PART II


(unedited)
INFORMATION
FOR DELEGATIONS

Extraordinary Session of the World
Meteorological Congress
Geneva, 29-31 October 2012

World Meteorological Organization
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INFORMATION FOR DELEGATIONS

A. THE WORLD METEOROLOGICAL ORGANIZATION

1. Historical summary

International cooperation in the field of meteorology may be said to have begun in 1853, when an international conference on maritime meteorology was held in Brussels. Further conferences followed and in 1873 the first International Meteorological Congress was held in Vienna. This led to the formal establishment of the International Meteorological Organization (IMO).

Under IMO, procedures for ensuring international cooperation and collaboration in meteorology were successfully developed and put into operation and IMO continued to play a central role in supporting international meteorological initiatives. On 23 March 1950, the World Meteorological Organization (WMO) was formally established and in April 1951, the functions and responsibilities of IMO were handed over to the newly created World Meteorological Organization; IMO then ceased to exist. This change in title was accompanied by a change in status: WMO was designated as an intergovernmental organization and a specialized agency of the United Nations (December 1951), whereas IMO had been a non-governmental organization.

The first World Meteorological Congress was held in 1951 in Paris, immediately following the last meeting of IMO. Subsequent sessions of Congress were held in Geneva in every four years, starting in 1955. In accordance with the established timetable, the Extraordinary Session of the World Meteorological Congress is taking place in Geneva from 29 to 31 October 2012.

2. Structure of the Organization

The World Meteorological Congress brings together representatives of all Members (States and Territories) at least once every four years. As the supreme body of the World Meteorological Organization, it determines the Organization’s general policies, programmes and budget.

The Executive Council, as the executive body of the Organization, is entrusted with implementation of the decisions taken by the Members of the Organization. It meets at least once every year and prepares studies and recommendations on all questions of international interest in meteorology and operational hydrology. It provides Members of WMO with technical information and advice and assists them within the Organization’s terms of reference. It is composed of 37 directors of National Meteorological or Hydrometeorological Services. In the performance of their duties, the Executive Council members act as representatives of the Organization and not as representatives of their respective countries. The present composition of the Executive Council is as follows (as of 25 September 2012):

- **President:** David GRIMES (Canada)
- **First Vice-President:** Antonio Divino MOURA (Brazil)
- **Second Vice-President:** Mieczslaw S. OSTOJSKI (Poland)
- **Third Vice-President:** Abdalah MOKSSIT (Morocco)

Ex-officio members of the Executive Council (presidents of regional associations)
- **Africa (Region I):** Mamadou L. BAH (Guinea)
- **Asia (Region II):** Victor CHUB (Uzbekistan)
South America (Region III): Julian BAEZ BENITEZ (Paraguay)
North America, Central America and the Caribbean (Region IV): Arthur W. ROLLE (Bahamas)
South-West Pacific (Region V): Sri Woro B. HARIJONO (Ms) (Indonesia)
Europe (Region VI): Ivan ČAČIĆ (Croatia)

Elected Members of the Executive Council (1 vacant seat):
Gerhard ADRIAN (Germany)
Anthony C. ANUFOROM (Nigeria)
Daniel CANO VILLAVERDE (Spain) (acting)
Seok-Joon CHO (Republic of Korea)
Héctor Horacio CIAPPESONI (Argentina)
Luigi DE LEONIBUS (Italy) (Acting)
Juan Carlos FALLAS SOJO (Costa Rica)
Alexander FROLOV (Russian Federation) (acting)
Mitsuhiko HATORI (Japan)
John L. HAYES (United States of America)
John HIRST (United Kingdom of Great Britain and Northern Ireland)
François JACQ (France)
Agnes L. KIJAZI (Ms) (United Republic of Tanzania) (acting)
Camille LOUMOUAMOU (Republic of the Congo)
Linda MAKULENI (Ms) (South Africa)
Saad Mohamad S. MOHALFI (Saudi Arabia)
Joseph Romanus MUKABANA (Kenya)
Carlos NARANJO JACOME (Ecuador)
Jacob NKOMOKI (Zambia)
Tyrone SUTHERLAND (British Caribbean Territories)
Petteri TAALAS (Finland)
Abdoul-karim TRAORE (Niger) (acting)
Ajit TYAGI (India)
Robert VERTESSY (Australia) (acting)
Alipate WAQAICELUA (Fiji)
ZHENG Guoguang (China)

There are six regional associations (for Africa; Asia; South America; North America, Central America and the Caribbean; South-West Pacific; and Europe) composed of Member States and Territories. They examine, from a regional point of view, all questions referred to them by the Executive Council and coordinate meteorological and hydrological activities within those Regions. On matters of regional interest, they are able to submit recommendations to Congress and the Executive Council.

The technical commissions, composed of experts designated by Members, are established by Congress to review matters related to the scientific and technical activities of the Organization. They develop technical recommendations, which are subsequently submitted to the Executive Council and Congress for approval. There are at present eight commissions, namely:

Commission for Basic Systems (CBS); (F. Branski - president)
Commission for Instruments and Methods of Observation (CIMO); (B. Calpini - president)
Commission for Atmospheric Sciences (CAS); (M. Bélond – president)
Commission for Aeronautical Meteorology (CAeM); (C.M. Shun – president)
Commission for Agricultural Meteorology (CAgM); (Lee B.-L. - president)
Commission for Hydrology (CHy); (J. Wellens-Mensah – acting president)
Commission for Climatology (CCl); (T. Peterson - president)
WMO/IOC Joint Technical Commission on Oceanography and Marine Meteorology (JCOMM); (J. Stander, N. Pinardi – co-presidents).

The Secretariat, located in Geneva, Switzerland, completes the structure of WMO. Its international staff, under the direction of the Secretary-General, Mr M. Jarraud, carries out the technical and administrative work of the Organization. It undertakes technical studies, prepares specialized international publications, acts as secretariat during the meetings of various WMO bodies and generally serves as a link among Meteorological/Hydrometeorological Services of the world. Another of its tasks is to inform the general public and States that are not Members of the Organization of the activities of WMO and the decisions adopted by its constituent bodies.

B. THE EXTRAORDINARY SESSION OF THE WORLD METEOROLOGICAL CONGRESS, Cg-Ext.(2012)

1. Convening
In accordance with a decision taken by the World Meteorological Congress at its sixteenth session (Geneva, May-June 2011), the Extraordinary Session of the World Meteorological Congress has been convened to meet in the International Conference Centre – Geneva (CICG) (17, rue de Varembé, Geneva) from Monday, 29 October, to Wednesday, 31 October 2012.

2. Composition
In accordance with Article 7 of the WMO Convention, the Congress, as the supreme body of the Organization, is composed of delegates representing Members; each Member designates one of its delegates, who should be the Director of the Meteorological or Hydrometeorological Service, as its principal delegate. The other participants are as follows:

(a) Observers from non-Member States and Territories maintaining their own Meteorological or Hydrometeorological Service, as invited by decision of the Members;
(b) Presidents of technical commissions of the Organization invited in accordance with Article 19 of the Convention;
(c) Representatives of the United Nations and its specialized agencies, and other intergovernmental organizations, invited by virtue of existing agreements, working arrangements or other provisions for reciprocal representation;
(d) Representatives of non-governmental international organizations to which consultative status with WMO has been granted by the Executive Council;
(e) Representatives of other non-governmental international organizations invited in accordance with the provisions of General Regulation 19;
(f) Individual experts invited in a personal capacity in accordance with Article 7 of the Convention and General Regulation 19.
3. **Structure**

The President and the three Vice-Presidents of the Organization are the President and Vice-Presidents of the World Meteorological Congress by virtue of Article 4 of the Convention.

The following committees may be established by Congress in accordance with the provisions of General Regulations 23 and 25 to 32:

(a) A Credentials Committee, normally established immediately after the completion of the opening formalities and for the duration of the session, to examine the credentials of delegates and observers and report thereon;

(b) A Coordination Committee to be responsible for coordinating the activities of the session. It consists of the President, the three Vice-Presidents, the Secretary-General and the chairs of working committees;

(c) Drafting committees, or working committees, as Congress may deem necessary for certain draft decisions for their subsequent submission to, and final approval by, the plenary meetings.

With the exception of the Coordination Committee, whose chair is normally the President of WMO, each Committee shall elect its own chair and, whenever necessary, other officers.

4. **Credentials of delegations**

General Regulation 21 provides that:

*Prior to a session of a constituent body other than the Executive Council, each Member should, if possible, communicate to the Secretary-General the names of the persons composing its delegation to that body, indicating which of these shall be regarded as its principal delegate and, if necessary, alternate principal delegate (with indication of dates).*

*Besides this communication, a letter giving these particulars and otherwise conforming with the provisions of the Convention and of these Regulations and signed by, or on behalf of, an appropriate governmental authority of the Member shall be sent to the Secretary-General and shall be regarded as appropriate credentials for the participation of the individuals named therein in all activities of the constituent body.*

*The same procedure shall apply as regards the credentials of observers representing non-Member countries.*

*The credentials of observers representing international organizations shall be signed by the competent authority of the organization concerned.*

All credentials that have not been sent to the Secretary-General should immediately, on arrival, be deposited by delegations with the officer-in-charge of credentials at the Conference Registration, Information and Documentation Desk. All delegates and observers will have to be registered either in advance online or upon arrival at this desk and will receive their badges, which will constitute the pass for admission to the meetings. These passes are personal and non-transferable. The issuing of a pass does not prejudice the decision of Congress as to the credentials of the person concerned.

5. **Admittance to meetings – entry passes**

(a) Delegations

Only holders of passes issued by the Conference Registration, Information and Documentation Desk will be admitted to meetings. All passes are strictly personal and
non-transferable.

All participants will receive their passes upon arrival; they are expected to carry them at all times and to present them at the request of Security or Conference Services staff.

Participants may obtain passes for members of their families. Applications should be submitted in writing to the Conference Registration, Information and Documentation Desk.

Members of Permanent Missions holding UN passes shall be admitted.

(b) Press

Press and radio correspondents, photographers and camera operators should first contact the Communications and Public Affairs Desk before proceeding to the Conference Registration, Information and Documentation Desk, where the passes will be issued for them.

(c) Public

The public may obtain passes for public meetings by applying to the Conference Registration, Information and Documentation Desk. These cards will be issued according to the space available. They are provided exclusively for admission to the public gallery and should be presented at any time at the request of Security or Conference Services staff. Plenary meetings and working committee meetings will be public; any meetings of other committees and subcommittees will normally be private.

6. List of participants

A provisional list of delegates and observers will be distributed shortly after the beginning of the session. This list will be revised and redistributed upon final registration of all participants.

Delegations are requested to notify the Conference Registration, Information and Documentation Desk of any changes in the composition of the delegation during the session.

7. Opening of the session

The formal opening of the Cg-Ext.(2012) will take place at 09:30 a.m. on 29 October 2012 at the International Conference Centre – Geneva (17, rue de Varembé).

8. Agenda

The annotated agenda for Cg-Ext.(2012) is given in Cg-Ext.(2012)/AGENDA. It will be submitted for approval by Congress as soon as possible after the opening of the session.

9. Time and place of meetings

A daily timetable of meetings will be provided in the Congress workplan (Cg-Ext.(2012) Website) and published in the Congress Journal, which will be issued online in English and French. It will also be made available in a limited number of paper copies to delegates and observers early each morning. The timetable will be displayed on notice boards in the lobby as well.

Plenary meetings of Congress will be held in Salle I. As decided by the Executive Council at its sixty-fourth session, delegations will sit in alphabetical order based on the names of the Members of the Organization as spelled in French, starting from the front of the hall and beginning with Canada. A plan showing the places of delegations and observers will be posted at the entrance. Seating arrangements will be made in accordance with information received by the Secretariat prior to the session.
Smaller conference rooms will be available for meetings of the Credentials Committee, the Coordination Committee, drafting or working committees and side events. The daily allocation of schedule of these meetings and rooms will be announced in the Congress Journal and on the electronic notice board in the entrance hall.

10. Documents

The documents for Extraordinary Session of the World Meteorological Congress will be in six categories, namely:

(a) Main documents for decision, bearing the prefix Cg-Ext.(2012)/Doc., item number (document number) and Status “Draft 1”;
(b) Subsequent draft decisions will show the Status as “Draft 2”, (...3 etc). These documents could be approved by Plenary if no further amendments are required;
(c) If required, the informal Drafts, prepared by Working Committees on issues under discussion (English only) will be posted on the Website under the “Work in progress” tab, e.g., Cg-Ext.(2012)/WP 4.2_draft 2.3.4;
(d) Information papers, bearing the prefix Cg-Ext.(2012)/INF.;
(e) Minutes of the plenary meetings, prefixed Cg-Ext.(2012)/MIN.;
(f) FINAL draft decision documents, prefixed by Cg-Ext.(2012)/Doc. item number (document number), will show a status of FINAL DRAFT, submitted to plenary meetings for approval.

In accordance with General Regulation 119 and the decisions of the Executive Council, Congress documents in categories (a), (b) and (f) above will be issued in Arabic, Chinese, English, French, Russian and Spanish. Documents in categories (d) and (e) will be issued in English and French only.

11. Documents submitted by delegations

Documents and written inputs submitted by a delegation should be in one of the six official and working languages of the Organization and must be submitted in the name of the Member(s) concerned and not in the name of an individual. Documents will be channelled through the Assistant Secretary-General.

The attention of delegations is drawn to General Regulation 140 which states that “except by decision of Congress, a new item of business shall not be definitely settled unless it has been included in an order of business and distributed with pertinent documentation at least 18 hours before”.

12. Distribution of documents

The distribution of all Congress documents to participants at the session will be carried out according to the following plan:

(a) All documents will be systematically posted on the WMO Cg-Ext.(2012) Website https://sites.google.com/a/wmo.int/cg-ext-2012/;
(b) From Monday to Wednesday noon, all documents issued will be available online in the “Documents” folder of the Cg-Ext.(2012) Website.

The CICG is equipped with Wi-Fi, allowing delegates to electronically access documents.
13. Interpretation

In accordance with General Regulation 119, the official and working languages of the Organization are Arabic, Chinese, English, French, Russian and Spanish. Simultaneous interpretation into these languages will be provided. In addition, Portuguese interpretation will be provided. Interpretation will also be provided to selected meetings of Congress committees within available resources.

14. Records of meetings

In accordance with General Regulation 112, the Secretariat should prepare summarized minutes for each plenary meeting of Congress, unless this Regulation is suspended. The minutes will be distributed as soon as possible to all delegates and persons taking part in the meeting, who may submit any proposed corrections to the Secretariat. These corrections should be handed to the Conference Registration, Information and Documentation Desk. The minutes will subsequently be submitted to a plenary meeting for approval, or approved by correspondence.

If required, written minutes of plenary meetings will be prepared on the basis of notes taken by the minute-writers attending the meeting. Alternatively, the audio recordings of plenary sessions will constitute the verbatim records.

Delegates are requested to hand over to the Secretariat representative texts of other statements or proposed amendments to the texts in the Draft Decisions or FINALS, once these have been agreed by the session. These texts could also be sent to the e-mail of the working body: plenary@wmo.int.

No records will be taken of meetings of the drafting committees or the working committees.

15. Statements

Delegates who wish to read a statement should supply in advance eight copies for the interpreters. These copies should be handed to the Conference Registration, Information and Documentation Desk together with an electronic version to be sent to cnf@wmo.int. Statements will only be posted on the WMO Congress portal Website after they have been presented.

16. Report of the session

The provisional edition of the abridged report of Extraordinary Session of the World Meteorological Congress will be made up of all texts included in the appendices to the FINAL documents, i.e. both general summary and resolutions approved by Congress. It will also include the list of participants.

17. Congress Journal

The Secretariat will issue and distribute to participants the Congress Journal. The Journal will be published in English and French. It will be issued daily and will be available in a limited number of copies at the Conference Registration, Information and Documentation Desk and online on the WMO Cg-Ext.(2012) Website. The contents of each issue of the Journal will normally be as follows:

(a) The time, place and programme of meetings on the day of publication, together with the order of business for each meeting;
(b) A list of documents issued and approved since the distribution of the previous issue of the Journal;
(c) Announcements of general interest made by the officers of Congress, delegations and the Secretariat.

The Congress Journal is to be issued for information purposes only, and will not have the status of an official Congress document.

Material for inclusion in the Congress Journal on a particular day should be handed to the Conference Registration, Information and Documentation Desk before 6 p.m. on the previous day. Material that is in a language other than English or French cannot be included in the Journal. All inquiries concerning the Journal should be addressed to the Conference Registration, Information and Documentation Desk.

18. Press and public information
Within the limits of available space and upon presentation of entry passes, accredited representatives of the media will be admitted to all plenary meetings unless Congress decides otherwise. Committee meetings are not public. Documents of the session will be available for download at the WMO Cg-Ext.(2012) Website.

Press releases containing summaries of the main decisions of Congress will be issued.

All inquiries concerning public information, including requests for interviews, should be referred to the Communications and Public Affairs Desk (cpa@wmo.int).

19. Information material from delegates
There will be a dedicated area (table) for the placement of information/reports/booklets, etc., from delegations. There will be no pigeon-hole distribution by the Secretariat.

20. GFCS User Conference: “A Dialogue for Climate Services Users and Providers: Towards Implementation of the GFCS”
The WMO and partner agencies will convene a two-day Dialogue between the users and providers of climate information and services in conjunction with the forthcoming Extraordinary World Meteorological Congress. The purpose of the Dialogue is to establish a solid foundation for the intergovernmental deliberations on the implementation of the GFCS. Noting that the User Interface Platform (UIP) remains the “pillar” of the GFCS that is least well defined, the Dialogue will give particular attention to defining and characterizing how the UIP will be implemented so as to continuously add value to the GFCS.

The Dialogue will be conducted entirely in “plenary mode”. However, poster sessions and side events will be encouraged during the lunch breaks and in the evening.

Information on the Climate Dialogue is posted on the Website https://sites.google.com/a/wmo.int/cg-ext-2012. Participants are requested to register through the form available on the Website.

Side events, posters and exhibitions:
There is an opportunity for holding side events during the Dialogue, during both the Friday and Saturday lunchtimes and on the Friday evening. The posters and exhibitions will be put in place for the Dialogue and remain in place throughout the Extraordinary World Meteorological Congress.
21. Secretariat of the Congress
The main Secretariat offices and telephone numbers in the CICG will be available under “Information Papers”, on the Cg-Ext.(2012) Website

The Secretariat of the World Meteorological Organization (7 bis, avenue de la Paix, tel. +41 (0)22 730 81 11, wmo@wmo.int) will be open to visitors every weekday.

22. Delegates’ mail – lost property
The Conference Registration, Information and Documentation Desk will collect and deliver mail addressed to participants. The same desk will also deal with lost property.

C. FACILITIES AVAILABLE IN THE INTERNATIONAL CONFERENCE CENTRE – GENEVA

1. International Conference Centre – Geneva (CICG)
The Conference Centre is located near the Place des Nations. A plan showing the location of CICG, the WMO Headquarters building and other international organizations can be found at http://www.cicg.ch/en/. The conference rooms are situated in the centre of the Conference Centre. The way to the various rooms will be indicated by signboards. Conference Services staff will be available to assist delegates. Personal computers with Internet connections will be at the disposal of participants in the Conference Centre. The Conference Centre has a wi-fi system for wireless connection of computers to the Internet. Instructions for connectivity will be available at the Conference Registration, Information and Documentation Desk. It is recommended that participants bring their own plug adapters to enable them to plug into Swiss power sockets. A limited number of adapters will be available from the Conference Registration, Information and Documentation Desk. There are no hard-wired Internet connections in the conference rooms. Cell phones should be switched off in the conference rooms.

2. Access to the CICG
Entrance to the building is through the main doors at 17, rue de Varembé.

3. Parking facilities
Parking at and around the main entrance of the Conference Centre is not allowed. In the streets adjoining the Conference Centre, parking is available for limited periods only. There is, however, a large underground car park (“Parking de la Place des Nations”) open day and night, in the vicinity of CICG near the International Telecommunication Union (ITU) Headquarters building. A limited number of entrance cards will be available for purchase from the Conference Registration, Information and Documentation Desk.

4. Local transportation and taxis
Bus numbers 5 and 8 and tram numbers 13 and 15 stop at the nearby Place des Nations and run to and from the centre of the city and the railway station (Place Cornavin). This service connects with all the Geneva tram, trolleybus and motorbus routes. In addition, bus numbers 11 and 22 pass close to the Conference Centre, connecting the Jardin Botanique/Place des Nations with Bout du Monde and Carouge, respectively. Public transportation schedules can be found online at:
Taxis can be obtained through the Conference Registration, Information and Documentation Desk.

5. **Post and telecommunications**

There is a Post Office to the left of the rue de Varembé entrance to the Conference Centre.

Telephone booths are located at various points in the building. Phone cards or credit cards may be used.

Mail for delegates may be sent to the following address:

World Meteorological Congress  
Centre international de conférences de Genève  
17, rue de Varembé  
CH-1211 GENEVA 20  
Switzerland

Mail can also be sent through the WMO Secretariat at its usual address.

The telephone number of the Conference Centre is +41 (0)22 791 91 11.

The fax number of the Conference Centre is +41 (0)22 791 90 64. Fax messages may also be sent to the WMO Secretariat (+41 (0)22 730 81 81).

6. **Office accommodation in WMO building**

A limited number of offices will be made available in the WMO building for rental during Cg-Ext.(2012). Delegations wishing to rent office facilities are requested to send a request specifying their needs to the Conference Services (cnf@wmo.int).

7. **Bank**

A branch office of the Union de Banques Suisses (UBS) is located on Chemin Louis-Dunant across from the Conference Centre.

8. **Cloakroom**

An unattended cloakroom is available to delegates in the entrance hall of the Conference Centre.

9. **Quiet room**

A quiet room for meditation, prayer, retreat and reflection will be available to delegates in the basement (floor -1), next to the Internet corner.

10. **Restaurant, bar and cafeteria**

A restaurant, bar and cafeteria are available in the CICG, with others available on adjacent streets.

11. **Medical service**

A medical service is available in the Palais des Nations, where qualified personnel are on duty throughout the day. Appointments can be arranged through the Conference Registration, Information and Documentation Desk. After 5:30 p.m. delegates may go to the "Permanence Médicale" located in the immediate vicinity at 9A, rue de Vermont, which is open 24 hours, 7 days a week (Tel.: +41 (0)22 734 5150).
For medical emergencies there will be a first-aid station located at CICG.

12. **Duty-free fuel and shopping**

   In order to obtain duty-free shop passes and cards for supply of duty-free petrol, delegates should apply to the Conference Registration, Information and Documentation Desk. Cards granting the right to buy duty-free fuel must be returned upon expiration.

13. **Travel and entertainment**

   Delegates may make any travel arrangements or reservations for their return journey through the accredited travel agency located at WMO Headquarters; the American Express Travel Agency, tel.: +41 (0)22 730 80 15, e-mail: ax.wmo@aexp.com.

   Information relating to customs formalities and visas, as well as to local travel, weekend resorts, sports, theatres, performances and other activities can also be obtained from the travel agency.
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| Algeria | Democratic Republic of the Congo | Kuwait |
| Angola | Denmark | Kyrgyzstan |
| Antigua and Barbuda | Djibouti | Lao People's Democratic Republic |
| Armenia | Dominica | Latvia |
| Australia | Dominican Republic | Lebanon |
| Austria | Ecuador | Lesotho |
| Azerbaijani | Egypt | Liberia |
| Bahamas | El Salvador | Libya |
| Bahrain | Eritrea | Lithuania |
| Bangladesh | Estonia | Luxembourg |
| Barbados | Ethiopia | Madagascar |
| Belarus | Fiji | Malawi |
| Belgium | Finland | Malaysia |
| Belize | France | Maldive |
| Benin | Gabon | Mali |
| Bhutan | Gambia (the) | Malta |
| Bolivia (Plurinational State of) | Georgia | Mauritania |
| Bosnia and Herzegovina | Germany | Mauritius |
| Botswana | Ghana | Mexico |
| Brazil | Greece | Micronesia, Federated States of Polynesia |
| Brunei Darussalam | Guatemala | Monaco |
| Bulgaria | Guinea | Mongolia |
| Burkina Faso | Guinea-Bissau | Montenegro |
| Burundi | Guyana | Morocco |
| Cambodia | Haiti | Mozambique |
| Cameroon | Hungary | Myanmar |
| Canada | Honduras | Namibia |
| Cape Verde | Iceland | Nepal |
| Central African Republic | India | Netherlands (the) |
| Chad | Indonesia | New Zealand |
| Chile | Iran, Islamic Republic of | Nicaragua |
| China | Iraq | Niger |
| Colombia | Ireland | Nigeria |
| Comoros | Israel | Niue |
| Congo | Italy | Norway |
| Cook Islands | Jamaica | Oman |
| Costa Rica | Jordan | Pakistan |
| Côte d'Ivoire | Japan | Panama |
| Croatia | Kazakhstan | Papua New Guinea |
| Cuba | Jordan | Paraguay |
Peru  
Philippines  
Poland  
Portugal  
Qatar  
Republic of Korea  
Republic of Moldova  
Romania  
Russian Federation  
Rwanda  
Saint Lucia  
Samoa  
Sao Tome and Principe  
Saudi Arabia  
Senegal  
Serbia  
Seychelles  
Sierra Leone  
Singapore  
Slovakia  
Slovenia  
Solomon Islands  
Somalia  
South Africa  
Spain  
Sri Lanka  
Sudan  
Suriname  
Swaziland  
Sweden  
Switzerland  
Syrian Arab Republic  
Tajikistan  
Thailand  
The former Yugoslav Republic of Macedonia  
Togo  
Turkey  
Turkmenistan  
Timor-Leste, Democratic Republic of  
Uganda  
Ukraine  
United Arab Emirates  
United Kingdom of Great Britain and Northern Ireland  
United Republic of Tanzania  
United States of America  
Uruguay  
Uzbekistan  
Vanuatu  
Venezuela (Bolivarian Republic of)  
Viet Nam  
Yemen  
Zambia  
Zimbabwe

**TERRITORIES (6)**

British Caribbean Territories  
French Polynesia  
Hong Kong, China  
Macao, China  
Netherlands Antilles and Aruba  
New Caledonia

A list of permanent missions in Geneva can be found on the website [www.unog.ch](http://www.unog.ch)
AGENDA ITEM 4: GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

AGENDA ITEM 4.1: IMPLEMENTATION PLAN FOR THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Summary and Purpose of Document
This document contains the Annexes to the draft Implementation Plan of the Global Framework for Climate Services (GFCS) provided as Doc. 4.1. The Annexes are provided as information material to allow the reader to obtain details of the Framework’s five functional components (the User Interface Platform; the Climate Services Information System; Observation and Monitoring; Research, Modelling and Prediction; and Capacity Development) that are described in the draft Implementation Plan.

CONTENT:

FOREWORD TO THE ANNEXES

USER INTERFACE PLATFORM COMPONENT

CLIMATE SERVICES INFORMATION SYSTEM COMPONENT

OBSERVATIONS AND MONITORING COMPONENT

RESEARCH, MODELLING, AND PREDICTION COMPONENT

CAPACITY DEVELOPMENT COMPONENT
FOREWORD TO THE ANNEXES

The GFCS Implementation Plan presents a roadmap for establishing the Global Framework and helping to ensure the provision and use of climate services around the world. It does not include the full details of all the steps that are needed to implement the Framework. These details have been placed in the five annexes that complete this report in order to keep the Plan focused and easier to read.

The annexes elaborate the Framework’s five functional components, or pillars, that are briefly described in the Plan. These pillars – the User Interface Platform; the Climate Service Information System; Observation and Monitoring; Research, Modeling and Prediction; and Capacity Development – will underpin the production and delivery of effective climate services. Cutting across the four priority sectors, they create a matrix that forms a comprehensive picture of how the Framework will operate.

The annexes explore how to build on and operationalize the concepts and strategies set out in the Plan. They are working documents that represent the current state of play, and their inclusion here is intended to catalyze and inspire further thought and discussion. The GFCS community will be able to strengthen and refine these texts based on the outcomes of the Extraordinary Congress and the guidance provided by governments.

The annex on the User Interface Platform includes four exemplars addressing the GFCS priority sectors of health, disaster risk reduction, water resources, and agriculture and food security. These prototype implementation plans consider how the approach proposed by the general Implementation Plan could be adapted and applied to each of the four sectors. The health and disaster risk reduction exemplars are the most fully developed, but all four exemplars need further work and engagement with the relevant communities. The exemplars have not yet been reviewed or translated.

The annexes and exemplars were developed through an inclusive process of consultation, including meetings on all five pillars. More than 300 global experts participated, and case studies of more than 60 nations were collected.

Readers are invited to engage with and contribute to the development of the ideas and activities presented in these annexes by contacting the WMO Secretariat.
ANNEX

TO

THE IMPLEMENTATION PLAN FOR THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

USER INTERFACE PLATFORM COMPONENT

Version: 31 August 2012
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1 INTRODUCTION

1.1 Objective, Scope and Functions of the UIP

Objective

The User Interface Platform (UIP) is the Framework pillar that provides a structured means for users, climate researchers and climate service providers to interact at the global, regional, and national levels to ensure that the GFCS meets user needs for climate services. The objective of the UIP is to promote effective decision-making where it involves climate considerations.

Maximizing the usefulness of climate information in the decision-making process is the intent of all the partners in climate services. The necessity to make climate related decisions drives the need to bring providers and users together. All countries, developed and most vulnerable, share that need and all have a place in the GFCS. To advance the provision of climate services, the UIP will include all those providing and using climate services at the global, regional and national levels.

Scope – priority areas

Implementation during the first years of the Framework will focus on the priority areas of agriculture and food security, health, disaster risk reduction, and water resources. Other relevant areas will follow in later years. These four areas are not mutually exclusive. On-going disasters, for example, can often present management challenges in the other three areas and the UIP will have to, at times, deal across all the user communities. At other times it will be more effective to deal with the stakeholder communities in the priority areas separately. An initial focus on the four priority areas will not, of course, preclude ongoing interest and activities in other areas of national, regional and global interest where there are sensitivities to climate variability and change.

Scope – Stakeholders

The scope includes all nations. All will benefit by participating in the Framework, with some having national processes that can contribute to the User Interface Platform. Globally, the United Nations system is a critical international stakeholder, with specialized agencies and programmes with mandates\(^1\) to coordinate the international production, dissemination and use of climate services to all regions and countries. Regionally, the UIP implementation will in some ways mirror the international level, albeit with stakeholders from governments, regional organizations, non-governmental organizations, scientific institutions and the private sector with a regional scope. At the national level, implementation will be a matter for individual government decision. It is expected that governments will identify their centres and agencies that will coordinate national interactions with the regional and global mechanisms, and that they will assess requirements at the sub-national level, and decide how services are implemented at the sub-national or community level. Stakeholders in private sector will inevitably be both a provider and consumer of climate services. For example, health interests in the private sector include private pharmacies, pharmaceutical production, medical equipment, and private practicing doctors. Engaging the private sector in the UIP will in many countries facilitate implementation at international to community geographic scales.

\(^1\) Mandates, agendas, and goals such as the Millennium Development Goals, the Hyogo Accord, the emerging Sustainability Development Goals, other intergovernmental frameworks and their implications for GFCS as they are implemented by partner organizations such as WHO, FAO, ISDR, UN-Water, etc. See section 2.2 and Box 1.
Functions

Earlier, the UIP was defined as a structured means of bringing together providers and users of climate services. It can be further defined as a managed methodology, or a collection of methods, means, approaches, and processes of systematic and mutually beneficial collaboration. It enables interactions that help define user needs and provider capabilities, tries to reconcile the needs with capabilities, and eventually promotes effective decisions through the use of climate information. To achieve its objective, the UIP is aiming for four outcomes:

a. Feedback - Identify the optimal methods for obtaining feedback from user communities;
b. Dialogue - Build dialogue between climate service users and those responsible for the observation, research and information system pillars of the Framework;
c. Outreach - Improve climate literacy in the user community through a range of public education initiatives and on-line training programmes;
d. Evaluation - Develop monitoring and evaluation measures for the Framework that are agreed between users and providers.

In addressing the scope of the UIP it must be borne in mind that the Framework is not a centrally managed system. The methods for developing interactions between climate service users and providers will be determined on a case-by-case basis by the available technologies and capabilities. Most important, although the local level is not one of the identified geographic domains, (like global, regional, and national) it is at the local level where concrete action takes place. Monitoring and evaluating how implementation projects happen locally, by people in places where decisions take place, helps deliver effective climate services (see Figure 1).

The UIP will operate through a wide-range of methods designed to promote mutual understanding, ranging from formally established committees and working groups, workshops, conferences, inter-agency task teams, and internship programmes, to one-on-one discussion. There are many informal approaches for exchanging perspectives that have proven effective, like focus group discussions, on-line social networks, engagement with opinion leader and innovative approaches used in the corporate world. Communication, outreach, and training approaches will be equally wide-ranging, including radio broadcasts, social media, and public service announcements. Access to and training on a range of public education initiatives and on-line training programmes like climate clearinghouses, map interfaces, web portals, information servers, structured decision tools, graphical information systems, information technology resources, database management systems and the like would also be considered. In many areas of this work there will be opportunities to build upon well-established dialogues or ones that are growing in effectiveness such as the Regional Climate Outlook Forums, community-based platforms, liaison working groups in the disaster management community, farmer field schools, water learning centres, and national health working groups. Several European Union projects are developing good results that can be used to better define what can be accomplished by a UIP at a regional level.

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2 The High Level Taskforce report p. 198 identified these four outcomes.
3 Conversely, there is also a need to improve literacy of the climate community in user needs
4 See references on-line to EUPORIAS, ECLISE, CLIMRUN
In summary, the objectives, scope and function of the UIP are defined by the Framework’s need for information on how climate services are developed, provided and used to meet clearly expressed needs at the global, regional and national levels (Figure 1). The UIP must be implemented flexibly to meet a diverse range of interests and requirements, which will evolve over time as technologies and science progress and as new environmental and societal challenges arise.

1.2 The Requirement for the UIP pillar

Across all priority areas, core demands for climate services are for planning, operations and impact assessment. Though there are many excellent examples of effective use of climate information (see cases in Appendix 1), all too often they remain isolated in one location or sector and are not supported by a routine, more widely-available service, a gap that the Framework aims to fill.

Why is a UIP required? Climate services often do not reach the people who need to make “on-the-ground” decisions. The UIP is required to promote mainstreaming of climate information into the decision-making process. Climate change adaptation requires a faster fluid path from research to applications, from science to humanitarian use, and from data to decisions. With good bridging between science and action, good use will be made of the many products and services that are already available and good guidance on the greatest need for new products and services will emerge. The UIP is to help get the right information, in the right amount, at the right time, delivered, understood, and used by actors in agriculture, health, disaster risk reduction, water resource management, and elsewhere.

A UIP is required to identify and respond to the needs of the user in all priority areas from global to local levels and to facilitate the improvement of performance and management through the use of

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5 HLT report p. 172
climate information. The UIP is neither an institution nor a stand-alone entity. Instead it functions as a go-between for the other Pillars of the Framework to help ensure that they generate and deliver what is needed in climate-sensitive decision-making.

Work in making decisions in climate-sensitive areas is spread among many organizations (as noted in Appendix 2). The actors in these organizations far outnumber climate experts and service providers, making it unfeasible to have personal conversations between climate specialists and all those seeking information. Thus, there is a need to aim for some common standard aspects of the UIP that have sufficient flexibility to meet the needs of a range of interests, rather than sector-specific UIP models to which the other GFCS pillars would have to respond. In a general sense and as noted, the UIP aims to respond to requirements through four objectives: Feedback, Dialogue, Outreach, and Monitoring and Evaluation. Section 2.4 lays out implementation activities for the UIP in those four objectives.

1.3 Inter-linkages of the UIP with other pillars of the GFCS and among the priority areas

The Framework is an end-to-end system that meets user requirements by using observations, technology and scientific understanding as inputs for the development of climate services. Each pillar has its requirement for internally monitoring its ability to meet deadlines, achieve agreed outcomes, and deliver expected results.

