



Annex to the Implementation Plan of the Global Framework for Climate Services – Climate Services Information System Component



World
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GFCS

GLOBAL FRAMEWORK FOR
CLIMATE SERVICES

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ANNEX
TO
THE IMPLEMENTATION PLAN OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES -
CLIMATE SERVICES INFORMATION SYSTEM COMPONENT

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EXECUTIVE SUMMARY

For delivering climate information effectively it is imperative that appropriate operational institutional mechanisms are in place to generate, exchange and disseminate information nationally, regionally and globally. The Climate Services Information System (CSIS) is the principal GFCS mechanism that will routinely collate, store and process information about past, present and future climate. The CSIS will comprise a physical infrastructure of institutes, centres and computer capabilities that, together with professional human resources, will develop, generate and distribute a wide range of climate information products and services to inform complex decision-making processes across a wide range of climate-sensitive activities and enterprises. The WMO World Climate Services Programme will be the principal mechanism for implementing the CSIS, a substantial part of which already exists.

The implementation strategy of the CSIS is based on a three-tiered structure of collaborating institutions (CSIS 'entities'¹) that will ensure climate information and products are generated, exchanged and disseminated:

- a) Globally through a range of advanced centres;
- b) Regionally through a network of entities with regional responsibilities;
- c) Nationally and locally by National Meteorological and Hydrological Services (NMHSs) and, through national institutional arrangements, with partners.

A set of initial, high priority minimum functions of CSIS include: (i) climate data rescue, management and mining; (ii) climate analysis and monitoring; (iii) climate prediction; and (iv) climate projection. These functions comprise processes of data retrieval, analysis and assessment, re-analysis, diagnostics, interpretation, assessment, attribution, generation and verification of predictions and projections and communication (including exchange/ dissemination of data and products) that will be carried out over a global-regional-national system of inter-linked producers and providers. Formalized structures and procedures governing CSIS entities and functions are essential for standardization, sustainability, reliability, and adherence to established policies and procedures. Knowing user requirements and understanding how users apply climate information will be essential for designing, disseminating and encouraging uptake of CSIS products and services. The CSIS will engage with the GFCS User Interface Platform (UIP) to achieve these objectives and will also work with the Observations and Monitoring (O&M) and Research, Modelling and Prediction (RM&P) pillars to obtain the inputs required for its operations.

There are already a number of advanced centres providing global-scale CSIS products, although their operations will need to be further coordinated and standardized, especially regarding exchange of routine data and products so as to ensure compatibility across geographical and jurisdictional boundaries. Making regional implementation a first priority gives countries that need the most help something to work with quickly, while awaiting further specification and funding of longer-term national climate capacity development efforts. A representative collection of WMO Regional Climate Centres (RCCs), building where possible on centres already planned or in place, will form the regional backbone of the CSIS. National entities will acquire, interpret and apply the data and products provided by global and regional centres and will develop their own national products to the extent possible. Considerable capacity development will be required, especially in developing countries, to strengthen national CSIS operations throughout the world.

Given the multiple sources of information within the CSIS that are available to users, there needs to be collaborative assessment to assist users in identifying robust climate signals and in understanding inherent uncertainties. At the regional level, Regional Climate Outlook Forums (RCOFs) are one effective mechanism for stimulating the development of such collaboration and consensus. Users of climate information can benefit from access to products reflecting collaborative expert assessment and consensus along with information derived from a variety of individual sources.

¹ A CSIS entity is any institution carrying out one or more CSIS functions

CSIS should manage and analyse climate data seamlessly in order to monitor, predict and project climate trends, while at the same time delivering climate products and services on specific time and space scales relevant both to general and targeted decision-making.

The priority actions for CSIS should address institutional, operational as well as research requirements along with training, capacity development, and governance aspects. Including CSIS functions in national centres that are found within or are closely associated with NMHSs would, from the outset, foster rapid development, operational production, and dissemination of well-targeted climate information. Climate Outlook Forums on a national scale may also serve useful purposes, with similar multiple roles to those seen in RCOFs (such as the technical development and enhancement of the outlook products for national context, the professional development of information providers and, most importantly, to enhance user-provider interactions).

To help ensure that user requirements are serviced optimally, a process of regular review and update of user requirements for climate data, products and information, as well as of the use of climate information in real-world contexts, should be formulated. The CSIS would need a formal technical reference manual articulating certain globally agreed standards and specifications for its primary functions, services and products across all geographical levels. It would not be appropriate or even feasible, however, to try to standardize all CSIS products and services because of the diversity of information and services needed by each region or country.

All CSIS entities should be able to access and use the vast quantities of data archived and information generated by the growing number of centres around the world. Developing and delivering routine climate monitoring products will be one of CSIS' key contributions, with their scope evolving along with user requirements. Harmonizing climatological normals will be essential for CSIS mandatory products, including the climatological base periods used in monitoring, predicting and projecting climate anomalies. All CSIS components must strive to comply with the evolving WMO Information System (WIS), to ensure interoperability and to facilitate the flow of data and information within the CSIS.

CSIS operational entities such as GPCs, RCCs, and NMHSs should participate in formulating research programmes to improve the effectiveness of CSIS products and services.

The focus for the CSIS should be on ensuring that developing countries are able to build and maintain the capacity to generate and disseminate operational climate information and to mainstream its use in their policies and institutions. A large share of CSIS resources must therefore be directed towards capacity development that will support the establishment of operational entities in developing countries as well as the development of crucial human resources.

It will be essential to ensure a tight nexus between the GFCS management structures for CSIS and those of the WMO Commission for Climatology (CCI), including integration where relevant and appropriate. National CSIS entities operate under governance arrangements put in place by national governments, so it is important to identify common ground for the varied structures and mandates responsible for ensuring seamless CSIS operations.

1 INTRODUCTION

1.1 *Objective, scope and functions*

The Climate Services Information System (CSIS) component of the GFCS is the principal mechanism through which information about climate – past, present and future – is routinely archived, analysed, modelled, exchanged and processed. The CSIS is the ‘operational core’ of the GFCS; it is designed for producing and delivering authoritative climate information products through appropriate operational mechanisms, technical standards, communication and authentication. Its functions include climate analysis and monitoring, assessment and attribution, prediction (monthly, seasonal, decadal) and projection (centennial scale). Part of the CSIS is in place, but new infrastructure is needed to fulfil the GFCS vision.

The overarching objectives of the CSIS are:

- Routinely to process and/or interpret data and products in order to generate and deliver user-relevant climate information and knowledge. It will accomplish this by means of numerical, visual and text-based climate data, information and products that include, assessments, outlooks, warnings, bulletins, reports and statements useful for climate-related risk management and adaptation policies and decisions;
- To ensure that climate information and products (data, analysis, monitoring, prediction and projection) are generated, exchanged and disseminated in a timely manner through a three-tier network of collaborating institutions:
 - Globally through a range of advanced centres;
 - Regionally through a network of institutions with consensus-based regional mandates;
 - Nationally and locally by NMHSs and, through national institutional arrangements, their partners;
- To tailor global climate products to meet regional needs sustainably and operationally through strategically located regional climate centres, as well as according to mutual arrangements that support national requirements;
- To foster rapid development, operational production and dissemination of climate information at the national level by incorporating the relevant functions in national CSIS entities or other mechanisms that encompass the GFCS more broadly.

The major elements, structures and data/information flows of the CSIS are shown in Figure 1. Actual institutional arrangements for managing these flows may vary significantly, especially at the national level, so this diagram should be seen as describing only the essential functional components needed for an effective CSIS.

The CSIS generates and disseminates information to users at all levels. Interdisciplinary research and development that support products tailored to user needs, as well as the dialogue between providers and users (needs assessment, feedback, etc.), are described in the User Interface Platform (UIP) and Research, Modelling and Prediction (RMP) Annexes. The CSIS, however, generates and provides the climate information and products, with CSIS practitioners frequently in direct liaison with users to facilitate a two-way information flow. CSIS entities are thus an integral and essential part of the UIP.

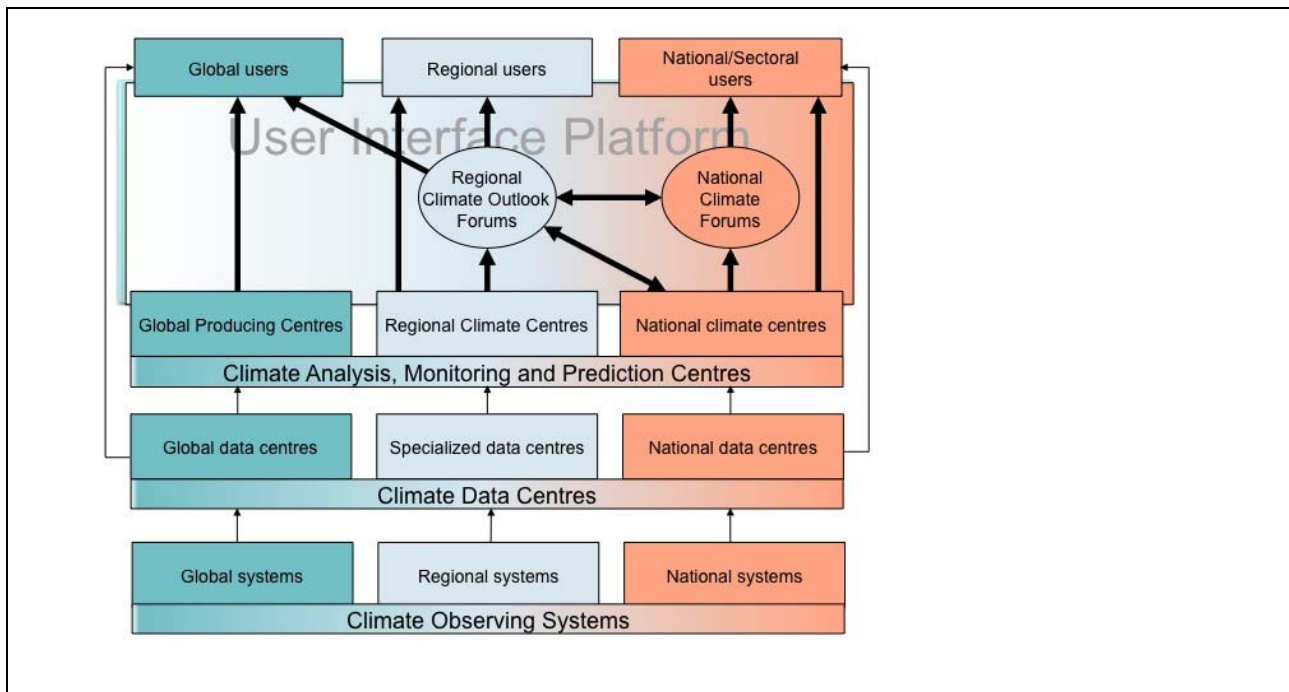


Figure 1: Data flows (thin lines) and value-added information flows (thick lines) into and through the entities and functions required for generating and delivering climate services. Implicit are the linkages and respective data and information exchanges between climate observing systems, the various climate data centres, and the climate analysis, monitoring and prediction centres. Evident from this figure are the central roles played by the Regional Climate Outlook Forums and their national counterparts in synthesizing and clarifying information fed by the CSIS entities to the various elements of the User Interface Platform. This platform will be more diverse and complex than the three basic geographic scale elements shown here.

The range of CSIS functions will include:

- Standardized management and exchange of climate and climate-related data as per WMO resolutions;
- Monitoring and analysing climate variability on different temporal scales, including extremes such as droughts and floods;
- Assessing and conducting attribution studies of observed climate anomalies;
- Predicting and projecting future climate states, including forecasting seasonal climatic anomalies and projecting long-term trends that could affect climate-sensitive sectors;
- Deriving products (datasets, text, maps, charts, statistics, etc.) that describe the past, present and future climate of a location, country, region and indeed the whole globe;
- Deriving tailored products and information within a range of social, economic and environmental contexts based on the tools and guidance developed by the UIP;
- Providing all such information and products to users in government, the general public, academia as well as to a diverse set of specialist users, along with advice on their interpretation and use;
- Undertaking capacity development activities to ensure effective incorporation of global and regional CSIS products in national level CSIS operations;

- Formulating recommendations for improvements in the observing and research inputs to CSIS operations provided by the Observations and Monitoring (O&M) and the RMP pillars.

From a practical point of view, predictions will very likely continue to be made over a set of more or less discrete time periods. The WMO Manual on the Global Data Processing and Forecasting Systems (GDPFS) defines these periods in some detail². It may be appropriate when implementing the GFCS to revisit the definitions attached to these time periods, taking note of any differences in terminology used by research, operational and user communities, with the aim of developing a common terminology.

1.2 Requirements of an information system for climate services

Many climate sensitive enterprises need to plan according to a range of time scales, in some cases extending from decadal to daily scales. Such enterprises are accustomed to adjusting their decision-making as new circumstances arise and will clearly benefit from an information system that can adapt to changing needs over a wide range of planning, production and delivery cycles. A principle of seamlessness needs to be applied to the time-scales for information that will flow from the CSIS, and that will merge with existing shorter-scale weather-related information systems. From a user perspective, an integrated body of services that spans all timeframes and the CSIS-defined space-scales is the ideal mechanism. Consequently, the global, regional and national entities that make up the CSIS infrastructure must be seamlessly linked to each other for the system to function effectively.

1.3 Interlinkages with other pillars

Wherever possible, all products and services should be designed and delivered in ways that best meet the needs of current and potential customers. CSIS product delivery can occur as direct uptake by end-users or through interfaces that seek to integrate the information more effectively into end-user decision-making. The UIP is intended to facilitate this latter process, which will inform CSIS entities of methods, tools and approaches that can be used in meeting user requirements.

CSIS outputs can be defined as all climate information and products that can be applied directly or indirectly to inform policy and decision-making in climate-sensitive areas. Consequently, and because of the nature of the CSIS and UIP relationship, they will need to work together from the outset to map out ways and means for ensuring effective delivery and uptake of user-relevant climate services in these areas. In essence, CSIS is the operational facility catering to all the climate information needs of the UIP. It also receives feedback that it uses to improve its products and services. Climate Outlook Forums can provide excellent opportunities at both regional and national levels for collaborating and cross-fertilizing ideas among CSIS and UIP entities.

CSIS needs to work closely with the RMP pillar of GFCS to put in place its technical infrastructure. This infrastructure should be based on the latest scientific advances and should produce and deliver user-relevant climate information operationally. In addition, ongoing research is needed for improving skill at the time scales where operational products currently exist (e.g., seasonal prediction), for narrowing and ultimately bridging the gaps in forecast capabilities across the shorter climate time scales and for providing a more seamless set of monitoring and prediction services. Interactions between the CSIS and RMP pillars will be critical in this regard. Climate services associated with longer-term decadal predictions and climate projections are still in their infancy; CSIS and RMP pillars will need to work closely over the next few years to ensure that the growing demand for more 'certainty' does not lead to compromising the standards and integrity of what contemporary science can deliver.

CSIS will draw on the O&M pillar of GFCS for *in situ* and remotely-sensed climate data from a combination of surface-, air- and space-based observing platforms. All CSIS products and services

² See Appendix I-4 in Manual on the Global Data Processing and Forecasting System (GDPFS), Volume I (Global Aspects), WMO-No. 485, World Meteorological Organization.

depend on climate data and monitoring products generated by the O&M pillar. In this context, climate monitoring through tailored diagnostics, assessment and predictions, as well as through value-added products and services (e.g., climate watches), is an essential CSIS function. On the other hand, the O&M pillar will generate primary data and products, and will provide the needed guidance and procedures for analysing climate data sets. More fundamentally, the O&M pillar will contribute to monitoring through sustained operations of its observational platforms and data systems.

Critical to the various connections between the CSIS and O&M components will be identifying and remedying deficiencies in observational networks. It will be essential to maintain robust feedback procedures from the CSIS to the O&M pillar to determine how well observation and data collection, as well as management systems, are meeting CSIS' current and future operational needs.

Finally, CSIS needs the Capacity Development component of the GFCS to improve the capabilities of national and regional CSIS entities, and to enhance use of global and regional inputs in national-level CSIS operations.

1.4 Relevant existing activities, and identification of gaps

The World Climate Programme (WCP) was established in 1979 and WMO's Climate Information and Prediction Services (CLIPS) project was established in 1995. Together they constitute the international foundations of modern climate services. Advances in providing climate services from these initiatives have been useful and timely, albeit gradual in nature. In the last decade, however, demand for climate information and expectation of better tools for decision-making have grown rapidly, outpacing capabilities in most countries. There are now a number of shortfalls to be addressed in present capacities with respect to the expectations of policymakers, planners, operators, nations, communities, and individuals. There are several significant gaps (which vary by region) in the availability of digital data for modelling and analysis as well as of trained, professional and technical staff to cover all CSIS activities. There are also inadequacies in the availability of, and access to, software for generating user-targeted products, especially with respect to forecasting and projection.

At its Sixteenth Session, the World Meteorological Congress decided to reconstitute the WCP in a form that aligns it better with the GFCS. The WCP will now include the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP) and a new World Climate Services Programme (WCSP)³. The Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA), coordinated by the United Nations Environment Programme (UNEP), has been subsequently added as the fourth component of WCP. The WCP is expected to be the key WMO-led programme for delivering on the promises of the GFCS. Furthermore, the Congress decided that the CLIPS project will be concluded by 2015 and its activities transferred as appropriate to the GFCS.

Through their commitments under the WCP and other related programmes, WMO Members make substantial investments in building infrastructure and in developing human resources for a range of climate products and services. These investments are expected to underpin CSIS operations (see Appendix I). The proposed implementation plan for the CSIS is therefore closely aligned with Principle 7 of the GFCS, i.e., to facilitate and strengthen existing infrastructure, and avoid duplication.

While existing infrastructure includes global, regional and national entities that can be directly integrated into the CSIS, several major gaps and shortfalls need to be addressed to achieve a fully operational CSIS that meets user needs with standardized products that can be widely disseminated and used. They can be summarized as follows:

- Nationally, climate service providers in many developing countries need their human resource capacities enhanced through better access to basic and targeted training courses and facilities.

