WATER

HEALTH

ENERGY

DISASTER RISK REDUCTION

2019 STATE OF CLIMATE SERVICES

AGRICULTURE AND FOOD SECURITY

WMO-No. 1242

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

ADAPTATION FUND

CGIAR Research Program on Climate Change, Agriculture and Food Security CCAFS

Food and Agriculture Organization of the United Nations

GREEN CLIMATE FUND

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"The global temperature has already risen to 1 °C above pre-industrial levels. The time left to achieve commitments under the Paris Agreement to remain within 2 °C is quickly running out requiring immediate action. The Global Framework for Climate Services was created to provide the scientific basis for adaptation. Climate services investments overall have a cost benefit ratio of 10 to one. The provision of climate services at country level relies on a cascading global-regional-national Climate Information System operated by WMO. More coherent financing is needed specifically to complete this system. Financing invested holistically in the WMO cascading operational system provides a return on investment of 80 to one."

PETTERI TAALAS
SECRETARY-GENERAL OF THE WORLD METEOROLOGICAL ORGANIZATION

Photo: UN Photo/Mark Garten

Photo: Daniel Klein

Executive Summary

In 2018, the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) called on the World Meteorological Organization (WMO) through its Global Framework for Climate Services (GFCS) to regularly report on the state of climate services with a view to "facilitating the development and application of methodologies for assessing adaptation needs" (Decision 11/CMA.1).

This inaugural 2019 State of Climate Services Report focuses on agriculture and food security. It reviews countries' priorities on climate services for adaptation, noting that agriculture is one of the highest, and identifies priority capacity needs. It examines capacity gaps across six components of the climate services value chain including: governance, basic systems, user interface, capacity development, provision and application of climate services, and monitoring and evaluation.

The report provides case studies, examples and explanations as to the role of climate information and services to support agriculture in the face of climate variability and change, assesses gaps and makes recommendations. This analysis helps highlight both challenges and opportunities for climate service efforts aimed at promoting climate resilient development and adaptation action.

Building on the work developed in collaboration with National Meteorological and Hydrological Services (NMHSs) and development partners, the report identifies four areas for action in enhancing climate services for effective adaptation in agriculture:

(a) Africa and Small Island Developing States (SIDS) are facing the largest capacity gaps. In particular, both regions are experiencing increasing challenges regarding the density of the observing network and reporting frequency of observations essential for generating products and data needed by the sector.

(b) Across all regions, monitoring and evaluation of societal outcomes and benefits of science-based climate services for adaptation action stand out as one of the weakest areas in the climate services value chain.

(c) Coordination in the delivery of climate services for agriculture both within and across local, national, regional and international institutions and operational systems remains challenging. Lack of data sharing is resulting in sub-optimal availability and use of climate information and services.

(d) While investments have increased substantially over the past decade, both more and better investments are needed to ensure the provision of high-quality climate information services for adaptation action in agriculture. Better investments include investments that support the national-regional-global integrated hydrometeorological system on which all countries depend in a more holistic, less piecemeal manner as well as investments in overcoming the "last mile" barriers impeding the full use and benefit of climate information and services.

The successful provision of climate services with proven, demonstrated benefits needs to be operationalized globally. Evidence suggests that the benefits of investing in the global-regional-national hydrometeorological system needed to accomplish this outweigh the costs by about 80 to one (Kull et al. 2016).

The report puts forward six strategic recommendations addressing five major areas in need of improvement:

(a) Fit-for-purpose financial support to operationalize and scale up climate services by enhancing the global-regional-national operational hydrometeorological system to support country-level agrometeorological service delivery, especially in Africa and SIDS.

(b) Systematic observations as fundamental for the provision of climate services;

(c) An enhanced climate science basis for priority climate actions;

(d) Addressing the "last mile" barrier through multi-stakeholder governance and partnerships;

(e) Systematic monitoring and evaluation of socio-economic benefits associated with climate services.

Information and analysis for this report has been provided by the WMO, the Adaptation Fund, the CGIAR Research Program on Climate Change Agriculture and Food Security, the Food and Agriculture Organization of the United Nations, the Green Climate Fund, the Global Environment Facility, the Global Facility for Disaster Reduction and Recovery, the World Bank, and the World Food Programme.

"We have learnt a lot and now know how to plan our planting and harvesting according to weather and climate conditions. Before we relied on knowledge passed down from our parents. But the weather is different from what it used to be and so traditional knowledge is no longer sufficient."

CLIMATE FIELD SCHOOL PARTICIPANT
Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG)

Photo: Simon Fanger

Climate information and associated services have demonstrably led to improved agricultural and food security outcomes and benefits for stakeholders in the sector. The capacity to deliver and access these services is highly uneven across regions and countries, however. The challenge is to strengthen the global-regional-national hydrometeorological system needed to operationalize and deliver these products and services at country level, particularly in developing countries, so that everybody benefits.

Photo: Joao Marcelo Marques

Data and Methods

As of 2019, 183 Nationally Determined Contributions (NDCs) have been submitted to the UNFCCC. Thirteen countries have also submitted National Adaptation Plans (NAPs) that identify medium-long-term adaptation needs and strategies and programmes to address those needs. For this report, WMO has analysed NDCs and NAPs to identify needs for climate services to support adaptation specifically in the agriculture and food security sector.

WMO Members assess their capacity for providing climate services and documenting associated socio-economic outcomes and benefits through a checklist that addresses functional capacities across the climate services value chain. Functional capacities assessed by the checklist are organized into six groups: Governance, Basic Systems, the User Interface, Capacity Development, Provision and Application of Climate Services, and Monitoring and Evaluation of socio-economic benefits. Many of these functional capacities constitute "basic", "essential", "full" or "advanced" functionalities. The percentages of "yes" and "no" responses to the checklist questions in each group for each capacity level provide a basis for assessing country capacities and needs in each area, and for categorizing the overall level of service provided by the Member according to WMO criteria. This data is currently available for 95 out of 193 WMO Member countries. The regional profiles in this report strongly reflect the profiles of the countries which have provided data, which is important for interpretation of the results. Additional sources used to collect information for the report included the WMO Country Profile Database, GFCS inventory of National Frameworks for Climate Services, information from WMO Global and Regional centres and Regional Climate Outlook Forums, WMO Commission for Agricultural Meteorology surveys, the World Agrometeorological Information Service[1] and NMHS websites.

Case studies have been provided by WMO, the CGIAR Research Program on Climate Change Agriculture and Food Security, the Food and Agriculture Organization of the United Nations, the Global Environment Facility, the World Bank and the World Food Programme. They highlight how climate services contribute to improved outcomes in the sector.

Information on projects and investments involving climate services has been provided by the Adaptation Fund, the Green Climate Fund, the Global Environment Facility, and the Global Facility for Disaster Reduction and Recovery of the World Bank.

[1] www.wamis.org

Trends

Photo: Ivan Bandura

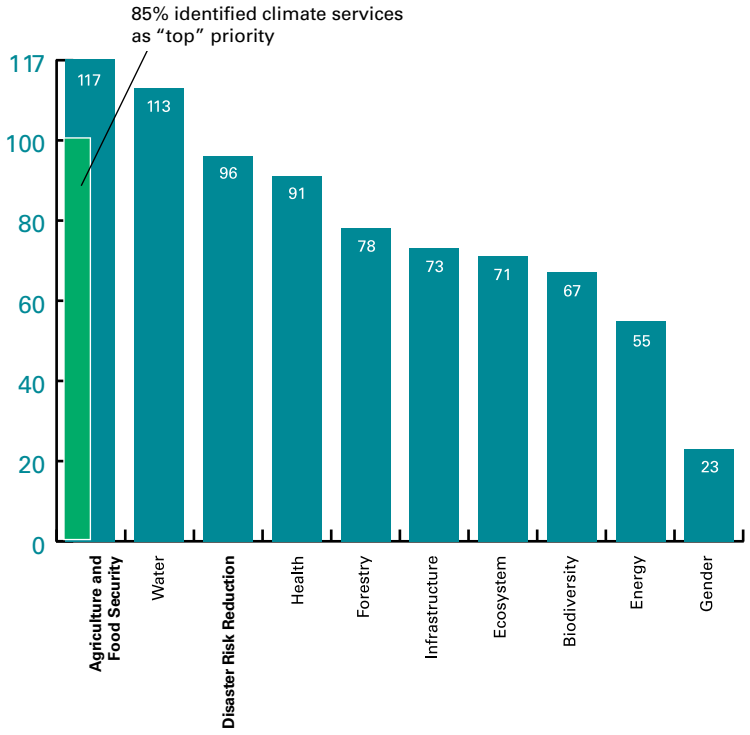
A Key to Addressing Hunger

Climate variability and extremes are a major contributor to the recent rise in global hunger. Climate change hits the most food-insecure people the hardest. Over 80% of the world's food insecure live in degraded environments exposed to recurrent extreme events (storms, floods, drought). In a warming world, extreme climate conditions will become more frequent and severe. A recent Food and Agriculture Organization of the United Nations (FAO) report estimated that the number of food insecure people in the world had declined from 2005 to 2014. However, the trend reversed in 2014. From 2014–2017, the number of undernourished or food insecure people grew from between 37 million–122 million to more than 800 million. The reason for this growth centered principally on climate shocks (GCA, 2019). This disturbing trend challenges the achievement of Sustainable Development Goal 2 (SDG) on Zero Hunger by 2030. A world that is 2 °C warmer is likely to have 189 million more food insecure people. This is an increase of around 20% compared with today[2] (WFP, 2017).

FAO estimates that over 500 million smallholder farms, producing more than 80% of the world's food in terms of value, and 750 million extremely poor people working in agriculture – usually as smallholder family farmers – are vulnerable to the effects of climate change.

[2] https://www1.wfp.org/publications/2017-2-and-4-degrees-infographic

NATIONALLY DETERMINED CONTRIBUTIONS



At present, 20-80% of the inter-annual variability of crop yields is associated with weather phenomena and 5-10% of national agricultural production losses are associated with climate variability (FAO, 2019). In addition, agriculture suffers 26% of the damage and loss during climate-related disasters in developing countries. In parallel with these trends, the global demand for food will increase by 50% and, in the absence of ambitious climate action, yields may decline by up to 30% by 2050 (GCA, 2019).

A Critical Priority

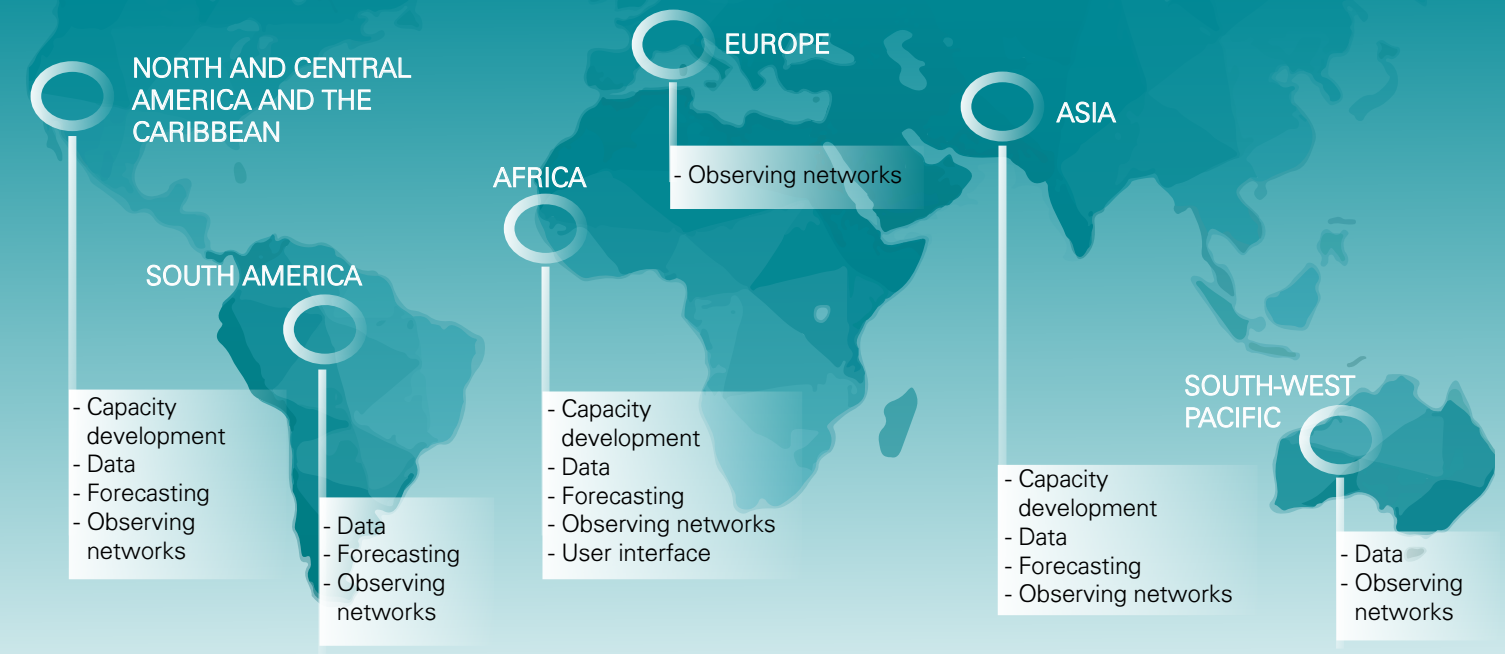
A 2019 analysis of NDCs by WMO and FAO found that the majority of countries highlighted agriculture, food security and water as the top priority sectors for climate change adaptation. In the area of agriculture and food security, 85% of countries (100 / 117) identified "climate services" as being a foundational element for planning and decision making.

Need

Adaptation has become a national priority for many countries, including recognition of the value of seamless weather and climate services. These services, and the operational hydrometeorological systems that support them, are critical to improve decision-making in climate-sensitive sectors.

Global Climate Service Needs: Agriculture and Food Security

Source: NDCs



Source: Nationally Determined Contributions (NDCs), WMO 2019

A Foundation for Better Decisions

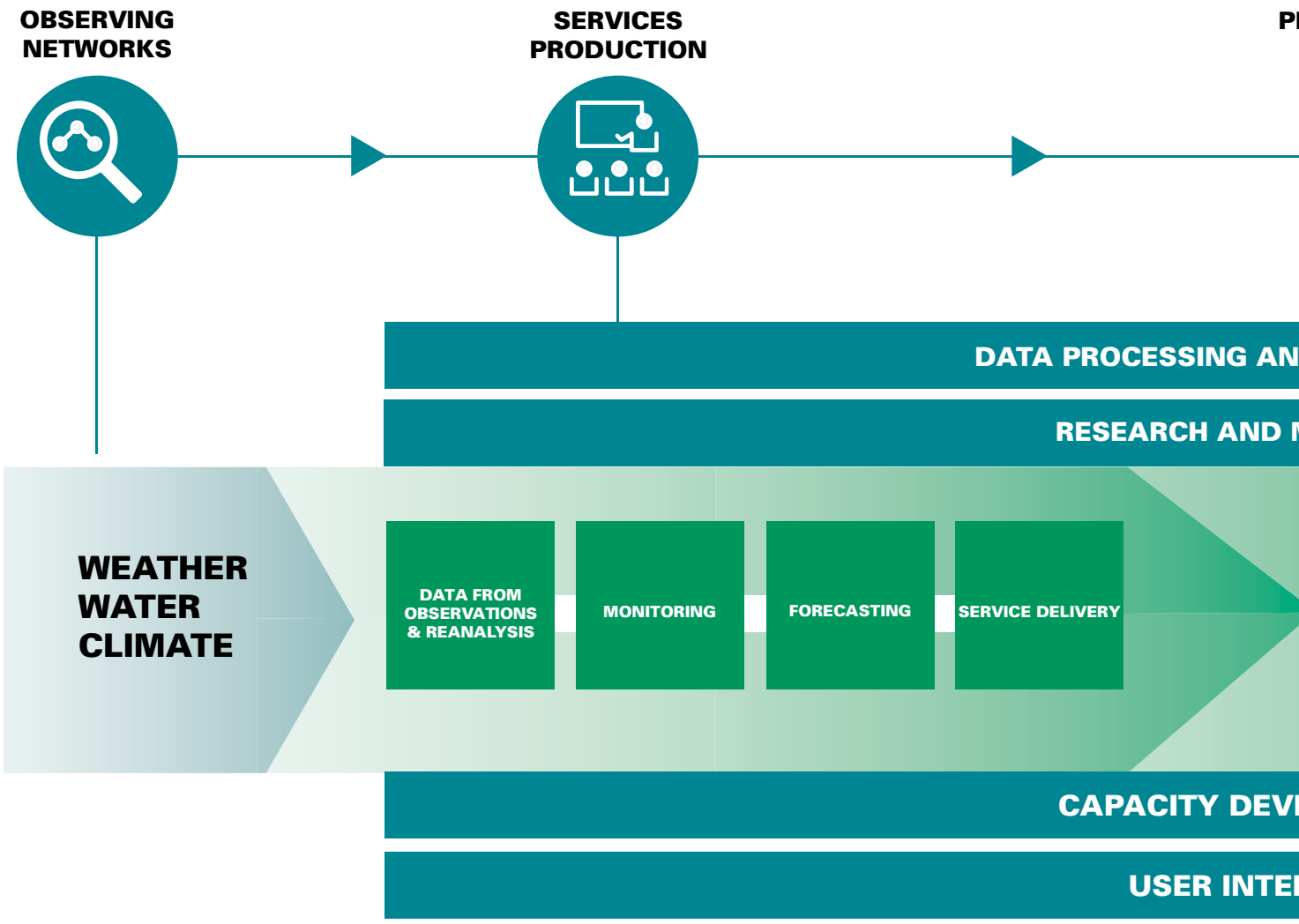
The ability to make better decisions through climate services[3] leads to the generation of more value for farmers. It is estimated that improved weather, climate, water observations and forecasting could lead to up to USD 30 billion per year in increased global productivity and up to USD 2 billion per year in reduced asset losses. The benefit-cost ratios are estimated to be in the order of 10 to 1 and in some cases even higher (WMO, WBG, GFDRR, USAID, 2015; GCA, 2019).

