population, gender and development.

Table 3. Agro-advisory services offered by AGRHYMET

Agro-advisory service	Target audience	Content	Frequency
Hydrological services	Agriculture and energy sector actors	Monitoring of hydroclimatic risks including runoff in river basins, dam water levels and runoff forecasts for hydropower, agriculture and other sectors.	Regular (monthly/ seasonal) and as needed during extreme climate events
Crop monitoring and protection services	Farmers, extension workers	Development and dissemination of tools for monitoring sowing dates, crop growth, water requirements, soil water stocks, yield forecasts and pest/disease risk management.	Seasonal (before planting and during growth period)
Pastoral information services	Pastoralists, livestock managers and rangeland stakeholders	Monitoring of herd movements, health, watering points and grazing areas. Development of tools for estimating forage biomass and ecosystem balance.	Regular (monthly) and as needed based on climate conditions
Food security monitoring and forecasting	Policymakers, humanitarian agencies and national disaster management authorities	Assessment of cereal balance sheets, food security early warnings and crisis response planning, using climate and agricultural data to prevent food shortages.	Seasonal assessments and crisis-specific updates
Agrometeorological and seasonal forecasting	Farmers, agricultural extension services and policymakers	Climate outlook on rainfall onset/ cessation, dry spells, cumulative seasonal rainfall totals, drought severity, plant health and water availability.	Monthly and seasonal forecasts
Disaster risk reduction and early warning systems	National and regional disaster management agencies and policymakers	Flood and drought forecasting, extreme weather alerts and coordination of emergency preparedness.	Continuous monitoring with early warnings issued as needed

2.3.3 AGRHYMET´s key achievements

- Trained staff from CILSS member countries and other African nations in agrometeorology and related fields, thereby strengthening regional expertise in CIS.
- Developed regional databases (Table A2) including CLIDATA (climatology), HYDROMET (hydrology) and TDBASE (demography, agriculture and livestock) to facilitate effective data management.
- Improved crop yield forecasting and early warning systems by enhancing observational data networks and using Earth Observation data to monitor crop pests and diseases over large areas.
- Promoted multidisciplinary collaboration between NMHSs and ministries of agriculture and livestock through multidisciplinary working groups.
- Advanced climate vulnerability and capacity analysis by prioritizing local knowledge in data collection and analytical processes, thus helping improve stakeholders' understanding of community vulnerability and adaptive capacity to climate change.
- Supported hydrometeorological infrastructure installation in Burkina Faso, Mali, Niger and Senegal to enhance those countries' data collection and weather monitoring capabilities.

2.3.4 Reflections

Effective CIS and AAS can significantly transform the agricultural sectors of the AGRHYMET countries, making them more resilient to climate variability. Despite the efforts of AGRHYMET, there exist some gaps in these services, mainly due to the following challenges:

- lack of sustainable funding affects AGHRYMET's ability to maintain core operations, retain qualified personnel and invest in infrastructure upgrades;
- lack of sufficient permanent staff; most experts are employed under short-term contracts tied to donor-funded projects;
- outdated IT infrastructure including servers and data collection tools, which hampers efficient data processing and storage;
- fragmented data systems, which makes data sharing across systems inefficient;
- inefficient data collection and transmission; the centre is still reliant on paper-based data collection methods;
- limited access to disaster risk and socioeconomic data affects AGRHYMET's ability to provide impact-based advisories and early warning systems;
- weak collaboration and partnerships with AGRHYMET member states, national disaster risk reduction agencies, hydrological services, and security institutions, which limits the integration of climate data into sectoral policies; and
- lack of focused measures to stimulate uptake of CIS and AAS among vulnerable groups such as women and youth.

2.3.5 Recommendations

- There is a need for additional staff, particularly in long-range forecasting and climate modelling for AGRHYMET.
- AGRHYMET should upgrade its Internet bandwidth to support regional climate simulations, downscaling, and communication with NMHSs and community stakeholders.
- External donor support is essential for the AGRHYMET.

- To enhance capacity, international partners should assist in mobilizing scientific staff exchanges between AGRHYMET and climate institutions in developed countries.
- The Council of Ministers should improve regional coordination and policy evaluation to give AGRHYMET clear leadership and responsibilities in climate information systems and services.
- There should be an outreach and communication unit at AGRHYMET to maintain regular contact with stakeholders and users across the region.

2.4 IGAD Climate Prediction and Applications Centre

As a specialized institution of the Intergovernmental Authority on Development, the IGAD Climate Prediction and Applications Centre (ICPAC), headquartered at Nairobi, Kenya, serves 11 countries in the Greater Horn of Africa (GHA). It is accredited as a regional climate centre by the WMO and provides CIS and AAS to help end-users make informed decisions, particularly in climate-sensitive sectors such as agriculture, water resources and disaster risk reduction. ICPAC's mandate is to enhance climate resilience, disaster risk management (DRM) and sustainable development by delivering reliable climate forecasts across multiple timescales including seasonal, dekadal and multidekadal projections. In a region prone to droughts, floods and other extreme weather events, the centre provides early warning systems and facilitates climate data sharing among its member countries Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan, Tanzania and Uganda. ICPAC's key services include climate forecasting, DRM, water resources monitoring, agriculture and food security advisories, environmental monitoring, and capacity development. By integrating cutting-edge meteorological and climate science with practical applications, ICPAC strengthens resilience and supports decision-making by communities, policymakers and development partners across East Africa.

2.4.1 Strategic partnerships and programmes

ICPAC collaborates with global, regional and sectoral partners to serve its mandate of strengthening climate services and enhancing resilience in the GHA. At the global level, it works with WMO, World Food Programme (WFP), Intergovernmental Panel on Climate Change (IPCC), FAO and ACPC to advance climate research, forecasting and capacity-building initiatives. Regionally, it partners with IGAD, the East African Community (EAC) and the Sub-Regional Office for Eastern Africa (SRO-EA) to align climate policies and support regional development objectives. Additionally, ICPAC collaborates with NMHSs, ministries of agriculture, disaster management authorities and water resource departments to ensure effective policy integration and render decision-making support.

ICPAC also engages in strategic programmes that foster knowledge sharing and climate resilience. These include capacity-building initiatives, the Agricultural Climate Resilience Enhancement Initiative (ACREI) Project and the Food Security and Nutrition Working Group (FSNWG), which strengthens early warning systems. Through these partnerships and initiatives, ICPAC continues to play a vital role in supporting climate-informed policies and promoting regional cooperation for sustainable development in Eastern Africa.

2.4.2 ICPAC agro-advisory services

ICPAC's agro-advisory services are designed to help farmers, policymakers, researchers and other stakeholders manage climate risks, enhance agricultural productivity and improve food security in the GHA. These services integrate seasonal forecasts, real-time weather monitoring, early warning systems and decision-support tools to deliver actionable climate information tailored to the needs of different categories of users (Table 4).

Table 4. ICPAC's agro-advisory services, target audiences, and delivery frequency

Agro-advisory service	Target audience	Content	Frequency
Food Security and Nutrition Working Group (FSNWG)	Member countries, policymakers, NGOs, development organizations	Regional food security updates, food security monitoring and nutrition trends	Monthly
IGAD Food Security, Nutrition and Resilience Analysis Hub	Governments, policymakers and humanitarian agencies	In-depth food security and resilience analysis	Ongoing
Greater Horn of Africa Climate Outlook Forum (GHACOF) and online co-production platform	Policymakers, climate scientists, agricultural experts, disaster managers	A platform for reviewing seasonal forecasts, engaging with stakeholders in co-producing CIS and integrating user feedback into product design	Seasonal (before key decision-making periods)
Warnings, alerts and quarterly crop monitors	Farmers, extension workers, disaster risk managers	Agrometeorological warnings, alerts, scenarios and advisories; quarterly crop monitoring	Quarterly
Agroclimatic advisory tools	Farmers, agricultural planners, policymakers	Climate prediction combined with the best agricultural practices (planting, irrigation, pest management)	Seasonal (before planting)
Forecasting Agricultural Stress using Temperature and Rainfall Anomalies (FASTA)	Farmers, agribusinesses, policymakers	Real-time weather and climate data for agricultural stress forecasting and risk mitigation	Real-time
Climate information and data visualization tools (interactive online mapping, web-based data visualization, monitoring tools).	Stakeholders, agricultural planners, disaster risk managers, water resource managers	Provides access to climate forecasts, projections, flood and drought risk data, and real-time lake-level monitoring	Real-time
CSA guidelines	Farmers, cooperatives, extension officers	Promotesclimate-smartpractices for crop selection, soil and water management, pest control	Seasonal and as needed
Agroecological integrated models	Researchers, agricultural planners, policymakers	Climate-based decision-support tools for adapting to climate variability	As needed
Agricultural Climate Resilience Enhancement Initiative (ACREI)	Farmers, policymakers, cooperatives	Co-produced downscaled seasonal forecasts and location-specific agroclimatic advisories	Seasonal
Collaboration with regional stakeholders	Ministries of agriculture, research institutions, farmer cooperatives	Strengthening partnerships to ensure climate services benefit agricultural systems	Ongoing

2.4.3 ICPAC's key achievements

- Established a state-of-the-art climate centre that provides critical CIS to over 200 million people.
- Developed regional and national disaster preparedness strategies through the IGAD Disaster Risk Management Programme.
- Advanced climate services delivery through improved station network coverage and data analysis.
- Strengthened resilience to impacts of climate change ICPAC member states
- Enhanced user engagement and co-production of climate services leading to better access and uptake of CIS for decision-making.
- Capacity-building and training of African climate specialists in weather forecasting.
- Accreditation as a WMO regional climate centre.

2.4.4 Reflections

ICPAC plays a vital role in enhancing climate resilience and driving sustainable development in Eastern Africa. By delivering innovative climate information and agro-advisory services, the centre empowers communities to adapt to climate variability and challenges. Challenges faced by the centre include:

- Limited technical expertise and capacity.
- Gaps in advanced computing and telecommunications infrastructure.
- Data accessibility and sharing restrictions.
- Fragmentation of CIS tools.
- Weak collaboration and limited private sector engagement.
- Barriers to reaching vulnerable communities.
- Limited user engagement in co-production of climate services.
- Uncertain and insufficient funding.

2.4.5 Recommendations

While ICPAC plays a central role in promoting climate resilience and sustainable development across the GHA by providing improved CIS and AAS advisories, it can further enhance its products and services. Some recommendations:

- Enhance regional capacity-building activities, such as hands-on training workshops, knowledge-sharing initiatives and e-learning platforms, to ensure continuous development of skills in advanced climate modelling and data interpretation.
- Strengthen partnerships with national agencies and research institutions to facilitate free flow of data
- Integrate climate information with socioeconomic data to improve the accuracy and relevance of impact-based forecasting.
- Use a variety of communication channels—including radio, community meetings, social media and SMS—to disseminate climate information and advisories to last-mile users including marginalized groups.
- Improve ICPAC's CIS co-production strategy to foster interaction among scientists, policymakers, farmers and businesses while establishing robust feedback mechanisms to make climate services more user-friendly and sector-specific.
- To become financially more resilient, diversify funding sources by seeking investment from development partners, regional governments and the private sector while exploring revenue models (e.g. public-private partnerships).

3. Gender and social inclusion in regional meteorological organizations

3.1 ICPAC

The Intergovernmental Authority on Development validated a regional strategy for DRM in February 2019. It implements a gender sensitive approach in strategic priorities, addressing gender, age and disability- driven vulnerability in policy, strategy, planning, implementation, monitoring and evaluation; and provides for building capacity to address gender and DRM issues at IGAD and member state levels. A DRM strategy was also developed to update DRM and CCA activities in the region to cover the next 10 years and enhance analysis to include a gender lens. ICPAC also published a blog in November 2023, calling for mainstreaming gender into climate services.

3.2 World Meteorological Organization

In 2019, WMO published a summary of a report on Gendered impacts of weather and climate in Asia, the Pacific and Africa, assessing the physical, material and psychological gender-differentiated impacts of weather and climate as well as gender-specific needs for information and services. The research encompassed 18 case studies, including three in-depth studies (Bangladesh, Botswana and Fiji) to assess the experiences of different groups of women and men to analyse gender relations and roles in two climate-sensitive sectors: (1) disaster risk reduction and (2) agriculture and food security, in an intersectional context of age, economic status, location, disability, or marital status. It provides practical recommendations to NMHSs and members for bridging information asymmetries and providing gender-responsive services in terms of content, dissemination channels and feedback mechanisms.

The WMO regional association (Africa) Resolution 22 (XIV-RA I) on women's participation in the association relates to promoting women in the sector in cases of equal competence and campaigns to generate awareness among women on the use of meteorological information in daily activities. It notes the appointment of countries of national gender focal points and designated an association focal point for gender issues.

3.3 SADC meteorology and climate

SADC established a gender mainstreaming policy for all units and programmes with the following key actions:

- put in place institutional mechanisms and operational guidelines to promote a culture that facilitates gender mainstreaming in the SADC secretariat;

- build the capacity of staff of the SADC secretariat and member states to systematically develop, implement and sustain gender mainstreaming plans, strategies and programmes on a continuing basis;
- ensure that the human and financial resources required for gender mainstreaming are mobilized for training, capacity building and program implementation; and
- ensure that the integration and development objectives commitments on gender equality and women's empowerment are effectively implemented at the member state level.

The gender unit of SADC has a mandate to facilitate, coordinate, monitor and evaluate the implementation of the SADC Protocol on Gender and Development, regional sectoral strategies, the Regional Indicative Strategic Development Plan (RISDP), as well as other regional, continental and global gender instruments that SADC member states are party to. The unit spearheads mainstreaming of gender in all regional initiatives to ensure that a gender perspective permeates the entire SADC Regional Integration Agenda[1].

3.4 ECOWAS

The ECOWAS Disaster Risk Reduction Gender Strategy and Action Plan 2020-2030 calls for awareness and timely and gender-responsive information on early warning and response. Actions include increasing the understanding of gender responsive early warning, integrating indigenous knowledge and traditional practices including risk knowledge, technical monitoring, early warning service, dissemination and preparedness. It commits to partner with member states for early awareness campaigns on the concept of gender responsive early warning.