³ See Annex to Resolution 18 (Cg-XVI)

They also need appropriate tools and guidance for customizing global and regional products to suit national and local priorities and purposes;

- There is often little coordination among national stakeholders in contributing to and benefiting from CSIS operations, leading to minimal uptake or inappropriate use of climate information in decision-making. By developing user understanding: (i) users can better incorporate available climate information into their decision-making; and (ii) providers can produce information that is better tailored to meet user needs;
- Given that climate extremes have profound socio-economic impacts across a wide continuum of time and space, there is a problem with early warning systems based on climate watch systems whose climate prediction and monitoring concepts are in place but whose customization and implementation do not yet cover all countries and regions;
- On the national and regional levels there is a huge potential for retrieving vital past observations, extending the historical climatological record while simultaneously ensuring its quality and homogeneity as well as providing a solid foundation for the record into the future;
- Unrestricted exchange of climate data among countries as well as among global and regional entities is critical to CSIS product generation and service provision; adequate international arrangements to achieve this goal are not yet in place;
- RCCs are some of the better-defined entities but their implementation is still sub-optimal, with several regions having limited or non-existent access to RCC services;
- There are several regions and sub-regions that could benefit from expanded RCOF activities;
- A set of primary, high-priority functions and products needs to be established involving analysis, diagnostics, interpretation, attribution, verification and communication for the system of providers that populate the CSIS on all spatial scales;
- Formally designated structures for CSIS entities and functions are essential for standardization, sustainability, reliability, authenticity, adherence to policy, etc. Most of the existing or proposed entities and functions should focus on climate data, monitoring and prediction on monthly and seasonal time scales. Further research will be required to extend these CSIS capabilities to longer time scales, especially regarding predictions/projections and their downscaling;
- Absence of long-term, authenticated meteorological records is a key gap that impedes providing a wide range of climate services in many lesser developed regions of the world.

2 IMPLEMENTATION OF CSIS

2.1 *Conditions for successful implementation*

The fundamental requirements for implementing CSIS include:

- A set of primary, high-priority functions and well-defined products;
- Formalized structures, standards and protocols;
- Knowledge of user requirements;
- Flows of huge amounts of data and information (see Appendix II for further discussion of data issues).

Most climate projection products available today are valid on global to large sub-continental scales, but additional regional and local products are needed. At the regional and national levels of the CSIS, mandated centres will downscale global climate change projections and scenarios where possible, based on model outputs available from the major climate model data centres, making these products and related information available to users. It is critical that services relying on downscaling be backed by confirmation from research on the efficacy of the techniques employed and include commentary on any uncertainties in the projections.

A CSIS based on the inputs from the observations and research components and supported by strong capacity building activities will require physical infrastructure such as computers and communications networks. It will need institutions and centres; skilled human resources for product development and consultation; and mechanisms for developing and delivering tailored products for users. Entities that can contribute to a fully operational CSIS already exist but many need to be developed further and urged to adopt the standardized approaches for generating and distributing the key CSIS products.

To be successful, a national climate services programme embodying the principles of the CSIS must be integral to the larger infrastructure supporting the implementation of national social, economic and environmental policies. The programme must connect available applications, scientific research, technological capabilities and communications in a unified system.

The overall infrastructure of the CSIS should:

- (i) Be based on a network of designated⁴ entities providing global and regional-scale climate products and services in the domains of climate data, climate monitoring, long-range forecasting, inter-annual to decadal predictions and climate change projections;
- (ii) Provide standardized minimum products as well as products that are highly-recommended, generating and distributing them on the basis of agreed-upon operating principles;
- (iii) Take advantage of as much authoritative information as possible;
- (iv) Help ensure that sufficient capacity exists on the national level to access, process and convert such global and regional climate information into national climate services.

2.2 *Engagement with Potential Partners*

Considering that a large portion of the operational components of the CSIS are already part of WMO structures at all the three levels, and given that the roles and responsibilities of NMHSs are enshrined in the WMO Convention, it is clear that WMO should be the primary implementing agency of the CSIS. That said, two types of partnerships are essential for the CSIS to function effectively, namely,

⁴ A 'designated' entity here is one that has formally been assessed by the WMO Regional Associations, CCI and CBS and approved for carrying out functions and delivering products and services to standards set down in relevant WMO Technical Regulations (such as in the Manual on the GDPFS).

technical partnerships and partnerships with user communities. Details of these types of partnerships are provided in Appendix III.

2.3 Criteria for identification of projects/activities

The criteria for identifying projects should be closely aligned with current capabilities and needs of the CSIS entities concerned in order to ensure that the primary and high-priority functions are operationally and adequately performed. A general checklist of questions to ask when selecting projects in the near term includes:

1. Does the project involve and/or contribute to activities in least developed countries, small island developing states or land-locked developing countries?
2. Does the project build upon something that already exists by expanding its coverage area, locating it in a new place, making it operational, or broadening its scope?
3. Will the activity achieve useful outcomes within a two-year time frame?
4. Does the project fit within the initial budget estimate of the HLT report?
5. Does the project address the Feedback, Dialogue, Monitoring and Evaluation or Literacy outcomes of CSIS and related GFCS components?
6. Does the activity or project build upon, and not duplicate, the partnerships in place between existing organizations and groups?
7. Does the activity contribute to the fundamental requirements for implementation (see Section 2.1)?
8. Does the project address the operational requirements at all three levels (global, regional and national) and ensure that formalized structures for all required CSIS entities and functions are in place?
9. Does the activity contribute to and strive for sustained operations and ownership of the CSIS in the post-project phase?
10. Is the project amenable to applicable standards and best practices as well as to protocols that may be prescribed for the CSIS?

2.4 CSIS Implementation activities

The World Meteorological Congress, through Resolution 17 (Cg-XVI) on the implementation of the CSIS, decided, *inter alia*:

- (1) To establish CSIS to include global, regional and national entities providing operational climate information including data, monitoring and prediction products within the GFCS;
- (2) That CSIS operations shall adhere to WMO Technical Regulations and should generate, as needed, new Technical Regulations pertinent to the advancement of operational climate services;
- (3) That core operational CSIS products would entail standardized production, presentation, delivery and verification;
- (4) That CSIS would promote consensus-based approaches to facilitate common understanding and user appreciation of uncertainties through, *inter alia*, Climate Outlook Forums;
- (5) That the CSIS would, over the long term, become the authoritative source of climate information required for climate services at the global, regional and national levels.

Building upon these decisions, several CSIS implementation activities have been formulated that build on a number of actions already planned or underway (Appendix IV). They include:

1. Supporting the implementation of climate watch system in the Regions;
2. Strengthening the capacities of Member countries to provide climate services by establishing frameworks for climate services at the national level as well as national climate assessments such as annual state of the climate reviews, etc.;
3. Undertaking training activities related to GPC and RCC infrastructure;
4. Enhancing the capacity of NMHSs and other national climate services providers to use GPC and RCC products more effectively in developing and delivering climate services at the national level;
5. Establishing a worldwide system of RCCs, with special focus on vulnerable developing regions;
6. Developing Climate Outlook Forums worldwide on regional and national scales;
7. Developing climate information products for climate risk management and adaptation customized for the agriculture and food security, water, and health sectors.

For CSIS implementation activities including but not limited to those listed above, the following aspects need to be considered adequately to ensure an effective, operational CSIS.

2.4.1 Historical climate data sets

Developing and securing basic, historical climate data sets for characterizing past climate behaviour on all time and space scales remains one of the highest priorities for the CSIS. Beyond this ongoing task there are a number of other important data-related activities that would help establish a fully effective CSIS. Routinely collecting climate 'event' data, for example, would be one such contribution. Full event-scale data on climate anomalies like droughts, floods and heat waves, as currently categorized for Tropical Cyclones, would improve understanding of the distribution, frequency and intensity of serious hazards. This greater understanding is needed for better climate risk assessments. Other user groups may need products such as indices of climate extremes or other, more complex indices that combine several parameters with different thresholds (e.g., temperature with precipitation and humidity for the health sector). A review and update of user requirements for climate data, products and information should be undertaken through the GFCS as a collaborative endeavour between CSIS and UIP.

Merging remotely-sensed data with traditional data to produce routine products at the national level offers a special challenge for the CSIS. Given the resources and technical proficiency required to handle and process satellite-based data, for example, such products should be routinely generated in RCCs, from where they can be distributed to client institutions that do not possess the required capabilities.

2.4.2 Climate monitoring

Monitoring of the climate provides information that can, for example, guide appropriate preparatory actions for mitigating the effects of extreme events. Close and meticulous monitoring also allows for detecting long-term climate change and determining its driving forces as well as its impacts around the world. Monitoring the climate at a global scale also helps improve regional and national predictions. Local conditions do not occur in isolation from the rest of the world: regional and global scale climate drivers directly influence local weather and climate.

Climate monitoring products will be a key CSIS contribution to the GFCS, with their scope evolving at global, regional and national levels in line with user requirements. In this regard it is important to stress the need for ongoing programmes of reanalysis to take advantage of recovered data and evolving analysis techniques.

Several countries already produce national State of the Climate reports and under the CSIS all countries will be encouraged to produce them. In addition to their value as references for a wide range of in-country users, they provide a baseline for documenting ongoing climate variability and change. This baseline is useful for national reporting under environmentally-related conventions that include the UN Framework Convention on Climate Change, the Convention on Biological Diversity and the UN Convention to Combat Desertification.

More frequent extreme events such as forest and grassland fires, floods, severe storms and drought are likely in a changed climate. Consequently, documenting their occurrence, including their meteorological settings and impacts, will be critical for developing effective national early warning systems as well as appropriate mitigation and response actions.

Under the CSIS, all countries will be encouraged to develop special bulletins and advisory mechanisms that draw attention to significant features of the continuously evolving climate system either routinely or on an *ad hoc* basis.

2.4.3 Monthly/seasonal/decadal climate predictions

Formal WMO mechanisms for the delivery of operational climate prediction services have been developed and implemented for seasonal timescales as well as the procedures for ensuring verification standards. Similar arrangements need to be established for forecast activities on monthly, multi-annual and decadal timescales.

2.4.4 Climate projections and scenarios Information

Another important activity for CSIS will be to promote the implementation of online climate projections as an efficient mechanism for delivering essential and consistent information to underpin national adaptation to climate change. While the databases of the fifth generation of the Coupled Model Intercomparison Project (CMIP5) and the CORDEX project of the WCRP will serve as comprehensive archives for the research community concerning climate simulations and climate change projections, they will likely not be in a suitable form to support the potentially wide range of specialized applications, especially at the national level. Consequently, a system of robust online databases at the regional and national levels should be designed and implemented to support a largely 'self-servicing' CSIS clientele via websites with state-of-the-art mapping and navigation tools. CSIS experts would be available to help users by evaluating the functionalities and limitations of these products in light of the users' areas of interest and would help identify those products most suitable for various applications. Other products relevant to climate change would include analyses of climate variability and extremes over time, including time series related to major Earth System atmosphere-ocean features such as El Niño and the North Atlantic Oscillation.

The objectives would be to:

- Create online regional and national sites for efficient access to climate change data and information services, supported by a robust and efficient infrastructure;
- Develop climate change data and information services needed for adaptation and risk management that would:
 - Provide information based on the latest scientific findings;
 - Combine historical and current climate observations with data streams projected into the future;
 - Represent a significant shift from *ad hoc* servicing by the research community towards a fully-operational climate change information service;
 - Support policy and adaptive response at the enterprise, local, national and regional levels.

2.4.5 Linking CSIS with users

In most cases so far, interaction between users and providers has not been systematically organized by an ongoing mechanism. In regard to climate services, it is widely recognized that climate products should be primarily user-centric to ensure that the climate information provided is actionable in real-world decision-making contexts. In light of this, CSIS will need to work hard in establishing mechanisms to facilitate ongoing connections between climate service users and providers, principally by activities being proposed for the UIP. The following specific actions are expected in this regard:

- **Facilitating user participation in national climate forums** (e.g., National Climate Outlook Forums (NCOFs), working groups, etc.). These are organized on a seasonal or annual basis to bring together technical and communication experts representing climate information providers and climate-sensitive user sectors. Such forums can be organized more frequently (e.g., monthly), to facilitate disseminating regular climate updates to user sectors and to promote regular interaction on a common platform. Members will need to be supported by guidance materials and training of trainers to develop technical skills for this kind of communication. Knowledge sharing will be needed concerning how different NMSs interact with users and how sectorial level partnership agreements can be arranged with various relevant ministries or interest groups. The generic concept of the NCOF can be developed centrally (e.g., by the WMO CCI in close consultation with other partners), but organization, funding and hosting of these activities will be the responsibility of Member countries. These functions will be tailored to the respective national contexts, and may be carried out under regional/sub-regional projects with suitable funding arrangements;
- **Developing a comprehensive framework for climate services at the national level.** This can be very effective for large countries with established strengths in observations, research and operational climate information and prediction services (see also Section 2.2). Mechanisms such as the NCOFs/NCFs mentioned above can also be integral components of the activities within such a national framework;
- **Promoting the single window weather and climate service concept** within the NMHSs to assist users in accessing weather and climate information they require in a seamless manner.

2.4.6 Building national capacity in developing countries

An early priority for the CSIS will be a systematic assessment of the baseline status of national capacity for WMO Member NMHSs, a task that will be coordinated by the WMO Regional Associations with CCI responsible for setting criteria for each baseline. Capability areas to be assessed would likely include:

- Climate observations;
- Data retrieval and management;
- Interactions with users;
- Climate system monitoring;
- Long-range forecasting (monthly to seasonal);
- Specialized climate products;
- Research and modelling;
- Decadal scale predictions;
- Long-term climate projections;
- Customized climate products;
- Climate application tools.

Once the current capabilities of an NMHS have been established and compared against desired baselines, a capacity building agenda can be drawn up to identify specific targets for the NMHS to achieve over 2-, 6- and 10-year periods to arrive at these baselines. It would not, however, be necessary for an NMHS to achieve a specified single capability in all areas. Some NMHSs, for example, might rely in part on an RCC for climate monitoring products to meet its national needs while nonetheless generating and distributing a range of specialized climate information products. In time it may be appropriate to move towards a more formal compliance system.

National capacity development should be approached through the following interventions:

Helping NMHSs to define clear roles and responsibilities within their national contexts for actions such as climate data management, climate monitoring and assessment, climate prediction and projection, and developing tailored climate products for various sectors. This will help provide end-to-end climate services.

Helping NMHSs establish mechanisms for national coordination of their activities concerning basic climate data, diagnostics, climate system monitoring, and in many cases long-range forecasts (LRF), taking advantage of the core products and services of GPCs and RCCs/RCC-Networks.

Strengthening the infrastructural capacity of NMHSs for data management and to generate and disseminate climate products and services is a major issue for developing countries. To enable access to national, regional and global climate products and services, NMHSs will require robust information processing, storage and communications (such as Internet, wireless and satellite-based telecommunication), as well as computing facilities adequate for producing national climate products.

Strengthening the capacity of NMHSs to participate fully in the WMO Information System (WIS) for disseminating data and products related to climate services. The WIS sets international standards for interfacing climate data with non-climate socio-economic data used in multidisciplinary products and socially beneficial climate services.

Establishing a capacity development strategy and implementing it to meet the needs of NMHSs. This strategy will identify NMHSs requirements for education and training at national and regional levels and will operate through hybrid systems that combine traditional training workshops, distance learning using modern communication technologies, manuals, guidance, best-practice documents, and technical papers to help NMHSs support climate services effectively. This will include:

- i. Updating the climate curricula at WMO Regional Training Centres (RTCs) to incorporate new advances in climate science, applications and services;
- ii. Upgrading technical skills in climate data management, climate statistics and diagnostics techniques, climate prediction, climate monitoring and climate watch and early warning systems;
- iii. Developing communication skills for interacting with users according to appropriate methodologies.

Undertaking a variety of training activities for enhancing the capacity of NMHSs in Climate Data Management Systems (CDMS), data rescue and transfer into digital format, time series quality control and homogenization, climate monitoring and assessment activities, development of climate indices, Climate Watch systems, seasonal prediction, climate change projection, downscaling and tailoring, user awareness activities, etc.

The qualifications and competencies for climatologists, climate services specialists, climate prediction experts, etc., must be established and a common understanding evolved of the professional, technical and administrative capabilities required.

The capability of NMHSs for supporting climate risk management and climate adaptation will depend on their capacity to manage and provide climate data, to convert these data into usable information and products, and to develop decision support and decision-making tools by applying the knowledge so generated.

2.4.7 Strengthening regional climate capabilities

Regional capabilities for supporting climate services have two major objectives: (i) to provide regional-scale information to enhance the detail of national-scale information; and (ii) to provide national-scale products on request to countries that do not yet have the required capacity for developing their own products. In strengthening regional capabilities it is important to take into account the global-regional-national levels of climate product generation and exchange. GPCs and other mechanisms providing basic climate data and climate system monitoring at the global level, along with RCCs and NMHSs, supported by GPCs and specialized centres such as the LC-LRFMME and the LC-SVSLRF, constitute the basic infrastructure for developing, producing and delivering climate services through the CSIS. WMO plays a critical role in establishing the CSIS and making it sustainably operational. The following activities need to be taken up in this regard:

- Standardizing the operational global climate products and promoting free access to them for WMO Members; promoting common understanding of global and regional climate variability and change, and developing consensus-based products such as the Global Seasonal Climate Update;
- Promoting effective use of the WMO Information System (WIS) for all information and data exchange among the CSIS entities;
- Identifying and facilitating the effective use of GPC and other key global climate products at the regional and national levels by promoting operational mechanisms involving mutually compatible products and protocols for exchanging and applying data products effectively; promoting access by NMHSs to a basic set of GPC digital forecast data (e.g. 2-metre temperature, precipitation, winds and temperature and geo-potential height at standard levels, as well as hindcast data and lateral boundary-condition data for regional downscaling) to support developing national climate services and prediction products for a range of users;
- Expanding RCC coverage to all Regions. A minimum of two or three Regional Climate Centres (RCCs) or region-wide/sub-regional RCC-Networks in each of the WMO Regions, along with some trans-regional RCCs, will be required for a global total of 15-22 existing and new RCCs and RCC-Networks;
- Expanding and sustaining RCOF operations in all Regions, particularly in developing and least-developed sub-regions;
- Providing technical guidance on best operational practices within RCCs and RCOFs, while promoting common standards and quality management in product generation as well as dissemination.

2.5 Initial implementation activities/projects

Since CSIS is the operational core of the GFCS, it needs to take into account the priorities identified under the other pillars as well as the sector-specific requirements highlighted by the exemplars. CSIS

activities are essentially defined to provide the information and infrastructural support for implementing climate services at different levels, as well as for subsequent upscaling. Major priorities for identifying the initial implementation activities are to establish national-scale CSIS entities in all countries, with a particular focus on developing countries, and to provide a regional support system (e.g. RCCs and RCOFs). The proposed initial implementation projects are described below. See also Appendix V, which provides a preliminary template for projects to create frameworks for climate services at the regional and national levels.

Project 1: *Establish and coordinate operational support for Frameworks for Climate Services at the national level in developing countries*

Activity:

Focusing on the needs of developing countries, the entities and necessary methods of cooperation are identified for generating and disseminating climate information, products and services that meet national needs and priorities. They are then formalized and coordinated in a consistent and sustainable manner. This activity needs to be closely aligned with the dialogue activities under the UIP pillar (e.g., Climate-Health Working Groups) and also with associated activities under the Capacity Development pillar.