Many UIP activities will integrate naturally with the other pillars. To use the example of the Regional Climate Outlook Forums: The UIP will play an important role in bringing climate service user perspectives. The Climate Services Information System will use these perspectives to encourage climate service producers to agree on the content of outlooks and the standards and procedures for their transmission. Similarly, the UIP will play a role in bringing user perspectives to the managers of operational observing networks and to researchers. See Appendix 1 Case 1 for an example of how the UIP will operate. As many of the UIP activities involve the use of climate services in vulnerable countries, it is inevitable that strong linkages will be required with the key stakeholders involved in setting capacity development priorities.

Furthermore, the UIP needs to be flexible to meet the requirements of many different user communities. Each will bring its own focus on the kinds of climate data and products it needs, on the sorts of decision-support tools it uses, and on the level of knowledge that it has to interpret all of this information. Working with all the Pillars, the UIP has to help connect to the central points of global, regional and national decision-making, and the formal processes within user areas. It should help identify the climate data and products that fit into the tools and services used by each priority area – users’ models, methods, portals, graphical information systems, information technology resources, database management systems, and information servers, and it should help users discover means to integrate climate information with their own data, the kinds of data that they use to make decisions (e.g. socio-economic data, vulnerable populations, crop varieties, epidemiological databases, infrastructure, and water data). While the details will differ greatly amongst priority areas, flexibility in the UIP is essential to allow for all of this, without inventing a separate unique UIP for each priority area. The UIP is to be structured, yet flexible to respond to multiple communities of users.

1.4 Relevant existing activities and identification of gaps

Unlike the other Pillars of the Framework, there is presently no UIP. While the other Pillars can point to specific activities underway, like the Global Climate Observation System, here we point out existing activities that exemplify the functions of a user interface. Some examples of climate services in the four priority areas that reveal facets of a user interface were explored in Chapter 5 of the HLT report. Other examples were presented at the World Climate Conference-3 and in subsequent consultations (see Table 2). Yet together they lack the unifying thrust and strong user focus embodied in the proposed activities that the Framework would bring to the UIP.
Six further examples of activities that highlight the functioning of the UIP are presented in Appendix 1. An example in North America (Case 1) illustrates the linking of climate service users with researchers and service providers. Case 2 describes the bringing together of water resource practitioners with climate service providers. A development project in Africa, now being implemented (Case 3) has strong linkages between users, the private sector, and service providers. Capacity building is described in Case 4 in a project that facilitates feedback from agriculture workers. Capacity building through working groups is described in a health related activity (Case 5). Lastly, Case 6 illustrates the linking of disaster risk reduction practitioners and communities with scientists. These examples demonstrate the necessary and sufficient conditions for a successful user interface (see the next section, 2.1). New projects to be undertaken in the two-year timeframe (presented in Section 2.5) refer to and build upon these previously successful projects.

Yet, despite these successes, gaps still exist. Extended examples (called Exemplars) of climate services in agriculture, health, disaster risk reduction, and water management reveal specific gaps in the effective delivery of climate services in those areas. Here we point to the kinds of gaps the UIP seeks to fill.

As described in the Health Exemplar, it is widely acknowledged that climate information and services are not being used to full potential in the health area. In its diagnosis of what is not working, it adds that a structured process would help identify needs and improve performance, particularly in a variable and changing climate. The Agriculture Exemplar states that climate data are extensively used for planning purposes in cropping, fisheries, and animal husbandry, but that there are gaps in bringing national climate change information into crop research.

From the Annex on Research, Modelling and Prediction, it is learnt that the dialogue between the climate research community, climate service providers, and climate information users is only starting. Until now, service providers generally infer – based on limited interaction and sometimes successfully – what users need. Turning the domain of research into a more use-driven mode focused on the needs of decision makers would be a cardinal change in practice. The means to convey the latest developments in fundamental climate science and its ability to deliver new and actionable information is all too often lacking. Research topics on sea level rise, changes in water availability, and in the nature of extreme events are important to decisions in all the priority areas. Guiding research towards developing practical applications of climate science in these and other areas will result from the continuous interaction of providers and users of climate data, filling the gap in user feedback.

The report on the Expert Meeting on Water Management Needs for Climate information in Water Resources Planning notes that “climate information is not widely used by water managers”. Shortfalls, lack of synergy, and mismatches in availability and use of information are among the gaps and deficiencies being compiled in a Technical Report by WMO’s Commission for Hydrology. As pointed out in the Water Exemplar, very often, gaps are functions of the scale of operations. Water management decisions are usually about a river basin or a watershed or catchment area, all of which may be on a quite different scale to the typical scale of meteorological analysis, both in time and space. Flood management and control, dams, flood plain zoning, coastal inundation, irrigation and drainage, groundwater recharge, navigation, power generation, potable water supply, industrial water supply, effluent disposal, recreation, fishing, response to major droughts, are some of the aspects of the water area that are sensitive to climate. Bridging the gap in the dialogue will lead to climate information being used to its full potential in these vital areas.

Gaps in user feedback and dialogue, as described above, impede the process of moving from data to decisions. Other gaps show up as deficiencies in the way information is delivered. The 2011 Global Assessment Report on Disaster Risk Reduction, for example, identifies the specific need to maintain a functioning network of rainfall monitoring stations required for a comprehensive probabilistic risk assessment, including drought risk. Historical information is needed for water projects and for statistics on climate hazard warnings; in the latter case to quantify the added value
of disaster risk reduction tools like early warning systems. Advocacy and communication of readily available data and products should bridge such gaps.

2 IMPLEMENTATION OF THE UIP

2.1 The necessary and sufficient conditions for a successful implementation of the User Interface Platform

A successful implementation of the Platform will enable strong engagement between providers and users of climate services. Thus, the UIP would need to recognize the importance of the existing formal processes within key user constituencies, and build upon them. “Communities of practice” that already link science, observations, and generation of information products need to be reviewed on the extent to which they recognize the requirements of user communities, their effectiveness in obtaining and acting on feedback, and on how well they work. The means for optimizing this shared participation include:

- Genuine ownership of the GFCS by end-users and engagement of end-users by all pillars of the GFCS (implying representation at the highest level within the overall management structure);
- Direct relevance to measurable outcomes, in support of existing mandates, agendas, and goals, as well as commitments and needs expressed through the UNFCCC and other environmentally related conventions and protocols;
- The most direct possible link to the operational, policy and technical support mechanisms of within the user community sectors, as well as the provider community, (implying secretariat functions run jointly between WMO as the lead GFCS agency and the partner agencies);
- Accountability for responding to needs and in support of their outcomes (requiring that GFCS activities are assessed against the needs-based criteria, ideally through existing surveillance and monitoring systems);
- Political and financial commitment to the Framework by stakeholders in the priority areas, and meteorological agencies (including through the global governing bodies for health, food security, disaster risk reduction, and water);

A practical list of results that each country should expect from participating in the Framework includes the ability of providers of climate information to:

- Interact with users, to meet their requests (for basic climatology questions) and to gather feedback on products;
- Conduct or contribute to regional and national climate forums and communicate information on current and future climate states;
- Interact with users in one or more user areas to identify their requirements for, and provide advice on, climate information and products for their application;
- Assist users to interpret/use climate predictions and products;
- Get feedback from users on the usefulness and effectiveness of the information and services provided.

Taken from the point of view of each of the priority areas, more specific conditions for a successful UIP implementation are offered in Tables 5.1–5.4, and have also been included in the Implementation Plan Chapter 2. These tables provide a practical picture of the results each priority area should expect through participating in the Framework’s UIP. These desired results are

6 HLT report p. 184-185
derived from the various inter-agency consultations on the UIP (see Table 2). The list of results is neither definitive nor exhaustive; however, it provides important indicators of what eventual success would provide. (Additionally, see results to be expected from participating in the Framework7.)

Many successful projects, which by their nature are examples of a UIP, have common ingredients. For instance, in each project described in Appendix 1, discussions on user needs began well before the project launch. Partners with extensive experience were brought together, each bringing unique expertise, be it technical and scientific, knowledge of the geographical area, or a capability in securing the funding. Most importantly, leadership came from the user. Continual dialogue between the users and providers enabled an understanding of the cultural and community values of the partners. In the case of larger projects, several teams were sometimes formed. Among them were teams for communications, product development, regulatory and legislative issues, deployment logistics and operational matters – with representatives from the country on each team. The teams provided continual monitoring and feedback on progress. These ingredients for a successful project appear in the objectives and outcomes of the UIP.

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

Climate affects every aspect of life; consequently there are many possible partnerships at all geographic levels. Appendix 2 lists some of the national institutions, international organizations and private sector entities involved in climate-related efforts in the four priority areas, and indicates their geographic scope of activity at global, regional, and national levels. Though the table is by no means comprehensive, it illustrates the breadth of potential partners.8

Any attempt to coordinate across the huge number of all potential partners from the ranks of the UN and other international bodies would likely draw off resources that would be more productively spent in the target countries themselves. Instead, the direct engagement of lead implementing and technical institutions would open an important pathway for serving end users. Each priority area is identified with a relatively small number of key international bodies and accordingly the engagement of organizations such as the WMO, WHO, UNEP, UNESCO and UN-Water, UNISDR, FAO, UNDP and WFP will be essential if stakeholder dialogues are to be efficiently coordinated at the international and regional levels. Some non-governmental stakeholders, such as the International Federation of Red Cross and Red Crescent Societies, also represent climate service user communities in all four priority areas. These institutions mentioned above, have specific processes and mechanisms to achieve their specific goals (see Box 1)

![Box 1

**Working Mechanisms of Potential Partners**

For example in the Health area, the World Health Organization is the leading normative body governed by the World Health Assembly and Regional Committees comprised of Ministries of Health. Ministries of Health, which have committed to various resolutions to protect populations from climate change and climate-related disasters. They need climate services to be able to fulfil this mandate. Other sectors such as Agriculture and food security have similar processes lead by the FAO.

Additionally, most governments as signatory members of the UNFCCC have commitments to develop National Communications which include climate impacts – which again need help to fulfil these commitments. Developing countries need collaboration with climate services for developing National Adaptation Plans of Actions.

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7 HLT report p. 184-185

8 Efforts were made to include in the Appendix 21 most of the organizations named in the various Case examples and priority activities within this Annex. (See Appendix 1 and sections 2.5).
Climate services are needed to inform national socio-economic planning and development strategies, and are needed in economic decision making supported through natural capital accounting. See: (http://www.wavespartnership.org/waves/sites/waves/files/images/Moving_Beyond_GDP.pdf)

Working mechanisms have already begun in response to the programmes. A reduced list of climate related working mechanism include:

At a National level, government authorities utilize UN Development Assistance Frameworks, Poverty Reduction Strategy Papers, and Common Country Assessments, to engage with multilateral bodies. The Millennium Development Goals and Post 2015 Sustainable development goals, Hyogo Framework of Action are global mechanisms which provide structure and direction for partners and governments on various development priorities, all of which can be climate informed and benefit from climate services.

It would also be useful to identify synergies, particularly for monitoring and reporting, among the three Rio conventions; UNFCCC, Convention on Biological Diversity, and UN Convention to Combat Desertification.

The UIP will serve to reconcile the mandates, commitments, and mechanisms in that have been created to address climate impacts in the priority areas, with the climate services that can be implemented. The UIP can facilitate the identification, communication, and engagement of providers with these mechanisms, in order to help the priority areas access and use climate information to better fulfil mandates related to climate change.

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

As in all of the pillars, criteria for the selection of UIP projects fit well within the Principles of the Taskforce. Each priority area (agriculture, disaster risk reduction, health, and water) has particular objectives and agendas, which are regularly reviewed and updated, e.g. the Hyogo Framework for Action in the case of disaster reduction, and WHO's Health Policy and Climate Change. Such agendas are generally established with a focus on the communities to be served. The Framework’s activities need to enable access to the kinds of climate data, products and services that will best support their objectives.

The criteria for identification of projects are particular to each priority area. Yet, a common checklist for the selection of projects in the near term would include:

1. Does the activity contribute to the UIP outcomes, which is in turn are based on objectives, agendas, work plans, goals and missions that have already been agreed to by the partner organizations and groups?
2. Does the activity or project build upon, not duplicate, the partnerships in place between existing organizations?
3. Are the Feedback, Dialogue, Outreach or Monitoring and Evaluation objectives of the UIP well evident in the planning process?
4. Does the project build upon something that already exists, for example by expanding the area, locating in a new place, making it operational, or broadening its scope?
5. Does the project involve a developing country, a land locked country, a small island state, or a least-developed country?
6. Can the project be executed in a two-year time frame?
7. Does the project fill gaps identified in the Implementation Plan, Annexes or Exemplars?

9 HLT report p. 188
2.4 UIP implementation activities in the four priority areas (including resource requirements and communication strategies)

Each priority area has differing needs for climate data and services to fit into its own operating tools and models, and to meet the needs of its decision-making communities. Each priority area, after preliminary consultations with leading UN organizations and key stakeholders, suggests a single fast track project to be undertaken in a two-year time frame. These projects are outlined in section 2.5, along with suggestions for additional activities that could be undertaken in six and ten year timeframes in the Exemplars.

Mindful of the desired outcomes of a UIP (Section 2.7), at the very beginning stage of constructing the UIP, there are common factors in all priority areas. An overview of the types of projects and activities that will be undertaken is grouped under the categories of Feedback, Dialogue, Outreach, and Monitoring and Evaluation.

a. Feedback

The flow of requirements from the users, and the technical advice from the Framework’s pillars, will be communicated through the UIP as depicted in Figure 1. As noted in section 1.1, the actual methods to be used in establishing and maintaining feedback will vary. By leveraging assets, the views of a wide array of user communities can be optimally heard by improving the communication channels between key actors.

**Activity:** Establish in each priority area at the national level a systematic process to gather and analyse the requirements for climate information. Data needs will vary between priority areas; from standard climate variables such as temperature and rainfall, to detailed information on significant climate and weather related events (like droughts, floods, heat waves, wild land fires, tropical storms). Products will vary from historical analyses, which will be used to provide evidence of impacts and to inform current operational activities, to mid-term climate forecasts and long-range climate projections. These products will be more useful when users can readily combine them with their own layers of social, economic or geographical information, such as population, income, land use, transportation, and infrastructure.

**Activity:** Undertake surveys of user-focused networks, collaborations, partnerships, forums, centres and learning exchanges relevant to each of the priority areas. Analyse their function, successes and impediments and provide recommendations on action via the UIP to enhance their capabilities.

b. Dialogue

In assessing the requirements of users for services, the process will be iterative, with capabilities to deliver becoming more aligned over time to requirements. The UIP will need to set up lines of communication with the other pillars to elicit user requirements for observations and climate monitoring, products and services, research, and capacity development. Dialogues should allow the views of users to be expressed in such a way as to help set priorities for the other Pillars. Helpful methods may include internship programmes, temporary exchanges, joint development of information portals, and so forth. At times the scientific community will lead with the development of new products, recognizing the opportunities that can arise from advances in climate sciences and technologies. At other times, dialogues will lead to demand driven operational implementation of new services through the Climate Service Information System.

**Activity:** Interact with other pillars of the GFCS to articulate user needs and perspectives as required. Identify what is needed to meet new understanding of requirements. Stimulate the development and dissemination of user-oriented applications methodologies, good practices and relevant standards of performance.
Activity: Build a suitable means (web site, social media cloud facility) for the UIP to foster the gathering, analysis and dissemination of user needs for climate information and its application. Each priority area has a set of tools that would benefit from better data and products from the climate providers. Tools employed by the users to integrate information, e.g. crop production models, or reservoir management models, are many and varied. Gathering and understanding how those tools might function better with improved climate data and information would be facilitated through regular and systematic user feedback.

c. Outreach

In many instances opportunities for a better uptake of climate services are missed because of lack of awareness of their availability or usefulness in field applications. The UIP will address the need for advocacy of climate services and help to create opportunities for user training and related capacity development initiatives.10

Indeed a critical focus of the UIP is advocacy and outreach through the provision of user education and training. Many potential users of climate services are already users of weather services; however the fundamental, yet sometimes subtle, differences in the nature of these services highlight the need for user education. From seasonal forecasts and inter-annual and decadal predictions, to climate change projections and scenarios, providers and users need to understand how different types of information should be used appropriately in all the priority areas.

Additional complications arise when users of climate services need to relate science-based forecasts and outlooks to information obtained from traditional (indigenous) knowledge. Harmonizing scientific methods and indigenous knowledge in the delivery of climate services is a critical area of concern for many vulnerable nations, and hence requires a significant effort.

Activity: Formulate key messages about the Framework, in consultation with representatives of user organizations and the other components of the Framework. Prepare a short communications brochure for user partners on the concepts underlying the User Interface Platform and its first year intentions. Identify and quantify the benefits of climate services through narrative and special reports. Use these means to advocate the benefits of using climate information and to demonstrate the utility of the Framework to potential beneficiaries, users and user organizations.

Activity: Contribute guidance and support to facilitate user engagement in the projects undertaken for Capacity Building. Support other actors, particularly in developing countries, to undertake these tasks at regional and national levels.

d. Monitoring and Evaluation

The UIP will need to establish and maintain monitoring and evaluation mechanisms to ensure that the framework promotes effective decision-making with respect to climate considerations. These mechanisms could be established through GFCS governance and management structures. The UIP would encourage the appointment of users in the priority areas to different task forces, expert teams, and committees having organizational responsibilities for projects and activities undertaken under the Framework.

Activity: Organize in each priority area a specific assessment of the most promising areas for introducing new or improved climate services to existing collaborative mechanisms. Through the Platform’s communication methods, provide open channels for users to express their needs and to communicate good practices and success stories in the application of climate services.

10 This role for the UIP is expanded in the HLT’s Principle 2.
Activity: Coordinate the monitoring of user perspectives and feedback on the functioning of the Framework, and provide user-oriented support to the other pillars of the Framework. While the Research pillar will be involved in elucidating the science and developing the technology to underpin the creation of soundly based climate products, and the CSIS pillar will be involved in the effective delivery of the products and services to the end-user, the UIP will facilitate the exchange of requirements and technical information between them and the users. Evaluating how the decision makers in the priority areas use the climate services would also be a useful function of the UIP.

2.5 Initial implementation activities/projects

In practice, there are many national and regional projects underway applicable to each priority area. Specific projects and activities were presented at the Inter-Agency Consultation Meetings on the UIP (see Table 2). Organizations made recommendations for the development of the draft implementation plan in those and in subsequent meetings. These recommendations are incorporated into the Exemplar for each of the priority areas. They need to be screened to assess how well they fulfil the implementation priorities of the UIP.

For this Annex, one suggested activity is described for each priority area. The activities are derived from consultations with principal partner organizations. They are submitted based on the criteria described in section 2.3, and they build upon the experiences described within the Cases in Appendix 1. Not one is a wholly new activity. The suggested activities were scrutinized by the leading UN agency within the priority area, and are considered the fast-tracked actions among the activities further explored within the Exemplars.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Priority area(s)</th>
<th>Implementation priority(ies)</th>
<th>Geographic scope</th>
<th>Participating organizations</th>
<th>Cost USD xM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improving communications between the climate and agriculture and food security communities</td>
<td>Agriculture and Food Security</td>
<td>Demonstrate value; develop national and regional capacities</td>
<td>FAO, IFAD, WMO</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>Developing National Climate and Health Working Groups</td>
<td>Health</td>
<td>Demonstrate value; develop national and regional capacities</td>
<td>WHO, WMO</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>Strengthening capacity for disaster risk reduction and early warning</td>
<td>Disaster Risk Reduction</td>
<td>Demonstrate value; develop national capacities</td>
<td>UNISDR, WMO, others</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>Partnering climate services and water resources management</td>
<td>Water</td>
<td>Demonstrate value; develop national and regional capacities</td>
<td>WMO, UNESCO, GWP</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 1. Listing of fast-track activities or projects for the first two years within each priority area.
Consultation Meetings on the Global Framework for Climate Services

World Climate Conference–3 held 31 August–4 September 2009, Geneva, Switzerland,
http://www.sciencedirect.com/science/journal/18780296

Consultation Meetings
http://www.wmo.int/pages/gfcs/consultations_en.php

| • Capacity Building — |
| Requirements of NMHSs for the GFCS (October 2011, Geneva) |

| • User Interface Platform — |
| Agricultural, Food Security and Water sectors (September 2011, Rome) |
| Disaster Risk Reduction and Health Stakeholders (November 2011, Geneva) |

| • Climate Services Information System — (April 2011, Geneva) |

| • Observations and Monitoring — |
| 1st meeting for WMO and WMO cosponsored programmes (August 2011, Geneva) |
| 2nd meeting addressing the user communities (in Agriculture, Water, Health, DRR) (December 2011, Geneva) |

Table 2 Listing of Consultation Meetings

2.5.1 Agriculture and food security

Activity:
Agriculture and Food Security: Improving communications between the climate and agriculture and food security communities. Bring providers and users together by conducting training for farmers and extension agents through roving seminars and farmer field schools.

In many countries, farmers get climate information from extension services, through daily radio, television, newspapers and through community interactions, as described in Case 4. The extension services, journalists and selected farmers need to be educated through forums, including Regional and National Climate Forums, and roving seminars, with the engagement of climate service providers, agricultural knowledge centres, and the rural user communities.

Objectives:
The overall objective is to improve the supply and uptake of relevant meteorological and climate information for rural producers in West Africa through: (1) Strengthening and expanding the model of Roving Seminars on Weather, Climate and Farmers in the Sahelian region; and (2) improving communication between farmers, extensions agents, NGOs, FAO, and National Meteorological and Hydrological Services.

Benefits:
- Communities and farmer organizations are strengthened with knowledge through the use of Information and Communication Technology (ICTx).
- Tools for communication are extended by improving, web-based storage of agricultural information and increasing connectivity to rural communities.

Deliverables:
- Collaborative partnerships between WMO, FAO, NGOs and other partner agencies, policy makers and NMHSs.
- Established and functional systems for disseminating information and evaluating the benefits.
- Organization of roving seminars and farmer field days.
Initial target region to be West Africa with expansion to other African regions.

**Current activities related to this activity:**
From 2008 to 2011 the Government of Spain through its State Agency of Meteorology (AEMET) funded the organization of 149 Roving Seminars on Weather, Climate and Farmers in fifteen countries in West Africa. Over 5,700 farmers participated in these seminars and over 3,100 simple rain gauges were distributed. Based on the success of this project, a new project called METAGRI-OPERATIONAL is being funded by Norway to strengthen activities such as developing crop advice based on historical climate data run through a crop model, standardizing rain gauges, and formalizing dissemination methods to farmers. Also, the Rockefeller Foundation is funding a project in Ethiopia to train agricultural extension workers on weather and climate information and products. FAO and CTA already have organized many farmer field and training events that seek to engage farmers in using and understanding weather and climate information and products.

**Indicators and assessment measures**: TBD

### 2.5.2 Public Health

**Activity:**

Developing National Climate and Health Working Groups

Within two years, establish national level climate and health working groups in at least five countries hosting existing projects or plans that could benefit from climate services. Countries that could benefit are those whose Ministries of Health have already expressed interest in the further development of health actions within UNFCCC National Adaptation Programmes of Action (NAPAs) and national communications, (NC), have conducted Vulnerability and Adaptation assessments, have climate informed health emergency preparedness and management plans, or have existing climate adaptation projects.

Work plans jointly developed by health and meteorological experts will respond to national needs to enhance health activities with climate information (e.g. climate vulnerability assessments and early warning systems targeted at local needs). New working groups would benefit from guidance and lessons learnt through existing WMO supported working groups, with the aim that activities reach beyond research to enhance policy and operations.

Regional Committees of the World Health Assembly endorsed in 2010 and 2011, climate and health work plans to guide the member state Ministries of Health in all world regions toward priority actions to address climate change. The health priorities defined within these workplans, such as the conduct of climate impact assessments and adaptation planning, and operational response to climate risks, all require closer collaboration and joint programming with National services in meteorology and climate.

**Objectives:** This activity aims to establish national mechanisms whereby the climate research and operational groups can interact with health actors to jointly identify, implement and evaluate the use of climate information services in support of improved health protection. It will serve as a model for broader applications and help establish standard tools and references for the expansion of the model in other countries and regions.

**Benefits:**
The capacity of both health and NMS partners will be developed through training, linkages to international and regional experts, and via a structured mechanism for collaboration that will assist health actors implement climate-informed policy, research, and practice. The capacity of national

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11 WHO has an existing list of countries waiting to start or expand climate and health actions
networks can be further strengthened by linking national collaborators, e.g. through bi-lateral working groups and through regional and international interactions in regional and global forums.

**Deliverables:**
- Working groups established in 3-5 countries.
- Guidance on the establishment of National institutional Mechanisms for collaboration between climate and health.
- Linkages between National Working Groups, in West/East Africa.
- Development of applied sessions within RCOFs that cater to health needs.
- Linkage of National WGs to RCOF processes as applied activities.
- Improved capacity for health and climate applications.
- National activities to fulfil and implement UNFCCC processes (i.e. NC, NAPAs, V&A assessments) and climate-enhanced national emergency preparedness and management plans.
- Engagement of WHO and health partners at National and Regional levels.

**Current activities related to this activity:**
Several climate and health working groups (CHWGs) have been established in Africa since 2008, supported by WMO and other partners, which could be extended to support this activity. These groups have proven to be successful in building national level capacity to respond to the tailored needs of the health community, and for establishing structured mechanisms for collaboration. This project will expand the model of CHWGs described in Case 5, noting the following initiatives in train or in planning:

- Existing working groups in Madagascar, Kenya, and Ethiopia that have experience in different models of CHWGs, albeit with similar objectives and aims.
- WMO proposal for the establishment of new WGs in Mali, Mauritania, Burkina Faso, and Niger.
- WHO support for climate adaptation projects around the world that could all benefit from stronger and active partnerships with NMS, and RCOF services. Including: a 7 country project (WHO/UNDP/GEF); (EUR) a German funded project in 7 Eastern European and Central Asia countries (EUR), and 16 Pacific Islands developing adaptation plans (WPR), etc.
- Existing training networks and collaborating centres that have active training and capacity building activities in both developed and less-developed country contexts.

**Indicators and Assessment measures**
- National work plans shared.
- National WGs attend RCOFs and cite benefits from specific activities.
- Health activities held at RCOFs that address the needs of the national groups (emergency preparedness, infectious disease control).
- Guidance documents published.
- Public health preparedness plans routinely use climate information.

**Risks:**
- Sustainability of funding.
- Motivation of local partners.

**Stakeholders:**
Key stakeholders are in WMO and WHO, at global, regional, and national levels. The primary stakeholders will be the member states represented by the MoH, NMS, Regional Climate Centres, regional processes such as the RCOFs, and national institutional partners.
2.5.3 Disaster Risk Reduction

Activity:
Strengthening risk communication for early warning

The Framework would support five workshops to develop the capacity of: (1) climate service providers to meet end-user needs and to communicate information, advice and early warnings; and (2) national and sub-national end-users to access and make use of climate services to improve decision-making and to take action as appropriate on early warnings. This activity would scale-up the “Early Warning, Early Action” workshops project, described in Appendix I Case 6, implemented by the Red Cross Climate Centre and UNISDR. The workshops would entail a three-day mediated dialogue through small-group presentations and games, as well as a site visit within the community where the warning communication strategy agreed-to in the workshop would be piloted. Participants would also agree on an evaluation plan for the strategy. The workshops would build the capacity of national and community-level end-users to use forecast bulletins for their day-to-day operations, to integrate them into their decision-making on disaster risk mitigation and to formulate simple operational messages to at-risk communities that would assist in disaster prevention. The workshops would include climate-service providers (such as from National Meteorological and Hydrological Services and Regional Climate Centres), representatives from communities affected by hydro-meteorological risks, disaster risk managers and other national actors involved in disaster prevention and climate change adaptation.

Objectives:
This activity aims to establish effective communication between climate service providers and the users of the information they provide to improve early warning. It will improve climate service provider understanding of the information requirements of their users, help align users’ expectations with service capabilities, promote the establishment of plans for communicating forecasts and warnings to pilot-project communities and for monitoring the effectiveness of implementation.

Benefits:
- Build trust between climate service providers and users;
- Improve the usability of climate services provided by local NMHSs;
- Enable early warning to high-risk populations in pilot communities;
- Provide forecasts for decision-making to pilot communities.

Deliverables:
The project will implement five workshops of three days in five countries. Each workshop will produce a strategy for communicating a defined set of climate services to a pilot community and an agreement on the criteria for evaluating the effectiveness of the services.

The activity is consistent with the Framework’s principles as it ensures greater access to climate services, builds on existing partnerships, and is inclusive of relevant stakeholders.

Current activities related to this activity:
This activity would scale up the “Early Warning, Early Action” workshops supported by IFRC and UNISDR in Senegal, Kenya, Uganda and Ethiopia (see Appendix 1 Case 6). The results of the workshops include opening communication channels between national meteorological services and national disaster risk management offices, the establishment of a national system for relaying warnings, and the development of partnerships with emergency preparedness organizations. Solid evidence of the sustained improvement of operational services provided through these workshops would be necessary input to the new activity.
Indicators and Assessment measures:
The workshop participants will agree on the criteria for evaluating the effectiveness of the communications strategy.

Risks:
Risks to the activity vary depending on the country and specific communities selected for implementation. They include unavailability of trainers for the workshops and the selection of workshop inappropriate participants from both the climate provider and user communities leading to ineffectual interactions. If the early warning strategy identified and implemented by the participants fails to protect the pilot communities, the credibility of the entire project would be compromised.

Stakeholders
Stakeholders include climate-service providers (such as from National Meteorological and Hydrological Services and Regional Climate Centres), UNISDR Africa Regional Office and Red Cross and Red Crescent societies, community-based NGOs, representatives from communities affected by hydrometeorological risk, disaster risk managers and other national actors involved in disaster prevention and climate change adaptation.

2.5.4 Water Resources

Activity:
Partnering climate services and water resources management

Bringing together Research, Climate Services, and Water Resources Management in highly vulnerable countries.

The Global Water Partnership, UNESCO and WMO would build upon their joint work in the field of hydrology and water resources (see Appendix 1 Case 2) with two sets of projects targeting water resource management issues in least developed countries in Africa and Asia. They include:

- Establishment of five projects in transboundary river basins identified as water scarce regions incorporating a UI Platform linking the hydrological and climatological communities.
- Establishment of five projects in river basins identified as highly dependent on snow or glacier melt for their water resources incorporating a UI Platform linking the hydrological and climatological communities.

Objectives:
- Establish a consultative process whereby the research and operational sections of the climate and water communities can interact to identify, implement and evaluate a range of climate information services in support of improved water resources management in a changing world.

Benefits:
- Increased understanding of the impacts of climate variability and change on water resources availability in areas at greatest risk.
- Decisions made on the basis of better information result in less wastage of a valuable resource and increased sustainability of the activities planned around the supply.
- The augmentation of water supplies due to increasing population or other demands are more effectively planned by having better information on climate variability and change.
- Improved decision-making processes associated with storage operations through the application of high quality seasonal climate outlooks.
- Decisions made on the basis of better information result in less wastage of a valuable resource and better sustainability of the activities planned around the supply.
• The augmentation of water supplies due to increasing population or other demands are more effectively planned by having better information on climate variability and change.
• High quality seasonal climate outlooks that can be readily included into decision-making processes associated with storage operations.

**Deliverables:**
The deliverables from this activity will be a consultative process whereby the research and operational sections of the climate and water communities can interact in terms of the identification, implementation and evaluation of climate information services. The process will be tested in areas of greatest water stress and fine-tuned to account for particular issues that arise at regional, national and local levels.

Further deliverables will include both climate information services closely aligned with water resources decision-making processes and the tools by which they can be developed, implemented and promoted through the climate and water communities.

**Current activities related to this activity:**
WMO, UNESCO and the Global Water Partnership (GWP) have a wide range of independent and cross cutting activities that are related to this initiative. They include the G-WADI initiative, the International Flood Initiative, Integrated Water Resources Management and the Associated Programme on Flood Management, and the Water, Climate and Development Programme for Africa. The GWP and the African Ministers Council on Water (AMCOW) have also unveiled a joint programme to support climate change adaptation in Africa.

The project will learn from and build on other activities and initiatives undertaken under the UN-Water coordination framework and within the members and associated partners of UN-Water. The UN Water Thematic Priority Area on Water and Climate Change (TPA-WCC) provides an opportunity to discuss climate change and water linkages in their widest sense and to ensure that the UN system through UN-Water is better prepared to meet future challenges and play an essential role in this area. The activities of the partners, mapped under the detailed mapping of activities and complementing with the mapping of mandates, capabilities, needs, gaps and strategies of the UN Water partners, provide a feeding ground for this activity.

**Indicators and Assessment measures:**
There are considerable benefits for the water priority area on all time scales from the provision of well-developed and targeted climate services. This area is arguably, the most climate sensitive of the GFCS priority areas. However, the linkages with other areas are strong, for example better climate services with regard to water will also improve food security in irrigated and rain-fed areas, reduce risk of water borne disease and improve sanitation, and in the extreme manifestations of water availability (floods and droughts) reduce disasters related deaths and damages. Water resources management is a day-to-day and year-to-year operational activity, and as well involves long-term strategic planning issues.

The proposed activities contribute to priorities:
• Link to Millennium Development Goal - Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.
• Number of countries in water scarce areas with the climate driven tools to address impacts of climate variability and change.
• Number of countries in areas dependent on snow and or glacier-melt with the climate driven tools to address impacts of climate variability and change.
• Number of Water Resources Management agencies using climate information services directly in their water resources management decision-making processes.

The proposed activities meet the following principles:
• High priority for the needs of climate-vulnerable developing countries.
• Primary focus is the better access and use of climate information by users.
• Framework will address needs at three spatial scales: global, regional and national.
• Framework will facilitate and strengthen - not duplicate.
• The Framework will be built through partnerships.

Risks
The risks to this initiative are all manageable, given adequate time and resources. They include:
• The expectations of users for robust and highly accurate information and services cannot be met because of inadequate data, limitations of the science, and/or poor communication of the information and services.
• The right people are not involved in the case studies and thus the cooperation and coordination expected are not achieved.
• The partners do not cooperate and share the required information.
• The application of the “cost recovery” principle to data collection.
• Inability to meet rising expectations about current capabilities.

Stakeholders:
Leading stakeholders include UNESCO and the Global Water Partnership, but also include, amongst others:
• World Bank.
• International River Basin’s Organization.
• African Ministers Council on Water (AMCOW).
• National Hydrological Services.
• National Meteorological Services.
• Regional Climate Centres.
• Water Research Community.
• Target countries.
• World Meteorological Organization, including its Commission for Hydrology and its Commission for Climatology.

2.6 Implementation approach (including operational and organizational aspects)

The implementation approach is first of all goal oriented. It aims for continuous evolution and enhancement. Generic targets for two, six and ten year implementation, targets that apply to all the priority areas, for both organizational and operational functions of the UIP are set in Table 3.
Table 3 sets out the organizational and operational targets in two, six, and ten years.

Secondly, in agreement with the Principles of the Framework, the implementation approach would be to work with existing entities, both providers and users, and to build upon activities already underway. To do this, the UIP should identify the organizational entities that are most involved in the initial activities, find the points of intersection, bring them together, and identify the drivers for timelines and reporting performance. Next, the operational functions need to be jointly developed.

A third approach to implementation is using pilot projects. Lessons learnt from these projects must help move steadily towards sustainable, operational, and valued service offerings. They should work to create real outcomes that lay out the pathways to fully operational systems, thus inspiring the donor communities to see the benefits in moving forwards.

A collective set of activities under a hierarchy of agreed deliverables, objectives, and goals that all serve to accomplish the higher goals, is a standard approach for implementing a Framework (see Appendix 3). All activities that help make climate services operational, that can meet the deliverables and objectives form part of the Framework. The UIP encourages as many contributions as possible, through unilateral, bi-lateral, and multi-lateral arrangements that work towards the Framework’s goals. Under the UIP, all participants are welcomed to conceive and implement activities that fill gaps or address identified priorities. Reports on contributions will be collected through the governance and a Catalogue of Contributions will give due recognition. All parties are encouraged to inscribe cases of climate services, including information about what made them successful or caused them to falter. In addition, a Compendium of potential activities that are trust-fundable will be maintained as an investment portfolio for those activities seeking financial support. This goal oriented approach, will inspire the sharing of lessons learnt among participants. It also assures a robust Framework in the near-term while future projects’ priorities and targets are honed through feedback and dialogue within the UIP.

\[ \text{WMO and Tudor Rose will publish } \text{Climate ExChange}, \text{ a book documenting a representative number of case studies of partnerships, interactions and relationships in climate services. It highlights good practices in a wide variety of societies and disciplines. Climate ExChange will be presented at the Extraordinary Session of the World Meteorological Congress (Geneva 29-30 October 2012) as well as the Technical Conference on Climate Services (Geneva 26-27 October) which precedes it.} \]
Lastly, the implementation approach is cognizant that local level activities are most important. Many countries, many entities undertake work that can contribute to climate services. The UIP, being the truly innovative part of the Framework, has to serve to connect well established programmes in all relevant organizations that can contribute to the framework components, from research to data archival, to service delivery and client consultation. The approach includes capitalizing upon the synergies in existing activities (Section 3.1) as one enabling mechanism. To illustrate this, the following paragraphs explore these aspects of the approach to implementation for disaster risk reduction by way of example.