Countries clearly recognize the value of climate services to supporting adaptation action. As of 2019, a significant majority of the Parties referred to the importance of climate services in their NDCs, with Africa citing climate services most frequently (96%), followed by Asia (83%) and South America (82%). Moreover, all South-West Pacific countries that highlighted agriculture and food security as a top priority in their NDCs also mentioned climate services as a means for achieving adaptation, followed by Africa (94%) and Asia (91%). Developing countries, SIDS and LDCs in particular highlighted data, observing networks and forecasting as the top priority climate services-related needs to be addressed.

WMO and partners, through the Global Framework for Climate Services (GFCS), work with countries to identify gaps and needs and coordinate efforts in delivering climate services at the national, regional and global levels.

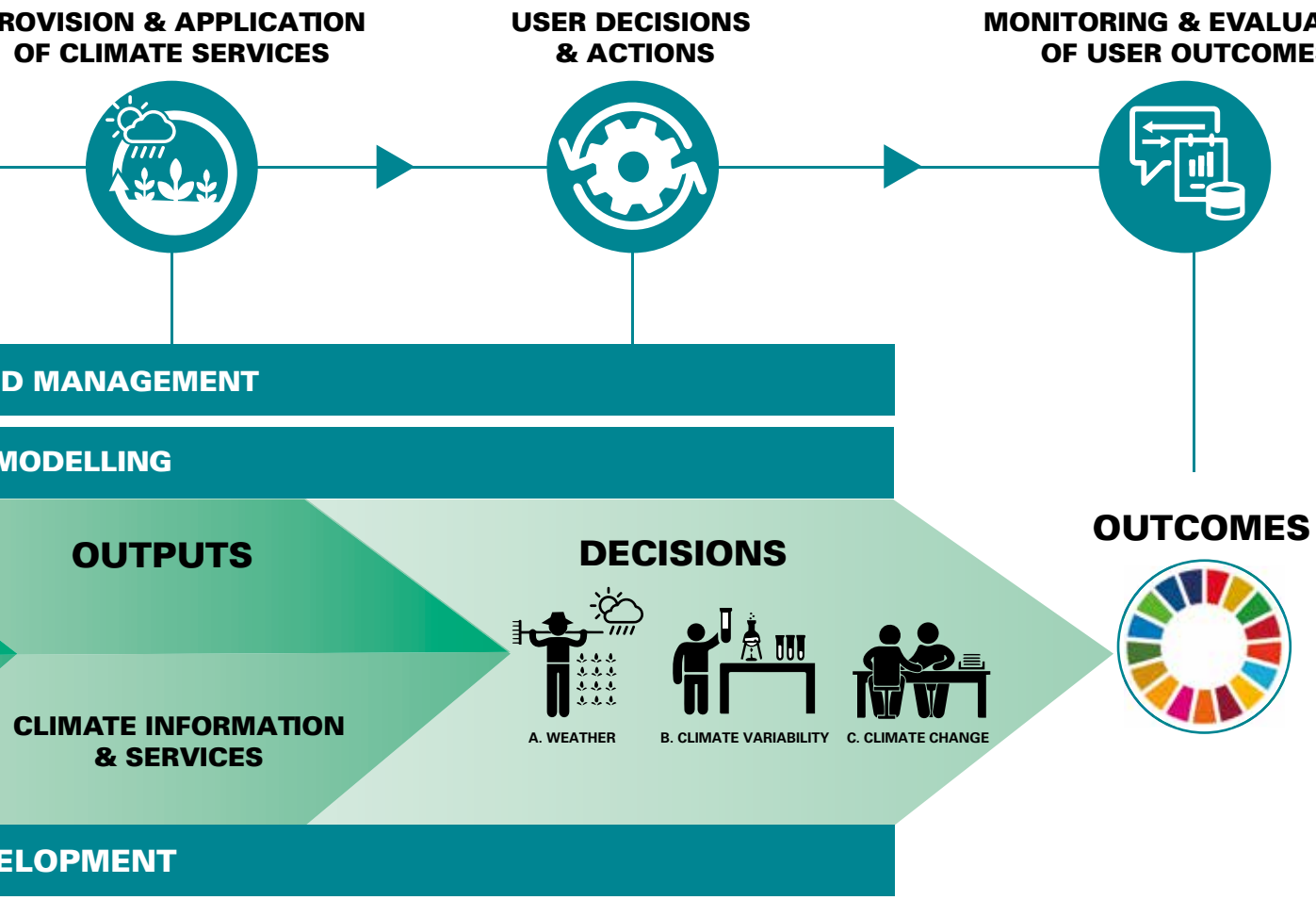
[3] *https://gfcs.wmo.int/what-are-climate-services*

Value



Climate services for improved adaptation outcomes hinge on a simple, yet comprehensive value chain. This value chain encompasses not only the production and delivery of climate services (the Climate Services Information System), but also stakeholder actions and outcomes, and involves the routine evaluation of associated socio-economic costs and benefits (WMO, WBG, GFDRR, USAID, 2015). Climate affects the agriculture sector in multiple ways, from farm-level production, processing, shipping and marketing. This report emphasizes services to farmers, who often represent some of the most vulnerable stakeholders in the sector.

Climate Services for Agriculture including crops, fisheries, forestry and livestock



RFACE

OUTPUTS

A. Weather

- Days suitable for fieldwork
- Accumulated growing degree days for season
- Heat indices for livestock
- Fire Danger Ratings
- Pest/Disease Forecasts

B. Climate Variability

- Crop-yield forecasts
- Average dates of beginning and end of rainy season
- Average first and last frost dates
- Crop-Weather Calendar
- Drought Indices/Warnings

C. Climate Change

- Maps of changes in agroecological zoning
- Maps of changes in first/last frost dates
- Analyses on future crop impacts

USER DECISIONS AND ACTIONS

- When to plant and harvest
- When to irrigate
- When to apply fertilizers/ pesticides
- When to rotate/move live stock
- Investing in drought resilient crops and livestock
- Investing in more efficient irrigation systems

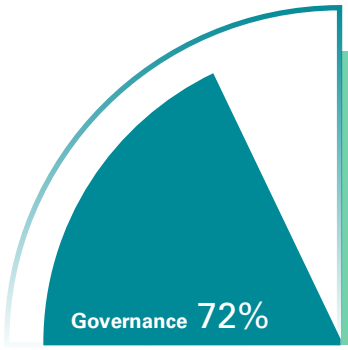
Status: GLOBAL

Although many countries have established basic functional capacities for providing climate services, the more advanced "essential" and "full" capacities needed to support specific decisions in the agriculture sector are often still lacking.

Out of 95 countries that have provided data to WMO, 5 (5%) are providing climate services at a less than basic level, 24 (25%) at a basic level, 42 (44%) at an essential level, 13 (14%) at a full level and 11 (12%) at an advanced level according to WMO criteria (see page 9). Data from additional countries will provide a more complete profile of capacities, needs and gaps at country and regional level.

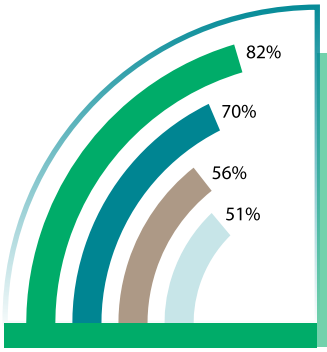
Current Global Needs

Globally, data from a checklist of climate services-related functions provided by selected WMO Members to date show that there has been progress in governance, implementation of basic hydrometeorological systems, and stakeholder engagement for the implementation of climate services. However, institutional capacities need to be strengthened in many countries and in some regions, particularly to complete the climate services value chain for adaptation planning and decision making, and to document associated socio-economic benefits. Additional research is needed to improve underlying predictions and projections as well as underlying observations and data, and to transition research results into operation. The latter will entail interactions between the research and operational communities to address the needs of users, stakeholders and decision-makers. Further strengthening of systems operationalization is needed to promote the exchange of GFCS-relevant data and products among countries and between national, regional and global centres. Monitoring and evaluation of the results and benefits of the use of climate services remains consistently weak across all regions.



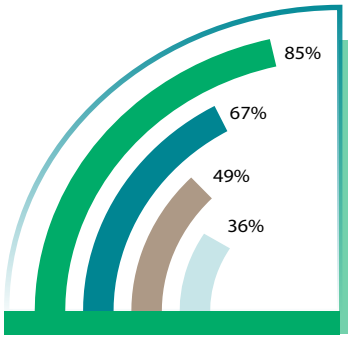
GOVERNANCE

National governance mechanisms to ensure coordination for climate services and enable NMHS contributions to national adaptation planning.



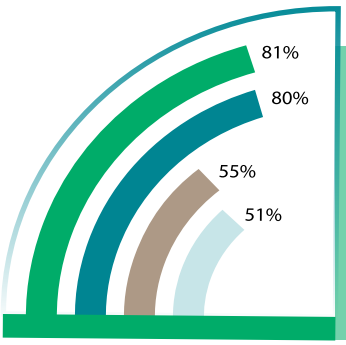
BASIC SYSTEMS

Comprising observing networks, data, data management, monitoring, and forecasting systems that allow the production and delivery of climate information and services.



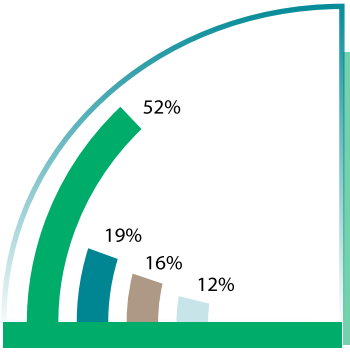
USER INTERFACE

Mechanisms, tools and systems that allow climate services users and providers to interact, to ensure co-production and tailoring of services for decision support and feedback.



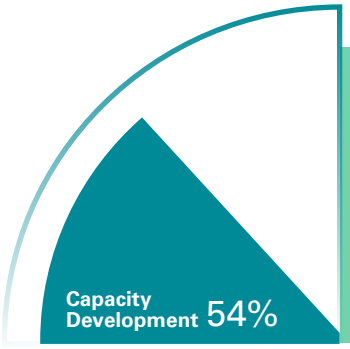
PROVISION AND APPLICATION OF CLIMATE SERVICES

Decision support products and services.



MONITORING AND EVALUATION

Tracking of outcomes and benefits associated with climate services.



CAPACITY DEVELOPMENT

Technical advisory services and training to address capacity development needs for climate service provision and use.

key BASIC ESSENTIAL FULL ADVANCED

The percentages of "yes" answers to checklist questions addressing each of the above areas is shown in the graphs, based on data from 95 countries who provided data to WMO. Many of the functional capacities assessed by the checklist constitute "basic", "essential", "full" or "advanced" functionalities. The graphs show the percentages of "yes" and "no" responses to the questions in each of the above areas, for each functional capacity level, from the data provided.

OBSERVATION AND MONITORING

Systematic observations are the foundation for effective climate action and sustainable development. Critical weather forecast and climate analysis products developed for any area on the globe depend on continued access to a reliable and real-time supply of observational data from everywhere. While data on all 54 Essential Climate Variables (ECVs) are freely available today, important observational data are missing in several parts of the world, particularly in Africa and SIDS. Despite covering a fifth of the world's total land area, Africa has the least developed land-based observation network of all continents, and one that is in a deteriorating state, amounting to only 1/8 of the minimum density required by WMO and only 22% of stations fully meeting Global Climate Observing System (GCOS) reporting requirements (down from 57% in 2011). Climate observations of the upper oceans are currently fairly well covered (e.g. ARGO buoys reach 88% of target density and drifters 80% with gaps in polar and coastal regions), while there are relatively few observations below 2 000 m. Funding is very fragile, however, with sustainable funding for only 28% of ocean observations, and with 52% requiring renewed funding within 2–3 years.

This lack of observational data significantly limits the quality of information used by governments and all stakeholders as the basis for important decisions such as those related to the climate services value chain supporting agricultural production. Local observations are important for local purposes, but they are also the basis of global climate forecasts and projections. There is a fundamental mismatch, however, between today's level of financing of observations in developing countries and the value these observations create for the global public good.

In 2019, WMO Members adopted the overall concept for the Global Basic Observing Network (GBON). It defines the obligation of WMO Members to implement a minimal set of surface-based and upper-air observing stations for which international exchange of observational data will be mandatory in support of global Numerical Weather Prediction (NWP) and climate analysis that will translate in improved climate services for everyone. Successfully achieving GBON compliance depends on innovative finance that values the global public good that these observations provide, ensures coherence of development activities, provides long-term finance beyond time-bound projects, incentivizes country performance, and ensures sustainability of investments – beyond business as usual.

CLIMATE SERVICES INFORMATION SYSTEM

Global and Regional centres and NMHSs provide climate service products to be used at the country level to support more effective adaptation. Currently, 13 Global Producing Centres for Long-Range Forecast (GPCLRFs)[4] and three Lead centres generate global forecast models, reanalysis and other products based on information from nationally operated observing networks. At the regional level[5], there are nine multifunctional Regional Climate Centres (RCCs) and three RCC-networks of collaborating centres. Three additional RCC-networks have started the demonstration phase, for formal WMO designation. WMO-designated RCCs post-process the data and products received from the Global Producing Centres and Lead Centres to generate regionally optimized and high-resolution data and products. At the national level, NMHSs are using data and products received from RCCs and other sources to generate tailored products for various users and applications, based on interaction with those users, to identify demand for specific products. At present, 137 countries have reported to WMO that they are providing services to the agriculture and food security sector especially in Africa and Europe.

USER INTERFACE

19 Regional Climate Outlook Forums (RCOFs)[6] are currently operational around the world, and have become one of the most widely used mechanisms for developing user-driven products and services as well as communicating those to users at regional and national levels. In addition, two inter-regional RCOFs exist. RCOFs are platforms that bring together national, regional and international climate experts, with users and country representatives in a climatic region to produce climate outlooks ahead of key seasons. As of August 2019, 46 WMO Members had established, or were in the process of establishing, National Frameworks for Climate Services (NFCSs)[7]. Of these, four were fully established, 15 had completed the steps and were moving into operation, four had started the process of NFCS establishment, 14 were in the process of initiating the first steps, and nine were in the planning phase. At the local level, users provide feedback on the quality and usefulness of information products and services they have received.

An NFCS is an institutional mechanism to coordinate, facilitate and strengthen collaboration among national institutions to improve the co-production, tailoring, delivery and use of science-based climate predictions and services. NFCSs create the space for sustained dialogue between users from climate-sensitive sectors and providers for the identification of gaps, needs and priorities to enable improvements and sustainable delivery of climate services.