Objectives:

- To identify the national providers and the national CSIS entity or entities responsible for:
 - Maintaining the official climate record (normally the NMHSs);
 - Developing the operational climate information products that constitute the essential climate science inputs for climate services at the national level (primarily the NMHS);
 - Creating and providing authoritative, credible, usable and dependable science-based climate information and advice that is valuable to users;
- To promote internationally consistent mandates for the national CSIS entities, including (based on identified user requirements) for:
 - The timing, content and format of a minimum set of climate information products to be provided to specific users;
 - Gathering, assembling and managing the data necessary to support climate services (physical climate, water, socio-economic, etc.);
 - Identifying research advances and incorporating relevant ones into national practices;
 - Active management of user engagement, including forums as well as dissemination and feedback mechanisms;
 - Procedures for issuing early warning for fast- and slow-onset hazards;
 - Cooperative mechanisms to ensure the consolidation, coordination and optimization of the development and provision of user-focused climate services;
 - Performance measurement, evaluation and response procedures;
- To identify gaps in national capacity along with options to address such gaps, including capacity development and, where necessary, options for delegating responsibilities to regional or international parties;
- To establish or expand interaction and dialogue between providers and users at the national level (i.e. the government ministries and institutions; UN and sector-based institutions representing key socio-economic sectors; the private sector; the broader community for identifying user requirements and for user training in climate matters, as well as for discussion and feedback on climate information and products;

- Ultimately, to improve user confidence in climate information and products so that they use them effectively and proactively in decision making for all aspects of climate risk management.

Benefits:

The extent to which climate services are available and used within a country, the numbers and types of agencies and institutions providing various climate and tailored climate products, and the level of interaction with and engagement of user groups in the cycle of development of the products and services intended for their uptake varies from one country to the next. Both providers and users of climate products and services will benefit from establishment of national frameworks, in that the available resources applied to product development will be optimized, consistent and more efficient; products will evolve to address gaps, improve quality and reduce uncertainty, resulting in improved confidence and trust; it will be clear where the services are developed which will help to improve access and dialogue between users and providers; dialogue between sectors on climate characteristics and impacts will improve, and greater common understanding of climate and its impacts will be possible. Countries and sectors will become active and proactive, and regularly engage in climate risk management, thus building resilience. Adherence to internationally recommended guidance will promote more internationally consistent policy and socio-economic applications.

Deliverables:

- A guidance document (developed by CCI, CBS, regional associations, countries, user stakeholders) to assist in development of frameworks for climate services at national levels, in which roles and responsibilities of the various actors are proposed;
- One or more relationship-building and demonstration activities with key stakeholders to discuss opportunities and constraints, identify national requirements (for risk management and adaptation, inter alia) and agree on sustainable operating procedures for ongoing collaboration;
- National Climate Outlook Forum/National Climate Forum sessions devoted to the establishment and coordination of frameworks for climate services at the national level;
- Agreements and MOUs (e.g. on provision of physical and socio-economic data, or institutional agreements for cooperation).

Current activities:

The WMO Secretariat held several meetings in Africa in 2012 in advance of the Extraordinary Congress (October 2012) to gather views on national frameworks for climate services. National Climate Outlook Forums have been established in a few countries.

Indicators and assessment measures:

- Number of Members with formally established operational support to frameworks for climate services at the national level;
- Numbers of meetings and meeting reports;
- Number of agreements (e.g. MOUs);
- Number of countries with access by their users (could be assessed by sector) to the climate information and products needed for climate risk management.

Participants:

CSIS entities at national levels including NMHSs and relevant nationally agreed service providers; relevant O&M entities such as those working towards interoperable data systems involving physical as well as socio-economic data; academic and research institutions; partnering agencies at global and regional scales including their regional and technical constituent bodies as required (e.g. FAO, WFP, WHO, UNESCO, ISDR, WMO (with CCI, CBS and other technical commissions, and its regional associations)); key national partners and

stakeholders representing users (e.g. national ministries and agencies for agriculture and food, health, water, disaster management and climate); the media; international and national banks and financing institutions; regional economic groups; aid agencies; etc.

Project 2: *Define, build and make available a Climate Services Toolkit to all countries*

Activity:

This project aims to identify, collect, enhance and package a high-quality set of knowledge products, software tools, public domain datasets and related training materials to assist developing countries in providing climate services. This set of offerings will incorporate the latest scientific and technological advances, as needed by users and stakeholders, and will promote consistency and quality in the products and services developed through CSIS. Many institutions will contribute to the toolkit, with considerable effort required to develop, test and complete the materials for widespread use. WMO, through CCI, will coordinate the compilation, production and distribution of a Climate Services Toolkit. This activity reflects relevant priorities under the DRR (risk analysis and assessment as well as early warning) and Health Exemplars (indeed, as an overarching, multi-sectorial requirement).

Objectives:

- To ensure that climate-sensitive sectors in any country have access to the most up-to-date, reliable and consistent climate information and products that meet their basic needs at least;
- To provide a conduit for technology transfer to developing countries, enabling their access to the latest methods, techniques and information required for CSIS activities and products;
- To increase the effectiveness, consistency and quality of CSIS activities and outputs;
- To identify, collect, enhance and package a high-quality set of knowledge products, software tools, and related training materials, i.e., a climate services toolkit;
- To distribute the toolkit to CSIS entities and advise them on its application;
- To establish a procedure for maintaining and updating the toolkit (as users increase their participation in the GFCS, and increasingly benefit from climate information, their requirements will likely evolve, which may require developing new tools to meet these requirements. Moreover, as research advances are made the toolkit must be updated to accommodate new materials).

Benefits:

Implementation of GFCS at national scales will impose considerable demands on the service providers, including NMHSs. Having a toolkit based on standards and good practices to support CSIS activities will improve efficiency and raise capacity of service providers, and will ensure that the information and products developed for and provided to users is reliable, consistent (through time and across regions) and of high quality. A toolkit can be kept up to date with new tools, information and methods, and therefore will enable all CSIS providers to take advantage of research advances. The datasets included in the toolkit will enable more countries to develop their national products and should encourage improved data sharing. The availability of the toolkit, with training materials, should reduce the need for expensive capacity building. The Climate Services Toolkit will also make training workshops more focused, tangible and efficient in imparting the operational skills.

Deliverables:

- A toolkit, consisting of knowledge products; bespoke software for data management, data analysis (including indices), climate monitoring, prediction, downscaling and verification, with the requisite training materials; a set of standards, and a certification process for new tools;
- A collection of standard public domain datasets (e.g. global gridded data, monthly SST data, etc.), as well as data generated by data rescue, digitization homogenization and CDMS projects for inclusion in the toolkit;
- A plan for maintenance and updating of the toolkit and its datasets.

Current activities:

CCI has an Expert Team on CSIS that is developing the toolkit as one of its key deliverables. Other CCI teams are developing software (e.g. CCI ETCCDI for climate indices, and ET-CRSCI for sector-specific indices). WMO Members and research and academic institutions have developed, inter alia, ClimSoft and CliSys for data management; CMT for monitoring, CPT, PRECIS and SCOPIC for forecasting, downscaling and verification and so on.

Indicators and Assessment Measures:

- Number of countries with access to and using the toolkit;
- Number of training workshops based on Climate Services Toolkit;
- Number of operational CSIS products using the Climate Services Toolkit;
- Number of contributors to Climate Services Toolkit.

Participants:

This work will be conducted by CCI and CBS experts, representatives from advanced NMHSs, academic and research institutions, on CSIS, RMP and relevant O&M aspects.

Project 3 - *Establish modern Climate System Monitoring based on improved operational monitoring products***Activity:**

This activity facilitates international coordination and collaboration in developing a set of standard climate monitoring products and climate indices to be generated by NMHSs and other climate centres. This includes developing gridded data sets and assisting developing countries with training and guidelines concerning new climate monitoring products, standards and exchange protocols and mechanisms. The activity contributes to the risk communication initiative of the DRR exemplar and enhances user awareness of ongoing or foreseeable climate anomalies, along with their associated health consequences, as highlighted by the Health exemplar. National products will be disseminated using standard templates and exchange protocols that will enable rapid aggregation of information on regional and global scales. Climate assessment reports and reviews (e.g., climate statements, state of the climate reports and reviews, reports and advisories on extreme weather and climate events, etc.) will improve in content and coverage with a reduced time delay. Sectorial users will be able to access consistent, systematic and timely climate monitoring reports and assessments covering national, regional and global scales. This activity will:

- Coordinate international work and collaboration in developing a set of standard climate monitoring products and climate indices to be generated by NMHSs and other climate centres;
- Develop gridded data sets based on *in situ*, model- and space-based data and products;
- Assist developing countries with trainings and guidelines on new climate monitoring products and related definitions, standards and exchange protocols and mechanisms.

Objectives:

Improve Climate System Monitoring based on standard definitions, new product templates and data exchange protocols while improving procedures for gridded data sets.

Benefits:

- Enhanced national operational climate monitoring and related services. The national products will be disseminated using standard templates and exchange protocols that will help quick aggregation of information at regional and global scales;
- Climate assessment reports and reviews (e.g., climate statements, state of the climate reports and reviews, reports and advisories on extreme weather and climate events...) will improve in content and coverage with a reduced time delay;
- Sectoral users will be able to access consistent, systematic and timely climate monitoring reports and assessments covering national, regional and global scales.

Deliverables:

- Standard templates of national climate monitoring products and climate reports will be delivered with guidance on definitions, procedures and exchange protocols and mechanisms;
- Identification and development of suitable procedures and tools for developing gridded data sets for climate monitoring and assessment at national and regional scales.

Current activities related to this activity:

- The WMO Commission for Climatology has a Task Team on National Climate Monitoring Products and is working on the definition of a set of new products to improve Climate System Monitoring;
- WMO coordinates the provision and dissemination of the annual statement on the status of the global climate;
- NOAA-NCDC in collaboration with WMO and countries publish an annual report on the state of the climate;
- A 10-years climate report summarizing the state of the climate during the decade and the impacts of climate extremes is being finalized with the help of WMO Members, international data and monitoring centres and several sector agencies;
- The CCI/WCRP/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices ETCCDI (developed a set of 27 climate indices suitable for analysing climate extremes. Regional workshops have been conducted to assist countries using climate indices techniques and software for national and regional climate assessment.

Indicators:

- Availability of and access to improved climate monitoring products on operational basis;
- Feedback on the usefulness of the reports from at least the priority sectors.

Assessment measures:

- Progress in developing standards and templates for the national climate monitoring products;
- Progress in the provision of tools and procedures for gridded data sets.

Participants:

WMO CCI, partnering agencies, members.

Project 4: *Implementation of Climate Watch System*

Activity:

A Climate Watch System provides a proactive mechanism for interacting with users (e.g. governments, industry, sectors, communities, and the public) and alerting them to major climate anomalies and extremes. CWSs, which use climate data, monitoring products, imagery, and predictions, add value to existing climate monitoring and forecasting systems within the NMHSs and should be developed to involve users fully in providing the conditional elements of the system: thresholds, indices, criteria and databases. CWS will enable climate sensitive sectors to access critical information on possible negative impacts of ongoing or foreseen climate anomalies and extremes in a timely manner. This activity includes conducting workshops and demonstration projects to facilitate interactions between NMHSs and key stakeholders as well as to develop templates for use in key climate sensitive sectors. NMHSs, RCCs and sectors will collaborate in different regions to agree on a set of procedures, tools and data bases needed for organizing and operating national and regional CWSs. This activity will also assist developing countries with trainings and guidelines on implementing climate watch systems at the national level. This activity will contribute to the DRR priority project on strengthening regional capacity for disaster risk assessment and early warning of hydrometeorological risks, as well as to the national training needs identified under the Capacity Development pillar.

Objectives:

Improve Climate System Monitoring based on standard definitions, new product templates and data exchange protocols as well as improving procedures for gridded data sets.

Benefits:

- Nations will be able to develop and take advantage of climate services with special emphasis on devising methods of adapting to, and mitigating, the adverse impacts of climate and its variations;
- Promote awareness of the potential benefits of climate services in human endeavour with particular emphasis on public safety and welfare;
- Sectors (i.e. Health, DRR, agriculture, food security...) will be able to be fully part of CWSs at national levels, enabling them to build consortiums with climate information providers for developing climate advisories for specific context and needs.

Deliverables:

- Templates of climate watches will be developed with consideration of specific needs of sectors and regional contexts;
- Regional CWS Implementation workshops leading to implementation of CWS at national levels.

Current activities:

In 2008 WMO started to facilitate the organization of workshops to develop collaborative efforts in the Regions to make best use of existing facilities. The workshops aimed at ensuring consistent approaches amongst the NMHSs in using WMO guidelines on climate watches. Each workshop was defined for a Region or a Sub-region where climate anomalies and related extremes have common origin and similar impacts.

Indicators and assessment measures:

Indicators

- Organization of CWS at regional then at national level with implementation of CWS demonstration projects in the countries in the various Regions.

Assessment measures

- Progress in organizing climate watch systems at regional level;
- Progress in the provision of climate watches at national levels.

Participants:

CSIS entities including NMHSs, key stakeholders representing sectors at global scales (e.g, FAO, WFP, WHO, UNESCO, ISDR); key stakeholders at national scales, e.g. national ministries and sector agencies.

Project 5: Standardize the operational CSIS products and promote CSIS-wide use of WMO Information System (WIS)**Activity:**

It is imperative that CSIS products adhere to internationally accepted standards in order to, *inter alia*: (i) enable systems to work interchangeably or together; (ii) provide a common set of tools for communicating effectively; and (iii) offer assurance that a product can deliver a certain level of performance. Adherence to standards, both on the input and the output sides, will be critically important for the various CSIS entities in delivering effective climate products and services. Given that most national CSIS entities will rely heavily on global and regional inputs, it is essential that CSIS-wide standards are developed, agreed and implemented. This activity aims to identify global and regional products that should have well-defined and commonly-agreed characteristics of content, format, frequency, etc. It will also develop standards and protocols for developing and disseminating those products. The WIS component of this activity will complement the efforts outlined under the O&M pillar and will focus on training CSIS information managers and information system developers on relevant WIS concepts and interoperability to ensure that WIS is widely used throughout CSIS operations.

Objectives:

- To ensure that all national CSIS entities generating climate information adhere to a set of standardized global and regional climate products;
- To the extent possible, to promote common standards in the generation and packaging of CSIS products at the global, regional as well as national levels to facilitate interoperability.

Benefits:

Adherence to internationally accepted standards will:

- Enable systems to work interchangeably or together;
- Provide a common set of tools for communicating effectively;
- Offer assurance that a product can deliver a certain level of performance;
- Facilitate comparison of products from different sources;
- Increase adherence to best practices, which should improve product quality and consistency;
- Facilitate product dissemination and data discovery.

Deliverables:

Assessment of products that should be common to all global and regional providers, and developed and presented following common standards; a set of standards and protocols for specific products. Guidance and training on WIS implementation.

Current activities:

CCI and CBS have identified criteria for mandatory products of GPCs and RCCs. Lead centres collect the products from other GPCs and create a common version. CBS/CCI Expert Team on Operational Prediction on Seasonal to Longer Scales (ET-OPSLs), CCI/CBS Expert Team on RCCs and CCI Expert Team on CSIS are currently engaged in defining and proposing standards for CSIS products. WIS implementation is in progress spanning weather and climate products, and WIS compliance is being promoted in all WMO-designated operational entities.

Indicators and assessment measures:

- Number of standardized CSIS products of GPCs, RCCs and NMHSs;
- Number of CSIS entities generating standardized products;
- Number of countries/sectors using standardized CSIS products.

Participants:

CCI, CBS, CAS and WCRP experts across O&M, RM&P and CSIS areas of activity; GPCs, RCCs and NMHSs; Other institutions operationally providing CSIS-related products.

Project 6: *Facilitate the effective use of GPC and other global climate products by regional and national providers (e.g. RCCs and NMHSs), including the operational provision of Global Seasonal Climate Update*

Activity:

At present, regional and national entities have access to many global products but often have to identify the most robust signals and likely future states of the climate in their areas on their own. Effective access, along with expert guidance and training in using global products including the Global Seasonal Climate Update (GSCU), will help regional and national users quickly identify where the global models are providing the most useful information for their areas of interest. This will help them apply the information in developing their own products. The activity will promote wider and more effective use of all global-scale CSIS products, such as those of GPCs, in the operational activities of RCCs, RCOFs and NMHSs, offering better access and guidance as well as training/capacity development where needed. This will further ensure the operational production and provision of the GSCU and will enable regional and national CSIS entities to access, understand and use global products (e.g. from GPCs), including the GSCU. The activity will develop training modules to explain the global products and will demonstrate their use in regional and national exercises. It will also train staff in RCCs and NMHSs (complementing the training activities proposed under the Capacity Development pillar).

Objectives:

- To ensure the operational development and dissemination of the GSCU to regional and national CSIS entities;
- To ensure that regional and national providers of climate information have access to and, where appropriate, use GPC products and the GSCU for generating their own products;
- To develop training modules that explain the global products, including GSCU, and demonstrate their use in regional and national exercises;

- To train staff in all current RCCs (including those in pilot mode), and in NMHSs (perhaps through regional workshops).

Benefits:

Access to the GSCU and training in the use of global products including the GSCU will help regional and national users to quickly identify where the global models are providing the most useful information for their areas of interest, and to apply the information in development of their own products.

Deliverables:

The GSCU; training modules in the use of GSCU and other global products; training sessions.

Current activities:

WMO El Niño/La Niña Update is being regularly produced by WMO in collaboration with IRI, and disseminated to all WMO Members, RCCs, RCOFs as well as the general public. WMO LC-LRFMME is providing easy access to LRF products of GPCs. CBS-CCI Expert Team on Operational Prediction on Seasonal to Longer Scales (ET-OPSLs) is promoting wider application of GPC products. CCI Task Team on GSCU is already working towards creation of a GSCU in a trial mode, building collaboration, testing methods of analysis and presentation and testing current capabilities with respect to development of consensus.

Indicators and assessment measures:

Availability of GSCU; number of regional and national CSIS entities accessing and applying global products including GSCU; Number of regional and national CSIS entities with staff trained in use of global products.

Participants:

CCI, CBS, regional centres, some NMHSs.

Project 7: *Strengthening regional systems for providing climate services*

Activity:

At present, climate services in many vulnerable countries are weak. While the capacities to develop and deliver climate services on a national scale are being strengthened, RCC products and information, especially for long-range forecasts and regional climate monitoring, will help fast track improved development and delivery of national climate services. This activity will support developing countries with regional climate services and mechanisms for capacity development, and will also bring together countries sharing common climate concerns for collaborative assessments and promote common understanding. Its major focus will be promoting and strengthening WMO RCCs, expanding RCC coverage to all WMO Regions, and expanding, improving and sustaining RCOFs, giving priority to vulnerable developing countries. Enhancing, strengthening and expanding the RCOF process, improving methods, implementing efficiencies and increasing user-focus will augment the sustainability of the COFs. This will provide users with more consistent and regular information and products pertinent to their needs, along with improved access to and dialogue with climate providers. The project will also assist RCCs and practitioners of RCOFs in optimizing, making more efficient and standardizing their practices and methods. It will complement activities aimed at developing/strengthening the RCC infrastructure and RCOF mechanisms under the Capacity Development pillar.