WMO has already sought the active engagement of the UNISDR secretariat, which has been involved in the Framework’s development to date: UNISDR has committed to sharing the consultation draft of the Framework’s Implementation Plan with its constituency, and has provided its views to WMO on the development of activities through the drafting of the Exemplar on Disaster Risk Reduction. UNISDR has organized interagency meetings to seek feedback, and will soon post the final drafts on PreventionWeb, its portal for information sharing.

The UNISDR Africa regional office would be a critical partner in building regional early warning capacity for weather and climate related disasters (see Section 2.5.3). For monitoring and evaluating the activity, the Hyogo Framework Monitor provides an assessment format (under Priority for action 2: Identify, assess and monitor disaster risks and enhance early warning). To keep the Disaster Risk Reduction activities focused on user needs, the UIP will work in close liaison with the UNISDR. The Exemplar should be used as the basis for discussion in upcoming regional platform meetings (Figure 2). Furthermore, a Task Team on Meteorological Services for Improved Humanitarian Planning and Response was set up by WMO’s Commission for Basic Systems. Its objective is to develop operational capacities to provide emergency contingency planning to other UN agencies, and involves the humanitarian community and WMO’s Disaster Risk Reduction programme.

![Figure 2. Timeframe for climate-sensitive disaster risk reduction planning and implementation. See URL: http://www.unisdr.org/files/25129_towardsapost2015frameworkfordisaste.pdf](http://www.unisdr.org/files/25129_towardsapost2015frameworkfordisaste.pdf)
To complete this example, the disaster risk reduction community is focusing its activities in a post-Hyogo Framework timeframe. How can that community, as it prepares for the Global Platform for Disaster Risk Reduction in May 2013, communicate its needs to the climate service provider community? The UIP could propose that the Global Platform be developed as a joint event. There the joint activities outlined in the Exemplar could be showcased and the projects selected would be undertaken in close collaboration with ISDR system partners. Capitalizing on this community’s timeframe for action would lead towards better synergies in delivering relevant climate services. It is this sort of collaboration that the UIP would foster in its approach to implementation.

Just as the disaster risk reduction community has identified implementation timelines, priorities, activities, and monitoring methods, so have the other three priority areas in their respective Exemplars. All areas have relevance to one or more WMO Technical Commissions and their expert teams. Identifying these points of intersection, and the processes involved would be part of the role of the UIP in its implementation approach.

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

“Monitoring and Evaluation” involves checking progress of activities being implemented under the GFCS and assessing effectiveness. Standard project management tools, reporting procedures, progress reports, etc. would be used for these tasks. Moreover, the Governance arrangement should foster adequate oversight for monitoring the stream flow of projects and activities, and also provide avenues for reporting into the existing governance mechanisms for partner agencies.

More importantly, the UIP should monitor and evaluate how the overall objectives of the Framework are being met and, in particular, the extent and rate of uptake of climate information within the priority areas. Each priority area likely has monitoring instrument that could contribute to GFCS monitoring and evaluation processes (for instance, the UNISDR guide “Developing Early Warning Systems: A Checklist). The UIP will monitor and evaluate the progress of the Framework against a list of criteria using a results-based approach (broadly following the Logical Framework Approach - see Appendix 3).

Taken from the point of view of each of the priority areas, more specific conditions for successful UIP implementation are offered in Table 4.1-4.4. These criteria are based on the different Inter-Agency Consultations on the UIP. The list is neither definitive nor exhaustive; however, it provides important indicators of what eventual success would provide.

Accordingly, the outcomes listed in Tables 4.1-4.4 should serve as guideposts. Are the conditions being met? Did a project or activity make them a reality? Were experiences of successful implementations transposed successfully to other places or other priority areas? Are the actors on the ground well served? Progress on projects and activities should be measured against such desired outcomes.

Most important, climate services delivery means linking all the way from data to decisions. Monitoring and evaluation of progress must not miss the link through to implementation. Success is not simply a hand-off of information to an end-user, but more a hand-holding process through to the implementation’s results, the lessons learnt, and binding means of improvements into the next opportunities.
### Table 4.1 Monitor and Evaluate: Performance Outcomes for priority area Agriculture and Food Security

- A wide array of agricultural decision makers use the Platform, including government policy makers, agricultural extension services, farmers, research and university institutions, agribusiness and crop insurance industry, and farm management groups;

- Decision makers receive accurate and timely climate information for daily short-term tactical decisions or long-term strategic decisions to mitigate the impact of extreme climate events and to adapt to climate changes and climate variability;

- Seasonal climate forecasts reduce the sensitivity of rural communities and industries to climate risk. Probabilistic forecasts are translated into easily understandable language for farmers;

- Key climate variables (rainfall, temperature and solar radiation, humidity and wind speed) are available and understood by agricultural communities and rural communities who use them to optimize decisions;

- Climate information is used in monitoring food supply and demand and to issue outlooks on crop prospects, and early warning of impending food crisis;

- Climate information helps improve early action and early warnings resulting from migratory pests and diseases;

- Needs that were met in an ad hoc fashion by a growing pool of sources of data products, services and information continue to be met in a more routine manner;

- Currently available databases increase climate knowledge and improve prediction capabilities in order to facilitate agricultural decision-making from international policy level to local operational farm management strategies;

- Agricultural users fully understand and appreciate how to use the technology in their decision-making activities. Essential scientific and technical capabilities of the climate services are effectively linked to the urgent needs of the agricultural decision makers;

- Established 4-way communication amongst climate scientists, climate and agricultural researchers, agricultural extension services and the decision-making community, ensures that applied research is refined and expanded to meet the appropriate needs of the user communities;

- Improved decisions can depend on effective communication from sources agriculture uses already know and trust (farmer associations, NGOs, village leaders);

- Government agencies that manage food stocks, national authorities, and private grain traders have information as derived from seasonal climate forecasts of a poor harvest is in the offing, sufficient to initiate grain purchases from abroad to build buffer stocks.
### Disaster Risk Reduction

**Table 4.2 Monitor and Evaluate: Performance Outcomes for priority area Disaster Risk Reduction**

The dissemination of warnings of approaching short-, middle- and long-range hazards enable the protection of lives through appropriate preparedness to respond;

Land-use planning, informed by climate information, reduces risk through the careful location of critical infrastructure (such as hospitals and bridges, to which access must be maintained in a disaster), by distancing industries that could contaminate soil and water supplies in a disaster from people and fragile ecosystems, and by impeding the development of settlements in high-risk areas such as unstable mountain slopes and flood-prone land;

The resilience of livelihoods to disaster is enhanced by planning based on short-, middle- and long-range hazard forecasts that enable income diversification and the protection of assets exposed to extreme weather and climate, such as, non-weather-dependent seasonal employment and cultivation of drought-resistant crops;

Social safety nets and risk transfer mechanisms, steered by effective climate-information communication, support populations impacted by disaster, such as through temporary employment programmes and conditional cash transfers for vulnerable households, insurance and catastrophe risk pools/bonds;

Extreme weather and climate event data and observation (e.g. frequency and distribution of droughts, floods, heat waves, etc.) are necessary to support the availability of disaster risk financing, allowing more users in climate sensitive areas (e.g. agriculture) to achieve increased livelihood security;

Ecosystems that mitigate hazards, such as forests on slopes and mangroves in coastal areas, are protected or restored as a result of climate forecasts and projections.
<table>
<thead>
<tr>
<th>Public Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health sector partners are supported with appropriate climate information and services to help them achieve their priorities in addressing climate risks to health, such as those established by the World Health Assembly and United Nations Framework Convention on Climate Change;</td>
</tr>
<tr>
<td>A greater understanding of current patterns and burdens of many diseases, and of the linkages to environment and climate, is developed, allowing for their integration into Early Warning Systems for improved preparedness;</td>
</tr>
<tr>
<td>High quality data from different sectors (trans-disciplinary data sets) for application to complex environment-health issues are available at the appropriate format and scale, in a manner that resolves privacy and ownership issues, thus making a valuable contribution to public health;</td>
</tr>
<tr>
<td>Capacity building and awareness coupled with widely disseminated and understood seasonal forecasts enhances the health sectors’ ability to plan more effectively when expected climate and weather conditions create health risks;</td>
</tr>
<tr>
<td>Partnerships are forged for effective collaboration and joint action which support existing health priorities, goals, and technical agendas such as the Millennium Development Goals, the Hyogo Framework for Action and the International Health Regulations;</td>
</tr>
<tr>
<td>Climate information is appropriately developed to be applicable and commonly used to improve performance and management of health risk assessment, integrated epidemiological surveillance and environmental monitoring, health emergency risk management, health service delivery.</td>
</tr>
</tbody>
</table>
2.8 Risk management in the implementation of activities

The risks associated with implementing the Framework fall broadly into categories of organizational complexity, leadership and management, resourcing, and support for coordination between high-level agencies and actors on the ground. These risks have been elaborated well in the Climate Services Information Systems Annex and are not repeated here. Furthermore, risks to implementing the initial priority activities are described in section 2.5. But in a general sense, when viewing the UIP, risk revolves around the effectiveness of communication between a climate sciences led provider community and a needs driven actor community.

As one of the key strands of the Humanitarian Futures Programme, efforts to strengthen the science-humanitarian dialogue have identified the principal risks inherent in initiatives that seek to put science into action by people with humanitarian responsibilities. It studies dialogues between
‘those who make science’ and ‘those who use science to make decisions’. Among the risks identified is associated with the treatment of uncertainty.

Scientists need to distinguish between uncertainties relevant for policymakers and those that are more relevant for scientific discussion; there are also different interpretations of uncertainty within the climate community. Yet without understanding humanitarian and development decision-making processes, scientists may set the uncertainty threshold too high: they may view as too uncertain information that may still usefully inform certain decision-making processes. Furthermore, without understanding some of the underlying science, users may overreach in applying climate services.

As pointed out in the Water Exemplar, decision-making is usually driven by imperatives. For example, the need to meet design standards for flood protection, to provide adequate storage for drought conditions, or to decide what sort of grains to develop. Such decisions will be made whether or not adequate climate change information is available. For the potential user, climate is typically only one factor of many factors involved in making a decision. What matters is knowing if the climate service is likely to improve the decision and promote the desired outcome by either reducing risks or by reducing costs that flow from the decision, or increase social economic benefit on decision from the decision.

Continuing to relate implementation risks, it is important to note that the scale of analysis of weather and climate may be different from the scale of decision-making. In atmospheric science, the scale of phenomena, from thunderstorms to tropical cyclones, to drought, to global warming, varies in space from metres to local, national, regional, and global scales, and from time frames of minutes to centuries, as depicted in figure 3. Decisions about building cooling centres to cope with more extreme heat waves would be based on scientific information about climate change projections and scenarios, but would result in something being built on the scale of a small locality.

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13 A discussion on how scientists from a range of disciplines handle the issue of uncertainty in their area of specialization was organized by Professor Tim Palmer FRS (University of Oxford and European Centre for Medium-Range Weather Forecasts) and Professor Paul Hardaker (Royal Meteorological Society)

14 The discussion on uncertainty as relates to climate scientists and humanitarian interests we contributed by the Humanitarian Futures Programme, Kings College, London. See: http://www.humanitarianfutures.org/about/futuresgroup/exchange
Credible means of ‘downscaling’ the large-scale projections to the space and time scales for which planning decisions are being made would be useful. Also, other means of using climate information in structured decision-making would be useful.

![Seamless forecasting services diagram](image)

Figure 4. Timescales of certain climate-sensitive decisions. UK Met Office.

Lastly, finding the right entry points for engagement between providers and users will entail another risk in the implementation of the UIP. Policymakers lack the time to engage in the full range of scientific inquiry. They may prefer to engage with a small number of trusted advisors. Finding time and opportunity to be able to infuse a degree of scientific literacy into politics and the right degree of societal awareness into science, is something the Humanitarian Futures Programme\(^\text{15}\) is addressing. An approach that assumes global agencies can represent decision-makers and the public, without more focus on intermediaries at the national and local levels would be risky. Whether through WMO Commissions and Technical Expert Teams, UN agency forums, local health ministers, National Meteorological and Hydrological Services, agricultural extension officers, the risk will lie in the failure to bring together the right people at the right time.

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\(^{15}\) The Humanitarian Futures Programme is an independent research programme based at King’s College London, to develop strategies, approaches and tools to ensure that humanitarian organizations are prepared to meet the uncertainties and complexities of the future.
3 ENABLING MECHANISMS

3.1 Synergies with existing activities

Proposed initial activities, both generalized for the UIP (section 2.4) and specific for each priority (section 2.5) all build upon existing activities. Each activity improves the functions of the UIP while at the same time contributing to an improvement in services. The UIP is the novel component of the Global Framework, and this section describes other user interfaces in the priority areas, citing them as examples of enabling mechanisms that could be drawn on for implementation of the UIP.

Through the UIP, information about operational climate services in the Catalogue of Contributions will be made available. Individual nations can benefit from the knowledge and experience with climate services in other nations. Broadly speaking, the UIP will collaborate with the institutions that fund or support the various global initiatives involved in climate sensitive areas. It is important that the user interface is seen as a function that underpins many of the existing global programmes and initiatives (see Box 1 Section 2.2).

Synergies within the wide range of user interfaces that already exist can be found within groups working in climate-sensitive sectors. For example, some entities act as clearinghouses for information about climate and how it relates to decisions taken in disaster risk reduction, food security, health, and water resources (see Box 2). These clearinghouses have several sponsors, partners, and individual donors. Non-profit organizations also support map-based platforms that combine different layers of scientific and social data. Clearinghouses and mapping tools provide the means of infusing climate variability and change into knowledge streams used by people taking action in climate-sensitive sectors.

Individual end users quite often receive their climate services through intermediaries such as the media, secondary web portals, private suppliers or other non-government organizations, but end users may also be institutions with regional and global reach that seek consistent climate services across national boundaries.

The UIP is the key to ensuring that climate services reach end users in ways that maximize the efficacy and value of the climate information. In essence, it is the pillar most concerned with facilitating decision-making, helping to build a two-way pipe that ensures clients have a say in the design of the products and services they need, and in the way they are supplied.

Climate is but one of many layers of information used in decision-making, obviously. While a primary role of the Framework’s Research pillar is to reduce uncertainty, the UIP has the important role of helping sectors to manage uncertainty. The UIP will act as a conduit for mainstreaming climate science into the processes of improved climate-related decisions.
The UIP should help link climate data with emerging structured decision-making. The University of North Carolina (USA) and the National Environmental Modeling and Analysis Center (USA), for example, have developed a structured decision process, linking technology tools to climate data and projections. The process and linked tools have been called a “decision theatre”, due to the ability for a group to interact with all of their data in a theatre-like setting while being led through a structured decision process by a group of trained facilitators. Other structured decision-making examples include the downscaling of climate scenarios and projections at University of British Columbia’s (Canada) climate-decisions.org, the Central American Probabilistic Risk Assessment, a regional group for Disaster Risk Reduction, or energy-focused decision-making at Carnegie Mellon University’s Center for Climate and Energy Decision Making (USA). The decision process is value-based and focuses on a well-defined problem with associated goals and objectives. To ensure consistency and transparency, a four step process is utilized: (1) Data Integration; (2) Visualization

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**Box 2: Existing synergies: clearing houses and mapping interfaces:**

PreventionWeb\(^{(1)}\) is one example of a platform for information sharing among disaster risk reduction professionals. Updated daily, it contains timely disaster risk data, statistics, graphs and country maps, academic programs and training resources. And conveniently, it links to humanitarian platforms named HEWS, Alertnet, CATNAT, GDACS, IRIN, Reliefweb, and SATCA web, for examples.

Similarly, the Climate Adaptation Knowledge Exchange\(^{(2)}\) (CAKE) aims at building an innovative community of practice by sharing knowledge about managing natural systems in the face of rapid climate change. It serves users by:

- Vetting and clearly organizing the best information available,
- Building a community via an interactive online platform,
- Creating a directory of practitioners to share knowledge and strategies, and
- Identifying and explaining data tools and information available from other sites.

Another related clearinghouse, called the Data Basin Climate Centre\(^{(3)}\) aims to provide reliable datasets and easy-to-use mapping tools in a central place. It involves contributions from experts in the field of climate change while it:

- Focuses on datasets, tools, and social networks related to climate impacts;
- Connects users with spatial datasets, tools, and expertise;
- Allows individuals and organizations to download from a vast library of datasets;
- Provides map galleries and produces customized maps; and
- Connects users with experts and working groups for effective collaboration.

Making climate data, products, and information available in map interface form aids the decision-making process. Mapping of food insecurity\(^{(4)}\) and disease epidemics\(^{(5)}\) are two examples. Forest management tools developed in Ireland\(^{(6)}\) and Republic of Korea\(^{(7)}\) and groundwater mapping in Australia\(^{(8)}\) are additional examples. The Adaptation Atlas\(^{(9)}\) is a dynamic mapping tool that brings together diverse sets of data on the human impacts of climate change and adaptation activities across the themes of food, water, land, health and livelihood. Based on IPCC science and rooted primarily in economics and other social science, the Atlas aims to help researchers, policymakers, planners and citizens to establish priorities for action on adaptation. Useful skills in mapping, such as taught by the United Nations Institute for Training and Research (UNITAR), could help ensure that climate layers can be added to the layers of other kinds of data used in decision-making.

* (See Appendix 5 for references.)
linked to key value drivers; (3) Storytelling to create narrative on climate change scenarios and alternatives; and (4) Decision Making with climate as one of many input variables.

### 3.2 Building national, regional and global partnerships

Implementation of the UIP at the global level requires the establishment of mechanisms to bring together the stakeholders that play a role in the supply and use of climate services. Governments head this list of international stakeholders, representing users and suppliers through their actions as facilitators. They provide human and financial resources to suppliers, and generally provide the principal channels for the rapid movement of climate services to the user communities.

“The UIP will have a particularly critical role in establishing credible mechanisms for engaging non-state stakeholders in the governance arrangements, while governments will have to involve user community representatives along with those from the provider agencies in their Framework-related processes”.

Where there is a strong relevance of their work to that of the Framework, international non-government organizations should be encouraged to join in the dialogues promoted by the UIP.

Universities and research institutions, through the World Climate Research Programme, the International Council for Science, and other similar coordination mechanisms, develop the atmospheric sciences and technologies that underpin the climate services delivered to specific users by operational institutions such as NMHSs. It is the CSIS pillar that is responsible for helping ensure the effectiveness of the ongoing operational delivery of primary climate services.

Implementation of the UIP at the regional level will likely differ around the world, driven by cultural differences in language, technological capabilities and the range of climate vulnerabilities and hazards faced. Stakeholder dialogues will be established using existing regional mechanisms (such as the regional economic groupings, e.g., the Southern Africa Development Community, the Regional Climate Centres and the Regional Climate Outlook Forums). On mid-term time scales (months to a year) the Forums have had success in applying seasonal forecasting to sector applications such as in the pre-positioning of supplies for an early onset rainy season. Likewise, to address planning for adaptation in the longer term, Forums with broader agendas could serve as an interface between the climate research groups, the operational groups, intermediaries and end users. Applying knowledge about climate drawn from medium to long-term climate projections in decisions about building reservoirs for future water supply, for example, would also be important regional level dialogues.

National governments will also need to participate in the international and regional mechanisms of the UIP, providing leadership, expertise and resources. If the UIP is to be effective in establishing the structures and opportunities through which end users can provide information on their requirements, provide feedback on service quality and relevance, and participate in climate services-related training then national governments will, as a minimum, make the end user participation possible. Ideally they will also provide financial support to facilitate the activities of the UIP.

National centres will play an important role in promoting the standards, protocols and good practice guidance for delivering climate services to end users at the community level, especially in adaptation activities. They will also be engaged through national contributions to the UN-System. It is expected that governments will highlight the important role national meteorological and national hydrological services play in gathering, managing, storing and analysing meteorological and hydrological data, as well the use to which they are put in a variety of services.

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16 Principle 8 of the HLT report
agriculture. In the interests of building a strong national climate service capability it will be beneficial to strengthen cooperation between these and the national meteorological and hydrological services. The assessment of the requirements at the sub-national level would be through nationally designed and implemented UPIs.

Beyond government, research, and non-governmental organizations, the private sector too will be engaged in the working mechanisms of the UIP. Engaging this sector will facilitate implementation from international to community geographic areas. Intermediaries make bridges between expert knowledge and effective practical applications. Examples of intermediaries include adaptation practitioners, agricultural extension officers, teachers, and professional associations of engineers, urban planners, and industry consultants.

The WMO has taken a leadership role through the World Climate Conference-3 and has shown its commitment to the Framework through its support of the High Level Taskforce and through the preparation of this implementation plan. To reach all affected stakeholder communities a broad range of other UN agencies and programmes need to become engaged. The HLT report says that the implementation plan should set criteria and include processes for encouraging their participation.

### 3.3 Review mechanisms

Roles and responsibilities for the user communities will be a necessary component of the review mechanism for the UIP, whatever the nature of the GFCS governance. To that end, the Governance Options recommended by the HLT\(^\text{17}\) were reviewed as a guide to suggesting ways that, through the UIP, user communities might be formally engaged.

A working structure for the UIP that fits within the overall Framework’s Governance would help improve the ability to build and sustain partnerships.

Interagency interaction through representation is imperative to ensure the participation and advice of major stakeholders in the Framework. Technical committees, responsible for the activities under the five pillars, could be organized to oversee the UIP implementation work. Mindful of the need to avoid duplication by making use of existing committees and mechanisms, leadership for the UIP would draw from the leading institutions of the priority areas. They include UN system organizations and coordination mechanism (FAO, UNISDR, UN Water, UNESCO, WFP, WHO and the World Bank) and those drawn from other potential partners noted in Appendix 2. In particular, organizations involved in initial fast-track projects and activities, and key stakeholders included in the suggested priority activities, should be involved in the review mechanisms.

Similarly, opening up technical panels of the UN agencies to climate experts would be equally valuable. At the national level, for example, a good mechanism would be to enable staff of NMHS to participate more in water resources planning meetings. Such opportunities would allow them to gain a deeper understanding of how climate affects the agency they are servicing with information, and thus identify what types of additional climate information might be useful, and how to make the information more actionable. On the reciprocal side, it would enable staff in the humanitarian agency to better understand the possibilities and limitations of climate information.

On the provider side, opening membership of WMO technical panels, committees, etc. to user representation would also further the goals of the UIP. Membership of WMO Technical Commissions, the Associated and Cross Cutting Programmes, and their Open Programme Area Groups and Expert Teams could include participants from relevant groups involved in the priority area sectors. The WMO Commissions for Agricultural Meteorology, Hydrology, Climatology, and the Commission for Basis Systems are all actively engaged in development of climate services in the priority areas. Some examples to illustrate this point follow.

\(^{17}\) HLT Report pages 216-217
The WMO’s Technical Commissions for Agricultural Meteorology and Hydrology are relevant to both the agriculture and water priority areas. Bringing together experts in these areas would help meet the first desired outcome of the UIP: identifying the optimal methods for obtaining feedback from climate service user communities. As one specific example, the recent *Expert Meeting on Water Manager Needs for Climate Information in Water Resource Planning* included both scientific and humanitarian experts. That meeting demonstrated how the flow of user requirements and the exchange of technical advice will be important to the success of the Framework.

Within the Commission for Climatology’s group that deals with Climate Information for Adaptation and Risk Management, there are expert teams focusing on areas key to the success of the UIP. Particularly applicable to the four priority areas are the Expert Team on Climate Risk and Sector-specific Climate Indices, with its Task Teams on: User Participation in Climate Outlook Forums, User Interface, and Climate Risk Management. (See Appendix 4 for a pertinent diagram).

CBS’s Expert Team on Public Weather Services, though not specifically focusing on climate time scales, carries out work to strengthen capacity of NMHS to meet the needs of the users they serve, including communications training, an important element of UIP’s climate outreach and literacy outcome. WMO’s cross cutting Disaster Risk Reduction Programme, manages a comprehensive effort to strengthen and integrate disaster risk reduction processes in all aspects of water, hydrology and climate. With Disaster Risk Reduction as one of the four priority areas, this programme’s efforts related to climate events (risk assessment, climate predictions at seasonal, inter-annual, and long range) would have direct application to the UIP. Cross membership on the UIP Management Committee would certainly aid dialogue between users and the components of the pillars, a UIP desired outcome.

Besides the need for an organizational structure for reviewing projects, there is also a requirement for an operational mechanism. WMO has established a Rolling Requirements Review (RRR) in the Commission for Basic Systems. This ongoing and iterative review process involves experts who ascertain the observational requirements to meet the needs of all WMO Programmes. Though the needs of the Global Framework go beyond observations alone, this rolling requirements review proposes to undertake a more comprehensive survey of climate service providers and their stakeholders in order to better quantify some of their requirements. It is suggested that a RRR type mechanism be used for the inter-agency review of climate services.

### 3.4 Communication strategy

Beyond the UN system, many intermediaries assist the flow of climate information to individual users. The media in all its forms (print, broadcast TV and radio, telephone and the Internet) contributes a critical role in communicating information quickly and efficiently to the widest number of recipients. Through its heavy involvement in all major forms of media content, the private sector becomes a critical intermediary in the consumption of climate services. Many non-government organizations working in disaster and humanitarian relief are both consumers of climate services and act as intermediaries, passing on advice and warnings to other users, as do local and provincial governments that have planning and disaster management response responsibilities.

Two communication strategies particular to the UIP can help the overall effectiveness of the Framework. The first is in gathering examples that demonstrate the value of climate services (value stories), and the second is in economic benefits analysis.

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18 The Rolling Requirements Review (RRR) process is defined by the *Manual on the Global Observing System* in WMO-No. 544.

19 An analysis of current and emerging capacity gaps in surface and upper air observations to support climate activities, from the Statement of Guidance for Climate (Other Aspects – CCL). Point of contact: Dr William Wright, Co-Chair CCI OPACE 1, Version updated in May 2012 by the PoC, and approved by the ET-EGOS-7, May 2012.
Interactions between providers and climate data users are not a new phenomenon. Value stories explain how climate data and information are already used by business, industry, and sectors from agriculture, transportation, construction, ecology, health and so forth. Such examples, when told as stories, can amplify the importance of climate services to the constituency. Sharing them can, enhance stakeholder engagement through building examples on uses and applications of climate data.

Besides their advocacy use, value stories can be useful as an adaptation tool. Communities need "climate analogues" to plan and adapt to climate change. Climate analogues can be built and used to exchange knowledge between communities on current practices (in agriculture, transportation, construction, etc.) that can help maintain productivity in the future, should there be significant shifts in climate conditions leading socio-economic disruption, for example to growing conditions, road maintenance, heating and cooling systems, building codes, frost damage. The situation in the future will closely resemble conditions that already exist in other parts of the world or even in another part of a larger country. Making these links might offer clues about practical, proven approaches that could enable communities to adapt their practices to changes in temperature and precipitation patterns, to the frequency and intensity of extremes, and to shifts in the timing of the seasons.

Besides value stories, a second communications strategy within the UIP would be to build quantitative cases of the economic value of climate services. The UIP advocacy objectives should include efforts to establish intellectual capital in the area of economic consequences of climate variability and change, and expertise in the economic value of climate data and services.
4 RESOURCE MOBILIZATION

Resources will be provided by a range of partners in the UIP and come in a variety of forms. At the global level, governments are already providing resources to the UN systems and other international mechanisms that play active roles in the development of what will become elements of the GFCS. These contributions will be leveraged by the UIP as the international mechanisms that interact with the climate services stakeholders take advantage of the opportunities the Framework offers for coordination, standard setting, information exchange and capacity development in climate services.

One such coordination mechanism may be a counterpart framework for climate services operating at the national level, as exemplified by a World Bank project in Nepal (see Box 3).

Resource mobilization is necessary for the successful implementation of the UIP of the Framework. It will be achieved through:

a. The commitment of governments to the establishment of a UIP;

b. The application of financial and skilled human resources at the level needed to properly support the operational elements of the UIP and its ongoing governance; and,

c. The engagement of key stakeholders in the climate services supply and user communities to match demand for climate services with their production, and to improve decision-making in a wide range of economic sectors using the services.

Box 3 Resource Mobilization

The World Bank, through the Pilot Programme for Climate Resilience, is developing a programme to modernize Nepal’s Department of Hydrology and Meteorology. This programme has three components: institutional strengthening, improving observing networks and forecasting, and enhancing service delivery, the latter mostly through the introduction of climate services. In Nepal, as in many countries, there are several institutions involved in climate observations and many users of climate information in government and throughout civil society.

The World Bank challenge was to strengthen a single institution to provide better weather, climate and hydrological services, while recognizing that there are other actors in climate services sector. Making reference to a National Framework for Climate Services provided the World Bank an opportunity to bring together all of the different stakeholders (providers and users) to engage in building a more effect system to exchange information, while enabling them to strengthen the Department in rational way.

A national framework also provided the connection between each stakeholder and the Global Framework for Climate Services. For example, a health project developed at the national level between the Ministry of Health and the Department of Hydrology and Meteorology would likely require the engagement of ministries engaged in agriculture and water resources (e.g. climate sensitive water borne diseases, nutrition, etc.). Independently, each of these ministries would be able to utilize the GFCS through the NFCS to strengthen their own capacity, creating a much more robust national partnership than would otherwise be possible.

The World Bank has allocated approximately US$ 450,000 to establish the National Framework for Climate Services out of a total of about US$ 800,000 for allocated climate service delivery.

In addition, the World Bank Group’s infoDev is designing and launching a network of Climate Innovation Centers to accelerate the development, deployment, and transfer of locally relevant climate technologies. See URL http://www.infodev.org/en/Topic.19.html
4.1 National level (e.g. Governments, Private sector, Foundations, Bilateral and Multilateral funding mechanisms, international agencies, etc.)

Role of Governments
Besides helping to organize the Catalogue of Contributions from countries, the UIP will identify opportunities for implementation in developing countries. Furthermore, within the broader context of the overall objectives of the Framework, it is expected that these projects and activities will be eligible for funding through development banks and other similar aid-related funding mechanisms. Nationally based international aid programmes will also offer opportunities for funding projects.

With the development of the Framework there will be growth in demand not only for the climate services that are considered as “public goods” but also the services that are “private goods”, whose provision leads to a return of revenue to those who make them possible.

There is a broad range of climate services now supplied by the private sector, for example; climatological data, information and advice for the building sector, for climate vulnerable activities such as aquaculture, off-shore oil and gas exploration and exploitation, electricity grid management, for new developments in the tourism sector, etc. Inevitably these private goods have been, and will continue to be created through value-adding to the community investment in the collection and dissemination of climate data, climate science and the enabling technologies that have been created and are maintained at public expense.

How these issues are managed at the national level will vary: in some countries the return to the community from the private sector value-adding is seen to come from the employment they create, the taxes paid by private sector entities and the improved decision-making these services facilitate. In other countries a further contribution to the cost of maintaining the underpinning public good capability is, and will likely continue to be sought through a charge to access some forms of basic climate data and information. These are decisions for national governments within an agreed overall operational structure for the Framework.
5 APPENDICES

Appendix 1: *Examples of climate services that highlight the functions of a UIP*

Appendix 2: *Table of Potential Partners at Global, Regional and National Levels in the Four Priority Areas*

Appendix 3: *Logical Framework Approach*

Appendix 4: *WMO Commission for Climatology working mechanisms*

Appendix 5: *References*
Appendix 1

Examples of climate services that highlight the functions of a UIP

Examples of existing activities in agriculture, health, disaster risk reduction and water highlight the functioning UIP. An example in North America (Case 1) illustrates linking climate service users with researchers and service providers. Case 2 describes bringing together water resource practitioners with climate service providers. A development project in Africa, now being implemented (Case 3) has strong linkages between users, private sector, and service providers. Capacity building is described in Case 4 in a project that facilitates feedback from agriculture workers. Capacity building through working groups is described in a health activity (Case 5). Lastly, Case 6 illustrates an example of linking disaster risk reduction practitioners with scientists.

Case 1: Linking Climate Service Users with Researchers and Service Providers

The south eastern states of Florida, Georgia and Alabama of the USA make important contributions to the nation’s agricultural output, particularly for row crops, livestock, forage, small and tropical fruits and vegetables. The climate of the region is complex and varied and is strongly impacted by the El Niño – Southern Oscillation (ENSO). The challenge was to improve the management of this climate risk.

The Southeast Climate Consortium (SECC), which includes major universities from Florida, Georgia and Alabama, provides scientific research to the study of climate and climate variability in relation to agriculture. The SECC has made cooperative extension services a primary responsibility, and in each state has established extensive extension networks through county coordinators and agents whose main goal is to act as an interface between researchers, service providers and local farmers and growers.

A programme to improve operational services was initiated through small group meetings with county agents and extension specialists. A company was then hired for the research prototypes and developed a rather generic service delivery system design which allowed for easy modification and updates of the website. County agents expressed a need for local climate information during the coming three to six months. In response, the SECC developed a clear prescription for management decision involving which crop and cultivar to plant, and pest management applications. The SECC implemented an evaluation and impact assessment team that relayed the needs and requests from stakeholders to the research teams. AgroClimate (www.agroclimate.org) now provides seasonal climate forecasts developed by climatologists working with the Southeast Climate Consortium (SECC) to meet the precise needs of farmers with the best science and technology currently available.
Case 2: User Feedback in Water Resources
Climate Research and Water Resource Management in Semi-Arid and Arid Regions

A number of programs of UNESCO have been placing their emphasis on introducing improved, modelling, observation collection practices and decision tools for improved water resources. Water resources issues are an issue of particular interest to the decision makers and stakeholders of arid and semi-arid regions of the world.

A Workshop on Applicability of Climate Research and Information for Water Resource Management in Semi-Arid and Arid Regions was held in April 2005, in Cairo Egypt. The workshop was organized around presentations by stakeholders and researchers and included opportunities for dialogue and discussion. Presentations from the stakeholder community focused on the nature of water resources and operational hydrologic issues (current and emerging) of the semi-arid areas, including requirements for hydrometeorologic and hydroclimatic information. Presentations from the hydroclimate research community focused on the current state of observations and on modelling related to climate and hydrology of semi-arid areas.

Yet another workshop on Water and Development Information for Arid Lands – a Global Network (G-WADI) in Tehran, Islamic Republic of Iran, was held in June 2011 to promote better dialogue and understanding of potential climate change impacts on water resources of arid and semi-arid zones. Organized by the Ministry of Energy of the Islamic Republic of Iran and UNESCO Tehran Cluster Office in coordination with the Asian G-WADI Secretariat, the workshop also discussed a new paradigm of rethinking the approach to water use with the aim of increasing the productive use of water. During the workshop, which was attended by experts from various Asian countries, specific sessions were allocated to climate change risks and monitoring.

By sharing experience of regional countries in the field of climate change adaptation and managing scarce water resources new approaches to sustainable water resources management based on sound climate information and services can be established.
Case 3: Linking Climate Service Users with Private Sector and Service Providers
Water Efficient Maize for Africa (WEMA)

Drought is the most important constraint of African agriculture. Three-quarters of the world’s severe droughts over the past 10 years have occurred in Africa. The WEMA partnership was formed in response to a growing call by African farmers, leaders, and scientists to address the effects of drought in a way that is cost effective to African smallholder farmers.