RESEARCH MODELLING AND PREDICTION

Regional climate change projections, organized by the World Climate Research Program (WCRP) Coordinated Regional Climate Downscaling Experiment (CORDEX), are being used to inform national and local impact assessments and adaptation plans. The WCRP Coupled Model Intercomparison Project (CMIP), now in its 6th phase, was initiated in 1995 and involves more than 40 climate modelling centres from some 20 countries to deliver updated decadal climate predictions and climate projections around future scenarios to inform UNFCCC processes and Intergovernmental Panel on Climate Change (IPCC) assessments. Considerable additional work is needed, however, to validate these models and make downscaled outputs available for country-level planning and decision-making. Several Regional Climate Forums are taking steps to do this, which could inform similar processes in other regions. Major operational and research organizations are assisting countries to produce downscaled climate projections. For example, FAO and the University of Cantabria helped Morocco, the Philippines, Indonesia, Peru, Paraguay, Uruguay, Sri Lanka, Malawi, and Zambia to statistically downscale CMIP climate projections to local scales, as part of various climate change adaptation projects.

CAPACITY DEVELOPMENT

WMO Members support each other through "twinning" between NMHSs. The WMO Country Support Initiative, approved by the Eighteenth World Meteorological Congress in 2019, will increase WMO's capacity to provide such advisory services to developing countries and to development partners, to guide and increase the effectiveness of their investments in climate services. In doing so, it will contribute to strengthening developing country capacity in a more integrated, systematic and structured manner.

In 2018, WMO institutions and Members delivered 62 courses on various aspects of climate services. The majority focused on technical aspects (47% on Climate prediction and projection, 36% on data aspects and the remaining 17% on sectoral and policy applications). Only 13% of the trainings addressed the agriculture and food security sector users. Through its Technical Cooperation Programme (TCP), FAO provides technical support to member countries and national institutions to produce and disseminate agro-climate information for farmers and rural dwellers. To inform national climate change adaptation strategies and prioritize the needs of vulnerable countries and communities, the World Food Programme (WFP) has been working with several countries and research partners to provide analyses highlighting the current and projected impacts of climate change on food security and nutrition at global, regional and national level[8].

[4] http://www.wmo.int/pages/prog/wcp/wcasp/gpc/gpc.php
[5] http://www.wmo.int/pages/prog/wcp/wcasp/rcc/rcc.php
[6] https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products
[7] https://gfcs.wmo.int/NFCS_status
[8] https://www.wfp.org/climate-and-food-security-analyses

Delivery

137 countries currently provide climate services tailored to the agricultural sector

Covering the Last Mile

As highlighted by FAO and WFP, the accessibility of climate services, such as covering last mile delivery to farmers, is especially critical. Also important, according to both WFP and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), is filling gaps in historical observations, and using historical data to generate climate information that is verified and locally actionable.

Both WFP and FAO report a significant gap among users concerning the awareness of what kind of information is available, where it can be found and how it can be used in agricultural or livelihood management decisions. If climate and weather information is available but not used effectively, their value is lost. Despite rapid technological progress, most climate information and associated services do not reach small farmers due to a lack of adequate communication channels, because it has not been adequately tailored to community needs, or it has not been translated into the local language.

Two factors in particular contribute to the "last mile" information gap (FAO, 2019):

1. **Farmers require local level agrometeorological information that can realistically represent the farming environment, which is often lacking.**
2. **NMHSs often have limited access to local extension staff and farming communities, making the integration of meteorological and local knowledge very challenging.**

Forecasts are a source of valuable information for decision-making by local farmers. Limitations on their utility, as reported by CCAFS, include lack of information about the underlying local climate, forecast categories may not provide information about thresholds needed for particular decisions and that are prone to misinterpretation, ambiguity about forecast accuracy and uncertainty, and sometimes lack of decision-relevant information beyond seasonal average rainfall or temperature (Hansen et al., 2019).

To address this "last mile" gap, a platform for farmer education and empowerment was launched by FAO in 1989 – **Farmer Field Schools (FFS)**. FFSs now cover over 90 countries with between 400 000 and 1 million farmers using FFS annually[9].

Another innovative initiative is **Forecast-based Financing (FbF)**, implemented by WFP, that uses climate forecasts to trigger pre-defined and anticipatory community-level actions to reduce the risks and impacts of disaster. FbF projects can reduce the scale and costs of humanitarian response, changing the way the humanitarian system responds to climate-related disasters. WFP is currently implementing FbF initiatives in 14 countries in Africa, Asia Pacific and Latin America. Furthermore, WFP works to enable the dialogue between producers and users of information and invests in strengthening extension services and other knowledge intermediaries' capacities, as they have a key role to play in tailoring and communicating information to both stakeholder groups, including providing feedback on the validity of the information and products produced. For example, the GFCS Adaptation Programme that is currently implemented in Malawi and Tanzania has also enabled WFP to strengthen access to climate and weather information for food insecure, vulnerable communities working with extension officers, Red Cross volunteers and using a mix of ICTs such as mobile apps, radio programmes and SMS. Partnerships with NMHSs, the private sector and research partners, such as the University of Reading in this case, have been found to be crucial to the success of climate services initiatives[10].

More to be done

Overall, FAO reports that more short-term scale forecast and advisory products are becoming available to the sector. The potential of using weather and climate forecasts has been demonstrated in a number of climate-smart agriculture projects across the world (FAO, 2017). Scaling up these climate-smart initiatives to the regional and national level from individual projects can provide new approaches to tackling last mile challenges.

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[9] Global Farmers Field Schools Platform, http://www.fao.org/farmer-field-schools/en/

[10] https://www.wfp.org/climate-services

If climate and weather information are available but not used to modify the crop management and take other decisions, their value is lost.

Photo: Andrew Coelho

Uptake of probabilistic seasonal climate forecasts is still limited compared to weather monitoring and deterministic daily weather forecasts however. This is due to uncertainties and the difficulty in translating them into concrete actionable advice. Sub-seasonal scale forecasts are also drawing more attention because of potential applicability to decisions within a crop season.

Climate services addressing seasonal time scales are key to on-farm decision-making, as part of "incremental" adaptation. In the agriculture sector, improvements to crops (e.g. drought or flood tolerant varieties) or to on-farm management practices can be considered as "incremental" adaptation. However, "transformational" adaptation will be required in some agro-ecosystems (Kates et al., 2012). Transformational adaptation takes a variety of forms – switching crop types, shifting locations for producing certain crops and livestock, shifting farming systems new to an area, exploring alternative livelihood strategies, and others (Rippke et al., 2016). Designing transformational adaptation requires robust climate evidence – information on climate risks and vulnerabilities impacting different livelihoods at community levels. There are different types of climate information that facilitate evidence-based adaptation planning and decision-making on these longer time scales (Porter et al., 2014):

(a) Historical climate trends, including extreme weather events, and their impact on agriculture and food security;
(b) Projection of climate and its impact on agriculture and livelihoods; and
(c) Characterized risks and vulnerability to climate change and social and environmental factors.

Furthermore, innovative risk transfer mechanisms that combine climate information and insurance for food security – such as weather index-based insurance – can strengthen farmers' resilience to climate-related shocks and help secure the income of smallholders who are particularly vulnerable to climate variability.

Customized for Agriculture

According to the WMO Country Profile Database, 137 countries currently provide services to the agricultural sector (as of 2019). The level of service varies across countries. The most advanced countries monitor agriculture-specific variables such as growing degree days, soil condition, vegetation health, and crop conditions, and then provide actionable advice on planting, harvesting, fertilizer, irrigation and pest management based on forecasts and monitoring. A limited number of countries currently provide a full suite of climate services for the agriculture sector due largely to insufficient capacities of technical staff and limited resources, but specific applications like pest and disease management are drawing interest from countries for support.

As an important first step to identify the most appropriate policies and progammes, WFP performed three regional, three global and 19 country level climate and food security analyses. These analyses provide important inputs into national adaptation planning and are also essential for WFP and other actors to inform the design and implementation of climate change adaptation programmes. For example, the Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) is a methodology that has been developed by WFP in Asia Pacific to understand how food security will be affected by climate-related risks, both in terms of extreme weather events (such as drought, floods and cyclones) and long-term gradual changes (including shifting rainfall patterns, rising temperatures, salinity intrusions in coastal areas, and sea level rise). The innovative part of CLEAR is that it looks at impacts on specific livelihoods, taking into account livelihood strategies and coping mechanisms of different communities. This enables the development of specific adaptation measures, tailored to the need of different groups.

Product Status:

GLOBAL

Climate and early warning information services should underpin decision-making on climate action for adaptation

Cropland Affected by Severe Drought

CLIMATE SERVICES PRODUCT

TITLE: FAO's Agriculture Stress Index System (ASIS)

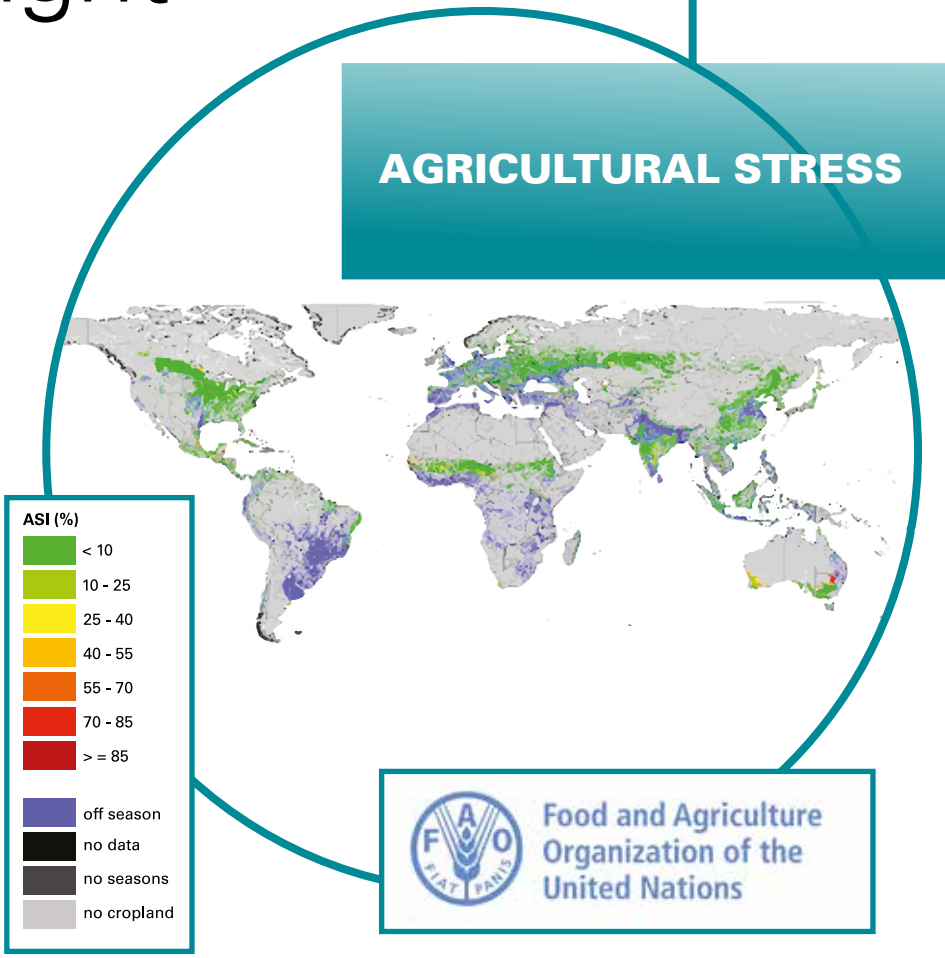
ORGANIZATION: The Food and Agriculture Organization of the United Nations (FAO).

DESCRIPTION: FAO has developed a global and country-level ASIS tool to help countries strengthen their agricultural drought monitoring and early warning systems, using satellite data to detect cropped land that could be affected by drought.

DECISIONS: Provides national decision-makers with early warning on possible decreases and increases in agricultural production. Provides international organizations with information to plan for possible shortfalls in agricultural production that could lead to food deficits and, in worst cases, famine.

BENEFITS FOR: Crops, livestock, and forestry.

RESULTS: Better planning, more informed investments, and reduced food shortfalls.



Global Climate Change Vulnerability

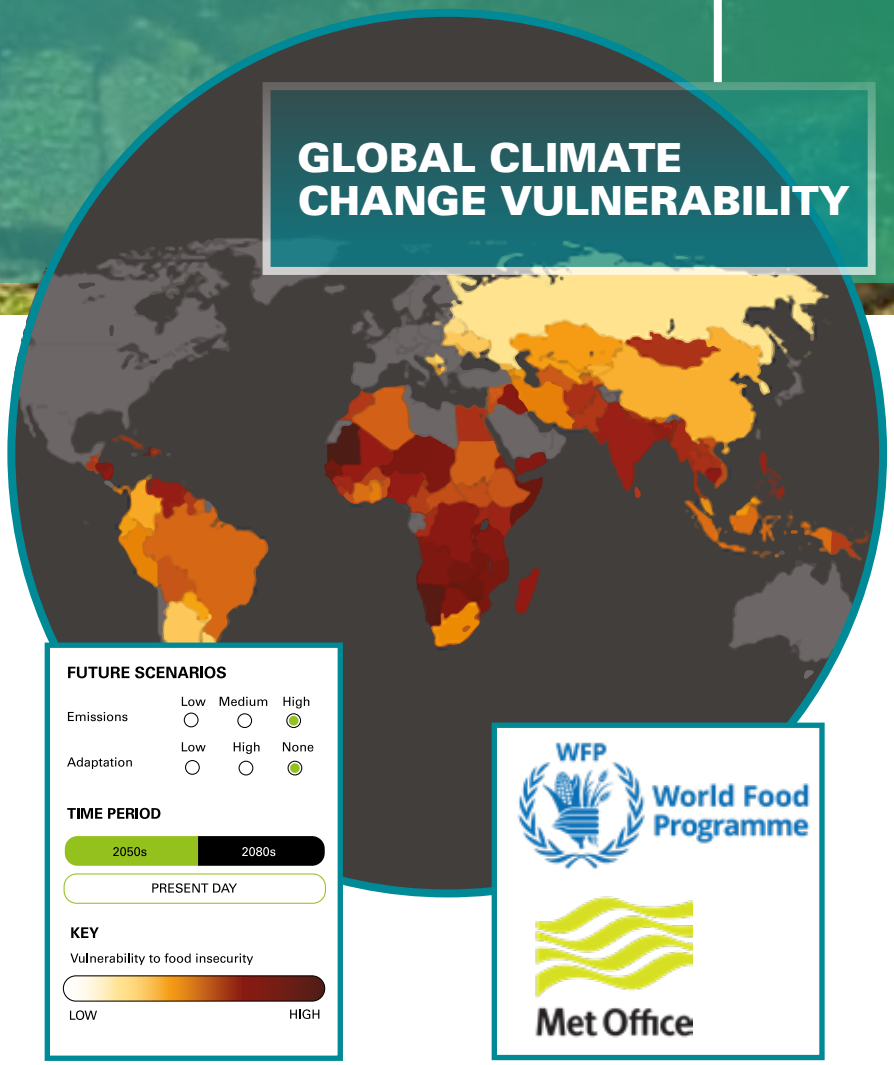


Photo: Ivan Zhang

CLIMATE SERVICES PRODUCT

TITLE: Food Insecurity Climate Change Index

ORGANIZATION: World Food Programme (WFP) and UK Met Office

DESCRIPTION: The Food Insecurity Climate Change index is a measure of risks to the food system associated with climate-related hazards. It is calculated based on exposure to climate-related hazards, sensitivity of agricultural production to those hazards, and the capacity of countries to cope with climate-related food shocks.

DECISIONS: Provides national and international decision-makers with information on long-term food insecurity. Mostly for long-term planning and investment decisions on agricultural infrastructure.

BENEFITS FOR: Crops, livestock, forestry, inland fisheries.

RESULTS: Better planning and reduced food shortfalls.