Objectives:

- To promote and strengthen WMO Regional Climate Centres (RCCs), to expand RCC coverage to all WMO Regions, and to expand and sustain Regional Climate Outlook Forums, giving priority to vulnerable developing countries;
- To ensure that all RCCs and RCOFs have the capacity to meet the needs of relevant national bodies for regionally-focused, high quality and reliable climate information;
- To identify a well-defined and commonly-agreed set of climate information products useful in any region, along with some region-specific products that address unique regional requirements;
- To develop guidelines providing best practices in creating and delivering the identified products.

Benefits:

- Improved development and delivery of national climate services, and therefore user decisions, for improved climate risk management;
- Improved, more reliable products, thus reducing uncertainty of users, and improving trust in and application of the information;
- Provision to users of more consistent and regular information and products pertinent to their needs, and improved access to and dialogue with climate providers;
- Increased comparability between and quality of RCC and RCOF procedures and outcomes.

Deliverables/outcomes:

Include facilitation of the launch of the demonstration phase of new RCC operations in critical areas (*proposed to inaugurate 3-5 RCCs in Africa, Asia, the Pacific or a trans-regional RCC, with the participation and support of the regional associations and countries to be served or acting as host(s)*), fast-tracking of the capabilities of RCC candidates to meet designation criteria (*could include support for computing facilities, skills development; networking, Internet access; satellite feeds; storage media; WIS compliance; resource materials, and consultancies*); standardizing technical procedures and tools; enhancing capacities for the development and coordinated operational flow of information and products from RCCs to national CSIS entities; guidance on the optimal utilization of RCC products by national CSIS entities; training in the use of RCC products as required; launch and stabilization of new RCOFs in vulnerable regions not yet served by COFs (*three to five based on needs and engagement*); promotion of sustainable funding structures for COFs in vulnerable areas; guidance on maintaining COF activity during periods when there is no opportunity for meetings. Guidance document on best practices within RCCs and RCOFs.

Current activities:

Two RCCs were officially designated by WMO in June 2009 under the current GDPFS procedures established jointly by CBS and CCI, viz. the RCC Beijing (China) and the RCC Tokyo (Japan), both in RA II (Asia). Formal RCC designation is imminent (as of August 2012) for an RCC-Network for Europe (RA VI) and the North Eurasian Climate Centre (NEACC, RA II). Other centres working towards formal RCC designation include the African-RCC in ACMAD and the IGAD RCC at ICPAC (both in RA I), India (RA II), the Caribbean Institute of Meteorology and Hydrology (CIMH, RA IV) and in RA III by CIIFEN, the Northern South America RCC-Network, and the Southern South America RCC-Network. Current Regional Climate Forums that are conducted on a regular or quasi-regular schedule include GHACOF – Greater Horn of Africa; PICOF – Pacific Islands; PRESAC – Central Africa; PRESAO – Western Africa; PRESANOR – Northern Africa; SARCOF - Southern Africa; FOCRAII – WMO Region II; SASCOF – South Asia; NEACOF – North Eurasia; EASCOF – Eastern Asia (under development); SSACOF – Southeast South America; WCSACOF – West Coast South America; CARICOF – Caribbean; FCCA – Central America; SEACOF – Southeast Asia (under

development); SEECOF - South East Europe (Figure 4). Criteria for activities and products sufficient for designation of RCCs exist.

Indicators and assessment measures:

Numbers of RCCs or RCC-Networks providing the mandatory minimum functions; level of regional ownership/participation and sustained funding for RCC operations; Numbers of countries served by regular RCOFs (note frequency of COF products); Types of products (e.g. for LRF/seasonal outlooks, monitoring products, bulletins and advisories); extent of participation, by sector, of user communities and partnering agencies in RCOFs (numbers and frequency); satisfaction of RCOF user groups with the RCOF process and products including the extent to which users feel products are tailored for their use and useable; extent to which RCOF products are used in decision making at national and regional levels. Availability of the guidance document.

Participants:

Include WMO Members; international and national funding organizations; existing designated and pilot-mode RCCs; WMO Regional Associations, WMO Technical Commissions, especially CCI and CBS for the RCC designation process and development of guidance; GFCS Research, Modelling and Prediction entities for improvements to methods and skill; RTCs, to participate in training; GFCS UIP experts and entities to facilitate and guide the user liaison aspects of RCOFs, GFCS partnering agencies for (at least) the high priority sectors, namely FAO, WFP, WHO, UNESCO, ISDR, and their regional and national counterparts; additional entities of national level of CSIS (e.g. academic institutions, government ministries) as recommended by the countries in question.

Project 8: *Expand and sustain NCOF/NCF operations*

Activity:

This activity will establish or enhance national mechanisms such as National Climate Outlook Forums (NCOFs)/National Climate Forums (NCFs) in order to extend the benefits and concepts of RCOFs to the national scale, and to increase access and use of climate outlooks and other climate information and products by users at the national level. It will also facilitate consistency in the use of climate information by all national user sectors. The activity will establish effective means of disseminating climate information, and of fostering dialogue between providers and users at national scales through NCOFs/NCFs. From a CSIS perspective, a more fundamental project objective is to strengthen the capability of CSIS entities to help users plan, produce, disseminate and secure feedback for their products and services. Deliverables include guidance on establishing and operationalizing NCOFs/NCFs as well as several demonstration projects. The activity will also facilitate consistency in interpreting and using climate information, which will improve multi-sectorial and cross-sectorial decision making.

Objectives:

- To ensure that National Climate Outlook Forums/National Climate Forums are established (or improved, where they already exist) and made operational for disseminating climate information effectively and for fostering dialogue between providers and users at national scales through several demonstration projects;
- To identify practices and methods, including using Internet technologies for provider-user engagement during periods when there is no opportunity, or it is impractical, for face-to-face meetings;
- To strengthen the capability of CSIS entities to engage with users in planning, producing, disseminating and securing feedback for their products and services.

Benefits:

CSIS entities will benefit by having direct contact with key users of climate information, and opportunity to participate in development of national and sector decisions where climate is a factor (e.g. for climate risk management and adaptation, emergency planning and response, etc.). Users will benefit from direct access to climate information providers, for increasing their awareness and knowledge, and for advice on application of the products in decisions. Both providers and users become aware of what is needed, what is possible, and how to cooperate. They will be prepared to optimize when climate is benign, and will be prepared should significant anomalous climate events threaten. Consistency in the interpretation and use of climate information will improve multi-sectoral and cross-sectoral decision-making in cases of common influences.

Deliverables:

Guidance on establishing and operationally conducting NCOFs/NCFs; several demonstration projects.

Current activities:

NCOFs are already in operation in a few countries.

Indicators and assessment measures:

- Numbers of countries having NCOFs/NCFs in operation;
- Number of user sectors actively involved in NCOFs/NCFs;
- Number of NCOF/NCF sessions.

Participants:

CCI, CBS, partnering agencies at global to national scales, national CSIS entities, national user communities; media.

2.6 Implementation approach (including operational and organizational aspects)

The nature of implementing activities will be influenced by whether or not they are dealt with at the global, regional or national level. This implementation approach will create efficiencies, delineate responsibilities and maximize value at each level. For example:

- Developing international standards and global scale products will best be achieved at the global level;
- Access to information, development and delivery of products for regions, some aspects of training and capacity development will be best undertaken at the regional level;
- Product development and delivery for the national and local scales, establishment of relationships between producers and users, and training and capacity development will best be undertaken at the national level;
- Effective implementation of the CSIS at the national level will particularly benefit from a structure that can readily encompass national priorities for generating and applying accurate and timely information about the climate for the past, the present and, where possible, the future. Structural elements that might be pursued at the national level include national climate services and their frameworks, national climate centres, National Climate Outlook Forums/National Climate Forums, etc. Countries will choose the models that best address their specific needs and circumstances, but it is clear that NMHSs should play a central role in their implementation.

This approach, while ensuring the operation of CSIS entities at the global, regional and national scales, should also have a special focus on an efficient, operational two-way flow of data and

information, keeping in mind that the operational functions at each of the three spatial scales are critically dependent on one another.

2.7 Monitoring and evaluation of the implementation of activities (including monitoring success)

Establishing criteria for the success of CSIS is important in order to set out realistic objectives for its implementation. These criteria will constitute a valuable management tool for measuring progress. In the event that progress is not up to expectations, the criteria should inform a review process to identify issues and offer options for remediation.

The first criterion for success must be that needed climate information is generated and made available in a timely and targeted manner. Another is that rules are established for a working structure with well-defined responsibility for technical oversight on CSIS implementation, with agreed primary and high-priority functions and product portfolio as well as standards and protocols that take user needs into account.

In the longer term, CSIS implementation may be monitored according to whether:

- CSIS products and access to them adequately meet priority sector needs;
- Sustained operations of global and regional CSIS entities regularly provide inputs for generating national-scale CSIS products and services;
- Sustained partnerships exist among agencies that are able to contribute to CSIS operations at all three levels;
- Increase in the overall use of CSIS products and services, and in the usefulness of such products in planning and other decision-making, is confirmed by systematic and cost-effective surveys of user communities;
- There is an increase in climate data and information exchanged globally and regionally;
- There is effective transferring of climate research outcomes into CSIS operations as measured by the increase in the range of products available, including in the number and types of decision support tools in which they are used, and in reducing the uncertainties associated with key climate products;
- Its ability to undertake projects funded by aid agencies and other donors improves;
- Its ability to attract the resources necessary for sustain its ongoing, long-term activities is maintained.

The current structure of CCI is closely aligned with GFCS implementation strategy, and its Open Panels of CCI Experts (OPACEs) are entrusted with thematic areas relevant to major components of the GFCS. Two of the OPACEs, dealing with: (i) climate monitoring and assessment; and (ii) climate products and services and their delivery mechanisms, deal with aspects directly relevant to CSIS. CCI can therefore play a key role in the review mechanisms for CSIS through the relevant OPACEs. CCI needs to work closely with other technical commissions and co-sponsored bodies (e.g., with CHy and CAgM on the user interface for water and food security sectors, with CBS on GPCs and observational standards for climate services, and with WCRP on climate change projections) to take fully into account the interests of all the stakeholders in CSIS operations.

2.8 Risk management in the implementation of activities

The risks associated with implementing the CSIS fall broadly into the following categories:

Organizational complexity: The CSIS is operations-intensive and will require close collaboration among many agencies and institutes at the national, regional and global levels. Coordinating these cross-cutting interests in developing a sustainable CSIS will be a complex task. To minimize risk, initial implementation of CSIS should ensure that a minimum number of core CSIS entities are put in place at the three levels, gradually expanding the range of their operations over time on the basis of results and experience and doing so in ways that best manage the risks that complexity creates. Additionally, the success of CSIS depends on adequate input from the other components of the GFCS, a subject needing to be addressed by efficient interaction with the respective technical committees and other stakeholders.

Leadership and management: Leadership of the CSIS operations, including oversight of adherence to standards and protocols, is essentially decentralized and comes from the governments/ intergovernmental agencies hosting the CSIS entities. The United Nations System, for its part, provides overall technical coordination and guidance. There is strong government and United Nations System support for the CSIS component, so developing leadership and management on its basis will minimize risk.

Resourcing: The rate at which the CSIS achieves its full potential will depend on resourcing levels. The resources necessary to support the CSIS will come from national and regional sources, including e.g. governments, development agencies, bilateral arrangements, funding arrangements with overseas aid agencies, and from financing that may emerge for the GFCS as a whole. A risk for the CSIS is a low level of engagement at the national level, a risk that must be minimized by highlighting and then demonstrating the benefits of regional and international cooperation. Regional institutions have a key role to play in capacity building, so the risk of their non-engagement must be minimized through programmes that strengthen and bring together regional institutions capable of contributing to climate services.

Support for coordination: Strong government and United Nations System support will be necessary to minimize the risks associated with under-resourcing key management functions. Linking with United Nations agencies and programmes that are doing related work will be essential to minimizing the risk of failure, as will access to experienced project management capability through the Framework's committee on capacity building.

Support for High-priority Projects: The CSIS should implement a number of high-priority projects in regions where climate services are least developed and most needed, and where logistical conditions are conducive for project implementation. These will be capacity development projects that engage users and providers and that are implemented using resources from aid agencies and drawing on expertise from climate centres currently delivering a range of climate services.

3 ENABLING MECHANISMS

The CSIS should work closely with the other pillars of the GFCS to ensure synergies between ongoing activities and to establish appropriate connections, partnerships and communication strategies for all the key inputs required for its operations, including effective dissemination of its products and services. A few such mechanisms are outlined below, with more details provided in Appendix VI:

- Synergy with the activities of the O&M pillar in establishing appropriate guidelines for the quality control and archiving of all climate data, including data collected from non-traditional sources;
- Close links between the CSIS and R&MP components to facilitate research programmes and projects that will generate outcomes improving the effectiveness of CSIS products and services and will ensure that the capabilities and limitations of monthly and multi-annual to decadal predictions as well as climate change projections are clearly communicated to all users;
- Collaboration between CSIS entities and the UIP pillar, especially at the national level, to ensure that climate information is properly integrated into decision and policymaking;
- Enhanced training and capacity building initiatives relating to generating and applying all CSIS products, an integral part of the overall GFCS Capacity Development pillar.

At all three levels of CSIS operations there is a range of institutions with different governing structures and mandates. They need to work together operationally, complementing one another and collaborating in order to obtain the most reliable climate information that science can deliver. Building partnerships among these institutions is therefore an essential requirement for ensuring the successful operation of the CSIS.

The communication strategy adopted for the CSIS will have two broad objectives: (i) raising awareness of CSIS entities and their operations/products, and establishing them as authentic sources of climate information; and (ii) raising awareness of CSIS products and services in order to promote their wider use in the application sectors.

4 RESOURCE MOBILIZATION

Further details on priority projects, including their resource implications, are available in the compendium of project initiatives identified by Cg-XVI for extrabudgetary or voluntary funding by Members. Resource requirements for CSIS will mostly concern developing and supporting operational climate service provision at the national level in developing countries, and establishing a suitable regional support system in the form of RCCs and RCOFs. Resource requirements at the global level will essentially be for defining products and standards while devising tools for operational climate activities. Implementing these projects will require funding directly from WMO voluntary contributions or through other funding arrangements that may emerge for the GFCS as a whole. As the latter source may take some time to come on stream, it would be appropriate to seek an interim funding solution, e.g. through the WMO VCP or other avenues for regional and national development (e.g. development agencies, bilateral arrangements, overseas aid agencies, etc.). There is also considerable interest from several development agencies in supporting climate risk management and vulnerability assessments concerning climate change, with focus on certain regions in need, which may provide opportunities for highlighting the benefits of establishing sustained CSIS entities.

Further, with heightened understanding of the general significance of climate for social, economic and environmental well-being, mechanisms widely available for engaging in climate change adaptation and mitigation activities could be explored in order to obtain resources for carrying out critical activities such as improving observation networks, data rescue, and data homogenization.

5 COSTED SUMMARY OF ACTIVITIES/PROJECTS

Section 2.5, describes eight important CSIS projects scheduled for completion by mid-2015. The costs of these activities are estimated in Table 1 below. The total cost for all of them is estimated to be 15 million USD. This is a conservative estimate, based on certain demonstrated capabilities and processes, and does not reflect the cost of full implementation in all areas of need. It should be noted that, if sufficient number of qualified experts are available to implement project activities, there may be a need for additional funds in some cases.

Table 1. CSIS Initial implementation projects.

No.	Activity	Key objective	Contributing Pillars	Implementation priority(ies)	Geographic scope	Lead organization	Other organizations	Time-line	Cost USD xM
1	Establish and coordinate operational support for Frameworks for Climate Services at the national level in developing countries	Entities and cooperation necessary for development and provision of climate services at national levels in developing countries are identified and formalized; climate services are developed and provided with engagement with users	CSIS O&M UIP CD	Guidance document(s) on national frameworks; demonstration project(s); agreements for cooperation; NCOFs/NCFs devoted to establishment and coordination of national frameworks	National	WMO	FAO WFP WHO UNESCO ISDR National partners and stakeholders	Mid-2014 and then on-going	1M
2	Define, build and make available a Climate Services Toolkit to all countries	Ensure that climate sensitive sectors have access to up-to-date, reliable and consistent climate information and products that meet at least their basic needs; a conduit for technology transfer	CSIS RM&P O&M	A toolkit with knowledge products, software, training materials, standards, along with public domain datasets	National and Regional	WMO	Academic and research institutions NMHSs	Mid-2015	1M
3	Establish modern Climate System Monitoring based on improved operational monitoring products.	Improve Climate System Monitoring and its products based on standards, data exchange protocols,	O&M CSIS RM&P CD	Standard templates of national climate monitoring products and climate reports; improved	National and Regional	WMO	FAO WFP WHO UNESCO	End 2014	0.4M

		improved gridded data, improve access to users		procedures for gridding data			ISDR		
4	Implementation of Climate Watch systems	Governments, industry and communities are forewarned of any emerging anomalous climate conditions	O&M CSIS UIP	Templates of CWS developed with user requirements included; implementation workshops	National and Regional	WMO	FAO WFP WHO UNESCO ISDR National stakeholders	End 2014	0.6M
5	Standardize operational CSIS products and promote CSIS-wide use of WMO Information System (WIS)	All national CSIS entities generating climate information adhere to standardized global and regional climate products. Promote common standards in a generation and packaging of national CSIS products. Ensure that WIS is widely used throughout CSIS operations; training	CSIS O&M	Identification of a set of standard climate analysis, monitoring and prediction products, and the protocols for their generation and production; CSIS experts are knowledgeable about WIS to facilitate its use	Global	WMO		Mid-2014	1M
6	Facilitate the effective use of GPC and other global climate products by regional and national providers (e.g. RCCs and NMHSs), including the operational provision of Global Seasonal Climate Update	GSCU is developed and disseminated; Regional and national providers of climate information access GPC products and the GSCU, and use them in generating their own products.	CSIS CD	The GSCU; Training and capacity building activities that foster uptake of GPC products and the GSCU	All scales	WMO		Mid-2014 then on-going	1M
7	Strengthening regional systems for providing climate services	Support and strengthen WMO RCCs; expand RCC coverage to all WMO Regions; expand and sustain RCOFs with priority to developing regions; guide RCCs/RCOFs to use best practices in their operational activities	CSIS UIP RM&P CD	Launch 3-5 RCC demonstrations; fast-track existing RCCs in demo-mode to meet designation criteria; guidance and training; launch 3-5 RCOFs; Guidance on best practices	Global Regional	WMO	FAO WFP WHO UNESCO ISDR National stakeholders	Mid-2015	3 million per annum = 9M

8	Expand and sustain NCOF/NCF operations	Develop and improve NCOFs/NCFs as an effective means of disseminating climate information at national scales, and for fostering dialogue between providers and users	CSIS UIP CD	Guidance on establishing and operationally conducting NCOFs/NCFs; several demonstration projects	Regional and National	WMO	FAO WFP WHO UNESCO ISDR, partnering agencies at regional to national scales	End 2014 then on-going	1.0M
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Box 1 Climate Watch Requirements

National Meteorological and Hydrological Services should assess their capabilities and needs to establish an effective climate watch production and dissemination system meeting the following requirements:

- Provide timely observations of current climate conditions for their areas of responsibility and adequate historical climate data;
- Perform timely monitoring and analyses of current climate anomalies;
- Enjoy access to current global climate predictions and possess the technical capabilities to interpret and downscale them to their region;
- Deliver probabilistic climate prediction products that the user community can understand;
- Regularly update records of past forecasts and analyses of past forecast performance;
- Employ effective methods for routine dissemination of climate information to user groups and sectors;
- Develop active partnerships with the user community as well as feedback mechanisms that provide guidance for designing climate watches and for evaluating their effectiveness.