Maize is grown by more than 300 million Africans farmers depend on it as their main food source – and it is severely affected by frequent drought. Drought leads to crop failure, hunger, and poverty. Climate change will only worsen the problem. Drought tolerance has been recognized as one of the most important targets of crop improvement programs, and biotechnology has been identified by the United Nation’s Food and Agriculture Organization (FAO) as a powerful tool to achieve significant drought tolerance. Identifying ways to mitigate drought risk, stabilize yields, and encourage small-scale farmers to adopt best management practices is fundamental to realizing food security and improved livelihoods for the continent. The African Agricultural Technology Foundation (AATF) is leading a public-private partnership called Water Efficient Maize for Africa (WEMA) to develop drought-tolerant African maize using conventional breeding, marker-assisted breeding, and biotechnology. The benefits and safety of the maize varieties will be assessed by national authorities according to the regulatory requirements in the partner countries: Kenya, Mozambique, South Africa, Tanzania and Uganda.

The partners in this five-year project will develop new African drought-tolerant maize varieties, incorporating the best technology available internationally. The long-term goal is to make drought-tolerant maize available royalty-free to small-scale farmers in Sub-Saharan Africa.

AATF will work with the internationally funded non-profit International Maize and Wheat Improvement Center (CIMMYT), the private agricultural company Monsanto, and the agricultural research systems in eastern and southern Africa in this effort. AATF will contribute its leadership, unique experience in public-private partnership management, technology stewardship, and project management expertise. CIMMYT will provide high-yielding maize varieties that are adapted to African conditions and expertise in conventional breeding and testing for drought tolerance. Monsanto will provide proprietary germplasm, advanced breeding tools and expertise, and drought-tolerance transgenes developed in collaboration with BASF. The varieties developed through the project will be distributed to African seed companies through AATF without royalty and made available to smallholder farmers as part of their seed business. The national agricultural research systems, farmers’ groups, and seed companies participating in the project will contribute their expertise in field testing, seed multiplication, and distribution. The project will involve local institutions, both public and private, and in the process expand their capacity and experience in crop breeding, biotechnology, and biosafety.
Case 4: Capacity Building - Agriculture and Food Security
Roving Seminar Training and Farmer Field Schools

The Food and Agriculture Organization works to raise levels of nutrition while improving agricultural productivity. National Forums and Farmer Field Schools are a good means of educating the agricultural users to the decision support tools and products available. Multi-agency meetings are used to engage stakeholders to assess their needs, prepare agro-advisories, and re-evaluate the results of the products and services provided to the user communities. The WMO Agricultural Meteorology Programme has also conducted a very effective Roving Seminar Training series for over a decade on many operational agricultural meteorology applications. Through Farmer Field Schools, climate service information can reach the farming community. Non-Governmental Organizations have been instrumental in setting up telecentres in remote areas of Least Developed Countries. There is ample potential for effective use of Information and Communication Technology in agriculture and food security initiatives.

Illustrated here for South Africa, knowledge of climatic variability, its frequencies and its causes can lead to better decisions in agriculture regardless of geographical location.
Case 5: Capacity Building – Climate and Health Working Groups in Africa: A Model for Developing a User Interface Platform

In recent years, the Public Weather Services Programme of WMO helped establish and strengthen “Climate and Health Working Groups” in a number of countries in Africa. These involve service providers and users and promote interdisciplinary assessment of socio-economic benefits of meteorological and hydrological services. In particular, the working groups address the specific needs of the health sector, as a user community for climate and weather information.

The Climate and Health Working Groups work to develop national capacity through the following process:

- Identifying the weather and climate data, information and service needs of the health sector; gaps in current data, information and service delivery; and recommendations for filling these gaps, including enhanced observing networks, decision support tools.
- Identifying gaps and problems which constrain the routine use of weather and climate information by the health sector, and identifying and pursuing the means to overcome them.
- Formulating institutional data sharing among the sectors.
- Identifying research needs on climate and health.
- Identifying education and training needs across the sectors.
- Facilitating access to tools of climate and weather for the health sector.
- Enhancing the use of early warning systems for climate-sensitive diseases like malaria and plague.
- Building the capacity of national, local and community based organizations to widen and strengthen their services in this area.
- Organizing and presenting to decision-makers scientific evidence on the impact of climate variability and climate change on health.
- Organizing annual workshops on weather/climate and health issues.
- Collaborating with similar entities throughout the region to share experiences and building on each other’s skills.

The Key outcomes of the CHWGs have been improved service delivery and enhanced capacity to use weather and climate services in the health sector.

- Helping the National Meteorological Services to move from data gatherer to service provider.
- Helping with the use of weather and climate knowledge and information versus simply building archives of data.
- Providing better services to the population.

Similar projects are underway to establish Climate & Health Working Groups in West Africa, namely in Burkina Faso, Mali, Niger and Mauritania, and strengthen the existing CHWG in Ethiopia.
### Case 6: Disaster Risk Reduction Priority Area

**Communicating climate information for early warning and early action**

The absence of dialogue between providers of climate services and vulnerable communities can be a barrier to the use of forecasts. Forecasts may not match the information needs and decision-making timelines of users and may be perceived as too technical at the community level. Conversely, ensuring that communities receive, understand and are able to act on warnings of impending hazards may be vital to their survival. To address this communication gap and promote effective early warning, the International Federation of Red Cross and Red Crescent Societies (IFRC) and the United Nations International Strategy for Disaster Reduction (UNISDR) supported workshops at community-level in Africa between 2009 and 2011.

The “Early Warning, Early Action” workshops took place in Senegal, Kenya, Uganda and Ethiopia. They included forecasters from national hydro-meteorological services, climate modellers from university climate research centres, hydrologists, remote sensing experts and agro-meteorologists, as well as representatives from communities affected by hydrometeorological risk, national and sub-national government disaster managers, representatives from community-based organizations and international non-governmental organizations working at community-level and other national actors involved in disaster prevention and climate change adaptation. In most cases, representatives from the provider and user communities had never met.

During the three-day workshop, participants were tasked with: (1) jointly developing a plan to communicate timely and actionable early warnings to populations facing climate risk; and (2) developing a strategy to enable access to climate information to the pilot disaster-prone community participating in the workshop.

The workshops used a dynamic, small-group discussion method, and included playing a game in which participants must decide whether to trigger a warning based on climate information, as well as a visit to the nearby community where the communication strategy will be piloted. The results of the workshops include opening communication channels between national meteorological services and national disaster risk management offices, the establishment of a national online forum to relay warnings, and the development of partnerships with emergency preparedness organizations.
Appendix 2
Table of Potential Partners at Global, Regional and National Levels in the Four Priority Areas

Table 1: Some of the institutions involved in climate-related efforts in the four priority areas of the GFCS. The geographic scope of engagement in the working mechanisms of potential partners is indicated at Global, Regional, and National levels. Though the table is not all inclusive, it illustrates the broad breadth of partners. Efforts were made to include organizations named in the Cases and priority activities in sections 2.4 and 2.5 of this Annex.

<table>
<thead>
<tr>
<th>Potential Partners at the Global, Regional National Levels</th>
<th>Agriculture</th>
<th>Disaster RR</th>
<th>Health</th>
<th>Water</th>
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<tbody>
<tr>
<td><strong>Levels</strong></td>
<td><strong>Priority Areas</strong></td>
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<td>Health agencies and ministries</td>
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<td>International cooperation and development agencies</td>
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<td>Natural resources and agriculture agencies and ministries</td>
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<td>Universities and research institutions</td>
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<tr>
<td>WMO Commission for Climatology</td>
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<td>WMO Commission for Hydrology</td>
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<td>WMO Disaster Risk Reduction Programme</td>
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<td>USGCRP - US Interagency Crosscutting Group on Climate Change and Human Health (CCHHG)</td>
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<td>Group on Earth Observations GEO Health and Environment Community of Practice</td>
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<td>Earth System Science Partnership ESSP Project: Global Environmental Change and Human Health (GECHH)</td>
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</tbody>
</table>

---
### Potential Partners at the Global, Regional National Levels

<table>
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<tr>
<th>Levels</th>
<th>Agriculture</th>
<th>Disaster RR</th>
<th>Health</th>
<th>Water</th>
</tr>
</thead>
</table>

#### United Nations System

- **Food and Agriculture Organization (FAO)**
  - Levels: GRN
  - Priority Areas: X, X, X, X, X
- **International Fund for Agricultural Development (IFAD)**
  - Levels: G
  - Priority Areas: X, X
- **Pan American Health Organization (PAHO)**
  - Levels: R
  - Priority Areas: X
  - Levels: GRN
  - Priority Areas: X
- **United Nations Convention on Biological Diversity (CBD)**
  - Levels: G
  - Priority Areas: X, X, X, X
- **United Nations Convention to Combat Desertification (UNCCD)**
  - Levels: G
  - Priority Areas: X, X, X, X
- **United Nations Development Programme (UNDP)**
  - Levels: GRN
  - Priority Areas: X, X, X, X
- **United Nations Educational, Scientific and Cultural Organization (UNESCO)**
  - Levels: GRN
  - Priority Areas: X, X, X
- **United Nations Environment Programme (UNEP)**
  - Levels: GR
  - Priority Areas: X, X, X
- **United Nations Framework Convention on Climate Change (UNFCCC)**
  - Levels: GRN
  - Priority Areas: X, X
- **United Nations International Strategy for Disaster Reduction (UNISDR)**
  - Levels: GRN
  - Priority Areas: X, X
- **United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA)**
  - Levels: GRN
  - Priority Areas: X, X, X
- **United Nations University (UNU)**
  - Levels: RN
  - Priority Areas: X, X
- **UN Water**
  - Levels: GRN
  - Priority Areas: X
- **World Food Programme (WFP)**
  - Levels: GRN
  - Priority Areas: X, X
- **World Health Organization (WHO)**
  - Levels: GRN
  - Priority Areas: X, X
- **WHO Regional Committees for Africa, Americas, Europe, South Asia, Western Pacific, and Mediterranean**
  - Levels: R
  - Priority Areas: X

#### Other inter-governmental and international financial institutions

- **African Climate Policy Centre (ACPC)**
  - Levels: R
  - Priority Areas: X, X, X, X
- **African Centre for Meteorological Applications for Development (ACMAD)**
  - Levels: R
  - Priority Areas: X, X, X, X
- **African Development Bank (ADB)**
  - Levels: R
  - Priority Areas: X
- **African Union (AU)**
  - Levels: R
- **AGRHYMET Regional Centre**
  - Levels: R
  - Priority Areas: X, X, X, X
- **Association of Southeast Asian Nations (ASEAN)**
  - Levels: R
  - Priority Areas: X, X
- **Applied Geoscience and Technology Division of the Secretariat of the Pacific Community (SOPAC)**
  - Levels: R
  - Priority Areas: X
- **Asia-Pacific Economic Cooperation (APEC)**
  - Levels: R
  - Priority Areas: X
- **Caribbean Catastrophe Risk Insurance Facility (CCRIF)**
  - Levels: R
  - Priority Areas: X
- **Caribbean Community Climate Change Centre (CCCCC)**
  - Levels: R
  - Priority Areas: X
- **Caribbean Development Bank (CDB)**
  - Levels: R
  - Priority Areas: X
- **Caribbean Disaster Emergency Management Agency (CDEMA)**
  - Levels: RN
  - Priority Areas: X
- **Caribbean Meteorological Organization (of CARICOM)**
  - Levels: R
  - Priority Areas: X
- **Community of Sahel-Saharan States (CEN-SAD)**
  - Levels: R
  - Priority Areas: X
- **Common Market for Eastern and Southern Africa (COMESA)**
  - Levels: R
  - Priority Areas: X
- **Eastern Caribbean Donor Group**
  - Levels: X
- **Economic Community of West African States (ECOWAS)**
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  - Priority Areas: X, X
- **Economic Community of Central African States (ECCAS)**
  - Levels: R
  - Priority Areas: X
<table>
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<tr>
<th>Potential Partners at the Global, Regional National Levels</th>
<th>Levels</th>
<th>Agriculture</th>
<th>Disaster RR</th>
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<th>Health</th>
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Appendix 3
Logical Framework Approach

The implementation approach described in this Annex is roughly based on the Logical Framework Approach, a widely used participatory planning and management tool for Frameworks. The Logical Framework Approach develops a common understanding of the expectations of a Framework by delineating a hierarchy of project Activities, Outputs, Purpose, and Goals that collectively will lead to the accomplishment of the greater Goal of the Framework (see Figure 1 below). All projects that accomplish the goal can be seen as contributing to the Framework.

The UIP activities described in section 2.5 in this Annex use the terminology:

Objective or Goal – greater why
The long-term impact of the project

Benefits or Purpose – why
What we hope to achieve – the immediate impact of the project

Deliverables or Outputs – what
Specific results produced by activities.

Projects or Activities – how
Units of work undertaken to produce outputs

A framework allows for a wide range of both contributions of projects from existing activities and investments in new activities. It defines criteria for project success and identifies means for verifying accomplishments (such as the criteria in Boxes 3.1-3.4). It incorporates the full range of views from donor countries and intended beneficiaries and others who have a stake in meeting the higher Goal of the Framework. Developed by USAID in the 1960’s, the Logical Framework Approach it is standard practice within many partner organizations (FAO, WFP, UNESCO, UNICEF, UNDP, UNEP, WHO, USAID, AusAid, NORAD, etc.).
**Figure 1: Vertical and Horizontal Logic of the Project/Programme Planning Matrix**

<table>
<thead>
<tr>
<th><strong>NARRATIVE SUMMARY</strong></th>
<th><strong>OBJECTIVELY VERIFIABLE INDICATORS</strong></th>
<th><strong>MEANS OF VERIFICATION</strong></th>
<th><strong>IMPORTANT ASSUMPTIONS</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>OVERALL GOAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The broader development impact in which the project contributes – all national and sectorial level.</td>
<td>Measures of the extent to which a contribution to the goal has been made. Used during evaluation.</td>
<td>Sources of information and methods used to collect and report it.</td>
<td>Assumptions concerning the purpose/goal linkage.</td>
</tr>
<tr>
<td><strong>PURPOSE</strong></td>
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</tr>
<tr>
<td>The development outcome expected at the end of the project. All activities will contribute to this.</td>
<td>Conditions at the end of the project indicating that the purpose has been achieved. Used for project completion and evaluation.</td>
<td>Sources of information and methods used to collect and report it.</td>
<td>Assumptions concerning the purpose/goal linkage.</td>
</tr>
<tr>
<td><strong>RESULTS / OUTPUTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The direct measurable results (goods and services) of the project which are largely under the project management's control.</td>
<td>Measures of the quantity and quality of the service and the timing of their delivery, used during monitoring and review.</td>
<td>Sources of information and methods used to collect and report it.</td>
<td>Assumptions concerning the output/composition/quantity linkage.</td>
</tr>
<tr>
<td><strong>ACTIVITIES / INPUTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The basic activities to implement the project and deliver the identified outputs. Implementation of the programme targets, used during monitoring.</td>
<td>Resources needed for implementation: At the implementation level, the costs must be reported and shown to be covered. The planner has to have an overview of the overall expenditure for each of the project components including the expected income generated (e.g. from levies, local taxes, etc.).</td>
<td></td>
<td>Assumptions concerning the cost identification.</td>
</tr>
</tbody>
</table>

**VERTICAL LOGIC (2)**
### Table 1: THE STRUCTURE OF THE COMMISSION FOR CLIMATOLOGY

<table>
<thead>
<tr>
<th>Management Group</th>
<th>President</th>
<th>Vice President</th>
<th>OPACE 1 Climate Data Management</th>
<th>OPACE 2 Climate Monitoring and Assessment</th>
<th>OPACE 3 Climate Products and Services and their Delivery Mechanisms</th>
<th>OPACE 4 Climate Information for Adaptation and Risk Management</th>
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</thead>
<tbody>
<tr>
<td>Dr. Thomas Peterson (USA, RA IV)</td>
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Appendix 5

References

1 References for Box 2

1 See URL http://www.preventionweb.net/english/
2 See URL http://www.cakex.org/about/faq
3 See URL http://www.databasin.org/climate-center
4 See URL esri.com/foodenvironments
6 Coillte, Ireland’s largest commercial forest management company, created a dynamic Forest Management Plan using ESRI tools that allows for direct participation of stakeholders in sustainable forest management.
7 The Forest Spatial Data Information portal provides public access to forest-themed maps that help to encourage sustainable forestry.
8 The National Groundwater Data and Information System is managed by the Australia Bureau of Meteorology’s Water Division.
9 The Adaptation Atlas is developed by Resources for the Future, in collaboration with a diverse network of partners. See URL http://www.rff.org/
ANNEX

TO

THE IMPLEMENTATION PLAN FOR THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

CLIMATE SERVICES INFORMATION SYSTEM COMPONENT

Version: 3 September 2012
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EXECUTIVE SUMMARY

For the effective delivery of climate information, it is imperative that appropriate institutional mechanisms are in place to generate, exchange and disseminate information at the global, regional and national levels on an operational basis. The CSIS is the principal GFCS mechanism through which information about climate (past, present and future) will be routinely collated, stored and processed to generate products and services that help to inform often complex decision-making processes across a wide range of climate-sensitive activities and enterprises. The CSIS will comprise a physical infrastructure of institutes, centres and computer capabilities that, together with professional human resources, will develop, generate and distribute a wide range of climate information products and services. The WMO World Climate Services Programme will be the principal mechanism to implement the CSIS. Encouragingly, a substantial part of a fully operational CSIS already exists.

The implementation strategy of the CSIS is based on a three-tiered structure of collaborating institutions (CSIS entities20) that will ensure climate information and products are generated, exchanged and disseminated:

a) At the global scale through a range of advanced centres;

b) At a finer regional scale through a network of entities with regional mandates; and

c) At the national and local levels by National Meteorological and Hydrological Services (NMHSs) and their partners through appropriate national institutional arrangements.

A set of primary and high priority functions of CSIS (a common, minimum set of functions spanning global, regional and national scales) can be defined to include: (i) climate data rescue, management and mining; (ii) climate analysis and monitoring; (iii) climate prediction; and (iv) climate projection. These functions include processes of data retrieval, analysis and assessment, re-analysis, diagnostics, interpretation, attribution, verification and communication (including exchange/dissemination of data and products) carried out over a global-regional-national system of inter-linked producers and providers. Formalized structures and procedures for CSIS entities and functions are essential for standardization, sustainability, reliability, and adherence to established policies and procedures. Knowledge of user requirements and understanding of how users apply climate information will be essential for the effective design, dissemination and uptake of CSIS products and services, and the CSIS will engage with the GFCS User Interface Platform (UIP) pillar to achieve this objective. CSIS will also engage with the Observations and Monitoring (O&M) and Research, Modelling and Prediction (RM&P) pillars for the inputs required for its operations.

There are already a number of advanced centres providing global-scale CSIS products, though there is a need to coordinate and standardize their operations, especially with respect to the exchange of routine data and products, which will help ensure compatibility across geographical and jurisdictional boundaries. Making regional implementation a first priority gives countries that need most help something to work with quickly, while longer-term efforts to build national climate capacity are described, funded and accomplished. A representative collection of WMO Regional Climate Centres (RCCs), building, where possible, on centres already in place or in planning, will form the backbone of the CSIS at the regional level. National entities under CSIS will acquire, interpret and apply the data and products from global and regional centres, and to the extent possible, will develop their own national products. Considerable capacity development will be required, especially in developing countries, to strengthen national scale CSIS operations around the world.

Given the multiple sources of information available for use within the CSIS and also emanating out of it, there is a need to facilitate collaborative assessment to assist users in identifying robust signals and also in understanding the inherent uncertainties. At the regional level, Regional Climate Outlook Forums (RCOFs) are widely recognized as one effective mechanism for stimulating such collaboration and consensus development. Users of climate information can benefit from having access to products

20 A CSIS entity is any institution carrying out one or more CSIS functions
that reflect expert assessment and consensus, in addition to information from a variety of individual sources.

CSIS should adopt a notion of seamlessness that aims to manage and analyse climate data, to monitor and predict climate, and to deliver climate products and services at all time and space scales relevant to both generalised and targeted decision making.
**PRIORITY ACTIONS**

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

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

**Implementation**

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

Significant and long-term investments will be required for implementing climate services; hence it is imperative that they be:

- **Available**: subject to capabilities, at time and space scales that the user needs,
- **Dependable**: delivered regularly and on time,
- **Usable**: presented in formats that the client can fully understand,
- **Credible**: for the user to confidently apply to decision-making,
- **Authentic**: entitled to be accepted by stakeholders in the given decision contexts,
- **Responsive and flexible**: to evolving user needs, and
- **Sustainable**: affordable and consistent over time.

Knowledge of user requirements and understanding of how users apply climate information are fundamental to the successful generation and delivery of climate services. While the GFCS UIP pillar is expected to facilitate this process, a basic appreciation of user receptivity will be essential to the effective design, dissemination and uptake of CSIS products and services.

A process for regular review and update of user requirements for climate data, products and information as well as the use of climate information in real-world contexts should be formulated for the GFCS as a collaborative endeavour between contributing pillars of GFCS.

Detailed documentation on CSIS data and products should be prepared, reviewed and updated as a WMO inter-commission endeavour that also involves the WCRP through its relevant programmes, projects and initiatives. The CSIS may need the guidance of a formal manual that lays down certain globally agreed and committed standards and specifications for its functions, services and products across all geographical levels. One approach might be the synthesising of relevant aspects of the diverse range of existing material in the mandatory and other guidance publications of WMO into a single CSIS reference catalogue. Such a task would not require duplication of material already

*While it is somewhat premature to assign action items prior to the formal establishment of the GFCS Governance mechanisms, doing so here provides an indication of the capabilities and readiness of the WMO and in particular the Commission for Climatology to work on the implementation of the CSIS.*
published but rather would seek to facilitate access to and, where appropriate, complement information and guidance that is currently dispersed throughout many existing publications and technical regulations. It may not be appropriate, however, to try to standardize all CSIS products and services because of the diversity of information and services needed in each region or country. To deal with such diversity, consideration could be given to the development and sharing of a CSIS catalogue or compendium of activities and best practices.

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

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

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

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

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

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

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

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

The development of the WMO Global Seasonal Climate Update (GSCU), a product for use within the CSIS and not for distribution to end-users, should be coordinated closely with all the relevant stakeholders with respect its content, presentation, and review. Operational implementation will require significant coordination and synthesis of contributions from GPCs, RCCs, NMHSs and other scientific organizations that routinely monitor climate variability and change. NMHSs should be enabled to interpret GSCU and other global and regional scale climate assessment products, in order to enhance the national products and services they provide to user communities at national scale.

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

While the CMIP5 and CORDEX databases will serve as the comprehensive archives for the research community with respect to climate simulations and climate change projections, they will likely be ill-suited to meet the needs of a wide range of specialist applications, especially at the national level. Consequently, strong consideration should be given to the development of well-designed system and robust online information systems at the regional and national levels that could support a largely ‘self-servicing’ CSIS clientele (both within the CSIS and external to the CSIS including intermediaries) via websites with state-of-the-art data mining, mapping and navigation.

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

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

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

Training and Capacity Building
The focus for the CSIS Component should be on ensuring that developing countries are able to build and maintain the capacity to generate, understand, and integrate national climate data into their policy and institutional settings in ways that are appropriate to their evolving circumstances and under conditions that are determined by them. This implies that a large share of resources to be used for the implementation of the CSIS Component must be directed towards capacity building in this area – including for the establishment of institutions and development of human resources in developing countries.
A programme for ongoing in-service training for NMHSs, related to their operational responsibilities within the CSIS, should be developed with the current CLIPS curriculum as a starting point. Sustainable mechanisms for training national CSIS personnel, including through WMO Regional Training Centres (RTCs), Regional Climate Centres (RCCs), workshops, forums and other opportunities should be established. Key infrastructure (e.g., computers, Internet) and technical know-how (e.g., a Climate Services Toolkit) will constitute the fundamental capacity development requirements for CSIS operations at the national level, particularly in developing countries.

**Resources**

With the heightened recognition of the significance of climate in general to social, economic and environmental well-being, mechanisms being made widely available for activities to mitigate and adapt to climate change should be explored to obtain resources for carrying out critical baseline activities such as improving observation networks (in collaboration with the Observations and Monitoring pillar), data rescue, and data homogenisation. In this regard, a number of high priority projects have already been identified for early implementation. As funds sourced through as yet undefined GFCS mechanisms may take some time to come on stream, it would be appropriate to seek an interim funding solution, e.g. through the WMO VCP or through other avenues for regional and bi-lateral development.

**Governance**

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

[To be expanded in light of emerging GFCS governance proposals]
1 INTRODUCTION

1.1 Objective, scope and functions

The Climate Services Information System (CSIS) component of the GFCS is concerned with the generation and dissemination of climate information that is essential for underpinning a wide range of user-oriented climate services. The phrase “climate information” in a CSIS context refers to knowledge and advice about the past, present and future characteristics of the earth’s climate and at all relevant time and space scales. The CSIS is the ‘operational core’ of the GFCS. It includes climate analysis and monitoring, prediction (monthly, seasonal, decadal) and projection (centennial scale) activities. Part of the CSIS is in place, but new infrastructure is needed to fulfil the GFCS vision. The overarching objectives of the CSIS are:

- To routinely process and/or interpret data and products to generate and provide user-relevant climate information and knowledge by means of numerical, visual and text-based climate data, information and products including, inter alia, assessments, outlooks, warnings, bulletins, reports and statements for use in climate related risk management and adaptation policies and decisions;

- To ensure that climate information and products (data, analysis, monitoring, prediction and projection) are generated, exchanged and disseminated in a timely manner through a fully operational three-tier network of collaborating institutions:
  - At the global scale through a range of advanced centres;
  - At a finer regional scale through a network of institutions with consensus based regional mandates; and
  - At the national and local levels by NMHSs and their partners including through appropriate national institutional arrangements;

- To tailor global climate products to meet regional needs on a sustainable operational mode through strategically located regional climate centres, and also through mutual arrangements to support national requirements where needed;

- To foster rapid development, operational production and dissemination of CSIS information at the national level through inclusion of its functions within national centres or other suitable mechanisms that encompass the GFCS more broadly.

In order to ensure that countries that need help the most are able to access relevant climate information and products with the least delay as GFCS is implemented, a first priority will be establishment of well-distributed WMO Regional Climate Centres (RCCs) that can meet national needs on request, while the longer-term efforts to build their national climate capacity are described, funded and accomplished.

The major elements, structures and data/information flows of the CSIS can be illustrated as shown in Figure 1. The actual institutional arrangements for managing these flows could vary significantly, especially at the national level, and hence this diagram should be interpreted more in terms of the essential functional components needed for an effective CSIS. The CSIS generates and disseminates information to recipients, or ‘users’ at all levels. The interdisciplinary research and development to support tailored products to meet user requirements, and the dialogue between providers and users (assessments of needs, feedback, etc) is described as part of the UIP, but it is the CSIS that generates and provides the information and products, and CSIS practitioners will, frequently take part in some user liaison essentially to facilitate a two-way feedback. It is important to recognize that in carrying out these functions, CSIS entities are an integral and essential part of the UIP.
The range of CSIS functions will include, \textit{inter alia}:

- The standardized management and exchange of climate and related data as per WMO resolutions;
- The monitoring and analysis of climate variability on different temporal scales, including extremes such as droughts and floods;
- Prediction and projection of future states of climate including forecasts of seasonal climatic anomalies and projections of long-term trends that could affect the climate-sensitive sectors of the community;
- The derivation of products (datasets, text, maps, charts, statistics, etc.) that describe the past, present and future climate of a location, country, region and indeed the whole globe;
- the derivation of tailored products and information to meet a range of social, economic and environmental contexts, based on the tools and guidance developed through UIP;
- The provision (exchange, dissemination) of all such information and products, with advice on their interpretation and use, to users in government, to the general public, to academia and to a diverse set of specialist users; and
- Capacity building activities to enhance national and regional CSIS entities, including the effective input of global and regional CSIS products to national level CSIS operations.

Meteorological and related data, obtained from both basic and specialized observation networks, are quality-controlled and generally archived in national climate databases and other related regional and
global databases. These databases are available for the generation of products that range from copies of the basic climate data, through processed data sets to a diverse suite of climate summaries, atlases and specialized analyses in a variety of different forms.

The diagnosis and attribution of climate variability and extremes are important CSIS tasks that require close cooperation between national, regional and global entities, and also with the climate research community. Communication of related climate monitoring information is required by users both in quasi-real time mode as well as through thorough scientific analyses in retrospect.

Knowledge of user requirements and understanding of how users apply climate information are fundamental to the successful generation and delivery of climate services. While the GFCS UIP component is expected to facilitate this process, a basic appreciation of user receptivity by providers of climate information will be essential to the effective design, dissemination and uptake of CSIS products and services.

1.2 Requirements of an information system for climate services

In essence the CSIS is the lynch pin of the GFCS since it acts as the principal mechanism through which information about climate – past, present and future – is routinely archived, analysed, modelled, exchanged and processed to generate, and enable generation of, information and products that help to inform often complex decision making processes across a wide range of climate sensitive activities and enterprises.

The HLT-GFCS has succinctly identified Climate Services as information about climate that has been prepared and delivered to meet users’ needs. Many climate sensitive enterprises need to plan on a range of time scales, in some cases from decades down to a day-to-day basis. Such enterprises are accustomed to adjusting their decision-making as new circumstances arise and hence will clearly benefit from an information system that can continuously meet changing needs throughout a wide range of planning – production – delivery cycles. A notion of seamlessness therefore needs to be applied to the characteristic time-scales of the information that will flow from the CSIS and indeed will merge with existing shorter scale weather-related information systems – from a user perspective, seamless services spanning all timeframes are ideal. Seamlessness can also be related to the CSIS in its scale-defined components, i.e. global, regional and national, which must be seamlessly linked to each other for it to function effectively. There is an aspiration that the GFCS, on the whole, should be essentially seamless in operation, in the sense that the inputs (observations and other data) will flow reliably and efficiently into a set of processing systems (analytical, diagnostic and predictive) for generating and delivering a diverse array of outputs (monitoring information and forecasts), which can then be applied in a wide range of climate sensitive contexts. This three-way view of seamlessness, viz., time scales, space scales and product/service delivery, is illustrated in Figure 2.
CSIS is a system essentially designed for the production and delivery of authoritative climate information products, in terms of operational mechanisms, technical standards, communication and authenticity, among other relevant aspects. The World Meteorological Congress, through Resolution 17 (Cg-XVI) on the implementation of the CSIS, decided, *inter alia*:

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

### 1.3 Interlinkages with other pillars

Ideally all products and services whatever their nature should be designed and delivered in ways that best meet the needs of current and potential customers. CSIS product delivery can range from direct uptake by end-users or through interfaces that seek to integrate the climate information more effectively into the decision-making contexts of end-users. The UIP pillar of GFCS is intended to facilitate this latter process, which will inform CSIS entities of methods, tools and approaches to be
used to meet user requirements, as these are determined. Thus CSIS outputs can be defined as all climate information and products that are applied directly or indirectly to inform policy and decision making in climate-sensitive areas. Consequently, and because of the intrinsic nature of the CSIS and UIP relationship, they will need to work together from the outset to map out ways and means for ensuring delivery and uptake of user relevant climate services in these sectors. In essence, CSIS is the operational production facility that caters to all the climate information needs of the UIP, and also receives feedback to improve the products and services. At a very practical level, CSIS and the UIP will find the Climate Outlook Forums, at both regional and national levels, to be excellent opportunities for collaboration and cross-fertilization of ideas.

CSIS needs to closely work with the RMP pillar of GFCS to put in place the technical infrastructure based on the latest scientific advances to operationally produce and deliver user-relevant climate information. Ongoing research is needed, in addition to improve the skill at the timescales where operational products currently do exist (e.g., seasonal prediction), to narrow the gaps in forecast capabilities across the shorter climate timescales in order to provide a more ‘seamless’ set of monitoring and prediction services that will support the diverse range of user needs. Interactions between the CSIS and RMP components will be critical in this regard. Climate services associated with longer term decadal predictions and climate projections are still in their infancy; these two pillars will need to work closely over the next few years to ensure that the growing demand for more ‘certainty’ does not lead to the compromising of scientific standards and integrity.

CSIS will draw on the Observations and Monitoring pillar of GFCS for in situ and remotely sensed climate data from a combination of surface, air and space based observing platforms, and all CSIS products and services depend on climate data and monitoring products generated by the Observations and Monitoring pillar. In this context, climate monitoring in terms of tailored diagnostics and predictions and value added products and services (e.g., climate watches) is essentially a key function of the CSIS component, while the Observations and Monitoring (O&M) pillar will essentially deal with generating primary data and products, and will provide the needed guidance and procedures for analysing the essential climate variables and related data sets. More fundamentally, the O&M pillar will include aspects of monitoring through its observational platforms and data systems. Critical to the linkages between the CSIS and O&M component will be the identification and remediation of gaps and deficiencies in observational networks. It will be essential to maintain robust procedures for generating feedback to the O&M pillar on how well observing and data collection and management systems are meeting the current and future operational needs of CSIS activities.

Finally, CSIS needs an extensive coverage within the Capacity Building component of the GFCS, particularly in enhancing the capabilities of national and regional CSIS entities, and also in the effective use of global and regional inputs to national level CSIS operations.

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

The World Climate Programme (WCP) established in 1979 and WMO’s Climate Information and Prediction Services (CLIPS) project established in 1995 are the international foundations for modern climate services. Advances in the provision of climate services have been gradual, useful and timely, but in the last decade the demands for climate information and expectations of better tools for decision-making have grown rapidly and continue to outpace capabilities in most countries of the world. There are a number of gaps between present capacities and the expectations of the policy makers, planners, operators, nations, communities, and individuals that must be addressed. Several predominant gaps (these vary by region) are in availability of digital data for modelling and analysis, availability of trained, professional and technical staff to cover all CSIS activities, availability of software to generate user-targeted products, adequate skill in forecasting and projection, etc.

At its Sixteenth Session the WMO Congress decided to reconstitute the WCP in a form that better aligns with the GFCS. The WCP will now encompass the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP) and a new World Climate Services Programme...
It is envisaged that the WCP will be the key WMO Programme in the delivery of the GFCS. Further, Congress decided that CLIPS will be concluded as a project by 2015, and that its activities will be transitioned into the GFCS.

Through activities under the WCP and other related programmes, as well as to cater to their own national needs, WMO Members have already committed substantial investments in building infrastructure and developing human resources for a range of climate products and services, which are expected to underpin the CSIS operations. The proposed implementation plan for the CSIS is therefore in close alignment with Principle 7 of the HLT-GFCS recommendations, to facilitate and strengthen the existing infrastructure, and not to duplicate.

1.4.1 Overview of CSIS products and mechanisms

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

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

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

a) Internal users encompassing parts of the CSIS that take information from the other parts in order to generate products and services for ‘external’ users, e.g., NMHSs drawing on the services provided by regional centres in order to generate products targeted at specific national requirements;

b) A group of external users operating at the strategic level, such as governments, insurance, finance, etc., who leverage off climate information in order to develop better policies and conduct their businesses more effectively;

c) The main group of ‘external’ end users for whom the productivity of their businesses and enterprises are directly affected by climate variability and change.

In some instances the CSIS could deliver to these sectors directly but it is more likely that higher value services in particular will be facilitated through the UIP. In all cases, CSIS entities will need to understand the nature and requirements of the sectors being targeted.

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

See Annex to Resolution 18 (Cg-XVI)
related to the predictions will include consensus summary assessments of key features, as appropriate, and at national levels may include advisories and warnings.

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

The WMO coordinates a number of operational climate monitoring activities that identify, document and provide an alerting service on current, incipient and potentially hazardous climate anomalies. The Climate Watch System (See Box 1) provides advisories and statements to inform users about evolving or foreseen climate anomalies at the global, regional and national levels, particularly to those users involved in natural hazards preparedness, mitigation and response. A typical Climate Watch includes the analysis of observations on current (monthly) climate conditions with respect to anomalies (departures from means), percentiles and exceedance of thresholds, as well as a wide range of other statistics on weekly, 10-day, monthly, seasonal and annual bases. NMHSs in contributing to the CSIS will continuously monitor and assess the status of the climate, evaluate available climate predictions for their areas of interest and where appropriate issue them to users in forms that facilitate their ease of use. GPCs and RCCs will play a major role in supporting the operation of climate watch systems at the national level. In addition to the climate watch systems being promoted by WMO, there are other efforts to coordinate and disseminate climate monitoring information to support decision making at different levels, such as the “Rainwatch” (see Box 2).

