

Checklist for Climate Services Implementation

This checklist is for National Meteorological and Hydrological Services (NMHSs) to self-assess progress with respect to climate services implementation and identify areas where support is needed. The checklist refers to the [Country-focused results based framework for WMO contribution to the GFCS](#) approved by the 68th WMO Executive Council ([abridged report](#) pp. 82-92).

The checklist consists of "YES/NO" self-assessments as to the degree to which actions have been taken or outputs generated. These actions or outputs are grouped into the categories of:

- Governance
- Basic Systems
- User Interface
- Capacity Development
- Provision and Application of Climate Services
- Monitoring and Evaluation.

Within each grouping, actions or outputs are listed under the "Basic, Essential, Full, Advanced" headings. Ideally simultaneous actions will be taken in all categories, moving from left to right, from "Basic" to "Advanced".

Key next steps, where such actions or outputs have not been completed, may be candidates for further effort and/or technical support. Please review each section and select the option that applies by checking the respective box (double-click on the appropriate grey box, select "checked" as "Default value", then OK).

Objective: Institutional, technical, financial, and human resources mobilized for climate services planning, implementation and results monitoring targeting climate-sensitive national priorities

Governance

1. Identification of climate-sensitive national development priorities (Indicate if the following strategy/plans are available at national level):
 - NDC¹: YES NO
 - NAP2: YES NO
 - National Development Policy or Strategy: YES NO
 - National DRM3 Strategy YES NO
 - National sectoral policies and strategies (e.g. food security, health, etc.): YES NO

2. Capacity assessments of key stakeholders (including NMHSs and NHSs):
 - Identify key stakeholders for improving climate-related outcomes in priority sectors (UIPs4 focused on GFCS5 priorities: health, agriculture and food security, WRM6, energy, DRM): YES NO
 - Identify key climatic factors of socio-economic significance at the national levels, establish baseline knowledge based on capacity assessments and co-define with stakeholders climate information needs for sectoral decision-making at national level: YES NO
 - Identify feasible climate services for meeting priority needs and capacity needs/requirements for their development and delivery: YES NO

3. National implementation plans/frameworks (e.g. NAPs or national action plans):
 - Verify status of and consult/support development and/or implementation of NAP and other plans listed in point 1 above reflecting priority needs: YES NO
 - Co-develop national action plan for climate services (if appropriate, depending on status of/prospects for NAP) in response to priority needs: YES NO
 - Establish institutional mandates for providing climate services as well as for using climate services, with the aim to mainstream efficient and well-informed climate risk management practices at all levels: YES NO

¹ NDC - Nationally Determined Contribution to the Paris Agreement

² NAP - National Adaptation Plan

³ DRM – Disaster risk management

⁴ UIP – User interface platform

⁵ GFCS – Global Framework for Climate Services

⁶ WRM – Water resource management

4. Resources reviews of relevant on-going and planned partner projects:

- Consult list of planned or on-going major adaptation (and mitigation) investment programmes (GEF7, GCF8, Adaptation Fund, PPCR9, development banks, RECs10): YES NO
- Jointly meet with national government Ministries/Departments and their counterpart(s) major international organizations (UNDP11, IFIs12, WFP13, FAO14, WHO15 etc.) as necessary to articulate NMHS needs to support development decisions: YES NO
- Negotiate access to financing from on-going programmes and/or contribute to the development of new proposals to address identified needs: YES NO

5. National planning, coordination, information sharing and monitoring structures:

Identify/establish/engage in an appropriate national governance mechanism to ensure coordination for climate services (there may already be one for NDCs, NAPs, DRM, etc.): YES NO

Basic Systems (observing networks, data, data management, monitoring, and forecasting systems)

(Note: see Table 1 on categorization of NMHSs)

6. Adequate observing networks, data, data management, monitoring, and forecasting systems:

*Note: The capabilities are incremental by moving from left to right columns in the table (i.e. competencies related to the category "Essential" include the ones related to "Basic" etc.)