If some aspects of the required capacities are lacking they will need to be developed. There are two elements to consider when planning on building climate watch system capacity: the need for activities for ensuring that National Meteorological and Hydrological Service staff have the skills to operate a climate watch system, and the need to build user capacity, requiring dedicated and sustained efforts best achieved by regular interaction and partnership. To that end, an outreach programme is necessary to ensure adequate use of system outputs and an understanding of its limitations and problem areas so that improvements can be made.

Box 2 Rainwatch

Rainwatch is a prototype Geographical Information System (GIS) based service designed to increase interactions between local climate information users, providers, and intermediary groups. It was developed at The University of Oklahoma through collaboration between the US National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) and the university's Department of Geography and Environmental Sustainability, as "an attempt to help Africa help itself" by minimizing the adverse societal impacts of Sahelian rainfall variability that has characterized the previous 30+ years. The development/operation of Rainwatch is funded largely by the NOAA through CIMMS.

Rainwatch was created to surmount the existing challenges to West African rainfall data acquisition, management, representation, and dissemination. The present prototype system consists of a database and customized software components. The database includes station identification information and historical rainfall data for each station. It is linked to a graphics feature that automatically updates the related charts and graphs as new data are added. The software allows the user to view a cumulative daily station rainfall plot for one year (or part of a year) against up to five percentile thresholds for the historical reference period, and also to compare this plotting with counterparts for: (a) other stations in the same year; or (b) other (extreme) years for the same station. The licensing challenges associated with Rainwatch use in West Africa are expected to diminish gradually as GIS software and its utilization become more widespread among relevant agencies and institutions in the region. Further development of Rainwatch will assess the availability and utility of free GIS software, and extend the treatment to other components of the surface water budget to guide irrigation scheduling. The ultimate goal is to make Rainwatch available to all African nations at minimal cost.

Use of Rainwatch to monitor the evolution of the generally very poor 2011 rainy season in southern Niger provided substantial early warning – as early as mid-August 2011 – of the high food insecurity situation in that region extending into 2012 (New York Times, January 19, 2012; The Economist, July 7, 2012). This early warning resulted from Rainwatch products being disseminated widely within the US, Europe, and West Africa throughout the 2011 season at 10- or 15- day intervals, and its value has been widely acknowledged by experts and policymakers.

Full details of the motivation, design, and construction of Rainwatch are published in the *Bulletin of the American Meteorological Society* (November 2009, vol. 90, pp. 1607-1614) and *ICT Update* (December 2001, Issue 63, pp. 8-9; <http://ictupdate.cta.int>).

Box 3 Climate Predictions and Projections

In any operational forecasting system the production cycle of forecasts is generally determined by the lead-time and period over which the forecasts are valid. Seasonal predictions, which are usually valid for a three-month period, will be issued typically on a monthly cycle, several days before the beginning of the validity period.

A long-range forecast for a shorter period such as a month will be updated more frequently, e.g. on a weekly basis and likely a day or two ahead of the validity period. In the event that sufficient useful skill can be demonstrated for multi-year forecasts, it is likely that they would be updated on an annual or six-monthly basis.

Information on conditions that might eventuate out to several decades will likely be dependent for the foreseeable future on projections of climate that are largely determined by a range of possible scenarios relating to 'external' forcing on the Earth-climate system, such as the socio-economic scenarios of anthropogenic greenhouse gas emissions.

The cycle of assessments of climate change projections being carried out under the auspices of the Intergovernmental Panel on Climate Change is currently on the order of 6-7 years. The uptake and use of such projections distributed during the four IPCC assessments carried out so far has largely been confined to the research environment, but a rapidly growing interest among a much wider community of potential users suggests that a more operational system for distributing climate change projections, with consistent and interoperable formats and access to products, will be required.

Box 4 Climate Database for the Environment (CliDE)

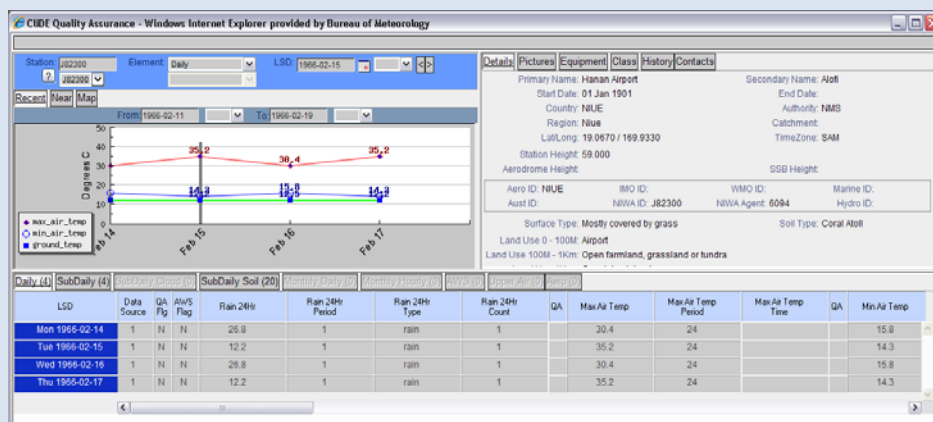
A climate database management system entitled Climate Database for the Environment is being produced as part of the Pacific Climate Change Science Program, a key activity of the Australian Government's International Climate Change Adaptation Initiative.

CliDE is an example of a suite of Climate Data Management Systems (CDMS) being developed and supported by various groups around the globe to assist countries, especially developing and least-developed countries, manage their data. Work is underway within CCI to define mandatory features of CDMS to assist countries in fulfilling their data management and data exchange requirements, and to support provision of climate services.

CliDE will be supplied to the National Meteorological Services of several Pacific Island countries to give the capability of storing their meteorological and related observations in a robust climate database management system via a user-friendly interface. CliDE can be used to store securely historical and current observations both manually and automatically.

NMHS staff can key in meteorological data obtained from observation recording booklets, sheets, and monthly registers. Station details can be recorded, including instrumentation, observation site details, and a history of any changes made to those sites. Electronic data are imported as comma-separated files (CSV) or in CliDE or CliCom formats. In addition, there is edit capability for reviewing and amending data as required. All meteorological data are stored as System International (SI) units where appropriate. When non-SI units are key-entered, the values are automatically converted to SI.

CliDE produces pre-formatted reports and line plots of key meteorological parameters (e.g. maximum temperature, minimum temperature, rainfall). Data can be transferred to global and regional data centres in CLIMAT formats, and can be ingested directly by other analysis and prediction systems currently used by the NMHS, e.g. the Seasonal Climate Outlook for Pacific Island Countries (SCOPIC) package that is also being implemented as part of the overall Australian Government Pacific initiative.



APPENDIX I

OVERVIEW OF CSIS PRODUCTS AND MECHANISMS

The primary data used in CSIS operations, particularly at the global and regional scales, comprise historical as well as real-time observations of the GCOS *Essential Climate Variables (ECVs)* in the atmosphere, the oceans, over land and the ice. Such data also underpin the running of global and regional climate models, which generate homogeneous and high-resolution gridded data sets in real-time, through re-analysis and, in some cases, in research modes that can in turn be used for the development of a wide range of CSIS products. Historical datasets shared across national, regional and global boundaries have enabled verification of these products and of the ability of models to simulate past climates and the validation of their ability to predict future climate, but the availability and access to such datasets for CSIS entities is currently sub-optimal. At national scale, however, in addition to the highly valuable ECVs, climate services for a wide range of sectors will require the full suite of data observed through the WMO Global Observing System, and data observed by partnering agencies.

A diverse array of climate data, information and products, and application services are already provided by a variety of national and international, public and private, research and operational organizations. Some climate services may be provided freely as public goods while others are customized and provided for consumption under commercial arrangements between service providers, individuals and business enterprises.

CSIS caters to users of climate services who can be grouped roughly into three categories:

- a) Internal users encompassing parts of the CSIS that take information from the other parts in order to generate products and services for 'external' users, e.g., NMHSs drawing on the services provided by regional centres in order to generate products targeted at specific national requirements;
- b) A group of 'external' users operating at the strategic level, such as governments, insurance, finance, etc., who rely on climate information in order to develop better policies and conduct their businesses more effectively;
- c) The main group of 'external' end-users for whom the productivity of their businesses and enterprises is directly affected by climate variability and change.

The CSIS will deliver services directly to users within the first category but it is more likely that services to the two other categories of users will be facilitated through the UIP, especially higher order services. In all cases, CSIS entities will need to understand the nature and requirements of the sectors being targeted.

Experimental monthly and decadal-scale products may become more widely available in time. It will be important, however, to develop and make accessible appropriate verification measures for all forecast time scales, noting that such measures have only been defined at this stage for climate predictions at the seasonal scale. Products will typically be provided as maps and tables of expected anomalies, e.g. for temperature or precipitation, and most likely in probabilistic formats. Information related to the predictions will include consensus summary assessments of key features, as appropriate, and at national levels may include advisories and warnings.

On a regular basis, WMO coordinates and publishes reviews and assessments of past climate patterns, to document the climate as it evolves and to explain the factors and processes involved in its evolution. Of particular note is the WMO Annual State of the Climate report, which provides a global summary of the past year's major climate events. Its preparation is coordinated by WMO in collaboration with several leading climate centres and organizations, with direct or indirect contributions from and review by a large number of NMHSs and climate scientists. For other UN bodies and NGOs such as UNEP, FAO, WHO, ICRC/IFRC it provides the authoritative climate context for events of importance to their own sectors of interest. The United Nations Framework Convention on Climate Change (UNFCCC) has also found it to be a valuable source of ongoing information about the evolving climate between the 5-7 year IPCC global assessments of climate change. The production of this Report will likely continue to evolve to include analyses of new user-

relevant indices that integrate climate, water, soil and socio-economic indicators to better characterize climate events and the extent of their impacts.

The WMO coordinates a number of operational climate monitoring activities that identify, document and provide an alerting service on current, incipient and potentially hazardous climate anomalies. The Climate Watch System (See Box 1) provides advisories and statements to inform users about evolving or foreseen climate anomalies at the global, regional and national levels, particularly to those users involved in natural disaster preparedness, mitigation and response. A typical Climate Watch includes the analysis of observations on current (monthly) climate conditions with respect to anomalies (departures from means), percentiles and the exceedance of thresholds, as well as a wide range of other statistics on weekly, monthly, seasonal and annual bases. NMHSs in contributing to the CSIS will continuously monitor and assess the status of the climate, evaluate available climate predictions for their areas of interest and where appropriate issue them to users in forms that facilitate their ease of use. GPCs and RCCs will play a major role in supporting the operation of climate watch systems at the national level. In addition to the climate watch systems being promoted by WMO, there are other efforts to coordinate and disseminate climate monitoring information to support decision making at different levels, such as the “Rainwatch” (see Box 2).

The “WMO El Niño and La Niña Update”, a collaborative effort between WMO and several major climate research and operational climate centres around the world, combines both monitoring and prediction information. It is a statement issued approximately once every three to four months on the current and expected evolution of the ENSO phenomenon, a quasi-regular feature of the global climate centred on the equatorial Pacific Ocean. This product was initiated during the major El Niño event of 1997 in response to a demand from UN Agencies and NGOs for information on what was to become one of the most significant global climate events of the 20th century. There are national and regional counterparts to the WMO El Niño/La Niña Update, especially in those countries and regions that border and are within the Pacific Ocean Basin where the impacts of ENSO are typically strongest.

A set of primary, high-priority functions of the CSIS (a common, minimum set of functions spanning global, regional and national scales) has been proposed along the lines of the operational functions identified for WMO Global Producing Centres of Long-Range Forecasts (GPCs), WMO Regional Climate Centres (RCCs) and NMHSs, namely: (i) climate data retrieval and management; (ii) climate monitoring; (iii) climate prediction; and (iv) climate projection. These functions include processes of analysis, re-analysis, diagnostics, interpretation/ assessment, attribution, verification and communication/exchange of data and products. The CSIS will facilitate the effectiveness of these functions through a linked global-regional-national system of providers. Notwithstanding the critical importance of the global and regional components, e.g. GPCs and RCCs, the vast majority of end-user climate services will be delivered within a national context. There are clearly advantages for end-user clients to obtain all their weather and climate (and where relevant hydrological and marine) information through a ‘single window’. In many countries, NMHSs can, and do provide such a single window, even if other partners might be involved in the actual generation of such products. For the CSIS to be successful in all countries, however, it will be important to establish a number of baseline capabilities and targets for bringing NMHSs and as necessary other relevant national institutions up to the appropriate baselines through well-designed capacity development activities.

The CSIS will seek to draw from, build on and, only where necessary, add to existing infrastructure, especially at the global scale where WMO and other organizations have already established well-functioning systems, programmes and centres. The various components of this existing infrastructure have been established at different times under different circumstances and, while they are not currently coordinated with a climate services perspective, will nevertheless serve as the basis for CSIS implementation. A summary of the key contributing components of this existing infrastructure follows.

A1.1 Basic systems for CSIS Infrastructure

It is widely recognized that for the generation of reliable operational climate information even on the national scale, it is critical that adequate global and regional inputs and products are available

on a continuing basis. The overarching aim of CSIS implementation is therefore to establish a global-regional-national infrastructure with capabilities and linkages for operationally sustainable production and flow of climate information, in analogy to as well as in close liaison with the World Weather Watch (WWW) and considering the principles of the WMO Information System (WIS).

A1.1.1 WMO World Weather Watch

The ongoing operation of the basic systems of the WMO World Weather Watch will be as fundamental to the delivery of climate services as they are to the delivery of weather forecasts and warning services. These basic systems are as follows:

- *Global Observing System (GOS)*: A coordinated system of methods and facilities for making meteorological and other environmental observations on a global scale in support of all WMO Programmes;
- *The Global Telecommunication System (GTS)*: A coordinated global system of telecommunication facilities and arrangements for the rapid collection, exchange and distribution of observations and processed information;
- *Global Data-Processing and Forecasting System (GDPFS)*: A three-level system comprising: World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs) and National Meteorological Centres (NMCs), which carry out a range of meteorological analysis and forecasting functions at the global, regional and national levels, respectively (note that GPCs and RCCs in CSIS are types of RSMC).

A1.1.2 WMO Information System

The WMO Information System (WIS) is the single coordinated global infrastructure responsible for the telecommunications and data management functions. It is the pillar of the WMO strategy for managing and moving weather, water and climate information in the 21st century. WIS provides an integrated approach suitable for all WMO Programmes to meet the requirements for routine collection and automated dissemination of observed data and products, as well as data discovery, access and retrieval services for all weather, climate, water and related data produced by centres and Members in the framework of all WMO Programmes including those contributing to the GFCS.

WIS is an enhanced information system built upon the GTS of WMO's World Weather Watch, using standard elements and being implemented at a pace feasible for all WMO Members. It will be capable of storing and exchanging large data volumes, such as from new ground and satellite based systems, for generating and handling finer resolutions in numerical weather prediction models and climate models, and in their applications. These data and products must be available to NMHSs, and also to national disaster authorities for more timely alerts where and when needed. WIS will be the vital data communications backbone integrating the diverse real-time and non-real-time high priority data sets, regardless of location.

Consistent with the principle of building upon what is already in place rather than duplicating existing institutions and efforts, Cg-XVI expected that the WIS could serve as a key dissemination mechanism under GFCS. Indeed, the operations of WMO RCCs, as key CSIS entities for implementation, are already required to be WIS-compliant, and may also become WIS Data Collection or Production Centres (DCPCs).

A1.2 CSIS at the Global Scale

A1.2.1 International Data Centres

Many of the international data centres that focus on geophysical systems from a global perspective, including climate related systems, operate within the World Data Centre (WDC) system. The WDC system was created to archive and distribute data collected from the observational programs of the 1957-1958 International Geophysical Year. Its holdings include a wide range of solar, geophysical, environmental, and human dimensions data. These data cover timescales ranging from seconds to millennia and they provide baseline information for research in many ICSU disciplines, especially for monitoring changes in the Geosphere and Biosphere –

gradual or sudden, foreseen or unexpected, natural or man-made. ICSU has recently created a new World Data System that has subsumed the WDC system (see <http://www.icsu-wds.org/>). The centres of most relevance to the CSIS are those dealing with:

- Climate (Hamburg, Germany);
- Glaciology (Cambridge, UK);
- Glaciology and Geocryology, (Lanzhou, China);
- Meteorology (Obninsk, Russian Federation; Ashville, USA);
- Oceanography (Tianjin, China; Obninsk, Russian Federation; Silver Spring, USA);
- Remotely Sensed Data (Wessling, Germany).

Other global data centres of interest to CSIS include those for: biodiversity, human interactions in the environment, land cover data, trace gases, and palaeoclimatology. Further, a number of WMO Members own and operate climate data centres routinely collecting, processing and disseminating climate data on a global scale. All CSIS entities should be familiar with and have the capacity to tap into and use the vast quantities of data archived and information generated by all these centres. CSIS for its part should encourage these data centres to respond in terms of policies, procedures and products to meet the needs of the GFCS in general and of the CSIS in particular.

A1.2.2 Global Climate Monitoring and Analysis Centres

Although there is no existing formal structure within the WMO System for the global monitoring and analysis of climate, a number of centres undertake various aspects of global scale climate monitoring and generate a wide range of analysis products. A few examples of such centres are the National Climate Data Center and National Centers for Environmental Prediction (USA), Tokyo Climate Center (Japan), Met Office (UK), European Centre for Medium-Range Weather Forecasts, Beijing Climate Center (China) and Global Precipitation Climatology Centre (Germany). The World Data Centres also generally carry out monitoring and analysis of their respective climate-related domains of interest. There may be value under the CSIS in identifying a suite of standard essential global climate monitoring products that these and other designated centres could agree to generate and make available on a routine basis.