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

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

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

### 1.4.2 Basic systems for CSIS Infrastructure

It is widely recognized that for the generation of reliable operational climate information even on the national scale, it is critical that adequate global and regional inputs and products are available on a continuing basis. The overarching aim of CSIS implementation is therefore to establish a global-regional-national infrastructure with capabilities and linkages for operationally sustainable production and flow of climate information, in analogy to as well as in close liaison with the World Weather Watch (WWW) and considering the principles of the WMO Information System (WIS).

#### 1.4.2.1 WMO World Weather Watch

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

- **Global Observing System (GOS):** A coordinated system of methods and facilities for making meteorological and other environmental observations on a global scale in support of all WMO Programmes.

- **The Global Telecommunication System (GTS):** A coordinated global system of telecommunication facilities and arrangements for the rapid collection, exchange and distribution of observations and processed information.

- **Global Data-Processing and Forecasting System (GDPFS):** A three-level system comprising: World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs) and National Meteorological Centres (NMCs), which carry out a range of meteorological analysis and forecasting functions at the global, regional and national levels, respectively (note that GPCs and RCCs in CSIS are types of RSMC).

#### 1.4.2.2 WMO Information System

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

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

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

1.4.3 CSIS at the Global Scale

1.4.3.1 International Data Centres

Many of the international data centres that focus on geophysical systems from a global perspective, including climate related systems, operate within the World Data Centre (WDC) system. The WDC system was created to archive and distribute data collected from the observational programmes of the 1957-1958 International Geophysical Year. Its holdings include a wide range of solar, geophysical, environmental, and human dimensions data. These data cover timescales ranging from seconds to millennia and they provide baseline information for research in many ICSU disciplines, especially for monitoring changes in the Geosphere and Biosphere – gradual or sudden, foreseen or unexpected, natural or man-made. ICSU has recently created a new World Data System that have subsumed the WDC system (see http://www.icsu-wds.org/). The centres of most relevance to the CSIS are those dealing with:

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

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

1.4.3.2 Global Climate Monitoring and Analysis Centres

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

In 2006, WMO began a process of identifying, as an integral part of the WMO GDPFS, a network of Global Producing Centres for Long Range Forecasts (GPCs) that make and distribute global seasonal predictions. The current, officially designated WMO GPCs are shown in Figure 3. Through a rigorous designation process, GPCs are expected to adhere to certain well-defined standards that support consistency and functionality across the network. In order to be designated as a GPC, a centre must as a minimum adhere to the following criteria:

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

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

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

22 http://www.wmo.int/pages/prog/wcp/wcasp/clips/producers_forecasts.html
The following products are currently set down as the recommended requirement for any designated GPC issuing seasonal time-scale products:

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

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

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

1.4.3.4 Centres providing Global Climate Change Projections

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

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

1.4.4 CSIS at the Regional Scale

Similar to the global scale, the CSIS will draw from and where necessary build on existing relevant regional scale infrastructure including primarily the structures already implemented under the WMO GDPFS and also any other existing entities that are already delivering effective climate information services, such as the several organizations operating in Africa, Asia and South America. These latter centres should be encouraged where feasible to operate within or at least collaborate informally with the overall structure of CSIS.
1.4.4.1 WMO Regional Climate Centres (RCC)

At a regional level, WMO is encouraging the establishment of a number of Regional Climate Centres (RCCs)\(^{24}\) that will generate and deliver more regionally focused, high-resolution data and products as well as offer training support on the use of their products. The RCCs are being implemented as part of the overall network of WMO Regional Specialized Meteorological Centres (RSMCs). Along with the GPCs they therefore constitute integral components of WMO’s GDPFS, with procedures in place for their formal designation for the purposes of helping underpin the generation of a wide range of national climate information products. The aim is for RCCs to assist WMO Members in a given Region or a defined sub-Region to deliver better climate services and products including long-range forecasts, and to strengthen their capacity to meet national climate information needs.

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

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

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

**Data Services, to support operational LRF and climate monitoring:**
- Development of regional climate datasets (factoring in long-term data quality and homogeneity), gridded where applicable;
- Provision of climate database and archiving services, at the request of NMHSs.

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

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

\(^{24}\) [http://www.wmo.int/pages/prog/wcp/wcasp/RCCs.html#RCCLinks](http://www.wmo.int/pages/prog/wcp/wcasp/RCCs.html#RCCLinks)
**Climate Change Projections:**
- Provision of regional and, on request, national projections of climate change;
- Efficient and cost-effective access to climate projections and related information;
- Clear explanations of the limiting factors associated with the use of climate projections in order to reduce risks to users from the misinterpretation of the information provided;
- Coordination with other centres/providers of climate change projection information to reduce unnecessary duplication in service delivery.

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

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

Two RCCs were officially designated by WMO in June 2009 under the current GDPFS procedures established jointly by CBS and CCl, viz. the RCC Beijing (China) and the RCC Tokyo (Japan), both in RA II (Asia). Formal RCC designation is imminent (as of August 2012) for a RCC Network for Europe (RA VI) and the North Eurasian Climate Centre (NEACC, RA II). Other centres working towards formal RCC designation include the African-RCC in ACMAD and the IGAD RCC at ICPAC (both in RA I), India (RA II), the Caribbean Institute of Meteorology and Hydrology (CIMH, RA IV) and in RA III by CIIFEN, the Northern South America RCC Network, and the Southern South America RCC Network. There are several additional climate centres performing at least some of the functions specified under the GDPFS provisions that could conceivably move towards attaining full RCC capabilities and seeking formal designation within the expanding WMO RCC coverage.

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

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

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

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

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

- A meeting (face-to-face, by teleconference or online) of regional and international climate experts to develop a consensus for regional climate outlooks, usually in a probabilistic form that will encompass:
  - Presentation of key points for the next (rainy) season,
  - Preparation of national statistical forecasts,
  - Capacity building activities to assist interactions between national providers and specific users,

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

- A broader forum involving both climate scientists and representatives from user sectors, for presentation of the consensus climate outlooks, discussion, and identification of expected sectoral impacts and implications, and the formulation of response strategies;
- Training workshops on seasonal climate prediction to strengthen the capacity of national and regional climate scientists;
- Special outreach sessions involving media experts to develop effective communications strategies.

### 1.4.3 Related Activities

It is possible for a country to have a number of climate divisions with well-defined administrative structures, and the term “regional” is often used to indicate region within a country. Larger WMO Member countries use the term “regional” climate centres to apply to centres servicing a region wholly within their respective national borders, for example, the USA and Australia, with the latter using the term Regional Climate Service Centre (RCSC). In the WMO GDPFS context, the term WMO Regional Climate Centre (RCC) is reserved for designated WMO entities that generate products and services for domains extending beyond a single country. Networks of climate centres operating in some of the geographically larger developed countries in effect operate in a similar vein by supplying information for a particular within-country geographical or political region. Such centres can provide a rich source of experience in terms of the products and services that WMO RCCs are expected to provide. There may also be some regional institutions engaged in climate activities on the regional scale but without the designation as WMO RCCs. It is useful to involve such institutions also in CSIS activities on the regional scale, to complement the regional inputs for national climate operations. WCRP’s Coordinated Regional Climate Downscaling Experiment (CORDEX) provides an internationally coordinated framework for producing an improved generation of regional climate change projections worldwide, and has set up data distribution centres to provide wide access to the downscaled climate change simulations.

### 1.4.5 CSIS at the National Scale

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

#### 1.4.5.1 Critical Role of National Climate Data

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

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

1.4.5.2 Supporting climate services at the national level

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

Given that more frequent extreme events will likely be a major characteristic of a changed climate, NMHSs or other national agencies (such as those mandated to deal with extremes, hazards and emergency responses) need to be encouraged to document cases of extreme weather/climate events including their meteorological settings and impacts, drawing on regional and global products as appropriate. Such studies will be critical to the development of effective national mitigation and response actions against events such as forest and grassland fires, floods, severe storms and drought.

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

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

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

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

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

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

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

**Seasonal Outlooks**
- Rainfall and temperature, adequately incorporating aspects of uncertainty.
- Verification statistics.

**Climate Change Information**
- National Downscaled national projections based on appropriate IPCC scenarios.
- Information on the causes of climate change.
- Tracking indices of extremes.

**Training in the use of operational national climate products and services**
- Provision of information on methodologies and product specifications for national climate products, and guidance on their use.
- Coordination of training for national users in interpretation and use of national climate products.

### 1.4.5.3 National Climate Outlook Forums/National Climate Forums

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

1.4.6 Other CSIS entities

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

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

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

1.4.7 Major gaps

While the existing activities do consist of global, regional as well as national entities that can be directly integrated into the CSIS, several major gaps need to be addressed to achieve a fully operational CSIS meeting user needs, in terms of standardized products as well as their dissemination and uptake. The following are some of the major gaps that can be identified:

- At the national level, climate service providers in many developing countries need their human resource capacities enhanced by training and other means, and to have appropriate tools and guidance for applying global and regional products in the generation of tailored products for national and local purposes.
- At the national level, there is very little coordination among the stakeholders, both providers and users, to contribute to and benefit from CSIS operations in a complementary manner, which leads to little or inappropriate use of climate information in decision making. By development of understanding of users: (i) users can apply the available information appropriately for their decision-making; and (ii) providers can produce information tailored to meet the needs of users.
• Given that climate extremes have profound socio-economic impacts across a wide range of time and space scales, there is a perceptible gap in early warning systems being based on climate watch systems for which concepts based on climate monitoring and prediction are in place but implementation and tailoring are yet to be taken up to cover all countries and regions.

• At the national and regional scales, there is a huge potential for retrieving vital past atmospheric observations and extending back in time the climatological record while, at the same time, ensuring its quality and homogeneity.

• Further, to facilitate CSIS product and service generation, exchange of data among the countries as well as the global and regional entities is critical, for which adequate international arrangements are not in place.

• RCCs constitute some of the relatively better defined entities, but their implementation is still sub-optimal, with several regions with limited or no access to RCC services.

• There are also several regions/sub-regions that can benefit from RCOF activities.

• There is a need to establish a set of primary, high-priority functions and products, involving analysis, diagnostics, interpretation, attribution, verification and communication over the system of providers that populate the CSIS, operating across all spatial scales.

• Formally designated structures for CSIS entities and functions are essential for standardization, sustainability, reliability, authenticity, adherence to policy, etc., with most of the existing or proposed entities focusing on aspects of climate data, monitoring and prediction at monthly and seasonal time scales. Further research effort will be required to extend these CSIS capabilities, especially with respect to prediction, at longer time scales.

• Absence of long-term authenticated meteorological records is a key gap in provision of a wide range of climate services.
2 IMPLEMENTATION OF CSIS

2.1 Conditions for successful implementation

The fundamental requirements for CSIS include, *inter alia*:

- A set of primary and high-priority functions and well-defined products;
- Formalized structures, standards and protocols;
- Knowledge of user requirements;
- Flow of huge amounts of data and information.

Prediction from a practical viewpoint will very likely continue to be done over a set of more or less discrete time periods. The Manual on the GDPFS defines these periods in some detail\(^{25}\). It may be appropriate, in implementing the GFCS, to revisit these definitions, taking into account the current terminology used by research, operational and user communities, and to promote the use of common terminology. More generally, a common set of definitions can be considered such as:

- Nowcasting – up to a few hours;
- Weather forecasting – hours to around 10-15 days;
- Monthly predictions – two to six weeks;
- Sub-seasonal predictions – six weeks to two months;
- Seasonal predictions – three to six months;
- Annual predictions – six to twelve months;
- Interannual predictions – one year to a decade;
- Decadal predictions – one to three decades;
- Climate change projections – two decades to a century or more.

Most climate projection products available today are valid from global to large sub-continental scales. Needs have been expressed for more regional and local products. At regional and, to the extent possible, at national levels of the CSIS, it is envisaged that mandated centres will downscale global climate change projections and scenarios based on model outputs available from the major climate model data centres, and make these products and related information available to users. It is critical that services relying on downscaling are backed by confirmation from research on the efficacy of the techniques employed and include commentary on any inherent uncertainties in the projections.

A CSIS based on the inputs from the observations and research components and supported by strong capacity building activities will require physical infrastructure such as computers and communications networks, institutions and centres; skilled human resources for product development and consultation; and mechanisms for development and delivery of tailored products for users, in particular what is being proposed for the UIP. Many of the entities that would contribute to the fully operational CSIS already exist in some form (in some cases providing only minimal climate services), but need to be further developed and standardized.

To be successful, a national climate services programme that embodies the principles of the CSIS must be an integral part of the larger infrastructure that supports the implementation of national social, economic and environmental policies. The programme must allow the linkage of available applications, scientific research, technological capabilities, and communications into a unified system.

In summary, an overall infrastructure for the CSIS should:

\(^{25}\) See Appendix I-4 in Manual on GDPFS, Volume I (Global Aspects).
(i) Be based on a network of designated\(^{26}\) entities providing global and regional-scale climate products and services in the domains of climate data, climate monitoring, long-range forecasting, interannual to decadal predictions and climate change projections;

(ii) Provide standardized minimum products and highly-recommended products, generated and distributed on the basis of agreed-upon operating principles;

(iii) Take advantage of as much authoritative information as possible; and

(iv) Ensure capacity on the national level to access, process and convert such global and regional climate information into national climate services.

2.1.1 CSIS Data Concerns

2.1.1.1 Data Quality (temporal and spatial gaps, QA/QC, homogeneity)

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

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

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

All NMHSs should be cognisant of the need to secure their raw data against loss, and therefore a data rescue programme is required in all countries. Data rescue is the process of preserving data at risk of loss due to deterioration of the medium on which the data are stored (paper, microfilm, etc.), which can occur under certain climate conditions such as high humidity, or can be related to failure to modernize or secure storage technologies. Rescue of data in paper-based or obsolete electronic formats, and the digitisation of current and past data, into CDMS-compatible form for easy access are vital activities (see Box 4). Data Rescue is carried out under well-established initiatives such as MEDARE, IEDRO and ACRE\(^{27}\) and has also been supported by several bilateral or multilateral projects sponsored for example by developed country agencies for international aid.

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

2.1.1.2 Data sharing principles and policies

At present Resolution 40 (Cg-XII) is the primary governing instrument for the international exchange of meteorological and related data. Similar resolutions were adopted by WMO for hydrological data

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\(^{26}\) A ‘designated’ entity here is one that has formally been assessed by the Regional Associations, CCI and CBS and approved for carrying out functions and delivering products and services to standards set down in relevant WMO Technical Regulations (such as in the Manual on the GDPFS).

\(^{27}\) MEDARE: Mediterranean Data Rescue, IEDRO: International Environmental Data Rescue Organization and ACRE: Atmospheric Circulation Reconstruction for the Earth
(Resolution 25, Cg-XIII) and by the Intergovernmental Oceanographic Commission for oceanographic data (Resolution 6 IOC Assembly XXII). Resolution 40 (Cg-XII) refers primarily to the exchange of essential meteorological data “required to describe and forecast accurately weather and climate, and to support WMO Programmes”, and secondly, to additional data on which restrictions may be placed by the data holder with respect to availability, secondary distribution and use. Such data typically include historical climate and related data held in national archives.

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

To facilitate CSIS product and service generation, WMO Members are strongly encouraged to make key historical data available for inclusion in gridded regional and global climate data sets, which would then more easily allow the free exchange of information contained within the data in ways that remain consistent with national data policies. In consideration of Resolution 40 (Cg-XII) and Resolution 25 (Cg-XIII), the WMO is proceeding with an examination of appropriate data policies under its Convention, in recognition of the importance of the exchange of climate-related data for the provision of climate services.

### 2.2 Engagement with Potential Partners

Considering that a predominant portion of the operational components of the CSIS are already part of WMO structures at all the three levels and given the roles and responsibilities of NMHSs as enshrined in WMO Convention, it is clear that WMO is very likely to be the primary implementing agency of the CSIS. That said, two types of partnerships are essential for the effective functioning of the CSIS, namely technical partnerships and those with user communities. Technical partnerships – between space agencies, climate data management and climate monitoring agencies, communications agencies, and the research community (institutes, programmes and academia/universities) – have steadily been integrated into supporting operational activities to ensure the timely production and dissemination of high-quality information and products. In particular, the three-way WCP partnership between the new WCSP (services), GCOS (climate observations) and WCRP (research and modelling) is critical to the success of the GFCS. Responsibilities of technical partners, such as ECMWF, EUMETSAT, the International Telecommunications Union, ACMAD, ICPAC, CIIFEN, CPTEC, APCC and CIMA, range from global to local in nature.

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

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

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

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

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

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

Considering that the production and dissemination of climate services information at the three levels is highly inter-dependent, there is a critical need to ensure optimal interactions and minimization of duplication between the three levels, both in the operational activities and also in communication and use of the products. Within and between the CSISs, Observations and Monitoring and Research pillars, existing structures, with modifications where appropriate, should largely be able to accommodate the necessary interactions. The introduction of the UIP, however, and the critical need for it to interact with the CSIS in particular, will likely lead to the need for new mechanisms for interaction between the three levels.

2.3 Criteria for identification of projects/activities

The criteria for identification of projects should be closely aligned to the current capabilities of the concerned CSIS entities, to ensure that the primary and high-priority functions are operationally and adequately performed. A general checklist for selection of projects in the near-term includes:

1. Does the project involve and/or contribute to activities in least developed countries, small island developing states or land-locked developing countries?
2. Does the project build upon something that already exists by expanding the area, locating in a new place, making it operational, or broadening its scope?
3. Is the activity achievable in a two year time frame?
4. Does the project fit within the initial budget estimate of the HLT report?
5. Does the project address the Feedback, Dialogue, Monitoring and Evaluation or Literacy outcomes of CSIS and related GFCS components?
6. Does the activity or project build upon, not duplicate, the partnerships in place between existing organizations and groups?
7. Does the activity contribute to the necessary and sufficient conditions (see Section 2.1)?
8. Does the project address the operational requirements at the three levels (global, regional and national), to ensure that formalized structures of all required CSIS entities and functions are in place?

9. Does the activity contribute to and strive for sustained operations and ownership of the CSIS in the post-project phase?

10. Is the project amenable to the applicable standards and best practices as well as protocols that may be prescribed for the CSIS?

2.4 CSIS Implementation activities

Noting that the GFCS should build on existing systems and structures wherever possible, several implementation activities for the CSIS have been formulated that build on a number of actions already in planning or underway. They include:

1. Support for the implementation of climate watch system in the Regions;
2. Strengthening the capacities of Member countries to provide climate services through the establishment of frameworks for climate services at the national level, national climate assessments such as annual state of the climate reviews, etc.;
3. Training aspects related to GPC and RCC infrastructure;
4. Enhanced capacity of NMHSs and other national climate services providers to more effectively use GPC and RCC products to develop and deliver climate services at national levels;
5. Establishment of a worldwide system of RCCs, with special focus on vulnerable developing regions;
6. Development of Climate Outlook Forums worldwide, on regional and national scales;
7. Development of tailored climate information products for agriculture and food security, water, and health sectors for climate risk management and adaptation.

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

2.4.1 Historical climate data sets

The development and securing of basic, historical climate data sets, containing a wealth of information that can be used to characterize the past behaviour of the climate on all time and space scales, remains one of the highest data priorities for the CSIS. Beyond that important and ongoing task, there are a number of other important data-related activities that would assist in the establishment of fully effective CSIS. The routine collection of climate ‘event’ data, for example, would be a new contribution. Full event-scale data, products and information on climate anomalies such as droughts, floods and heat waves, categorised as is currently done for Tropical Cyclones, would greatly help in understanding the distribution, frequency and intensity of serious and wide-reaching hazards, needed for climate risk assessments. Other user groups may need products such as indices of climate extremes, or more complex indices that combine several parameters with different thresholds (e.g. temperature with precipitation and humidity for the health sector). A review and update of user requirements for climate data, products and information should be undertaken through the GFCS as a collaborative endeavour between CSIS and UIP.

The use and merging of remotely sensed data with traditional data to produce routine products offers a special challenge for the CSIS. Given the resources and technical proficiency required to handle and process satellite based data, for example, such products should be routinely generated in RCCs from where they can be distributed to client institutions that do not have the requisite capabilities.
2.4.2 Climate monitoring

By carefully monitoring the climate, the effects of extreme events can be reduced through appropriate preparatory actions. Close and meticulous monitoring also allows for the detection of long-term climate change, its driving forces, as well as its impacts around the world. Monitoring the global climate also helps with regional or national weather predictions. Local conditions do not occur in isolation to the rest of the world, and the status of the regional and global climate directly influences local weather.

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

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

Given that more frequent extreme events will likely be a major characteristic of a changed climate, the documentation of cases of extreme weather/climate events including their meteorological settings and impacts, will be critical to the development of effective national early warning systems and mitigation and response actions against events such as forest and grassland fires, floods, severe storms and drought.

2.4.3 Monthly/seasonal/decadal climate predictions

Formal WMO mechanisms for the provision of operational climate prediction services have been developed for seasonal timescales and similar mechanisms, including verification standards. Similar structures need to be established for forecast activities on monthly as well as multi-annual to decadal timescales.

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

2.4.4 Climate projections and scenarios Information

An important target for CSIS would be to promote the implementation of online climate projections as an efficient mechanism for the delivery of essential and consistent information that would underpin national adaptation to climate change. While the databases of the fifth generation of Coupled Model Intercomparison Project (CMIP5) and the CORDEX project of the WCRP will serve as the comprehensive archives for the research community with respect to climate simulations and climate change projections, they will likely be ill-suited to meet the needs of a wide range of specialist applications, especially at the national level.

Consequently a well-designed system of robust online databases at the regional and national levels could support a largely ‘self-servicing’ CSIS clientele via websites with state-of-the-art mapping and navigation tools. CSIS experts would be available to interpret the skill and limitations of these products for users in their areas of interest, and would help to identify those products most suitable for various applications. Other products relevant to climate change would include analyses of climate variability and extremes over time, including time series related to major Earth System atmosphere-ocean features such as El Niño and the North Atlantic Oscillation.

The objectives would be to:
• Create online regional and, where feasible, national sites for efficient access to climate change data and information services, supported by robust and efficient infrastructure;

• Develop climate change data and information services needed for adaptation and risk management that would:
  o Provide information based on latest scientific findings,
  o Combine historical and current climate observations with ‘data’ streams projected into the future,
  o Represent a significant shift from ad hoc servicing by the ‘research domain’ towards a fully ‘operational climate change information service’,
  o Support policy and adaptive response at the enterprise, local, national and regional levels.

2.4.5 Linking CSIS with users

Interaction between users and providers has so far not been systematically organized through a sustained mechanism, in most cases. In the context of climate services, it is widely recognized that the climate products should primarily be user-centric, to ensure that the climate information is actionable within the real-world decision context. Keeping this in view, CSIS will need to closely engage itself with the establishment of mechanisms to facilitate linkages between climate service users and providers on a regular and ongoing basis, principally through activities being proposed for the GFCS/UIP. The following specific actions need to be taken up in this regard:

• National Climate Outlook Forums (NCOFs) or, more generally, National Climate Forums (NCFs), are organized on an annual (or seasonal, where required) basis to bring together technical and communication experts from climate information providers and representatives of climate-sensitive user sectors. NCFs can be organized more frequently (e.g., monthly), to facilitate dissemination of regular climate updates to user sectors as well as feedback and regular interaction through a common platform. Members will need to be supported by guidance material, and training of trainers to develop technical skills for such communication. Knowledge sharing on how different NMSs interact with users and how sectoral level agreements can be arranged with various sectoral ministries or interest groups on a partnership basis will be needed. Some early attempts have been made by Members, such as the Northeast Brazil Climate Outlook Forum, which could be used to further develop the concept and implement showcase projects. The generic concept of the NCOF will be developed by WMO’s World Climate Services Programme and CCl in close consultation with other partners, but organization, funding and hosting of these activities will be the responsibility of Member countries appropriately tailored to the respective national contexts, and may be carried out under regional/sub-regional projects funded through extra-budgetary resources.

• Development of a comprehensive framework for climate services at the national level can be very effective for large countries with established strengths in observations, research and operational climate information and prediction services (see also Section 2.2). Mechanisms such as the NCOFs/NCFs mentioned above can also constitute integral components of the activities within such a national framework. This 'proof of concept' initiative will be taken up in close collaboration with large developing countries having the required strengths in each of the above-noted components. Guidance will be developed with the help of CCl and the relevant national stakeholders. It is anticipated that Member countries will adequately support their respective national activities for this initiative.

• Promoting the single window weather and climate service concept within the NMHSs to assist the users in accessing the weather and climate information required by them in a seamless manner. Guidance material will be developed in collaboration with WMO's weather service programmes.
2.4.6 Building national capacity in developing countries

It is proposed that a four-category approach be adopted for setting national baseline capabilities in delivering climate services, e.g. basic, essential, full and advanced (see Fig. 5 and Box 5).

![Figure 5: Proposed categories of CSIS centres at the national level with indications of their baseline functions/products.](image)

An early priority for the CSIS would be to carry out a systematic assessment of the baseline status of WMO Member NMHSs according to this categorization, a task that could be coordinated by the WMO Regional Associations with CCI being responsible for setting the criteria for each baseline. Capability areas to be baselined would likely include:

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

Once the current capabilities of a NMHS have been established and compared against desired baselines, a capacity building agenda can be drawn up that would identify specific targets to be achieved by the NMHS over 2-, 6- and 10-year periods in order to reach the desired baseline(s). It would not be necessary for an NMHS to achieve a specified single capability in all areas to be baselined. Some NMHS, for example, might rely in part on an RCC for climate monitoring products to meet its national needs while at the same time having the capacity to generate and distribute a range of specialized climate information products.
In time it may be appropriate to move towards a more formal compliancy system.

It is proposed to approach national capacity building by first identifying the category to which an NMHS belongs and then make efforts to incrementally build the capacity of each of the NMHSs to move to the next higher category during the course of a four-year financial period, through the following interventions:

**Supporting NMHSs in facilitating definition of clear roles and responsibilities** within the national context to undertake actions such as climate data management, climate monitoring and assessment, climate prediction and projection, and development of tailored climate products for various sectors in order to provide end-to-end climate services.

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

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

**Strengthening the capacity of NMHSs to fully participate in WIS** for dissemination of data and products related to climate services are through the WMO Information System (WIS) that provides international standards needed to interface climate data with non climate socio-economic data for the multidisciplinary products and climate services designed to benefit society.

**Development of a capacity building strategy by CCI** and its implementation for meeting the needs of NMHSs by identifying their new and ongoing requirements for education and training at national and regional levels using hybrid systems such as traditional training workshops, distance learning through modern communication technologies, manuals, guidance and ‘best-practice’ documents, technical papers to equip NMHSs to support climate services effectively. This will include:

- Updating of the climate curricula at WMO Regional Training Centres (RTCs) to incorporate the new advances in climate sciences, applications and services;
- Upgrading technical skills in climate data management, climate statistics and diagnostics techniques, climate prediction, climate monitoring and climate watch and early warning systems;
- Developing communication skills to interact with users utilizing appropriate methodologies

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

Establish the qualifications and competencies for a climatologist, climate services specialist, climate prediction expert, etc., and evolve a common understanding of the professional, technical and administrative capabilities required.

The ability of NMHSs to support climate risk management and climate adaptation will depend on their ability to manage and provide climate data, converting them into reasonable and usable information
and products developing decision support and decision making tools to convert the information based on the application of knowledge so generated into tools for decision making.

2.4.7 Strengthening regional climate capabilities

Regional capabilities to support climate services have two major objectives: (i) provide regional-scale information as input for deriving more detailed national-scale information; and (ii) provide national-scale products to countries not yet having the required capacity to develop their own products, on request. In the course of strengthening the regional capabilities, it is important to address the global-regional-national levels of climate product generation and exchange. GPCs and other mechanisms dealing with basic climate data and climate system monitoring at the global level, RCCs and NMHSs, with the support of the GPCs and specialized centres such as the LC-LRFMME and the LC-SVSLRF constitute basic infrastructure for the development, production and delivery of climate services, through the CSIS. WMO has a critical role to play in fully establishing and operationalizing the CSIS on a sustained mode. The following activities need to be taken up in this regard:

- Standardizing the operational global climate products and promoting free access to them by WMO Members; promoting common understanding of global and regional climate variability and change, and development of consensus based products such as Global Seasonal Climate Update.

- Promoting effective use of WMO Information System (WIS) for all information and data exchange among the CSIS entities.

- Identifying and facilitating the effective use of GPC and other key global climate products at the regional and national scales, by promoting operational mechanisms that involve mutually compatible products and protocols for efficient exchange and application of data products; promoting access by NMHSs to a basic set of GPC digital forecast data (e.g. 2-metre temperature, precipitation, winds and temperature and geopotential height at standard levels, as well as hindcast data and lateral boundary-condition data for regional downscaling) to support development of national climate services and prediction products for a range of users;

- Expansion of RCC coverage to all Regions. A minimum of two or three Regional Climate Centres (RCCs) or Region-wide/sub-regional RCC Network, in each of the WMO Regions, and some trans-regional RCCs, will be required resulting in a global total of 15-22 existing and new RCCs or RCC Networks;

- Expanding and sustaining RCOF operations in all Regions, particularly in developing and least developed sub-regions;

- Providing technical guidance on best operational practices within RCCs and RCOFs, and promoting common standards and quality management in product generation as well as dissemination.

2.5 Initial implementation activities/projects

Major priorities for identifying the initial implementation activities are to establish national-scale CSIS entities in all countries with a particular focus on developing countries, and to provide a regional support system (e.g. RCCs and RCOFs). The proposed initial implementation projects are listed below, and are summarized in Table 1. See also Appendix A which provides a preliminary template to develop projects leading to frameworks for climate services at the regional and national levels. It is noted that Activity 8: Strengthening regional systems for providing climate services, is also identified as an overarching GFCS priority activity (Activity 7) in the GFCS Implementation Plan itself.
Activity 1: Establish and coordinate operational support for Frameworks for Climate Services at the national level in developing countries

Activity: With a focus on the needs of developing countries, the entities and methods of cooperation necessary for the development and provision of the climate information, products and services that meet national needs and priorities are identified, formalized and coordinated in a consistent and sustainable manner.

Objectives:

• To identify the national providers: the national CSIS entity (entities) responsible for:
  o Maintaining the official climate record (the NMHs normally),
  o Developing the operational climate information products that constitute the essential climate science inputs to the climate services at the national level (primarily the NMHS, in most cases), and
  o Creating and providing authoritative, credible, usable and dependable science-based climate information and advice that is of value users;

• To promote internationally consistent mandates for the national CSIS entities, including (based on identified user requirements) for:
  o The timing, content, and format of a minimum set of climate information products to be provided to specific users,
  o Gathering, assembling and managing the data necessary to support climate services (physical climate, water, socio-economic, etc.),
  o Identifying research advances and incorporating relevant ones into national practices,
  o Active management of user engagement including forums, and dissemination and feedback mechanisms,
  o Procedures for issuing early warning for fast- and slow-onset hazards,
  o Cooperative mechanisms to ensure the consolidation, coordination and optimization of the development and provision of the user-focused climate services, and
  o Performance measurement, evaluation and response procedures;

• To identify gaps in national capacity and options to address such gaps including capacity development and, where necessary, options for delegation of responsibilities to regional or international parties;

• To establish or expand interaction and dialogue between providers and users at national level (i.e. the government ministries and institutions; UN and sector-based institutions representing key socio-economic sectors; the private sector; the broader community) for identification of user requirements, for user training in climate matters, and for discussion and feedback on climate information and products;

• Ultimately, to improve user confidence in, and effective proactive use of, climate information and products in decision making for all aspects of climate risk management.

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

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

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

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

Participants: CSIS entities at national levels including NMHS and relevant nationally agreed service providers; relevant O&M entities such as those working towards interoperable data systems involving physical as well as socio-economic data; academic and research institutions; partnering agencies at global and regional scales including their regional and technical constituent bodies as required (e.g. FAO, WFP, WHO, UNESCO, ISDR, WMO (with CCI, CBS and other technical commissions, and its Regional Associations); key national partners and stakeholders representing users (e.g. national ministries and agencies for agriculture and food, health, water, disaster management and climate); the media; international and national banks and financing institutions; regional economic groups; aid agencies; etc.

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

Activity: To identify, collect, enhance, and package a high-quality set of knowledge products, software tools, public domain datasets and related training materials to encourage consistency and quality of products and services developed through CSIS, to assist developing countries provide the climate services, optimally incorporating the latest scientific and technological advances, as needed by users and stakeholders, and to encourage consistency and quality of products and services developed through CSIS. Many institutions will contribute to the toolkit, and considerable effort will be required to develop, test and complete the materials for
widespread use. WMO will coordinate the compilation, production and distribution of the Climate Services Toolkit.

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

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

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

**Current activities:** CCl has a task team (CLIPS evolution) that is developing the requirements for, and contributions to the toolkit. Other CCl teams are developing software (e.g. CCl ETCCDI for climate indices, and ET-CRSCI for sector-specific indices). WMO Members and research and academic institutions have developed, inter alia, ClimSoft and CliSys for data management; CMT for monitoring, CPT, PRECIS and SCOPIC for forecasting, downscaling and verification and so on.

**Indicators and Assessment Measures:**
- Number of countries with access to and using the toolkit;
- Number of training workshops based on Climate Services Toolkit;
Number of CSIS products included in Climate Services Toolkit;
Number of contributors to Climate Services Toolkit

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

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

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

**Objectives:**
Improve Climate System Monitoring based on standard definitions, new product templates and data exchange protocols and on improved procedures for gridded data sets.

**Benefits:**
- Enhanced national operational climate monitoring and related services. The national products will be disseminated using standard templates and exchange protocols that will help quick aggregation of information at regional and global scales;
- Climate assessment reports and reviews (e.g. climate statements, State of the climate reports and reviews, reports and advisories on extreme weather and climate events…) will improve in content and coverage with a reduced time delay;
- Sectors (i.e. Health, DRR, agriculture, food security…) will be able to access to consistent, systematic and timely climate monitoring and assessment covering national, regional and global scales.

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

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

Indicators and assessment measures:
Indicators
• Availability of and access to improved climate monitoring products on operational basis
Assessment measures;
• Progress in developing standards and templates for the national climate monitoring products;
• Progress in the provision of tools and procedures for gridded data sets

Participants: WMO CCI, partnering agencies, members

Activity 4: Implementation of Climate Watch System

Activity:
• Conduct workshops and demonstration projects to facilitate interactions between NMHSs and key stakeholders and develop templates for climate watches for use in key climate sensitive sectors, e.g. DRR, Health and food security;
• NMHSs, RCCs and sectors will collaborate in different regions to agree on a set of procedures, tools and data bases needed for organising and operating Climate Watch Systems;
• Assist developing countries through trainings and guidelines on implementing climate watch systems at national level.

Objectives
A Climate Watch System aims at providing a proactive mechanism for interacting with users (e.g. governments, industry, sectors, communities, the public) and alerting them to major climate anomalies and extremes. CWSs, which use climate data, monitoring products, imagery, and predictions, add value to existing climate monitoring and forecasting systems within the National Meteorological and Hydrological Services and should be developed with a view to fully involving users in providing the conditional elements of the system: thresholds, indices, criteria and databases. CWS will enable climate sensitive sectors to access in a timely manner to critical information on possible negative impacts of ongoing or foreseen climate anomalies and extremes.

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

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

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

**Indicators and assessment measures:**

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

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

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

**Activity 5: Standardize the operational CSIS products**

**Activity:** to identify global and regional products that should have well defined and commonly agreed characteristics for content, format, frequency, etc., and to develop standards and protocols for development and dissemination of those products.

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

**Benefits:** Countries receiving standardized products from global and regional providers will have increased opportunity to compare products from different sources. Standardization can also increase adherence to best practices, which should improve product quality and consistency.

**Deliverables:** assessment of products that should be common to all global and regional providers, and developed and presented following common standards; a set of standards and protocols for specific products.

**Current activities:** CCl and CBS have identified criteria for mandatory products of GPCs and RCCs. Lead centres collect the products from other GPCs and create a common version.

**Indicators and assessment measures:**
- Number of standardized CSIS products of GPCs, RCCs and NMHSs;
- Number of CSIS entities generating standardized products;
- Number of countries/sectors using standardized CSIS products.
**Participants:** CCI, CBS, CAS and WCRP experts across O&M, RM&P and CSIS areas of activity; GPCs, RCCs and NMHSs; Other institutions operationally providing CSIS-related products.