A Kenyan farmer uses a mobile phone in the field. Photo: Alliance of Bioversity CIAT/Neil Palmer.

1 https://www.sadc.int/pillars/gender-mainstreaming

4. Country profiles

4.1 Kenya

Highlights

Climate Information and Agro-advisory Service process

Figure 2 outlines Kenya's climate information flow from data collection to advisory dissemination. Data sources include 170 Automatic Weather Stations (AWS), 40 synoptic stations, satellite data (EUMETSAT), and field observations from farmers—all managed by the Kenya Meteorological Department. Monitoring is conducted by NDMA, KMD, and CGIAR, highlighting challenges such as limited software access and data gaps. Forecasts—seasonal, sub-seasonal, and short-range—are generated by ICPAC, KMD(NCOF) using models like GFS, WRF, and ECMWF. These forecasts are then translated into weather-based agro-advisories by partners including KARLO, various government ministries, NGOs, and the private sector. The advisories cover key topics such as crop management, planting and irrigation schedules, pest control, and soil care. Dissemination occurs via extension agents, television programs (e.g., Shamba Shape-Up), radio stations (e.g., Shujaa FM, Mbaitu FM), digital platforms (e.g., KAOP, DigiFarm, Nuru AI Assistant), and SMS alerts, ensuring that critical climate information reaches all farming stakeholders efficiently.

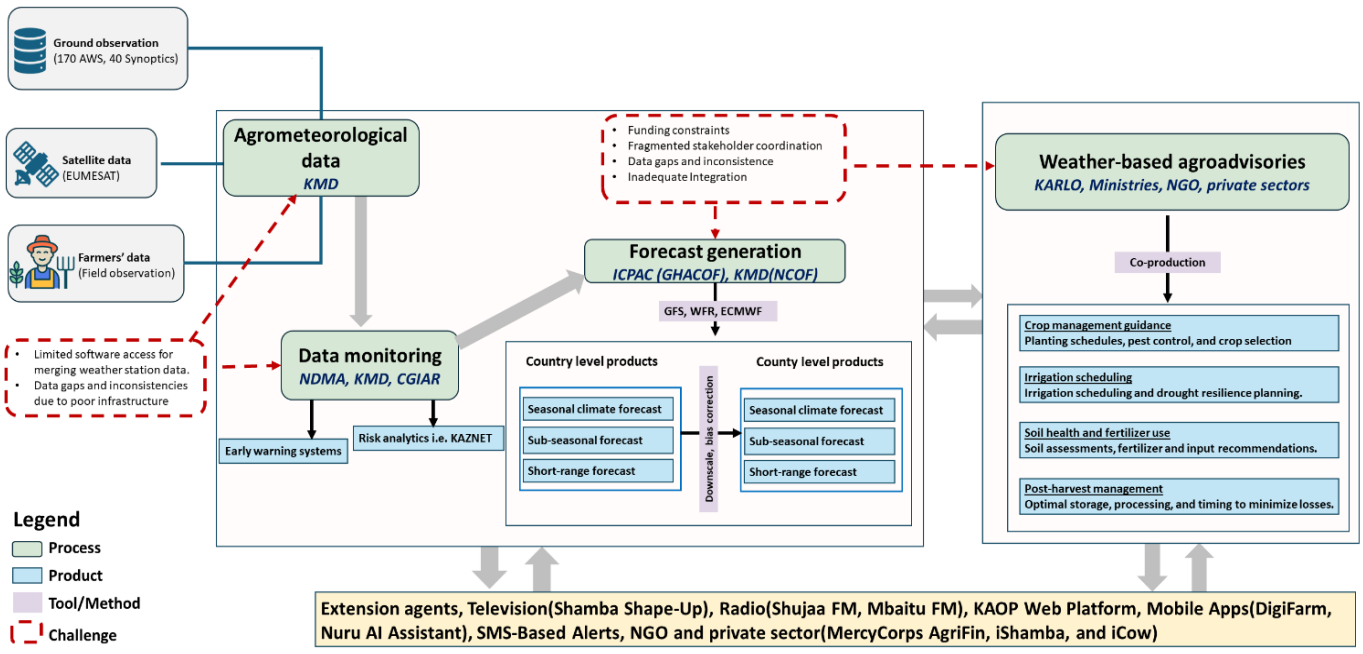


Figure 2. Flow of agrometeorological and climate information services in Kenya, highlighting key data sources, actors, delivery channels, and systemic gaps across the CIS-AAS value chain.

Main gaps in CIS and AAS delivery in Kenya

- Lack of access to software to merge data from different sources and to automatically generate agro-advisories from forecasted weather.
- Insufficient weather-based and context-specific agro-advisories hence low adoption rates.
- Fragmented coordination of stakeholders, most of whom operate in silos limiting CIS and AAS dissemination.
- Insufficient funding.

Opportunities for improvement

- Digitization of CIS uptake by KALRO, Ministry of Agriculture, various NGOs and the private sector could enhance the production and dissemination of weather-based agroadvisories.
- Continued investment in digital platforms and tools (like ag data hub) to enhance data sharing, co-ordination and co-development of CIS and agroadvisories.
- Enhanced stakeholder coordination.

4.1.1 Background

Agriculture is a key sector in Kenya, employing 54 percent of the country's labour force and contributing 22 percent to its the gross domestic product (GDP. The country's diverse agroclimatic zones support various crops and livestock, but the sector is highly vulnerable to climate variability, including erratic rainfall, droughts and floods. While the country has seen progress in CIS and AAS, access to them remains patchy, particularly in arid and semi-arid lands (ASALs), where over 75 percent of farmers lack timely climate information. With over 80 percent of agricultural production driven by smallholders, reliable weather and climate services are essential for improving agricultural productivity, food security and climate resilience.

4.1.2 Climate information services

In Kenya, CIS has progressed significantly in the past few years, with the Kenya Meteorological Department (KMD) playing an important role in collecting and archiving weather data, forecasting weather and climate and dissemination.

Data collection

The Department uses satellite data from the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and ground observation data from 170 automatic weather stations and 40 synoptic stations to collect climate information. It also maintains a network of farmer enumerators (known as climate volunteers) who are provided with manual rain gauges to collect data on rainfall, crop stage, crop health and pest and disease outbreaks among other agrometeorological variables.

Data monitoring

Early warning systems (EWS) play a critical role in mitigating the impacts of adverse weather conditions (i.e. drought, flood, heat wave, and cold spell) in sectors such as agriculture, health and transportation, among others. The National Drought Management Agency (NDMA) is the nodal agency that issues these alerts as well as early warnings. It works closely with KMD to source weather and climate data or with CGIAR to build analytics and crowdsourcing approaches e.g. KAZNET. KAZNET is an open-source, phone-based micro-tasking

platform developed by ILRI to collect high-frequency, localized data in remote pastoral regions. It enables trained local contributors with smartphones to perform small, structured tasks—such as tracking livestock markets, nutrition, and rangeland conditions—even offline, using the Open Data Kit (ODK). KAZNET combines features like geofencing, temporal gates, photo verification, and dynamic incentives to ensure data quality and flexibility, making it a cost-effective alternative to conventional surveys for real-time monitoring in data-scarce environments.

Forecasts

The Department provides seasonal forecasts every 3 months at the national and county levels, monthly forecasts at the national level, weekly forecasts at the national and county levels and a 3-day forecast at the national level. It uses Global Forecast System (GFS), European Centre for Medium-Range Weather Forecasts (ECMWF), and GHACOF products to generate forecast products at different timescales. For seasonal forecasts, KMD collaborates with IGAD ICPAC to develop consensus-based forecasts using products from GHACOF, which is then downscaled to develop the NCOF at the country level. For sub-seasonal or monthly forecasts, KMD uses ECMWF model products downscaled to the national level and made available to 47 counties. For the short-range/3-7-day forecast, KMD runs a Weather and Research Forecast (WRF) model using the GFS 16-day weather forecast and produces a 7-day rolling forecast. The 7-day forecast is corrected for bias using data from the 40 synoptic weather stations. Counties use the 7-day forecast once a week (on Mondays) and provide a weekly county forecast by downscaling the WRF output developed by KMD.

Communication platforms

Weather services are offered in Swahili and English via television, radio, websites, social media and weather apps. The Kenya meteorological department works with counties and radio stations to broadcast seasonal advisories in Swahili for the March-April-May and October-November-December seasons. Kenya Agriculture and Livestock Research Organization (KALRO) hosts the Kenya Agriculture Observatory Platform (KAOP) website which is a rich source of short-range, subseasonal and seasonal forecasts aggregated from various sources including KMD. The organization also maintains a registry of over six million farmers who receive text messages every week with weather forecasts and agriculture advisories. Partnerships with mobile network operators enable the delivery of SMS-based weather alerts. Climate information services are also disseminated by NGOs (MercyCorps AgriFin), startups (iShamba, icow, etc.) and transnational organizations (Safaricom's DigiFarm) to farmers who subscribe to their services.

4.1.3 Agro-advisory services

Content and delivery

Content delivered to farmers includes weather-based agro-advisories on crop management, irrigation schedules, soil health and fertilizer use, and postharvest management. The content is delivered by extension workers through interactions with farmers and at workshops. Digital platforms like the KAOP app also play an important role in disseminating agro-advisory content. Table 5 provides information about various digital tools and platforms offering agro-advisory services in Kenya. These tools are categorized into three main groups: Helplines and SMS-based tools, Web-based platforms, and Radio and television programmes.

Table 5. Description of digital Agro-Advisory Services(AAS) in Kenya

Category	Tool	Provider	Description
Helplines and SMS-based tools	iShamba	The Mediae Company	A subscription-based service offering weather updates, market prices and agronomic advice.
	WeFarm app	WeFarm	A peer-to-peer platform where farmers can ask questions and share solutions to agricultural challenges, providing community-based support.
Web-based platform	KAOP	KALRO; KMD; Ministry of Agriculture, Livestock, Fisheries and Irrigation	Uses geodata from satellites to generate real-time and location-specific weather forecasts and agro-advisories to farmers and other stakeholders. The platform also provides market information on various crops.
Mobile app-based tools	DigiFarm	Safaricom	A platform that offers farmers access to weather forecasts, financial services and agronomic advice.
	Nuru mobile AI assistant	PlantVillage	A mobile app that uses AI to diagnose crop diseases and provide recommendations.
Radio and television programmes	Local radio programmes	Shujaa FM and Mbaitu FM	Deliver weather updates, pest alerts and agronomic advice in local languages.
	Shamba Shape-Up Kenya's Gold	The Mediae Company	Provides educational content on sustainable farming practices, pest control and market trends.
	Kenya's Gold	Citizen TV Kenya	Provides educational agricultural content on soil health, new technologies, sustainable practices, expert interviews and youth in agriculture.

4.1.4 Stakeholder identification

Various entities such as government institutions, research organizations, non-governmental organizations (NGOs), and the private sector play crucial roles in the dissemination and implementation of CIS and AAS. n Kenya, several stakeholders contributing to CIS and AAS have been identified and summarized. Figure 3 categorizes these stakeholders into four main groups.

GGovernment institutions	Research institutions	NGOs	Private sector
• KMD • Ministry of Agriculture • Ministry of Environment	• KALRO • Universities such as University of Nairobi and Jomo Kenyatta University of Agriculture and Technology	• ILRI • World Bank • FAO • USAID • Oxfam	• Safaricom, • Airtel, • Kenya Women Microfinance Bank

Figure 3. Key stakeholders involved in CIS and AAS delivery in Kenya

4.1.5 Challenges in CIS and AAS delivery

- There is a lack of access to software that can merge data from synoptic weather stations and automatic weather stations for more accurate bias correction.
- Inadequate integration of CIS into agro-advisory services is leading to low adoption rates.
- KMD and other CIS stakeholders often face budget limitations, hindering the ability to invest in modern equipment, infrastructure and training of staff.
- Fragmented stakeholder coordination, gender and social inequalities, socioeconomic barriers, and challenges in dissemination channels are prevalent.

4.1.7 Reflections and recommendations

Despite the significant progress Kenya has made in developing CIS and AAS, critical barriers continue to hinder their full impact in various regions across the country. **Figure 2** illustrates the end-to-end flow of Kenya's CIS and AAS systems—from agrometeorological data collection to forecast generation and the dissemination of agro-advisories through various channels such as radio, mobile apps, and extension agents. It highlights the involvement of key actors like KMD, ICPAC, NDMA, and private platforms such as DigiFarm and iShamba. However, it also exposes systemic constraints: inadequate software for integrating station data, funding and coordination challenges in forecast production, and limited mechanisms for tailoring or validating advisories at the local level.

These gaps reveal the need for a more integrated, user-centered design of CIS that strengthens institutional coordination, improves feedback loops from farmers, and ensures that climate information is both accessible and actionable. Addressing these challenges is essential for realizing the full potential of CIS in enabling climate-smart agriculture and building resilience among smallholder communities.

The following steps are recommended:

- mobilize public and private investments to increase the density of the network of weather stations;
- improve the capacity of KMD staff and county directors of meteorology and agriculture in downscaling, crop modelling and the use of digital dissemination tools;
- continue to invest in digital platforms and tools (like agDatahub) to enhance data sharing, co-ordination and co-development of CIS and agro-advisories for smallholder farmers and livestock keepers;
- institutionalizing agrometeorological services as a collaboration between KMD, KALRO and the county departments of agriculture and meteorology; and
- conceptualize, test and scale new business and partnership models that could improve the availability of granular agrometeorological data and expand the dissemination of weather based agro-advisory services for smallholder farmers and livestock keepers.