The global demand for food will increase by 50% and, in the absence of ambitious climate action, yields may decline by up to 30% by 2050. (GCA, 2019)

Photo: Ben Den Engelsen

The Centres

- Global Producing Centres for Long Range Forecasts
- Designated RCC
- Designated RCC-Network
- RCC in demonstration phase
- RCC-Network in demonstration phase
- RCC proposed
- RCC-Network proposed

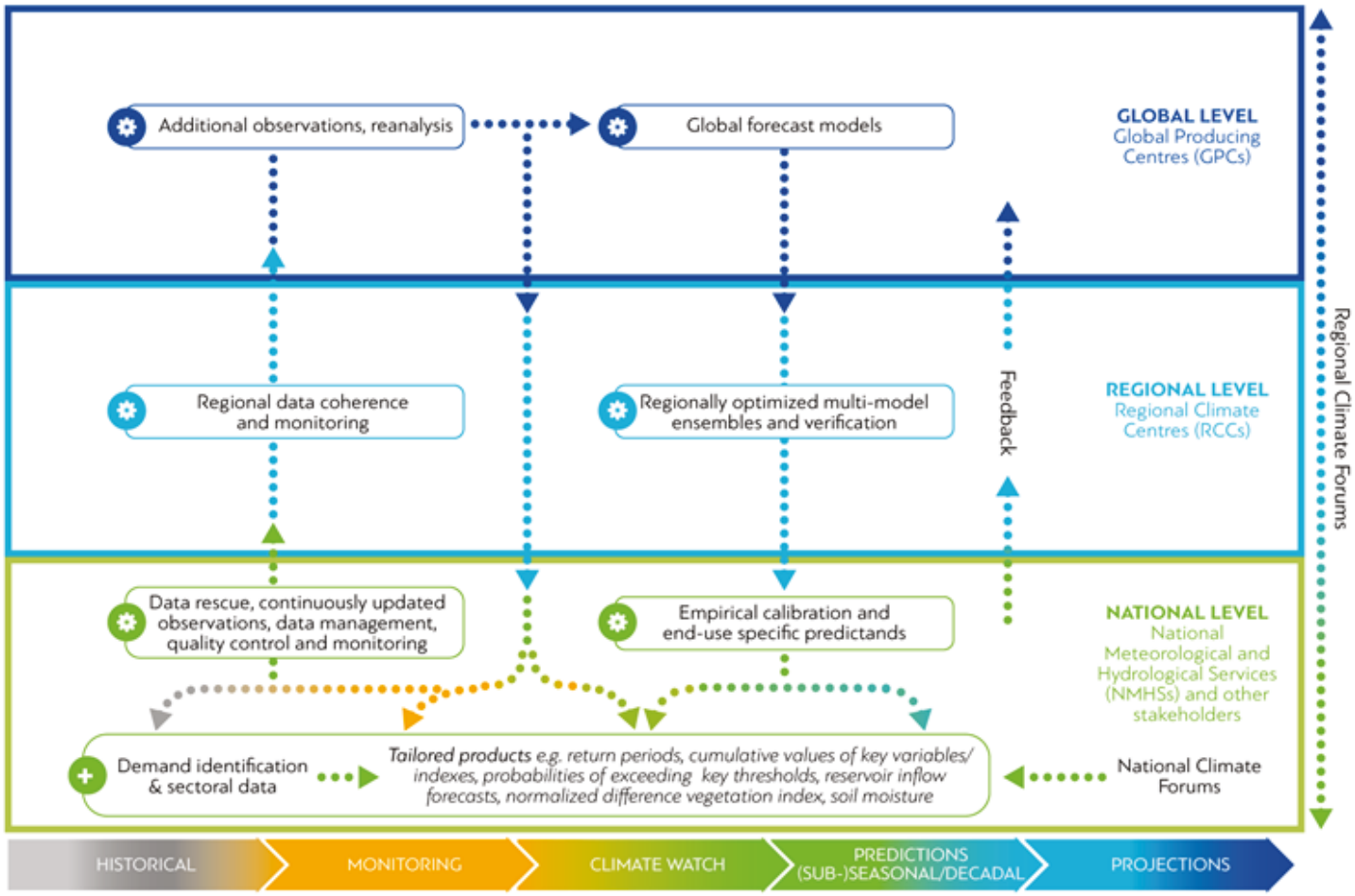
Our Centres

To support NMHSs in operationally generating and delivering up-to-date climate information and prediction products for climate services, WMO has designated Global Producing Centres for Long Range Forecast (GPCLRFs). As of June 2019, 13 GPCLRFs have been designated to provide a range of global long-range forecasting products relevant for climate adaptation and risk management. In addition, WMO has also designated Regional Climate Centres (RCCs) which generate and deliver more regionally-focused, high-resolution data and products, and which provide training and capacity development services.

Climate Services Information System

Photo: Ales Krivec

The Climate Services Information System (CSIS) comprises a physical infrastructure of institutes, centres and computer capabilities at the global, regional and national levels that, together with professional human resources, develops, generates and distributes a wide range of climate information products and services to inform decision-making across a variety of climate-sensitive applications. Country-level service delivery in any given region depends on the operational exchange of data and products within this cascading global-regional-national system.



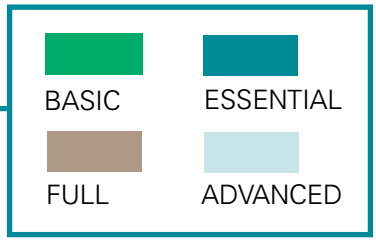
Status: **AFRICA**[1]

Africa faces high risks in the agricultural sector and as regards food security due to its high exposure and vulnerability to climate variability and change. African ecosystems are already being affected by climate change, and future impacts are expected to be substantial. Climate change will amplify existing stress on water availability in Africa and will interact with non-climate drivers and stressors to exacerbate the vulnerability of agricultural systems, particularly in semi-arid areas (IPCC, 2014).

WMO data on Member climate services capacity show that the set of functional capacities focused on the monitoring and evaluation of socio-economic outcomes and benefits in the region is less well established than are the capacities for generating services. **Basic systems, including observing networks and data as well as data management, are significantly lagging compared to the global average.** However, capacities for Provision and Application of Climate Services at relatively sophisticated levels are quite high. This suggests that countries can focus efforts on deriving use-value from available information which at the same time could encourage investments in basic systems capacity. Though gaps exist in several regions, Africa has the highest percentage of non-reporting stations for supplying timely data to global modelling centres. Needs persist even for basic meteorological data such as temperature, pressure and precipitation.

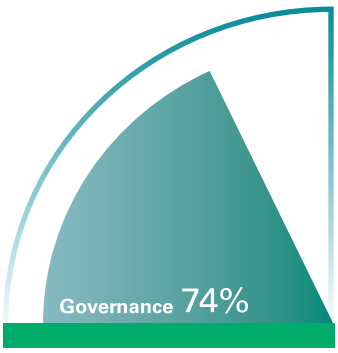
Looking ahead, for the strengthening of sustainable networks, careful planning and resource allocation covering maintenance and consumables; staff development, training and retention; planning for equipment replacement; data archiving; and data dissemination, emerge as top needs (GCOS, WIGOS, UNFCCC Regional workshop in Uganda, 2019).

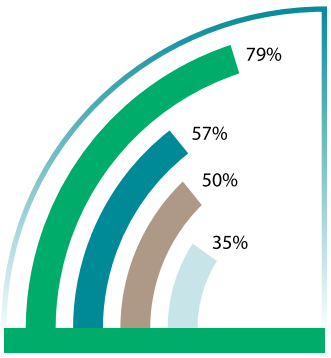
key



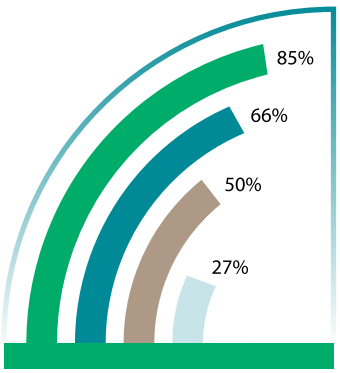
[1] https://public.wmo.int/en/about-us/members

overview

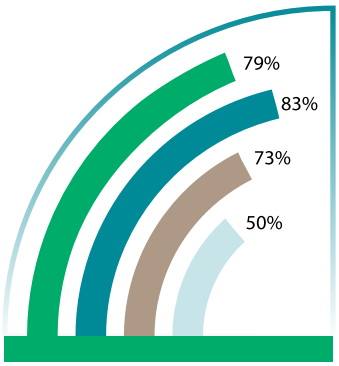




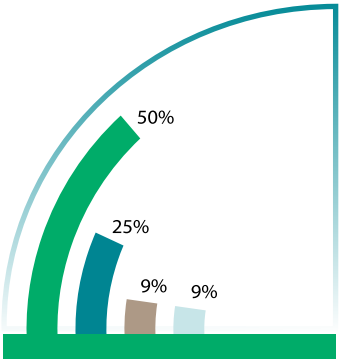
BASIC SYSTEMS



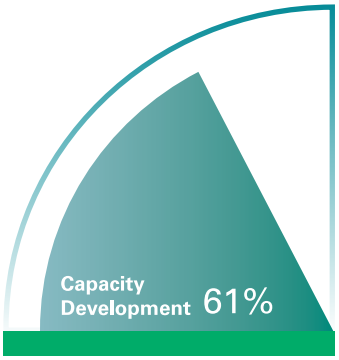
USER INTERFACE



PROVISION AND APPLICATION CS



MONITORING AND EVALUATION



REGIONAL INFORMATION

COUNTRIES REPORTING DATA TO WMO ON CLIMATE SERVICES
CAPACITY USED FOR THIS REPORT: 22 (42%)
WMO REGIONAL CLIMATE CENTRES:
DESIGNATED

- The African Centre of Meteorological Applications for Development (ACMAD)
- IGAD Climate Prediction and Applications Centre (ICPAC)
- RCC Network - Northern Africa

PROPOSED

- Southern African Development Community (SADC - CSC)
- Economic Community of West African States (ECOWAS) AGRrometeorology, HYdrology, METeorology (AGRHYMET)
- Economic Community of Central African States (ECCAS)

NUMBER OF NATIONAL FRAMEWORKS FOR CLIMATE SERVICES (NFCSs):

- Completed 14
- In Progress 12
- Started 2
- Planned 7

WMO CLIMATE SERVICES CAPACITY LEVEL: LESS THAN BASIC: 1 (5%), BASIC: 8 (36%), ESSENTIAL: 9 (41%), FULL: 4 (18%)
NUMBER OF COUNTRIES PROVIDING SERVICES TO AGRICULTURE AND FOOD SECURITY ACCORDING TO 2019 WMO DATA: 38
NUMBER OF REGIONAL CLIMATE OUTLOOK FORUMS: 7 (and 1 Inter-Regional)


Photo: Jakub Kriz

Example: **CLIMATE SERVICES PRODUCT**

TITLE: Seasonal rains onset anomaly

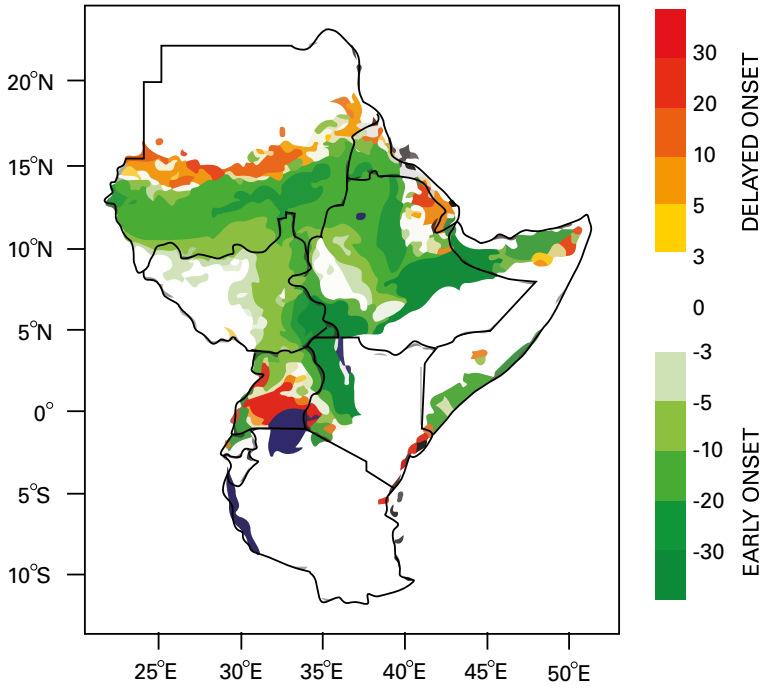
ORGANIZATION: Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC)

DESCRIPTION: The forecasted onset and cessation anomalies for June–September 2019 rainfall season are computed as the deviations from long term average (1989–2008).

DECISIONS: What crops to plant and when to plant them; movement of livestock for better foraging conditions; when to use reservoir supplies for crops.

BENEFITS FOR: Crops, livestock and water supplies for irrigation.

RESULTS: Higher crop yields and higher weight gain for livestock.



Status: **ASIA**

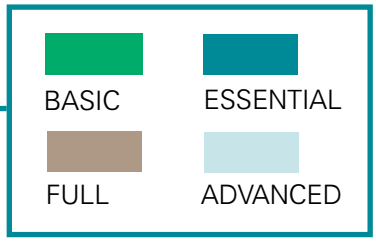
Warming trends and increasing temperature extremes have been observed across most of the Asian region over the past century. These trends have been noted with high confidence by climate scientists. Extreme climate events such as heat waves, tropical cyclones, floods and droughts will increase risks arising from water supply scarcity, food production and food security, coastal and marine systems, ecosystem and human health.

Apart from the detrimental impacts of extreme events, the vulnerability of people's livelihoods in agrarian communities also can stem from circumstances such as geographic settings, demographic trends, socioeconomic factors, access to resources and markets, unsustainable water consumption, farming practices, and lack of adaptive capacity (IPCC, 2014).

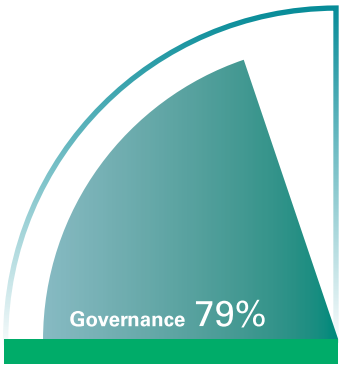
The profile of climate services capacities for this region reflects the capacities of many highly advanced national services that provided data. Basic Systems are especially advanced compared to the global average. Data rescue and data sharing remains a challenge in the region, however, with the lowest percentage of positive responses on these functional capacities.

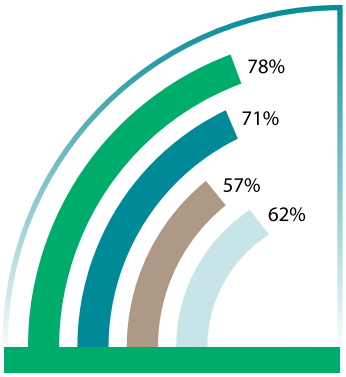
The region stands out in its capacity for Monitoring and Evaluation of socio-economic outcomes and benefits of climate services, an important capacity which is generally weak globally. There is a high potential benefit, therefore, in transfer of knowledge in this area within this region and from this region to others.

key

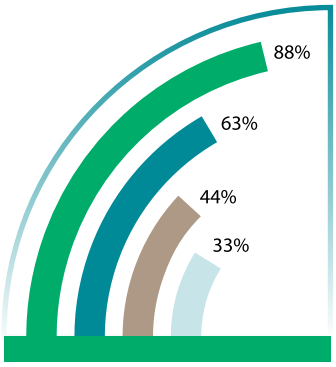


overview

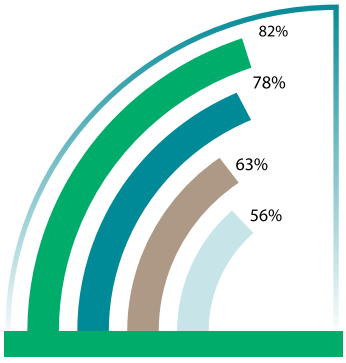




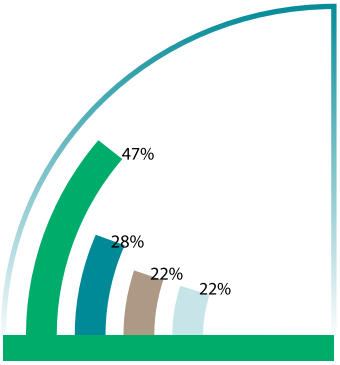
BASIC SYSTEMS



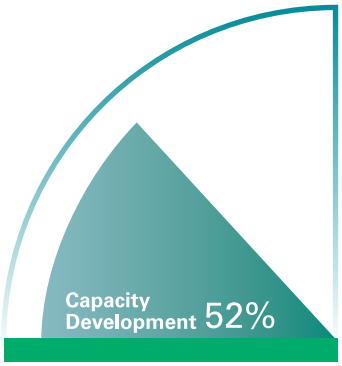
USER INTERFACE



PROVISION AND APPLICATION CS



MONITORING AND EVALUATION



REGIONAL INFORMATION

COUNTRIES REPORTING DATA TO WMO ON CLIMATE SERVICES CAPACITY USED FOR THIS REPORT: 18 (53%)

WMO REGIONAL CLIMATE CENTRES:

DESIGNATED

- Beijing Climate Centre (BCC)
- Tokyo Climate Center (TCC)
- Indian Meteorological Department (IMD)

PROPOSED

- Tehran Iran Climate Centre
- Saudi Arabia Climate Centre
- Nur-Sultan Kazakhstan Climate Centre
- Third Pole RCC-Network

NUMBER OF NATIONAL FRAMEWORKS FOR CLIMATE SERVICES (NFCSs):

- Operational 1

WMO CLIMATE SERVICES CAPACITY LEVEL: LESS THAN BASIC: 2 (11%), BASIC: 3 (17%), ESSENTIAL: 9 (50%), FULL: 1 (6%), AND ADVANCED: 3 (17%)

NUMBER OF COUNTRIES PROVIDING SERVICES TO THE AGRICULTURE AND FOOD SECURITY ACCORDING TO 2019 WMO DATA: 21

NUMBER OF REGIONAL CLIMATE OUTLOOK FORUMS: 3


Photo: Murthy

Example: **CLIMATE SERVICES PRODUCT**

TITLE: Operational Agromet Advisory Services in India

ORGANIZATION: Indian Meteorological Department (IMD) in coordination with State Agricultural Universities, Institutes of Indian Council of Agricultural Research and Indian Institutes of Technology.

