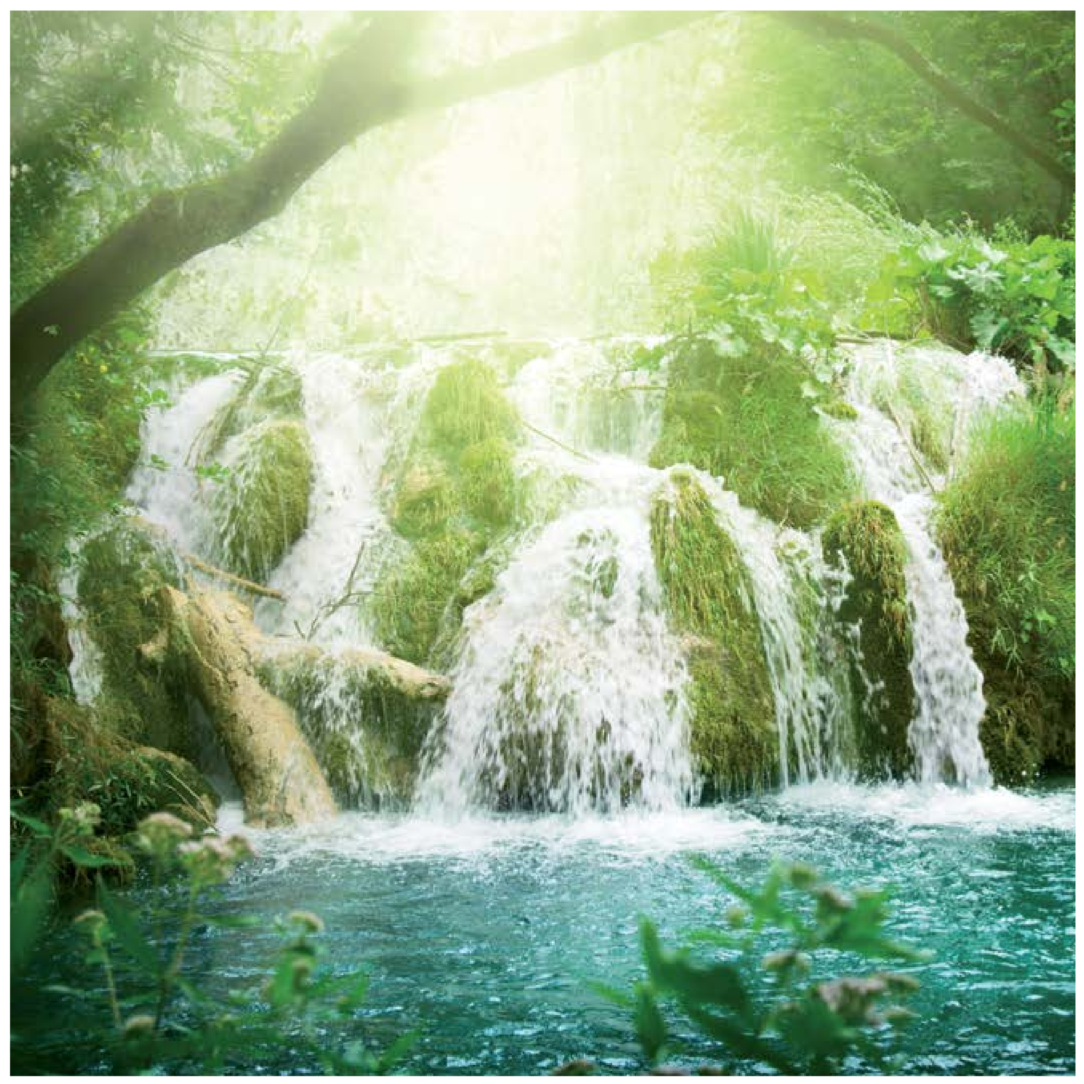

# Water Exemplar to the User Interface Platform of the Global Framework for Climate Services

World Meteorological Organization
Weather • Climate • Water

GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

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# WATER EXEMPLAR

TO

THE USER INTERFACE PLATFORM

OF THE

GLOBAL FRAMEWORK FOR CLIMATE SERVICES

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Global Water Partnership

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french water partnership fwp

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## EXECUTIVE SUMMARY

Water services or agencies and professionals are dealing with the impact of human interventions and climate variability and change on flow regimes. Water is a key driver of economic and social development while it also has a basic function in maintaining the integrity of the natural environment. However water is only one of a number of vital natural resources and it is imperative that water issues are not considered in isolation. Managers, whether in the government or private sectors, have to make difficult decisions on water allocation. More and more they have to apportion diminishing supplies between ever-increasing demands. Drivers such as demography and climate change further increase the stress on water resources.

As a result, the Integrated Water Resources Management (IWRM) approach, a more holistic approach to water management, has now been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands.

In implementing IWRM, water resources management institutions and professionals deal with climate variability and change. They must be aware of and manage the response of a particular water regime to climatic and human interventions on hydrological regimes and water courses including land use changes, changes in water use patterns as well as the construction and management of dams and embankments and changes in the freshwater-ocean interfaces. Water managers have developed a range of standard methods to assess and manage water-related risks. These methods rely, to a substantial degree, on our ability to monitor and replicate (through models) our environment on a wide range of spatial and temporal scales. Functioning water observation networks and sharing of observations are key for informed decision-making for water management, minimizing uncertainties.

As water management (both surface water and groundwater) is intrinsically linked to climate variability and change, water managers have a central role to play in the development and implementation of adaptation strategies and on the ground measures. Water resources management is in a difficult transition phase, trying to accommodate large uncertainties associated with climate change while struggling to implement a difficult set of principles and institutional changes associated with integrated water resources management. Existing water management methodologies, including the design of engineering structures, are generally based on the concept of stationarity of historical time series that are extrapolated into the future, a concept that is not valid under conditions of climate change, thus adding an additional substantive uncertainty factor. This problem of non-stationarity is particularly critical in water-related risk management, especially when dealing with the management of and adaptation to hydrometeorological extremes (floods and droughts).

To improve water management through the use of climate services, it is important to identify the tasks and the products of the service. These will include climate predictions products, seasonal climate outlooks, downscaling products at various levels, different downscaling methodologies describing the underlying assumptions and uncertainties. This requires the establishment of professional interactions between climate service developers and water managers at scientific and operational levels and across the full spectrum of water resources, including surface water, both regulated and non-regulated systems, groundwater and the freshwater-ocean interface.

For making climate services useful for better water management, the communities that support the Water Exemplar call for:

- A development-centric approach based on IWRM and meeting user needs;
- Implementation through existing programmes and mechanisms that can be adapted according to requirements and that are flexible;

- Application of a mix of top-down (such as climate prediction based on Global Circulation Model (GCM) downscaling) and bottom-up (such as community-based local interventions) approaches to increase resilience to climate-related water issues;
- A focus on the climate services required to support IWRM, including the management of extremes (floods and droughts), as well as the day-to-day water resources operational management needs which are influenced by climate, including those of coastal regions;
- Enhancement of partnerships at all levels (local, national, regional and global). The functionality of the UIP Water will critically depend on the availability of coordination structures for the development of climate services at all levels and the inclusion of these mechanisms in the development of related IWRM plans;
- Well-defined linkages between the five pillars of the GFCS. User-driven services will require robust observation and monitoring systems, sound science, flexible service delivery mechanisms and targeted and deliverable capacity development support.

# 1 INTRODUCTION

## *1.1 Objective, scope and functions*

Water security in a variable and possibly changing climate continues to be a key concern at national, regional and global scales. In addressing this concern, the critical importance of ongoing climate data for the assessment of fluctuations, and trends in risks arising from exposure and vulnerability to climate variability and related natural hazards is well recognized, in order to assist countries and communities in optimal adaptation efforts. The purpose of the Water User Interface Platform (Water UIP) is to provide the necessary structure and processes to identify and respond to the needs of the water sector at all levels, in order to improve the sector performance and management enabled by the fuller use and understanding of climate information.

The Water UIP can accelerate interactions at global, regional, national and community levels through various mechanisms such as task forces, web-portals, committees, processes, mechanisms for communication, collaborative projects, etc. Increased dialogue and joint action can help maximize the usefulness of climate services and help develop new and improved applications of climate information for the water sector. This Water UIP plan outlines the general structure for partnerships and leadership, guiding needs, and opportunities to support and enhance climate informed decision-making.

The Integrated Water Resources Management (IWRM) approach is now accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands. Figure 1 shows the key stages of IWRM planning and implementation. Appropriate use of climate services can influence each of these stages.

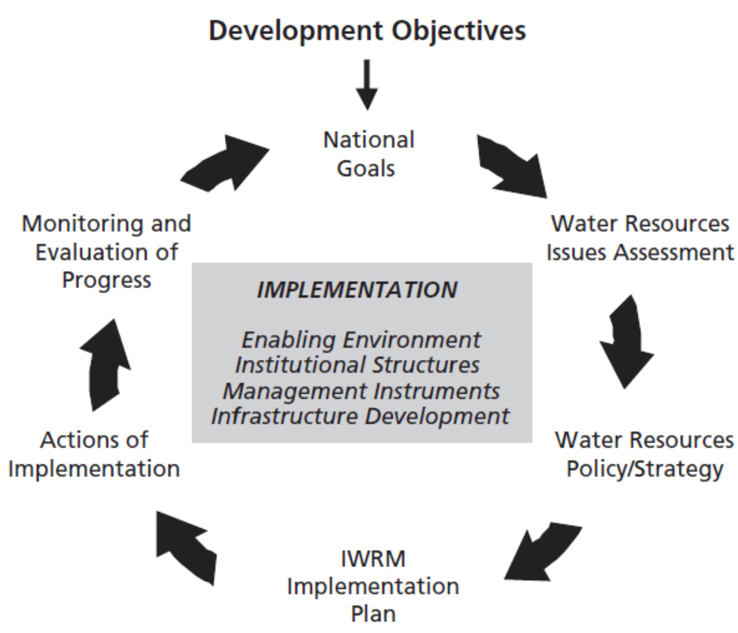



Figure 1. Stages in IWRM Planning and Implementation

The UIP should support these key stages as it performs its overall goals, which in relation to water, should cover the following:

1. Identify the optimal methods for obtaining **FEEDBACK** from these communities on the usefulness and performance of climate services from the water community in support of IWRM.
2. Build **DIALOGUE** between users of climate services and information in the water sector and those responsible for the observation, research and information system components of the Framework.
3. Develop **MONITORING AND EVALUATION** measures for the Framework that may be agreed to between users and providers.
4. Improve **CLIMATE LITERACY** in the user community through a range of public education initiatives and on-line training programmes. In many instances there are opportunities for the better use of climate services, which are not taken up because of lack of awareness of their availability or capability.
5. Improve **WATER LITERACY** of climate service providers: strongly related to the dialogue aspects above, climate service providers need to better understand the decision-making context of water managers from different fields of application.

### *1.2 The requirements for the UIP*

The connection between the weather and climate and the terrestrial water cycle, including the freshwater-ocean interface, appears fundamental, and thus a high level of synergy should exist between the disciplines involved. However, the opening statement of the report on the Expert Meeting on Water Management Needs for Climate Information in Water Resources Planning (see reference 2) states: "climate information is presently not widely used by water managers". A WMO Technical Report (see reference 3) sets out to identify the fundamental gaps and weaknesses that fail to produce the desired synergies between climate, meteorology and water management. There are a variety of reasons for the mismatches between practice and theory, which are the basis of the lack of synergy and even understanding between suppliers of climate information of all sorts, and water management activities. Quite often these gaps in synergy are functions of the scale of operations, e.g. water management operates on a catchment scale, whereas meteorological information is generally available on a broader basis and different spatial scales. Similarly, water management design depends heavily on historical data, whereas use of operational data may depend on data delivery and assimilation into models. The range of water dependence and risk that are sensitive to changes in weather and climate conditions is extensive, and are summarized in Box 1.1

The fundamental rationale of a Water UIP within the GFCS is the critical importance of ongoing climate data for the assessment of fluctuations and trends and the risks arising from exposure and vulnerability to natural hazards (floods and droughts) as well as sustainable management of the resource through the application of the IWRM approach. The World Meteorological Organization (WMO) and UNESCO are already closely linked to the highest policy levels through their membership and participation in UN-Water. Included in the 24-member UN-Water partnership are bodies such as the Food and Agricultural Organization (FAO), United Nations International Strategy for Disaster Reduction (UNISDR) and United Nations Secretary-General's Advisory Board on Water & Sanitation (UNSGAB). The Global Water Partnership (GWP) is a partner of UN-Water providing a neutral multi-stakeholder platform with a worldwide network of partner organizations. Collectively, these bodies should largely encompass the users of climate data relating to water management, including agriculture, water supply and sanitation, and water- related disaster risk reduction. Additional partner agencies covering various stakeholder groups at the international level, include the International Association of Hydrological Sciences (IAHS) and the International Federation of Private Water Operators (AquaFed).

With respect to the freshwater-ocean interface, WMO and UNESCO Intergovernmental Oceanographic Commission (IOC) are linked through the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM).