**Activity 6: Promote effective CSIS-wide use of WMO Information System (WIS)**

**Activity:** Under the O&M pillar of GFCS, activities will be launched to build the capacity in WIS to meet GFCS needs, and training GFCS data and product contributors in the relevant interoperability standards. This activity under CSIS, will complement the O&M efforts, and will focus on training CSIS information managers and information system developers on relevant WIS concepts and interoperability and ensuring that WIS is widely used throughout CSIS operations.

**Objectives:** To ensure that WIS is widely used throughout CSIS operations, by training CSIS information managers and information system developers on relevant WIS concepts and interoperability and encouraging all CSIS entities to prepare their data and products identification and exchange through WIS.

**Benefits:** Staff members in CSIS entities are knowledgeable about WIS and its capabilities.

**Deliverables:** training modules; train-the-trainer sessions

**Current activities:** to be completed by WIS

**Indicators and assessment measures:** to be completed by WIS

**Participants:** to be completed by WIS

**Activity 7: Facilitate the effective use of GPC and other global climate products by regional and national providers (e.g. RCCs and NMHSs), including the operational provision of Global Seasonal Climate Update**

**Activity:** This activity will promote wider and more effective use of all global-scale CSIS products, such as those by GPCS, in the operational activities of RCCs, RCOFs and NMHSs, through better access and guidance, as well as training/capacity development where needed. This activity will further ensure the operational production and provision of the Global Seasonal Climate Update (GSCU), and will enable regional and national CSIS entities to access, understand and use global products (e.g. from GPCs) including the GSCU, in development of their own products.

**Objectives:**
- To ensure the operational development and dissemination of the GSCU to regional and national CSIS entities;
- To ensure that regional and national providers of climate information access and use GPC products and the GSCU in generating their own products;
- To develop appropriate training modules that explain the global products, including GSCU, and demonstrate their use in regional and national exercises;
- To train staff in all current RCCs (including those in pilot mode), and in NMHSs (perhaps through regional workshops).
**Benefits:** At present, regional and national entities have access to many global products, and have to identify on their own the most robust signals and likely future states of the climate in their areas. All global products are ‘authoritative’, but may differ in many aspects. Access to the GSCU and training in the use of global products including the GSCU will help regional and national users to quickly identify where the global models are providing the most useful information for their areas of interest, and to apply the information in development of their own products.

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

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

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

**Participants:** CCI, CBS, regional centres, some NMHSs.

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**Activity 8: Strengthening regional systems for providing climate services**

**Activity:** To support developing countries with regional climate services and mechanisms for capacity development, professional networking and RCOFs.

**Objectives:** to promote and strengthen WMO Regional Climate Centres (RCCs), to expand RCC coverage to all WMO Regions, and to expand and sustain Regional Climate Outlook Forums, with a particular priority on vulnerable developing countries.

**Benefits:** At present, climate services in many vulnerable countries are weak. While the capacity to develop and deliver climate services at national scale is being strengthened, RCC products and information including for, inter alia, Long-range Forecasts and regional climate monitoring will quickly support improved development and delivery of national climate services, and therefore user decisions, for improved climate risk management. Improved and standardized methods, tools for the mandatory RCC functions and as many highly recommended functions as is feasible, as well as building technical skills through training of RCC personnel, will result in improved, more reliable products, thus reducing uncertainty of users, and improving trust in and application of the information. Enhancements to, and strengthening and expansion of the RCOF process, including inaugurating COFs where needed, improving methods, implementing efficiencies such as use of internet technologies and increasing user-focus will improve the sustainability of the COFs, and will provide users with more consistent and regular information and products pertinent to their needs, and improved access to and dialogue with climate providers.

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

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

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

Participants include WMO Members; international and national funding organizations; existing designated and pilot-mode RCCs; WMO Regional Associations, WMO Technical Commissions, especially CCI and CBS for the RCC designation process and development of guidance; GFCS Research, Modelling and Prediction entities for improvements to methods and skill; RTCs, to participate in training; GFCS UIP experts and entities to facilitate and guide the user liaison aspects of RCOFs, GFCS partnering agencies for (at least) the high priority sectors, namely FAO, WFP, WHO, UNESCO, ISDR, and their regional and national counterparts; additional entities of national level of CSIS (e.g. academic institutions, government ministries) as recommended by the countries in question.
Activity 9: Expand and sustain NCOF/NCF operations

Activity: This activity will establish or enhance National Climate Outlook Forums/National Climate Forums, to extend the benefits and concepts of RCOFs to national scale, and to increase the access and use of climate outlooks and other climate information and products by users at national scale. This activity will also facilitate consistency in the use of climate information by all national user sectors. The focus is on developing countries.

Objectives:

- To ensure that National Climate Outlook Forums/National Climate Forums are established (or improved, if existing already) and operational as an effective means of disseminating climate information, and for fostering dialogue between providers and users at national scales, through several demonstration projects;
- To identify practices and methods including use of Internet technologies for provider-user engagement during periods when there is no opportunity for meetings;
- To strengthen the capability within CSIS entities to engage with users in planning, production, dissemination and feedback for their products and services.

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

Deliverables: guidance on establishing and operationally conducting NCOFs/NCFs; several demonstration projects

Current activities: NCOFs are already in operation in a few countries.

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

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

Activity 10: Provide technical guidance on best operational practices within RCCs and RCOFs

Activity: To assist RCCs and practitioners of RCOFs in optimizing, making more efficient and standardizing their practices and methods.

Objectives:
- To ensure that all RCCs and RCOFs have the capacity to meet the needs of relevant national bodies for regionally focused, high quality and reliable climate information;
• To identify a well-defined and commonly agreed set of climate information products that would be of use in any region, along with some region-specific products that address unique requirements of a given region; and
• To develop guidelines that provide best practices in developing and delivering the identified products.

**Benefits:** increased comparability between and quality of RCC and RCOF procedures and outcomes; increased reliability of outcomes; improved confidence of providers and users.

**Deliverables:** a guidance document on best practices within RCCs and RCOFs.

**Current activities:** Criteria for activities and products sufficient for designation of RCCs exist.

**Indicators and assessment measures:** availability of the guidance document.

**Participants:** CCI and CBS experts, some NMHSs and some research and academic institutions.
<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Key objective</th>
<th>Contributing Pillars</th>
<th>Implementation priority(ies)</th>
<th>Geographic scope</th>
<th>Lead organization</th>
<th>Other organizations</th>
<th>Time-line</th>
<th>Cost USD xM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Establish and coordinate operational support for Climate Services at the national level in developing countries</td>
<td>Entities and cooperation necessary for development and provision of climate services at national levels in developing countries are identified and formalized; climate services are developed and provided with engagement with users</td>
<td>CSIS O&amp;M UIP CD</td>
<td>Guidance document(s) on national frameworks; demonstration project(s); agreements for cooperation; NCOFs/NCFs devoted to establishment and coordination of national frameworks</td>
<td>National</td>
<td>WMO</td>
<td>FAO WFP UNESCO ISDR National partners stakeholders</td>
<td>Mid-2014 and then ongoing</td>
<td>1M</td>
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<tr>
<td>2</td>
<td>Define, build and make available a Climate Services Toolkit to all countries</td>
<td>Ensure that climate sensitive sectors have access to up-to-date, reliable and consistent climate information and products that meet at least their basic needs; a conduit for technology transfer</td>
<td>CSIS RM&amp;P O&amp;M</td>
<td>A toolkit with knowledge products, software, training materials, standards, along with public domain datasets</td>
<td>National and Regional</td>
<td>WMO</td>
<td>Academic and research institutions NMHSs</td>
<td>Mid-2015</td>
<td>1M</td>
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<tr>
<td>3</td>
<td>Establish modern Climate System monitoring based on improved operational monitoring products.</td>
<td>Improve Climate System Monitoring and its products based on standards, data exchange protocols, improved gridded data, improve access to users</td>
<td>O&amp;M CSIS RM&amp;P CD</td>
<td>Standard templates of national climate monitoring products and climate reports; procedures and to old for gridding data</td>
<td>National and Regional</td>
<td>WMO</td>
<td>FAO WFP UNESCO ISDR</td>
<td>End 2014</td>
<td>0.4M</td>
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<td>4</td>
<td>Implementation of Climate Watch systems</td>
<td>Governments, industry and communities are forewarned of any emerging anomalous climate conditions</td>
<td>O&amp;M CSIS UIP</td>
<td>Templates of CWS, developed with user requirements included; implementation workshops</td>
<td>National and Regional</td>
<td>WMO</td>
<td>FAO WFP UNESCO ISDR National stakeholders</td>
<td>End 2014</td>
<td>0.6M</td>
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<td>5</td>
<td>Standardize the operational CSIS products</td>
<td>All national CSIS entities generating climate information adhere to standardized global and regional climate products. Promote common standards in a generation and</td>
<td>CSIS O&amp;M</td>
<td>Identification of a set of standard climate analysis, monitoring and prediction products, and the protocols for their generation and</td>
<td>Global</td>
<td>WMO</td>
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<td>Mid-2014</td>
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<tr>
<td></td>
<td>Packaging of national CSIS products.</td>
<td>Production</td>
<td>All scales</td>
<td>WMO</td>
<td>End 2013 then on-going</td>
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<td>6</td>
<td>Promote effective CSIS-wide use of WMO Information System (WIS)</td>
<td>Ensure that WIS is widely used throughout CSIS operations; training</td>
<td>CSIS</td>
<td>O&amp;M CSIS</td>
<td>All scales</td>
<td>WMO</td>
<td>End 2013 then on-going</td>
<td>0.5M</td>
<td></td>
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<td>7</td>
<td>Facilitate the effective use of GPC and other global climate products by regional and national providers (e.g. RCCs and NMHSs), including the operational provision of Global Seasonal Climate Update</td>
<td>GSCU is developed and disseminated; Regional and national providers of climate information access GPC products and the GSCU, and use them in generating their own products.</td>
<td>CSIS</td>
<td>CD</td>
<td>All scales</td>
<td>WMO</td>
<td>Mid-2014 then on-going</td>
<td>1M</td>
<td></td>
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<tr>
<td>8</td>
<td>Strengthening regional systems for providing climate services</td>
<td>Support and strengthen WMO RCCs; expand RCC coverage to all WMO Regions; expand and sustain RCOFs with priority to developing regions</td>
<td>CSIS</td>
<td>UIP RM&amp;P CD</td>
<td>Global and Regional</td>
<td>WMO</td>
<td>Global and Regional</td>
<td>Mid-2015</td>
<td>3 million per annum = 9M</td>
</tr>
<tr>
<td>9</td>
<td>Expand and sustain NCOF/NCF operations</td>
<td>Develop and improve NCOFs/NCFs as an effective means of disseminating climate information at national scales, and for fostering dialogue between providers and users</td>
<td>CSIS</td>
<td>UIP CD</td>
<td>Regional and National</td>
<td>WMO</td>
<td>Regional and National</td>
<td>End 2014 then on-going</td>
<td>0.7M</td>
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<tr>
<td>10</td>
<td>Provide technical guidance on best operational practices within RCCs and RCOFs</td>
<td>All RCCs and RCOFs use best practices in their operational activities, in order to meet the needs of relevant national bodies for regionally focused, reliable and high quality climate information</td>
<td>CSIS</td>
<td>O&amp;M RM&amp;P CD</td>
<td>Regional and National</td>
<td>WMO</td>
<td>Regional and National</td>
<td>End 2014</td>
<td>0.3M</td>
</tr>
</tbody>
</table>
2.6 Implementation approach (including operational and organizational aspects)

The approach for implementing activities will be influenced by whether they are dealt with at the global, regional or national level. The implementation approach should strive to create efficiencies, delineate responsibilities, and maximize value at each level. For example:

- The development of international standards and global scale products will be best developed at the global level;
- Access to information, development and delivery of products for regions, some aspects of training and capacity development will be best undertaken at the regional level;
- Development and delivery of products for the national and local scale, establishment of relationships between producers and users, and training and capacity development will be best undertaken at the national level;
- Effective implementation of the CSIS at the national level will benefit in particular from a structure that can readily encompass national priorities for the generation and application of accurate and timely information about the climate – past, present and, where possible, the future. Possible structural elements that could be pursued at the national level include national climate services, frameworks for climate services at the national level, national climate centres, National Climate Outlook Forums/National Climate Forums, etc. While countries may choose a model that best addresses their specific needs and situation, it is clear that NMHSs will play the central role in their implementation.

The implementation approach, in addition to ensuring the operation of CSIS entities at the global, regional and national scales, should also have a special focus on efficient operational two-way flow of data and information, keeping in view that the operational functions at each of the three spatial scales are critically dependent on each other.

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

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

The first criterion for success must be that rules for a working structure with a well-defined responsibility for technical oversight on CSIS implementation are established, and the primary and high-priority functions and product portfolio along with the standards and protocols are agreed upon.

In the longer term the CSIS implementation could be monitored by:

- Sustained operations of global and regional CSIS entities regularly providing inputs for the generation of national-scale CSIS products and services;
- The ability to build and sustain partnerships among the agencies that can potentially contribute to the CSIS operations, at all the three levels;
- The increase in the overall use of CSIS products and services and the utility of such products in planning and other decision making in target communities as confirmed by systematic yet cost-effective surveys of user communities;
- The increase in climate data and information exchanged globally and regionally;
- The effectiveness of transitioning climate research outcomes into CSIS operations as measured by the increase in the range of products available, including number and
types of decision support tools in which they are used, and the reduction in the uncertainties associated with key climate products;

- Its ability to undertake projects funded by aid agencies and other donors; and,
- Its ability to attract the resources necessary to sustain its ongoing, long-term activities.

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

2.8 Risk management in the implementation of activities

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

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

Leadership and management: Leadership of the CSIS operations, including oversight on adherence to standards and protocols, is essentially decentralized, must come from the governments/intergovernmental agencies hosting the CSIS entities, while the United Nations System provides overall technical coordination and guidance. There is strong government and United Nations System support for the CSIS component and building on this support in developing the leadership team will minimize the risk of leadership shortcomings.

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

Support for coordination: Strong government and United Nations system support will be necessary to minimize the risks associated with under-resourcing key management functions. Linking with United Nations agencies and programmes that already do related work will be essential to minimising the risk of failure, as will access to experienced project management capability through the Framework’s committee on capacity building.
Support for High-priority Projects: the CSIS should successfully implement a number of high-priority projects in regions where climate services are least-well-developed and most needed and logistic conditions are conducive for project implementation. These will be capacity building projects that engage users and providers and that are implemented with resources from aid agencies in partnership with expertise from climate centres currently delivering a range of climate services.
3 ENABLING MECHANISMS

3.1 Synergies with existing activities

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

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

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

Ultimately the CSIS will need the guidance of a formal manual that lays down mandatory sets of functions, services and products across all geographical levels. CCI and CBS should give consideration to the form that such a guidance document should take, bearing in mind the

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

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

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

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

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

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

### 3.2 Building partnerships and communicating

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

Experiential and analytic processing systems often compete, and personal experience and vivid descriptions are often favoured over ‘dry’ statistical information. Such ‘realities’ have implications for how information will be received and used\(^{28}\). CSIS product dissemination should try to translate statistical information into formats readily understood in the language, and personal and cultural experience of the recipients.

The respective roles and perspectives of government and business in planning to live with climate variability and change vary from sector to sector and country to country but can be usefully assessed in respect of their motives, their expertise, their influence, their attitude to science, their attitude to risk and their attitude to planning\(^ {29}\). User engagement will span all geographical domains of the CSIS (Figure 6). Planning at the national level, for example, is usually led from the Public Sector and involves well-established climate-focussed organizations such as National Meteorological Services, interacting with agencies representing climate-sensitive sectors such as agriculture, energy, infrastructure, and the environment.

\(^{28}\) Living with Climate Change and Variability: Understanding the uncertainties and managing the risks, 2006 *Ibid*

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

### 3.3 Communication strategies

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

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

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

Further, with heightened understanding of the significance of climate generally to social, economic and environmental well-being, mechanisms being made widely available for activities to mitigate and adapt to climate change could be explored for obtaining resources to carry out critical activities such as improving observation networks, data rescue, and data homogenization.
5 COSTED SUMMARY OF ACTIVITIES/PROJECTS

In section 2.5, ten important CSIS projects are described, for completion by mid-2015. The costs of these activities are estimated in Table 2 below. The total cost for all is estimated as 15 million USD. This is a conservative estimate, based on demonstrating certain capabilities and processes, as opposed to full implementation in all areas of need. It should be noted that with a sufficient number of qualified project leads and personnel to carry out implementation activities, additional funds could be utilized in some cases.

<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Key objective</th>
<th>Geographic scope</th>
<th>Cost USD xM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Establish and coordinate operational support for Frameworks for Climate Services at the national levels in developing countries</td>
<td>Entities and cooperation necessary for development and provision of climate services at national levels in developing countries are identified and formalized; climate services are developed and provided with engagement with users</td>
<td>National</td>
<td>1M</td>
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<tr>
<td>2</td>
<td>Define, build and make available a Climate Services Toolkit to all countries</td>
<td>Ensure that climate sensitive sectors have access to up-to-date, reliable and consistent climate information and products that meet at least their basic needs; a conduit for technology transfer</td>
<td>National and Regional</td>
<td>1M</td>
</tr>
<tr>
<td>3</td>
<td>Establish modern Climate System monitoring based on improved operational monitoring products.</td>
<td>Improve Climate System Monitoring and its products based on standards, data exchange protocols, improved gridded data, improve access to users</td>
<td>National and Regional</td>
<td>0.4M</td>
</tr>
<tr>
<td>4</td>
<td>Implementation of Climate Watch systems</td>
<td>Governments, industry and communities are forewarned of any emerging anomalous climate conditions</td>
<td>National and Regional</td>
<td>0.6M</td>
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<tr>
<td>5</td>
<td>Standardize the operational CSIS products</td>
<td>All national CSIS entities generating climate information adhere to standardized global and regional climate products. Promote common standards in a generation and packaging of national CSIS products.</td>
<td>Global</td>
<td>0.5M</td>
</tr>
<tr>
<td>6</td>
<td>Promote effective CSIS-wide use of WMO Information System (WIS)</td>
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<td>All scales</td>
<td>0.5M</td>
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<td>7</td>
<td>Facilitate the effective use of GPC and other global climate products by regional and national providers (e.g. RCCs and NMHSs), including the operational provision of</td>
<td>GSCU is developed and disseminated; Regional and national providers of climate information access GPC products and the GSCU, and use them in generating their own products.</td>
<td>All scales</td>
<td>1M</td>
</tr>
<tr>
<td></td>
<td>Global Seasonal Climate Update</td>
<td>Support and strengthen WMO RCCs; expand RCC coverage to all WMO Regions; expand and sustain RCOFs with priority to developing regions</td>
<td>Global Regional</td>
<td>3M per annum =9M</td>
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<tr>
<td>8</td>
<td>Strengthening regional systems for providing climate services</td>
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<tr>
<td>9</td>
<td>Expand and sustain NCOF/NCF operations</td>
<td>Develop and improve NCOFs/NCFs as an effective means of disseminating climate information at national scales, and for fostering dialogue between providers and users</td>
<td>Regional and National</td>
<td>0.7M</td>
</tr>
<tr>
<td>10</td>
<td>Provide technical guidance on best operational practices within RCCs and RCOFs</td>
<td>All RCCs and RCOFs use best practices in their operational activities, in order to meet the needs of relevant national bodies for regionally focused, reliable and high quality climate information</td>
<td>Regional</td>
<td>0.3M</td>
</tr>
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APPENDIX A:
Establishment of Frameworks for Climate Services at the national and regional levels, particularly for developing countries

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

a. Identify and assign the mandate to the:
   • National entity responsible for the maintenance of the official climate record, and for operational climate information products that constitute the essential climate science inputs to the climate services at the national level, most often an NMHS;
   • Provider of climate services at the national level – responsible for creating and providing authoritative, credible, usable and dependable science-based climate information and advice that is of value to government institutions, socio-economic sectors and the broader community;

b. Where national capacity is lacking, determine which functions should be delegated to regional and/or international parties;

c. Establish and/or expand forums for climate outlooks to include partnership building, gathering and analyzing user needs for climate information and its applications, and identifying supplier needs for improved data and training.

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

a. Determine the support required from the RCC and regional sectoral offices by the climate service provider at the national level and the associated operational centres;

b. Identify mechanisms for fulfilling demand for regional climate services from users.

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

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

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

Consistency with Principles
• All countries will benefit from the concept note, and priority will be given to developing countries for hosting of workshops (Principle 1);
• Official regional and national climate service providers will be mandated, and forums for user – provider interaction will be initiated / strengthened (Principle 2);
• The multi-stakeholder meetings will be held at national and regional levels (Principle 3);
• Regional and national operational service providers will be designated (Principle 4);
• National governments’ responsibility in the provision of climate services will be defined (Principle 5);
The establishment of national and regional frameworks will require formulation of agreements about the exchange of data (Principle 6);
The frameworks will define the roles and responsibilities of existing organizations and identify the needs for additional support and investment (Principle 7);
Users and providers will participate in the multi-stakeholder meetings (Principle 8).

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

Current activities related to this activity (if any)

Prerequisites
Create a concept note for the framework for climate services at the national level, including identifying, developing and standardizing the components of a fully functional NCS, and for ensuring quality control of products and services;
- Hold preparatory discussions with the key stakeholders (primarily NMHSs and relevant Ministries) to ensure commitment, and to establish local organizing committee;
- Conduct mapping of key stakeholders;
- Establish fully functioning RCCs in all regions;
- Strengthen the capacity of RCCs to provide support to the climate service providers at the national level;
- Develop and sign agreements on the exchange of data between national and regional centres to enable the RCC to generate and provide the required information, and support;
- Develop and sign agreements on the exchange of data between national climate service participants and users.

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

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

Linkages with other projects

Stakeholders
To be identified through the mapping process, but to include as a minimum the following:
- NMHS;
- Government Ministries representing health, water, agriculture, the environment, transport, energy, disaster preparedness and response;
- National Red Cross / Red Crescent Society;
- University and other research groups;
- Key industry representatives;
- Other existing significant clients of the NMHS.
Box 1 Climate watch requirements

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

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

If some aspects of required capacities are lacking, they will need to be developed. There are two points to consider when planning to build climate watch system capacity: activities that are necessary to ensure that National Meteorological and Hydrological Service staff have the skills to operate a climate watch system, and the need to build user capacity, requiring dedicated and sustained efforts best achieved by regular interaction and partnership. To that end, an outreach programme is necessary to ensure adequate use of system outputs and an understanding of its limitations and problem areas so that improvements can be made.
Box 2 Rainwatch

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

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

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

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

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

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

The cycle of assessments of climate change projections being carried out under the auspices of the Intergovernmental Panel on Climate Change is currently of the order 6-7 years. The uptake and use of such projections distributed during the four IPCC assessments carried out so far has largely been confined within the research environment but a rapidly growing interest amongst a much wider community of potential users suggests that a more operational system for distributing climate change projections, with consistent and interoperable formats and access to products, will be required.
Box 4 Climate Database for the Environment ( CliDE )

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

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

CliDE will be supplied to the National Meteorological Services of several Pacific Island countries to provide them with the capability to store their meteorological and related observations in a robust climate database management system via a user-friendly interface. CliDE can be used to securely store historical and current, and manual and automatic observations.

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

CliDE produces pre-formatted reports and line plots of key meteorological parameters (e.g. maximum temperature, minimum temperature, rainfall). Data can be transferred to global and regional data centres in CLIMAT formats, and can be ingested directly into other analysis and prediction systems being used by the NMHS e.g. the Seasonal Climate Outlook for Pacific Island Countries (SCOPIC) package also being implemented as part of the overall Australian Government Pacific initiative.
Box 5 Categories for National Meteorological and Hydrological Services*

The functional capabilities of NMHSs in four categories of an incremental hierarchy of their capacity for providing/supporting climate services at the national level are described in the following paragraphs, together with their expected capabilities contributing to the delivery of services at each level.

Category 1: Basic climate services
Functions of Category 1 capability include design, operation and maintenance of national observing systems; data management including QA/QC and homogeneity testing and homogenization; development and maintenance of data archives; climate monitoring; oversight on climate standards; climate diagnostics and climate analysis; climate assessment; dissemination via a variety of media of climate products based on the data; participation in regional climate outlook forums and some interaction with users, to meet requests and gather feedback.

All NMHSs should be able to function at the Category 1 level, performing the basic functions of a national climate centre. At present all but a very few NMHSs provide some measure of the basic climate services through their observing, archiving, data services and basic analysis capabilities. Optimally, climate service staff should be proficient in climate statistics, including basic homogeneity testing and quality assurance techniques, etc. They should also be capable of interpreting products provided by RCCs in order to place national/local conditions within a broader scale context.

Category 2: Essential climate services
In addition to encompassing all Category 1 functions, Category 2 climate services should include the capacity to develop and/or provide monthly and longer climate predictions including seasonal climate outlooks, both statistical and model-based; be able to conduct or participate in regional and national climate outlook forums; interact with users in various sectors to identify their requirements; provide advice on climate information and products; and get feedback on the usefulness and effectiveness of the information and services provided.

A NMHS delivering Category 2 climate services would add value from national perspectives to the products received from RCCs and in some cases GPCs, conduct climate watch programmes and disseminate early warnings. Staff in category 2 NMHSs should be proficient in development and interpretation of climate prediction products, and in assisting users in uptake of these products.

Category 3: Comprehensive climate services
In addition to encompassing Category 2 services, organizations delivering Category 3 climate services would have the capacity to develop and/or provide specialized climate products to meet the needs of major sectors and should be able to downscale long-term climate projections as well as develop and/or interpret decadal climate prediction (as and when available). They would serve to build societal awareness of climate change issues, and provide information relevant to policy development and National Action Plans.

A NMHS delivering Category 3 climate services would meet the requirements for supplying climate information and products to cover all the elements of Climate Risk Management, from risk identification, risk assessment, planning and prevention, services for response and recovery from hazards, information relevant to climate variability and change, and information and advice related to adaptation.

A NMHS functioning at the Category 3 level would contribute to regional-level climate activities and could serve as a node in a Regional Climate Centre Network. Staff in Category 3 NMHSs would require special knowledge in risk assessment, risk management and may have knowledge of financial tools for risk transfer.

Category 4: Advanced climate services
In addition to the ability to deliver Category 3 services, organizations delivering the Category 4 services would have certain in-house research capacities, and would be able to run Global and Regional Climate Models. They would be able to work with sector-based research teams to assist them in developing applications models (e.g. to combine climate and agriculture information and produce food security products), and to develop software and product suites for customized climate products.

A NMHS functioning at the Category 4 level could serve as a Global Producing Centre, a Regional Climate Centre or as a node in a Regional Climate Centre Network. Staff would have modelling and statistical expertise, in a multi-disciplinary context, and would be able to downscale global scale information to regional and national levels. They would also be required to receive and respond to user requirements for new products.
ANNEX

TO

THE IMPLEMENTATION PLAN FOR THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

OBSERVATIONS AND MONITORING COMPONENT

Version: 31 August 2012
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The Observations and Monitoring Pillar is a foundational pillar upon which the success of the Global Framework for Climate Services will be built. For effective climate services to be delivered, observations of appropriate types and of adequate quality and quantity must be made, and these observations must be available at the right place and at the right time. Both surface-based and space observations are required of physical and chemical climate variables of the atmosphere, land, and oceans, including the hydrologic and carbon cycles and the cryosphere. In addition, however, the delivery of useful climate services also requires the availability, for national use in particular, of socio-economic, biological, and environmental data. Physical and chemical climate observations and complementary socio-economic and other data must be effectively integrated to develop and provide users of climate services—farmers, public health officials, disaster risk reduction managers, water resources administrators, and the like—with information that will help to minimize losses due to climate variability and change and to effectively manage natural and human systems.

Despite the fundamental importance of observations for the delivery of climate services, many key regions and climatic zones remain poorly observed. Significant gaps in observations exist, especially in developing countries, and timely access to observational data is still problematic in many locations. The requirement for complementary socio-economic, biological, and environmental data raises additional challenges in ensuring that such data are collected, quality assured, archived, and made accessible in standardized formats. This Observations and Monitoring Plan identifies needs and gaps in climate observing systems, including their associated data management and data exchange infrastructures, and underlines the importance of socio-economic, biological, and environmental data in developing and delivering effective climate services. It proposes actions to address these gaps and requirements, placing particular emphasis on the areas of greatest need in Developing and Least Developed Countries (LDCs) and Small Island Developing States (SIDS) in adherence with GFCS Principle 1. It also draws attention to the importance of the inter-linkages between the Observations and Monitoring and other Pillars.

The Plan presents an overview of existing activities that are being undertaken to address climate observing needs. Highlighted are the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC, the development of architecture for sustained climate monitoring from space, the WMO Rolling Review of Requirements (RRR), the Implementation Plan for the Evolution of Global Observing Systems, the development of a Framework for Ocean Observations, cryosphere activities, and climate monitoring activities. The Observations and Monitoring Pillar of the GFCS relies heavily upon these existing observational programmes, activities, and initiatives. This Plan seeks to increase the focus of observational programmes on the data needed to support the provision of climate services to users, particularly in the key sectors of agriculture and food security, health, water, and disaster risk reduction, which comprise the initial focus of the GFCS Implementation Plan. It targets the highest GFCS priorities through filling observational gaps and enhancing networks and data management and exchange systems, and it highlights the need for monitoring of socio-economic, biological, and environmental variables relevant to the impacts of climate on health, agriculture, water, disaster risk reduction, and other sectors.

Implementation of the Observations and Monitoring Pillar will require full engagement in the programmes and working mechanisms of partners at global, regional, and national levels. At the global level these include a number of UN agencies, such as WMO, UNEP, UNESCO and its
IOC, IMO, FAO, and WHO, and also systems that these organizations co-sponsor, such as the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), and the Global Terrestrial Observing System (GTOS). They also include initiatives fostering integration of different observing systems, such as the WMO Integrated Global Observing System (WIGOS). Equally important at national and regional scales are the contributions made by National Meteorological and Hydrological Services (NMHSs), national and regional space agencies, and national environmental, natural resources, and oceanographic agencies. Attention is also drawn to the important observational contributions of non-governmental organizations and universities and to the potential for greater engagement of non-governmental and private sector observational networks. Initial implementation activities proposed to address observational needs in at least one of the four sectors in which the GFCS Implementation Plan will initially focus—agriculture, health, water resources, and disaster risk reduction—are presented in this Plan. The Plan also includes a more extensive list of relevant activities that partners will seek to implement over a longer period.

While observations of some new types of physical or chemical climate variables may be required, there clearly is a need for greater observational density in both space and time for those variables that are already being monitored. Since it will not be possible to do everything necessary in the first few years of the GFCS, an initial focus will be on the rehabilitation of silent stations, the activation of key stations in data poor areas, and the sustaining of space-based observations in support of climate, in particular as addressing these needs will lead to improved climate services. Greater efforts to rescue historical data are also proposed in order to make use of all the observational data that already exists. To facilitate access, all data must be securely archived in electronic formats with at least basic data management capabilities.

Where socio-economic, biological and environmental data (and perhaps some additional physical and chemical observations) are concerned, more consultation is needed before specific actions can be identified. Determination of needs will vary by sector and will be achieved through an interactive process, in line with GFCS Principle 8, with the key sectorial end users of climate information. Consequently, the Plan proposes several early activities that can be undertaken, starting with the establishment of a formal consultation mechanism with users and an assessment of the need for, and role of, climate observations for adaptation to climate change. The linkages to both the User Interface Platform (UIP) and the Climate Services Information System (CSIS) will be vital to the success of these activities.

Proposals for initial projects have been formulated with the preceding considerations in mind and are included in the Plan. These projects, developed in consultation with international experts and coordinators of observational programmes, address the following issues and will be initiated during the first two years of the Plan. Some, but not all will be completed, in the initial period. Much will remain to be done in the 6- and 10-year timeframes:

- Establishment of a formal mechanism for consultation with users;
- Assessment of the role of observations in adaptation to climate variability and change;
- Rehabilitation of silent stations and key stations in data poor areas, including GCOS Surface Network (GSN) and GCOS Upper-Air Network (GUAN) stations;
- Design of baseline networks;
- Set-up Trust Fund to support operation of regional baseline networks in LDCs and SIDS;
- Improve ground-based and space-based networks for measurement of precipitation;
- Develop guidelines for creation of Discovery Metadata (ISO19115) for registering climate observations and products in the WMO Information System (WIS) and develop the WMO
Data Model to enable the representation and exchange of additional climate observations;

- Development of an integrated global greenhouse gas information system, including enhancing regional scale chemical measurements;
- Establish best practices for air quality observations and monitoring in urban environments;
- Fully implement Hydrological Cycle Observing Systems (HYCOSs) in key shared international river basins to provide information for sustainable water resources development and management;
- Large scale data recovery and digitization;
- Monitor coastal regions in support of adaptation and understanding of vulnerabilities;
- Establish a coordination mechanism for collection, management, and exchange of climate and related food security data; and
- Establish a coordination mechanism for architecture for climate monitoring from space.

In addition to the initial priority projects identified above, tables at the end of the document propose a more extensive list of relevant activities that partners in the GFCS will undertake over a longer period of time as priorities dictate and resources become available. Concluding sections of the Plan draw attention to the need for mobilization of resources to undertake planned initiatives and to important operational issues, including approaches to implementation, the management of risks, and project monitoring and evaluation.
1 INTRODUCTION

1.1 Objective, scope and functions
This document presents a high-level implementation plan for the Observations and Monitoring Pillar of the Global Framework for Climate Services. The plan identifies priority needs for observations to support climate services, encompassing needs for climate data in atmospheric, oceanic, and terrestrial domains and for observations of the impacts of climate. The plan:

- Specifies key actions and activities required to address these needs;
- Pays special attention to the observations, and associated data management and data exchange systems, needed to support services in four key sectors—agriculture and food security, water resources, health, and disaster risk reduction;
- Draws attention to some of the non-physical climate-related data and information, including socio-economic data, that will also be required to support the development of climate services; and
- Identifies organizations that are expected to take the lead in implementing these actions.

1.2 The Requirement for the Observations and Monitoring Pillar of the GFCS
The High Level Taskforce for the GFCS noted that to support climate services, high quality observations are required across the entire climate system and of relevant socio-economic variables. Existing capabilities for climate observation and data exchange provide a strong basis for improving climate services globally. However, there are major gaps in climate observations, particularly over the oceans, Polar Regions, unpopulated regions, and in many developing countries. There are shortcomings in the organized and standardized observation of biological, environmental, and socio-economic variables and a need to ensure these can be adequately integrated with climate data. The Plan for the Observations and Monitoring Pillar of the GFCS seeks to address these gaps and shortcomings, building on existing observational, data management, and exchange systems and initiatives, and adding enhancements where needed to support the provision of climate services.

Long-term, well-calibrated, global observations of variables such as air temperature, rainfall, sea-surface temperature, sea-level, and concentrations of greenhouse gases and aerosols are critical for defining the evolving state of the Earth’s climate. Observing systems must accurately record the constantly changing physical, chemical, and biological conditions of the atmosphere, oceans, and land, enabling climate extremes and consequent vulnerabilities to be identified and contributing to enhancing our understanding of the causes of climatic variations and their impacts. Building this knowledge base requires a significant investment in monitoring biological, environmental, and socio-economic variables.

The instrumental climate record has been largely constructed from surface weather observations acquired from the 19th Century onwards. Balloon-based upper-air observations became well established in the mid-20th century, and temperature and humidity sounding by satellites on an operational basis began in the 1970s. Significant developments in both surface-based and space-based observations have continued since then, along with development of much-improved capabilities for data management, analysis, modelling, and prediction. Significant gaps nevertheless remain in surface-based network coverage, and, for some
networks, there has been an overall decline in observational coverage and dissemination capacity.

Observations needed to provide climate services include those directly related to user needs, such as measurements of precipitation, soil moisture, and surface air temperature, observations of phenomena (e.g. thunderstorms, hail, fog, dust, cloud type and amount), and those observations required for preparation of useful forecasts. The observational data record is fundamental for defining the initial states for model runs, for validating the numerical models used for weather and short-term climate forecasting, and for longer-term scenario-based projections of climate change. In conjunction with appropriate socio-economic, biological, and environmental data, observations of climate variables provide inputs to application models and indices that link climatic conditions to user-relevant measures, such as disease incidence, crop yield, and energy demand. In such applications, data on biological, economic, and social systems must be organized and combined with regional or local climate observations to derive indices that can be used in decision making. Examples of the latter include heating and cooling degree days, growing degree days, and indices for drought, wind chill, and UV exposure.