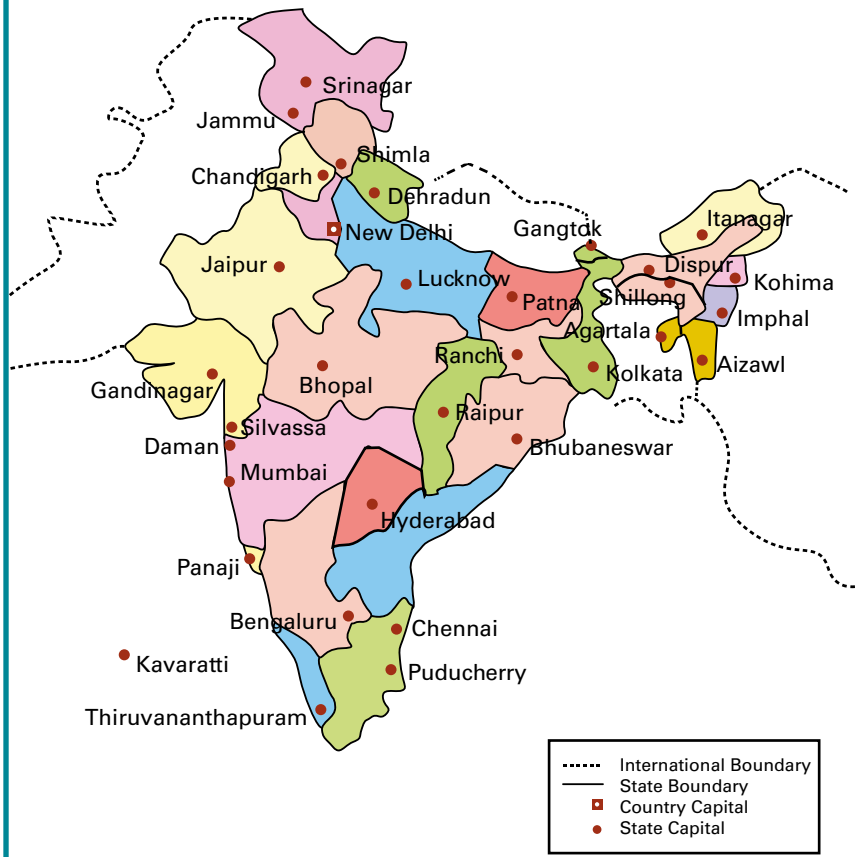
DESCRIPTION: The Agromet Advisory Services take quantitative 5-day local weather forecasts (rainfall, maximum and minimum temperatures, wind speed and direction, relative humidity and cloudiness) from IMD that are sent to 130 AgroMet Field Units which prepare value-added local crop advisories. The phenological stages of plant development are included in crop specific advisories to offer farmers guidance on cultural practices. All of the information is geared to help farmers maximize output and avert crop damage or loss. The Agromet Advisory Services also has an end-user group feedback mechanism to help the district level forecasters to tailor their services further.

DECISIONS: Assist farmers in making tactical decisions on which crops to plant and when, when to undertake fieldwork, apply fertilizer and pesticides, and when to harvest.

BENEFITS FOR: Crops, fruits, vegetables, livestock, water supplies for irrigation, efficient use of chemicals.

RESULTS: Agromet Advisory Services have decreased cultivation costs overall by up to 25%, increased net returns of farmer up to 83%. The crops that benefited most are paddy, wheat, pearl millet, and fruits and vegetables. Economic benefit estimated at USD 7.575 billion per year (Rathore and Chattopadhyay, 2016).

Network of AAS Units

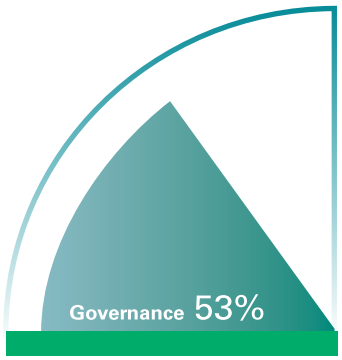


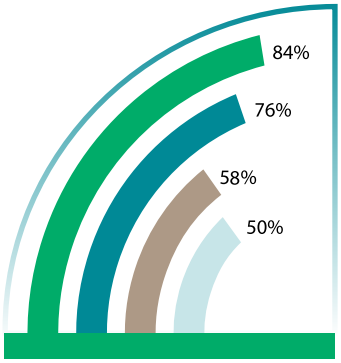
Status: **SOUTH AMERICA**

Significant trends in precipitation and temperature have been observed and acknowledged with high confidence in South America. There is high confidence that reduced precipitation and increased evapotranspiration in semi-arid regions will increase risks from water-supply shortages, affecting cities, hydropower generation, and agriculture (IPCC, 2014).

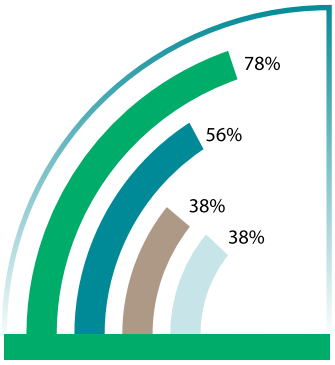
In terms of climate services capacities, Governance for climate services delivery appears to be an area in which this region is lagging behind compared to the global average, as are User Interface-related capacities. Basic Systems and Monitoring and Evaluation of socio-economic benefits capacities are close to the global average, while Provision and Application of Climate Services is above average. Strengthening stakeholders engagement, via User Interface and Governance mechanisms for climate services would better inform the Provision and Application of Climate Services and stimulate Monitoring and Evaluation of socio-economic benefits.

overview

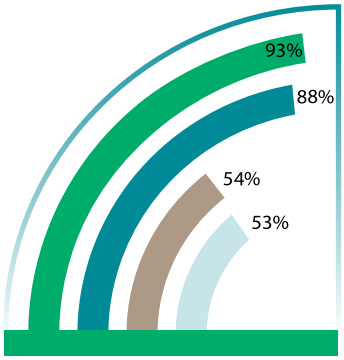




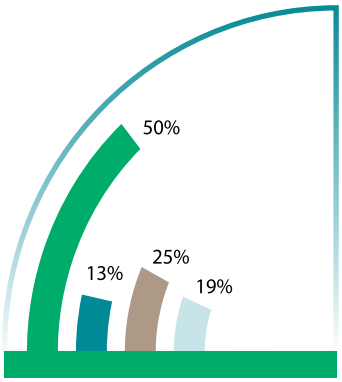
BASIC SYSTEMS



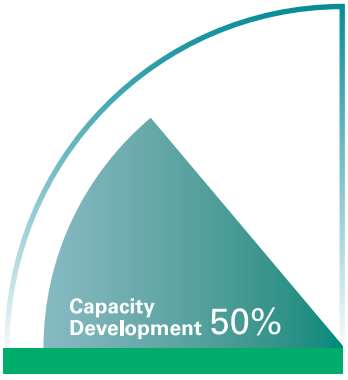
USER INTERFACE



PROVISION AND APPLICATION CS



MONITORING AND EVALUATION



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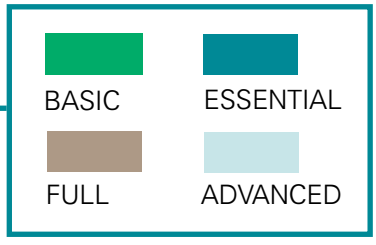


REGIONAL INFORMATION

COUNTRIES REPORTING DATA TO WMO ON CLIMATE SERVICE CAPACITY USED FOR THIS REPORT: 8 (67%)

WMO REGIONAL CLIMATE CENTRES:

DESIGNATED

- International Research Centre on El Niño (CIIFEN)
- RCC Network Southern South America (SSA)

PROPOSED

- RCC Network Northern South America (NSA)

NUMBER OF NATIONAL FRAMEWORKS FOR CLIMATE SERVICES (NFCSs):

- In progress 1
- Started 1
- Planned 2

WMO CLIMATE SERVICES CAPACITY LEVEL: BASIC: 2 (25%), ESSENTIAL: 4 (50%), AND ADVANCED: 2 (25%)

NUMBER OF COUNTRIES PROVIDING SERVICES TO THE AGRICULTURE AND FOOD SECURITY ACCORDING TO 2019 WMO DATA: 11

NUMBER OF REGIONAL CLIMATE OUTLOOK FORUMS: 2

Photo: Amanda Kerr

Example: **CLIMATE SERVICES PRODUCT**

TITLE: North-east Brazil's Drought Monitor

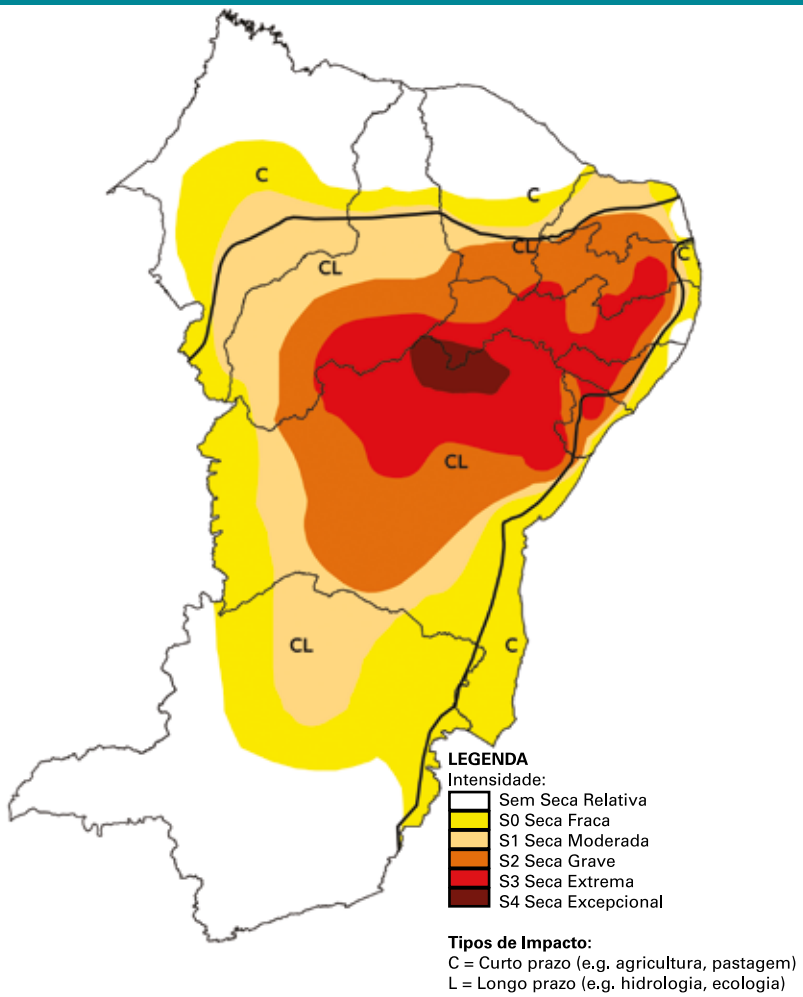
ORGANIZATION: National Water Agency of Brazil in coordination with 12 state and five national institutions

DESCRIPTION: The Drought Monitor provides regular, periodic monitoring of the drought situation in the north-east of Brazil. The Drought Monitor helps in improving drought early warning and prediction to support decision-making and policy at the federal, state and local levels.

DECISIONS: Levels of rivers and reservoirs for irrigation for crops.

BENEFITS FOR: Corn, soybeans, cacao, sugarcane, beans.

RESULTS: Integrated drought information at the federal, state and municipal levels in the areas of meteorology, water resources and agriculture in a collaborative effort among different institutions. Improves drought early warning and forecasting for decision-making and policy settings at the federal, state and local levels. Monitor is being used in three drought preparedness plans at the river basin, metropolitan region and municipality level.



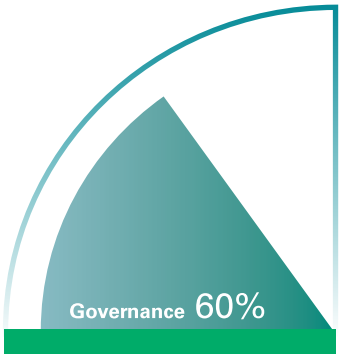
Status: NORTH AMERICA, CENTRAL AMERICA AND THE CARIBBEAN

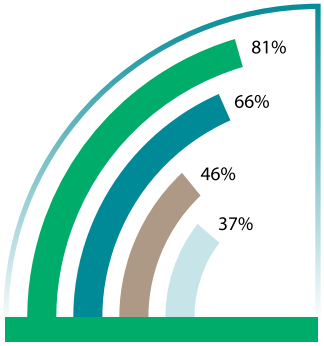
There is a very high level of confidence that a number of climate stresses will increase in frequency and/or severity in North and Central America and the Caribbean in the coming decades. Specifically, these include stresses related to severe heat, heavy precipitation, and declining snowpack. These changes are projected to lead to increased stresses to ecosystems due to changes in ice, snow cover, permafrost, and freshwater/ocean conditions. These changes will likely impact areas including agriculture, human health, urban and rural settlements, infrastructure, and the broader economy (IPCC, 2014).

The majority of the countries in this region which have reported data to WMO are SIDS, which is an important consideration in the interpretation of the results. The capacity needs in the region based on the data provided span all segments of the climate services value chain. These needs are likely reflective of those in other SIDS dominated regions, such as the Pacific and Indian Ocean, where data from SIDS countries is currently lacking. The results highlights the situation of Caribbean SIDS that are struggling to build their capacities for the production and use of climate information and services.