**Box 1.1 Water management aspects dependent on climate and weather information**

*Hydrological characterization*. Catchment/Watershed planning; general water balance
*Flood management and control*. Structures (dams, river training); flood forecasting and warning; flood plain zoning/flood frequency estimation; coastal inundation; erosion
*Drought Management.* Structures (dams, weirs, etc.), demand,
*Irrigation and drainage*. Supply; demand scheduling; drainage management; salinity
*Groundwater.* Recharge; groundwater flooding
*Navigation*. Canal systems; dredging
*Power generation*. Hydropower; cooling water
*Water supply*. Potable water; industrial processing
*Water quality*. Effluent disposal; pollution control; dilution; salinity and sedimentation
*Fisheries and conservation*. Hydro-ecology; hydromorphology; amenity; public access; recreation
*Tourism*

This extensive network of international water organizations should provide an excellent basis for the UIP to focus upon at the global level, although the range of organizations equally means that their interests and use of climate-related services is also highly variable. While this potential for interaction is an excellent start, it does not necessary follow through to the level of implementation, and the need for intensified collaboration between the climate and water sector has increased over recent years as awareness of the importance of climate and weather impacts has achieved greater recognition. With ever-growing population worldwide and fundamental demands across the board of human activity, from subsistence to high-tech industry, the need for a water-climate interface can only increase. The specific needs have been articulated through an ongoing technical dialogue, reflected in the call of the water community in the WCC-3 process, for the GFCS to recognize these needs as a priority in the water sector (see reference 4).

Over the past decade, WMO and partners in the meteorological sector have pro-actively sought the perspective of operational "end-users", including the water sector, to help guide the development of climate services. The drivers of these developments are varied, including demand from government and society, and commercial users for improved information. Major developments have been driven by the need to respond to extreme events, such as floods and droughts, where international agency collaboration has been necessary. The collaborative (i.e. interagency) structures to respond to these water management challenges have been developed over the last 10 years at the global level and should form a basis for the activities under the Water UIP. Other factors also play a major role in IWRM, including changes in the demand for water, both through changes in land use and also changes in behaviour of water users. The need for, use and applications of climate data in this regard is equally important. However, it is widely recognized that both available weather and climate information and services are not being used to their full potential in the water sector. A structured process, such as the Water UIP can identify and respond to water sector needs from global to local levels, and facilitate the improvement of water sector performance and management with the better use of focussed climate services and information.

The water community has a need for a range of services to support decisions relating to a range of uses related to IWRM planning, which include:

- Identification of extreme weather and climate hazards that pose water-related risks;
- Identification of populations vulnerable to weather and climate hazards, including those in the coastal zone;
- Allocation and re-allocation of water resources;

- Design and placement of infrastructure and personnel (i.e. water management organizations, structures and facilities);
- Implementation of risk management and emergency preparedness practices and procedures;
- Dissemination of information to users, including the public, i.e. Public Service forecasts and alerts;
- Development and implementation of water and environmental policy;
- Development and implementation of water and flood management policies and strategies;
- Development and implementation of water management regulations and laws.

Only by working collaboratively and iteratively, will water and climate professionals be able to develop tools and systems that can effectively forecast and provide information and warnings that improve water security and build resilience, by critically extending the lead time water managers have for decisions and response measures.

### *1.3 Inter-linkages with the GFCS pillars*

The water-related priorities and activities articulated in this Water UIP implementation plan will inform and benefit from the developments made in the other pillars of the Framework, Climate Services Information System (CSIS), Observations and Monitoring (OBS), Research, Modelling and Prediction (RMP), and particularly, Capacity Development (CD).

*Climate Services Information System (CSIS).* This encompasses the development and delivery of climate information and products and also allows for the collection of feedback from the user communities. The CSIS will communicate with user-communities through products such as data holdings, periodic reports, forecasts, or warnings, etc. Water stakeholders will particularly need to inform the CSIS of specific needs for variables and information monitored, the format and presentation of these items and particular gaps and opportunities identified. The improved and targeted delivery of climate information products and open communications will enhance the quality of information available to the water community to conduct operations, research, impact and risk assessment and planning. In particular advances made in the area of seasonal climate outlook fora and the establishment of regional climate centres will be of interest to the water community, taking specific care of the communication aspects of the scientific content of specific products.

*Observations and Monitoring (OBS).* These are the basis of the CSIS provision. Past weather and water observations have left an enormous legacy of data that now provides the basis of knowledge on climate variability and change. The various purposes of water management require a wide range of data and products, and these are available in Table 3.1 in reference 3. The required data, although common to a number of purposes, are likely to be required in different formats, e.g. point or distributed data, instantaneous or averaged over different lengths of time. Many meteorological and hydrological models are now designed to produce probabilistic output for risk analysis, so the interfacing of climate data feeds with predictive water models is a complex matter. There are frequently gaps and mismatches between the nature and distribution of climate observing systems and those networks devised for water monitoring. An improved climate-water interface will enhance the structure and development of compatible observation networks, by extending them to meet user needs, and ensure quality assurance of data. Recent decades have seen a progressive decline in the size and quality of meteorological and hydrological observing networks, especially in countries at most risk from climate-water related impacts. Of relevance from the water perspective is the World Hydrological Cycle Observing System (WHYCOS), a WMO Programme aiming at improving the basic observation activities, strengthening the international cooperation and promoting free exchange of data in the field of hydrology. The programme is implemented through various components (HYCOSs) at the regional and/or basin scale. Improved integration of climate and hydrological networks is seen as a necessary and essential initiative in improving the linkages between the climate and hydrological communities. The importance of hydrological observations as supporting evidence of the influence of climate change should not be overlooked. Also the philosophy of improving the efficiency and effectiveness of monitoring systems espoused by the WMO Integrated Global Observing System (WIGOS) will be an important contribution to monitoring networks in the future. Annex I lists the different climate data sets required for a range of water-related services.

*Research, Modelling and Prediction (RMP)*. There will be strong links within RMP, through joint Research and Development on climate and water applications and modelling, to support and create new products for the needs of the water community. Work conducted under the RMP pillar in other sectors, such as health, disaster risk reduction, and agriculture will also have benefits for the water sector. The work within RMP will expand the available knowledge base for the benefits of the water and other sectors. Through joint RMP related work between water and climate actors, available products and services for the water sector are likely to improve in quality and reliability, and thus improve the utility and confidence in climate services. The role of the UNESCO International Hydrological Programme (IHP) in hydrological research, education and training needs to be recognized in this regard. The research engagement for the Water Interface must have a practical, operational goal. The underpinning need, for a variety of user applications, is to make quantitative climate predictions on time scales from seasons to decades and spatial scales of local to regional to global. Research will also be necessary into methods to improve integration between climate and water science, which must include the identification of the users' needs from the outset. This research approach has to ensure that climate information and services are provided in a timely manner to decision makers and operational organizations.

*Capacity Development (CD).* This inevitably is needed to support enhanced functionality (CSIS and OBS), and the delivery of enhanced products (RMP), and will be linked to awareness, training, interdisciplinary work, and public information. A very important element is that a provider of a capacity development programme is fully appreciative of the decision-making context the recipients work in. Therefore, programmes with established reputation and trust with the water sector professionals (many of them with an engineering background) need to be used to implement the Water UIP.

### *1.4 Relevant existing activities, and identification of gaps*

The existing use of climate data and information by the water sector is very much dependent on the level of economic development in a country or region, and how well links between the sectors has developed historically. At the highest international level, some of the current related initiatives undertaken between various international organizations, such as development banks, UNDP, WMO, UNESCO and the Global Water Partnership (GWP) in the field of hydrology and water resources include:

- Hydrology and Water Resources Programme (HWRP) (WMO);
- Marine Meteorology and Oceanography Programme (MMOP) (WMO);
- UNESCO International Hydrological Programme (IHP);
- UNESCO Intergovernmental Oceanographic Commission (IOC);
- International Flood Initiative (IFI) (UNESCO, WMO);
- The Pilot Programme on Climate Resilience (PPCR) (World Bank);
- UNDP/GWP-Cap-Net: Capacity Building for Integrated Water Resources Management;
- The Associated Programme on Flood Management (APFM) (WMO, GWP);
- The Integrated Drought Management Programme (IDMP) (WMO, GWP);
- Water, Climate and Development Programme for Africa (WACDEP)– a joint programme to support climate change adaptation in Africa, between the Global Water Partnership (GWP) and the African Ministers Council on Water (AMCOW);

- The Global Network on Water and Development Information for Arid Lands (G-WADI) initiative (UNESCO);
- The Global Ocean Forum.

How far these high level initiatives can penetrate and influence a particular national situation, depends very much on how individual countries respond to and are capable of accommodating the initiatives, or indeed see a practical benefit. The APFM, the IDMP and the WACDEP are programmes which are specifically structured so as to support national and sub-national level decision-making in a number of countries, but much more is needed.

At the national level, there are a variety of reasons for the mismatches between practice and theory, which are the basis of the lack of synergy and even understanding between suppliers of climate data and water management activities. Quite often these mismatches are functions of the scale of operations, e.g. water management operates on a catchment scale, whereas meteorological information is generally available on a broader spatial basis, and varying temporal regularity. Similarly, water management design depends heavily on historical data, whereas use of operational data may depend on rapid data delivery and assimilation into models. An assessment of gaps and needs has been identified by the UN Intergovernmental Panel on Climate Change (IPCC) (see reference 7): some are technical and some organizational.

Climate services are fundamentally limited by availability of observations and analyses, and by the inherent limitations in accurately predicting the climate or weather. It is thus not feasible to address all user needs, and ***identifying what services*** can scientifically and practically be provided for a particular water focus will need to guide their potential delivery. It cannot be too strongly emphasized that the achievement of a suitably close relationship between a weather service and water user is an iterative and evolutionary one. Box 1.2 summarizes such an evolution which has taken place over more than two decades between the Bangladesh National Flood Forecasting and Warning Centre (FFWC) (under the Ministry of Water) and the Bangladesh Meteorological Department (BMD) (under the Ministry of Defence) and highlights issues associated with working in the coastal zone. ***It is therefore imperative to consider the development of a Climate-Water Interface and its programme in a long-term perspective***.

**Box 1.2 Timeline for the evolution of weather service capability in support of flood forecasting and cyclone warning in Bangladesh**

***Pre 1988.*** The National Flood Forecasting and Warning Centre (FFWC) relied on simple hydrological relationships to predict timing and magnitude of flood levels. The Meteorological Department (BMD) provided a simple category-based system for rainfall on a broad regional basis.

***1988-92.*** Two major UN-WMO projects saw the introduction of weather radar to BMD, with a direct line to a live display at FFWC. FFWC also established weather satellite receiving facilities, and a direct fax link was established with the Storm Warning Centre (SWC) at BMD. This greatly facilitated the exchange of near real-time information, necessary to provide the quality and quantity of inputs for the upgraded hydrodynamic river forecast models.

***1994-1999.*** These facilities were progressively upgraded through donor-funded support, to improve the required provision of better public service flood warning to local areas and priority locations.

***2004-2008.*** Additional weather radar stations introduced to improve detail and accuracy of rainfall and cyclone warning, plus a web-based real time river level monitoring and prediction portal.

***2006-2007.*** Feasibility of developing facilities at a national level (BMD) facility to deliver NWP products and provide real time delivery of weather and climate data.

***Projection for the future.*** Development of a local area model (LAM) for severe weather warning purposes, including sub-catchment quantitative precipitation forecasting (QPF).

## 2 IMPLEMENTATION OF THE EXEMPLAR

### *2.1 Necessary and sufficient conditions for successful implementation*

The water communities are well aware of the added value of climate information and services to improve their decision-making within the IWRM approach. However, they remain to be convinced that the current information and services meet their requirements. These include areas such as water management, disaster risk management, agricultural production, water supply, coastal zone management, sanitation and economic considerations when deciding on large-scale investments in water infrastructure (with a life time of between 50-100 years). These decisions are made under uncertainty and climate information has the potential to reduce uncertainties in both medium-term and long-term decision-making processes.

Climate services must be seen as having, or possessing, potential to benefit the IWRM approach in the water sector, for example:

- The Platform is to be used by a wide cross-section of users from the water sector, including for example, hydrological characterization, water supply, flood management and control, irrigation and drainage, power generation, fisheries and conservation, navigation and recreation;
- Climate information services can be used as regular inputs to decisions in the water sector, from short-term water allocation or use to longer-term infrastructure development and operations;
- The applications of climate information services can be shown to result in greater efficiencies and effectiveness in the sustainable use of water resources across the sector;
- Improved access to accurate and reliable climate information results in appropriate and robust design and construction of water-related structures such as culverts, bridges and dams and coastal zone infrastructure;
- Climate prediction services support improved water resources management and prioritized allocation of resources to the wide variety of water demand sectors, including urban water supply, irrigation systems, flood storage capacity, etc.;
- Users of climate information and services in the water sector are fully aware of, and understand, the limitations of the data and science behind the services and take this into consideration when using the services;
- Climate information services are provided to the water sector in formats and content that enable direct ingestion in water related decision-making systems;
- The water sector's requirements for long time series of climate data in support of hydrological modelling to enable greater understanding of the impacts of climate variability on water resources availability may be met;
- A wide variety of communication channels between the climate and water communities are open, transparent and easily accessible.

Underpinning much of the above are the capabilities of the climate service provider in observations, data exchange and the provision of information. These in turn have to be matched by appropriate user demands and requirements – perhaps a useful parallel from the business world would be the respective roles of supplier and consumer, with the consumer able to drive suitable improvements in products from the supplier.

In parallel with observations, climate services must provide adequate levels of data quality and external availability (data provision). Climate observations cannot be used with confidence for the purposes intended unless they meet established international standards in terms of how they are measured and quality controlled. Common standards and good quality control enable comparability of results across countries as well as worldwide use of established good-practice methodologies that use the data. Climate observations are undertaken under a wide range of circumstances and management regimes, but nevertheless need to be of consistent quality globally, with few gaps in the record over time and with appropriate spatial density and temporal frequency. Standards for instrumentation and observational technique are developed by international experts and are mandated by the World Meteorological Organization and other international agencies in formal documents and specifications, e.g. the various WMO Guides.