4.2 Ethiopia

Highlights

Climate Information and Agro-advisory Service process

The process for delivering agro-advisories and climate services in Ethiopia involves four steps: data collection and monitoring, forecasting, advisory creation, and dissemination. Figure 4 visually represents this flow. Data are gathered through ground observations, satellite imagery, and weather stations, monitored by institutions such as EIAR, EMI, MoA, IRI, and CGIAR. Forecasts are generated by bodies like ICPAC, GHACOF, EMI/NCOF, and RCOF using methods such as GFS, WFR, ECMWF, PyCPT, and analogue techniques, resulting in country-level and zonal products (seasonal, sub-seasonal, and short-range forecasts). Advisories are produced by EMI, government ministries, universities, NGOs, and private sector partners, offering agroclimatic guidance, market and finance information, and yield predictions. The figure clearly outlines the process and highlights existing gaps in data integration and stakeholder coordination that may hinder effective CIS and AAS delivery.

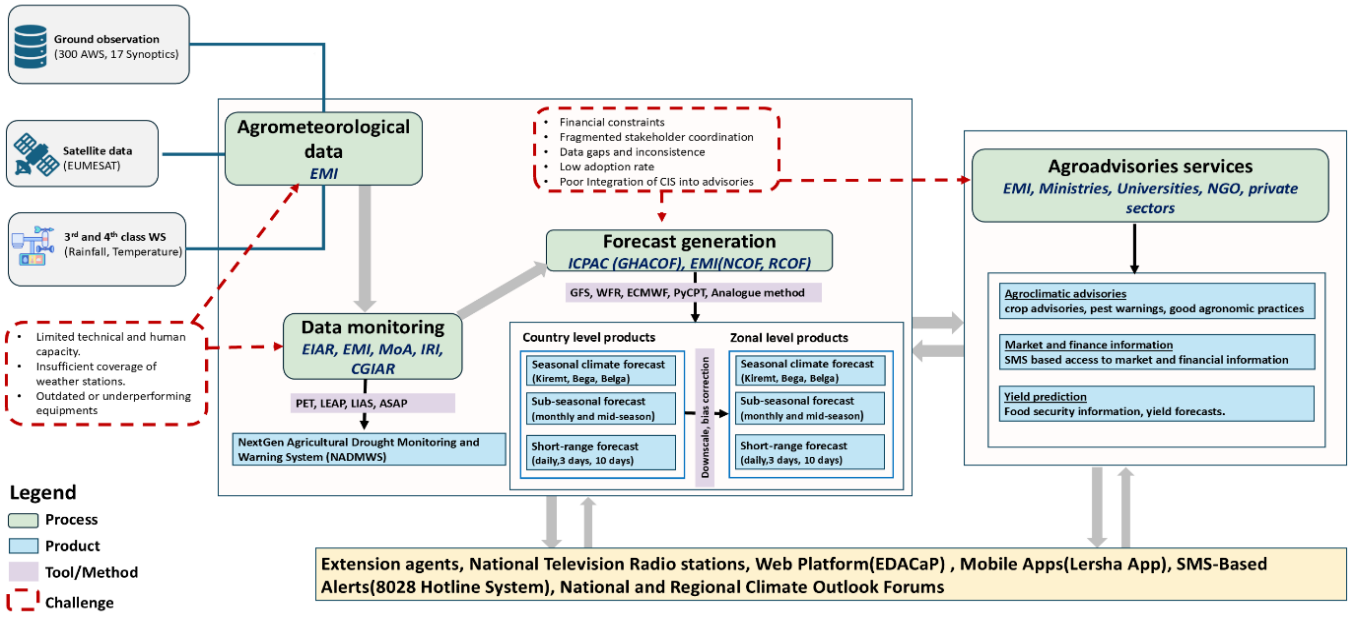


Figure 4. Flow of agrometeorological and climate services and potential gaps in Ethiopia

Main gaps in CIS and AAS delivery in Ethiopia

- Infrastructure deficiencies and limited technical and human capacities which hinder effective climate data collection and dissemination.
- Poor integration of CIS into agroadvisories, with the livestock sector often neglected.
- Fragmented stakeholder coordination in the delivery of CIS and AAS.

Opportunities for improvement

- Digital platforms, e.g. EDACaP, offer the opportunity to enhance the reach of CIS and AAS in Ethiopia.
- Strengthened stakeholder coordination and incentivizing private sector participation.
- Strengthening the capacities of actors such as NMI's technical personnel, researchers, and extension workers to improve CIS delivery and to reach more end-users.

4.2.1 Background

Agriculture is one of the major sectors of the Ethiopian economy, involving 70 percent of its labour force and accounting for over 30 percent of the country's GDP. It has wide topographical and climatic diversity, ranging from the arid lowlands to the cool highlands, and supports a wide range of agricultural activities that are highly susceptible to climate variability. Hence, effective CIS and AAS are key to adapting to climate impacts, improving agricultural productivity and enhancing DRM. To date, only 10 percent of the districts in Ethiopia receive CIS regularly, although the expansion of services is planned. With over 12 million smallholder farming households relying on agriculture for their livelihoods, the production of and access to CIS could improve productivity, especially of staple crops such as maize and wheat, and enhance food security. The livestock sector, often neglected in CIS, could also benefit from better integration of tailored climate services. Such gaps need to be addressed through targeted capacity building and better access to climate data to realize climate resilience and sustainable development within Ethiopia's agricultural sector.

4.2.2 Climate information services

Data collection

The Ethiopian Meteorological Institute (EMI) collects data from European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and ground observations from 300 automatic weather stations and 17 synoptic stations. Several third- and fourth-class stations are used to collect only rainfall and temperature data. The tools used in Ethiopia to monitor agricultural practices include the pictorial evaluation tool (PET) and the NextGen Agricultural Drought Monitoring and Warning System (NADMWS).

Forecasting models

The Ethiopian Meteorological Institute uses ECMWF, GFS and a Python-interfaced climate production tool which incorporates products from C3S and North American Multi-Model Ensemble (NMME), and the WRF model for weather and climate forecasting across different timescales. For seasonal forecasts, EMI combines objective forecasts from ICPAC, its own outputs from PyCPT and the analogue method to develop consensus-based forecasts at the national level. The status of El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) are also factored in as inputs for seasonal forecasting. These forecasts are downscaled at subnational level at an NCOF, where stakeholders from various sectors gather to coproduce agro-advisories at the national and subnational levels. Regional Climate Outlook Fora (RCOF) are held in respective regions to downscale climate information and agro-advisories at regional and woreda levels. For sub-seasonal and monthly forecasts, EMI uses products from ECMWF and GFS models as well as the analogue method. For short and medium range forecasts (1-10 days), EMI runs the WRF model using six-hour products from Climate Forecast System (CFS).

Forecast types

The Ethiopian Meteorological Institute provides daily, 3-day, dekadal, monthly, sub-seasonal and seasonal forecasts. In addition to weather and climate forecasts, it produces agromet bulletins, providing data on weather and agriculture, rainfall anomalies and vegetation conditions.

Communication platforms

Weather services are offered in English and Amharic via television, radio, FM radios, websites, social media,

mobile apps and NCOFs. At the regional level, GHACOF hosts quarterly fora to review past seasons, future forecasts and develop mitigation strategies.

4.2.3 Agro-advisory services

Like climate information services, agro-advisory services play a critical role in supporting Ethiopian smallholder farmers to adapt to climate variability and improve agricultural productivity. These services provide timely weather information, agronomic advice, early warnings, and decision-support tools to guide farm-level planning and risk management. Multiple tools and platforms—delivered via mobile phones, SMS, web platforms, and institutional systems—are currently being used across the country, facilitated by a range of public and private actors (**see Figure 4**).

Table 6 summarizes key Agro-Advisory Service (AAS) tools currently deployed in Ethiopia, highlighting their providers, delivery channels, and main functions. These tools can be grouped into three main categories: communication-based tools (hotlines and mobile/web platforms), mobile applications, and early warning systems for climate and food security monitoring.

Table 6. Key Agro-Advisory Service tools in Ethiopia: providers, delivery mechanisms, and core functions

Category	Tool	Provider	Description
Helplines and SMS-based tools	8028 Hotline system	Agricultural Transformation Institute (ATI)	Delivers weather advisories, pest warnings and agricultural guidance to farmers via SMS and calls.
Web-based platforms	Ethiopian digital AgroClimate Advisory platform (EDACaP)	EDACaP in partnership with the Ministry of Agriculture and EMI	A digital platform delivering agroclimatic advisories through SMS, voice messages and interactive platforms, reaching over 129 000 farmers.
Mobile app-based tools	Lersha app	Green Agro Solutions	Provides integrated services for smallholder farmers on crop advisories, pest warnings and access to agricultural inputs and finance.
Early warning systems	LEAP system	Government of Ethiopia	Predicts food insecurity and enables timely resource allocation by estimating crop yield reduction and identifying people in need.
	Livelihood impact analysis sheet	FEG Consulting; Ministry of Agriculture and Rural Development, Disaster Risk Management and Food Security, funded by USAID	Assesses vulnerability in rural populations, considering livelihoods, market access and prices.
	ASAP system	International Fund for Agricultural Development (IFAD)	Predicts food insecurity and enables timely resource allocation by estimating crop yield reductions and identifying people in need.
	CCAFS Regional Agricultural Forecasting Toolbox	CGIAR Centers and Research Programs	Uses crop models and spatial data to predict crop yields and support decision making.
	The East Africa Hazards Watch system	ICPAC	Tracks extreme weather events like droughts, cyclones and pests, and overlays socioeconomic data to assess vulnerability.

4.2.4 Stakeholder identification

To understand the institutional landscape supporting CIS and AAS in Ethiopia, a basic identification of key stakeholders was done. A list of organizations actively involved in the development, coordination, dissemination, or support of CIS and AAS was compiled. The identified stakeholders(Figure 5) in Ethiopia span four main categories: government institutions, research institutions, non-governmental organizations (NGOs), and private sector actors. This stakeholder identification provides a foundational understanding of the actors shaping Ethiopia's CIS and AAS ecosystem and offers a basis for further analysis of their roles, interactions, and coordination mechanisms. Figure 5 presents these stakeholder groups, categorized by their institutional type.

GGovernment institutions	Research institutions	NGOs	Private sector
• NMI • Ministry of Agriculture • Ethiopian Disaster Risk Management Commission (EDRMC)	• Ethiopian Institute of Agricultural Research (EIAR) • Regional research institutes • Universities • International Republican Institute (IRI) • Agricultural Transformation Institute (ATI) • AICCRA-ILRI	• WMO • ICPAC • FAO • WFP • UNDP • Care-International • UK-Met • NMHS Sweden • National Oceanic and Atmospheric Administration (NOAA)	• Kifiya Financial Technology • Green Agro Solutions - Lersha platform

Figure 5. CIS and AAS stakeholders in Ethiopia, grouped by institutional category

4.2.5 Policy and regulatory framework

The environment to improve climate information services to inform policy as well as investments is enabled by:

a) *National Framework for Climate Services (NFCS)*: Established in 2018, it supports climate-sensitive sectors like agriculture, water resources and health; facilitates the development and delivery of climate services across federal, regional, zonal and woreda levels; and aligns with the Global Framework for Climate Services.
b) *Sendai Framework for Disaster Risk Reduction*: Aligns with national efforts to reduce disaster risks, supporting Ethiopia's climate resilience.
c) *Paris Agreement*: National policies and strategies are designed in alignment with this global climate agreement.
d) *Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System*: Aims to enhance disaster preparedness and improve access to multi-hazard early warning systems by 2030.
e) *National Information and Communication Technology Policy and Strategy*: Promotes the use of ICT for climate change communication.
f) *Agricultural Extension Strategy*: Focuses on building resilience in agriculture by promoting climate-smart agriculture and improving access to climate information.
g) *National Disaster Risk Management Policy*: Advocates for the integration of climate considerations into DRM.
h) *Agricultural Transformation Agenda*: Emphasizes incorporating climate concerns into agricultural development.

4.2.6 Challenges and opportunities in CIS and AAS delivery

Challenges

Limited technical and human capacity hinder effective CIS data collection and dissemination, particularly in remote areas. However, widening network coverage, particularly in eastern pastoral areas and upgrades to automatic stations are underway. Some of the shortcomings of AAS include inadequate funding, low adoption, poor integration of CIS into advisories and lack of coordination between sectors at the regional states.

Opportunities for improvement

Technology

Mobile apps, artificial intelligence (AI) and remote sensing can enhance the reach of CIS and AAS. The launch of the Ethiopian Digital AgroClimate Advisory Platform (EDACaP V2.0) by Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) in December 2024 and the scaling up of existing systems like Livelihoods, Early Assessment and Protection (LEAP) and EDACaP will enable the services to reach more people.

Partnerships

Strengthening collaboration between institutions and ensuring coordinated efforts to improve financing for climate services are a step in this direction. Public-private partnerships can bridge resource gaps and encourage private sector participation in climate services.

Capacity-building

Ethiopia has an extensive network of extension workers that can help improve agro-advisories' dissemination. Training extension workers and farmers will enhance the adoption of climate services and improve overall service effectiveness. Capacity building in installation, maintenance and data utilization is also needed.

4.2.7 Reflections and recommendations

The uptake of weather-informed agricultural advisory services is still limited in Ethiopia (Figure 5). This is largely the result of limited resources, weak coordination and low inclusivity. Effective CIS and AAS can significantly transform Ethiopian agriculture, making it more resilient to climate variability. Prioritizing accessibility, technology and partnerships will empower farmers and foster sustainable development. Though EMI is developing early warning systems for floods, droughts and pests, access remains limited, particularly in remote areas.

To enhance climate services in Ethiopia, stakeholders should prioritize and scale up efforts to reach all woredas by:

- increasing weather station networks, mobile platforms and local dissemination channels to better support farmers and pastoralists;
- strengthening links and data exchange between global and regional climate institutions to maximize the availability of resources and tools, as well as skillful forecast products;
- co-development of tailored climate products through coordination with sectors under the NFCS;
- investing in training programmes for extension workers, meteorologists and farmers to improve data interpretation and the application of climate information in agricultural and livestock decision making;
- mobilizing resources from the government, private sector and development partners to improve infrastructure, technology and the sustainability of climate services;
- embedding climate services into national agricultural strategies, extension programmes and risk management frameworks to promote climate-smart agriculture and build resilience; and
- strengthening resources for capacity building and training at NMHSs and universities.