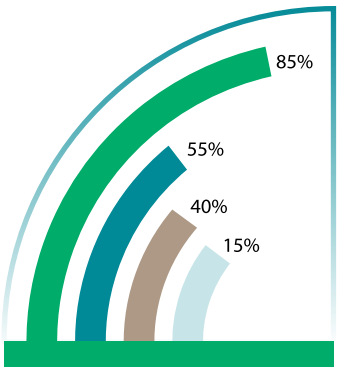
The challenges facing the SIDS in this region highlight the importance of a strong Regional Climate Centre (RCC) such as The Caribbean Institute of Meteorology and Hydrology (CIMH) which provide crucial support to the Caribbean countries. RCCs should be strengthened to play this role in other SIDS dominated regions as well.

overview

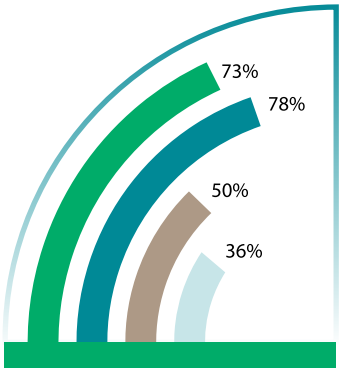




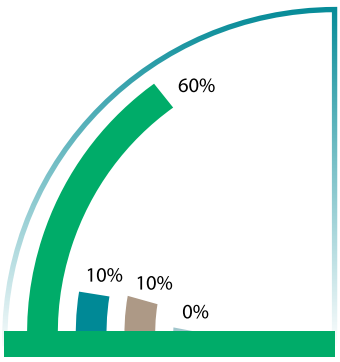
BASIC SYSTEMS



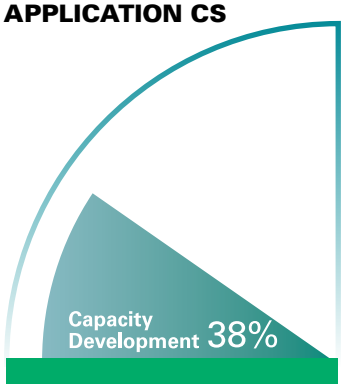
USER INTERFACE



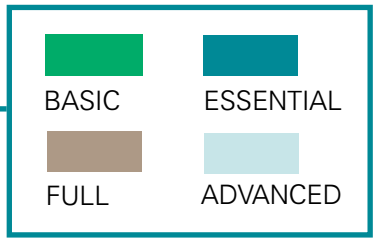
PROVISION AND APPLICATION CS



MONITORING AND EVALUATION



key



REGIONAL INFORMATION

COUNTRIES REPORTING DATA TO WMO ON CLIMATE SERVICES USED FOR THIS REPORT: 10 (43%)
WMO REGIONAL CLIMATE CENTRES:
DESIGNATED
- NOAA Climate Prediction Centre (CPC)
- Caribbean Institute for Meteorology and Hydrology (CIMH)

IN DEMONSTRATION PHASE
- Arctic RCC Network

NUMBER OF NATIONAL FRAMEWORKS FOR CLIMATE SERVICES (NFCSs):
- Started 1

WMO CLIMATE SERVICES CAPACITY LEVEL: LESS THAN BASIC: 1 (10%), BASIC: 3 (30%), ESSENTIAL: 5 (50%), FULL: 1 (10%)
NUMBER OF COUNTRIES PROVIDING SERVICES TO THE AGRICULTURE AND FOOD SECURITY ACCORDING TO 2019 WMO DATA: 15
NUMBER OF REGIONAL CLIMATE OUTLOOK FORUMS: 2 (and 1 Inter-Regional)

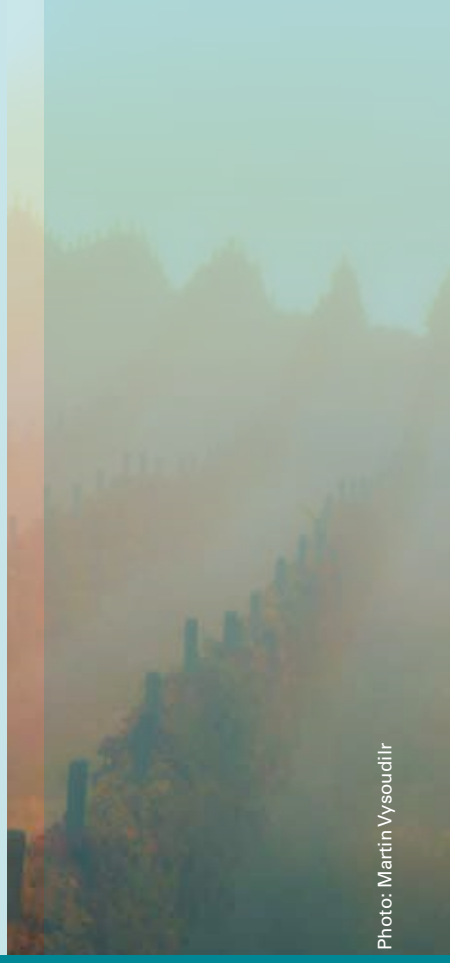
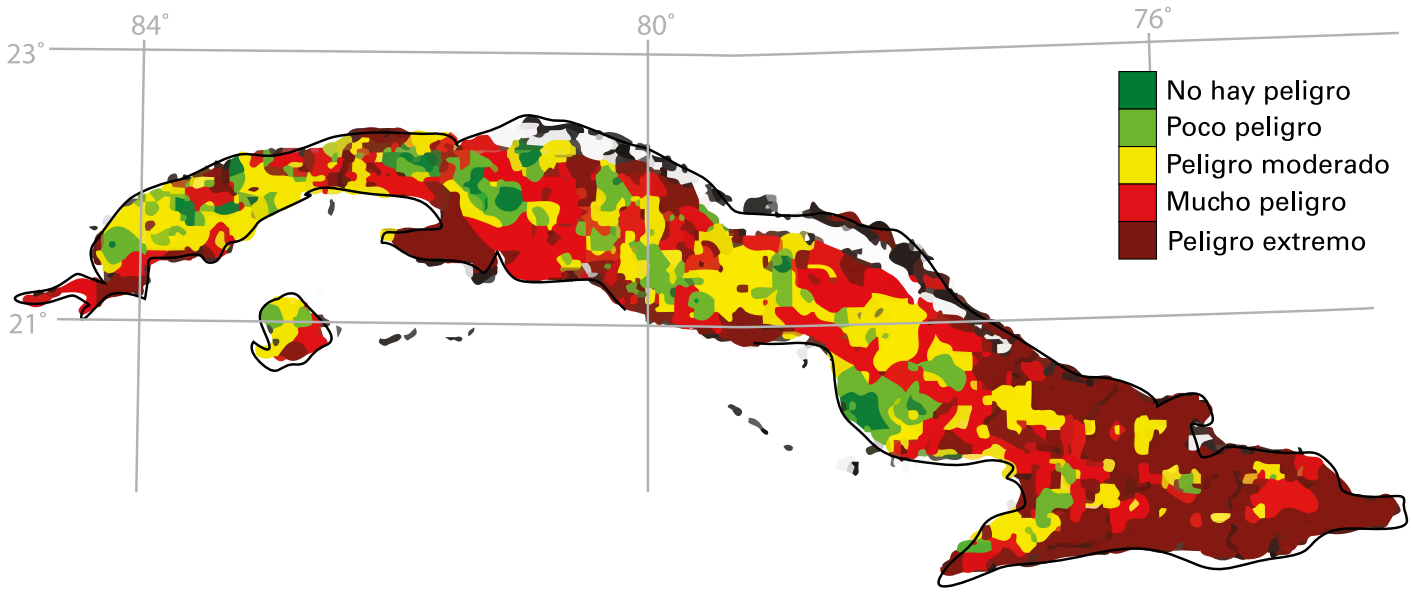


Photo: Martin Vysoudil/r

Example: **CLIMATE SERVICES PRODUCT**



TITLE: Cuba's fire danger index map, August 2019

ORGANIZATION: National Hydrological and Meteorological Service of Cuba (INSMET)

DESCRIPTION: The Fire Danger Index (FDI) is a rating system that provides an indication as to the fire risk for a specific area on a specific day. The FDI is calculated from temperature, relative humidity, wind speed and previous rain. The FDI is calculated for the real-time (present time) conditions. If these environmental factors are known for the coming period, the FDI can be forecast in advance.

DECISIONS: Assists farmers and foresters on whether to make planned burns. Policy makers can move firefighting resources to areas at a high risk of fire.

BENEFITS FOR: Rice, coffee, sugarcane, tobacco, citrus, cocoa, and forestry.

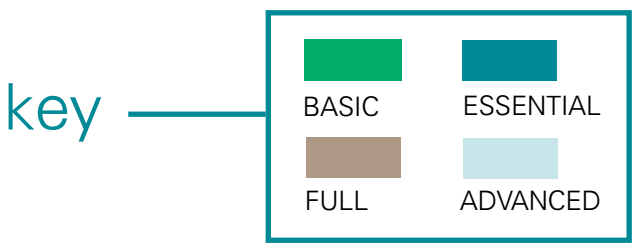
RESULTS: An alert system was designed that issues warnings for three different temporal scales, providing analyses of different agrometeorological indices and meteorological variables.

Status: SOUTH-WEST PACIFIC

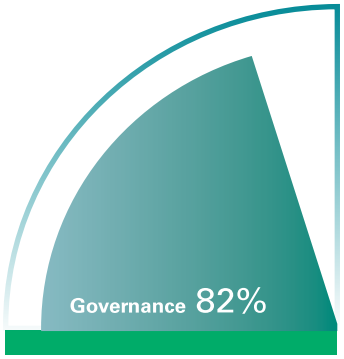
The region continues to experience long-term trends toward higher surface air and sea surface temperatures, greater heat extremes and fewer cold extremes as well as changes in rainfall patterns. Regional sea level rise will very likely exceed the historical rate. Impacts associated with recent extreme events, including tropical and extratropical cyclones, demonstrate the significant vulnerability of some ecosystems and many human systems. Given the inherent physical characteristics of small islands, the IPCC Fifth Assessment Report reconfirms the high level of vulnerability of small islands to multiple stressors, both climate and non-climate (IPCC, 2014).

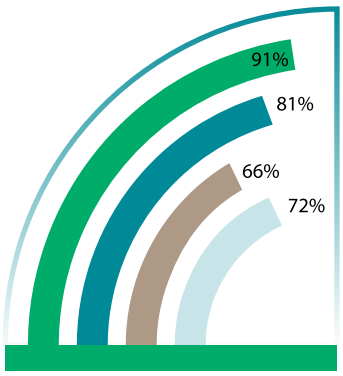
In interpreting the profile of climate services capacity for this region, it is essential to note that data were provided to WMO by only one SIDS among many advanced NMHSs which responded to the climate services checklist. Therefore, the results of the analysis are not representative of the capacities of SIDS in the region. That said, the countries that provided data are among the most advanced in the world given, based on their capacities in Governance, Basic Systems, User Interface, Capacity Development, and Provision and Application of Climate Services. As compared to the global average, the capacities are higher in all functional areas except for Monitoring and Evaluation of socio-economic outcomes and benefits associated with climate services. Therefore, further work is needed to complete the value chain with attention to this area.

Advanced capacities among the countries providing data for this region suggest that there is a high potential for "twinning" within the region, through which more advanced countries can assist the less advanced to build capacities and benefits from operational capabilities that are clearly present. Strengthening of RCC capacities is also important to address the needs of Pacific SIDS. Lack of data from SIDS in this region might be attributable to the lack of staff within the NMHSs.

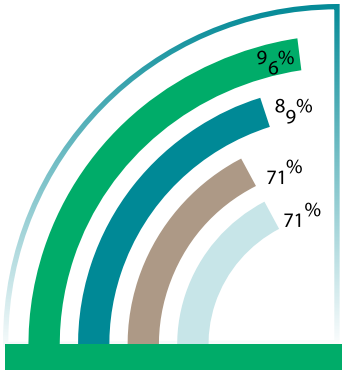


overview

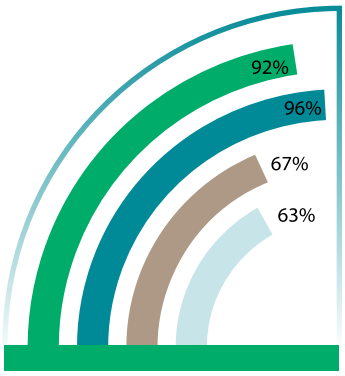




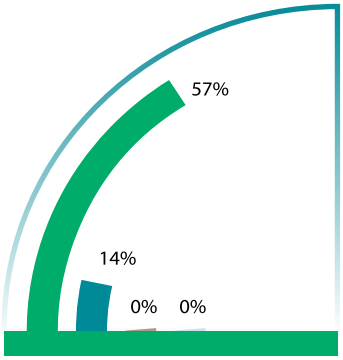
BASIC SYSTEMS



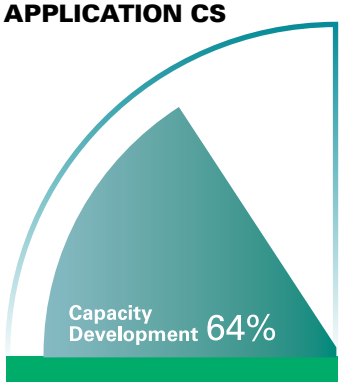
USER INTERFACE



PROVISION AND APPLICATION CS



MONITORING AND EVALUATION



REGIONAL INFORMATION

COUNTRIES PROVIDING DATA TO WMO ON CLIMATE SERVICES CAPACITY USED FOR THIS REPORT: 7 (33%)

WMO REGIONAL CLIMATE CENTRES:

IN DEMONSTRATION PHASE

- Pacific RCC Network
- South East Asia RCC Network

NUMBER OF NATIONAL FRAMEWORKS FOR CLIMATE SERVICES (NFCSs):

- Completed 1

WMO CLIMATE SERVICES CAPACITY LEVEL: ESSENTIAL: 3 (43%), FULL: 2 (29%), AND ADVANCED: 2 (29%)

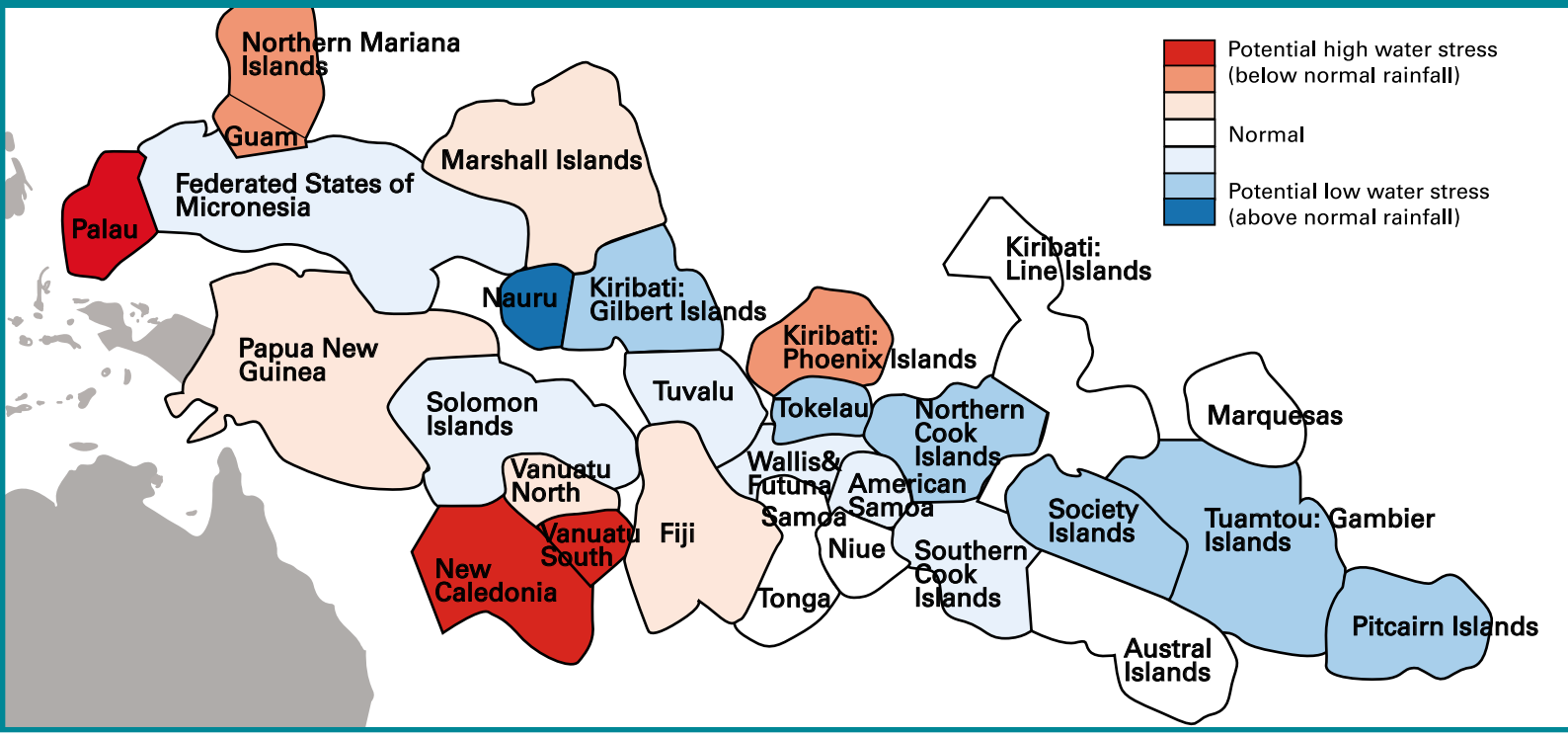
NUMBER OF COUNTRIES PROVIDING SERVICES TO THE AGRICULTURE AND FOOD SECURITY ACCORDING TO 2019

WMO DATA: 9

NUMBER OF REGIONAL CLIMATE OUTLOOK FORUMS: 3

Photo: Eugene Triguba

Example: **CLIMATE SERVICES PRODUCT**



TITLE: Regional Drought Potential Advisory, Aug.-Oct. 2019

ORGANIZATION: The National Institute of Water and Atmospheric Research (NIWA) of New Zealand in association with over 25 Pacific Island Meteorological and Hydrological Services and other supporting meteorological organizations.