The technology and systems for electronic dissemination and exchanging of data are generally present in most countries, though in many developing countries, the speed, reliability and capacity of systems is far from adequate. At the highest level, a new World Meteorological Information System (WIS) is being developed to serve as the coordinated global infrastructure for the telecommunication and management of weather, climate and water and related data.

It is at the national level that a significant country-to-country variation exists in the provision of adequate climate and weather data to water users, and it is the objective of this UIP that the needs of the water sector are adequately met to an agreed standard.

### *2.2 Engagement in the working mechanisms of potential partners at global, regional and national levels*

Based on the relevant initiatives identified in section 1.4 above, a range of existing mechanisms can serve as points of engagement for the Water UIP to bring water and climate partners together. Although many of these partnerships exist outside the developing country context, these partners often operate internationally, or may serve as a resource base for capacity development, technical transfer, and collaboration.

In considering which mechanisms should form part of initial activities, the following criteria have been applied:

- Ability to address sector decision-makers and other professionals across the global, regional or national domains;
- Ability to develop actions within accepted development policy norms, especially Integrated Water Resources Management;
- Interagency character and ability to foster networks that jointly deliver results;
- Ability to direct or generate resources in the context of climate or weather resilience;
- Ability to provide technical assistance, capacity development or “pools of expertise” (or a technical support base) in major areas of concern of water stakeholders (in particular floods and droughts).

#### 2.2.1 Existing interagency programmes of direct relevance

The strategic starting point for the implementation of the Water UIP is the concept of a phased implementation approach, starting with interagency programmes that have proven relevance at national and international levels. Building on milestones of success, other programmes can then be developed, refined and implemented in subsequent phases. The overarching process for sustainable water resources management is the formulation of Integrated Water Resources Management (IWMR) Plans. IWMR is about management of water resources and the allocation of the available resource amongst the many competing uses and users.

Two existing interagency programmes in the areas of flood and drought management are consistent with the criteria mentioned above: the Associated Programme on Flood Management (APFM), including the coastal zone, and the Integrated Drought Management Programme (IDMP). Between the extremes of floods and droughts, water resources managers are charged with the management, allocation and delivery of water resources for a variety of purposes from agriculture, mining, recreation, tourism, rural and urban water supplies and sanitation. Following the 6th World Water Forum, it was decided to initiate a Science Policy Interface (SPI) platform, under the auspices of UNESCO and French Water Partnership, for researchers and water managers as a water science-policy interface in order to facilitate communications in relation with the IPCC and other UN conventions, and to provide relevant inputs to help water resources managers develop effective management and climate change adaptation strategies. Further details on these initiatives are provided in Annex II.

The APFM, IDMP and SPI Platform together focus on the major water-related challenges for governments in relation to water security in a changing climate, including floods, droughts and sustainable water resources management. Through a number of fairly small adjustments, the Water UIP could develop a range of necessary implementation actions through those programmes. A visualization of the overall approach is shown in Figure 2 below. This would entail on the institutional level the following elements:

**Global** coordination of the Water UIP through the existing interagency programmes APFM, IDMP, IDI AND G-WADI and the SPI-Platform with their own technical support unit, networks, HelpDesk function, decentralized Support Base, and advisory and management committees and the connections of the partners into groups such as UN-Water and the IPCC.

**Regional** institutions such as the regional tiers of UNDP, WMO, UNESCO, FAO, and GWP provide access to regional users from different sectors and from river basin organizations; provides synthesis of national needs to the global level; provide certain specialized meteorological tasks (e.g. drought monitoring or tropical cyclone warning); ensures feedback to respective regional component of CSIS.

**Frameworks for climate services at the national level** form the foundation of the undertaking in providing a continuous national platform and process for user interaction with one focus area on water sector needs. From a water perspective this platform should entail to the extent possible the national agencies responsible for hydrology, meteorology, flood protection, forecasting & warning, irrigation, drought monitoring, river engineering, navigation, aquatic ecology, coastal zone management and national climate centre hosts. While in some countries such platforms may have their nucleus available through climate adaptation initiatives, they are entirely absent in others.

Global level interaction between the water management community and the climate modelling community has been matched during the technical segment of WCC-3. The broad needs and capabilities available were identified; it has however become clear that, unless such interaction is replicated at national level and embedded in a clear process of follow-up, these efforts may be in vain.

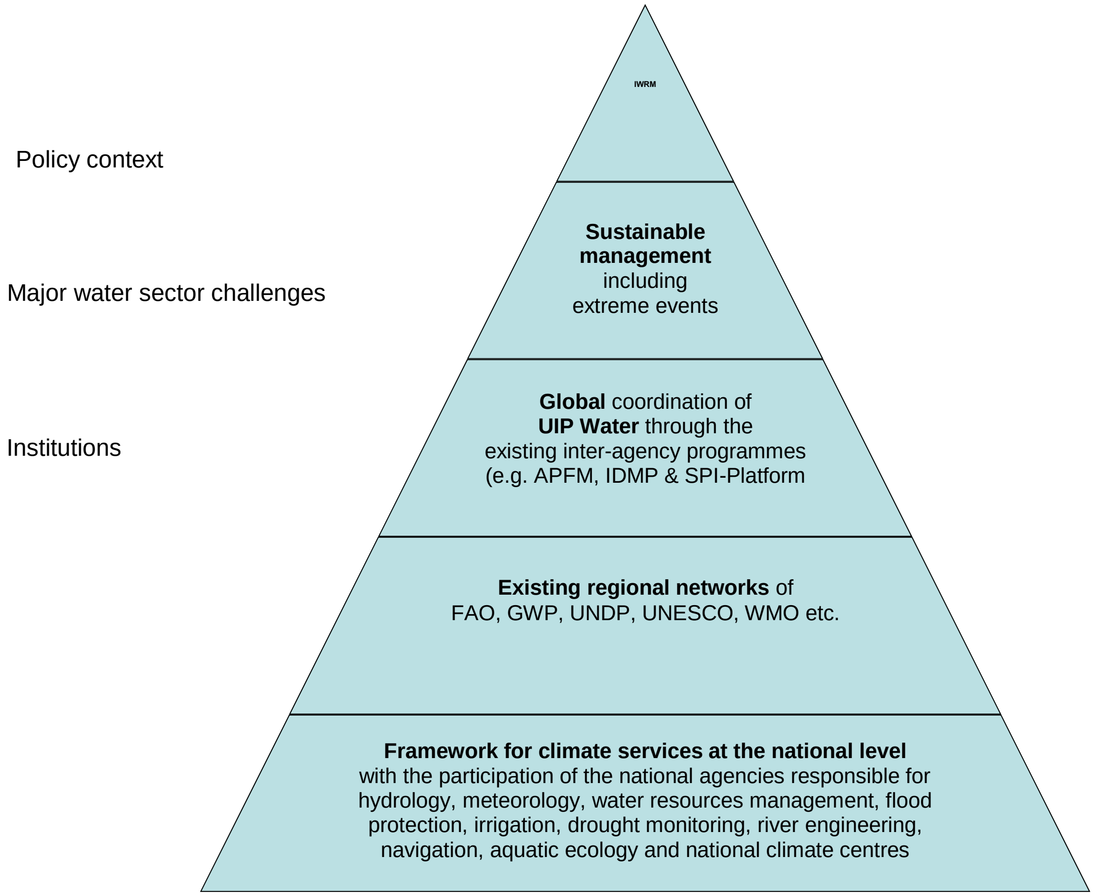



Figure 2. Visualization of overall approach

The necessary adjustments could include:

- Enlargement of the above-mentioned support-bases and networks with high-level expertise from the climate (research) community: experts or scientific institutions highly familiar with climate statistics, and climate modelling on seasonal, interannual or decadal timescales, model evaluation as well as the coupling of models. For example, the HelpDesk of the Associated Programme on Flood Management could then respond to requests from the national level by bringing in, from the global level, the initial expertise required to steer the development of larger adaptation programmes and projects in the water sector (e.g. through national user interfaces with the water sector). At the global level the World Climate Research Programme is an essential partner in this respect, at national level NMHSs experienced in climate monitoring and prediction, or leading climate research centres would need to be formally brought into the Support Base;
- Building a strong relationship with the global and regional development banks, an obvious link being through the Pilot Programme on Climate Resilience (PPCR);

- Strengthening of the linkages with the national tiers of WMO, UNESCO, GWP, UNDP (country offices) on the basis of national projects;
- The water community and the leadership of the APFM, IDMP, SPI-Platform will require a strong voice in the governance of the GFCS, for instance by adequate representation in the relevant Technical Management Committee for the UIP. More than political advocacy, this representation should be made up of technical experts from the water resources management/engineering profession. A subcommittee for water sector users could be envisaged under this Committee. Another possible way would be through the Partners Advisory Committee currently under consideration.

This proposal has the following benefits (+) and shortcomings (-):

+ It would work through programmes with "sector acceptance" that are not climate-centric, but embedded into the development planning context of that professional community;
+ It is based on established mechanisms of interagency collaboration by WMO, UNESCO, GWP, and many others;
+ No additional institutions to be developed for UIP Water specifically. Adequate representation of water sector practitioners in the governance of the UIP will, however, be required;
+ The concept is founded on frameworks for climate services at the national level. Otherwise the distance between global to local is too large, and there is no sustainable national uptake;
+ Initial focus on floods and droughts, allows for targeted delivery and proof of concept. This Water Exemplar should be seen as a living document and evolve over time;
+ The two programmes have strong institutional linkages with the relevant scientific technical bodies under the Commission for Agrometeorology (CAgM), the Commission for Hydrology (CHy), the Joint WMO/IOC Technical Commission forOceanography and Marine Meteorology (JCOMM), the International Hydrology Programme (IHP) and the Intergovernmental Oceanographic Commission (IOC);
+ The Programmes and Platform through annual meetings of their governance structure and annual work programmes are showing a good degree of flexibility in responding to upcoming challenges;
+ The SPI Platform provides an avenue for the water exemplar to become thematically "all-embracing" from the sense of a total integrated water resources management perspective. For instance: water quality management aspects remain a disjointed effort in many cases even at national level and the GFCS will not solve this issue. It can only maintain awareness of it in implementation, for example by including those aspects into project proposals;
- Centralized approaches to resource mobilization have shown limited success, while project funding at least on pilot project scales seems to be attainable. However, without a continued stable basis of funding into the small central facilities, the UIP Water will not be able to develop the necessary "gravity".

### 2.2.2 International agencies, programmes and coordination mechanisms involved in water

Water is a topic related to a wide spread of UN and other international agencies and their initiatives. The following list is just a sample;

- UN-Water (an inter-agency mechanism);
- The International Bank for Reconstruction and Development (IBRD) and the regional development banks through their Pilot Programme on Climate Resilience (PPCR);
- World Meteorological Organization (WMO);
- United Nations Educational, Scientific and Cultural Organization's (UNESCO) - International Hydrological Programme (IHP) and Intergovernmental Oceanographic Commission (IOC);
- UN Intergovernmental Panel on Climate Change (IPCC);

- Food and Agriculture Organization (FAO);
- International Association of Hydrological Sciences (IAHS);
- International Association for Hydro-Environment Engineering (IAHR);
- UNESCO Institute for Water Education;
- Global Water Partnership (GWP);
- Global Earth Observation System of Systems (GEOSS);
- International Commission on Irrigation and Drainage (ICID);
- World Water Council (WWC);
- International Network of Basin Organizations;
- AquaFed;
- International Water Association (IWA);
- Global Ocean Forum (GOF).

The activities of some of the above are briefly outlined in Annex III. The wide reaching importance of water inevitably means that agency interest in different aspects of the water cycle will overlap. The role of UN-Water would be particularly useful as a channel for coordination, as its umbrella function for implementing agencies for water already exists. In this regard, UN-Water has now designed a focal point for the GFCS.

### 2.2.3 National Meteorological and National Hydrological Services

For practical purposes, it is at the national level, that the development of climate services and their synergy with the needs of the water stakeholders, can be most effectively implemented. In a number of countries, hydrological and meteorological services are provided under a single government department. (These are termed National Hydrological and Meteorological Services – NHMSs.) This internal linkage of course improves the connectivity between climate and water, but may not fully accommodate some of the more direct uses of water, such as water supply and irrigated agriculture. The ultimate goal for national climate and meteorological services should be to replicate the higher quality service interfaces that do exist in some parts of the world, but it is recognized that many technical and bureaucratic obstacles for a rapid transition will remain.

In those climate and water organizations whose remit extends beyond their core functions to provide a national service regarding data and forecasts, a wide range of applications are encompassed. Examples of the wider range of climate services include:

- A variety of services for ecological applications, including agriculture and coastal zone management;
- An extended role for the media (written, broadcast and electronic) to communicate climate information;
- Existing activities to enhance a country's capacities to develop tailored user-oriented climate services;
- Good knowledge of the user needs together on the spatial and temporal resolution for successful climate services;
- The existence of a "feed-back" culture, where the civil society could provide helpful guidance on the needs for he development of climate information and services at local levels;
- Demonstration that good exchange of knowledge and experiences at regional and sub-regional levels can be beneficial for all involved in delivering climate services.

All of the water-based "purposes" defined in Box 1.1 would benefit from climate information, either to augment monitoring coverage, extend and enhance data for design and management purposes, and to provide specialized forecasting and warning information. The nature of the type of information required and provided will vary. However, accuracy, error levels and confidence, are important features in any service provision, and must be agreed between the climate service and the recipient water services. Table 1.2.5 of the Guide to Hydrological Practices (see reference 8) gives a convenient summary of recommended accuracy (uncertainty levels).

Invariably economic constraints play a significant part in the facilities used, and the balance between costs and benefits will influence what is technically feasible. It is unlikely that the water sector could justify the provision of all of the range of their desired climate data requirements, and similarly the climate service could not justify a universal provision of all types of data. There are however inherent benefits in coordination between climate services and water management on some key applications.