**Note: Section 6.a refers to the assessment of observing networks in the context of climate services

- Establish an internal management structure to integrate all basic systems into a functioning observing system: YES NO

7 GEF – Global Environment Facility

8 GCF – Green Climate Fund

9 PPCR – Pilot Program for Climate Resilience

10 RECs – Regional Economic Commissions

11 UNDP – United Nations Development Programme

12 IFI – International Financial Institution

13 WFP – World Food Programme

14 FAO – United Nations Food and Agriculture Organization

15 WHO – World Health Organization

- Establish national requirements for observational needs to support climate services: YES NO
- Perform gap analysis by matching observational needs against existing national capabilities: YES NO
- Develop national observing strategy for weather and climate in order to address identified gaps YES NO
- Aware of climate monitoring principles (Annex 3) YES NO
- Adhere to climate monitoring principles (Annex 3) YES NO

(a) Observing networks:

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> • Operate and maintain adequate national observing systems, in support of the weather-related application areas of the WMO¹⁶ Rolling Review of Requirements: YES <input type="checkbox"/> NO <input type="checkbox"/> • Develop complete inventory of existing national observing systems and their metadata by completing and updating national entries in OSCAR¹⁷/Surface: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Undertake to improve station density based on established and known national requirements: YES <input type="checkbox"/> NO <input type="checkbox"/> • Improve observations through compliance with WIGOS regulatory and guidance material: YES <input type="checkbox"/> NO <input type="checkbox"/> • Observing network delivers against ECVs¹⁸: YES <input type="checkbox"/> NO <input type="checkbox"/> • Formal partnership agreements established with external (non-NMHS) entities operating third party; observing networks under guidance on minimum set of requirements for use in local climate services: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Adoption of long- term strategy for managing observing network and its change, including relocation of stations, establishment of automated observations that meet climate observation requirements and standards, and protection of long-term observing stations: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Improve and strengthen national observing network based on national observing strategy, the relevant Regional WIGOS¹⁹ Implementation Plan and the EGOS-IP²⁰: YES <input type="checkbox"/> NO <input type="checkbox"/>

¹⁶ WMO – World Meteorological Organization

¹⁷ OSCAR - Observing Systems Capability Analysis and Review Tool

¹⁸ ECVs - Essential Climate Variables

¹⁹ WIGOS - WMO Integrated Global Observing System

²⁰ EGOS-IP - WMO Implementation Plan For The Evolution Of Global Observing Systems

(b) Data and data management:

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> • Collect and store data and metadata in relational databases (OSCAR/Surface): YES <input type="checkbox"/> NO <input type="checkbox"/> • Conduct data rescue: YES <input type="checkbox"/> NO <input type="checkbox"/> • Apply quality control processes to climate data: YES <input type="checkbox"/> NO <input type="checkbox"/> • Conduct data management including weather forecasting and warnings, quality assurance/quality control, using Quality Management Framework principles: YES <input type="checkbox"/> NO <input type="checkbox"/> • Apply when necessary spatial temporal interpolation to ensure data continuity: YES <input type="checkbox"/> NO <input type="checkbox"/> • Create, archive and document climate datasets of the appropriate length, time resolution and units: YES <input type="checkbox"/> NO <input type="checkbox"/> • Assess climate data homogeneity and adjust inhomogeneous time series where possible: YES <input type="checkbox"/> NO <input type="checkbox"/> • Comply with the standards set and the recommendations made by WMO : YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Historical as well as real time observations in the atmosphere, the oceans, over land and ice of the ECVs prepared by GCOS21 and partners for climate purposes, exchanged freely for use in RCCs22 for at least one Global Surface Network site: YES <input type="checkbox"/> NO <input type="checkbox"/> • Adopt well documented strategy including vision and operating manual for ensuring security, integrity, retention policy and technology migration for data archival process and systems: YES <input type="checkbox"/> NO <input type="checkbox"/> • Register data in WIS²³: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Ensure all further observations are accumulated into time series: YES <input type="checkbox"/> NO <input type="checkbox"/> • Identify additional required data that can be accessed from regional and global sources: YES <input type="checkbox"/> NO <input type="checkbox"/> • Document and register rescued and non-rescued data in the WMO-GFCS I-DARE²⁴ portal: YES <input type="checkbox"/> NO <input type="checkbox"/> • Use Data Management Systems that are compliant with WMO Specifications as recommended by the Commission for Climatology: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<p>Identify and engage research to improve data availability: YES <input type="checkbox"/> NO <input type="checkbox"/></p>

²¹ GCOS - Global Climate Observing System

²² RCC - Regional Climate Center

²³ WIS - WMO Information System

²⁴ I-DARE – International Data Rescue

(c) Monitoring:

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> • Identify and retrieve adequate climate data from different sources to generate climate products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Compute basic climate products, such as World Weather Records, Climatological Standard Normals , and other basic statistics i.e anomalies, standard deviations, percentiles contingency tables, etc.: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Compute Climate Indices and derived products for the monitoring of climate change and climate extremes using ETCCDI²⁵ (and other tools such as iTacs²⁶ for example) and NCMP²⁷ approach: YES <input type="checkbox"/> NO <input type="checkbox"/> • Generate generic monitoring products (i.e. drought monitoring, climate watch, etc.): YES <input type="checkbox"/> NO <input type="checkbox"/> • Compute sector-specific Climate Indices and other sector oriented climate products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as health, agriculture, water and disaster management: YES <input type="checkbox"/> NO <input type="checkbox"/> • Comply with the standards set and the recommendations made by WMO: YES <input type="checkbox"/> NO <input type="checkbox"/> • Register in WIS operational climate monitoring data and products that are recommended by WMO for regional or global climate monitoring activities: YES <input type="checkbox"/> NO <input type="checkbox"/> • Apply QMS²⁸ principles: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Apply multi-variate statistical analysis to provide space-time distribution of climate patterns and identify statistical relationships across multiple variables: YES <input type="checkbox"/> NO <input type="checkbox"/> • Create integrated, continually updated data product time series, e.g. combining satellite observations and reanalysis with station data: YES <input type="checkbox"/> NO <input type="checkbox"/> • Produce gridded data sets based on peer-reviewed techniques and complying with WMO recommended practices: YES <input type="checkbox"/> NO <input type="checkbox"/> • Generate and manage consistent and systematic information on Extreme Weather and Climate Events complying with the WMO recommended practices: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Identify and engage research to improve monitoring and related products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Publish regular, quality controlled authoritative information on the status of climate relevant to policy making for climate adaptation: YES <input type="checkbox"/> NO <input type="checkbox"/> • Simulation of past climate and generate model-based analysis and Reanalysis: YES <input type="checkbox"/> NO <input type="checkbox"/> • Statistical and dynamical down-scaling, using advanced empirical techniques and regional climate models: YES <input type="checkbox"/> NO <input type="checkbox"/> • Maintain, update regularly and make available for global access high quality peer-reviewed ECV datasets and document the underlying uncertainty assessment: YES <input type="checkbox"/> NO <input type="checkbox"/>

²⁵ ETCCDI - Expert Team on Climate Change Detection and Indices

²⁶ iTacs - Interactive Tool for Analysis of the Climate System

²⁷ NCMP - National Climate Monitoring Products

²⁸ QMS – Quality management system

(d) Forecasting systems:

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> • Participate in RCOFs²⁹: YES <input type="checkbox"/> NO <input type="checkbox"/> • Disseminate climate outlooks provided by GPCs³⁰, RCCs and RCOFs: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Create value-added products, such as graphics, maps and reports to explain climate forecasts and climate model information: YES <input type="checkbox"/> NO <input type="checkbox"/> • Develop and/or provide monthly, seasonal and longer scale climate predictions, using both empirical and dynamical approaches: YES <input type="checkbox"/> NO <input type="checkbox"/> • Generate value-added forecast products for national scales based on RCC and GPC products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Conduct and/or contribute to RCOF sessions: YES <input type="checkbox"/> NO <input type="checkbox"/> • Register forecasting products in WIS: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Generate sub-seasonal and seasonal forecast products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Run climate models within the adequate domain and with adequate parametrization and scenarios: YES <input type="checkbox"/> NO <input type="checkbox"/> • Downscale climate prediction and projection products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Interpret annual to decadal climate prediction products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Coordinate RCOFs and NCOFs³¹ and assist users in forecast interpretation: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Evaluate the performance of climate models output and quantify the associated uncertainties: YES <input type="checkbox"/> NO <input type="checkbox"/> • Run Global and/or Regional Climate Models (sub-seasonal to decadal and longer): YES <input type="checkbox"/> NO <input type="checkbox"/> • Locate, select and retrieve climate forecasts and climate models output generated by Regional Climate Centers, Global Producing Centers and other institutions to complement self-produced climate products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Provide large scale data resources as input to modelling, research, applications, etc.: YES <input type="checkbox"/> NO <input type="checkbox"/> • Host GPCs/RCCs: YES <input type="checkbox"/> NO <input type="checkbox"/> • Guide/lead process improvement studies for RCOFs and NCOFs: YES <input type="checkbox"/> NO <input type="checkbox"/>