The acquisition and exchange of meteorological observations are generally carried out on a managed, well-established, and usually securely funded basis, although, as indicated earlier, gaps do exist in some atmospheric networks. Other types of data are, however, required for comprehensive provision of climate services, including:

- Terrestrial, cryospheric, and marine (open-ocean and coastal) observations;
- Observations for ecosystems; and
- Observations of additional physical and chemical variables beyond those normally included in weather observations (e.g., measurements of atmospheric pollutants and solar and terrestrial radiation).

For many of these variables enhancement of the collection of observations, exchange of data, and/or funding stability are still needed. Furthermore, the quality and duration of time series of historical data held in global data centres show considerable variations from country to country. In consequence, continued efforts must be devoted to recovery and analysis of historical data, including paleo-climatic reconstructions, reprocessing and reanalysis of the modern instrumental record, and sustaining and improving observations into the future in order to extend these vital historical records. The Climate Data Management Systems (CDMS) initiative being developed under the international efforts led by the WMO Commission for Climatology provides technological solutions for modern archiving and quick retrieval of historical and near-real time climate time series. NMHSs in developing and least developed countries should be assisted and encouraged to use modern CDMSs.

As a particular deficiency, there is, at this time, no system in place for sustained monitoring of climate from space. Yet space-based observation has demonstrated potential to contribute valuable information on important climate variables such as albedo, snow cover, soil moisture, and sea ice. Consequently, there is also a need to assess the quantitative value of new measurements available from space that have potential climate service applications and, where appropriate, ensure sustained monitoring. The calibration of space-based sensor outputs against conventional surface and upper-air observations will require continued research attention.
As noted previously, biological, environmental, and socio-economic data are needed for translating observations and forecasts of climate variables into indices and other products that address user concerns, such as disease incidence, crop yield, and energy demand.

One of the primary constraints affecting climate and related data access and data exchange is the restrictive data policies of some data providers who have, in certain instances, indicated their unwillingness to share certain types of data needed for climate services. Agencies responsible for data management and exchange have generally developed their own data policies, often based on national legislation, and many are not willing to provide free and unrestricted access to their data. As a fundamental principle of data sharing within the GFCS, an open door policy should be pursued, as expressed by GFCS Principle 6. Thus, countries should continue to be encouraged to adopt the free and unrestricted (non-discriminatory and without charge) international exchange of climate-related data and products. The WMO Congress, for example, has adopted WMO Resolutions 40 and 25 as guidance for its Members in relation to access and exchange of meteorological and hydrological data. These Resolutions may provide a useful model for consideration in pursuing the development of broader, overarching data access and exchange policies that can address all components of the climate system, including biological, environmental, and socio-economic data requirements within the context of the GFCS. Nevertheless, where the exchange of socio-economic and other data is sensitive, as it will often be, the availability of such data at the national level is still crucial for the development of national climate services.

1.3 Inter-linkages with Other Pillars

1.3.1 Linkage with Research, Monitoring, and Prediction

The Research, Modelling and Prediction (RMP) Pillar of the GFCS stresses the vital importance of climate observations, pointing out that climate predictions from a week to a season are strongly dependent on the availability of accurate initial conditions for all components of the climate system that have longer memory than the atmosphere. The achievement of progress in such predictions is, to a significant degree, dependent on more comprehensive observations that not only serve as the main means of initializing climate models but also are the foundation for improved understanding and representation in models of key phenomena and processes. Equally, the conduct of research into the impacts of climate requires access to both climate data and biological, environmental, and socio-economic data. Conversely, research support is essential for the continued evolution of observing systems and practices, including improving the economic efficiency of existing technology and techniques, the more effective design of observing networks, and the migration of research-based observing systems, where appropriate, to operational status. Moreover, research funding continues to be an important source of support for climate monitoring, particularly in providing resources for the acquisition of oceanographic, atmospheric chemistry, and some important cryospheric and atmospheric observations.

The GFCS will facilitate and accelerate transitions from research-based to operational observing capabilities and will generate corresponding requirements for research and development. As an example, to enable climate prediction, modern observing systems should include variables necessary for initialization of climate models through coupled data assimilation. Research is also required on how climate variability and change interact with air pollution on regional to global scales to achieve improved understanding of the links between climate, ecosystems, and biogeochemical cycles. Other research areas relevant to the Observations Pillar include coordinated climate data reprocessing, the extension of meteorological reanalyses, and initiation of new types of reanalysis, culminating in integrated Earth system reanalyses.
Research groups, such as those coordinated by the World Climate Research Programme (WCRP), will produce key inputs to the activities proposed in the area of observations and monitoring. Similarly, research constituencies affiliated with GCOS, GOOS, GTOS, WIGOS and other observing programmes will be key contributors to the achievement of GFCS objectives in the research, modelling, and prediction domains. The WMO Global Atmosphere Watch (GAW) Programme, as a particular example, will provide the mechanism for the transition of greenhouse gas, aerosol, and air pollutant observations from a research to operational mode. The preceding considerations clearly underline the need for the development and maintenance of effective linkages and coordination between the Observations and Research Pillars of the GFCS.

1.3.2 Linkage with the Climate Services Information System
The Climate Services Information System (CSIS) Pillar is the principal mechanism through which information about climate – past, present and future – is routinely collated, stored and processed to generate products and services that help to inform decision making processes across a wide range of climate-sensitive activities and enterprises. Fundamentally, the climate services produced and delivered by the Climate Services Information System (CSIS) of the GFCS will be based on the observations of the climate system, on products derived from these observations, and on relevant socio-economic data and information for the sectors of concern, such as, for example, statistics on disease incidence, crop and livestock production, and deaths and losses associated with disasters. It is, to some extent, in the domain of the CSIS Pillar to specify what observations are needed for the development of specific climate services and, correspondingly, in the domain of the Observations and Monitoring Pillar to deliver those observations or, if they are not available, to determine what is needed to make them available. Hence, structured ongoing communication will need to be established between those engaged in the work of the Observations Pillar and the CSIS to generate feedback on how well observing and data collection systems are meeting CSIS needs, identify gaps and deficiencies, and motivate remedial actions. In specifying what observations are needed, the CSIS can also serve as an important link between the Observations Pillar and the User Interface Platform and, ultimately, user needs. Similarly, where observations are needed that require research efforts, the CSIS can serve to reinforce the linkage between the observation and the research platforms.

1.3.3 Linkage with the User Interface Platform
The User Interface Platform (UIP) is the Pillar of the GFCS that provides a structured means for users, climate researchers, and climate service providers to interact at the global, regional, and national levels. The managers of operational observing networks need to understand what observations users require, while users need to be able to communicate what they need and to understand the limitations of what can be delivered. In assessing the requirements of users for services, the process will inevitably be an iterative one as capabilities are matched to needs. An example of a related initiative that will be undertaken as part of this implementation plan is the organization of one or more workshops by the GCOS programme (see section 2.2 below) to focus on identifying specific needs for observations for adaptation to climate change and for the development of climate services.

1.3.4 Linkage with the Capacity Development Pillar
The availability and carefully targeted application of adequate financial, technical, and human resources will be essential for the successful implementation of the GFCS. The GFCS addresses all components of the climate system and has an initial emphasis on the four key priority areas of application discussed in the Exemplars (agriculture and food security, health,
disaster risk reduction, and water). Given this broad perspective, its implementation will lead to requirements for new types of environmental and socio-economic data that are either not, at present, being collected on an operational basis or are obtained, processed, and stored by a variety of agencies and institutions. Remediating gaps and deficiencies in existing observational networks and systems, acquiring new types of observations, and processing and integrating this information will necessitate significant capacity building efforts spanning GFCS partner agencies and institutions at all levels, especially in developing countries. The establishment and maintenance of effective ongoing liaison and partnership between the Observations and Monitoring Pillar and the Capacity Development Pillar will be essential to a successful response to the capacity development challenge presented by implementation of the GFCS.

1.4 Relevant Existing Plans and Activities and Identification of Gaps

Table 4 at the end of this Annex reviews the current status of observational networks and systems for important atmospheric, terrestrial, and oceanic variables needed to support the provision of climate services to user communities. Plans and activities addressing the need to improve these climate observing systems currently exist for a variety of requirements, and some of the most important of these are described in the following subsections.

1.4.1 The Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC

The Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC is highly relevant to the implementation of the observing component of the GFCS, as many needs for observations have been elaborated in the Plan.\[30\] Updated in 2010, this Plan includes the acquisition of observational data for purposes directly aligned with those of the GFCS and highlights the need to encompass all components of the climate system. It is also based on extensive consultations with a broad and representative range of scientists and data users, and it has been developed in collaboration with the Group on Earth Observations (GEO).

The Plan pays special attention to the needs for observation of 50 Essential Climate Variables (ECVs) covering the three physical domains (atmosphere, land, and oceans) and includes observations related to the hydrological and carbon cycles and the cryosphere. The Plan was prepared at the request of the Parties to the UNFCCC. These Parties are essentially the same countries that requested the development of the GFCS, and implementation of the actions identified in it will address many of the needs for climate observations in support of the GFCS.

Implementation of the actions in the Plan will, among other things, enable projection of global climate change information down to regional and local scales and characterization of extreme events important for impact assessment, adaptation, and assessment of risk and vulnerability. The Plan was supplemented in 2011 by provision of details on its satellite-specific components in the report Systematic Observation Requirements for Satellite-Based Data Products for Climate. This report defines climate variable product requirements and needs for satellite missions, datasets, and reprocessing and represents an important step forward in integrating surface and space-based observations, thus partially filling gaps in the global observing system. However, the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC and its satellite supplement do not address the whole range of non-physical climate-related data and information, in particular biological and socio-economic data, that are needed to support the development of climate services.

1.4.2 World Climate Programme (WCP)
The World Climate Programme (WCP) aims, primarily, to enhance climate services, with an adequate focus on user interaction, so as to facilitate even more useful applications of climate information to derive optimal socio-economic benefits. It is thus an integral part of the Global Framework for Climate Services (GFCS). The scope of the WCP is to determine the physical basis of the climate system that would allow increasingly skilful climate predictions and projections, to develop operational structures to provide climate services, and to develop and maintain an essential global observing system fully capable of meeting the climate information needs.

A new structure for the WCP was adopted by Resolution 18 of WMO Congress-XVI. This new structure has three major components:

- The Global Climate Observing System (GCOS), which is aimed at meeting the full range of needs for climate observations. It is built on the WMO Global Observing System, Global Atmosphere Watch, and Global Cryosphere Watch (now brought together as part of the WMO Integrated Global Observing System), the IOC-led Global Ocean Observing System, and the FAO-led Global Terrestrial Observing System. It is co-sponsored by WMO, IOC, UNEP and ICSU and is particularly focused on supporting the WCRP and the World Climate Services Programme, (introduced below);

- The World Climate Research Programme (WCRP), whose mission is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit, and value to society, with the overall objectives being to determine the extent to which climate can be predicted and the degree of human influence on climate;

- The World Climate Services Programme (WCSP), whose scope spans across climate data and analysis; climate monitoring, watch, and prediction; climate system operation and infrastructure; and climate adaptation and risk management. The WCSP contributes to improving the availability of and access to reliable data, the advancement of knowledge in the area of climate data management and climate analysis, the definition of technical and scientific standards, and development of activities to support them in countries. Climate data management will include the whole array of data rescue techniques (from data transfer into digital format to time series quality control and homogenization) and the development and coordination of a global climate data management system compatible with the WMO Information System (WIS). The WCSP serves the Climate Services Information System and the User Interface Platform components of the GFCS.

In addition, consideration is being given to adding the Programme on Research on Climate Change Vulnerability, Impacts, and Adaptation (PROVIA) to the World Climate Programme. PROVIA is a global initiative that aims to provide direction and coherence at the international level for research on vulnerability, impacts and adaptation. Current partners in this new programme include UNEP, UNESCO, and WMO. The Secretariat is hosted by UNEP in Nairobi.

1.4.3 An architecture for climate monitoring from space
The definition and implementation of an architecture for sustained climate monitoring from space will bring the same structures and rigor to climate monitoring that are currently in place for weather monitoring and forecasting. The architecture, based on requirements established by GCOS and as the key space component of the WMO Integrated Global Observing System (WIGOS), will be an essential building block of the GFCS Observations and Monitoring Pillar and will support all four priority sectors and all ECVs observable from space. It will be defined as
an end-to-end system, involving the different stakeholders, including operational satellite operators and R&D space agencies, the Coordination Group for Meteorological Satellites (CGMS), the Committee on Earth Observation Satellites (CEOS), GCOS, WCRP, and GEO.

In building the architecture, synergies with surface- and space-based observing systems and with existing coordination mechanisms will be leveraged to fully exploit all available resources and to fill observational gaps. Among these are the inter-calibration activities of the Global Space-based Inter-Calibration System (GSICS); additional calibration and validation activities to be conducted in coordination with the WMO Commission for Instruments and Methods of Observation (CIMO); CEOS calibration, validation, and virtual constellation efforts; product generation efforts like the Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) initiative; and the training and capacity building activities of the Virtual Laboratory for Education and Training in Satellite Meteorology (VLab).

1.4.4 Rolling Review of Requirements
Observational requirements have been identified by WMO in twelve Application Areas including, among others, climate, hydrology, agricultural meteorology, oceans, atmospheric chemistry, and seasonal-to-interannual forecasting, which are each relevant to the GFCS. The Rolling Review of Requirements (RRR) process routinely updates these requirements, identifies gaps, and thus guides WMO Members in the evolution of both surface- and space-based global observing systems. The review process includes wide community consultation with scientific experts, WMO Technical Commissions, and other interest groups. Capabilities are examined and information is quantitatively recorded in an online database of observational requirements and observing systems capabilities. Table 1 lists WMO Applications Areas monitored through the RRR, assesses their relevance to the GFCS, highlights the types of observations required to support these areas, and flags their importance for various societal sectors.

1.4.5 Implementation Plans for the Evolution of Global Observing Systems (EGOS-IP) and WMO Integrated Global Observing System (WIGOS-IP)
The WMO Integrated Global Observing System Implementation Plan (WIGOS-IP) provides a new framework for WMO observing systems and the contributions of WMO to co-sponsored observing systems. WIGOS (see section 2.2.1.2 for additional detail) does not replace the existing observing systems, but is rather an over-arching framework for the evolution of these systems that will continue to be owned and operated by a diverse array of organizations and programmes. WIGOS will focus on the integration of governance and management functions, mechanisms, and activities to be accomplished by contributing observing systems in relation to the resources allocated on global, regional, and national levels.

A principal WIGOS document is the new Implementation Plan for the Evolution of the Global Observing Systems (EGOS-IP). This plan takes into account WIGOS and GFCS requirements and will provide WMO Members with clear and focused guidelines and recommended actions so that requirements of WMO Programmes can be met in an integrated way by 2015 and beyond. The EGOS-IP also covers observational requirements for application areas, including those relevant to climate (see Table 1).

1.4.6 Development of a Framework for Ocean Observing
A Framework for Ocean Observing was developed following the international OceanObs'09 conference (September 2009, Venice, Italy) and adopted by the IOC Assembly in June 2011. The Framework for Ocean Observing seeks to deliver a collaborative ocean observing system based on a set of principles and best practices that can deliver needed physical,
biogeochemical, and biological data to answer societal issues and scientific inquiry. More specifically, the Framework:

- Articulates a systems approach for sustained global ocean observing, introducing the “Essential Ocean Variables” (EOVs) as a common language;
- Fosters recognition and development of interfaces among all actors for mutual benefit;
- Provides the basis for transformation of observational data organized by EOVs into syntheses, analyses, assessments, projections, and scenarios that serve a wide range of societal needs.

The GOOS Steering Committee is working with international stakeholders to use the Framework to improve the ocean observing system, including the evaluation of new requirements imposed by climate services.
Table 1. Observational Requirements for Various Applications and Their Relevance to the GFCS across WMO-Defined Societal Sectors


<table>
<thead>
<tr>
<th>Application Areas</th>
<th>GFCS relevance</th>
<th>Societal sectors</th>
<th>Main Domain(s)</th>
<th>Types of observations required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Monitoring</td>
<td>Very High</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>Atmospheric, Oceanic, Terrestrial</td>
<td>Surface, upper-air, atmospheric composition, terrestrial, ocean surface, ocean sub. surface</td>
</tr>
<tr>
<td>Climate Applications (incl. services)</td>
<td>Very High</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>Atmospheric, Oceanic, Terrestrial</td>
<td>Surface, upper-air, atmospheric composition, terrestrial, ocean surface, ocean sub. surface</td>
</tr>
<tr>
<td>Seasonal and Inter-Annual Forecasts</td>
<td>Very High</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>Atmospheric, Oceanic, Terrestrial</td>
<td>Surface, upper-air, atmospheric composition, terrestrial, ocean surface, ocean sub. surface</td>
</tr>
<tr>
<td>Atmospheric Chemistry</td>
<td>High</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>Atmospheric</td>
<td>Atmospheric composition, and ancillary variables</td>
</tr>
<tr>
<td>Global Numerical Weather Prediction</td>
<td>High</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>Atmospheric, Oceanic, Terrestrial</td>
<td>Surface, upper-air, ocean surface</td>
</tr>
<tr>
<td>Application Areas</td>
<td>GFCS relevance</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Ocean Applications</td>
<td>High</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Agricultural Meteorology</td>
<td>High</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hydrology</td>
<td>High</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>High Resolution Numerical Weather Prediction</td>
<td>Medium</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Nowcasting and Very Short-Range Forecasting</td>
<td>Low</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aeronautical Meteorology</td>
<td>Low</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Space Weather</td>
<td>Low</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
1.4.7 Climate Monitoring Activities

The goal of Climate System Monitoring (CSM), a project of the World Climate Data and Monitoring (WCDMP) sub-programme of the World Climate Programme (WCP), is to deliver timely and authoritative information on the status of the climate system at multiple temporal (sub-monthly, monthly, seasonal, annual, decadal, and multi-decadal) and spatial (local, regional, and global) scales along with the ability to assess the uncertainty underlying this information. CSM outputs include high-quality climate datasets based on in situ and space-based observations, data recovered from old archives, and data processed from model outputs (reanalysis data) that provide historical references and baselines for assessing climate variability, changes, and extremes and can be integrated with data on risks, exposures, and impacts to prevent or mitigate disasters.

The World Weather Records (WWRs) global datasets compiled and published since 1927 by the World Data Centre for Meteorology at the US National Climatic Data Centre (NCDC) include monthly mean values of pressure, temperature, precipitation, and where available, station metadata notes documenting observation practices and station configurations. More than one-third of the 1990’s station data included in global datasets, such as the Global Historical Climatology Network–Monthly, come from WWRs, greatly enhancing climate analyses. Since 1920, data have been updated on a decadal basis, and while once-a-decade provision of the WWRs has served the climate community’s needs very well, annual dissemination of these data is now required to support improved climate assessment.

High-resolution gridded data sets and satellite data have become increasingly useful in agriculture and other key application areas, in addition to their important role in global climate monitoring. As a specific example, satellite-based monitoring of the Intertropical Convergence Zone (ITCZ) in West and East Africa would be very helpful in supplementing the scarce and low resolution in situ data traditionally used for this purpose. Systematic use of satellite data and products, reinforced by much-needed training and guidance, will permit better planning and operations for the crop season, contributing to improved food security in these regions. Regional Climate Centres, NMHSs, and agricultural institutions should be enabled to access and use these outputs.

In some countries, community operated networks are in place that represent potential sources of additional observational data, although many may not comply with WMO standards and practices. There is, therefore, a need within the GFCS to improve the quality of these observations in order to generate good quality climate data. The assignment of a data centre to host such data should be fostered.

Records can be extended, and gaps filled, by recovering, from various sources, older data that exist within countries, digitizing data that are held in paper or scanned records, and, where needed, converting data from older formats to modern digital formats. It is important to note that many climate records, particularly prior to 1960, are still in paper formats (including strip charts) and face the risk of degradation and loss. Such paper records should, as an interim measure, be securely stored (e.g. in acid-free boxes) to prevent further degradation until digitization or imaging can be undertaken. Important amounts of digital data also continue to be stored on obsolete or degrading media, such as microfiches, punch cards, magnetic tapes, and old floppy disks. To date, however, digitization efforts have focused on some archives and not on others. Data rescue and digitization of climate data needs to be pursued aggressively and should be expanded, where necessary, to address the rescue and recovery of other relevant data, such as
oceanographic data (e.g., sea level measurements), and records of outbreaks of malaria and other diseases or of other impacts of climate.

The strategy recommended by the WMO Commission for Climatology (CCI) links Data Rescue and Digitization (DARE&D) to Climate Risk Management (CRM) and climate change assessment and adaptation. At the global scale, international data rescue efforts include, for example, those being coordinated and facilitated by the Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative and its various regional foci (i.e., ACRE Chile, ACRE Pacific, ACRE Arctic, ACRE India, ACRE Africa, and ACRE China). These efforts, along with others under WMO and at the NOAA National Climatic Data Centre (NCDC), are very useful in linking historical terrestrial and marine surface weather observations with the International Surface Pressure Databank (ISPD), the International Comprehensive Ocean-Atmosphere Data Set (ICOADS), and global surface temperature datasets, which are used for monitoring and assessing global climate at various time scales. At the regional scale, the Mediterranean Data Rescue Initiative (MEDARE), aimed at developing high-quality long-term climate data sets for the greater Mediterranean region, represents a good model for other regions and sub-regions. Additional regional examples include the European Climate Assessment and Data (ECA&D) project (Europe), the DARE project of ACMAD (Africa), and the Pacific Island Countries data rescue project, supported by the Australian Bureau of Meteorology. The planned establishment of an International Climate Assessment and Data set initiative (ICA&D), which will build on regional components of DARE&D, will ensure harmonized, sustained, and cost effective implementation of the strategy recommended by CCI.

1.4.8 Summary of Gaps and Needs
Significant gaps and deficiencies related to observations can be summarized as follows:

- Shortcomings in atmospheric observations that include non-reporting by some climate stations (due to inability to sustain observational networks, lack of training and capability, inadequate communication systems or other factors), limited space and surface-based remote sensing capabilities, and the absence of operational monitoring of some important air quality, radiation, and other variables;

- Weaknesses in observational coverage of important oceanographic variables that include incomplete moored buoy networks for monitoring ocean currents, mass flux, ocean salinity, and sea ice parameters; uncertainties regarding the continuity of satellite monitoring programmes such as microwave sensing, high precision altimetry, and Light Detection and Ranging (LIDAR) and Synthetic Aperture Radar (SAR) coverage of sea ice parameters;

- Gaps in terrestrial observing networks, such as for river discharge, ground water, lake levels, permafrost, glaciers and ice caps; the absence of designated networks for soil moisture, Leaf Area Index (LAI), Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) and above ground biomass; and uncertainty regarding the continuity of satellite missions that monitor land cover;

- Needs for complementary biological, environmental, and socio-economic data (e.g., records of disease incidence, crop yield, energy demand, and disaster losses) to enable the production of indices and other products that assist the user communities in planning and management;

- Data policies and information infrastructures that need to be enhanced to improve data management and access to historical observational and other relevant data and derived products;
• Continuing needs to improve local, regional, and global monitoring systems to enhance efficiency and improve data management, including careful attention to minimization of data losses and inhomogeneities when observational systems change or are upgraded;

• Needs to rescue, digitize, and develop (e.g., time series quality control and homogenization) historical climate and sectorial user data that are currently held in perishable paper formats or available only on obsolete or degrading media and to place re-analysis, a substantial technical as well as scientific undertaking, on a firmer, operational footing.
2 IMPLEMENTATION OF THE OBSERVATIONS AND MONITORING PILLAR

2.1 The Necessary and Sufficient Conditions Needed for Successful Implementation of the Pillar

Successful implementation of the Observations and Monitoring Pillar requires that all data needed by climate services be measured and available on a sustained basis. Satisfying this condition will depend on several factors:

- Entities that develop and operate observing networks (such as NMHSs, research institutes, universities, and the private sector) will need to make their observations, data, and observational products (including historical data and products) available;
- Technological developments and national, regional, or global economic circumstances must enable these entities to sustain the collection and delivery of observations and data over the long term.

Coordinating bodies, such as UN organizations acting either individually or collectively, and international and regional groupings (such as GEO, EUMETNET and ASECNA) play a catalyzing role in ensuring both the availability of data and, to the extent possible, coordinated, interoperable observing networks. Mechanisms to influence the implementation and evolution of observing systems to meet global, regional, and national needs should be supported. Ensuring global and regional coordination in observing system operations and development and strong partnerships, nurtured by close collaboration among partners irrespective of socio-economic situation or political differences, is another necessary condition. Addressing observing system gaps is also necessary to enable uninterrupted functioning of the observing systems to support the provision of equivalent services in all parts of the world and to all in need, with special attention to the most vulnerable developing countries and populations as endorsed by GFCS Principle 1. To fully meet these overarching conditions, the following subsidiary conditions must be satisfied:

- Effective engagement among entities operating or coordinating observing systems and among those entities and users, including the conduct of interdisciplinary rolling reviews of requirements (RRR) for data and observing system capability analyses;
- Implementation of agreed observing standards and best practices among entities operating or coordinating observing systems and mutual development of new standards in collaboration with international standardization bodies, such as the International Organization for Standardization (ISO) and the Bureau International des Poids et Mesures (BIPM);
- Identification of data gaps (using information from the RRR and capability analyses) and building of capacities or technical support to fill them;
- Provision of adequate funding, human resources, and observing and IT technology to operate observing systems, to implement QA/QC procedures (including calibration and maintenance of the systems), to ensure reliability of data delivery, to ensure staff competencies, to ensure delivery using interoperable formats, and to distribute data and information worldwide in real or near-real time;
- Implementation of policies for open and broad access to all data needed for the provision of climate services at the frequencies required;
- Ensuring the relevance of observed variables and data to the climate services required by users;
- Political commitment and accountability of entities operating or coordinating observing networks to implement this Pillar.

It may take many years for the Observations and Monitoring Pillar of the GFCS to fully satisfy each of these conditions. Consideration should, therefore, be given to a two-stage implementation process, comprising ‘Initial Implementation’ and ‘Full Implementation’ actions.

The highest observational priorities from a climate services perspective for the four sectors that are the initial focus of the GFCS are discussed in the following sections. However, it should be stressed that additional requirements for climate observations and for other climate-related data in support of the GFCS will need to be determined over time through an interactive process involving the providers of climate data and various user communities. The definition of such requirements should incorporate and build upon information gained during previous consultations undertaken under the aegis of the GFCS and other programmes. It is recognized that most countries will have explicit policies about the release of socio-economic data beyond national borders and that much such data will not be released. Nevertheless, for national and local use, socio-economic, biological, and environmental data will be essential for the development of climate services.

2.1.1 Important Observing System Needs for Agriculture and Food Security

The Exemplar on Food Security points out that greater frequency, severity, and intensity of weather and climate extremes have continued to increase food deficits despite technological advances, ranging from improved crop varieties and farm management systems to enhanced decision support tools, that have benefited agricultural productivity. Concerns regarding climate and its impacts led the Committee on World Food Security and Nutrition (CFS), at its October 2010 meeting, to request its High Level Panel of Experts on Food Security and Nutrition (HLPE) to prepare a report on Food Security and Climate Change. The HLPE report calls on the Committee to “facilitate a dialogue on improved global data collection efforts for climate change and food security,” providing encouragement for an early initiative by the Observations and Monitoring Pillar to engage the agricultural community in coordinated efforts to refine and address needs for observational and other data related to climate and its impacts on food security.

Long-term monitoring of basic climate variables related to the fluxes of energy at the surface is essential if we are to plan for changes in the location, extent, and productivity of agricultural and grazing lands. The provision of climate services for agriculture requires, inter alia, observations of the following types:

- In addition to standard weather parameters such as air temperature, precipitation, relative humidity, wind speed/direction, evaporation, and solar radiation, it is also important to collect soil moisture and soil temperature data at strategically located stations and, as appropriate, from space;
- Other observations useful for agricultural applications include those yielding vegetation indices (e.g., on photosynthetic activity), snow depth and snow cover, sand and dust loads, evapotranspiration measurements, and dew;
- Phenological observations record the dates of recurrence of the important phases of plant and animal life. Examples of these include the dates of such events as leafing, flowering, fruiting and leaf-fall of trees, migration of birds, and the appearance of insects;
• Since air pollutants can decrease crop yields, air pollutant observations, particularly of ozone, are also very important.

Other types of data and socio-economic information also contribute to the production of climate services for agriculture. For example,

• Data on crop yields, area, and production statistics; livestock production; water quality (salinity, BOD/COD); information on biodiversity (species migration and extension); societal impacts; and assessments of vulnerability are all relevant for identifying and recording impacts on agriculture from climate and other natural hazards;

• Some vulnerability-related measures that may also need to be considered in producing climate services include gender, age, ethnicity, political status, dependency on agriculture, level of wealth/poverty and human development, level of education, access to natural assets, access to alternative supplies of water and fodder, access to markets, baseline health, livelihood and employment options, access to alternative or supplemental employment and social networks, level of isolation, access to infrastructure, underlying climate variability, and exposure to previous droughts, floods, and other hazards.

Of particular relevance to the GFCS, the HLPE report on Food Security and Climate Change also stresses the need for:

• Expanded monitoring of agricultural emissions of GHGs;
• Enhanced and better coordinated collection and international exchange of climate and food security data;
• Strengthening of national and international meteorological, statistical, and data services, including the adoption of common metadata standards to maximize all possible synergies;
• Improved dissemination of forecast information to farmers to enable them to cope with increased climatic variability and extreme events.

2.1.2 Important Observing System Needs for Health

The GFCS Health Exemplar identifies a range of observations required to provide climate services to the health sector:

• Local measurements of precipitation, humidity, soil moisture, and surface air temperature are needed to identify malaria risk by correlating health and population information with observations of local ecological and other conditions (e.g., such as vulnerability of population and type of habitation) conducive or non-conducive for transmission;

• Historical observations of temperature, humidity, satellite estimates of rainfall, the predicted start date of the rainy season, and the likelihood of extreme temperatures during the coming season are required to help manage diseases that are sensitive to climate (e.g., malaria, acute respiratory infections, intestinal helminths, and diarrhoea);

• Observations of chemical variables that contribute to air pollution, such as ozone, sulphur dioxide, oxides of nitrogen, and aerosols, and of wind are important for identifying risks to the body’s respiratory and the cardiovascular systems.

There are also additional observational requirements that may not be of direct or immediate interest to the health sector, but that are necessary for making some types of climate
information available. As an example, the production of seasonal forecasts of conditions over tropical land areas requires observations of oceanographic conditions in the tropics, in addition to observations of atmospheric variables.

In many areas, an important constraint to climate analysis for health needs is the limited access to sufficiently long time series of quality-controlled daily observations. Such information must, moreover, be broadly available in a timely manner for it to have optimal value. Since many health effects tend to be localized, it is also important that climate observations are maintained at the local scale, whether in urban or rural areas. Substantial improvements are required in the availability of relevant and reliable climate data at the local scale, especially in regions such as Africa where vulnerability to climate is high and information is often insufficient for local point-scale analyses. Last but not least, it is important to recover and digitize historical climate and health data that are still in obsolete media to enable cause-and-effect studies on climate and health and to develop the necessary interoperable climate-health databases for health risk monitoring and analysis.

2.1.3 Important Observing System Needs for Water

In many regions of the world, the availability of fresh water is becoming an important limiting factor for socio-economic development. Water availability governs agricultural practices, including animal husbandry, and influences inland fishing and aquaculture potential as well as being essential to municipal water supplies, industry, transportation, and energy. Monitoring climate variables associated with the availability and quality of fresh water involves:

- Systematic observation of the basic atmospheric variables, such as precipitation, temperature, evaporation and wind;
- Systematic monitoring of hydrological variables that characterize the storage and movement of water, including stream flow, lake volume changes, groundwater, soil moisture, and water bound in snow and glaciers in high mountain areas and cold climates.

Observations of atmospheric variables allow the flux of water across the atmosphere-land interface to be estimated, while observations of hydrological variables, such as stream-flow and soil moisture, enable the water budget to be calculated for catchment areas.

Three main actions can be identified with regard to improving and adapting water management, including integrated management of extremes such as floods and droughts:

- At the global scale, there is a need for hydrological monitoring of changes in water resources availability and changes, including fluxes, of freshwater from continents in the world’s oceans. This could be implemented through the GTN-H;
- At the regional and trans-boundary basin scale, implementation of the WHYCOS concept should be pursued through individual Hydrological Cycle Observing System (HYCOS) projects, based on agreed basin-wide and regional requirements;
- Finally, at the national scale, the need exists to strengthen the capabilities of national hydrological services to monitor and assess water resources, forecast extremes, and improve water management practices in a changing climate.

As in other application areas, it is essential that information on relevant socio-economic variables be available to support the provision of climate services for the water sector. While
more research is required to identify the most critical variables, the following aspects are certainly relevant:

- Socio-economic changes in the patterns of water use and consumption that are caused by general socio-economic development processes;
- Changes in population dynamics, including rapid urbanization and migration movements;
- Assessment of the adequacy of national policies and strategies in water resources management, including the management of extremes;
- Perceived societal value of water and ability to pay for improved water services.

The Water Exemplar highlights that gaps and mismatches are often evident between the nature and distribution of atmospheric observing networks and water monitoring networks. This is seen as a pressing problem in view of a progressive decline in the size and quality of meteorological and hydrological observing networks during recent decades, especially in countries at most risk from climate-water related impacts. Improved coordination between atmospheric and water monitoring networks is, therefore, urgently needed to achieve compatible observation networks, to extend them to meet user needs, and to ensure the quality of the data. Given the increasing use of ground water for human consumption in many parts of the world, greater effort will need to be devoted to monitoring ground water storage and change. This further underlines the importance of developing and maintaining close linkages and effective coordination between the Observations and Monitoring and the other Pillars of the GFCS.

2.1.4 Important Observing System Needs for Disaster Risk Reduction (DRR)

Disaster risk arises when hazards interact with physical, social, economic, and environmental vulnerabilities. The DRR Exemplar stresses that:

- The basis for effective disaster risk management is the quantification and understanding of risks associated with natural hazards;
- Climate information is critical for the analysis of hazard patterns and trends;
- Climate information must be complemented with socio-economic data and analysis for vulnerability assessment.

The identified need to develop hazard, vulnerability, and risk analyses and to implement effective multi-hazard early warning systems (MHEWS), therefore, brings with it requirements for systematic, high quality, and reliable observational data on appropriate spatial and temporal scales. In order to understand vulnerability and manage weather and climate-related extreme events, it is vital to have good-quality observational records. Moreover, since extreme events are infrequent (by definition), these records need to be long-term and temporally homogeneous. In addition to hydrological, oceanographic, atmospheric, and other physical observations, such information must also be complemented with socio-economic data and analysis for vulnerability assessments.

With risk knowledge, governments can manage risks through early warning systems and preparedness, sectorial planning, and insurance and financing mechanisms. The collection of loss data is also essential to enable cost-benefit analysis to provide economic justification for investment in DRR systems.
The Observations and Monitoring Pillar of the GFCS directly addresses several of the Hyogo Framework’s priorities for action. However, provision of effective support to Disaster Risk Reduction will also require close coordination with other pillars of the GFCS to ensure that the requirements of the DRR community for observations and socio-economic data are clarified and addressed in an optimal manner, drawing, as and when appropriate, on research capacities to enhance observational techniques, monitor new variables, and improve data analysis and delivery systems. Among other things, the DRR community has a strong interest in accelerating data rescue and digitization of climate records, given that a significant amount of NMHS and other data that would be valuable for developing operational climate early warning for DRR are still in obsolete media and face the risk of loss and degradation.

2.2 Engagement in the Working Mechanisms of Potential Partners at Global, Regional, and National Levels

The GFCS will require extensive engagement between and among global, regional, and national partners in the implementation of the Framework and its Pillars. The development of mechanisms to ensure effective coordination and partnership between stakeholders at all levels will be fundamental to the success of the GFCS in addressing the challenges posed by climate variability and climate change and responding to needs for climate services. Major stakeholders in the Observations and Monitoring Pillar are identified in the following sections.