A1.2.3 Global Producing Centres for Long Range Forecasts

In 2006, WMO began a process of identifying, as an integral part of the WMO GDPFS, a network of Global Producing Centres for Long Range Forecasts (GPCs) that make and distribute global seasonal predictions. The current, officially designated WMO GPCs are shown in Figure 3⁵ & 6. Through a rigorous designation process, GPCs are expected to adhere to certain well-defined standards that support consistency and functionality across the network. In order to be designated as a GPC, a centre must as a minimum adhere to the following criteria:

- Have fixed production cycles and time of issuance;
- Provide a minimum suite of products;
- Provide verifications as per the WMO Standardised Verification System for Long Range Forecasts (SVSLRF);
- Provide up-to-date information on methodologies used by the GPC;
- Make products accessible through the GPC Website and/or disseminated through the WIS and/or the Internet.

⁵ http://www.wmo.int/pages/prog/wcp/wcasp/clips/producers_forecasts.html

⁶ Official WMO reference for designated GPCs is the *Manual on the GDPFS*, Volume I (Global Aspects), WMO-No. 485; http://www.wmo.int/pages/prog/www/DPFS/documents/485_Vol_I_en.pdf.



Figure 3: Current distribution of Global Producing Centres (GPCs) for Long Range Forecasting.

WMO has also designated two Lead Centres among the GPCs, namely the Lead Centre for Long-Range Forecast Multi-model Ensembles (LC-LRFMME) hosted by the Korean Meteorological Agency in collaboration with the US National Oceanic and Atmospheric Administration, and the Lead Centre for Standard Verification System for Long-Range Forecasts (SVSLRF) hosted by the Australian Bureau of Meteorology in collaboration with the Meteorological Service of Canada. LC-LRFMME collects a number of GPC real-time LRF products as well as some hindcast data, and by arrangement makes available a range of ensemble products to regional and national users in uniform formats and with common graphical displays. LC-SVSLRF is the authoritative source for mandatory verification information for all the GPCs, providing a single source for all information on the skills of the GPC products for any specific region/country in the world. The SVSLRF is a comprehensive set of standard measures for verifying seasonal predictions and communicating their skill.

The following products are currently set down as the recommended requirement for any designated GPC issuing seasonal time-scale products:

- Predictions for averages, accumulations, or frequencies over 1-month periods or longer - typically, anomalies in 3-month-averaged quantities is the standard format for seasonal predictions. Forecasts are usually expressed probabilistically;
- Lead time: between 0 and 4 months;
- Issue frequency: monthly or at least quarterly;
- Delivery: graphical images on GPC website and/or digital data for download;
- Variables: 2m temperature, precipitation, sea-surface temperature (SST), MSLP, 500hPa height, 850hPa temperature;
- Long-term forecast skill assessments, using measures defined by the WMO Standard Verification System for Long-Range Forecasts (SVSLRF).

Data or products additional to the recommended list above may also be provided by GPCs on request by regional or national centres. Centres using GPC products are required to adhere to any conditions attached by the GPCs to these data and products.

There are as yet no set standard product sets relating to shorter time-scales, e.g. monthly forecasts, or longer time-scales, e.g. multi-annual forecasts. With respect to the latter, it is clear that at this point in time, useful skill in multi-annual forecasting has yet to be demonstrated and it would be premature at this time to move any such experimental forecasts into the mainstream for routine uptake or application. That does not preclude their application, however, within a controlled, research-driven context.

A1.2.4 Centres providing Global Climate Change Projections

The use of longer-term climate projections, e.g. out to several decades, has begun to mature rapidly following the Fourth Assessment Report of the IPCC. It is likely that the upcoming Fifth Assessment Report will lead to a further upsurge in climate change projections and related information becoming available from the many research organizations that have signalled their intention to contribute projections under the procedures and rules being set down by the IPCC. There will be many users that will seek to apply the information to their own particular situations, and a need will arise in the foreseeable future to serve them by a suite of standard products suitably scaled in time and space. In this context, it is also important to clarify to the users on the not-so-obvious distinction between climate prediction and projection products (see Box 3).

An appropriately resourced CSIS will be well placed to help service this wider community demand, with the GPC network having the potential to provide a suite of standard products at the global scale drawing in particular on the various global centres established to service the research directed at informing the IPCC including the data centre for the Program for Climate Model and Diagnostic Intercomparison, the World Data Centre for Climate and the IPCC Data Distribution Centre.

A1.3 CSIS at the Regional Scale

Similar to the global scale, the CSIS will draw from and where necessary build on existing relevant regional scale infrastructure including primarily the structures already implemented under the WMO GDPFS and also any other existing entities that are already delivering effective climate information services. These latter centres should be encouraged where feasible to operate within or at least collaborate informally with the overall structure of CSIS.

A1.3.1 WMO Regional Climate Centres (RCC)

At a regional level, WMO is encouraging the establishment of a number of Regional Climate Centres (RCCs)⁷ that will generate and deliver more regionally focused, high-resolution data and products as well as offer training support on the use of their products. The RCCs are being implemented as part of the overall network of WMO Regional Specialized Meteorological Centres (RSMCs). Along with the GPCs they therefore constitute integral components of WMO's GDPFS, with procedures in place for their formal designation for the purposes of helping underpin the generation of a wide range of national climate information products. The aim is for RCCs to assist WMO Members in a given Region or a defined sub-Region to deliver better climate services and products including long-range forecasts, and to strengthen their capacity to meet national climate information needs.

The primary 'clients' of WMO RCCs are intended to be NMHSs and other RCCs in a given Region or RCCs in a neighbouring Region. RCC responsibilities being regional by nature could by agreement provide services directly to other entities and agencies operating at a regional level. However, such arrangements should not duplicate or unilaterally seek to replace ongoing national services within the Region.

WMO RCCs can be implemented either by institutions providing all the mandatory functions under one roof, or as virtual RCC-Networks comprising one or more nodes with the mandatory functions distributed among the nodes, and each node delivering its assigned function(s) for the entire domain of responsibility.

The operational functions carried out by RCCs may be grouped as follows:

Data Services, to support operational LRF and climate monitoring:

- Development of regional climate datasets (factoring in long-term data quality and homogeneity), gridded where applicable;
- Provision of climate database and archiving services, at the request of NMHSs.

⁷ <http://www.wmo.int/pages/prog/wcp/wcasp/RCCs.html#RCCLinks>

Climate Monitoring:

- Performance of climate diagnostics including analysis of climate variability and extremes, at regional and sub-regional scales;
- Establishment and maintenance of an historical reference climatology for the Region and/or sub-Regions;
- Implementation of a regional Climate Watch;
- Preparation and dissemination of routine monthly and seasonal climate bulletins.

Long Range Forecasting:

- Interpretation and assessment of relevant products from GPCs making use of the SVSLRF; distributing relevant information to national entities, particularly NMHSs, and to other regional clients; and providing feedback to GPCs;
- Generation of regional and sub-regional tailored products relevant to RCC client needs, including seasonal outlooks etc.;
- Verification of RCC generated quantitative LRF products, including the exchange of basic forecasts;
- Generation of 'consensus' statements on regional or sub-regional forecasts;
- Provision of on-line access to products and services and to national and regional clients;
- Assessment of the use and value of RCC products and services through feedback from clients.

Climate Change Projections:

- Provision of regional and, on request, national projections of climate change;
- Efficient and cost-effective access to climate projections and related information;
- Clear explanations of the limiting factors associated with the use of climate projections in order to reduce risks to users from the misinterpretation of the information provided;
- Coordination with other centres/providers of climate change projection information to reduce unnecessary duplication in service delivery.

Training in the use of operational RCC products and services:

- Delivery of short-term training courses in climate science to partner countries e.g.
 - Advanced climate courses;
 - Training workshops and other specialized training events;
- Development of materials (e.g. power point presentations, guidance notes, fact sheets) that can be used to further train staff of national providers of climate services in the region, i.e. a train the trainers approach;
- Develop the capacity of NMHSs to effectively deliver climate change science information including working with their local media outlets.

WMO has been making concerted efforts to implement RCCs, in close coordination with its Regional Associations CCI and CBS. All six WMO Regional Associations have strongly endorsed the concept of RCCs, and have committed to the establishment within their respective domains of responsibility and in close compliance with the applicable WMO Technical Regulations (GDPFS) a number of multifunctional RCCs or RCC-Networks that will deliver a range of climate products and services to meet the needs of NMHSs and, as agreed, other national and regionally focused organizations.

As of October 2013, three RCCs and one RCC-Network have been formally designated by WMO under the current GDPFS procedures established jointly by CBS and CCI, viz. the RCC Beijing (China), the RCC Tokyo (Japan) and RCC Moscow (Russian Federation), all three in RA II (Asia), and RCC-Network (RA VI, Europe) with AE De Bilt (The Netherlands) Node on Climate Data Services, Offenbach (Germany) Node on Climate Monitoring and Toulouse (France) and Moscow (Russian Federation) Node on Long Range Forecasting. Other centres working towards formal RCC designation include the African-RCC in ACMAD and the IGAD RCC at ICPAC (both in RA I),

India (RA II), the Caribbean Institute of Meteorology and Hydrology (CIMH, RA IV) and in RA III by CIIFEN, the Northern South America RCC-Network, and the Southern South America RCC-Network. There are several additional climate centres performing at least some of the functions specified under the GDPFS provisions that could conceivably move towards attaining full RCC capabilities and seeking formal designation within the expanding WMO RCC coverage.

The WMO Regional Association structure is not fully global in coverage, notably leaving out the Polar Regions. WMO, through an expert panel, has begun to explore the establishment of Regional Climate Centres/Networks for the Polar Regions in support of the GFCS.

A well-representative collection of WMO RCCs building on those centres already in place or in planning clearly has the potential to form the backbone of the CSIS at the regional level. For example, in close liaison with WMO GPCs and upon request from NMHSs, RCCs could develop capabilities for downscaling predictive information across all climate timescales for use at regional and national levels within their respective Regions. In addition, they could set up mechanisms to enable their national clients including NMHSs, to perform downscaling or other tailored analyses online.

Further, again on request from NMHSs, RCCs have the capacity for: (i) generating climate analysis products on an operational basis; (ii) conducting data homogeneity assessments and adjustments; (iii) coordinating agreement on a relevant list of useful climate indices for their respective Regions of responsibility and maintaining records of these indices; and (iv) promoting consensus development mechanisms including the RCOF coordination, etc.

A1.3.2 Regional Climate Outlook Forums

Regional Climate Outlook Forums (RCOFs) provide platforms to bring together countries having common climatological characteristics and facilitate consistency in the access to and interpretation of the available information on current and expected seasonal conditions and to deliver a range of regional climate monitoring and outlook products. RCOFs also facilitate user-liaison efforts, and thus straddle both CSIS and UIP pillars of the GFCS, contributing to their linkages. Using a predominantly consensus-based approach, the RCOFs have an overarching responsibility to produce and disseminate an assessment of the expected state of the regional climate for the upcoming season. The forums bring together national, regional, and international climate experts, on an operational basis, to produce regional climate outlooks based on inputs from NMHSs and other national institutions, regional institutions, RCCs, and GPCs. In addition to these technical activities for product generation, and the networking and capacity development opportunities the forums provide for climate scientists, RCOFs also facilitate user awareness of climate products, feedback from the users to climate scientists, and catalyze the development of user-specific products. They also review impediments to the use of climate information, share successful lessons regarding applications of the past products, and enhance sector-specific applications. The forums often lead to national forums for developing detailed national scale climate outlooks and risk information, including warnings for decision-makers and the public (see Section 1.4.7). The major RCOFs currently in action are indicated in Figure 4.

The Regional Climate Outlook Forum process varies in format from region to region, but typically includes at least the first of the following activities and, in some instances, all four:

- A meeting (face-to-face, by teleconference or online) of regional and international climate experts to develop a consensus for regional climate outlooks, usually in a probabilistic form that will encompass:
 - Presentation of key points for the next (rainy) season;
 - Preparation of national long-range forecasts;
 - Capacity building activities to assist interactions between national providers and specific users;
 - Sharing of experiences in creating new products or improving existing material;
- A broader forum involving both climate scientists and representatives from user sectors, for presentation of the consensus climate outlooks, discussion, and identification of expected sectoral impacts and implications, and the formulation of response strategies;
- Training workshops on seasonal climate prediction to strengthen the capacity of national and regional climate scientists;
- Special outreach sessions involving media experts to develop effective communications strategies.

A1.3.3 Related Activities

It is possible for a country to have a number of climate organizations with well-defined administrative structures, and the term “regional” used in a within-country context. For example, larger WMO Member countries use the term “regional” climate centres to apply to centres servicing delineated areas wholly within their respective national borders, for example, in the USA and Australia, with the latter using the term Regional Climate Service Centre (RCSC). In the WMO GDPFS context, the term WMO Regional Climate Centre (RCC) is reserved for designated WMO entities that generate products and services for domains extending beyond a single country. Networks of climate centres operating in some of the geographically larger developed countries in effect operate in a similar vein by supplying information for a particular within-country geographical or political region. Such centres can provide a rich source of experience in terms of the products and services that WMO RCCs are expected to provide. There may also be some regional institutions engaged in climate activities on the regional scale but without the designation as WMO RCCs. It is useful to involve such institutions also in CSIS activities on the regional scale, to

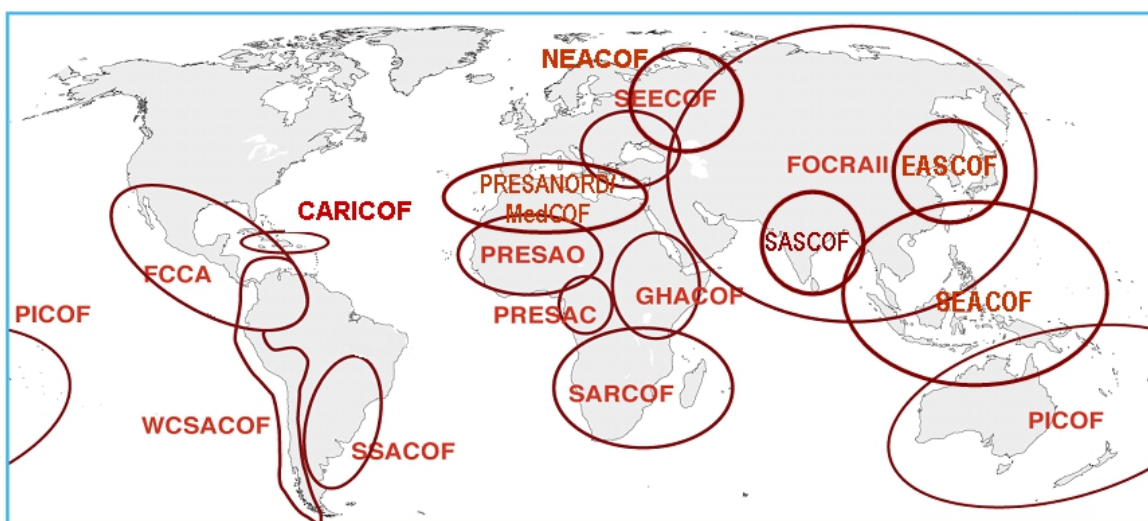


Figure 4: Current distribution of Regional Climate Forums that are conducted on a regular or quasi-regular schedule (GHACOF – Greater Horn of Africa; PICOF – Pacific Islands; PRESAC – Central Africa; PRESAO – Western Africa; PRESANOR – Northern Africa; SARCOF - Southern Africa; FOCRAII – WMO Region II; SASCOF – South Asia; NEACOF – North Eurasia; EASCOF – Eastern Asia (under development); SSACOF – Southeast South America; WCSACOF – West Coast South America; CARICOF – Caribbean; FCCA – Central America; SEACOF – Southeast Asia (under development); SEECOF - South East Europe;)

complement the regional inputs for national climate operations. WCRP's Coordinated Regional Climate Downscaling Experiment (CORDEX) provides an internationally coordinated framework for producing an improved generation of regional climate change projections worldwide, and has set up data distribution centres to provide wide access to the downscaled climate change simulations.

A1.4 CSIS at the National Scale

The development of CSIS-related activities within countries has so far been variable, ranging from countries with a long tradition of implementing well-coordinated operational systems for climate data, monitoring and prediction/projection that underpin a wide range of derived services, to countries that are struggling to populate and maintain a basic archive of climate data. There is value in characterizing the role of individual NMHSs in implementing the CSIS according to a number of capability steps on a scale from basic, through intermediate to advanced. This notion is explored in Section 2.4 in terms of the functions and outputs that might be expected at each level of capability.

A1.4.1 Critical Role of National Climate Data

While there has been an explosive growth in the exploitation of remotely sensed data from satellites for climate related purposes, *in situ* data collected by countries remain the bedrock of climate services and any gaps and shortcomings in quality and continuity feed through the system to weaken realization of the potential value at all space scales. NMHSs have traditionally performed the primary role of collectors of climate data and are likely to retain this role. Nevertheless, with a growing interest in understanding how climate change and variability affect the economic and social health of a country as well as the broader environment, there has been a corresponding growth in the recording and documentation of critical climate parameters amongst a wide range of climate sensitive industries and enterprises. For these additional data to be fully exploitable they must conform to a set of standards such as those of the Global Climate Observing System (GCOS). While some data may not meet these strict standards, which are required for purposes such as the documentation of climate change, they are likely to be very useful to the CSIS with the application of appropriate tools in a wide range of comparative studies. NMHSs must play an important role in ensuring that standards are adhered to and that data collected by other agencies are incorporated, with caveats as necessary, into the national climate database along with the official climate record.

Climate data are an important national asset. In many countries, the NMHS or another branch of its parent organization, has traditionally performed the task of processing and archiving the basic data that have been collected in real-time for generating weather service products or collected in delayed mode. In some countries this responsibility has been vested in another organization altogether, e.g., one that has been established specifically to handle climate change or other broader environmental matters. For convenience, however, the NMHS will generally be identified as the primary GFCS entity for maintaining a national climate archive and for generating and delivering at least basic climate services, without explicitly prescribing that these roles must be the exclusive domain of NMHSs.

A1.4.2 Supporting climate services at the national level

To generate and deliver climate information for effective climate services, most NMHSs require a suite of tools, including guidelines and training on their use, in order to efficiently apply global and regional products, especially where the information is of a predictive nature. It is critical therefore that a baseline of current NMHS capabilities to implement the CSIS at a national level, and to interact with other GFCS components, be established by appropriate means, as a follow-on from the initial, very provisional exercise conducted in support of the work of the HLT. This baseline should also include reference to how well NMHSs are equipped to interact with users, either directly or through systems and procedures being proposed for the UIP. The baseline will be essential for guiding implementation priorities, and for monitoring the progress of CSIS implementation.

Given that more frequent extreme events will likely be a major characteristic of a changed climate, NMHSs or other national agencies (such as those mandated to deal with extremes, hazards and

emergency responses) need to be encouraged to document cases of extreme weather/climate events including their meteorological settings and impacts, drawing on regional and global products as appropriate. Such studies will be critical to the development of effective national mitigation and response actions against events such as forest and grassland fires, floods, severe storms and drought.