²⁹ RCOF – Regional Climate Outlook Forum
³⁰ GPC – Global Producing Center of WMO
³¹ NCOF – National Climate Outlook Forum

BASIC	ESSENTIAL	FULL	ADVANCED
			<ul style="list-style-type: none">• Create future climate projections using different scenarios: YES <input type="checkbox"/> NO <input type="checkbox"/>• Apply statistical and geo-statistical analysis, including downscaling/ calibration, to monitor the spatial distribution and temporal evolution of model output: YES <input type="checkbox"/> NO <input type="checkbox"/>• Develop tailored products for decision support in priority sectors: YES <input type="checkbox"/> NO <input type="checkbox"/>• Apply recalibration procedures to model outputs: YES <input type="checkbox"/> NO <input type="checkbox"/>• Make skill assessments publicly available: YES <input type="checkbox"/> NO <input type="checkbox"/>• Identify and engage research to improve forecasting and related products: YES <input type="checkbox"/> NO <input type="checkbox"/>

User Interface

7. Decision support tools and systems (identified, designed and improved, including any necessary research):

BASIC	ESSENTIAL	FULL	ADVANCED
<p>Identify the top five most prominent sectoral users groups (list in the order of priority):</p> <ul style="list-style-type: none"> • Interact with users, to meet requests (for basic climatology questions): YES <input type="checkbox"/> NO <input type="checkbox"/> • Assist users to interpret/use climate predictions and products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Get periodic feedback from users on the usefulness and effectiveness of the information, products and services provided (including through NCOFs): YES <input type="checkbox"/> NO <input type="checkbox"/> • Establish effective relationships and communication channels with users: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Interact with users to identify their requirements for, and provide advice on, climate information and adequate and viable products for their application: YES <input type="checkbox"/> NO <input type="checkbox"/> • Conduct and evaluate user satisfaction on a regular basis (e.g. meetings, surveys): YES <input type="checkbox"/> NO <input type="checkbox"/> • Revise climate services and the means of communication based on user feedback: YES <input type="checkbox"/> NO <input type="checkbox"/> • Develop and apply in partnership with users applications to facilitate the understanding and use of existing climate products and services: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Co-design and co-develop products with users: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Work with sector-based research teams to develop applications models (e.g. to combine climate and agriculture information and produce food security knowledge products): YES <input type="checkbox"/> NO <input type="checkbox"/> • Jointly (with sector-based research teams) develop software and product suites for customized sector-specific climate products: YES <input type="checkbox"/> NO <input type="checkbox"/>

Capacity development

8. Capacity development services:

Identify a source of and invest in capacity development assistance and training to support the capacity development needs emerging from the other activities (see section 4 in Governance):

- Neighbouring or other NMHS for basic education and cross-discipline operational training: YES NO
- RTC³², Education and/or Research Universities/institutions/organizations: YES NO
- RCC: YES NO
- GPC: YES NO
- other: YES NO

Involve users, if possible, from the other sectors in training events: YES NO

Provision and Application of Climate Services

9. Decision-support products and services (established or strengthened):

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> • Data services (unless prohibited under current mandate and legislation): YES <input type="checkbox"/> NO <input type="checkbox"/> • Access remote sensing and reanalysis products (i.e. EUMETCast): YES <input type="checkbox"/> NO <input type="checkbox"/> • Weather forecasting products: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Climate monitoring products: YES <input type="checkbox"/> NO <input type="checkbox"/> • Targeted dissemination of climate products to priority sectors (i.e. those based on data; regional and national climate monitoring products if available; seasonal outlooks provided by RCOFs and RCCs): YES <input type="checkbox"/> NO <input type="checkbox"/> • Generic seasonal forecasts: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Sub-seasonal forecasts: YES <input type="checkbox"/> NO <input type="checkbox"/> • Tailoring of products received from RCCS and in some cases GPCs for national applications: YES <input type="checkbox"/> NO <input type="checkbox"/> • Tailored seasonal forecasts (to address user needs): YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> • Climate change projections: YES <input type="checkbox"/> NO <input type="checkbox"/> • Helpdesk function: YES <input type="checkbox"/> NO <input type="checkbox"/> • Provide products that can directly be plugged-in decision support tools including for policy development: YES <input type="checkbox"/> NO <input type="checkbox"/>