The New Zealand National Institute of Water & Atmospheric Research (NIWA) presents an interesting template of an organization which has integrated a comprehensive range of climate and water topics under 13 separate "National Centres", which are in fact specifically focussed joint climate and water based foci – see Box 2.1.

**Box 2.1 The National Centres of the New Zealand National Institute of Water and Atmospheric Research (NIWA)**

| | |
|---|---|
| Agriculture & Biotechnology | Aquatic Biodiversity and Biosecurity |
| Atmosphere | Climate |
| Coasts | Energy solutions |
| Environmental information | Fisheries |
| Freshwater | Natural Hazards |
| Oceans | Pacific Rim |
| Vessels | |

It is unlikely that most countries would be in a position to reorganize their climate and water activities in a similar way, but there are a number of topics which lie at the core of interfacing climate and water services, as follows:

- The level of data sharing and inter-agency cooperation;
- Rationalization or modification of observing networks;
- Standards of equipment and modernization;
- Meeting data requirements and data management;
- Use of information from centralized or internationally available remote sensing;
- Public awareness and information services.

National examples of user interface programmes specific for the water sector are available in Germany through the Programme "KLIWAS" on impacts of climate change on waterways and navigation (see reference 18) and in the United States of America through the "Federal Climate Change and Water Working Group (CAWWG)". Common to both is the direct engagement of the officially mandated federal agencies for flood protection, navigation, the hydrological and meteorological services, and the services for protection of aquatic ecosystems. While the national approaches will have to vary it is clear that UIP Water will have to provide a "support base" from both the hydrological/river engineering and meteorological/climate modelling communities to support national efforts in countries that may at the outset lack guidance. Such global support base for the hydrologic and flood management expertise exists within the Associated Programme on Flood Management, and as described in section 2.2.1 above, could be complemented with respective climate modelling/climate information support.

### 2.2.4 Non-Governmental Organizations (NGOs)

NGOs have a prominent role in delivery of services at a community level, and a large number of such bodies are involved in water sector activities. These include water supply and sanitation, agriculture, disaster preparedness, relief and response, and range from small charitable institutions to large, globally active bodies like Oxfam, Red Cross/Crescent, Save the Children, Christian Aid and the World Wildlife Fund. These major organizations, in addition to their implementation capability, can exert a powerful political lobby, and are most active with concerns around climate change impacts on various aspects of water in a strategic framework. As such, they may be considered largely as users of climate data, with a potential for development of much more targeted information and services for more immediate issues, both from the climate and water sectors.

The social orientation of many of the NGOs does however mean that in general their personnel have little scientific knowledge of meteorology and hydrology, and thus are not widely receptive of the potential for better data and information services. Most organizations at their policy level tend to utilize information, e.g. on climate change, in a non-critical second-hand manner. With their local presence however, NGOs could provide a useful dissemination focus for forecast and warning material.

### 2.2.5 Universities and research institutions

These organizations can play key roles in progressing knowledge through observations and monitoring. They can apply a depth of concentration on particular topics, applications and methods, which may not always be possible within a publicly owned NMS or NHS. However, the need to coordinate the work in the research community with the remit and goals of national climate and water service providers is important, especially in terms of careful application of scarce funds. National research councils and international research networks (e.g. UNESCO's IHP science networks), if powerfully structured, are important to coordinate research and its applications, and to maintain impetus over long-running research programmes.

In countries where the NMS and NHS activities have limited capacity for research efforts, universities and research institutions could have a significant role in carrying out experimental work on climate and water interfaces, or provide special skills such as climatological or hydrological modelling, providing tools to account for data sparse areas and ungauged basins, or augment the observation network for specific uses, e.g. upland area climate observation. In some instances, these facilities were more available in the past, when international aid support was more forthcoming for practical, technical programmes. Examples of this are agricultural universities in Sri Lanka and Bangladesh, which were supported by FAO in the 1960s-70s, to install and run full agro-climatic observation stations. These stations operated manual instruments, which in most cases are no longer functional. No similar funded effort has been implemented to re-equip observation stations with modern automatic electronic sensors.

### 2.2.6 The private sector

The private sector has a vitally important role as a driver to improve and evolve climate services, by creating a need for better climate information in relation to both water activities and impacts. The involvement of the private sector in water varies from country to country, but it may be considered that in the majority of countries, water supply and sanitation is managed by private undertakings. Their operation therefore has an emphasis on commercial activities, although overall they will be regulated by government legislation. Water companies can therefore exert pressure on governments to provide the necessary facilities from a state operated NMS to carry out a reliable service to the public. Private involvement and control may also extend to operation and management of major irrigation and power generation schemes, but their operation should be strictly controlled by license arrangements. The design and operation conditions are dependent on sound hydrological information, which in turn require sufficient meteorological and climatological data.

Engineering consulting companies provide major elements of decision-support to governments in devising water resources management infrastructure, monitoring, forecasting and warning systems, plans and projects. Also in terms of policy support, those companies may have a role to play. Therefore, the UIP Water should seek the engagement of these consultancies actively. An example of an open platform where those consultancies have also been included is the Support Base under the HelpDesk supporting Integrated Flood Management under the Associated Programme on Flood Management.

Private sector water supply and power generation companies may require specific data for locations and at timings outside the normal programme of forecasts and data delivery from the climate service. These users may also require warnings of extreme events which need to be customized between the climate information provider and the user. These undertakings, along with other critical infrastructure, may also need extreme event design data to comply with stringent safety regulation, e.g. for dams, power stations and harbours, etc.

*Insurance and legal services* represent a particular aspect of private sector users and demand, in that they require high quality, verifiable data to support claims, losses and liability issues relating to extreme weather climate and water related events. With insured losses in connection with floods and droughts exponentially rising over time, there is perhaps a case for insurance companies funding capacity development in water and climate services.

### *2.3 Criteria for identification of projects/activities at global, regional and national levels*

The identification of proposed activities within the Water UIP should aim to meet the following criteria:

- Contribute to enhanced climate resilience of vulnerable populations and areas, e.g. those at risk of flood and drought;
- Activities must be linked to the national development goals and policies, for the water community in particularly development policy concepts such as Integrated Water Resources Management;
- Support the achievement of existing water sector national and international goals;
- Address climate sensitive water programmes, internationally and nationally;
- Address major gaps identified at regional and/or national levels in climate-water partnership and project delivery;
- Engage a range of water, disaster management, and meteorological stakeholders in partnership with the aim of addressing water risk management and security;
- Develop water sector and public awareness to value and uses of climate and weather information for water;
- Serve to develop the capacity of national water and meteorological functions and partners;
- Provide initiatives and projects to include effective monitoring and evaluation functions,
- Aim to be cost-effective;
- Strengthen the evidence base of links between climate and water for policy and programmatic decision-making;
- Provide initiatives and projects to include a sustainability and mainstreaming plan, as appropriate.

The Water UIP should be designed with the following lessons and experience evident from activities over the past decades:

- Water stakeholder participation in partnerships between climate and water have been successful when focused on user priorities and needs, prime examples being flood forecasting and warning and coastal zone management in a number of countries;

- To make the available climate services useful, they have to recognize the diverse demands for climate information and services among the separate water stakeholder applications, and have to be flexible to suit those needs. Too many NMSs continue with rigidly formatted forecasts and warnings because they have been defined in long-established proscribed duties as “standing-orders”;
- Where climate services have developed to provide a wider range of information, they have been most successful when the products have been jointly developed and managed, to give products and processes that enhance water risk management;
- For the broader based aspects of water risk management, it is useful to incorporate requirements for other sectors which have associated water risk, e.g. transport, built environment, and agriculture;
- Focus on activities which have strengthened national capacity. As well as strengthening water sector activities directly, develop information systems that are most relevant to the effective use of climate information and services on a broad basis, particularly for public information. The role of information from weather and climate service websites is important in this respect;
- Develop a greater understanding of the nature of climate data and products in relation to their use and effectiveness in water activities. It is however necessary to manage expectations of users and not exaggerate the usefulness of a product;
- Improvement of the access to both climate and water data between both active parties. This has had to overcome past compartmentalization and ownership restrictions on information and roles. Trust must be built between both communities to enable data sharing and collaboration;
- Although many weather and climate information products appear to be underutilized, it equally cannot be assumed by potential water sector users, that products are available “off the shelf” for immediate application. Research and development is still needed to develop reliable models, methods, tools, that can be used by GFCS operational systems to produce consistent and reliable products.

An important outcome from the experience of the past 10-20 years has been the degree to which the climate and water interface in many countries has benefited from feedback to generate enhanced and improved services. A few examples of this synergy are given in Box 2.4.

**Box 2.4 Examples of development of climate products through feed-back from water sector**

***A. Quantitative precipitation forecasting (QPF)***. The requirement for more definitive information in flood forecasting has led weather service providers to move away from qualitative statements on rainfall, e.g. light-moderate-heavy, occasional-persistent and localized-widespread. From moving to defining numerical or proportional ranges to these descriptors, QPF is now provided in well-defined rainfall ranges, e.g. 30mm-50mm, over geographically defined areas and with definition of likely start and finish times.
***B. Seasonal and long-range forecasting***. These forecasts are required by major water management undertakings, where knowledge of forthcoming seasonal water conditions is helpful. Forecasts of rainfall and temperature are most commonly needed, and are presented as probabilities of conditions falling within different categories, expressed in relation to seasonal norms in 3- or 5-step categories, e.g. very low to very high.
***C. Rainfall depth-duration-frequency datasets.*** These are provided as tables or sets of curves, having been obtained from a comprehensive probability analysis of rainfall records. They are required as a basis for drainage design or flood estimation in a standard manner over e.g. a particular country, and so are related to a geographical distribution, either by iso-lines or as tables or grids.

### *2.4 Implementation activities (including resource requirements and communication strategies) at global, regional and national levels*

The initial framework for developing the Water UIP is based on existing interagency collaboration in integrated water resources management (including floods and droughts) representing priority areas for water management. Clearly, the initial implementation model will be adjusted over time based on experience gained and resources being made available in support of UIP Water. The principal areas of activity envisaged include but are not limited to:

- National and regional tools (river basin level) to enable water resources managers to identify those aspects of water resources management in their domains most likely to be impacted by climate variability and change;
- National and regional (river basin level) pilot projects to develop sustainable water resources management plans (including dealing with floods and droughts), with full engagement of the climate and water communities;
- Collection of methodologies to account for climate-related uncertainties, and publication in the form of a "climate-tools-for-water-managers series";
- Strengthening collaboration between WMO, GWP, UNDP/Cap-Net and UNESCO to enhance the ability to deliver education and training programmes at regional and national levels;
- Helpdesk functions in support of water user interaction at national level (e.g. national multi-stakeholder workshops);
- Improved climate services for managing the freshwater-ocean interface, including storm surges and waves and coastal inundation forecasting.

The capacities of many elements covered by the Framework are currently inadequate and need improvement, especially in vulnerable developing countries. The term "capacity development" should refer to raising and sustaining capacity growth within a given organization over time, and for systematically developing necessary institutions, awareness, technical and financial resources and to foster an "enabling" environment. In many cases, the task of "enabling" may extend to changing engrained mindsets toward the role of public services. Capacity development is not an activity however that is carried out exclusively in the developing world: it may be required in many developed nations and sectors as changing demands of society evolve.

A continuing task for the Interface will be to regularly analyse and update the needs of the different elements of the Interface Framework, particularly at national levels, and promote efforts to address them. Initially, a suite of priority actions need to be identified to raise the capacities of those countries currently least able to participate in the Interface, and so to provide a basic level of climate services.

Some of the Interface's capacity development work will be implemented by specialist technical and development organizations and coordinated by the Framework secretariat, but there will also be capacity development activities whereby climate professionals share knowledge and experiences within and between regions. The Capacity Development component should actively engage with multilateral funds and programmes that are promoted from time to time. Major demonstration projects, using both multilateral support, and linked to national programmes, are often a useful vehicle to develop capacity, but experience shows that these major programmes can lose momentum as priorities change.

The primary objective of the Water UIP should be to enable water resources managers to develop national water resources management plans (based in IWRM) that take into consideration the impacts of climate variability and change on the provision of water related services. An example of such a plan is that for Egypt, developed in 2005 (Box 2.5).

**Box 2.5 National Water Resources Management Plan for Egypt, 2005 (see reference 12)**

The challenges facing the water sector in Egypt are enormous and require the mobilization of all resources and the management of these resources in an integrated manner. Changes in the way water resources are currently allocated and managed are inevitable. Accordingly, a National Water Resources Plan for Egypt (NWRP) was launched. The NWRP is a comprehensive document which describes how Egypt will safeguard its water resources in the future, both with respect to quantity and quality, and how it will use these resources in the best way from a socio-economic and environmental point of view. The NWRP needs to be augmented by a transitional strategy including further reform interventions which ensure smooth and enhanced streamlining with Integrated Water Resources Management principles and approaches. The current integrated water resources management plan (IWRM Plan) has been prepared to serve the later concerns and is intended to be a complementary, action-oriented, implementation framework to the NWRP. It addresses the gaps in NWRP and provides for additional measures and provisions which facilitate the transition towards an integrated management approach within the water sector. The IWRM Plan assesses the current water resources management setup and practices along with the ongoing reform efforts led by the MWRI. The Plan identifies the actions agreed upon as major interventions to pursue an effective integrated framework for water management over the next 15 years.

### *2.5 Initial Implementation activities/projects*

Below, options for initial implementation activities have been outlined under four broad headings, mainly based on input by GWP, and also provided some suggestions for early activities.

### A. User Needs

*i.* *Foster the gathering, analysis and dissemination of user needs for climate information and its application.*

Activity: Undertake a mapping of climate information requirements, users and stakeholder interface mechanisms across the water sector.