Countries that do not yet have well-developed climate services need to identify the organization or organizations that, with appropriate resources, will be best suited to deliver them, and must consider issues related to mandate, resources, commitment and responsibility associated with implementing the various options.

To be successful, a national climate services programme must have a structure that works effectively within the country. The structure must be one that allows the linkage of available applications, scientific research, technological and operational capabilities, and communications into a unified system. The essential components of a national climate services programme are:

- Mechanisms to ensure that the climate information and prediction needs of all users are recognized;
- Retrieval and collection of meteorological and related observations, management of data bases, and the provision of data;
- Coordination of meteorological, oceanographic, hydrological, and related scientific research to improve climate services;
- Multidisciplinary studies to determine national risk, sectoral, and community vulnerability related to climate variability and change, to formulate appropriate response strategies, and to recommend national policies;
- Development and operational provision of climate information and prediction services to meet user needs;
- Linkages to other programmes with similar or related objectives to avoid unnecessary duplication of efforts.

The range of climate services delivered at the national level is potentially very large, especially where a NMHS has responsibilities for generating specific products for a range of different sectors. Nevertheless, one can define a set of basic functions at the national level that will be essential for underpinning similar functions carried out by the RCC at a regional level, i.e. functions related to data management, climate monitoring and prediction, with the potential for expanding into the delivery of information on downscaled climate projections. A typical set of basic activities expected of a national climate service information system would include:

Climate Data

- Maintenance of an archive of recent and historical climate data, the latter being underpinned by data rescue and recovery activities;
- Data and information services based on the national archive;
- Ensuring quality and homogeneity of historical climate time-series.

Climatological Analyses

- Long-term means and trends;
- Diagnostics of climate variability characteristics;
- Extremes including special reports on contemporary and past events.

Monitoring

- Information on the relevance of major drivers of climate variability, e.g. El Niño/La Niña, North Atlantic Oscillation, Indian Ocean Dipole, Madden-Julian Oscillation;
- Diagnostics, assessment, and attribution of current seasonal/sub-seasonal rainfall and temperature patterns, and their anomalies including the associated circulation features;
- Information on current drought/flood conditions and other extremes.

Seasonal Outlooks

- Rainfall and temperature, adequately incorporating aspects of uncertainty;

- Verification statistics.

Climate Change Information

- National downscaled national projections based on appropriate IPCC scenarios;
- Information on the causes of climate change;
- Tracking indices of extremes.

Training in the use of operational national climate products and services

- Provision of information on methodologies and product specifications for national climate products, and guidance on their use;
- Coordination of training for national users in interpretation and use of national climate products.

A1.4.3 National Climate Outlook Forums/National Climate Forums

Section 1.4.4.2 highlights the important role that RCOFs play in bringing different forecasting groups together to facilitate assessment of the available seasonal predictions and the development of consensus-based outlooks for the region. Usually such forums also provide opportunities for forecast providers to interact with forecast users with the aim of communicating better the content and uncertainties inherent within seasonal predictions. There is clearly merit in extending this concept to the national level by establishing operational periodic National Climate Outlook Forums (NCOFs). Indeed some countries already conduct such forums on a regular or irregular basis, including Australia, Botswana, Philippines and South Africa. Some are confined to developing the consensus forecast while others extend their reach into the user communities. Although the nature of NCOFs will likely vary significantly from one country to another, a set of basic guidelines for conducting NCOFs needs to be drawn up, including advice on how best to incorporate user engagement segments. Further, in order to formulate such national forums in ways that allow more flexibility and dialogue for design of tailored climate information including data, monitoring, prediction and projection, the NCOF concept could be generalized to go beyond the “climate outlook” context, i.e., to develop and establish “National Climate Forums” (NCFs). In any case, given that there will be only one operational CSIS entity at the national level, it is clear that NCOFs/NCFs will be dominated by the user sectors, and it is appropriate that the NCOF/NCF concept is scoped out by the UIP pillar of the GFCS.

A1.5 Other CSIS entities

Reference should also be made to international climate centres that cooperate closely with WMO structures and programmes but not formally as GPCs or RCCs, e.g. the International Research Institute for Climate and Society (IRI) and the APEC Climate Centre (APCC). Such centres deliver a wide range of climate products and services openly through the Internet or through special arrangements.

At a regional and national level there are many organizations whose prime focus is on sectors that are especially sensitive to climate, e.g. agriculture, fisheries, human health and water resources. The CSIS has the potential for better servicing such organizations directly with the climate data and services they require. Sixteenth Congress noted that NMHSs should reach out to these organizations as part of their role in implementing the GFCS and the CSIS in particular.

Several countries and international/intergovernmental entities have established institutions for developing strategies related specifically to the effects of climate change. There are also a number of centres and networks such as the Global Atmospheric Watch and Monsoon Activity Centres that focus on different aspects of climate and operate under other WMO Programmes. Many institutions of these types operate in research mode; however, the fruits of the research are likely to lead to opportunities to provide improved climate services, and in some cases facilitate an ongoing demand for climate services in the form of basic data or value-added information about the climate system. Meeting the demand will require the concepts that underlie the CSIS to function effectively at the national level through the adoption of effective institutional arrangements that ensure that the research outcomes from these institutions are translated into ongoing and sustainable services.

APPENDIX II

OVERVIEW OF CSIS PRODUCTS AND MECHANISMS

The secure archival of data in climate data management systems (CDMS) is an essential underpinning activity of all climate services and related activities. A well-constructed CDMS facilitates all the key processes associated with data collection, quality assurance and archival, and is central to the development of all interactive data and information services. For this reason, the CCI has placed emphasis on the development and implementation of CDMS in all countries.

Under the CSIS, climate data received for processing – at least for the Essential Climate Variables – should be subject to rigorous quality control processes, and the results fed back to observation managers to ensure future improvement in the quality of the incoming data.

Up-to-date metadata are essential for ensuring the reliability and fitness for purpose of climate records, for assessing the effects of local land-use changes, and for applying necessary homogeneity corrections. CSIS will rely heavily on metadata for a number of key products and services and should work closely with the Observations and Monitoring component to ensure that current and historical metadata are to the maximum extent possible stored in electronic form and made readily accessible.

All NMHSs should be cognisant of the need to secure their raw data against loss, and therefore a data rescue programme is required in all countries. Data rescue is the process of preserving data at risk of loss due to deterioration of the medium on which the data are stored (paper, microfilm, etc.), which can occur under certain climate conditions such as high humidity, or can be related to failure to modernize or secure storage technologies. Rescue of data in paper-based or obsolete electronic formats, and the digitisation of current and past data, into CDMS-compatible form for easy access are vital activities (see Box 4). Data Rescue is carried out under well-established initiatives such as MEDARE, IEDRO and ACRE⁸ and has also been supported by several bilateral or multilateral projects sponsored for example by developed country agencies for international aid.

The needs of the CSIS must be adequately taken into account when automating networks, which requires that the installation, communications and, most importantly, the ongoing maintenance of stations be resourced sustainably. It also requires ongoing dialogue between climate scientists and observation managers in the areas of network planning, end-to-end quality assurance processes, and requirements analysis.

At present Resolution 40 (Cg-XII) is the primary governing instrument for the international exchange of meteorological and related data. Similar resolutions were adopted by WMO for hydrological data (Resolution 25 (Cg-XIII)) and by the Intergovernmental Oceanographic Commission for oceanographic data (Resolution 6 IOC Assembly XXII). Resolution 40 (Cg-XII) refers primarily to the exchange of essential meteorological data “required to describe and forecast accurately weather and climate, and to support WMO Programmes”, and secondly, to additional data on which restrictions may be placed by the data holder with respect to availability, secondary distribution and use. Such data typically include historical climate and related data held in national archives.

A culture of fewer restrictions on the exchange of data would lead to greater benefits to the data holder and especially to society at large, than would be obtained by treating the data as a commodity to be sold as a means of generating revenue. The ability to combine data sets for regions that span more than one country enables researchers to gain a greater understanding of climate processes that are clearly not constrained within the national borders. Such increased insights lead to capacities for improved climate services for countries on both sides of a border. It will be important for the success of the CSIS and the GFCS as a whole for free and open exchange of all climate data to remain a high priority issue.

To facilitate CSIS product and service generation, countries are strongly encouraged to make key historical data available for inclusion in gridded regional and global climate data sets, which would then more easily allow the free exchange of information contained within the data in ways that remain consistent with national data policies. WMO is actively pursuing a review of data policies under its Convention, in recognition of the importance of the exchange of climate-related data for the provision of climate services.

APPENDIX III

CSIS PARTNERSHIPS

Technical partnerships – between space agencies, climate data management and climate monitoring agencies, communications agencies, and the research community (institutes, programmes and academia/universities) – have steadily been integrated into supporting operational activities to ensure the timely production and dissemination of high-quality information and products. In particular, the three-way WCP partnership between the new WCSP (services), GCOS (climate observations) and WCRP (research and modelling) is critical to the success of the GFCS. Responsibilities of technical partners, such as ECMWF, EUMETSAT, the International Telecommunications Union, ACMAD, ICPAC, CIIFEN, CPTEC, APCC and CIMTA, range from global to local in nature.

Organizations that routinely produce and provide climate data, monitoring analyses, as well as prediction and projection products will be the principal CSIS operational entities. Climate data sets, analyses of the current state of the climate system and seasonal (three-monthly) climate predictions and outlooks will be the initial standard operational products at global, regional and national scales for both land/ocean surfaces and the atmosphere. To ensure the future availability of acceptably reliable and useful decadal predictions and climate change projections, CSIS will need to continue to partner with the research community, including through the coordination mechanisms established under the WCRP projects CMIP, CORDEX, etc. and promoting the wider uptake of such research-based products through CSIS dissemination mechanisms.

The CSIS requires ongoing and sustained relationships between providers and users. There have been long-standing collaborative arrangements on climate and related matters between various United Nations Agencies and Programmes – including WMO, WHO, UNWTO, UNEP, UNDP, UNESCO-IOC, ICAO, IAEA, FAO, WFP, UN-ISDR and UN-Water – and with professional societies – including IAUC, ISB, ICSU and ICID. These collaborations should be further exploited to incorporate interaction with users in various sectors. In many cases, extension, academic and research communities will contribute to both types of partnerships. For example, WMO has experience working with such organizations (for example, AGRHYMET (Niger), IRI (USA), ICRISAT (India), University of Southern Queensland, etc.). Important partnerships exist, and should be further strengthened, with Non-Governmental Organizations such as the IFRC, World Wildlife Fund and the International Union for the Conservation of Nature. It is anticipated that the CSIS and the UIP will work closely together in this regard.

At the national level, partnerships between NMHSs and universities, research institutions, agencies and sectoral ministries (for example, National Health Services, national energy sector, the disaster management sector and ministries for agriculture, water resources, the environment) will facilitate dialogue and help bridge any gaps between providers and users.

Achieving the goals of GFCS at all levels will require the active participation of the finance and aid sectors, including the World Bank, regional economic groupings and banks, and bi-lateral and multi-lateral Aid programmes.

The partnerships noted above are representative of what will be required for an effective GFCS, but by no means can an exhaustive list be assembled. These and many more partnerships will be developed and sustained as GFCS evolves.

Through a mix of international and regional partnerships a number of global, regional and national centres run climate prediction systems that, with active facilitation by WMO, adhere to a fixed production cycle, generate a standard set of prediction products, and routinely exchange, and disseminate predictions and related information in an operational environment similar to that operating for weather forecasting, albeit on longer production cycles.

Considering that the production and dissemination of climate services information at the three levels is highly inter-dependent, there is a critical need to ensure optimal interactions and minimization of duplication between the three levels, both in the operational activities and also in

communication and use of the products. Within and between the CSIS, Observations and Monitoring and Research pillars, existing structures, with modifications where appropriate, should largely be able to accommodate the necessary interactions. The introduction of the UIP, however, and the critical need for it to interact with the CSIS in particular, will likely lead to the need for new mechanisms for interaction between the three levels.

APPENDIX IV

PRIORITY ACTIONS

Institutional

Countries that do not yet have well-developed climate services need to identify the organization(s) that, with appropriate resources, will be best suited to generate and deliver them. Inclusion of the CSIS functions within national centres that encompass the GFCS more broadly and that are within or are closely associated with NMHSs would, from the outset, foster rapid development, operational production, and dissemination of well-targeted climate information.

An early priority for the CSIS should be to carry out a comprehensive assessment of the current capacities of the NMHSs to provide the functions expected of CSIS at the national level, within the framework of the categories identified by the High Level Taskforce. Such an effort would provide baselines or reference points for capacity development requirements and for developing and implementing further improvements.

Implementation

CSIS outputs can be defined to cover all climate information products and services that are applied directly or indirectly to inform policy and decision making in areas where there are sensitivities to climate variability and change. Many of the entities of what should comprise the fully operational CSIS already exist in some form, but need to be further developed, standardized and operationally coordinated.

Knowledge of user requirements and understanding of how users apply climate information are fundamental to the successful generation and delivery of climate services. To help ensure that such requirements are serviced optimally, a process for regular review and update of user requirements for climate data, products and information as well as the use of climate information in real-world contexts should be formulated for the GFCS as a collaborative endeavour between contributing pillars of GFCS.

Detailed documentation on CSIS data and products should be prepared, reviewed and updated as a WMO inter-commission endeavour that also involves the WCRP through its relevant programmes, projects and initiatives. The CSIS may need the guidance of a formal manual that lays down certain globally agreed and committed standards and specifications for its functions, services and products across all geographical levels. One approach might be the synthesising of relevant aspects of the diverse range of existing material in the mandatory and other guidance publications of WMO into a single CSIS reference catalogue. Such a task would not require duplication of material already published but rather would seek to facilitate access to and, where appropriate, complement information and guidance that is currently dispersed throughout many existing publications and technical regulations. It may not be appropriate, however, to try to standardize all CSIS products and services because of the diversity of information and services needed in each region or country. To deal with such diversity, consideration could be given to the development and sharing of a CSIS catalogue or compendium of activities and best practices.

The Sixteenth WMO Congress requested that the Commissions for Climatology (CCI), Basic Systems (CBS), and Instruments and Methods of Observation (CIMO) facilitate an analysis of the strengths, weaknesses and opportunities associated with climate data in order to provide an up-to-date assessment of the existing gaps and shortcomings and to propose solutions for improved data availability and exchange. It is important that this analysis encompasses issues relating to the responsibilities and processes associated with quality assurance/control of climate data, including homogeneity testing and homogenization.

All CSIS entities should have the capacity to tap into and use the vast quantities of data archived and information generated by the growing number of centres around the world archiving climate data. In addition, CSIS needs for climate data should be effectively communicated to such centres, and sustained operational partnerships should be built with them.

The development and delivery of routine climate monitoring products will be one of the key CSIS contributions within the GFCS, with their scope evolving at global, regional and national levels along with user requirements. There would be value in first identifying a suite of standard essential global climate monitoring products that designated CSIS centres could agree to generate and make available on a routine basis to support monitoring at regional and national scales.

Climate Outlook Forums at national scale also can serve very useful purposes, with similar dual roles as seen in RCOFs (in part technical development and enhancement of the outlook products for national application along with professional development of the information providers, and more importantly, user-provider interaction). Although the nature of National Climate Outlook Forums (NCOFs), or more generally National Climate Forums (NCFs), will vary significantly from one country to another, consideration should be given to drawing up a set of basic guidelines for conducting NCOFs/NCFs and development of NCOF/NCF processes and products. Advice on user engagement in NCOFs/NCFs is more appropriately covered under the UIP pillar.

CSIS operational entities, such as WMO Global Producing Centres for Long Range Forecasts (GPCs), other centres routinely providing global-scale climate information, RCCs and NMHSs should participate in the formulation of research programmes and projects that are expected to generate outcomes that will improve the effectiveness of CSIS products and services. Such collaboration would, *inter alia*, facilitate at an early stage an estimate of the resources required to transfer the expected research findings into an operational environment.

All CSIS components must strive to be compliant with the evolving WMO Information System (WIS), to ensure interoperability and facilitate the flow of data and information within the cascading networks of CSIS entities. WIS may also be one of the key mechanisms to enable data discovery and access, thus promoting the essential linkages of CSIS with the other pillars of the GFCS.

Harmonization of climatological normals will be essential for CSIS mandatory products, including the climatological base periods used for creating anomaly products for monitoring, prediction and projection of climate. However, CSIS should also take into account the varying requirements of users in defining climatological periods relevant to their decision contexts, and facilitate the availability of data/information to generate user-relevant climatological averages.

Several countries already produce national State of the Climate reports, and under the CSIS all countries should be encouraged to produce them. In addition to their value as a reference for a wide range of in-country users, they provide a baseline for documenting ongoing climate variability and change for national reporting under the Multiple Environmental Agreements including the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the UN Convention to Combat Desertification (UNCCD).

The development of the WMO Global Seasonal Climate Update (GSCU) should be coordinated closely with all the relevant stakeholders with respect to its content, presentation, and review. Operational implementation will require significant coordination and synthesis of contributions from GPCs, RCCs, NMHSs and other scientific organizations that routinely monitor climate variability and change. The GSCU is a product for assistance to NMHSs rather than for distribution to end-users, and is meant to provide NMHSs with information to enhance, and to augment their respective national products and services to user communities at national scale. For this system of information to be most effective, NMHSs should be enabled to interpret GSCU and other global and regional scale climate assessment products.

An appropriately resourced CSIS will be well placed to help service the community demand for information on climate change projections. Centres having the potential to provide a suite of standard products at the global scale will be able to draw in particular on the global mechanisms established to service the research directed at informing the IPCC. Backed by research progress in downscaling global climate projections, the CSIS will be able to generate more credible information on the potential for specific climate change outcomes at regional and national scales.

While the CMIP5 and CORDEX databases will serve as the comprehensive archives for the research community with respect to climate simulations and climate change projections, they will likely be ill-suited to meet the needs of a wide range of specialist applications, especially at the national level. Consequently, strong consideration should be given to the development of well-

designed and robust online information systems at the regional and national levels that would include websites with state-of-the-art data mining, mapping and navigation.

The use of climate projections and scenarios for policymaking purposes, however, is a sensitive issue. Given that the results of such projections and scenarios often depend on the use of a variable range of multiple assumptions and conditions that may not necessarily be uniformly agreed to by experts, governments, or various stakeholders, such projections and scenarios may have some utility for policymaking, but should not be confused as being the equivalent of the hard data contained in historical data sets or even the climate predictions being made on seasonal to interannual time scales. CSIS operational modalities in this respect should therefore provide users with caveats and information regarding the assumptions, conditions for and limitation of the projections and scenarios so that users would be appropriately informed about the extent to which they may be able to rely on these for policymaking, planning and action programming purposes.