4.3 Rwanda

Highlights

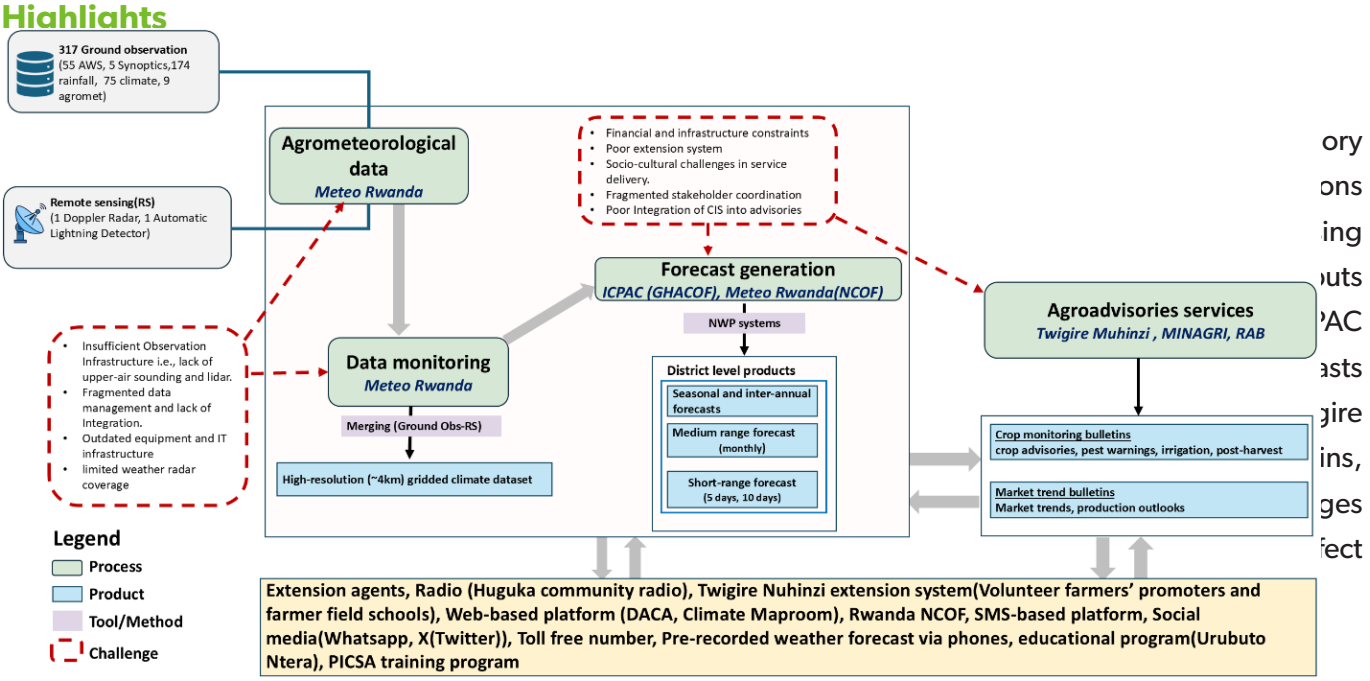


Figure 6. Flow of agrometeorological and climate services and potential gaps in Rwanda

Main gaps in CIS and AAS delivery in Rwanda

- Lack of critical infrastructure e.g. integrated data management system by Meteo Rwanda.
- Little private sector involvement in CIS and AAS delivery when compared to other countries such as Kenya.
- Agro-advisory services are project-based with no organized AAS provision, hence limiting its reach.
- CIS and AAS last mile delivery challenges including high farmer-to-extension ratios and relatively low rural ICT access.

Opportunities for improvement

- Modernization of data collection, processing and dissemination infrastructure and equipment, and leveraging of technological advancements such as AI to facilitate real-time data processing and information dissemination.
- Incentivizing private sector participation.
- Strengthening the capacities of extension personnel to improve CIS and AAS delivery and to reach more people.
- Expand access to mobile technology in rural areas
- Public awareness campaigns to promote CIS and AAS

4.3.1 Background

Agriculture is the main economic activity in Rwanda, with 70 percent of the population engaged in the sector and around 72 percent of the working population employed in it. It is the main source of income for rural households, especially women. It accounts for 33 percent of the national GDP. Yet the sector is highly vulnerable to current and projected climate and weather variability. Recurring hail and windstorms, heavy rains and prolonged droughts that take a toll on agricultural productivity are expected to become more frequent and intense with climate change, posing a threat to food security.

4.3.2 Climate information services

Data collection

Climate data that it collected includes weather station observations and merged data. Mateo Rwanda, the country's meteorology agency, has observing infrastructure that includes 317 operational automatic and manual weather stations: surface synoptic (5), agrometeorological (9), climate (75), rainfall (174), and automatic (55); a doppler radar and an automatic lightning detector.

Data monitoring

Weather station records are merged with satellite and re-analysis data to generate high-resolution (~4 km) gridded historical (>40 years) daily rainfall and temperature data that fills observation gaps, including the ~15-year collapse in observations following the 1994 genocide. Meteo Rwanda provides access to historical climate data upon request for approved uses such as socioeconomic development, research and civil contracts.

Forecast types

- Five-day weather forecasts, issued daily for 28 district/station locations, include deterministic forecasts of minimum and maximum temperature and rainfall.
- Medium-range forecasts are issued at 10-day and monthly timescales. Predicted rainfall, minimum and maximum temperatures, and maximum wind speed are presented as qualitative narratives and maps.
- Seasonal climate forecasts, generally aligned with GHACOF regional outlooks, present a narrative, maps and tables of predicted ranges in seasonal rainfall and the onset and cessation dates.
- Monthly climate bulletins cover a review of climate conditions observed during the previous month, rainfall prediction for the upcoming month and the socioeconomic impacts of observed and predicted climate conditions.
- Dekadal agrometeorology bulletins analyse rainfall and temperature conditions during a given 10-day period, including long-term means for the same time of the year, anomalies, number of rain days, maximum and minimum temperatures and soil moisture estimates. The bulletins include generalized agricultural management advisories.
- Climate map-rooms provide online access to spatial and localized historical, monitored, and forecast products based on 4-km gridded data. Through a flexible interface, users can analyse averages, trends, seasonal cycles, rainfed growing season timing and dry/wet spell characteristics. Specialized tools include: (a) spatial climate summaries for provincial, district and sector local governments; (b) crop-specific soil water balance and Water Requirement Satisfaction Index analyses; and (c) localized climate graphs formatted for Participatory Integrated Climate Services for Agriculture (PICSA) farmer workshops.

Communication platforms

Radio is the channel that Rwandan farmers commonly use to access weather and climate information, primarily in the form of daily weather forecasts. Through the Rwanda Climate Services for Agriculture (RCSA) project, the Radio Huguka rural radio network launched weekly interactive talk shows and Urubuto Ntera educational programmes to support awareness and use of climate services for agriculture.

Rwanda NCOF is a biannual public event at which Meteo Rwanda disseminates its official seasonal climate forecast in advance of each of the two rainfall seasons. Other dissemination channels used include:

- SMS sent to 6000 people representing central and local management;
- WhatsApp groups with 3000 recipients from different districts and emergency services;
- Twitter (18k followers); Facebook (5 k followers) and YouTube (> 1000 followers);
- pre-recorded weather forecast by phone (has a cost, and thus, limited use); and
- Toll free number to which there are approximately 10-20 calls/day and 200 calls/day in the rainy season, mainly from farmers.

4.3.3 Agro-advisory services

Content and delivery

Crop monitoring bulletins provide a growing season assessment of maize, beans, and rice using data from rainfall, remote sensing and field reports. They highlight crop conditions, pest challenges and weather anomalies, and recommend irrigation and post-harvest handling advice. The bulletins include production outlooks, market trends and climate forecasts to guide agricultural planning.

Twigire Muhinzi is Rwanda's decentralized, hierarchical and participatory agricultural extension system managed by local governments and guided by the Ministry of Agriculture and Animal Resources (MINAGRI) and Rwanda Agriculture and Animal Resources Development Board (RAB). It relies largely on volunteer farmers' promoters and farmer field schools to deliver advice and promote community-based learning. It aims to deliver knowledge, technologies and services to smallholder farmers – who constitute a majority of the agricultural sector – to improve their productivity, food security and climate resilience. As in most African countries, Rwanda is working to integrate digital technologies to enhance extension service delivery. Agro-advisory services are also delivered through web-based platforms such as the Digital AgroClimate Advisory (DACA) Internet and mobile app. Tools available for the delivery of AAS in Rwanda are summarized in Table 7.

Table 7. A description of AAS tools available in Rwanda

Category	Tool	Provider	Description
Web-based platforms	DACA	Alliance of Bioversity and CIAT	An app that translates weather and climate information, combined with crop characteristics, to provide localized crop management and value chain advisories.
Others	Farmers' promoters	MINAGRI; RAB	These are lead farmers who provide technical advice to groups of peers, on a voluntary basis.
	Farmer field schools	MINAGRI; RAB	They facilitate experiential learning and problem-solving among farmers.

4.3.4 Stakeholder identification

Figure 7 illustrates the key stakeholders involved in delivering CIS and AAS in Rwanda. It highlights the coordinated efforts of government institutions such as Meteo Rwanda, MINAGRI, and Twigire Muhinzi, which oversee climate forecasting and agricultural extension. Research institutions, including RAB and the University of Rwanda, contribute scientific expertise, while NGOs like One Acre Fund and Heifer International play a crucial role in implementation and farmer outreach. These entities ensure that climate and agricultural advisories are developed, disseminated, and tailored to Rwanda's farming communities, strengthening resilience and informed decision-making.

Figure 7. CIS and AAS delivery stakeholders in Rwanda

Government institutions	Research institutions	NGOs
• Meteo Rwanda • MINAGRI • MINALOC • Twigire Muhinzi (decentralised extension system) • Rwanda Green Fund (FONERWA)	• RAB • Universities such as University of Rwanda • International Center for Tropical Agriculture (CIAT)	• One Acre Fund • Heifer International • Action for Environment Protection and Promotion of Agricultural Sector (APEFA)

4.3.5 Policy and regulatory framework

a) *National Strategy for Transformation (NST-2)*: Climate resilience and sustainable development is the first of six priorities of the strategy focusing on climate services to support sustainable agricultural practices. It calls for strengthened meteorological services and multi-hazard early warning for disaster risk reduction.

b) *Fifth Strategic Plan for Agriculture Transformation (PSTA-5):* The plan supports climate-resilient agri-food systems for increased production by integrating climate-smart approaches and establishing climate-smart information systems and advisory services.

c) *Green Growth and Climate Resilience Strategy:* It promotes climate services as a tool for climate-resilient sustainable development.

4.3.6 Challenges and opportunities in CIS and AAS delivery

Challenges

Last-mile Delivery Constraints

- High farmer-to-extension professional ratio, limiting personalized support.
- Weak agricultural extension logistics and transportation infrastructure.
- Sociocultural barriers restricting women's access to extension services.
- Low ICT access in rural areas, impeding climate information dissemination.
- Absence of a systematic feedback mechanism to refine services.

Observational and technical limitations

- Restricted weather radar coverage (only one radar with limited data access).
- Absence of upper-air sounding and lidar systems for precise forecasting.
- Semi-automatic surface weather observation system with manual data transfer, delaying real-time exchange.
- Lack of an integrated data management system for efficient storage and processing.

Capacity and resource constraints

- Limited technical expertise in forecasting and user engagement.
- Shortage of modern automation and dissemination tools.
- Inadequate IT infrastructure and bandwidth for efficient data processing.
- Insufficient financial resources for equipment modernization.
- Dependence on project funding cycles, affecting long-term service continuity.

Opportunities for Improvement

- Strengthening extension services through workforce optimization.
- Enhancing logistics and transportation to improve service delivery.
- Addressing gender-related barriers to extension accessibility.
- Expanding rural ICT infrastructure for better connectivity and information flow.
- Establishing a structured user-feedback system to enhance Meteo Rwanda's responsiveness..

4.3.7 Reflections and recommendations

Rwanda benefits from strong public sector meteorological and agricultural institutions, farmer organizations and enabling policies, whereas private sector agricultural information, finance and market services are relatively nascent (Figure 7). Rwanda was an early adopter of improved, localized, online historical and forecast climate information for agriculture; it built farmer capacity through climate services educational radio programming, and intensive participatory training and planning. However, dependence on donor funding challenges scaling and sustainability.

Rwanda can improve its climate services by focusing on key areas and systematically building capacity and capability by:

- strengthening national coordination mechanisms for climate services and enabling NMHSs contributions to adaptation planning;
- building robust observation networks, data management and forecasting systems to ensure accurate climate information;
- implementing tools and systems to enhance interaction between users and providers, and ensuring services tailored for decision makers;
- developing decision-support products for informed decision making;
- setting up systems to assess the socioeconomic benefits of climate services driving continuous improvement; and
- offering training and advisory services to enhance the skills of professionals in climate service provision and utilization.

4.4 Mozambique

Highlights

Climate Information and Agro-advisory Service process

Figure 8 illustrates Mozambique's flow of agrometeorological and climate services. Data collection begins with ground observations from 130 AWS and 23 synoptic stations, supplemented by satellite data (EUMETSAT) and remote sensing from the Beira Radar. These inputs are consolidated by the National Institute of Meteorology (INAM) into agrometeorological data. Data monitoring involves INAM in collaboration with INGD, NIC, the Red Cross, and the UN Resident Coordinator's office, which support the Early Warning System for drought and flood monitoring. Forecasts are generated by INAM using models like GFS and ECMWF, producing seasonal, sub-seasonal (monthly), and short-range (daily, 4-day) predictions at region/province levels. The Ministry of Agriculture and Food Security translates these forecasts into agro-advisories that include crop advisories, pest warnings, irrigation recommendations, and even weather-based insurance schemes. The figure also flags key challenges affecting service efficiency: limited financial resources, insufficient technological infrastructure,

restricted access to digital devices, fragmented stakeholder coordination, and data inconsistencies.