DESCRIPTION: The regional drought potential advisory is based on rainfall anomaly classification over the past six months and forecast rainfall anomaly classification over the forthcoming three months.

DECISIONS: On what crops to plant and when to plant them; movement of livestock for better foraging conditions; when to use reservoir supplies for crops.

BENEFITS FOR: Crops, livestock, water management for irrigation.

RESULTS: Better early warning of drought events; input into national drought policies.

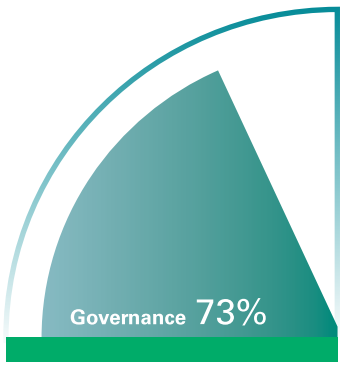
Status: **EUROPE**

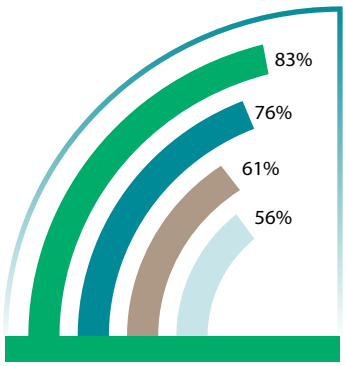
overview

Observed climate trends and future climate projections show regionally varying changes in temperature and rainfall in Europe. The observed climate change has had wide ranging effects throughout the European region including the distribution, phenology, and abundance of animal, fish, and plant species. There will be a marked increase in extremes in Europe, in particular, in heat waves, droughts, and heavy precipitation events which will result in a decrease in agricultural yields in Southern Europe, future energy production, coastal and river flood risks and reduced water availability (IPCC, 2014).

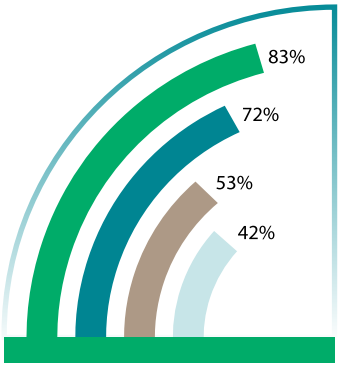
Data for this region was provided by countries with advanced as well as less advanced climate services capacities, and capacities vary significantly across the region. Consequently, the results shows that the region is close to, but above average in every area except Provision and Application of Climate Services, which is below average. More data is needed to explain this apparent Provision and Application of Climate Services gap, given that the region is slightly better than the global average in Monitoring and Evaluation of socio-economic outcomes and benefits.

The Copernicus Climate Change Service (C3S) is an important regional and global resource for supporting Provision and Application of Climate Services. By offering free and open access to climate data and tools based on the best available science, C3S program of the European Commission's (EC) Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, supports society by providing authoritative information about the past, present and future climate. The Copernicus program has the potential to meet the service provision gap identified by some countries within the region. While the primary target region is Europe, C3S will bring benefits to other regions as well. As of September 2019, 20 400 users have registered for the service across 189 countries.

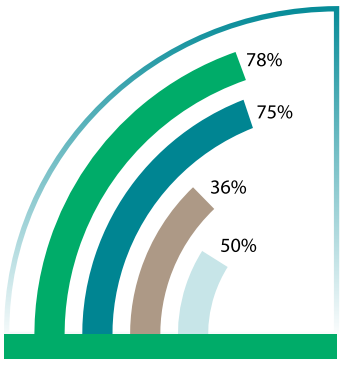




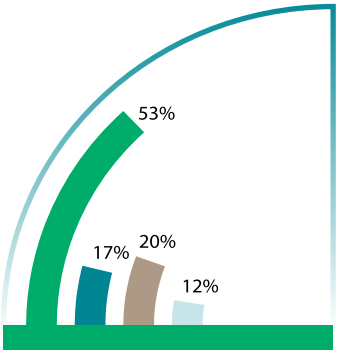
BASIC SYSTEMS



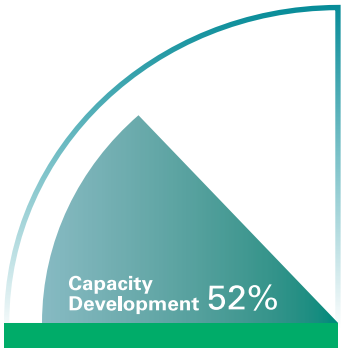
USER INTERFACE

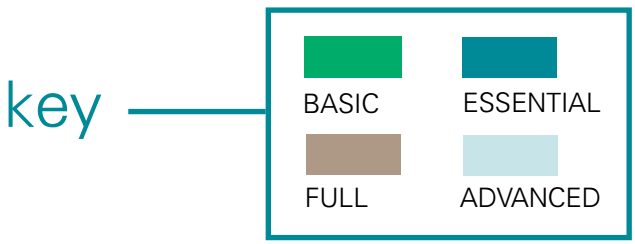


PROVISION AND APPLICATION CS



MONITORING AND EVALUATION





REGIONAL INFORMATION

COUNTRIES REPORTING DATA TO WMO ON CLIMATE SERVICES CAPACITY USED FOR THIS REPORT: 30 (60%)

REGIONAL CLIMATE CENTRES:

DESIGNATED

- North EurAsia Climate Centre (NEACC)
- RCC Network Europe

IN DEMONSTRATION PHASE

- Arctic RCC Network

NUMBER OF NATIONAL FRAMEWORKS FOR CLIMATE SERVICES (NFCSs):

- Operational 3
- In progress 1

WMO CLIMATE SERVICES CAPACITY LEVEL: LESS THAN BASIC: 1 (3%), BASIC: 8 (27%), ESSENTIAL: 12 (40%), FULL: 5 (17%), AND ADVANCED: 4 (13%)

NUMBER OF COUNTRIES PROVIDING SERVICES TO AGRICULTURE AND FOOD SECURITY ACCORDING TO 2019 WMO DATA: 43

NUMBER OF REGIONAL CLIMATE OUTLOOK FORUMS: 3 (and 1 Inter-Regional)

Photo: Marco Formo

Example: **CLIMATE SERVICES PRODUCT**

TITLE: Relative Index of Pasture Productivity, July 2019

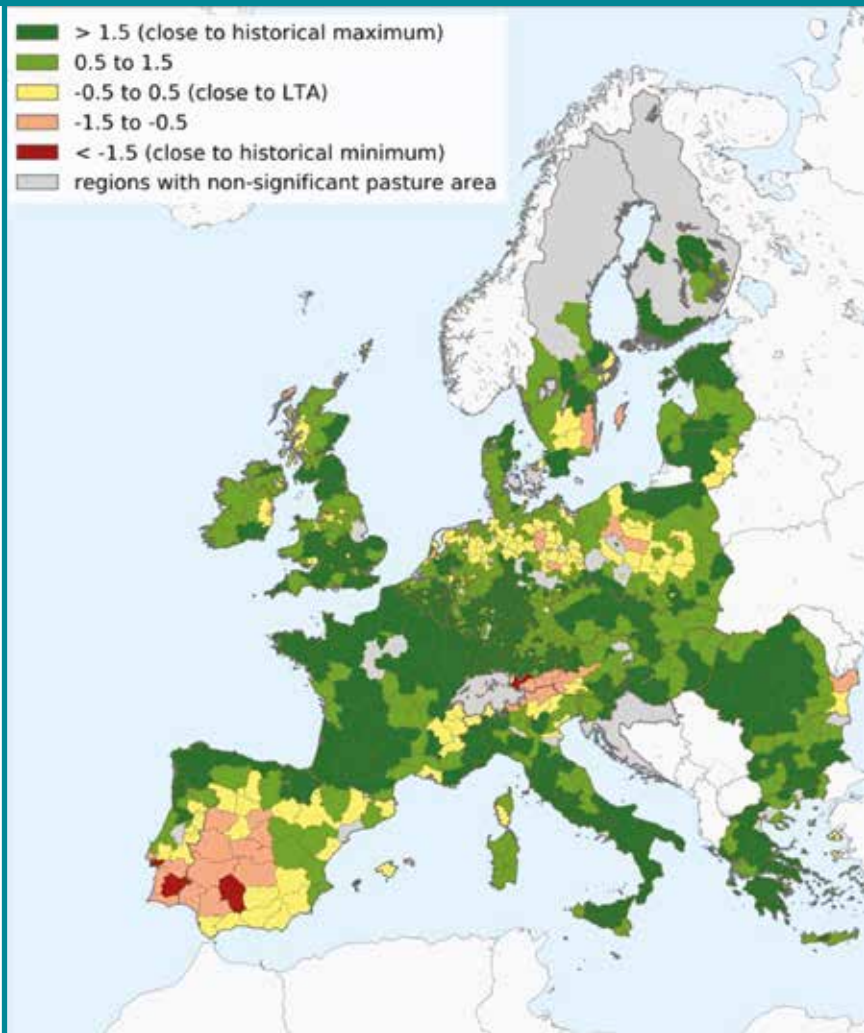
ORGANIZATION: European Commission

DESCRIPTION: The relative Index of Pasture Productivity is an indicator of biomass formation based on the integration of the FAPAR (the fraction of absorbed photosynthetically active radiation) remote sensing product over pasture areas at a regional level over a period of interest.

DECISIONS: Ranchers can determine where their livestock should be moved or if they need supplemental feed. European level policy-makers can adjust assistance to ranchers and verify impacts of drought for disaster payments.

BENEFITS FOR: Livestock

RESULTS: More efficient management of livestock.



Investment

While substantially increased over the past decade, more and better investments are still needed to ensure the provision of high-quality climate information and services for climate-resilient action.

More is needed. The World Bank estimates that additional investments beyond those already programmed of up to USD 2 billion are needed to create national institutions that are capable, and fully equipped, to deliver timely, reliable climate, weather and water information and services relevant for policy and investment decisions. The Alliance for Hydromet Development aims at scaling up the efforts of major development and climate finance partners to close the capacity gap on high-quality weather forecasts, early warning systems, and climate information services through collective action. It will bring WMO and development and climate finance partners together to close the finance gap on climate services.

Photo: Yang Shuo

Some examples of current financing for climate services:

The Adaptation Fund (AF) has financed early warning and climate services related project components embedded within at least 37 projects, totaling USD 303.8 million, that cut across various adaptation sectors in the AF project/programme portfolio. Out of this amount, approximately USD 34 million are allocated specifically towards concrete components focusing on climate services and early warning and related activities in its projects in various sectors. The regions receiving the highest share of this funding are Africa, Asia-Pacific, Latin America and the Caribbean.

The Green Climate Fund (GCF) has invested USD 649 million and leveraged an additional USD 899 million for a total of USD 1.55 billion investment in climate information and early warning systems. About 75% of these investments are in cross-sectoral applications whereas 25% focus on modernizing hydromet services. About 79% of projects were developed and are being implemented by international Accredited Entities, compared to 21% by direct access Accredited Entities. The regional distribution comprises Africa (34%), Asia-Pacific (42%), Latin America and the Caribbean (18%) and Eastern/ Central Europe (6%). These investments have the potential to produce a high impact and shift paradigms in climate action in a large number of countries. An estimated 125 million people are expected to benefit from climate risk reduction in terms of reducing multiple hazards, securing lives and livelihoods, and protecting assets.

The Global Environment Facility (GEF), through the Least Developed Countries Fund (LDCF) and Special Climate Change Fund (SCCF), has in total provided approximately USD 415 million to 63 projects which focus on climate services and early warning systems. Africa and Asia are the regions towards which most GEF support is being allocated. The GEF's implementing partners and countries have greatly increased their awareness and capacity on climate change impacts and adaptation. For projects that are sensitive or vulnerable to climate change, countries increasingly recognize that project design and implementation are to address current and future climate risk.

The World Bank has invested approximately USD 1.2 billion in the strengthening of weather and climate services and early warning systems. In 2019 the program reached 60 projects, with total investments of USD 944 million. The pipeline of identified future investments has increased by another USD 250 million. Since 2010, World Bank investments in weather and climate services have almost quintupled, with the bulk of this new volume concentrated in South Asia and Africa. In addition, through its recently announced Action Plan on Climate Change Adaptation and Resilience, the Bank committed to providing an annual investment of USD 10 billion for climate-change adaptation, including better forecasts, EWS, and climate services in 30 countries. More than 250 million people are expected to benefit.

CASE STUDY
GLOBAL

Informing the design of climate adaptation policies and programmes through better understanding of climate change impacts on food security and nutrition

The World Food Program's Climate and Food Security Analysis increases the ability of vulnerable communities and governments to build resilience to climate-related risks and climate change.

Photo: Sho Hatakeyama

PARTNERS: The World Food Programme and key research partners

TIMELINE: 2010–ongoing

CHALLENGE

The development of climate adaptation policies and programmes needs to be built on a clear understanding of climate change impacts on key sectors to ensure that climate adaptation interventions are tailored to meet specific needs of vulnerable communities and governments and designed to support greater resilience to current and projected climate variability and extreme weather events. Given the diversity of impacts and risks at the local, regional and at country levels, information is needed to aid communities, governments and organizations in developing a range of possible adaptation actions to help decision-makers identify the most appropriate policies and programmes. Specifically, these needs range from developing a better understanding of vulnerabilities, designing more effective strategic plans and enabling better planning of resources and access to climate finance.

OUTCOMES

A key measure of the success of the Climate and Food Security Analyses is the development of national strategies and policies for countries which were integrated with and informed by climate change adaptation priorities.

APPROACH

CLIMATE SERVICES INFORMATION SYSTEM: WFP developed different methodologies for their climate and food security analysis, based on country-specific needs.

An example is the Consolidated Livelihood Exercise for Analysing Resilience (CLEAR), a methodology that has been developed by WFP Asia Pacific to understand how food security will be affected by climate-related risks, both in terms of extreme weather events and gradual changes. The approach also helps policy-makers to better understand how a changing climate may affect people's lives, their food consumption, and their income and expenditures. To date, CLEAR assessments have been completed in Cambodia, Lao PDR, Sri Lanka, Nepal, Timor-Leste and Vietnam, and additional countries are planned. Additional methodologies WFP adopts include: (i) Historical Analysis, which examines the historical relationship between climate risks and vulnerability of food-insecure populations, therefore based on past trends of climate shocks, (ii) Climate Risk Analysis, which examines short-term impacts of climate variability on food security and nutrition, therefore focusing on past and present trends in climate shocks, and (iii) Climate Change Analyses, which identifies longer-term shifts in climate (e.g. precipitation, temperature, seasonal patterns) based on future climate change projections.

USER INTERFACE PLATFORM: Consultations with relevant stakeholders are conducted throughout the different stages of the analysis to ensure transparency, accountability and engagement. Once the analysis is completed, validation of results enhances ownership. This improves the likelihood that the analysis is used in policies and programme design.

CASE STUDY
EUROPE

Strengthening agrometeorological services and early warning systems in North Macedonia

case study 3

The project successfully supported the technical capacity of national institutions to produce and disseminate agrometeorological information to farmers and other stakeholders.