Activity: Use meeting of key stakeholder groups, e.g. the WMO Commission for Hydrology and the UNESCO-IHP Intergovernmental Council to seek improved understanding of user requirements.

Activity: Wave and surge climate services to reduce the vulnerability of society to climate-related hazards through better provision of climate information

*ii.* *Stimulate the development and dissemination of user-oriented applications methodologies, lessons learnt, good practices and relevant standards of performance.*

Activity: Build on the World Meteorological Organization's Hydrological Operational Multipurpose System (HOMS) by incorporating a set of user-oriented applications for the water sector.

Activity: Further develop and review the "Flood Management Tools Series" from a climate service perspective

Activity: Incorporate user-oriented applications methodologies, good practices and relevant standards of performance in the materials presented through the UNU "Water Virtual Learning Centre" and courses held at the UNESCO-IHE and UNESCO's category II centers and water chairs .

Activity: Enhance literacy of water managers towards the understanding and appropriate use of climate information and services.

### B. Feedback and Support

i. *Coordinate the formation of user perspectives and feedback on the functioning of the Framework, and provide necessary user-oriented support to the other components of the Framework.*

Activity: Include within the Agendas of key stakeholder meetings (e.g. UN-Water) an item on the Framework and the Water UIP.

Activity: Continue and upscale the capacity development programme on "IWRM as a tool for Climate Change Adaptation" based on the collaboration between the UNDP/Cap-Net, the Associated Programme on Flood Management, UNESCO-IHP and UNESCO IHE.

Activity: Interact with other UIP related sectors to better define common user needs and perspectives as required.

Activity: Interact with the FGCS pillars/components informing them of the requirements of the water community.

*ii.* *Support other actors, particularly in developing countries, to undertake these tasks at regional and national levels.*

Activity: Support the holding of River Basin stakeholder interaction workshops in the areas of water scarcity and large-scale flooding, involving water and climate operational, research and academic groups from the basins.

### C. Advocacy and Outreach

*i. Advocate the benefits of using climate information and the utility of the Global Framework for Climate Services to potential beneficiaries, users and user organizations.*

Activity: Hold special sessions and/or organize stands at key stakeholder conferences, workshops and meetings (e.g. World Water Forum, Stockholm Water Week, National Water Weeks, etc.).

Activity: Prepare communications brochures on the Water User Interface Platform for general use by user partners.

*ii. Promote the active and systematic consideration of climate information use and the Global Framework for Climate Services in the work of key policy institutions, such as intergovernmental forums, sector technical bodies and professional organizations.*

Activity: Organize a keynote or other high level event at the principal international meeting each year in the water sector.

*iii. Stimulate the development of user-focused networks, collaborations, partnerships, forums, centres and learning exchanges.*

Activity: Promote the establishment of leadership groups, networks and activity programmes on climate services within the water sector.

Activity: Organize in the water sector an assessment of the most promising areas for introducing climate services to existing collaborative mechanisms.

### D. Pilot Projects

*i Climate Driven Water Resources Management Issues – Tool Development/Workshops.*

Activity: Develop a tool and hold workshops to assist water resources managers in assessing the aspects of their water resources management programme (and development of national water management plans) most at risk to the impacts of climate change.

*ii Water Scarce Regions.*

Activity: Establish pilot projects in 5 transboundary river basins identified as water scarce regions incorporating a Water User Interface Platform between the hydrological and climatological communities.

*iii Basins dependent of snow and glacier melt for water.*

Activity: Establish pilot projects in 5 river basins identified as basins highly dependent on snow or glacier melt for their water resources incorporating a UIF Platform between the hydrological and climatological communities.

*iv Freshwater-Ocean Interface.*

Activity: Establish Coastal Inundation Forecasting Demonstration Projects (CIFDP) with the aim of reducing the vulnerability of society to climate-related hazards through better provision of climate information.

The implementation of activities and projects are discussed further in sections 3.1 and 3.2.

## *2.6 Implementation approach (including operational and organizational aspects)*

### 2.6.1 General considerations

The Water UIP should be implemented in three phases, short-, medium- and long-term, and the timing of these phases is in effect set by the World Meteorological Congress, namely 2015 and then in four year increments. These periods are suitable to maintain focus on activities that will achieve desired outcomes. Table 2.2 sets out proposed implementation activities for each phase, which can be scaled accordingly for the global (G), regional (R) and national (N) levels.

**Table 2.2 Suggested Timeframes for Implementation**

| **Phase 1 2013-2015** | **Phase 2 2015-2019** | **Phase 3 2019-2023** |
|---|---|---|
| 2 year targets & types of activities | 6 year targets & types of activities | 10 year targets & types of activities |
| Establish institutional mechanisms/secretariat<br><br>Establish workplans<br><br>Establish website & communication strategy<br><br>Develop initial technical guidance<br><br>Incorporation of existing projects involving climate and water<br><br>Awareness and partnership building with the water sector | Maintenance and improvement of engagement in institutional mechanisms<br><br>Develop more refined technical guidance & training curricula<br><br>Identify new projects and processes<br><br>Expansion and continuation of existing projects | Maintenance and sustainability of institutional mechanisms<br><br>Technical and operational support for continuation of existing projects<br><br>Widespread use of technical guidance & training curricula<br><br>Review of performance and lessons learned<br><br>Ensuring sustainability and mainstreaming of CS for Water |

The presence of a centralized User Interface Platform for the four pillars of the GFCS at global level could see the need for a water focussed component of the GFCS Secretariat**,** concerned with the involvement of climate services and water, at the global level. This would help to streamline bureaucracy, but it will be necessary to ensure that there is good engagement with the GFCS. The UIP will need to include a coordinating role to support and oversee the implementation of the Water UIP activities, to bring together partners, and maintain the requirements for success of Framework activities, within and for the water sector. Selection of a coordinating group (a *de-facto* secretariat) for water within UIP would be a matter for deliberation by the Intergovernmental Board on Climate Services, but should include representatives from the members of UN-Water.

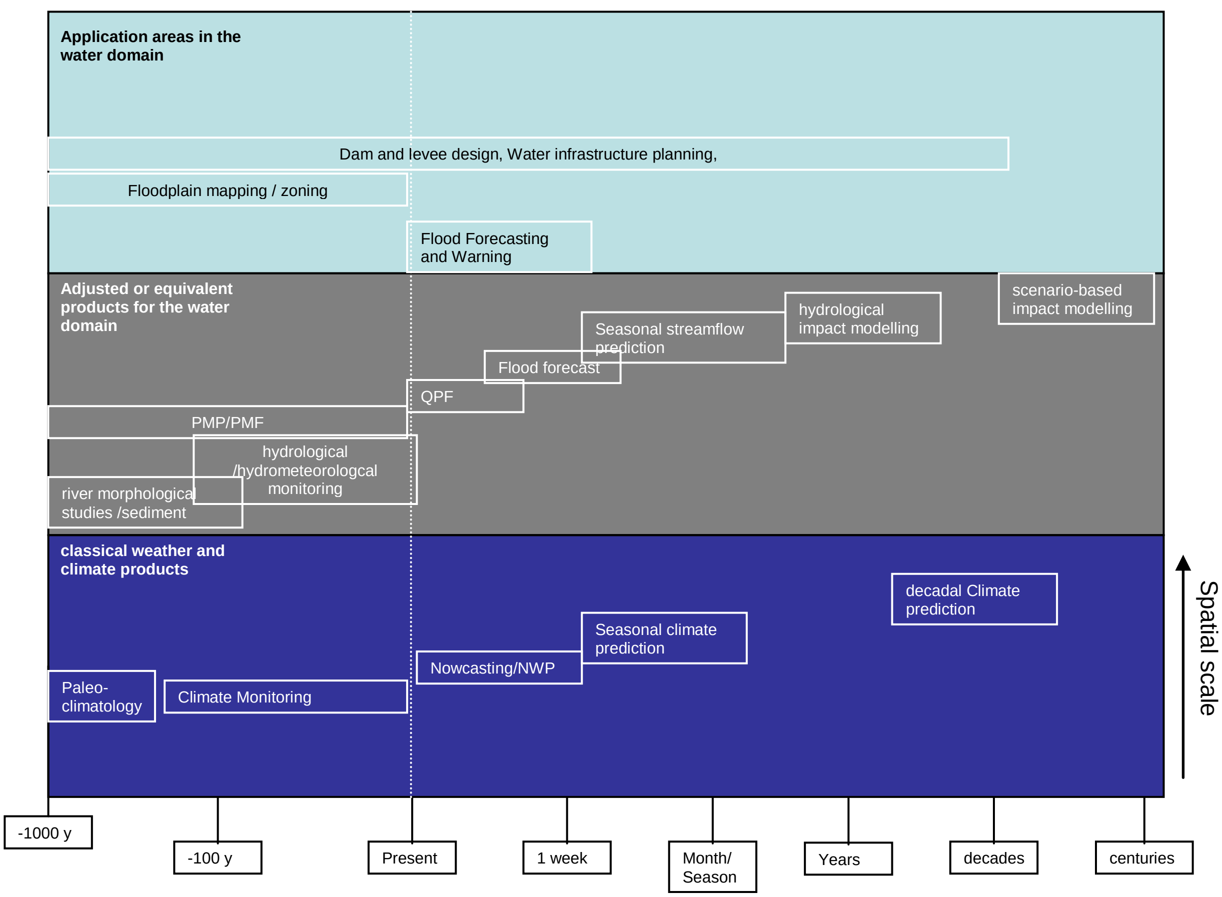
Implementation activities regionally and nationally will concentrate within Phases 2 and 3 although Phase 1 may be largely centralized with the GFCS UIP and the representative bodies involved, implementation activities regionally and nationally will concentrate within Phases 2 and 3. Some situations will require a fast-track approach, whereas others might require an extended implementation time-frame. Different targets may also lend themselves to a staggered or stepped approach, influenced partly by constraints on programme capacity and finance, but also through the benefit of having some pilot projects providing experience on how other projects may be replicated using “lessons-learned”.

Over-arching foci for enhancing climate services for any interface need to address the following:

- The end-to–end process of making better use of climate observations in support of model development and use for operational prediction;
- The role of national and international research programmes in supporting the development and improvement of climate services;
- The diverse experiences of different regions, countries and institutions, in the implementation of climate services.

### 2.6.2 Temporal scales of relevance to water resources management

An adjusted Figure 4 from the UIP Annex (p. 32) “Timescales of certain climate sensitive decisions” showing the timescales/forecasting lead times of different outputs from climate monitoring, and seamless prediction can be shown adding the related water sector product and application area.



### 2.6.3 The Pilot Project Approach

This situation lends itself for the use of pilot projects on a regional basis or perhaps for small groups of nations, where the pilot project provides a template for others to use. A number of topic foci are given as examples:

a) The societal need for authoritative information on climate impacts on water, in terms of risk and impacts, variability and change;
b) Developing capacity for gathering, processing, and sharing observational data for model evaluation and initialization;
c) Development of hardware and software capabilities for analysing and interpreting model and observational results;
d) The understanding and quantification of uncertainties in a probabilistic manner including recognition of the high-impact end of the distributions;
e) Streamlined transition of research into an operational mode including the generation of climate products and services;
f) Facilitation of feedback from the user community so providing guidance on refining research priorities;
g) Methods to improve resources and skills to provide and utilise information, to meet user needs for decision-making at the global, regional and local levels.

### 2.6.4 Focusing implementation at regional and national level

The GFCS-HLT recommended that the implementation of climate services in any Pillar of the UIP could take place, perhaps initially by a series of workshops, as follows:

- *Communication strategies*. Development of strategies to effectively communicate relevant and tailored climate information (including measures of uncertainties) to stakeholders, decision-makers, general public and media;
- *Ownership*. Development of "ownership" by the population and users, including translation of products into local language is important for the effective use of information;
- *Capacity-building.* To ensure sustainability of services, capacity-building and effective in-country training is necessary, as well as funding identification. Funding must be flexible, and not proscribed for limited uses, e.g. only "improved governance": funding must cover development of appropriate tools (e.g., numerical models) and adequate human resources to develop these tools;
- *National activities*. The development of national-level information on a prioritized appreciation of climate interaction and impacts on the water sector has to be carried out. Matching capability to user requirements needs effective dialogue for preparation of national adaptation strategies;
- *Regional climate services*. These services are very important to contribute to enhanced social and economic resilience and decision-making in many climate-sensitive sectors, including water and related disaster risk management;
- *Climate in development*. Climate information is essential for socio-economic development. Conscious efforts are needed by stakeholders and key players in the water sector to understand the full potential and usefulness of this information;
- *Integration.* Good linkages between Global Climate Prediction Centres (GCPCs);
- Regional Climate Centres (RCCs) are needed for the best use of products at the regional and national levels. Exploring and reviewing regional coordination is needed to foster improvements at the national level. Lessons learned to better tailor information from GCPCs, RCCs and National Climate Centres (NCCs) should be applied.

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

In order to monitor and evaluate the progress and success of implementation, it is advisable to:

1. Undertake monitoring and evaluation primarily on the level of the different programmes and projects employed in the delivery of the Water UIP. Specific projects goals have to be evaluated against the achieved outcomes and their value to the specific water sector needs. Technical audits of the practice established as part of those projects are the favoured approach;
2. Establish monitoring and evaluation standards for new interventions, and the development of suitable performance indicators. The latter may apply to the consistency of delivery, speed and quality of the product delivery and also to economic measures, such as costs-damages-and benefits statistics;
3. Integrate reporting on delivery of the GFCS into the existing governance mechanisms for meteorological agencies, and water agencies, including the World Meteorological Congress and the UN Water grouping, and equivalent bodies at the regional and national level.