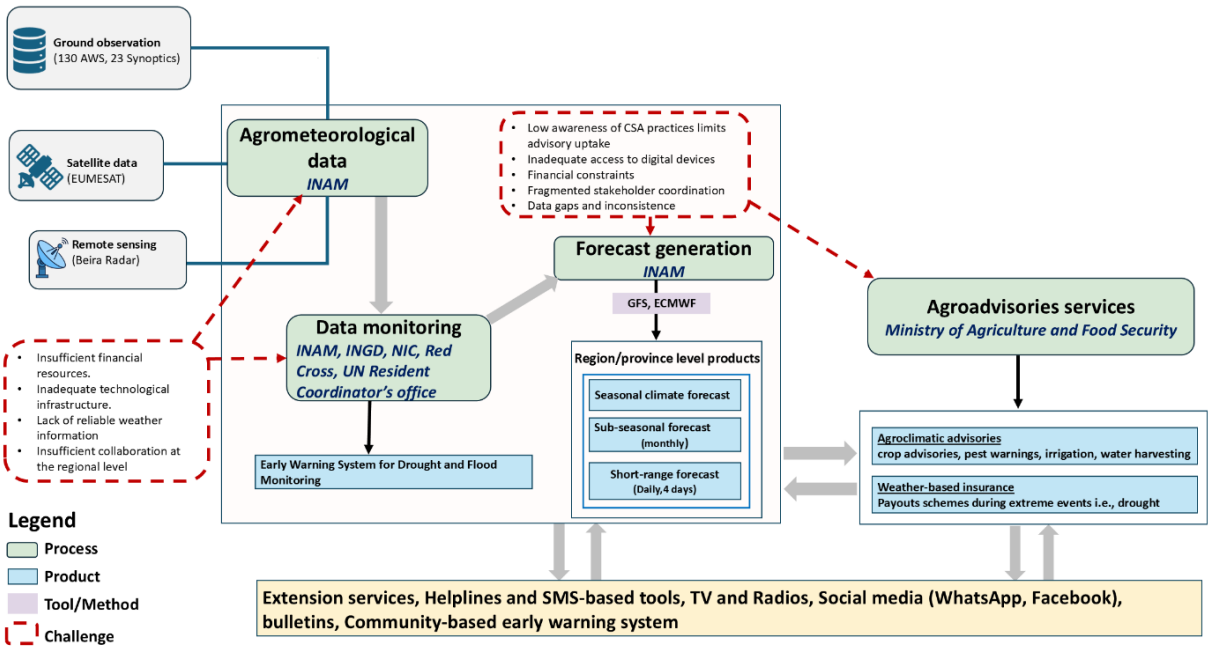


Figure 8. Flow of agrometeorological and climate services and potential gaps in Mozambique

Main gaps in CIS and AAS delivery in Mozambique

- Limited dissemination methods used by INAM, who directly disseminate weather data to users through radio and bi-annual bulletins.
- Poor integration of CIS into agro-advisory services.
- Agromet advisories in the country are project based.
- INAM receives little financial support from the government which limits its ability to upgrade infrastructure and to provide reliable weather information.

Opportunities for improvement

- Expanding CIS dissemination methods.
- Strengthening the capacities of extension workers and community leaders in interpretation and use of climate information.
- Technological advancements e.g remote sensing can modernize data collection, processing and dissemination processes and expand CIS to remote areas currently underserved.
- Fostering collaborations at the national and regional level to improve access to CIS and AAS.

4.4.1 Background

The National Institute of Meteorology (INAM) plays a central role in providing climate data through over 130 weather stations around the country, with advanced models that forecast both weather patterns and extreme events for farm-level decision making. The institute and partners provide critical information to farmers on seasonal weather forecasts, early warning of extreme events and climate-resilient farming practices to increase agricultural productivity and reduce climate risks. Mozambique faces substantial challenges due to climate variability, particularly from tropical cyclones, making the provision of timely and accurate CIS vital for safeguarding the agricultural sector and food security.

4.4.2 Climate Information Services

Data collection

Climate data is collected by INAM through a combination of satellite imagery, weather stations and ground-based observation. To improve weather and climate data availability, it launched the One District, One Weather Station strategy (2020-2024) to expand and modernize the country's meteorological network, which currently stands at 130 automatic weather stations and 23 synoptic stations. It also collaborates with regional meteorological organizations for data collection.

Data monitoring

The Early Warning System for Drought and Flood Monitoring is a key tool used for assessing seasonal rainfall patterns and forecasting extreme weather events. The system integrates satellite data to ground-based data to provide timely warning for agricultural and humanitarian purposes.

Forecast types

The National Institute of Meteorology issues daily, weekly and monthly weather forecasts, along with seasonal outlooks, which are crucial for guiding agricultural practices. Additionally, agrometeorological bulletins offer key weather information and agricultural advisories to farmers.

Forecasting models

International models such as ECMWF and GFS, along with national models, are used by INAM to generate forecasts of different timescales.

Communication platforms

Weather forecasts are disseminated in Portuguese and local languages through radio broadcasts, mobile apps, television, websites and social media. A partnership with mobile network operators enables the delivery of SMS-based weather alerts to farmers.

4.4.3 Agro-advisory services

Content and delivery

Extension workers together with digital platforms provide farmers with advice on climate-smart agricultural practices, including crop selection, irrigation, pest and disease management and the use of fertilizers. This support is particularly beneficial in areas prone to erratic rainfall and droughts. Tools available for the delivery of AAS in Mozambique are summarized in Table 8.

Table 8. Description of AAS tools available in Mozambique

Category	Tool	Provider	Description
Helplines and SMS-based tools	Agrisat SMS Services	Sociedade Algodoeira do Niassa João Ferreira dos Santos (SAN-JFS)	Offers farmers weather updates, pest alerts and crop management tips via SMS
	Farmer support hotlines and helplines	SAN-JFS	Offer direct support to farmers needing urgent advice on farming practices, pest outbreaks, or climate-related issues.
Web-based platforms	Agri-Weather App	Agri-Intelligence Mozambique	Provides farmers with localized weather forecasts and advisory services. These app advice on best farming practices, irrigation needs and pest control based on real-time weather data.
Risk management tools	Weather-based crop insurance	National Cooperative Business Association CLUSA, Feed the Future, Phoenix Seeds, Hollard Insurance	Uses weather data to trigger payouts to farmers during extreme weather events such as droughts. These services often come with advisory tools to help farmers manage their risks.
Radio and television programmes	Weather and agricultural programmes	Local media	Provide information on seasonal weather forecasts, pest and disease outbreaks, and advice on best farming practices targeting rural farmers.
Others	Research-based publications and bulletins	Research institutions (e.g. Eduardo Mondlane University)	Provide periodic bulletins and publications on agro-advisories, which include weather forecasts, pest outbreaks and seasonal agricultural advice targeting specific regions in Mozambique based on climate conditions and farming systems.
	Weather stations	INAM	Remote weather stations are part of the government's efforts to enhance early warning systems and help improve climate data accessibility for farmers.
	Farmer field schools	Ministry of Agriculture and Food Security (MASA)	Training sessions where extension officers and agricultural experts educate farmers on climate-smart agricultural practices.
	Climate-smart agricultural practices	MASA	Provides advisory services on crop diversification, early planting, pest management, and water-saving techniques.

4.4.4 Stakeholder identification

Figure 9 showcases the key stakeholders involved in delivering CIS and AAS in Mozambique. It categorizes the stakeholders into government agencies (such as INAM and MASA), research institutions (including Eduardo Mondlane University and INIA), non-governmental organizations (such as FAO and USAID), and private sector actors (like Vodafone Mozambique and ag-tech startups). These entities work collectively to ensure climate information and agro-advisory services reaches farmers, enabling informed decision-making and resilience against climate variability. By leveraging diverse expertise, this stakeholder framework strengthens agricultural productivity, supports climate adaptation strategies, and enhances information dissemination to farming communities across Mozambique.

Figure 9. CIS and AAS delivery stakeholders in Mozambique

Government institutions	Research institutions	NGOs	Private sector
• National Institute of Meteorology (INAM) • Ministry of Agriculture and Food Security (MASA) • National Disaster Management Institute (INGC)	• Eduardo Mondlane University • ozambique National Institute for Research in Agricultural Development (INIA)	• World Bank • FAO • WMO • USAID • Oxfam	• Vodafone Mozambique • Agri-Intelligence Mozambique • Various ag-tech startups

4.4.5 Policy and regulatory framework

a) *National Adaptation Plan*: Mozambique's NAP includes the enhancement of climate information systems to support agriculture, water resources and disaster management.

b) *Sendai Framework for Disaster Risk Reduction:* Mozambique aligns its national DRM policies with this global framework to enhance resilience to climate-related hazards.

c) *Paris Agreement:* Mozambique's climate policies align with the global climate action goals set out in the Paris Agreement.

d) *Mozambique National Climate Change Strategy:* It focuses on building climate resilience in agriculture and promoting the integration of climate-smart practices.

e) *Agricultural Development Strategies:* The Strategic Plan for Agricultural Development (*Plano Estratégico para o Desenvolvimento do Sector Agrário,* PEDSA) promotes sustainable agricultural practices and climate-smart technologies. Climate information is integrated into these strategies to improve agricultural productivity and resilience.

4.4.5 Challenges and opportunities in CIS and AAS delivery

Challenges

The integration of CIS into agro-advisory services is still at an early stage, with some areas lacking access to reliable weather information. Inadequate funding, low awareness levels and lack of technological infrastructure in remote areas hinder the effectiveness of AAS.

Opportunities for improvement

Mobile technology and remote sensing can be used to further develop climate services within Mozambique, along with big data analytics and supporting the improvement of extension services, while AI and machine learning can improve the accuracy of weather forecasts. Strengthening public-private partnerships, especially with mobile network operators and ag-tech companies, could reduce inequalities in accessing digital climate services. Capacity building by training extension workers and community leaders in the interpretation and use of climate information is paramount for better service delivery. In addition, collaboration at the regional level with agencies such as Southern African Regional Climate Outlook Forum (SARCOF) will go a long way in providing more accurate and commonly shared climate data to inform national systems.

4.4.7 Reflections and recommendations

Effective CIS and AAS are crucial to improve Mozambique's agricultural productivity and food security, particularly as the country faces increasing risks from climate change. Though the country is building a solid foundation for the production, dissemination, and use of climate information services and agro-advisory services, it still requires sustained investment in infrastructure, capacity building and partnerships to improve these services' effectiveness and reach, especially in rural and vulnerable areas (Figure 8). By addressing these challenges and seizing opportunities for improvement, Mozambique can build a more resilient agricultural sector and ensure better adaptation to the impacts of climate change.

To enhance the effectiveness and reach of climate services in rural and vulnerable areas, stakeholders in Mozambique should:

- consistently invest in infrastructure, capacity building and partnerships to improve the effectiveness and reach of climate services, particularly in rural and vulnerable areas;
- provide localized early warning systems for droughts, floods, and extreme weather events by using remote sensing, AI-based analytics and community-based response mechanisms;
- leverage mobile-based platforms, SMS alerts and agri-weather apps to deliver real-time, user-friendly climate advisories to farmers, particularly in remote areas with limited access to extension services;
- foster collaboration between the government, mobile network operators and ag-tech startups to improve climate information accessibility, finance climate-smart solutions and scale digital advisory platforms; and
- mainstream climate information services into Mozambique's agricultural and DRM strategies to embed climate resilience in policies, extension services and farmer training programmes.

4.5 Burkina Faso

Highlights

Climate Information and Agro-advisory Service process

Figure 10 illustrates the flow of agrometeorological and climate services in Burkina Faso. The process begins with extensive data collection from 19 Automatic Weather Stations (AWS), 10 synoptic stations, 120 rainfall stations, 10 climate stations, and 20 agromet installations, supplemented by satellite data from EUMESAT. These inputs are consolidated by ANAM and monitored alongside support from WMO, PET, and the NextGen Agricultural Drought Monitoring and Warning System (NADWMS). Forecasts are generated by ANAM and AGRHYMET using models such as GFS, WFR, and ECMWF, producing region-level products that span seasonal forecasts, monthly sub-seasonal updates, and short-range (daily up to 10-day) predictions. These forecasts form the basis for agro-advisory services delivered by MARAH and various NGOs, which include pest alerts, recommendations for best agronomic practices, market and finance support, and near-real-time drone-based crop monitoring. The figure also highlights challenges facing the system—including sparse station coverage, outdated equipment and databases, a shortage of skilled professionals, fragmented stakeholder coordination, and poor communication infrastructures—that must be addressed to improve service delivery.