³² RTC - Regional Training Centre

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> Conduct basic climate diagnostics and climate analysis (staff will have some proficiency in climate statistics, or be able to reliably use statistical software (e.g. Climate Database Management System)): YES <input type="checkbox"/> NO <input type="checkbox"/> Basic statistics (graphs, counts, etc.) on extremes, frequency of occurrence, spatial means for temperature (Max, Min, Mean), precipitation, and possibly relative humidity, evapotranspiration, thunder days, sunshine duration, cyclones, etc., climatological normal: YES <input type="checkbox"/> NO <input type="checkbox"/> Regularly conduct NCOF sessions: YES <input type="checkbox"/> NO <input type="checkbox"/> Conduct climate watch programmes and disseminate early warnings: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> Update/Improve/Develop products and services based on users' feedback and requirements: YES <input type="checkbox"/> NO <input type="checkbox"/> 		<ul style="list-style-type: none"> Diversified channels of communication used to disseminate climate products (e.g. radio, social media): YES <input type="checkbox"/> NO <input type="checkbox"/> Provide products relevant to neighbouring or other countries: YES <input type="checkbox"/> NO <input type="checkbox"/>

Monitoring and Evaluation

10. Monitoring of benefits resulting from climate services:

BASIC	ESSENTIAL	FULL	ADVANCED
<ul style="list-style-type: none"> Identify climate sensitive user sector outcomes and associated variables to measure them i.e. disaster losses, crop yields, hydropower: YES <input type="checkbox"/> NO <input type="checkbox"/> Identify sources of this information: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> Establish ongoing monitoring systems for documenting user outcomes: YES <input type="checkbox"/> NO <input type="checkbox"/> Establish baselines of sectoral outcomes for continuous evaluation of climate services: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> Socio-economic analysis of cost-benefits of climate services conducted in collaboration with users: YES <input type="checkbox"/> NO <input type="checkbox"/> 	<ul style="list-style-type: none"> Investment plans of climate sensitive sectors based on results of socio-economic analysis of cost-benefits of climate services: YES <input type="checkbox"/> NO <input type="checkbox"/> Policy response as an outcome of the results of the socio-economic analysis of cost-benefits of climate services: YES <input type="checkbox"/> NO <input type="checkbox"/>

Annexes

1. Table 1. Categorization of NMHSs

(Source: Commission for Climatology Guidelines for NMHSs on capacity development for climate services)

Level of service	Weather servicers	Climate services	Hydrology services	Description of capacity needed to achieve service level
Category 1- Basic	<ul style="list-style-type: none"> ➤ Weather observations ➤ Weather Data Management ➤ Interaction with users of weather data and products 	<ul style="list-style-type: none"> ➤ Climate observations ➤ Climate Data Management ➤ Interaction with users of weather data and products 	<ul style="list-style-type: none"> ➤ Hydrological observations ➤ Hydrological data management ➤ Interaction with users of hydrology data and products 	<ul style="list-style-type: none"> ➤ Small network of quality controlled observations ➤ Basic data-processing, archiving and communication systems ➤ Little or no backup / offsite storage, or contingency options ➤ Staff: observers and some meteorologists trained to Basic Instruction Package (BIP) ➤ No 24 /7 operation ➤ Rudimentary Quality Management System ➤ No research and development
Category 2- Essential	<ul style="list-style-type: none"> ➤ Medium-range (synoptic scale) forecasts and warnings ➤ Established links with media and disaster risk reduction (DRR) communities 	<ul style="list-style-type: none"> ➤ Seasonal Climate outlooks ➤ Climate monitoring 	<ul style="list-style-type: none"> ➤ Hydrological data products for design and operation of water supply structures ➤ Water level and flow monitoring ➤ Short-term flow forecasts (low flows) ➤ Flood forecasting 	<ul style="list-style-type: none"> ➤ Able to take and integrate observations from other parties ➤ Well-established protocols for emergencies, backup of data and minimum offsite facilities ➤ Staff: observers and meteorologists trained to BIP standards ➤ 24/7 operation. ➤ Well established quality management system ➤ Able to access most numerical weather prediction data/products from other centres ➤ Small research and development unit ➤ Some partnerships as junior members
Category 3- Full	<ul style="list-style-type: none"> ➤ Specialized weather products for a wide range of sectors ➤ Well integrated into DRR communities and mature links with media 	<ul style="list-style-type: none"> ➤ Specialized climate products ➤ Decadal climate prediction ➤ Long-term climate projections 	<ul style="list-style-type: none"> ➤ Seasonal stream flow outlooks ➤ Specialized hydrology products 	<ul style="list-style-type: none"> ➤ Advanced observation equipment ➤ Ability to run its own numerical prediction suite ➤ Research and development unit ➤ Well educated/trained staff ➤ Own training group ➤ Developed library and information services ➤ Active partnerships with NMHSs taking a leading role
Category 4- Advanced	<ul style="list-style-type: none"> ➤ Customized weather products ➤ Weather application tools. 	<ul style="list-style-type: none"> ➤ Customized climate products ➤ Climate application tools 	<ul style="list-style-type: none"> ➤ Customized hydrology products ➤ Hydrology application tools 	<ul style="list-style-type: none"> ➤ Advanced observations ➤ Leading Research and development team ➤ Well-developed Education and training Unit