Similar monitoring and evaluation mechanisms also need to be established at regional and national levels, to ensure that the progress of projects is properly maintained. The six WMO Regional Associations (RAs) would most likely provide the appropriate level of regional scrutiny as part of their regular meetings and management programmes.

At a national level, the organization for monitoring and evaluation will need to be setup on a case-by-case basis, depending on the particular involvement of government departments and the project focus established. At the least, the monitoring and evaluation process should involve:

- Senior officials from those and ministries agencies involved technically;
- Central government finance and international aid management departments;
- Relevant universities and research institutions;
- National representatives of concerned UN agencies.

See also Section 3.3 - Review Mechanisms, below.

### *2.8 Risk management in the implementation of activities*

The risks to the effective development of a water interface for GFCS are all manageable, given adequate timetables and resources, including manpower. The general risks include:

- The expectations of users for robust and high accuracy information and services cannot be met, because of inadequate data at the climate centre, limitations of the science and/or poor communication of the information and services;
- The right people are not involved in the particular activities being advanced and thus the cooperation and coordination expected are not achieved;
- The partners do not cooperate in defining the full requirements of the required information;
- The application of the “cost recovery” principle to data collection inhibits the expanded levels of data and information delivery desired;
- Inability of the beneficiaries within the water sector to meet the raised expectations of their clients/end-users about future enhancements, e.g. that flood warnings, based on improved QPF forecasts, will be more timely and accurate.

Most of the above depend on clear, decisive leadership from the highest echelons of government, as risk stems from inherent defensiveness within bureaucracies at departmental or sectional level. Much also depends on how the interaction between the private and public sectors is established, which will vary between countries. Often it may be the case that the private sector is not aware of the services available from government agencies, or in fact do not recognize what value this information could be for their operations, e.g. the value of relevant climate and weather information for transport logistics, agricultural marketing, consumer demand, etc.

Two major risks exist to the implementation of the Water UIP workplan. Firstly, if there is not significant and genuine buy-in and ownership from the national water management community, then partnerships and actions to apply climate services to water will remain marginal and climate services will not become a standard and mainstreamed application for the water sector. Therefore, communication is a priority area of work to improve understanding and buy-in, as well as justification for the pre-requisite conditions for water engagement in the Framework. Secondly, without mobilizing and sustaining financial resources at global, regional, and national levels engagement of the water sector, any implementation will not be possible. The Framework Secretariat and the Water Secretariat for the UIP will need to make active efforts to identify, raise and sustain funding for partners and secretariat level operations. The actions proposed in Operations, as well as rigorous M&E linked to water outcomes can help mainstream climate services as an essential contributor to the water sector and enhance water management, as a means to further leverage resources for all aspects of water service delivery and emergency management.

# 3 ENABLING MECHANISMS

## 3.1 *Synergies with existing activities*

Section 1.4 (and Annex II) has listed a number of the key initiatives interfacing climate and water activities within WMO and between WMO and other UN water focused initiatives. It is important that the Water Interface of GFCS builds on the existing synergies, rather than duplicating them. A detailed proposal on employing the interagency programmes APFM and IDMP has been made in section 2.2.1 and it is clear from the follow-up actions to the WCC-3 Conference, 2009, reported in the GFCS-HLT report (see reference 14) and the report on the Inter-Agency Consultation Meeting on User Interface Platform (see reference 15), that much relevant activity has already been undertaken.

Section 2.2 (and Annex III) has also outlined an extensive range of existing partnerships, institutions, projects, and mechanisms that can serve as initial points of engagement for the Water UIP to bring water and climate partners together. Although many of these existing institutions exist outside the developing country context, all of these partners either operate internationally or may serve as a resource base for capacity development, technical transfer, and collaboration.

In addition there are regional specialist centres linked to WMO, such as:

Regional Specialized Meteorological Centres (RSMC);
Tropical Cyclone Warning Centres (TCWC);
Drought Monitoring Centres (DMC).

There are also other regional and specialist centres that would have a role to play, either at a regional level or for individual countries within their grouping, for example:

World Hydrological Cycle Observing System (WHYCOS) centres;
AGRHYMET Regional Centre, Niamey (for Sahelian countries);
African Centre for Meteorological Development (ACMAD);
Mekong River Commission, Phnom Penh, Cambodia and Vientiane, Lao PDR, (for Cambodia, Lao PDR, Thailand, Vietnam);
International Centre for Integrate Mountain Development (ICIMOD), Kathmandu for Hindu-Kush – Himalayan Region.

There are important synergies to be developed with all the above organizations and many others, but care needs to be taken that by involving a plethora of interested parties, the functional effort of the Water UIP will become diluted. In developing an effective Water UIP, the question needs to be addressed as to how these fragmented sources have been used, and how coordination may be improved in the future. It is essential that the required synergies and linkages must:

a) Be directly relevant to the management of climate sensitive water impacts;
b) Be able to practically enhance and improve the performance of existing water priorities, goals, and technical agendas;
c) Have explicit connections with the operational mechanisms of the water sector.

## 3.2 *Building national, regional and global partnerships*

At the conclusion of the WCC-3 meeting, there was a call for major strengthening of the essential elements of the GFCS through the means summarized in Box 3.1. These several points have to be at the basis of the enabling mechanisms for development of the Water Interface at national, regional and global levels.

**Box 3.1 Essential elements of development frameworks for climate services**

These reflect the components of the GFCS programme, but should be tailored to water sector needs:

- Enabling the provision of and access to climate data and exchange of information with water users (N.B. data may be categorized as free, purchased as a commodity or service, but only treated as restricted in matters of state or commercial sensitivity;
- The provision and establishment of adequate computing resources, nationally and with links to regional and global services;
- Encouragement for interaction with relevant global climate research initiatives;
- Provision of climate services information systems taking advantage of enhanced existing national and international climate service arrangements that exist elsewhere:
- Delivery of products including, water sector-oriented information to support adaptation activities and strengthened outreach and communication;
- Climate user interface mechanisms focussed on building linkages and integrating information, at all levels, between the providers and users of climate services, aimed at developing and efficient use of climate information products, including the support of adaptation activities;
- Efficient and sustained capacity development programmes through education, training, and professional development.

All of the above require adequate, reliable and consistent funding for capital and recurrent expenses, with a planned future investment policy.

The WCC-3 meeting also concluded that from the scientific and operational perspective, the proposed Framework should reinforce and complement the established international organizations that exist for the provision and application of weather, climate, water and related environmental information, forecasts and warnings, etc. The Framework should build on, and integrate, the existing international systems and programmes for climate observations and research, which are co-sponsored by WMO, other UN system partner organizations. The ICSU, WMO and user-sector organizations should enhance collaboration in the development of practical guidance on the preparation and use of climate products in different sectors and regions.

The ability to secure adequate financing and the effective establishment of a functional and communicative secretariat are vital. Importantly, the UIP work plan must offer concrete incentives, opportunities and advantages for partners to engage.

Examples of collaborative services for water exist in many countries and regions. Boxes 3.2 and 3.3 present brief summaries of case studies which could be useful in developing services where none exist, or where levels of service have requirements to improve.

**Box 3.2. Streamflow Forecasting Service – Australia**

Streamflows in Australia are highly variable and nationwide are relied upon by a range of water managers and users, including irrigators, urban and rural water supply authorities, environmental managers and hydroelectricity generators. Predictions of short-term and seasonal streamflows, and long-term water availability forecasts can potentially allow these water managers and users to better plan, operate and manage water use, to inform water allocation, environmental flow management and water trading decisions and to assist with development of water policies to ensure security of supply.

An operational Seasonal Streamflow Forecasting Service was publicly launched by the Australian Bureau of Meteorology in December 2010, covering parts of the states of New South Wales and Victoria. Each month the Bureau issues three-month outlooks of total streamflow volumes at specific sites or total inflows at sites of water storage. These forecasts are freely available online at www.bom.gov.au/water/ssf for thirty-six sites in sixteen river basins. Seasonal Prediction Unit (SPU) staff members and the Bureau's Communication and Adoption Team (CATs) are involved in stakeholder engagement and tailoring information to suit users.

The seasonal streamflow forecasts rely on streamflow data collected over many years by state agencies and other organizations, as well as climate information from the Bureau and international organizations, such as the US National Oceanic and Atmospheric Administration (NOAA). Most of the climate indices used in the forecasts are generated within the Bureau from raw data using a geo-processing model. Most data from external sources is downloaded from public websites, then converted into a suitable format.

To support the service, a new modelling system WAFARi (Water Availability Forecasting for Australian Rivers) was developed. Through frequent contact between the Bureau service team and external stakeholders, critical user needs for the service were identified and implemented. As an operational system, WAFARi is equipped with many tools, which range from data management in a central database, to web publication.

Needs in individual countries will vary, but a level of commonality should be sought, and in the regional context, commonality between neighbouring countries is required, especially those which share a major river basin.

Important topics in any service development for water applications include:

- *Data integration.* Integration of space-based and ground-based observational systems that accurately capture key climate variables, and are sustained over decades for a robust determination of trends and variations at the regional and global level; (i.e. linking research with operations, services and delivery);
- *Significantly enhanced computing and telecommunication capabilities*. Significant enhancements in computing and telecommunications systems are required to ensure high quality information products derived from observational data and a seamless flow of information in a timely manner networks;
- *Enhanced access to internationally available forecast products.* As well as internationally available weather satellite data, there are now numerous global and regional scale model forecast outputs available. Although many of these are freely accessible over the Internet, there is a need for NMSs to incorporate these data into their forecast process, and the aim should be to obtain model output as data feeds and move towards the regular operation of Local Area Models (LAM);

- *Capacity Development.* Especially in the developing regions of the world capacity-building is essential for the development, use and interpretation of models, the generation of relevant information products the operation and maintenance of demand-driven end-to-end observation networks and forecasting and prediction services. Important mechanisms and partners are national knowledge hubs such as universities and regional as well as global partners.

**Box 3.3. North American Drought Monitor (NADM) and European Drought Centre (EDC)**

NADM is a collaborative continental drought monitoring product prepared jointly by the United States, Canada, and Mexico for the benefit of users within the participating countries. Historically, people have responded to drought in a reactive manner, but the development of products and programmes enables people to begin to anticipate drought and to act in a more proactive and cost-efficient manner.

Developing from the US Drought Monitor in 1999, and trialled between 2002 and 2005, NADM is now one of a suite of products to improve the monitoring and assessment of a wider suite of climate extremes on the continent (to include heat waves and cold waves, drought and flooding, and severe storms). National partners contribute time and personnel to the NADM activity as part of their normal operational duties, since the NADM activity does not have a dedicated budget or any funds specifically allocated.

The drought depiction for each of the participating countries (US, Canada, and Mexico) is determined independently by experts within each of the three countries, and published on a monthly basis. The NADM is available at no cost on both a static website (http://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/) and via the NIDIS drought portal (http://www.drought.gov/portal/server.pt/community/nadm). Both the NADM map and narrative are provided in the languages of the three countries (English, French, Spanish). The continental drought indicators are also available at the website in both map format and ASCII data files.

The European Drought Centre (EDC) was established in 2004 by UNESCO in the framework of the FRIEND programme and is a virtual centre of European drought research and management organizations to promote collaboration and capacity building between scientists and the user community. The long term objective of the centre is to enhance European cooperation in order to mitigate the impacts of droughts on society, economy and the environment. It acts as a platform to initiate and discuss scientific progress on drought research within the academic society, but is also important as a meeting place between multi-disciplinary experts in drought research, policy and operational management.

The stakeholders in the water resources management are many and varied. They include the National Meteorological and Hydrological Services (NMHSs), water supply managers, irrigators, farmers, hydro-power generators, national, state and local government groups, the general public and many others. Therefore, mechanisms for involvement and interactions also vary significantly, from high-level Ministerial Councils to local meetings and also involve media-based awareness raising and information distribution mechanisms. Communication of information on the progress of collaborations to stakeholders will contribute to successful outcomes.

**Box 3.4 G-WADI and G-WADI Geo-server Development**

UNESCO launched the Water Information for Arid Lands: A Global Network (G-WADI) to strengthen the global capacity to manage the water resources of arid and semi-arid areas. Within the frame work of G-WADI, the Centre for Hydrometeorology and Remote Sensing (CHRS) of the University of California in Irvine has been developing several online data access and visualization tools that allow hydrologists to access high resolution precipitation estimates in real- and near real-time that are customized, rather responsively to suit the needs of Member States in terms of the ability to both view and subset the data by country, administrative unit, and multiple scale watersheds easily. CHRS provides access to global satellite estimates of precipitation at high spatial and temporal resolutions that are relevant to the monitoring of precipitation input, especially important in transboundary basins and aquifers in areas where ground observation networks are lacking. The website contains applications and tools for water resource managers that can improve flood forecasting and warning, as well as drought monitoring. A training video demonstrating the functions of the global high resolution precipitation server is available on YouTube.
http://www.gwadi.org/
http://hydis.eng.uci.edu/gwadi/

### *3.3 Review mechanisms*

The overall Climate and Water UIP needs to be administered by a Technical Committee for Water, established as a sub-committee of the UIP Management Committee. This Water UIP committee will be responsible to review progress, report needs and issues, and inform members of changes and opportunities.

In terms of governance, ensuring accountability the Water UIP should:

1. Establish a results-based monitoring and evaluation framework for the Water UIP that connects with water sector outcomes, such as improved relevance and quality of forecasts, effectiveness of warnings, and achievement of better public awareness of climate and water interactions;
2. Develop and apply indicators to measure progress and success of different implementations; these have been developed for the APFM and it is recommended to identify indicators based on actual implementations;
3. Integrate reporting on delivery of the GFCS into the existing governance mechanisms for meteorological agencies, and water management agencies, including the World Meteorological Congress and UN-Water, and equivalent bodies at the regional and national level;
4. Adopt financial reporting and auditing processes that comply with the standard criteria of WMO and/or UN.