Photo: Hari Nandakumar

PARTNERS: Food and Agriculture Organization, the Macedonian Hydrometeorological Service (HMS) and the Ministry of Agriculture, Forestry and Water Economy (MAFWE)

TIMELINE: 2016–2019

CHALLENGE

The institutional capacity of the government and other entities needed improvement, especially in the area of assessing climate-change impacts and identifying adaptation options for providing improved extension and education materials to farmers. Lack of coordination and training within national institutions affected the effectiveness of data collection and the quality of reporting. Collection and processing of data from meteorological and agrometeorological stations needed to be calibrated and systematized into databases.

OUTPUTS

(a) Successfully supported the technical capacity of national institutions to produce and disseminate agrometeorological information to farmers and others

(b) Increased automatic agrometeorological network in agriculturally important regions

(c) Development of knowledge sharing web portal

(d) Capacities built for monitoring of plant diseases and phenology with academic and international partners (plant disease model applied: Powdery Mildew (Uncinula necator) of Grape Vine).

APPROACH

The project's multiple objectives included strengthening capacity development, improving the climate service products offered by the NMHS, and building a coordinated network among national stakeholders.

CAPACITY DEVELOPMENT: Institutional capacities and administrative structure in MAFWE to support the transition to Climate-Smart Agriculture measures are improved. Increased coordination between government institutions and academia.

CLIMATE SERVICES INFORMATION SYSTEM: Technical capacities of NMHS (specifically the Agrometeorology Department) to develop climate services and provide early warnings were tailored to the needs of stakeholders in the agricultural sector.

USER INTERFACE PLATFORM: Among national and international research entities and extension services there was an improved display and dissemination of research results into useful extension products and farmer services.

CASE STUDY
ASIA

Mainstreaming Climate Change Adaptation in Irrigated Agriculture in China

Climate Services served as a starting point for shaping a climate change adaptation strategy in an ongoing project to increase agricultural productivity and improve water efficiency in a major agricultural region in China

OUTCOMES

Average per capita income among farmers rose by USD 326 per year, and high-value crop production rose from 3.2 million tons to 4.2 million tons per year (S. Dobardzic, et al. 2016).

PARTNERS: The Global Environment Facility's Special Climate Change Fund (SCCF), Government of China, World Bank and other partners

TIMELINE: 2008–2012

CHALLENGE

Grain production in an important agricultural region in China was in decline due to increased water scarcity. Large scale irrigation projects had been started but because of climate change this region was especially vulnerable and adjustments needed to be made in the ongoing irrigation project.

APPROACH

CLIMATE SERVICES INFORMATION SYSTEM: Focus centered on identifying and prioritizing adaptation options. The project assessed climate change projections for the region, identifying regional vulnerabilities that could be exacerbated because of climate change, and identifying different actions to help reduce vulnerability in the region

USER INTERFACE PLATFORM: The largest component of the work sought to demonstrate, implement, and integrate adaptation measures among stakeholder groups. Significant effort and resources were put into applying the solutions found in the assessments.

CAPACITY DEVELOPMENT: Emphasis was placed on mainstreaming adaptation into the national Comprehensive Agriculture Development program and strengthening institutional capacity. This centered on research and development of adaptation policies, building institutional capacity on climate change adaptation, monitoring and evaluation, and project management.

CASE STUDY
WEST AFRICA

Providing training and seminars to improve decision-making at the local level in West Africa

Roving Seminars increased crop production by building rural farmers' knowledge and access to information during the growing seasons. The Seminars focused on how to better generate and integrate climate services and information at local level.

Photo: Markus Spiske

PARTNERS: World Metorological Organization

TIMELINE: 2012–2015

CHALLENGE

Farmers in West African countries needed to build capacity across several areas including improving skills in weather and climate risk management and the use of weather and climate information and services to improve rural agricultural production, and preparation against the weather threats emerging from climate change.

OUTCOMES

Project outcomes include:

(a) Better strategic choices by farmers on seed varieties;
(b) Better decisions on appropriate planting date to avoid losses;
(c) Better choices regarding favorable periods for fieldwork resulting in better alignment of crop development cycles with the rhythm of the rains;
(d) 35% increase in crops yields reported in project evaluations for four countries;
(e) USD 45/ha savings achieved by not weeding.

APPROACH

CAPACITY DEVELOPMENT: one to two-day Roving Seminars on Weather, Climate and Farmers were conducted with the aim of sensitizing farmers to weather and climate information and how best to apply that information to their operational farm management.

The objective was to provide farmers with increased information for dealing with weather and climate impacts on agricultural production on their farms and to increase the interaction between local farming communities and local staff of NMHSs. Farmer feedback was also crucial in enabling NMHS staff to provide better services for the agricultural community. The seminars focused on five main areas: climate variability and climate change, specific climate risks to agriculture in each region, agro meteorology products and tools, agronomic research for adaptation to climate change, and farmer perception of weather and climate information provision and feedback.

18 400 people from 4 500 villages have been trained through 428 Roving Seminars in 17 different countries. Among participants, 11 042 were farmers and 1 457 extension and other services' agents. Among farmers, 1 464 were women (13%). An average of 46 people participated in each seminar, representing 17 villages.

USER INTERFACE PLATFORM: Significant effort was devoted to obtaining farmer feedback fostering participation and building capacity among agricultural extension agents, establishing routes for information flow between stakeholders, and developing methods for rapid processing of data and their conversion into appropriate and useful advice.

OBSERVATION AND MONITORING: 8 125 plastic rain gauges have been distributed, an average of 18 per seminar. Seminars provided training on rainfall observation techniques, data collection and transmission and rain gauge installation.

CASE STUDY
SOUTH AMERICA

Integrating stakeholders from the agricultural sector at the local level to co-produce services for smallholder farmers

Blended committees of scientists, agricultural technicians, public and private sector stakeholders and local farmers generate seasonal climate information, and develop recommendations to reduce the negative impacts of climate variations on agricultural production and livelihoods.

Photo: Annie Spratt

OUTPUTS

(a) Due to the success of the committees, since the initial pilot of LTACs in Colombia in 2014, programmes have expanded to Honduras, Guatemala and Nicaragua;

(b) More than 500 000 farmers have been served across the four countries by both receiving and working to build relevant climate information for agriculture;

(a) A network of more than 200 institutions across Latin America has been built for the purpose of producing and developing climate and crop prediction tools.

CHALLENGE

Coordination and dialogue were needed across a range of stakeholders to co-produce information to reduce the negative effects and take advantage of the opportunities that climate variability has on key agricultural systems

APPROACH

USER INTERFACE PLATFORM: Local Technical Agro-Climatic Committees (LTACs) were developed to facilitate discussions between departmental secretariats of agriculture ministries, guilds, regional environmental authorities, universities, producer associations, municipal technical assistance units (UMATA), research centres, among others, for the management of local agro climatic information. This was done to help identify best practices for adaptation to climatic phenomena. Once the information was developed, it was transferred to local technicians and producers through the Local Agro climatic Bulletin newsletter. This newsletter summarized the seasonal predictions and climate forecasts that were analysed at the LTAC, along with recommendations and climate-smart practices by crop type (Loboguerrero et al., 2018).

CAPACITY DEVELOPMENT: The LTAC approach also sought to strengthen participants' capacities by conducting training workshops on agro-climatic information and tools which are used to inform crop management decisions. To build skills, it also focused on empowering members of the committees by assigning alternating roles and tasks among participating organizations.

CLIMATE SERVICES INFORMATION SYSTEM: The initiative also developed climate and crop prediction tools and fostered co-production, translation, transfer, and use of climate information for agriculture. This included enhancing the quality of seasonal forecasts and tailoring forecast information for agricultural decision making.

PARTNERS: CGIAR Research Programme on Climate Change Agriculture and Food Security (CCAFS) in coordination with Colombia Ministry of Agriculture and Rural Development and other partners

TIMELINE: 2014–ongoing

Gaps

1. **NEEDS FOR CAPACITY STRENGTHENING IN KEY REGIONS:** Capacity gaps with regard to the provision of climate services in Africa and SIDS are the most urgent to be addressed. 41% of countries in Africa are providing services at basic or less than basic level of capacity and SIDS in the Caribbean are lagging behind in all six functional areas as compared to the global average. Even data on climate services capacity from many SIDS is lacking.

2. **MONITORING AND EVALUATION OF SOCIO-ECONOMIC OUTCOMES AND BENEFITS OF CLIMATE SERVICES IS CONSISTENTLY WEAK WORLDWIDE:** Overall, available WMO data suggests that there has been progress on governance for climate services, implementation of basic hydrometeorological systems, and stakeholder engagement for the implementation of climate services, but the set of functional capacities focused on monitoring and evaluation of the results and benefits of the use of climate services remains weak. Systematic documentation of adaptation outcomes and returns on investments are essential for financial sustainability.

3. **SYSTEMATIC OBSERVATIONS GAPS:** Today important observational data from many developing countries are missing. Observational data availability from most developing countries is insufficient to meet even the minimum global basic observing network for the global weather prediction that underpins climate services, to determine local impacts and it is getting worse at an alarming rate. Lack of integrated networks, the fundamental mismatch between today's developing country financing of observations and the value these observations create for the global public good; and lack of sustained and predictable finance for capacity development continue to be the primary obstacles, aggravated by a limited awareness amongst senior decision makers on the use and benefits of these unique observations.

4. **COORDINATION AND DATA SHARING:** Data sharing and co-production of climate services between NMHSs and other ministries or research institutions remains limited due to a lack of interdepartmental agreements and of resources for NMHSs. Operational exchange of data and products between national, regional and global levels needs to be strengthened.

5. **LAST MILE BARRIER:** Even when relevant agrometeorological information is produced at the national level, the information may not reach the intended end user(s) such as farming communities. Information produced by NMHSs should be tailored according to the needs of users at the local level and presented in a way and in a language that ensures that it is comprehensible for decision-making. Employing new technologies or information systems including web-based portals, digital applications, SMS or radio services to reach farmers and rural dwellers is needed to improve information access and use.

Recommendations

1. **CLIMATE SERVICES WITH PROVEN DEMONSTRATED BENEFITS FOR ADAPTATION IN THE AGRICULTURAL SECTOR NEED TO BE OPERATIONALIZED, SCALED UP AND SUPPORTED BY ADEQUATE FINANCING:** In place of the current, project-by-project, piecemeal, financing model, fit-for-purpose financial support suitable for enhancing the global-regional-national operational hydrometeorological system to support country-level agrometeorological service delivery is necessary. The benefits in investing in the global cascading operational system as an integrated, global-regional-national entity outweigh the costs by about 80 to one (Kull et al. 2016).

2. **SYSTEMATIC OBSERVATIONS:** A global network of systematic observations is fundamental for the provision of services, yet poorer countries bear a disproportionate burden for financing such systems within their borders, leading to many observations gaps. While financing for systematic observations is increasingly available, there is a need to provide financial resources in sustained and new ways through innovative finance that values the global public good that observations provide, ensures coherence of development activities and integration into the observations network, provides long-term finance beyond time-bound projects, incentivizes country performance and data sharing; and ensures sustainability of investments – beyond business as usual. Observational gaps are to be filled through data rescue, data merging and strategic observing infrastructure investments.

3. **THE URGENCY OF ACTION FOR SIDS AND AFRICA:** Climate change may depress growth in global yields by 5–30 % by 2050 (GCA, 2019). Impacts from the increase in the number of extreme weather events is also impacting food insecure communities the hardest and reducing their capacity to cope and access food (WFP). Due to the large magnitude and scale of projected climate impacts and the priority accorded to the agriculture sector in countries NDCs and NAPs, the international donor community should develop a coherent approach and scale up technical and financial support for upgrading and enhancing a full value chain of proven climate services for agriculture with a special focus on Africa, least developed countries (LDCs) and SIDS, including addressing the existing gaps identified in this report.

4. **ADDRESSING THE "LAST MILE" BARRIER:** Multi-stakeholder governance and partnerships are crucial for innovation in climate services enabling information sharing and feedback, by connecting different actors along the climate services value chain. Increased recognition of the needs of youth and women and their engagement in innovation for climate services in agriculture and food security is required. At the same time, a shift from top-down push of information to users should be replaced by co-production processes, whereby final users are engaged at all times in the development of information and products.

5. **ENHANCED CLIMATE SCIENCE BASIS FOR PRIORITY CLIMATE ACTIONS:** The generation and use of climate information for planning and decision-making should be strengthened, drawing on the best available climate observations, data and science. To ensure the best societal outcomes from climate action, information on past, present and potential future climate conditions affecting impacts and adaptation outcomes in agriculture and other climate-sensitive sectors should be systematically integrated in national adaptation policies and project planning. The relevance and adequacy of climate information for decision-making can be identified through collaborative, multi-stakeholder, country-level processes, drawing on the resources of the global hydrometeorological community and this information flowing across global to local scales. Participation of key users from the agriculture and food security sector is essential to inform research needs of the future.

6. **SYSTEMATIC MONITORING AND EVALUATION OF SOCIO-ECONOMIC BENEFITS ASSOCIATED WITH CLIMATE SERVICES IS NEEDED:** Improved documentation of socio-economic outcomes and improvements thereof in relation to investments to document the returns on these investments, and good practices, will be essential as levels of investment continue to grow. Consolidation and management of this body of knowledge will be needed to facilitate cross-country learning and sharing.

Acronyms

ACMAD - The African Centre of Meteorological Applications for Development
AF - Adaptation Fund
AGRHYMET - AGRrometeorology, HYdrology, METeorology Regional Centre
ANACIM - Agence Nationale de l'Aviation Civile et de la Météorologie
ASIS – Agriculture Stress Index System
BCC- Beijing Climate Centre
BMKG- Indonesian Agency for Meteorology, Climatology, and Geophysics
C3S - Copernicus Climate Change Service
CCAFS - CGIAR Climate Change Agriculture and Food Security
CIIFEN - International Research Centre on El Niño
CIMH - Caribbean Institute for Meteorology and Hydrology
CLEAR - Consolidated Livelihood Exercise for Analysing Resilience
CMIP - Coupled Model Intercomparison Project
CMA - Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CORDEX - Coordinated Regional Climate Downscaling Experiment
CPC - Climate Prediction Centre
DRMFSS - Disaster Risk Management and Food Security Sector
EC - European Commission
ECCAS - Economic Community of Central African States
ECOWAS - Economic Community of West African States
ECV - Essential Climate Variable
EU - European Union
FAO - Food and Agriculture Organization of the UN
FAPAR - Fraction of Absorbed Photosynthetically Active Radiation
FbF - Forecast-based Financing
FDI - Fire Danger Index
FFS - Farmer Field School
GBON - Global Basic Observing Network
GCF - Green Climate Fund
GCOS - Global Climate Observing System
GEF - Global Environment Facility
GFCS - Global Framework for Climate Services
GFDRR - Global Facility for Disaster Reduction and Recovery
GPCLRF - Global Producing Centres for Long-Range Forecast
HMS - Hydrometeorological Service in the Republic of Macedonia
ICPAC - Climate Prediction & Applications Centre of IGAD
IGAD - Intergovernmental Authority on Development
IMD - Indian Meteorological Department
INSMET - Meteorological Institute of Cuba
IPCC - Intergovernmental Panel on Climate Change
LDCF - Least Developed Countries Fund
LDCs - Least Developed Countries
LTACs - Local Technical Agro-Climatic Committees
MAFWE - Ministry of Agriculture, Forestry, and Water Economy of the Republic of Macedonia
NAPs - National Adaptation Plans
NDCs - Nationally Determined Contributions
NEACC - North EurAsia Climate Centre
NIWA - National Institute of Water and Atmospheric Research of New Zealand
NMHSs - National Meteorological and Hydrological Services
NOAA - National Oceanic and Atmospheric Administration
NSA - Northern South America
NWP - Numerical Weather Prediction
RCC - Regional Climate Centre
RCOF - Regional Climate Outlook Forum
SADC – CSC - Southern African Development Community Climate Services Centre
SCCF - Special Climate Change Fund
SDGs - Sustainable Development Goals
SIDSs - Small Island Developing States
SSA - Southern South America
TCC -Tokyo Climate Centre
TCP - Technical Cooperation Programme
UMATA - Municipal Units of Agricultural Technical Assistance
UNFCCC - United Nations Framework Convention on Climate Change
USAID - United States Agency for International Development
WBG - World Bank Group
WCRP - World Climate Research Programme
WFP - World Food Programme
WIGOS - WMO Integrated Global Observing System
WMO - World Meteorological Organization

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Photo: Adrian Gaede

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