2. List of acronyms

DRM	Disaster Risk Management
ECV	Essential Climate Variables
EGOS-IP	WMO Implementation Plan for the Evolution of Global Observing Systems
ETCCDI	Expert Team on Climate Change Detection and Indices
FAO	United Nations Food and Agriculture Organization
GCF	Green Climate Fund
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GFCS	Global Framework for Climate Services
GPC	Global Producing Centre of WMO
I-DARE	International Data Rescue
IFI	International Financial Institutions
iTACS	Interactive Tool for Analysis of the Climate System
NAP	National Adaptation Plan
NCMP	National Climate Monitoring Products
NDC	Nationally Determined Contribution to the Paris Agreement
NMHS	National Meteorological and Hydrological Service
OSCAR	Observing Systems Capability Analysis and Review Tool
PPCR	Pilot Program for Climate Resilience
QMS	Quality Management System
RCC	Regional Climate Center of WMO
RCOF	Regional Climate Outlook Forum
RECs	Regional Economic Commissions
RTC	Regional Training Center
UIP	User Interface Platform
UNDP	United Nations Development Programme
WFP	World Food Programme
WHO	World Health Organization
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organization
WRM	Water Resource Management

3. Global Climate Observing System climate monitoring principles

(Revised Reporting Guidelines as agreed by the UNFCCC at Bali, December 2007, decision 11/CP.13)

Effective monitoring systems for climate should adhere to the following principles:

- (a) The impact of new systems or changes to existing systems should be assessed prior to implementation;
- (b) A suitable period of overlap for new and old observing systems is required;
- (c) The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves;
- (d) The quality and homogeneity of data should be regularly assessed as a part of routine operations;
- (e) Consideration of the needs for environmental and climate-monitoring products and assessments, such as Intergovernmental Panel on Climate Change assessments, should be integrated into national, regional and global observing priorities;
- (f) Operation of historically-uninterrupted stations and observing systems should be maintained;
- (g) High priority for additional observations should be focused on data-poor regions, poorly-observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution;
- (h) Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation;
- (i) The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted;
- (j) Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

Furthermore, operators of satellite systems for monitoring climate need to:

- (a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system;
- (b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

Thus satellite systems for climate monitoring should adhere to the following specific principles:

- (a) Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained;
- (b) A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations;
- (c) Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured;
- (d) Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured;
- (e) On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored;
- (f) Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate;
- (g) Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained;
- (h) Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on decommissioned satellites;
- (i) Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation;
- (j) Random errors and time-dependent biases in satellite observations and derived products should be identified.

4. References

1. High Level Task Force Report - Climate Knowledge for Action: A Global Framework for Climate Services: http://library.wmo.int/pmb_ged/wmo_1065_en.pdf
2. WMO Capacity development strategy and implementation plan: <https://www.wmo.int/pages/prog/dra/CDS.html>
3. Commission for Climatology Guidelines for NMHSs on Capacity Development for climate services (ref: Table 2, p 31)