Apart from particular targets, any review mechanism needs to focus on the major strengthening of the essential elements of a Global Framework for Climate Services, as recommended at WCC-3, and summarized in Box 3.1.

### *3.4 Communication strategy*

Communication is a vital area of work necessary to maximize the uptake, understanding, and partnerships for water and the available climate services. The Water UIP priority actions for communications should highlight three principal objective actions to support the water and climate partners:

1. To support the water and climate partners to increase participation and demand by communicating: climate risks to water; the availability and benefits of climate services for water policy; operations and services in the water sector;
2. To build, maintain, and facilitate an active community of practice, and network of partners and experts supporting and implementing climate and water work;
3. To facilitate and support dialogue and partnerships between the water sector and climate partners which can build trust and success between disciplines.

# 4 RESOURCE MOBILIZATION

The success of the Water UIP will be a function of the effectiveness of communicating the benefits (see 3.4 above) of such an initiative, and leveraging existing and new resources and partnerships. Mobilizing manpower and material are the foundations needed in order to benefit from a systematic framework for the delivery and uptake of both general and targeted climate information services. At present the arrangements for provision of climate services for water, in many instances, fall far short of meeting the identified needs. There is vast, and as yet largely untapped, potential to improve these arrangements and enhance the quality and utility of climate services for the benefit of many countries and all sectors of society.

At the three levels discussed below, the Framework leadership should facilitate cross-sectorial discussion at the funding source, particularly with Development Banks to make resources holistically available to support and protect water sector functions from climate impact and risks.

## *4.1 National level*

At the national level government agencies, the private sector, foundations, bilateral and multilateral funding mechanisms as well as international agencies form the potential sources of funding. Mobilization needs to be built around national 'flash-points' of climate-water based risk, e.g. floods, droughts, infrastructure damage and loss of life. There are also more generally relevant development goals that are channels for programme support, particularly such foci as water supply and sanitation, disaster preparedness and links to high level initiatives such as the millennium development goals (MDGs). Resources will probably need to be mobilized to develop efficiency in existing activities at national level as a stepping-stone towards enhancing a country's capacities to develop tailored, user-oriented climate services.

The basic rationale of the Climate-Water UIP is to foster interaction between the two sectors. Historically, some NMSs and NHSs have had very little involvement with inter departmental cooperation, and in particular involvement in different sorts of 'outreach', objectives, such as public information, forecasts and warnings, which will be some of the main drivers in the UIP evolution. Mobilization and expansion of staff resources and capabilities and a widening of tasks and services will be significant issues in government services where there are constraints due to rigid staffing establishment structure and organization levels, and centralized pay restrictions on departmental budgets and staff salary structures.

## *4.2 Regional level*

At the regional level, regional development banks, regional organizations, multi-national (transboundary) river basin organizations trade groupings and others form the potential sources of funding.

Some of the national 'flash points' have a particular regional focus, such as aridity in parts of RA I (Africa), and RA II (Asia), problems of small island states in parts of RA V (South-West Pacific), and RA IV (North America, Central America and the Caribbean), and urbanization RA VI (Europe) and RA II (Asia). Groups of countries can be linked by geographic similarities, e.g. the Sahelian group of countries, and treaty-trade associations, e.g. SADC (Southern African Development Community), ASEAN (Association of Southeast Asian Nations), CARICOM (Caribbean Community Secretariat). These bodies may be able to facilitate cooperation or collective development projects between sub-groups of neighbouring states, especially where over-arching goals such as poverty alleviation may be included in the target benefit group.

Other regional, i.e. national groupings with a focus on a major river basin or physiographic area may have similar potential. Some of these organizations are well established and have good, functioning central management, as for example the Mekong River Commission, others, such as the Hindu-Kush-Himalaya Region under ICIMOD (International Centre for Integrated Mountain Development), form more loose associations dealing with water matters. Being established they have considerable experience of funded and internationally supported development activities. Other large and multi-national river basins, although sometimes having treaty based arrangements, such as the Nile Treaty, are non-functioning, because of long running disputes, and will thus be less straightforward to operate cross border and shared activities.

### *4.3 Global level*

At the global level the UN family of organizations, bilateral and multilateral funding mechanisms, international agencies including disaster relief agencies, among others form the potential source of funding.

Apart from specialized UN agencies, many agencies and organizations which operate at the global level, particularly in respect of project planning, financing and implementation, have limited knowledge and understanding of the practicalities of climate and water interfaces. Additional resources will need to be made available, through incorporating specialists in their establishment or accessing expert inputs from outside.

# 5 COSTED SUMMARY OF ACTIVITIES/PROJECTS

The majority of the activities listed in Section 2.5 are ensuring that expertise and knowledge on climate variability and change are integrated into existing water-related communication mechanisms and thus do not need nor warrant the provision of additional or extra resources. However, the three activities under D, pilot projects, would require the provision of new resources.

An expansion of the activities proposed is provided below. Full costing details can be provided on request, but would be an order of magnitude of US$ 200,000 per project.

## *5.1 Project 1 – Water-Climate Sensitivities*

This project would involve the development of a tool (web-based) which identifies those aspects of their water resources management programme that are most at risk to the impacts of climate variability and change. The driver of the hydrological cycle is climate and variability and change in the climate can have widely varying impacts on the different elements of the hydrological cycle, including the amount of rainfall, the level of discharge/flow from rivers, the amount of recharge of aquifers and the volumes held in storage over time. A tool which links changes in climate averages and variability to changes in water resources will identify those areas on which the water manager may wish to place greater emphasis when developing IWRM plans for the future. The tool would require a wide range of climatological and hydrological (including water use) inputs, and could also be used to identify hotspots. Some work has been done in some countries that show for example, that 10 percent reductions in rainfall will lead to 20 percent reductions in river flows with obvious impacts on the refilling of water supplies and also groundwater recharge. The tool will need to cover all aspects of the hydrological cycle including water stored as snow and ice.

Tool development would draw on the approaches taken in a number of existing studies (see reference19) and develop a web-based tool for application at local, national and regional levels. Associated with the tool, a capacity development programme to support its use will be established and regional and national workshops will be held to support the application of the tool. The tool development is expected to cost in the order of US$ 50,000 and initially be supported by five workshops at US$ 30,000 each. Tool development is expected to about 6 months and the workshops will be used to evaluate and fine-tune the tool.

## *5.2 Project 2 – Pilot Project Water Scarce Regions*

Pilot projects will be established in 5 transboundary river basins identified as water scarce regions incorporating a Water User Interface Platform between the hydrological and climatological communities. The pilot projects will provide guidance and assistance in the setting up of a Water UIP at the national and/or regional level and provide technical guidance on practices and procedures that can be adopted. Guidance on stakeholder involvement, seeking, obtaining and using feedback to identify and then improve services and their delivery, awareness raising and the development of national action plans to address the major climate-water interface issues will be addressed. The tool developed in Project 1 would assist in this activity. Depending of the issues of greatest concern to the countries involved, advice and guidance on Integrated Flood Management would be provided through the Associated Programme on Flood Management and similarly, advice on Integrated Drought Management through the IDMP.

As water resources management is already built on a risk management approach, the activities would build on existing initiatives, re-cast to meet the specific needs of the selected transboundary river basins. Funding for this initial activity would come from these initiatives. Additional resources would be necessary for the workshops that would follow in each of the 5 Pilot Projects (5 x US$40,000). The workshops would be held over 2014-2015 time frame and involve a wide range of stakeholders from the climate and water-related sectors.

### *5.3 Project 3 – Pilot Project Basins dependent of snow and glacier melt for water*

Pilot Projects will be established in 5 river basins identified as basins highly dependent on snow or glacier melt for their water resources incorporating a UIF Platform between the hydrological and climatological communities. As with Project 2, the Project will provide guidance and assistance in the setting up of a Water UIP at the national and/or regional level and provide technical guidance on practices and procedures that can be adopted. In this case the major issue in the hydrological cycle of interest will have already been identified and therefore apart from the user interface, the workshops will involve advice and guidance on how to address the impacts of a reduction in reliability of the existing supply options. As indicated above, some measures are already in existence, but based on the issues encountered in each individual country, new approaches to integrated water resources management will be required and incorporated into water management planning. Funding for this initial activity would come from these initiatives. Additional resources would be necessary for the workshops that would follow in each of the 5 Pilot Projects (5 x US$ 40,000). The workshops would be held over 2014-2015 time frame and involve a wide range of stakeholders from the climate and water-related sectors.

### *5.4 Project 4 – Coastal Inundation Forecasting Demonstration Projects*

Coastal inundations are an increasing threat to the lives and livelihoods of people, living in low-lying, highly-populated coastal areas. According to the World Bank Report 2005, at least 2.6 million people have drowned in coastal inundations, particularly caused by storm surges, over the last 200 years. The aims of the Coastal Inundation Forecasting Demonstration Projects (CIFDP) are to meet challenges of coastal communities' safety and to support sustainable development through enhancing coastal inundation forecasting and warning systems at the local and regional scale. Upon completion of national sub-projects of CIFDP, countries will implement an operational system for integrated coastal inundation forecasting and warning, providing an objective basis for coastal disaster (flooding) management; contributing to saving lives, reducing loss of livelihood and property, and enhancing resilience and sustainability in coastal communities. Resources would be required for the 2 additional Pilot Projects (2 x US$ 200,000). The projects would be implemented over 2014-2015 time frame and involve a wide range of stakeholders from the climate and water-related sectors, including costal zone stakeholders.

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**ANNEX I**

## CLIMATOLOGICAL DATA REQUIRED FOR WATER RESOURCES MANAGEMENT

| **Purpose** | **Features** | **Required Data** |
|---|---|---|
| Hydrological characterization | Catchment/Watershed planning<br>General water balance | Precipitation<br>Temperature<br>Humidity<br>Wind speed |
| Flood management and control | Structures (dams, river training) | Precipitation<br>Temperature<br>Humidity<br>Wind speed and direction |
| | Flood plain zoning/Flood frequency estimation | Precipitation<br>Evapotranspiration |
| Irrigation and drainage | Supply<br>Demand scheduling | Precipitation<br>Temperature<br>Humidity<br>Wind speed<br>Medium-/long-range forecasts |
| Groundwater | Recharge<br>Groundwater flooding | Precipitation<br>Temperature<br>Humidity<br>Wind speed<br>Medium-/long-range forecasts |
| Navigation | Canal systems<br>Dredging | Precipitation<br>Medium-/long-range forecasts |
| Power generation | Hydropower<br>Cooling water | Precipitation<br>Temperature<br>Humidity<br>Wind speed<br>Medium-/long-range forecasts |
| Water supply | Potable water<br>Industrial processing | Precipitation<br>Temperature<br>Humidity<br>Wind speed<br>Medium-/long-range forecasts |
| Water quality | Pollution control<br>Dilution<br>Salinity and sedimentation | Precipitation<br>Temperature<br>Humidity<br>Wind speed<br>Forecasts and alerts |
| Fisheries and conservation | Hydro-ecology<br>Hydromorphology | Precipitation<br>Temperature<br>Humidity<br>Wind speed<br>Medium-/long-range forecasts |
| Amenity | Public access<br>Recreation | Precipitation<br>Temperature<br>Wind speed<br>Synoptic information<br>Forecasts and alerts |

**ANNEX II**

# RELATED IWRM PROGRAMMES IN THE PROCESS OF IMPLEMENTATION

## Associated Programme on Flood Management (APFM)

The APFM has been jointly developed by the Global Water Partnership and the World Meteorological Organization since 2001. Its mission is to assist countries in the development of Integrated Flood Management policies and strategies within the overall context of national development policy.

The possible advantages in employing the APFM for delivering essential elements of the UIP Water are the following:

- The APFM is closely linked to **development planning** with regard to water: contrary to climate-centric approaches which may have their overall objectives in risk minimization, the underlying concept of the APFM aims at maximizing the net-benefits derived from flood plains (livelihood perspective), while minimizing the losses of life from flooding;
- The Programme continues to be implemented through **joint activities** with a wide range of UN bodies, intergovernmental organizations, as well as governmental and non-governmental actors;
- **Activities** of the Programme have entailed several peer-reviewed publications as part of the Flood Management Policy Series, case studies, a Flood Management Tools series, a capacity development programme, as well as pilot and field demonstration projects. The Tools series included many publications and capacity development materials, which are directly relevant in a climate change adaptation context;
- In 2009 a **HelpDesk** was added to the Programme that allows Governments to issue calls for assistance in the field of flood management policy and strategy. The HelpDesk has been the central element of ensuring the demand-driven development of the Programme;
- The HelpDesk is strongly decentralized through the establishment and continuous development of a **Support Base**. This support base has been necessary with a view to have readily at hand a global technical advisory capacity to assist countries in specific thematic areas of flood management (such as flood loss assessment, flood mapping, flood forecasting and warning, flood management policy design, environmental impact assessment), or a specific regional response capacity;
- The APFM continues to be implemented through voluntary contributions from a number of actors: **resources** to the Programme over the past ten years have been provided by WMO (hosting and leading the technical support unit of the APFM), the Global Water Partnership, and the Governments of Japan, Switzerland, the United States of America, the Netherlands, Italy and Germany;
- The **governance** of the Programme is based on two Committees: an advisory and a management committee meeting annually.