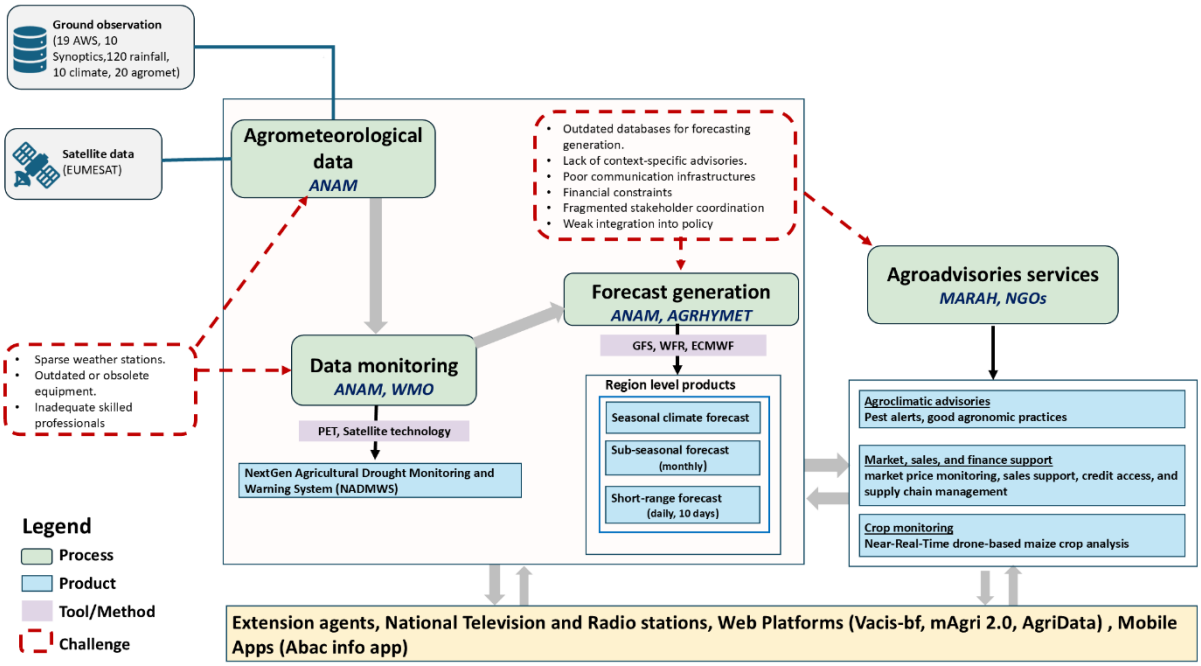


Figure 10. Flow of agrometeorological and climate services and potential gaps in Burkina Faso

Main gaps in CIS and AAS delivery in Burkina Faso

- Poor quality and unreliable meteorological and agricultural data owing to obsolete equipment and lack of skilled personnel.
- Blanket advisories that do not cater for the specific needs of end users, and which are often misinterpreted by farmers.
- Last mile delivery challenges especially in rural villages located in remote regions that lack access to communication infrastructure.
- Fragmented coordination among key stakeholders in CIS and AAS.

Opportunities for improvement

- Awareness-raising campaigns for better targeting of CIS and AAS and to improve usage by farmers and other end-users.
- Strengthening the capacities of INAM staff, extension workers and other actors to improve effective implementation of services.
- Improving infrastructure, coverage and use of innovative technologies such as remote sensing and AI.
- Enhanced public-private partnerships, financing and integration CIS and AAS into agricultural policies and planning

4.5.1 Background

Burkina Faso's socioeconomic development is largely based on its agrosilvipastoral (ASP) sector. The sector employs around 63.3 percent of the working population, provides around 61.5 percent of the monetary income of agricultural households and contributes 21.2 percent to the country's GDP. Livestock farming is a key subsector of Burkina Faso's economy, engaging over 80 percent of the population and accounting for more than a third of the country's agricultural GDP. The livestock subsector has significant growth potential, given that global demand for beef, milk and eggs is predicted to increase by 412 percent, 270 percent and 276 percent, respectively between 2010 and 2050 (FAO, 2018). The demand for animal-source foods (ASF) in Africa is growing rapidly, with the demand for meat and milk projected to increas by 145 percent and 155 percent

respectively, between 2005 and 2050 (World Bank et al. 2013). Egg consumption is projected to increase by 155% between 2000-2030 (Robinson et al. 2011). In addition, the subsector represents a major lever in the fight against poverty, food insecurity, unemployment and climate change. Therefore, CIS and AAS are vital to support decision making by farmers and other players in the agricultural sector.

4.5.2 Climate information services

Data collection

The country's meteorological department currently has an observation network of 10 operational synoptic stations (9 of which are functional), 20 agrometeorological stations (not all of which are functional), 10 climatological stations and around 120 rain gauge stations. This is highly inadequate in terms of geographical coverage and representativeness of climatic zones. It also has 19 automatic weather stations (16 supplied by ADCON and 3 by PULSONIC) currently being tested.

Data monitoring

Data monitoring is done through the following:

- pictorial evaluation tool (PET): Assists in crop and food security assessments; and
- NextGen Agricultural Drought Monitoring and Warning System (NADMWS): Uses satellite technology to monitor agricultural droughts and provide early warnings.

Forecasting models

The National Meteorological Agency of Burkina Faso (ANAM, Agence Nationale de la Météorologie du Burkina Faso) uses ECMWF, GFS, and two numerical weather prediction models (Fifth-Generation Penn State/NCAR Mesoscale Model [MM5]) and WRF for weather forecasting.

Forecast types

Daily, dekadal, monthly and seasonal forecasts are provided. ANAM produces agromet bulletins, providing weather and agricultural data, rainfall anomalies, and vegetation conditions.

Communication platforms

Climate and meteorological information is disseminated through a diverse range of platforms including the Internet, television, radio, and print media. These products and services are promoted at workshops, training seminars, farmers' days, scientific fairs, exhibitions, tourism events, and World Meteorological Days. Additionally, dekadal agrometeorological bulletins and seasonal precipitation forecasts are distributed nationwide via an Internet mailing list, while national and local broadcast media further extend outreach.

4.5.3 Agro-advisory services

Content and delivery

Extension workers and digital tools advise farmers on crop selection, irrigation and pest management. There is evidence of increased yields and reduced losses where AAS has been implemented well. The tools available for the delivery of AAS in Burkina Faso are summarized in Table 9.

Table 9. A description of AAS tools available in Burkina Faso

	Tool	Provider	Description
Mobile app-based tools	Abac infos	L'Association Burkinabè d'Action Communautaire (ABAC)	Android application for training in cereal production and preservation
Web-based platforms	Vacis-bf	Burkina Ministère des Technologies de l'Information et de la Communication (NTIC)	Information platform for agricultural data, including information on agricultural value chains
	mAgri 2.0	Ministry of Agriculture, Animal and Fishery Resources (MARAH), NGOs	Provides users with a price observatory service, standards, best practice guides, sales support, resource management functions, supply chain management, access to credit, as well as communication facilities such as a messaging service, forum and alarms
	AgriData	EcoData	A platform integrating a market information system, a weather information system and a call center called Cocorico
Early warning systems	Livelihood impact analysis sheet	MARAH	Assesses vulnerability in rural populations, considering livelihoods, market access, and prices
Others	Garbal	SNV Netherlands Development Organisation	Uses satellites to find water and greenery, and provide agrometeorological information to growers
	Agri-drône	MARAH; FasoDrone, Kono Digital, West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)	A tool used to capture field humidity levels
	AgriTIC	MARAH, FasoDrone, Kono Digital, WASCAL	Uses drones to collect and analyse information on corn crops

4.5.4 Stakeholder identification

Figure 11 presents the network of stakeholders engaged in delivering CIS and AAS in Burkina Faso. It showcases government agencies such as ANAM and the Ministry of Agriculture, which oversee climate forecasts and policy implementation, alongside research institutions like INERA and the University of Ouagadougou, which provide scientific expertise. The figure also includes private sector actors such as *Yam Pukri* and *Green Agro Solutions*, which contribute digital innovations, market-based solutions, and climate-smart agricultural technologies to enhance advisory services.

Government institutions	Research institutions	NGOs	Private sector
• ANAM • Burkina Faso dedicated grant mechanism (DGM) • Ministry of Agriculture	• National Center for Scientific Research and Technology (CNRST) • Regional research • Universities • Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA)-ILRI	• Agency for the Safety of Air Navigation in Africa and Madagascar (ASECNA) • AGRHYMET • Famine Early Warning Systems Network (FEWS NET) • WMO • United Nations - FAO, WFP, and UNDP • Care-International • Agencia Estatal de Meteorología (AEMET) • UK-Met • Météo France • International Republican Institute (IRI) • NMHS Sweden • NOAA	• Yam Pukri • Green Agro Solutions

Figure 11. CIS and AAS delivery stakeholders in Burkina Faso

4.5.5 Policy and regulatory framework

Following are the key enabling circumstances for enhanced climate information services to inform policy as well as investments:

- *National Framework for Climate Services (NFCS)*: It aims to consolidate and promote the production, supply, access and effective application of relevant and easily understandable weather and climate information and services for optimum use by various users and decisionmakers. The initial priority sectors include agriculture and food security, water resources, health, energy and the management of natural risks and disasters.
- *Paris Agreement*: National policies and strategies are aligned with this global climate agreement.
- *National Disaster Risk Management Policy*: It advocates for the integration of climate considerations in DRM.
- *Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System*: It aims to enhance disaster preparedness and improve access to multi-hazard early warning systems by 2030.
- *National Information and Communication Technology (ICT) Policy and Strategy*: It promotes the use of ICT for climate change communication.
- *Agricultural extension strategy*: It focuses on building resilience in agriculture by promoting climate-smart agriculture and improving access to climate information.

4.5.6 Challenges and opportunities in CIS and AAS delivery

Challenges

Data quality and availability

- Meteorological and agricultural data are not always available on time or are of poor quality, affecting forecast accuracy.
- Updating databases and forecasting models remains a major challenge, notably due to obsolete equipment and the lack of qualified personnel.

Lack of context-specific advisories

- Services are often generic and do not always consider the local specificities of different agricultural regions and systems (crop variety, soil type, livestock types and systems).
- Early warnings are sometimes not adequately anticipated or misunderstood by farmers, which limits their capacity to take anticipatory action against an impending shock or event.

Last-mile delivery challenges

- Many rural areas, particularly in remote regions, have no weather stations or access to mobile technology to receive real-time information.
- Communication infrastructures (telephone networks and the Internet) are sometimes insufficient for effective dissemination of information.

Weak integration with agricultural policies

- Agrometeorological information is not always considered in planning agricultural and natural resource management policies.
- Lack of effective coordination between various players (government, NGOs, private sector, development partners) reduces the efficiency of services (Figure 11).

Opportunities for improvement

Awareness-raising and capacity building

- Innovations in awareness-raising campaigns can lead to better targeting and dissemination of the benefits of CIS and AAS and their use by farmers to boost their participation.
- Skill enhancement of local technicians and researchers in modelling, interpretation and messaging can contribute to the effective implementation of services.

Improving infrastructure, coverage and use of innovative technologies

- Expanding communication infrastructure (mobile networks, Internet, use of radio) could enable a wider reach to farmers, especially in rural areas.
- Strengthening the network of weather stations, using remote sensing (satellites) and new approaches such as citizen science can provide more context- and system-specific accurate, real-time and localized data.
- The use of artificial intelligence and machine learning for data analysis will enable more accurate forecasts tailored to both crop and livestock farmers' needs.

Public-private partnerships, financing and integration into agricultural planning

- Partnerships with private companies, international organizations and research organizations can improve access to cutting-edge technologies and climate data. This will require additional resources (both human and capital) to improve forecasting systems and train agricultural stakeholders.
- Better integration of CIS and AAS into public policies on agriculture, natural resource management, and climate change could improve sector resilience.
- Developing an integrated early warning system at the national and local levels in collaboration with communities could improve the response to climate crises.

4.5.7 Reflections and recommendations

Burkina Faso's climate information and agro-advisory services system brings together an extensive range of data sources—from numerous ground-based stations and rainfall gauges to satellite inputs—to support weather forecasting and early warning systems. However, the system faces significant challenges due to outdated equipment, limited skilled personnel, fragmented coordination among key stakeholders, and inadequate communication infrastructures. These obstacles result in generic advisories that are often misinterpreted and poorly reaching remote communities, thereby limiting the system's overall effectiveness in supporting local agricultural decision-making.

Based on these reflections, the following recommendations aim to address the identified challenges:

- expand and modernize the meteorological network by investing in advanced equipment, remote sensing technologies, and AI-driven data analysis to deliver precise, localized, and timely forecasts;
- strengthen collaboration among government agencies, research institutions, NGOs, and private sector partners to enhance data sharing, improve capacity building, and establish coordinated response mechanisms;
- develop context-specific agro-advisories that integrate localized data, direct farmer feedback, and indigenous knowledge to ensure advisories meet the unique needs of different agricultural regions;
- invest in comprehensive training and capacity-building initiatives for local technicians, extension workers, and decision-makers to improve forecast accuracy, data interpretation, and overall service delivery; and
- improve communication infrastructures and diversify outreach channels by expanding both digital and traditional media networks to guarantee that actionable climate information reaches even the most remote rural communities.

4.6 Nigeria

Highlights

Climate Information and Agro-advisory Service process

Figure 12 outlines Nigeria's agrometeorological and climate service process from data collection to advisory dissemination. Data are gathered from ground observations across 88 Automatic Weather Stations (AWS), 43 synoptic stations, and 51 agromet stations, supplemented by satellite sources such as CHIRPS, TAMSAT, and Imerge, along with field observations from the Farmers Observation and Research Institute. These inputs are coordinated by NiMET, despite challenges including limited technical/human capacity and insufficient station coverage. Data monitoring is conducted by NiMET and AGRHYMET, providing the essential basis for an early warning system that addresses drought and flood risks. Forecast generation employs models such as GFS, ECMWF, and COSMO, with contributions from NiMET, AGRHYMET, CRU, and WMO to produce region-level products—encompassing seasonal, sub-seasonal, and short-range forecasts. The process culminates in the creation of agro-advisories that offer practical agricultural guidance, including pest alerts, recommended agronomic practices, soil fertility management, and fish production advisories. These advisories are disseminated through multiple channels—annual reports, bulletins, radio and television programs, extension agents, mobile apps (such as Nimet Weather App) and digital platform (NiMet and NAERLS website)—to ensure that essential climate information reaches all farming stakeholders.