Supporting Research

Research is needed to bridge climate prediction capabilities across the various timescales in order to provide a 'seamless' set of reliable monitoring and prediction products to support the diverse range of user needs. Interactions between the CSIS and RM&P components of the GFCS will be critical in this regard.

The CSIS, in parallel or in tandem with the CCI, should seek close interactions at the regional and national levels with WCRP/WWRP committees and panels with the responsibility for implementing key regionally focused research projects of relevance to the CSIS, linking the interactions where possible with Regional and Nation Climate Outlook Forums.

Training and Capacity Development

The focus for the CSIS Component in this area should be on helping to ensure that developing countries are able to build and maintain the capacity to generate, understand, and integrate national climate information into their policy and institutional settings in ways that are appropriate to their evolving circumstances and under conditions that are determined by them. A large share of resources to be used for the implementation of the CSIS Component must therefore be directed towards capacity development, essentially for the establishment of operational entities and development of human resources in developing countries.

A programme for ongoing in-service training for NMHSs, related to their operational responsibilities within the CSIS, should be developed with the current CLIPS curriculum as a starting point. Sustainable mechanisms for training national CSIS personnel, including through WMO Regional Training Centres (RTCs), Regional Climate Centres (RCCs), workshops, forums and other opportunities should be established. Key infrastructure (e.g., computers, Internet) and technical know-how (e.g., a Climate Services Toolkit) will constitute the fundamental capacity development requirements for CSIS operations at the national level, particularly in developing countries.

Resources

With the heightened recognition of the significance of climate in general to social, economic and environmental well-being, mechanisms being made widely available for activities to mitigate and adapt to climate change should be explored to obtain resources for carrying out critical baseline activities such as improving observation networks (in collaboration with the Observations and Monitoring pillar), data rescue, and data homogenization. In this regard, a number of high priority projects have already been identified for early implementation. While funds sourced through GFCS mechanisms may help finance some priority projects, it would be appropriate to pursue a range of funding solutions, e.g., through the WMO VCP or through other avenues for regional and bi-lateral development, to address CSIS development in a complementary manner.

Governance

It will be essential to ensure a tight nexus and, where appropriate, integration of CSIS management structures with relevant CCI management structures. It is important to recognize in this context that national CSIS entities operate under the governance arrangements put in place by the national governments. At the same time, some such entities also take on regional and global CSIS responsibilities, depending on their capabilities. Additionally, some regional/global CSIS

entities also operate under intergovernmental arrangements. It is important to find a common ground for these varied governance structures and mandates, to implement a seamless operational arrangement for the CSIS.

APPENDIX V

ESTABLISHMENT OF FRAMEWORKS FOR CLIMATE SERVICES AT THE NATIONAL AND REGIONAL LEVELS, PARTICULARLY FOR DEVELOPING COUNTRIES

Objectives

Through various mechanisms at national level, the following objectives will be met:

- a. Identify and assign the mandate to the:
 - National entity responsible for the maintenance of the official climate record, and for operational climate information products that constitute the essential climate science inputs to the climate services at the national level, most often an NMHS;
 - Provider of climate services at the national level – responsible for creating and providing authoritative, credible, usable and dependable science-based climate information and advice that is of value to government institutions, socio-economic sectors and the broader community;
- b. Where national capacity is lacking, determine which functions should be delegated to regional and/or international parties;
- c. Establish and/or expand forums for climate outlooks to include partnership building, gathering and analysing user needs for climate information and its applications, and identifying supplier needs for improved data and training.

Through various mechanisms at a regional scale, the following objectives will be met:

- a. Determine the support required from the RCC and regional sectoral offices by the climate service provider at the national level and the associated operational centres;
- b. Identify mechanisms for fulfilling demand for regional climate services from users.

Benefits

Availability and use of science-based climate information at the national level in an internally consistent, authoritative and dependable manner feeding into government policy and socio-economic applications.

Deliverables

Memoranda of Understanding between and amongst providers and users of climate information services clarifying the mandate for climate services provision at the national level, and specifying the expectations from regional and global providers:

1. Memoranda of Understanding amongst users of climate information services clarifying the process for coordinating action based on climate information;
2. Agreement on the timing, content, and format of a minimum set of climate information products to be provided to specific users, and identification of dissemination mechanisms to ensure access to the information at local levels;
3. Agreement on procedures for issuing early warning for fast- and slow-onset hazards;
4. Agreement on monitoring mechanism for the framework.

Consistency with Principles

- All countries will benefit from the concept note, and priority will be given to developing countries for hosting of workshops (Principle 1);
- Official regional and national climate service providers will be mandated, and forums for user – provider interaction will be initiated / strengthened (Principle 2);
- The multi-stakeholder meetings will be held at national and regional levels (Principle 3);
- Regional and national operational service providers will be designated (Principle 4);

- National governments' responsibility in the provision of climate services will be defined (Principle 5);
- The establishment of national and regional frameworks will require formulation of agreements about the exchange of data (Principle 6);
- The frameworks will define the roles and responsibilities of existing organizations and identify the needs for additional support and investment (Principle 7);
- Users and providers will participate in the multi-stakeholder meetings (Principle 8).

Consistency with Priorities

- In countries where there is minimal user – provider interaction, the multi-stakeholder meetings will act as an initial forum for building dialogues, and will strengthen such dialogues in countries where there is already some interaction (Principle 1). In establishing the Frameworks, monitoring and evaluation measures will have to be agreed;
- The responsibilities of the RCCs to support national climate services will be defined, and priorities for developing RCC capabilities to provide this support will be defined;
- The strengthening of the RCCs and of their service provision back to national levels could be achieved partly through a fellowship programme;
- The multi-stakeholder workshops could act as an opportunity to formulate national multi-disciplinary research programmes.

Prerequisites

Create a concept note for the framework for climate services at the national level, including identifying, developing and standardizing the components of a fully functional NCS, and for ensuring quality control of products and services:

- a. Hold preparatory discussions with the key stakeholders (primarily NMHSs and relevant Ministries) to ensure commitment, and to establish local organizing committee;
- b. Conduct mapping of key stakeholders;
- c. Establish fully functioning RCCs in all regions;
- d. Strengthen the capacity of RCCs to provide support to the climate service providers at the national level;
- e. Develop and sign agreements on the exchange of data between national and regional centres to enable the RCC to generate and provide the required information, and support;
- f. Develop and sign agreements on the exchange of data between national climate service participants and users.

Indicators

- Number of signed Memoranda of Understanding;
- Meeting reports;
- Operational production of agreed climate information, measured by frequency and timeliness of production, and evidence for evolution of product formats in response to documented feedback;
- Published specifications for issuing early warnings, and examples of issued warnings in the event that the agreed criteria are met.

Risks

- Lack of commitment on the part of key stakeholders to participate and/or follow-up with signing of MOUs, and or perform agreed actions;
- Failure to obtain, through exchange, the data necessary to develop a particular service;
- Inability to reach agreement on the respective roles of possible multiple information suppliers;
- Inability of regional climate centre to provide adequate support where needed.

Linkages with other projects

Stakeholders

To be identified through the mapping process, but to include as a minimum the following:

- NMHS;
- Government Ministries representing health, water, agriculture, the environment, transport, energy, disaster preparedness and response;
- National Red Cross / Red Crescent Society;
- University and other research groups;
- Key industry representatives;
- Other existing significant clients of the NMHS.

APPENDIX VI

ENABLING MECHANISMS FOR CSIS

A6.1 Synergies with existing activities

The Observations and Monitoring (O&M) pillar of the GFCS is responsible for dealing with the observations and generating primary data and products, and it will provide the guidance and procedures for analysing the essential climate variables and related datasets and aspects of monitoring related to observing platforms and data systems. Exchange of data in its raw form, falls within the O&M pillar. Quality assurance is a vital component for ensuring that climate data are fit for purpose and is a responsibility shared between the O&M and CSIS pillars. The CSIS should work closely with the O&M pillar in establishing, where necessary, appropriate guidelines for the quality control and archiving of all climate data including data collected from non-traditional sources. Once the data are available in producing centres (national, regional or global) and fit for purpose, operational activities to use the data for tailored diagnostics, prediction, climate watches and development of value-added products and services fall to CSIS, as does the exchange of the processed, value-added data, information and products. With respect to CSIS-O&M feedback, it is important to note that effective quality assurance, and the future evolution of the observing systems as GFCS develops, involves a feedback of information from CSIS about deficiencies in, and evolving needs to be met by, the underpinning observations, data collection and data management systems.

Close links between the CSIS and R&MP components are needed to ensure that the capabilities and limitations of monthly and multi-annual to decadal predictions are clearly communicated to all users. Further, to ensure that the unprecedented volume of climate projection information that will emerge from the activities supporting IPCC 5th Assessment Report (AR5) is delivered efficiently to the widest possible range of users, the component structures of the CSIS will need to work closely with the WCRP to deliver data and products that are reliable, timely and based on sound science. It is important to stress here that the achievement of a climate research objective may not of itself result in a usable product or service without further resources to bring it into application or operation. Accordingly, CSIS operational entities, such as WMO GPCs and RCCs and NMHSs should participate in the formulation of research programmes and projects that are expected to generate outcomes that will improve the effectiveness of CSIS products and services. Such collaboration would, *inter alia*, facilitate at an early stage an estimate of the resources required to transfer the expected research findings into an operational environment.

Given the fact that there are multiple sources of climate information, CSIS will actively promote consensus-based approaches, where consistent signals are present, and will help clarify aspects of uncertainty where the signals are divergent. This involves close cooperation between the concerned CSIS entities. A product exemplifying this approach is the WMO El Niño and La Niña Update, which Cg-XVI has endorsed to be expanded into a Global Seasonal Climate Update (GSCU), a more comprehensive product that will also encompass information on other factors that drive climate variations and extremes. While this product is essentially to assist RCCs, RCOFs and NMHSs, the task could prove to be quite complex in terms of the synergies required as the update is to encompass prediction as well as monitoring aspects. Given that such a product would essentially be 'operational' in nature, it may need identification of a key CSIS entity to have the responsibility for coordinating the task of assembling the update.

Ultimately the CSIS will need the guidance of a formal manual that lays down mandatory sets of functions, services and products across all geographical levels. CCI and CBS should give consideration to the form that such a guidance document should take, bearing in mind the relevant material currently contained in the Guide to Climatological Practices and the Manual on the Global Data Processing and Forecasting System. It may however be clarified that, while a standardized set of CSIS outputs is needed from an operational perspective, other user-tailored products might indeed be developed either by CSIS entities or by the concerned UIP entities.

To ensure that climate information is properly integrated into decision-making and policymaking, CSIS entities – especially at the national level – will need to collaborate with relevant user/interface institutions that will include broadly based and sectorial specific governmental and non-governmental organizations, universities and national research institutes. This latter process in effect encapsulates the functions of UIP at the national level. National level CSIS entities will be able to draw for their activities on global and regional inputs from the global and regional centres as well as from their own national data streams.

It is clear that formalized mechanisms for these CSIS entities and functions will be essential for standardization, sustainability, reliability and adherence to policies. Not all WMO Programmes, activities and structures and those of other relevant entities that can be accommodated within the CSIS, particularly on the global level, fully cover as yet the required aspects of climate data, climate monitoring or, except for the seasonal timescale, climate predictions; these gaps will need to be bridged.

The operational functions of CSIS should follow the procedures developed within an internationally agreed technical regulations framework, such as the WMO GDPFS framework to ensure that products and services are delivered according to agreed user requirements on content and format/presentation as well as quality and reliability. The operational functions of participating centres should be specified, along with the mandatory and any proposed additional (highly) recommended products. Information on system and product characteristics and on verification and monitoring results should also be made available.

With the enormous technological growth in the means of disseminating information, all CSIS components must strive to be compliant with the evolving WMO Information System (WIS), to ensure interoperability and a wide utilization of CSIS data and services. In particular, global, regional and national climate data sets and climate products generated by CSIS should be identified and catalogued under WIS compliant procedures for exchange. WIS will play an important role in managing the complex data and information flows associated with the CSIS and ensuring its connectivity to a wide range of Internet-based and private networks all operating within an envelope of interoperability. In time all WMO GPCs and RCCs, at least, should be designated as WIS Data Collection and Production Centres (DCPCs), noting too that it is the intention that all WWW RSMCs evolve into WIS DCPCs. These efforts should also involve global telecommunication partners such as International Telecommunication Union (ITU), to take advantage of the rapidly developing telecommunication platforms, and their ability to reach a wide range of stakeholders in an interactive manner, noting in particular the special needs of many developing countries.

Activities to raise awareness on the availability of information on the changing climate and on the use of model-based projections of climate change into the future should be undertaken as part of the CSIS, in association with other components of the GFCS.

Finally, enhanced training and capacity building initiatives relating to the generation and application of all CSIS products should be an integral part of the overall GFCS capacity building effort.

A6.2 Building partnerships and communicating

At all the three levels of CSIS operations, there is a range of institutions with different governing structures and mandates, which need to work together in an operational mode to complement and collaborate in order to reach the most reliable climate information that science can deliver. Building partnerships among these institutions is therefore an essential requirement to ensure successful operation of CSIS. For example, the HLT recommended that special priority be given to the implementation of the GFCS at a regional level. With respect to the establishment of WMO RCCs, while it will be the responsibility of each WMO Regional Association, with the assistance of the concerned WMO Technical Commissions, to determine the most appropriate implementation strategy to suit its particular needs, they need to work with a range of partners from individual NMHSs, groups of NMHSs to regional intergovernmental bodies and autonomous institutions to ensure effective implementation of WMO RCCs.

While communicating climate information in a decision-making context, it must be recognized that

experiential and analytic processing systems often compete, and personal experience and vivid descriptions are often favoured over 'dry' statistical information. Such 'realities' have implications for how information will be received and used⁹. CSIS product dissemination should try to translate statistical information into formats readily understood in the language, and personal and cultural experience of the recipients.

The respective roles and perspectives of government and business in planning to live with climate variability and change vary from sector to sector and country to country but can be usefully assessed in respect of their motives, their expertise, their influence, their attitude to science, their attitude to risk and their attitude to planning¹⁰. User engagement will span all geographical domains of the CSIS (Figure 6). Planning at the national level, for example, is usually led from the Public Sector and involves well-established climate-focussed organizations such as National Meteorological Services, interacting with agencies representing climate-sensitive sectors such as agriculture, energy, infrastructure, and the environment.

With a full realization of the complexity of tackling the root causes of human induced climate change and the need to develop national strategies for living with both climate variability as well as climate change, governments are now substantially involving various business organizations and other private sector bodies on whom they must rely for most of the implementation action through technological innovation, market developments and the like. These increasingly complex settings provide significant challenges for climate service providers.

A6.3 Communication strategies

The communication strategy to be adopted for CSIS can have two broad objectives: (i) raising awareness of the CSIS entities and their operations/products, and establish them as authentic sources of climate information; and (ii) raising awareness of CSIS products and services, to promote their wider use in the application sectors. Brochures on GPCs, RCCs, RCOFs, etc. in simple language can serve in publicizing such entities, also clarifying on their relevance to specific user groups.

⁹ Living with Climate Change and Variability: Understanding the uncertainties and managing the risks, 2006
Ibid

¹⁰ Zillman, J. 2009, in Proceedings of the Conference on Living with Climate Variability and Change, Espoo, 2006.

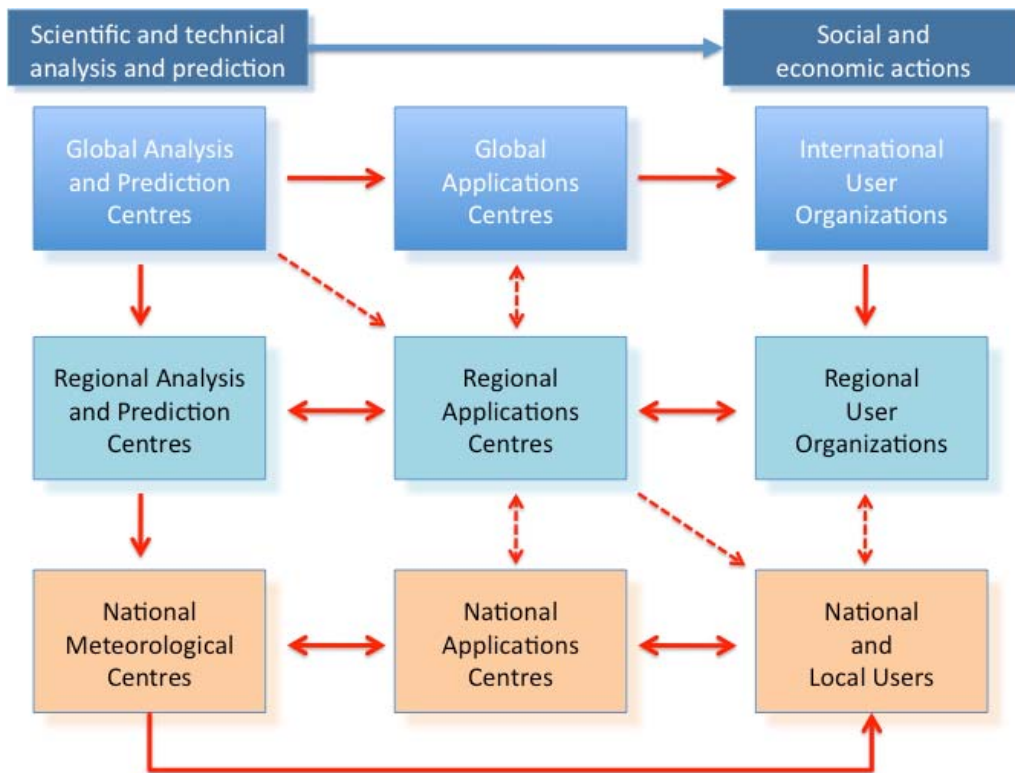


Figure 6: User engagement will occur between GFCS centres at the global, regional and national scales. Primary CSIS centres are in the left hand column with the User Interface Platform structures in the central column, and the user groups in the right-hand column. Solid lines indicate primary information flows and dashed lines indicate secondary flows. Double-headed arrows indicate the interactions are likely to be collaborative.

CSIS product communication will be based on further analysis and interpretation of climate statements or products with the general public or specific users usually from a non-climate community as the principal beneficiary. Collaboration with the UIP will be essential in this process, and it will include press releases, media interviews, and climate assessments prepared as an element of a climate service. It is important to ensure wider access of climate information and ease of discovery to all relevant stakeholders, by exploiting the latest communication technologies including the Internet, mobile communications, etc. In this regard, close collaboration with telecommunication leaders such as the International ITU will greatly help in extending the reach of CSIS products and services to users. Considering that the CSIS mechanisms are being conceived to be WIS-compliant, many of these aspects are best addressed through the WIS platform. The delivery of CSIS products across all domains and timescales should be accompanied by appropriate documentation (including metadata) and, where appropriate, scientific publications. CSIS should also clearly communicate the nature and size of any uncertainties associated with its products, including datasets, climate monitoring and prediction products and climate projections.

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