## Integrated Drought Management Programme (IDMP)

The successful implementation of the APFM has led the different agencies involved in its creation to plan for a new programme with a focus on drought policy: the Integrated Drought Management Programme (IDMP) with an initial start-up in the 2012/2013 timeframe. Drought management is an even more complex undertaking on largely different timescales than floods and with strong linkages to the agricultural *and* water sector. The IDMP will promote an approach that moves drought management practices from reactive, representing crisis management, to more proactive drought management based on risk management principles. It will provide global coordination for efforts towards integration of science, policy and implementation by strengthening drought monitoring, drought risk assessment, development of drought prediction; drought early warning services and sharing best practices at the local, national and regional levels.

The IDMP will:

1. Provide support for regional coordination of drought monitoring, prediction and early warning activities, serving as an interface between the climate service providers and various stakeholders involved in drought management;
2. Enable collection and dissemination of information and knowledge on good practices in drought mitigation, preparedness and response;
3. Produce guidelines, methodologies, tools and supporting documentation for policy development and management practices and procedures;
4. Support the inception of pilot projects and coordination of regional projects to showcase best practices through scientific inputs into policy, planning for drought risk reduction and drought management;
5. Support regional and national efforts in drought risk awareness and management;
6. Enable capacity development and advice on Integrated Drought Management.

**Science Policy Interface Platform (SPI-Platform)**

To globally face the water management challenges, there is a need to develop evidence-based policy with accurate up-taking of figures related to global changes. Water managers could then benefit from it to develop climate change adaptation strategies based on up-to-date scientific knowledge fulfilling their needs for information. Enhanced knowledge sharing and better communication between stakeholders, namely "policy makers/water managers" and "scientists", is required to improve the use of existing knowledge, in particular information associated with climate change impacts. The complementary aspect is to support water managers to express their needs for information useful to develop appropriate adaptation strategies.

The SPI-platform will liaise with the water and climate coalition (which focuses on how to shape global policy to better address the needs of the water and climate communities and on identification of priorities for the international water agenda, and communication of them to decision-makers), the Alliance for global water adaptation (AGWA - which focuses on how to implement climate adaptation practices), and the Nairobi work programme (NWP- undertaken under the Subsidiary Body for Scientific and Technological Advice - SBSTA).

Moreover, education tools and awareness raising campaigns to mainstream new knowledge and new water management technologies and practices are needed.

Facilitating the delivery of research and knowledge sharing is particularly challenging given water specificities: the water sector is broad, fragmented and diverse. It is composed of a plurality of stakeholders with different interests at various levels from public institutions and utilities, industries, consultants and service providers, NGO's and trade associations, universities, research entities and not least, the civil society.

In the field of water resources, two United Nations conventions are of relevance concerning international watercourses. The UNECE "Convention on the Protection and Use of Transboundary Watercourses and International Lakes" (Helsinki, March 1992), initially a regional instrument, was turned into a global legal framework for transboundary water cooperation in February 2013, allowing accession by all the UN Member States.

The "1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses" (May 1997) was until February 2013 the only treaty of universal applicability governing shared freshwater resources. Over the last years, work on the water sector has been initiated at the scientific body (SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC), evidencing the interest of governments in interlinkages between climate change and water.

This SPI-platform will:

- Provide relevant scientific inputs to help water resources managers consider the uncertainty related to climate change projections within the context of water resources decision-making;
- Support development of education and capacity development programmes to enhance understanding and to integrate the water resources community in the climate change debate;
- Raise awareness among policymakers in order to enhance capacities to assess, monitor and communicate the impacts of and responses to climate change on water resources at local, national and regional levels;
- Facilitate dialogue with scientists, researchers and water managers and create awareness among policy makers in order to benefit from UN processes such as UNCCD, UNCBD and UNFCCC;
- Help prioritize the scientific research agenda for the development of adaptation policies and allow water managers at different levels to specify their needs in terms of (new) knowledge on water and climate change towards scientists at an appropriate timing.

## INTERNATIONAL AGENCIES, PROGRAMMES AND COORDINATION MECHANISMS INVOLVED IN WATER

*UN-Water*, formally established in 2003 by the United Nations High Level Committee on Programmes, has evolved out of a history of close collaboration among UN agencies. It was created to add value to UN initiatives by fostering greater cooperation and information-sharing among existing UN agencies and outside partners. UN-Water strengthens coordination and coherence among UN entities dealing with issues related to all aspects of freshwater and sanitation, including surface and groundwater resources, the interface between freshwater and seawater and water-related disasters. UN-Water has 26 members from the UN system and external partners representing various organizations and civil society.

The Pilot Program for Climate Resilience (PPCR), approved in November 2008, was the first programme developed and operational under the Strategic Climate Fund (SCF), which is one of two funds within the design of the Climate Investment Funds (CIF). The PPCR aims to pilot and demonstrate ways in which climate risk and resilience may be integrated into core development planning and implementation. In this way, the PPCR provides incentives for scaled-up action and initiates transformational change. The pilot programmes and projects implemented under the PPCR are country-led, build on National Adaptation Programmes of Action (NAPA) and other relevant country studies and strategies. They are strategically aligned with other donor funded activities to provide financing for projects that will produce experience and knowledge useful to designing scaled-up adaptation measures.

Through connecting directly with UN-Water, the Framework UIP will have direct access to the key UN and other programmes, specialized agencies, regional commissions, United Nations conventions and other entities within the UN system dealing with water issues. The Framework UIP will thus become the manner in which the dialogue between the climate community and water community at the international level is coordinated. At the level of the UN Secretary-General, the High-Level Expert Panel on Water and Disaster recommended that "National and international hydrological institutes must take the initiative to identify underlying analytical and data requirements to meet climate changes that are likely to be highly uncertain and so as to support structural and non-structural measures for disaster risk reduction" (see reference 17). Collaborative action will be required among others between UIP Water and a range of UNESCO Category II centers, for instance the International Centre for Water Hazard and Risk Management (ICHARM) and the International Centre for Integrated Water Resources Management (ICIWaRM).

*World Meteorological Organization*. The WMO has a number of programmes and initiatives that target the interface between climate and weather. Through its Hydrology and Water Resources Programme, the World Meteorological Organization promotes water-resources assessment and provides the forecasts needed to plan water storage, agricultural activities and urban development. It supports an integrated multidisciplinary approach to water-resources management. WMO's Commission for Hydrology will provide the Water UIP with direct access to the National Hydrological Services of its members. Following the World Climate Conference–3, held in Geneva from 31 August to 4 September 2009, the Commission for Hydrology (CHy) formulated a progamme to "Prepare guidance material on the climate information requirements of water resources managers for operations, long-term planning and design".

There are numerous initiatives, plans and strategies in place, largely driven by the recognition of the need for high quality data and information. Some of these are broad based, dealing with global initiatives such as the Global Observation System (see reference 1), while others are highly focussed, at the national level or on specific topics in the water sector (see reference 4). The Group on Earth

Observations (GEO) has specifically examined the role of monitoring for benefit to society in the water sector (see reference 6), or Water Societal Benefit Area (SBA). The Water SBA Task of the GEO Work Plan considers all types of earth observations, including ground, in situ, airborne, and space-based observations. The investigation includes direct measurements and derived parameters, as well as model products. Focal areas of Water Task activities include: integrated water-cycle products and services; information systems for hydrometeorological extremes; information service for cold regions; global water quality products and services; and information system development and capacity building. In addition, recent achievements under the GEOSS Architecture and Implementation Pilot (AIP) has laid the foundation for a GEOSS Water Services online, featuring a global registry of water data, map and modelling services catalogued using the standards and procedures of the Open Geospatial Consortium and the WMO. The GEO Integrated Global Water Cycle Observations (IGWCO) community of practice brings together water cycle data providers, processors, researchers and end-users, and is a principal driving force behind activities of the Water Task. One of the main objectives of the GEO programme is to coordinate the acquisition and dissemination of earth observations, and identify needs from all geographic regions, with significant representation from developing countries; and participating organizations can use the results in determining priority investment opportunities for earth observations. GEO is also tasked with creation of GEOSS, the means by which earth observation data and information are made discoverable and accessible.

The activities of the *WMO-UNESCO Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)* are aimed at enhancing the provision of marine meteorological and oceanographic services in support of the safety of life and property at sea and in coastal areas: contribute to sustain healthy and productive oceans, sustainable development of the marine environment, coastal area management and recreational activities, and in support of the safety of coastal habitation and activities and managing the evolution of the services through the selective incorporation of advances in meteorological and oceanographic science and technology.

*The International Hydrological Programme (IHP)* is the United Nations Educational, Scientific and Cultural Organization's (UNESCO) international scientific cooperative programme on water. It was created in 1975 and is focused on the scientific and educational aspects of hydrology. IHP is governed by an Intergovernmental Council, which constitutes a subsidiary body of UNESCO's General Conference. IHP is implemented in six-year phases and, from 2014 onwards, in eight-year phases, to stimulate and encourage hydrological research, and to assist Member States in their research and training activities in the filed of hydrology. This is achieved through a comprehensive consultative process with its 168 IHP National Committees, international scientific associations and other UN bodies, ensuring IHP's continuous relevance and its overall institutional coordination.

The *Intergovernmental Oceanographic Commission (IOC)* helps nations prepare for marine hazards by aiding in the establishment of warning systems, such as the Tsunami Warning Systems. Through its Global Climate Change Programmes it helps monitor the ocean response to climate change and help coastal nations adapt. The IOC marine science programmes investigate issues of ocean ecology and ecosystem health, such as the Harmful Algal Blooms and endangered coral reefs. Environmental Management IOC supports a variety of marine ecosystem-based management and marine information programmes, for use by all nations, for development and equitable, sustainable use of the ocean.

In the face of increasing water scarcity, and the dominance of agricultural water use, the *Food and Agricultural Organization (FAO)* is in the forefront to enhance global agricultural performance while promoting the sustainability of water use for food production. By 2025, 1,800 million people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be under stress conditions. The situation will be exacerbated as rapidly growing urban areas place heavy pressure on neighbouring water resources.

*The United Nations University (UNU) Institute for Water, Environment & Health (UNU-INWEH)* is the United Nations Think Tank on Water, created to strengthen water management capacity, particularly of developing countries, and to provide on-the-ground project support. With the launch of the UN "Water Virtual Learning Centre," UNU-INWEH, together with UN DESA, now offers an adult distance-education programme on integrated water resources management (IWRM). The networks of the UNU, *the International Association of Hydrological Sciences (IAHS), International Association for Hydro-Environment Engineering (IAHR), UNESCO IHP and UNESCO IHE* will be used to connect with the academic and educational elements of the water sector. The International Association of Hydrological Sciences (IAHS) promotes the study of all aspects of hydrology through discussion, comparison, and publication of research results and through the initiation of research that requires international cooperation*. The International Association for Hydro-Environment Engineering and Research (IAHR)* is a worldwide independent organization of engineers and water specialists working in fields related to the hydro-environmental sciences and their practical application.

*The Global Water Partnership (GWP)* was founded by the World Bank, the United Nations Development Programme (UNDP), the World Meteorological Organization (WMO) and the Swedish International Development Cooperation Agency (SIDA), to foster IWRM. In 2002 it was established as an intergovernmental organization through the sponsorship of a number of national governments. The GWP's vision is for a water secure world. Its mission is to support the sustainable development and management of water resources at all levels. The Water UIP can make extensive use of the regional and national networks established through the Global Water Partnership in order to further its outreach to key stakeholders worldwide. *The Water, Climate and Development Programme for Africa*, established jointly by GWP together with the *African Ministerial Council on Water*, will be a key vehicle for developing the water UIP in Africa.

*The Global Ocean Forum (GOF)*, first mobilized in 2001 to help governments place issues related to oceans, coasts, and small island developing States (SIDS) on the World Summit on Sustainable Development agenda, brings together ocean leaders from all sectors from 112 countries to advance the global ocean agenda. The Global Ocean Forum promotes the implementation of international agreements related to oceans, coasts, and SIDS by assessing progress made, and identifying obstacles and opportunities for achieving sustainable development.

*The International Network of Basin Organizations* was established by organizations whose common goal was to implement integrated basin water resource management. As water resources are in the main managed and operated on a river basin or groundwater aquifer scale, the involvement of the river basin organizations in the Water UIP will enable the requirements of these organizations to be more clearly presented.

*UNDP/Cap-Net: Capacity Building for Integrated Water Resources Management* is an international network for capacity development in sustainable water management. It is made up of a partnership of autonomous international, regional and national institutions and networks committed to capacity development in the water sector. Cap-Net is conducting, among others, training on climate change adaptation in the water sector. Since 2008 training materials have been issued and regional Training of Trainers Courses have been conducted in collaboration with UNESCO-IHE and the WMO/GWP Associated Programme on Flood Management.

*The World Water Council* was established in response to increasing concern from the global community about world water issues. It is an international intergovernmental and NGO network dealing with water policy topics and issues at a high level, including transboundary issues.

*The International Commission on Irrigation and Drainage (ICID)* is a Scientific, Technical and Voluntary Not-for-profit Non-Governmental International Organization (NGO). The Commission is dedicated to enhancing the worldwide supply of food and fibre for all people by improving water and land management and the productivity of irrigated and drained lands through appropriate management of water, environment and application of irrigation, drainage and flood management techniques.

*AquaFed* is an association set up to connect international organizations with private sector providers of water and sanitation services. It does this on the international scene, representing the operators through direct membership or through their national associations. Aquafed has observer status within UN-Water.

The *International Water Association* (IWA) also has observer status as a Partner of UN-Water. The IWA is a global reference point for water professionals, providing links between research and practice covering all facets of the water cycle. Through its network of members and experts in research, practice, regulation, industry, consulting and manufacturing, IWA is able to help water professionals create innovative, pragmatic and sustainable solutions to the challenge of global needs. Members of IWA are leaders in their field and represent:

- Researchers;
- Utilities;
- Consultants;
- Industry;
- Regulators;
- Equipment manufacturers.

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