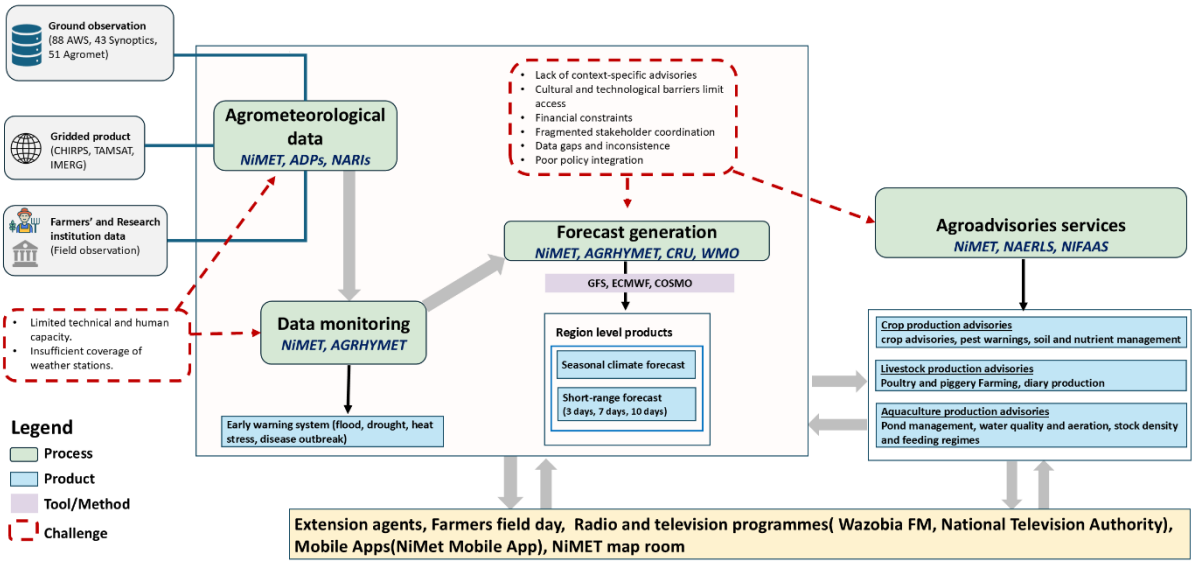


Figure 12. Flow of agrometeorological and climate services and potential gaps in Nigeria

Main gaps in CIS and AAS delivery in Nigeria

- Lack of context-specific CIS and AAS contributed to by limited weather stations and inadequate end-user feedback.
- Inadequate agro-advisory coverage of the livestock sector.
- Poor institutional coordination occasioned by differing organizational structures and limited resources.
- Last mile delivery challenges attributed to mistrust by end-users, ineffective dissemination methods, and neglect of indigenous knowledge among other systemic failures.

Opportunities for improvement

- Increase the number of weather stations and improve associated data collection and processing infrastructure.
- Provide tailored crop and livestock weather-based advisories.
- Strengthen institutional collaboration and incentivize private sector participation.
- Enhance effective CIS and AAS dissemination through diversified communication channels and platforms, and using local languages.

4.6.1 Background

Between January and March 2021, agriculture contributed 22.4 percent to Nigeria's GDP (FAO, 2024), and over 70 percent of Nigerians were engaged in the agricultural sector, mainly at the subsistence level. Yet, the sector faces numerous challenges that affect productivity. The sector grew by only 1.3 percent in the third quarter of 2022. This stunted growth was due to poor infrastructure, climate change, pests and diseases, poor farming practices and inadequate access to credit and finance. Climate change affects farmers' ability to grow food and raise livestock. Increasingly volatile weather and more extreme events – like floods and droughts – are altering growing seasons, limiting water availability, allowing weeds, pests and fungi to thrive and reducing crop productivity. Critical technologies and innovations such as CIS and AAS can boost farm productivity and ensure reliable and stable crop and livestock productivity across the country's agroecological zones.

4.6.2 Climate information services

Data collection

A whole range of weather data is collected by automatic weather stations coordinated by Nigeria Metrological Agency (NiMET) and independent stations owned and operated by state agricultural development projects (ADPs), national agricultural research institutes (NARIs), the River Basin Development Authority (RBDA), and other institutions. Simple rain gauges and minimum-maximum thermometers can be found in many academic institutions, local government councils, farms and other private bodies (FEWS NET, BabaGona, Premier Seeds, MAAP Seeds, Techni Seeds, etc.). Some of these data sources contribute to the one coordinated by NiMet. Additional forecasts are obtained from regional and international organizations. Farmers are generally consulted during data gathering and sometimes input into its analysis.

Forecast types

Nigeria Meteorological Agency generates seasonal and short-range forecasts, and public daily forecasts for the country and states, covering land, aviation and marine spheres. Nigeria Hydrological Service Agency (NHISA) produces agrometeorological bulletins annually. National Space Research and Development Agency (NASRDA) is mainly involved in geospatial climate information and forecasts, while AGRHYMET focuses on flood and drought monitoring along with Climate Research Unit (CRU), and WMO provides forecasts on health and extreme events.

Data monitoring

The NiMET map room is a feature that allows current climate conditions to be monitored through maps and figures. It also allows users to download the data in various forms, e.g. GIS-compatible formats.

Forecasting models

International models such as COSMO, ECMWF and GFS are used by NiMET to generate forecasts.

Communication platforms

Nigeria Meteorological Agency organizes annual meetings to present year-long forecasts, attended by major stakeholders and usually covered by most electronic and print media. It also produces monthly forecast bulletins. Local media and community radio broadcast the daily weather forecast.

4.6.3 Agro-advisory services

Content and delivery

Extracts from NiMET reports and forecast bulletins are duplicated and disseminated to farmers by extension agencies such as NAERLS and ADPs. This is also done through pamphlets, social media, farmer-to-farmer discussions, mobile applications and town criers, among others. Tools available for the delivery of AAS in Nigeria are summarized in Table 10.

Table 10. A description of AAS tools available in Nigeria

Category	Tool	Provider	Description
Radio and television programmes	Raneta Project in Kebbi State	Green Habitat Initiative (GHI)	Radio, SMS and Internet agromet advisory
Mobile app-based tools	NiMET weather app	NiMET	Weather and climate advisory
Others	Weather stations	NiMET, ADPs, NARIs, RBDAs	Remote weather stations are part of the government's efforts to enhance early warning systems and help improve climate data accessibility for farmers.
	NiMET map room	NiMet	Weather and Climate information services

4.6.4 Stakeholder identification

Figure 13 succinctly identifies the main stakeholders responsible for delivering Climate Information Services (CIS) and Agricultural Advisory Services (AAS) in Nigeria. It categorizes them into government institutions (for example, NiMET, NASRDA, and other regulatory agencies), research bodies (such as NAERLS and affiliated agricultural research centers), and non-governmental organizations (including international partners like FAO and UNDP). Together, these stakeholder groups form a collaborative network that ensures production and dissemination of climate information and agro-advisory services for Nigeria's agricultural community.

Government institutions	Research institutions	NGOs
• NiMET • NASRDA • National Centre for Remote Sensing (NCRS) • NHISA • Nigeria Integrated Water Resources Management Commission (NIW) • National Emergency Management Agency (NEMA) • National Bureau of Statistics (NBS) • FMAFS • Federal Ministry of Environment (FMENV)	• NAERLS • Community Development Associations (CDA) • IITA • Institute of Agricultural Research(IAR) • National Animal Production Institute(NAPRI) • Lake Chad Basin Development Authority(LCBDA)	• Precision Development • FAO • WFP • UNDP • United Nations Office for the Coordination of Humanitarian Affairs (OMOCHA)

Figure 13. CIS and AAS delivery stakeholders in Nigeria

4.6.5 Policy and regulatory framework

- *National Climate Change Policy (NCCP):* This is the overarching framework for addressing climate change in Nigeria, including the development and implementation of climate information services.
- *Climate Change Act:* Signed into law in 2021, it provides a legal framework for achieving climate goals and promoting long-term sustainability.
- *National Climate Change Adaptation Strategy:* This strategy focuses on building resilience to the impacts of climate change, requiring effective climate information services for informed decision making.
- *Nationally Determined Contributions*: These outline Nigeria's commitment to reducing greenhouse gas emissions, which are also linked to the need for robust climate information services.
- *National Environmental Policy*: This policy provides a broader context for environmental management, including climate change, and supports the development of climate information services.

4.6.6 Challenges and opportunities in CIS and AAS delivery

Challenges

Information

- The lack of location-specific forecasts, limited number of weather stations and insufficient reliable weather data dissemination channels pose challenges.
- There is a lack of information on crop-livestock, disease and pest outbreaks, feed, water resources and rangeland.
- There is inadequate feedback from farmers on the uses and outcomes of weather information and inadequate emphasis on the dissemination of climate information and agro-advisories in local languages.
- The integration of weather and farm management practices, including an early warning and response platform, is needed.

Data gathering, analysis and interpretation

- There are gaps in weather, rainfall, crop health and diseases, and livestock data because of limited capacity and skill sets and a lack of subject matter specialization.
- Inadequate capacity to generate customized information and products for different socioeconomic groups from the complex climate data collected limits the availability of CIS information for small and medium scale livestock farmers.

Institutional coordination

- There are issues in institutional coordination due to differences in organizational structures and budgets.
- Cultural barriers restrict CIS accessibility and feedback, worsened by resource limitations.
- Advisory services have inadequate gender and social diversity considerations.
- Poor policy communication affect implementation.
- There is confusion and distrust caused by multiple sources providing similar information.
- Indigenous knowledge is neglected and there is a lack of capacity to integrate it into technical advisories.
- Livestock and pastoralism extension services are often overlooked due to a shortage of trained personnel in livestock management. Key areas needing attention include heat stress management, event calendars, animal health advisories, and integrating climate data into feed formulation.

Last-mile delivery

- Language barriers and digital infrastructure gaps limit access, especially in remote areas, affecting the timeliness and relevance of information.
- There is user skepticism and lack of awareness due to weak extension systems, poor funding, and lack of collaboration between service providers.
- Security challenges and weak local institutional structures hinder service delivery at the community level.
- There is a disconnect with local needs leading to inconsistent policy formulation and implementation.
- Limited access to finance prevents farmers and livestock keepers from adopting climate advisory services.
- Delayed information delivery reduces its usefulness in decision making.
- Extension services are severely understaffed (e.g. 1 worker per 10 000 farmers), with low incentives limiting mobility and outreach to remote areas.

Opportunities for improvement

- Strengthen institutional collaboration (e.g. between NiMET and stakeholders) with coordinated efforts and supportive policy frameworks.
- Enhance data collection and dissemination by increasing weather stations, using innovative methods and covering remote areas.
- Expand training and capacity for livestock management and other agricultural enterprises.
- Ensure local language dissemination of CIS and AAS, and create intermediaries between farmers and service providers, including private extension services.
- Incentivize private sector involvement (e.g. banks) to improve access to financial and non-financial services.
- Use communication channels like radio, television and social media to reach remote communities.

4.6.7 Reflections and recommendations

While there has been limited uptake of weather-informed agricultural advisory services in Nigeria, the existing framework reveals significant gaps and opportunities (see Figure 13). The integration of comprehensive climate data—from ground observations and satellite sources—with locally tailored agro-advisories shows promise. However, persistent challenges in data collection, institutional coordination, local language dissemination, and interplay with indigenous knowledge underscore the need for a renewed strategy to enhance resilience across the agricultural sector.

The key recommendations include:

- increase the number of weather stations and integrate advanced remote sensing tools to generate precise and localized forecasts that boost early-warning systems;
- strengthen collaboration among government agencies, research institutions, and private sector partners to streamline data sharing and optimize resource use;
- enhance advisory services by crafting tailored messages that incorporate local languages and indigenous knowledge, ensuring relevance for diverse farming communities;
- invest in capacity-building programs for extension agents and technical staff, enabling them to better interpret, analyze, and disseminate climate information to end-users; and
- Expand the range of communication channels by combining traditional methods such as radio and community meetings with digital platforms like mobile apps and social media to improve last-mile delivery of essential climate services.

By implementing these recommendations, Nigeria can transform its current status of the climate information and agro-advisories generation and dissemination to increase uptake of more inclusive, responsive, and proactive climate information. This, in turn, will bolster agricultural resilience, enhance productivity, and contribute significantly to national food security and economic growth.

National-scale digital platforms for agrometeorological data in Focus Countries are essential tools for enhancing agricultural resilience and productivity by delivering timely weather forecasts, climate data, advisories, and remote sensing information. Developed mainly by national meteorological services and agriculture ministries—often with public-private support—these platforms use formats like web portals, mobile apps, SMS, and IVR to reach farmers, extension agents, and agribusinesses. While some are well-integrated into national policies and supported by research institutions, others face challenges such as poor infrastructure, limited data quality, and low interoperability. Nonetheless, efforts are underway to improve sustainability through open data standards, advanced analytics, and AI-driven decision tools. Strengthening institutional ownership, user capacity, and regional collaboration will be key to scaling these platforms and maximizing their long-term impact. A summary of the state of climate information and agro-advisories in the countries is described with focus on the key challenges which are areas of intervention and potential opportunities:

State of Climate Information Systems and Agro-advisories in the target countries		
Kenya		Well established tools and infrastructure, with active involvement of the public sector, research institutions, NGOs and private sector in data collection, monitoring and dissemination. Examples of providers are KMD, Ministries of Agriculture and Environment, KARLO, ILRI, FAO, Safaricom, Airtel, Kenya Women Microfinance Bank among others. Areas covered are location specific weather forecasts, agronomic advice in local languages, educational content and peer learning tools among others. However, there is a lack of software that can merge data from synoptic weather stations and automatic weather stations for more accurate bias correction. Issues persist around limited access to services in remote areas, low digital literacy and fragmented service delivery, thus hindering in the institutionalizing of CIS and agro-advisory services.
Ethiopia		Variety of tools around early warning, agro-climatic advisories, crop yield estimations, tracking shocks such as droughts, cyclones, pests and diseases through government, development and private sector initiatives. Examples of providers include Ministry of Agriculture, Rural Development, IFAD, Green Agro Solutions, ATA among others. However, livestock sector neglected in CIS but stands to benefit from it. Limited technical and human capacity is a challenge for data collection and dissemination for remote areas, though expansion in network coverage could resolve this issue. Issues such as inadequate funding, low adoption, lack of co-ordination and poor integration of CIS into advisories remain as challenges to institutionalizing CIS and agro-advisory services

Rwanda		Government as the main agency for collection and dissemination of CIS and agro-advisories. Radio is the main channel for dissemination of information, though SMS, WhatsApp, Twitter, pre-recorded weather forecasts through phones along with toll free numbers. Other institutions include research organizations such as University of Rwanda and development agencies such as One Acre Fund and Heifer International with not much active involvement of the private sector. Besides challenges around ICT access, high farmer- extension professional ratios, there are issues around skills in technical aspects of forecasting and engagement on climate services, lack of modern software and tools for automation and dissemination of weather forecasting and early warning information and dependence on project funding cycles; creates barriers to sustainability and institutionalizing of CIS and agro-advisories
Nigeria		Several institutions are responsible for providing CIS and agro-advisory services with NiMET being the primary body responsible for climate and weather forecasting. In partnership with NGOs, international donors and extension systems it provides seasonal climate predictions, downscaled weather forecasts, agro-climatic bulletins and early warning systems. Other key institutions include the National Agriculture Extension and Research Liaison Services (NAERLS), Nigeria Hydrological Services Agency (NIHSA), along with research institutions such as, NCRI, who generate crop-specific advisories, often integrating weather and climate data into recommendations. NGOs such as IFAD, FAO, GIZ, CGIAR centers provide funding, technical support, and capacity strengthening for CIS delivery, while also supporting pilot and scaling of advisory tools. Some of the private sector players include Hello Tractor, Crop2Cash, FarmCrowdy, and Tulaa for delivering agro-advisories through digital platforms. However, the livestock sector and specific advisories around feed, pasture and herd management are missing and not included in the advisories. Challenges remain related to the weak extension system such as poor linkages with NiMet, and lack of use of local language in delivering the technical content leading to low uptake and trust issues. Moreover, the absence of a unified national strategy has led to fragmentation across agencies resulting in duplicated efforts and inefficiencies. However, growing the potential of public private partnerships, along with growing awareness among farmers and policymakers about climate change impacts is creating demand for timely and localized CIS.

Burkina Faso		Agro-advisory tools include web-based platforms providing information on agricultural value chains, mainly managed by the Ministry of Agriculture, Animal and Fishery Resources and agencies such as AGRHYMET, FEWSNET, WMO along with research institutions such as National Center for Scientific and Technology and programmes like AICCRA among others; though there is often a lack of effective co-ordination between these actors. Challenges exist around data quality and availability because of sparce meteorological agriculture data mainly due to obsolete equipment which also results in poor data quality. Many of the rural areas, particularly in remote regions, have no weather stations or access to mobile technology to receive real-time information. Need for taking advantage of new technologies, strengthening public-private partnerships including with research organization to strengthen and improve existing infrastructure and institutional capacities. .
Mozambique		Main actors in the delivery of CIS and agro-advisories are INAM, Ministry of Agriculture and Food Security, National Disaster Management Institute, research organizations such as Mozambique National Institute for Research in Agriculture Development, development agencies such as FAO, WMO, Oxfam with private sector entities such as Vodafone, Agro-intelligence and agri-tech startups. However, the integration of CIS into agro-advisory services is still at an early stage, with some areas lacking access to reliable weather information. Though, the country is building a solid foundation for the production, dissemination, and use of climate information services and agro-advisory services, there continues to be a need for sustained investment in infrastructure, capacity building, and partnerships to improve the services effectiveness and reach, especially in rural and vulnerable areas. A more in-depth understanding is required into the institutional arrangements, available sources of CIS and agroadvisories, including institutional differences in how information flows in different regions of the country

= CIS and CSA ready to be institutionalized, downscaled for last mile delivery

= Need effort in strengthening capacities of different actors, adoption of digital technologies and efforts in partnerships beyond existing ones

= Either comprehensive information is not available, along with need for basic infrastructure development around digital capabilities, capacities and institutional buy-in

5. Gaps and action areas

Climate information services and agro-advisory services are essential for strengthening agricultural resilience across Africa. However, several key challenges are hindering them from reaching full effectiveness:

1. Gaps in institutional capacities

One of the primary challenges faced in the delivery of climate information services and agro-advisory services is the lack of strong institutional capacities, especially among the many NMHSs, which are responsible for providing these services. This is due to a combination of factors, including a shortage of skilled personnel and inadequate tools and IT infrastructure. The nonavailability of trained experts in climate modelling and advisory services limits these institutions in generating accurate, timely and reliable climate forecasts and agro-advisories. Additionally, most NMHSs in the continent lack high-performance computing (HPC) infrastructure, which is essential for downscaling global models into localized, actionable climate advisories. The lack of experts proficient in UNIX operating systems or HPC environments further limits the capacity to process complex climate data at the required scale and speed. In agriculture, the challenge is compounded by a shortage of agronomists and process-based modellers, which restricts the effective translation of climate forecasts into farm-level recommendations, thereby limiting the practical application of climate information to improve agricultural productivity and resilience.

2. Gaps in infrastructure and data

Accurate CIS and AAS depend on the availability of reliable weather stations, forecasting models and data-sharing platforms. However, in many parts of Africa, weather stations, sensors and other technological tools required to collect real-time climate data are either insufficient or poorly maintained. Additionally, gaps in data availability, especially in rural and remote areas, make it difficult to provide accurate, timely and localized climate information. Data-sharing platforms are too few in number, which hinders collaboration among meteorologists, agronomists and policymakers. Where such platforms do exist, restrictive data-sharing policies and the absence of arrangements for inter-institutional collaboration hinder the flow of information between meteorologists, agronomists, policymakers and other stakeholders.

3. Financial constraints

Persistent financial limitations too curtail scaling up of climate information and agro-advisory services. Sustainability remains a challenge as such programmes are heavily dependent on external donor funding. Despite recognizing the importance of climate services for agriculture in the context of increasing climate variability exercising adverse impacts on food security, few African governments allocate sufficient resources in their annual budgets to support sustained CIS/AAS operations. The lack of consistent government investment in key areas such as research, technology, infrastructure and personnel training exacerbates these challenges. Inadequate investment in research and technology limits the capacity to develop and improve climate models, forecasting tools and agro-advisory platforms. Additionally, without adequate infrastructure and skilled personnel, these services cannot be effectively deployed or scaled to meet the growing demand for reliable climate information and tailored agricultural advice.

4. Fragmented stakeholder coordination

The effective delivery of CIS and AAS requires collaboration among a diverse range of stakeholders, including governments, NGOs, the private sector and local communities. However, many of these organizations operate

in silos, leading to duplication of effort and inefficient resource use. The lack of coordination hampers the integration of various services, limits information sharing and reduces the overall impact of climate and agricultural advisory initiatives. So, the different services provided by meteorological, agricultural and extension services are disconnected, hindering farmers' access to comprehensive and actionable advice that addresses their specific needs. Though there is minimal involvement of the private sector in CIS and AAS, limiting opportunities for innovation and alternative funding sources, where it is active, it is limited to better organized and profitable value chains that often exclude smallholder farmers and marginalized communities. Additionally, institutional mechanisms to ensure that CIS/AAS reach farmers remain weak or underdeveloped, reducing their impact. While some programmes do deliver these services, their capacity to effectively disseminate information and provide ongoing support to farmers is limited.

5. Limited reach and adoption of climate services

Despite advances in climate forecasting and the availability of climate information, many smallholder farmers struggle to access and use CIS and AAS effectively, mainly due to language barriers, inadequate communication, poor dissemination strategies, limited awareness and a lack of trust in the services. Often, climate advisories are not customized to specific needs of local farming communities, and don't reflect local agricultural conditions. For instance, advisories may not be informed by ground-level data on soil moisture, crop growth stages, or other context-specific factors that are critical for making actionable decisions on the farm and are too general for practical application, reducing their effectiveness for farmers.

6. Social and gender disparities and institutional gaps in last mile service delivery

The lack of structured last-mile delivery systems hampers the reach of climate information and agro-advisory services to smallholder farmers, limiting their ability to make informed agricultural decisions and adapt to climate change. Though public institutions are supposed to be in the forefront in providing these services, they often fail to ensure timely and accessible delivery at the community level.

Access to Climate Information Services (CIS) and agro advisories in Africa is heavily shaped by gender and social factors such as wealth, education, age, and location. Wealthier and urban farmers often benefit from better technology and services, while poorer, rural, and indigenous communities face limited access due to poor infrastructure, weak extension networks, and exclusion from program design. Women often lack access to mobile phones, internet, training, and decision-making spaces, with services frequently designed for a male "average farmer," ignoring women's distinct roles and needs.

Youth constitute a significant part of the last mile making up about 60% of the population in Sub-Saharan Africa, of which 60-70% of the youth in rural areas engaged in agriculture or agriculture-related activities. Specifically, when it comes to CIS and agro advisories, the youth are faced with structural, social, and technological barriers such as no access to smartphones and/or limited internet coverage, which is contrary to popular assumptions that all youth possess mobile phones and are technology savvy. Part of the challenge also lies in the fact that there are high proportions of illiteracy among the youth, which in turn leads them not to be aware that CIS and agro-advisories exist, and even if they do, there is a lack of training and capacity to interpret and apply the information effectively in farming practices. Moreover, if one were to focus on young women, there are cultural barriers potentially on technology use and limited decision-making capacity in agricultural practices

In order to make CIS and agro-advisories more gender inclusive, certain tools have been developed such as the Gender – Transformative Adaptation Framework by CARE International. This is an approach that links CIS with livelihood development to explicitly address underlying gender inequalities, with a focus on gender power dynamics, integration of climate services into livelihood decision making processes, gender- responsive climate

information tailored to different needs, capacity and leadership development along with addressing structural barriers such as norms, mobility and land ownership.

There are strategies that can be adopted to make CIS and agro-advisories more inclusive such as i) customized information delivery through voice based systems such as Interactive Voice Response (IVR) in local languages and voice notes instead of text messages ii) initiatives that combine the distribution of mobile phones, digital literacy training, and low-cost data access for women farmers iii) gender – sensitive content design e.g. agro-advisories that are related to tasks that women are typically responsible for associated with crops, livestock and so on and iv) tools for tracking not just who receives the information, but who actually uses it and how practices change differently for men and women.



Cooperative farmers in Burkina Faso water their vegetable field. Photo: World Bank/Dominic Chavez.

Appendix: Regional initiatives by RCCs

Table A1. A summary of the ACPC's initiatives, partnerships and key achievements

Initiative/programme	Summary	Key achievements	Partners
ClimDev-Africa	Focuses on integrating climate change into African development policies.	a) Upgrading meteorology and hydrology equipment in Ethiopia, Rwanda and The Gambia b) Enhancing early warning and seasonal forecasting in Small Island Developing States (SIDS) in Africa c) Supporting African countries in developing NAPs and NDCs towards achieving the goals of the Paris Agreement d) Supporting the Young African Lawyers programme to build capacity for climate negotiations.	AUC, AfDB
ClimDev-Africa Special Fund	CDSF funds government institutions, NGOs, civil society groups and community-based organizations focused on building climate-resilient and inclusive economies.	a) Increased availability and accessibility of climate data through new and upgraded meteorological stations, both ground-based and satellite b) Enhanced climate information access for governments, institutions and stakeholders via contributions to regional and national climate data platforms c) Improved integration of climate data into development planning by strengthening NMHSs and other key players' capacity to use climate information effectively	AfDB
WISER	Addresses the impacts of climate variability and change on sectors like agriculture, health, energy and infrastructure in Africa.	a) A compendium of good practices and a community of practice for sharing CIS b) A study on enhancing the engagement of women and the private sector in CIS c) Mapping of climate initiatives and experts across Africa d) Baseline assessment of needs and gaps at RCCs e) Demonstrated the socioeconomic benefits of CIS in agriculture and disaster risk reduction; trained over 6,200 individuals and built partnerships and networks for CIS development.	Foreign, Commonwealth and Development Office (FCDO)

Afri-Res	Programme aimed at strengthening Africa's capacity to plan and implement climate adaptation strategies in key sectors like infrastructure, agriculture, and water management.	a) Promoting climate-resilient development through improved data analysis and risk management b) Developing resilience indicators to track progress c) Providing CIS to support climate-resilient infrastructure	AfDB and various regional and international partners
Sweden Climate Resilience Program	Programme aimed at enhancing Africa's resilience to climate change through improved governance, policy and capacity-building initiatives.	a) Strengthening institutions including NMHSs to provide reliable climate information b) Conducting vulnerability assessment for national planning c) Providing policy support to integrate climate risk and resilience	Government of Sweden
CR4D	Advances Africa's climate research by building scientific capacity, fostering collaboration and providing CIS for policymaking.	a) Postdoctoral fellowship programme supported young African scientists in climate research, resulting in 87 publications and 47 conference presentations. b) S2S (subseasonal to seasonal) forecasting improved climate prediction models for Central and West Africa. c) Institutional collaboration platform connects 34 climate research institutions, universities and policymakers for joint research and knowledge sharing. d) Scientific advisory committee of 19 experts ensures that research aligns with Africa's climate policy needs. e) Economic benefits of CIS: Assesses how climate data enhances productivity, risk reduction and policy development. f) Crop yield forecasting tools: Develops models to predict crop yields in SADC region, supporting climate-resilient agriculture.	AMCOMET, WMO, GFCS

Table A2. A summary of databases managed by AGRHYMET

Tool	Description	Application	Partners
HYDROMET	Application	Used for hydrological data management. The application has been deployed in all 17 countries of ACCIC-ECOWAS.	World Bank Group, the Global Facility for Disaster Reduction and Recovery (GFDRR) and AfDB.
CLIDATA	Database	This is a hydrometeorological database management system.	Hydrometeorological Institute (Czech Republic) and Czech IT system development company ATACO.
TDBASE	Data management system	Used for storing and analysing agricultural, livestock and demographic data collected from member states. It is also used to monitor the agricultural season and to assess crop yields.	-
PHYTOBASE	Data collection tool	Phytobase forms part of the phytosanitary information and monitoring system of the early warning and food security system in the CILSS-ECOWAS countries. It facilitates collection of data on threats to crops.	-

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