2.2.1 Global Observing Systems

The following sections provide an overview of major, globally coordinated, observing networks and systems, noting the contribution made by real-time observing networks and space-based systems to the monitoring of the overall climate system. The effective engagement of these globally-coordinated observational programmes within the Observations and Monitoring Pillar will be essential to the success of the GFCS.

2.2.1.1 The Global Climate Observing System (GCOS): A Cross-Cutting Mechanism for Climate Observations

As recognized by the World Climate Conference-3, an adequate global climate observing system is an essential element of the GFCS, underpinning all other elements. The overarching framework for observing the climate is the Global Climate Observing System. GCOS was launched in 1992 by four co-sponsors—WMO, IOC of UNESCO, UNEP, and ICSU—and is also supported by the Food and Agriculture Organization (FAO). Essentially a UN-wide system in partnership with ICSU, the GCOS also encompasses the entire non-governmental observations community and is intended to meet the full range of national and international requirements for climate and climate-related observations at global, regional, and national scales.

The success of the GFCS will be dependent on the adequacy of the component observing networks on which the GCOS is built: the Global Observing System (GOS) and Global Atmosphere Watch (GAW) (components of WIGOS); the climate-related networks of the Global Ocean Observing System (GOOS) and Global Terrestrial Observing System (GTOS); and a number of other domain-based and cross-domain research and operational observing systems. The GCOS includes both surface-based and space-based components and constitutes, in aggregate, the climate observing component of the Global Earth Observation System of Systems (GEOSS). The implementation of improvements in the climate observing system needed to support the GFCS will require the maintenance of close coordination with GCOS.
2.2.1.2 The WMO Integrated Global Observing System (WIGOS)

The WMO Integrated Global Observing System (WIGOS) is an integrated, comprehensive, and coordinated system that is comprised of the present WMO global observing systems, in particular of the in situ and space-based components of the Global Observing System (GOS), the Global Atmosphere Watch (GAW), the Global Cryosphere Watch (GCW), and the World Hydrological Cycle Observing System (WHYCOS). Through the mechanism of the WMO Information System (WIS), WIGOS will ultimately provide accurate, reliable, and timely climate observations for atmospheric, marine, and terrestrial domains as part of the GFCS.

WIGOS provides a new framework for WMO global observing systems and the contributions of WMO to co-sponsored observing systems. WIGOS does not replace the existing observing systems, but is rather an over-arching framework for the evolution of these systems, taking into account identified gaps, that will continue to be owned and operated by a diverse array of organizations and programmes. WIGOS will focus on the integration of governance and management functions, mechanisms, and activities to be accomplished by contributing observing systems in relation to the resources allocated on global, regional, and national levels.

As part of WIGOS, climate-relevant data and metadata will adhere to standards in order to facilitate the self-assessment of quality by data producers and will ensure transparency in the generation of climate datasets and products. This approach will enable users to judge the quality and fitness for purpose of climate datasets and products. In many cases, observing networks include stations operated independently by research or environmental institutions. Strengthening future interactions between research and operational observing communities through increased communication and enhanced partnerships is, therefore, important for sustaining and evolving observing systems and practices and should be pursued through existing forums that involve these communities. The WIGOS framework Implementation Plan (WIP) addresses the necessary activities to establish an operational WIGOS by the end of the period 2012-2015.

The GFCS Observations and Monitoring Pillar will use WIGOS governance mechanisms and implementation activities, including those defined for its basic components and associated programmes, to make sure that the observational requirements of climate services are given a high priority. At the same time, GFCS stakeholders will need to ensure that appropriate resources are committed nationally and globally to address the GFCS gaps identified through WIGOS mechanisms.

Requirements for climate observations related to the provision of operational climate services under the GFCS are expected to increase as the users of these services become increasingly engaged. A close link is being established and will be maintained between the WIP, EGOS-IP, and the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC. This will ensure that requirements for climate observations for the GFCS are taken into consideration as observing systems evolve.

2.2.1.2.1 The Global Observing System (GOS)

The Global Observing System (GOS) is the WMO backbone operational observing system. It provides observations of the state of the atmosphere and ocean surface needed in real time for the preparation of weather analyses, forecasts, advisories, and warnings. These observations also support climate monitoring and environmental activities carried out under programmes of WMO and of other relevant international organizations. It is operated by NMHSs and national or
international satellite agencies and involves several consortia dealing with specific observing systems or specific geographic regions. It is coordinated by the Commission for Basic Systems of the WMO. The main long-term objectives of the GOS are:

- To improve and optimize global systems for observing the state of the atmosphere and the ocean surface to meet requirements for the preparation of increasingly accurate weather analyses, forecasts and warnings and for climate and environmental monitoring, in the most effective and efficient manner;

- To provide for the necessary standardization of observing techniques and practices, including the planning of networks on a regional basis, to meet the requirements of the users with respect to observational quality, spatial and temporal resolution, and long-term stability and sustainability.

### 2.2.1.2.2 The Global Atmosphere Watch (GAW)

The Global Atmosphere Watch (GAW) programme is considered to be the atmospheric chemistry component of GCOS. Its operation is coordinated by the Commission for Atmospheric Sciences of the WMO. The GAW provides data and information on the chemical composition of the atmosphere, including natural and anthropogenic changes therein, to assist in improving understanding of interactions between the atmosphere, the oceans, and the biosphere. The GAW monitoring system focuses on six classes of variables (ozone, UV radiation, greenhouse gases, aerosols, selected reactive gases, and precipitation chemistry).

GAW is supported by more than 100 WMO Member countries who work in partnership to operate global networks that deliver observations, which are then used to address gaps in understanding of climate, weather, and air pollution issues and to deliver services and products required to fulfill their national mandates.

### 2.2.1.2.3 The Global Cryosphere Watch (GCW)

The cryosphere collectively describes elements of the Earth System containing water in its frozen state and includes solid precipitation, snow cover, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost, and seasonally frozen ground. Cryospheric observations and derived products contribute many services to society, including in the key GFCS areas of food security, water, health, and disaster risk reduction. For example, their availability reduces uncertainties in available (frozen) fresh water reserves. They assist in enhancing understanding of environmental factors affecting human health and well-being, underpin the management of energy and water resources, and contribute to assessing, predicting, and adapting to climate variability and change. In addition, they support weather, climate and hydrological forecasting and hazard warning and have important applications in transportation and engineering design. The WMO Global Cryosphere Watch (GCW) is intended to provide authoritative, clear, and useable data, information, and analyses on the past, current, and future state of the cryosphere to better meet the needs of partners in delivering services to users, including the media, the public, and policy makers. User needs discussed in the Cryosphere Theme Report (CryOS), prepared by the global cryospheric science community, and in GCW documents relate directly to issues to be considered within the GFCS and, in particular, to observational requirements in support of improved climate services.

The GCW is being built on strong partnerships with other UN bodies, international organizations, World Data Centres, scientific associations, and national and international
institutes. Among these are UNESCO and its International Hydrological Programme (IHP) and its Intergovernmental Oceanographic Commission (IOC), international bodies such as International Permafrost Association (IPA), World Glacier Monitoring Service (WGMS), Global Precipitation Climatology Centre (GPCC), and national institutions such as the US National Snow and Ice Data Centre (NSIDC). Other important partners include the International Arctic Science Committee (IASC), which has been working with the Arctic Council to develop a suite of plans for cryospheric observations and Arctic Observing Networks. Strong relationships are also being forged with bodies such as CEOS and CGMS and with major satellite operators like CSA, ESA, EUMETSAT, JAXA, NASA, NOAA, ISRO, and USGS, since observations from satellite borne sensors provide uniquely valuable perspectives on cryospheric elements such as sea ice, snow cover, and glaciers.

2.2.1.2.4 The World Hydrological Cycle Observing System (WHYCOS)

The World Hydrological Cycle Observing System (WHYCOS) is a WMO global programme developed in response to the scarcity or absence of accurate, timely, and accessible data and information in real or near-real time on freshwater resources in many parts of the world and, particularly, in developing countries. These gaps and deficiencies result from the obsolescence of many hydrological observing networks and inadequate data management capabilities. The WHYCOS programme is being implemented through various components (HYCOSs) at the regional and/or basin scale, guided by the WHYCOS International Advisory Group (WIAG). Each regional component is independently implemented and responsive to local needs. Regional components bring together several hydrological services that have common interests, either because they share a common drainage basin or are in a well-defined geographical and hydrological region. A regional HYCOS is launched when the countries concerned have expressed their collective desire for such a development along with their commitment to making it a success. To enable participating countries to perform this basic task is therefore a priority in the project implementation to establish the necessary data transmission and management infrastructure and create the required human capacity in the NHSs involved. WHYCOS aims at improving basic observation activities, strengthening international cooperation, and promoting free exchange of data in the field of hydrology.

2.2.1.3 The Global Ocean Observing System (GOOS)

Co-sponsored by IOC of UNESCO, WMO, UNEP, and ICSU, the Global Ocean Observing System (GOOS) coordinates a system of open-ocean and coastal observations for scientific and societal benefit, with active support from the International Maritime Organization (IMO) and shipping lines who contribute vital meteorological and oceanographic observations through their participation in the Voluntary Observing Ships (VOS), Automated Shipboard Aerological Programme (ASAP), Ship of Opportunity (SOOP) and other marine observation programmes. GOOS develops advice about requirements for observations, which for climate purposes are developed in cooperation with GCOS and for ocean services are developed through the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). The GOOS provides a forum for coordinating ocean observing networks. Implementation and development of standards for many in situ networks are undertaken in partnership with JCOMM. Coordination of space-based ocean observations occurs through CEOS and CGMS.

The composite ocean surface and sub-surface observing networks include global monitoring of certain Essential Climate Variables (ECVs). Monitoring of other ECVs depends on observations from reference stations or sites, or, in the case of sub-surface ocean carbon, nutrients, and tracers, on repeat ship-based surveys. Very recently, there have been significant contributions
to sub-surface ocean measurements, particularly in data-sparse areas near ice. Despite this recent progress, ocean observing networks and their associated infrastructure and analysis systems are not yet adequate to meet the specific needs for most climate variables in most regions of the planet, particularly in the Southern Hemisphere. Some of the specific gaps in ocean observing systems include:

- Sea surface temperature and upper ocean temperature (heat content) for short-term seasonal to interannual climate forecasts;
- Deeper measurements, including salinity and ocean currents, for decadal-scale climate forecasts;
- Sea level, waves, and sea ice for development of a coastal/marine climatology and climate change monitoring;
- Local bathymetry and social variables, such as population and infrastructure in vulnerable zones, for coastal inundation early warning;
- Ocean carbon variables for constraining mitigation action;
- Mapping of habitats, ocean biogeochemical variables, and ecosystem variables, among others, for identifying and projecting key vulnerabilities of living marine resources and key coastal and ocean ecosystems.

Overall, there is considerable scope for GFCS engagement with GOOS in addressing these matters, and the ocean community proposes to implement five broad actions through the GFCS:

- Refining specific requirements for climate services (GOOS and JCOMM),
- Sustaining and developing in situ observations (GOOS and JCOMM),
- Sustaining and developing satellite observations (CEOS and CGMS),
- Improving the data management system (IODE, JCOMM, GEO),
- Developing ocean information appropriate for climate services (many stakeholders).

2.2.1.4 The Global Terrestrial Observing System (GTOS)

Co-sponsored by FAO, ICSU, UNEP and WMO, the mission of the Global Terrestrial Observing System is to support sustainable development through a programme for observations, modelling, and analysis of terrestrial ecosystems. GTOS liaises with relevant research and operational communities to identify terrestrial properties that control the physical, biological, and chemical processes that affect climate, are affected by climate change, and/or serve as indicators of climate change. Increasing emphasis is now being placed on terrestrial data for estimating climate forcing and for better understanding climate change and variability, as well as for impact and vulnerability assessment and for mitigation activities. The establishment of Global Terrestrial Networks (GTNs) in a number of topical areas (e.g., hydrology, glaciers, and permafrost), where data collection takes place largely through in situ measurements, has significantly improved the coordination and global coverage of these observations, although gaps remain. The Global Terrestrial Network for Hydrology (GTN-H), for example, was established as a “network of hydrological networks” that links existing global hydrometeorological data centres and systems for integrated observations of the global water

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31 As of the third quarter of 2012, the status of the GTOS Secretariat at FAO is uncertain. Nevertheless, many of the GTOS Panels (including the joint GCOS/GTOS Terrestrial Observations Panel for Climate (TOPC) operate effectively. Indeed, their continued operation is necessary and important for the success of the GFCS.
cycle to support global and regional climate and water applications. The GTN-H covers such ECVs as precipitation, snow and glaciers, evapotranspiration, water use, water quality, soil moisture, ground water, lake level, and river discharge.

Improving understanding of the terrestrial components of the climate system and of the causes and responses of this system to change is vital to society, as is assessing the consequences of such change in adapting to and mitigating climate change. Mechanisms exist for both the in situ observing networks and the space-based components of the terrestrial domain ECVs, but these need to be strengthened. Furthermore, better observations of the terrestrial carbon-related variables have assumed greatly increased relevance in the context of implementing the UNFCCC Bali Road Map.32

2.2.1.5 Global Earth Observation System of Systems (GEOSS)

The Group on Earth Observations (GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). GEOSS will provide decision-support tools to a wide variety of users, proactively linking together existing and planned observing systems around the world and supporting the development of new systems where gaps currently exist. It will, moreover, promote common technical standards so that data from the thousands of different instruments can be combined into coherent data sets. GEO is constructing the GEOSS on the basis of a 10-Year Implementation Plan that runs from 2005 to 2015.

Of immediate relevance to the GFCS initiative, GEO supports the realization of an effective and sustained operation of the GCOS, as the climate observing component of the GEOSS, including reliable delivery by 2015 of climate information of a quality needed for monitoring, predicting, mitigating, and adapting to climate variability and change and better understanding of the global carbon cycle. The GEO will also:

* Promote data sharing as well as coordination of data management and exchange systems;
* Contribute to major advances in the monitoring and prediction of climate on seasonal, interannual, and decadal time scales, including the occurrence of extreme events;
* Strengthen GCOS support for the assessment role of the IPCC and the policy development role of the UNFCCC.

2.2.2 UN Agencies and Programmes

Many UN agencies and programmes have units whose mission it is to facilitate the availability of the various types of observations required for the development and provision of services for users within the four priority sectors -- water, health, agriculture, and disaster risk reduction.

* The UNEP Global Environment Outlook (UNEP/GEO), for example, was initiated in response to the environmental reporting requirements of Agenda 21 and to the UNEP Governing Council. At the 22nd session of the UNEP Governing Council/Global Ministerial Environment Forum (GC/GMEF) in 2003, governments requested UNEP to prepare an annual Global Environment Outlook statement to highlight significant environmental events and achievements during the year. Other UNEP/GEO outputs

include regional, sub-regional, and national integrated environmental assessments, technical and other background reports, a website, products for young people (GEO for Youth), and a core online database – the UNEP/GEO Data Portal that holds information on more than 450 different variables addressing themes such as freshwater, population, forests, emissions, climate, disasters, health, and Gross Domestic Product (GDP);

- Other UN agencies, such as the World Health Organization (WHO) and the UN International Strategy for Disaster Reduction (ISDR), are also important users of weather and climate data while some, such as the International Civil Aviation Organization (ICAO) and FAO, also facilitate the provision of important observational data by their members;

- WMO and its constituent bodies facilitate worldwide cooperation in the establishment of networks of stations for meteorological, hydrological, and other geophysical observations related to meteorology and promote the establishment and maintenance of centres charged with the provision of meteorological and related services. They also promote the establishment and maintenance of systems for the rapid exchange of meteorological and related information and endeavour to ensure standardization of meteorological and related observations and the uniform publication of observations and statistics.

Thus, UN agencies will be major contributors to the GFCS as both users and providers of observational data in addition to being sources of socio-economic information needed to produce and deliver climate services.

### 2.2.3 National Meteorological and National Hydrological Services (NMHSs)

The NMHSs are a fundamental part of national infrastructures and play an important role in supporting vital functions of governments. In particular, the climate observations and data gathered by NMHSs are the foundation for their monitoring and prediction services and, in addition, make essential contributions to regional and global climate programmes and services. The engagement of the NMHSs with the GFCS is, therefore, vitally important. However, marked disparity exists between NMHSs’ observation networks, with developing and least developed countries having sparse networks that do not adequately provide for the range of services that could be provided under the GFCS. In consequence, the observing networks in many countries, in particular in developing and least developed countries and in small island developing states, need upgrading and expanding if the GFCS is to succeed.

Many of the actions identified in this plan are intended to address networks operated by NMHSs. GCOS has engaged with developing countries’ NMHSs at both national and regional scales to facilitate improvements in climate observations. Through the GCOS Regional Workshop Programme, 10 Regional Action Plans have been produced containing project proposals to address high-priority atmospheric, terrestrial, and oceanic climate observing needs as defined by the countries of each region. Implementation of these projects, which has been advocated both by the WMO Congress and the Conference of Parties to the UNFCCC, would make a significant contribution to the GFCS. The NMHSs also use telecommunications networks, vital for the timely exchange of climate data and products, which enable them to fulfil their national mandates. Networks used by some NMHSs, however, are inadequate and obsolete, and this hampers the efficient flow of observations and products.
2.2.4 Space Agencies

Space agencies of the world have been contributing unique information on the state of our planet for more than half a century. This information has helped significantly to improve weather predictions, monitor the climate system, and inform societally-relevant decisions. Satellite agencies with a prime responsibility for research and development have been pioneering satellite observing capabilities and provide space-based measurements of ever more complex environmental phenomena. Operational satellite agencies are responding closely to the evolving needs of NMHSs and of other environmental user communities for monitoring and predicting weather, climate, water, and related environmental conditions. Telecommunication systems developed in conjunction with satellites provide a backbone for global exchange of meteorological and environmental data.

Effective coordination of common interests relating to the design, development, operation, and use of planned meteorological and environmental satellites is facilitated through two major international mechanisms – the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS). Through the CGMS, for example, plans have been put in place for continuity in both polar and geostationary orbits, and existing or potential gaps in satellite coverage are being addressed. International agency collaboration in the areas of mission planning, intercalibration of sensors, comparison of processing algorithms, and standardization of telecommunication activities has led to more effective data utilization and better user services. Agencies also collaborate in the area of user preparedness, education, and training in the use of satellite data.

Following the model of collaboration in support of weather forecasting, space agency activities are increasingly converging in the area of climate monitoring. In the past six years, space agencies have been very responsive to requirements established by GCOS for the ECVs, and they are now collaborating to develop a Space-based Architecture for Climate Monitoring (described earlier).

2.2.5 National Environmental and Natural Resources Agencies

In some countries, environment, agriculture, forestry, and other natural resources departments and agencies operate climate observation stations and networks, monitoring atmospheric, hydrologic, and terrestrial variables. While their observational activities are frequently undertaken in collaboration with NMHSs, this may not be the case in all instances. Within the framework of the GFCS, it will be important to engage the observational capacities of such departments and agencies, encourage the adherence of their data to appropriate standards, and gain optimum benefits for all users of climate services from their respective observational programmes.

For urban populations, air pollution represents a particular problem with pollutants of concern including, among others, gaseous compounds, ozone, \( \text{NO}_2 \) and \( \text{SO}_2 \), and aerosols. There is, moreover, growing evidence that airborne pollutants are contributing significantly to climate change in addition to harming human and environmental health and agricultural production. Conversely, climate variability and change influence atmospheric chemistry through factors such as temperature, surface properties, cloud cover, precipitation, and boundary layer mixing that affect the life cycle (sources, transport, chemical/physical transformation, and removal) of pollutants in the atmosphere. Consequences of climate change such as increased drought can, moreover, result in increases in biomass burning and in the emissions from fires. More accurate, quality-controlled and well-calibrated observations of atmospheric constituents are,
therefore, needed to support the provision of information to the public, for inclusion in models, and in order to carry out studies of air pollution interactions with climate variability and change.

Local and regional scale air quality observations are made by many different organizations at the municipal level, under regional governments, and by national environmental agencies and are also supplied to regional bodies such as the European Environment Agency (EEA). NMHSs, however, often possess greater expertise in air quality modelling and forecasting than such agencies. There is, therefore, a need for close collaboration between different institutions involved in observing and providing information on air quality, in particular between environmental agencies and NMHSs, if air pollution issues are to be addressed effectively. In the context of the GFCS, particular attention must be given to needs for improved air quality observations in urban areas.

### 2.2.6 Universities, Research Institutions, and Non-Governmental Organizations

*In situ*, surface-based observing networks operated by NMHSs and other government agencies are not comprehensive in all parts of the world. The largest gaps exist in remote locations (Polar Regions, high mountains, deserts, tropics, and oceans) and in developing and least developed countries and small islands. Universities and research institutes, however, operate several extremely important observing networks in these regions that partially fill the existing gaps. For example:

- **The University of Wisconsin at Madison (USA)** maintains a number of observing stations in Antarctica;
- Similarly, several universities and research institutes operate research sites in the Arctic and high-mountain regions that are invaluable not only for research purposes but also for providing services related to health, water supply, food production, transportation, hydropower production, and hazards, such as the risk of floods and droughts;
- **The University of Hamburg (Germany)** operates several observing stations in Africa, mainly in support of agriculture and food production, although data from those stations are also useful for health, water, and disaster risk reduction applications;
- Research observing networks, such as the Global Atmosphere Watch, also provide essential data needed to address health concerns, as they often monitor parameters not typically covered by NMHSs, such as air pollution, contaminants, and the chemical composition of the atmosphere, including greenhouse gases. A recent example is the development of the Monitoring of Atmospheric Composition and Climate (MACC) project under the auspices of the European Global Monitoring for Environment and Security (GMES) initiative.

Inventories of data from these university and research institute observing networks are, unfortunately, often not readily available. A need exists, therefore, to compile such inventories, ensuring that they include appropriate metadata to provide insight into the representativeness and quality of the data.

A large number of non-governmental and quasi-governmental organizations (NGOs) also exist that could potentially contribute to the Observations and Monitoring Pillar of the GFCS. An exhaustive list of these organizations is not attempted here, but early action should be taken to identify those NGOs that could contribute observational data to this pillar and are willing to be part of the GFCS working mechanism. The International Research Institute for Climate and Society (IRI) is an illustrative example of the type of organization that could usefully be involved
in helping to implement this Pillar. IRI has played a leading role in establishing the Climate Services Partnership (CSP), an informal interdisciplinary network of climate information users, providers, donors and researchers. The CSP was represented by IRI at a recent workshop in South America, co-organized by the GCOS Secretariat and the Centro Internacional de Investigaciones para el Fenómeno El Niño (CIIFEN), to consider strategies and specific activities to improve observations to support climate services and adaptation to climate change. The workshop could serve as a model for similar meetings in other regions.

2.2.7 The Private Sector

Although NMHSs and NHSs have a pivotal role in the operation of multipurpose atmospheric and hydrological observing networks, some private-sector interests have also developed and deployed dense observational networks. The advent of inexpensive digital electronics and high bandwidth communications has enabled literally thousands of small private businesses, corporations, agricultural producers, recreation providers and many others to enter the field of observations, driven by a wide range of missions and markets at various investment levels. Typical private sector entities that operate their own observing systems include those working in oil and gas, mining, insurance, farming, hydropower, shipping, tourism, media, sports, air transportation, roads, railways, and private weather companies.

There are existing initiatives to encourage cooperation and dialogue between NMHSs and the private sector, such as the Madrid Action Plan adopted by the International Conference on Secure and Sustainable Living: Social and Economic Benefits of Weather, Climate, and Water Services (Madrid, Spain, March 2007). This Plan includes several actions with a bearing on the issue of public-private relations. In the face of the demand for ever more detailed observations at much finer spatial and temporal resolutions than are widely available today from national, international and intergovernmental organizations, data from the private sector could potentially fill some of the existing observational gaps. At the same time, increased attention to quantity, quality, accessibility, instrumentation, site selection, and metadata of these observations could significantly enhance their utility. Inventories of private-sector networks are not generally available and will need to be compiled, including metadata that will provide insight into the representativeness and quality of the data. Moreover, the observational capacities and activities of the private sector vary significantly between countries, suggesting the need for initiatives to be undertaken at the country level by NMHSs and other national agencies if the private sector is to be engaged effectively in addressing overall requirements for observational data and products.

2.3 Criteria for Identification of Projects/Activities at Global, Regional, and National Levels

The criteria for selecting observation and monitoring projects should closely adhere to the overall guiding principles of the GFCS as initially enunciated by the High Level Task Force but now enshrined as GFCS Principles, including being directly relevant to the four priority areas of agriculture, health, disaster risk reduction and water. Where climate observation networks and systems are concerned, however, a most important imperative is to sustain what already exists, particularly since observational coverage has been declining in many countries in recent years. In general, therefore, projects should be aimed at enhancing these observational programmes where this is essential to providing the data needed to support services to the priority sectors and the overall implementation of the GFCS. Such enhancements could include filling observational gaps, increasing observational frequency, measuring new climate-system variables, and/or implementing improvements to telecommunications systems for data exchange.
Among specific criteria that must also be considered in selecting and prioritizing observation and monitoring projects for near-term implementation are the following:

- Does the project provide the data needed to build the capacity to provide climate services to those in need of such services?
- Does the project address the data needs of the priority activities of the UIP, CSIS, and RMP Annexes?
- Does the project give priority to the immediate needs of climate-vulnerable developing countries, especially the least developed countries in Africa and the small island states?
- Does the project achieve synergies, where collective efforts produce results that would not have otherwise been possible?
- Does the project build upon, and not duplicate, partnerships that are already in place?
- Does the project encourage free and open exchange of climate data and promote climate information as, primarily, an international public good?
- Can the project be completed within the time frame and proposed budget?

Ideally, projects should also, to the extent possible, address observational needs at all spatial scales—contributing data that are relevant at global, regional, national, and local levels.

The projects that are introduced below for near-term action are aligned with at least one of the four priority sectors; will contribute to building regional and national capabilities to provide climate services; and will address needed improvements in relevant climate networks, including, for example, the GCOS Surface and Upper-Air Networks (GSN and GUAN) and the broader Regional Basic Climatological Networks (RBCNs).

### 2.4 Initial Implementation Activities/Projects

A large number of improvements are needed in climate observing systems at global, regional, and national scales. For example, most of the 138 actions identified in the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC are relevant to the GFCS, although neither this Plan, nor others mentioned in section 1.4, address information needs for sector-specific socio-economic, biological, and environmental data. This section of the Annex identifies some initial implementation activities that address needs and gaps, while section 5 provides a more extensive list of actions and activities that are also considered important to implement as resources become available.

Seven initial implementation activities and sub-activities are introduced in Table 2. They address needs for observations identified in section 1.4.8 and target at least one of the four focus areas described above. All of the activities meet at least one of the criteria for selection cited in section 2.3, but most meet multiple criteria. Following their introduction in Table 2, the initial implementation activities are described in more detail on the pages that follow.

Some of these initial projects are intended to increase and sustain consultation with users of climate information through the UIP mechanism so as to clarify evolving requirements for physical observations and socio-economic data, highlight deficiencies, and facilitate response actions. Another group of activities recognizes that needs have been clearly expressed for greater densities in both space and time for the types of observations already being produced (including, but not limited to, the ECVs). Consequently, early emphasis is placed on filling gaps and sustaining existing observational networks. Since it will not be possible to do everything during the first few years of the GFCS, initial priorities will be to reactivate silent stations and rehabilitate key stations in data poor areas and to pursue complementary efforts in relation to space-based observation and atmospheric chemistry. Urgent needs for enhancement of
hydrological observation networks and for coastal monitoring are likewise addressed. In addition, the expansion of observational databases needed to support applications in the key sectors implies that all existing data should be utilized and made accessible to providers and users of climate services. Thus, it is proposed that concerted efforts be made to rescue historical data and capture observational data from external sources, such as community groups, the private sector, and research institutions.

A more extensive list of relevant activities that have been proposed is given in section 5, Tables 3a and 3b. These latter Tables 3a and 3b propose additional projects that can be undertaken during later phases of implementation as and when resources become available and priorities dictate. Table 3a provides a highly condensed synthesis of the more detailed information included in Table 3b. This synthesis draws attention to the expected deliverables that will result from implementation of the proposed initiatives, provides a sense of the related timelines, flags the involvement of many key partners, and presents very preliminary estimates of costs. It also draws attention to potential risks that could slow or otherwise negatively affect the implementation process. All of the projects proposed are responsive to at least two of the eight GFCS Principles and represent a subset (of an even larger number of required observing system improvements) that the various contributors to this Annex deem to be especially relevant to the GFCS.
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<thead>
<tr>
<th>ACTIVITY</th>
<th>PRIORITY SECTOR(S)</th>
<th>IMPLEMENTATION PRIORITY(IES)</th>
<th>GEOGRAPHIC SCOPE</th>
<th>LEAD ORGANIZATIONS</th>
<th>OTHER ORGANIZATIONS</th>
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<tr>
<td>1</td>
<td>Rolling consultations with users, in particular to better understand data and product needs from the GFCS priority sectors and other sectors.</td>
<td>All Sectors</td>
<td>1.1. Establish a formal mechanism for consultations with users. 1.2. Assess the role of observations in adaptation to climate variability and change.</td>
<td>Global, Regional, National</td>
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<td>All stakeholders</td>
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<td>2</td>
<td>1) Translate data and product needs from GFCS users/sectors into specific observational requirements and incorporate them into near- to long-term observing baselines</td>
<td>All Sectors</td>
<td>2.1. Rehabilitation of silent stations and key stations in data poor areas, including GSN and GUAN stations 2.2 Consider inputs from RRR consultations and coordinate with stakeholders to design the in situ and space-based components of baseline networks. 2.3. Set-up Trust Fund to support operation of regional baseline networks in LDCs and SIDS 2.4. Improve ground-based and space-based networks for measurement of precipitation 2.5. Develop guidelines for creation of Discovery Metadata (ISO19115) for registering climate observations and products in WIS and develop the WMO Data Model to enable the representation and exchange of</td>
<td>Global, Regional, National</td>
<td>WMO, IOC, FAO, Space agencies</td>
<td>All stakeholders, Funding agencies</td>
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<td>2) Sustain, fill gaps, and generally expand the comprehensive atmospheric, oceanic, and terrestrial surface-based networks, including air quality and cryospheric networks, and increase the frequency of observations.</td>
<td>All Sectors</td>
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<td>3</td>
<td>Large scale data recovery and digitization, with the integration of data from community observation networks.</td>
<td>All sectors</td>
<td>3. Strengthening the existing global and regional data rescue projects; Development of an International Climate Assessment and Data set initiative (ICA&amp;D) for delivering high-quality climate data sets.</td>
<td>National</td>
<td>WMO</td>
<td>RAs, RCCs ACMAD, CLIMDEV UNFCC UNEP, ACRE Nairobi Work Programme</td>
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<td>4</td>
<td>Fully implement HYCOS in key shared international river basins to provide information for sustainable water resources development and management.</td>
<td>Water</td>
<td>4. HYCOS initiatives in ten priority basins/regions of water scarcity.</td>
<td>Regional</td>
<td>WMO</td>
<td>NMHSs, NHSs, UNESCO</td>
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<td>5</td>
<td>Monitor coastal regions to understand vulnerabilities and in support of adaptation</td>
<td>All sectors</td>
<td>5. Prioritized national and regional plans.</td>
<td>Regional, National</td>
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<td>WMO</td>
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| 6 | Climate and Food Security | Agriculture | 6. Establish a coordination mechanism for collection, management, and exchange of climate and 
 | Global | FAO, CFS | WMO | 0.1M |
### Project 1.1: Establishment of a formal mechanism for consultation with users

**a)** Description: By means of a brainstorming workshop or workshops representatives of user communities (including the agriculture, health, water resources, and disaster risk reduction communities) and representatives of observation providers will convene to discuss mutual concerns. Linkages to the User Interface Platform and the Climate Services Information System will be especially important.

**b)** Objective: Establish a continuing mechanism, in line with GFCS Principle 8, whereby representatives of different user communities, including, but not limited to, the four focal areas of the GFCS Implementation Plan, can consult with providers of climate observations and of other relevant socio-economic, biological, and/or environmental data to clarify data needs for the provision of climate services.

**c)** Benefits: Among observation providers, an understanding of the needs of users is deficient. Moreover, requirements for socio-economic, biological and environmental data to support the provision of climate services are not as yet well defined. Establishment of a consultation mechanism will help to address these problems, ensure user needs are considered, and help clarify requirements for socio-economic, biological, and environmental data. All Exemplars draw attention to the need for close liaison and coordination between the observational and user communities.

**d)** Deliverables: Initially, a mechanism for continuing consultation between observation and data users and providers will be agreed. Subsequent consultations will address critical issues including: (1) specific requirements for climate observations and for other socio-economic, biological, and environmental data; and (2) data standards, formats, and protocols for the quality assurance, management, and exchange of these data types in support of the provision of climate services.

**e)** Prerequisites: Although most conditions specified in section 2.1 apply, the key for this activity is the effective engagement with different user communities, especially those representing the four focal areas of the Implementation Plan, and with data providers from relevant socio-economic, biological, and environmental sectors.

**f)** Timeframe and Costs: To be undertaken in 2013. Cost for initial workshop approximately $0.1M. Subsequent workshops would also cost about $0.1M annually.

### Project 1.2: Assessment of the role of observations in adaptation to climate variability and change

**a)** Description: An international, multi-stakeholder workshop will be organized to assess the adequacy of, and future requirements for, observations to support adaptation to climate variability and change.
b) Objectives: The general adequacy of observations to support adaptation to climate variability and change will be assessed. The requirements for new observations and their use in monitoring to support climate services addressing adaptation needs will be identified. Requirements for observations to support research into adaptation, such as through the Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) and/or the WCRP, will be identified.

c) Benefits: Focuses on gaps in observing networks within atmospheric, terrestrial, and oceanic domains specifically related to the needs for adaptation to climate variability and change. User-provider partnerships will be strengthened (GFCS Principle 8).

d) Deliverable: An assessment report including strategic guidance on steps that can be taken in the coming years to address the needs for observations for adaptation to climate variability and change.

e) Prerequisites: Although most conditions specified in section 2.1 apply, the key for this activity is the effective engagement with different user communities, especially those representing the four focal areas of the Implementation Plan.

f) Timeframe and costs: To be undertaken in 2013. Cost approximately $0.2M.

**Project 2.1: Rehabilitation of silent stations and key stations in data poor areas, including GSN and GUAN stations**

a) Description: In order to sustain, fill gaps, and generally expand the comprehensive atmospheric, oceanic, and terrestrial surface- and space-based networks, including air quality and cryospheric networks, the silent stations and key stations in data poor areas, including GSN and GUAN stations, will be rehabilitated, and agreed standards for observing practices will be applied to ensure that data are suitable for climate purposes.

b) Objectives: The silent stations and key stations in data poor areas, including GSN and GUAN stations are rehabilitated. This contributes to addressing needs expressed in all Exemplars for climate observations on appropriate temporal and spatial scales.

c) Benefits: This implementation activity addresses gaps identified in sections 1.4.1, 1.4.2, 1.4.5, 1.4.6 and 1.4.7. Acquisition of observational data will be better aligned with the GFCS, climate predictions and projections will be increasingly skilful, and the global observing system will be better able to meet climate information needs and to deliver timely and authoritative information on the status of the climate system at multiple temporal and spatial scales, thus addressing GFCS Principles 2 and 7.

d) Deliverables: Data from the previously silent and key stations in data poor areas are provided to GTS in real-time.

e) Prerequisites: (i) Entities that operate observing networks (such as NMHSs, research institutes, universities, and the private sector) will need to make their data available; (ii) Technological developments and national, regional, or global economic circumstances must enable these entities to sustain the delivery of these data over the long term, and (iii) Provision of adequate funding, human resources, and observing and IT technology to operate observing systems, to implement QA/QC procedures (including calibration and maintenance of the systems), to ensure reliability of data delivery, to ensure staff competencies, to ensure delivery using interoperable formats, and to distribute data and information worldwide in real or near-real time.

f) Timeframe and costs: 2 years; $5M.
Project 2.2: Design of baseline networks

a) Description: In order to incorporate new observing requirements for GFCS sectors and to sustain and generally expand the comprehensive atmospheric, oceanic, and terrestrial surface- and space-based networks (including air quality and cryospheric networks) the baseline (core) networks will be designed and included in global, regional, and national near- and long-term plans. The baseline network will respect standard observing practices and will be managed according to agreed QMS to ensure that data are suitable for climate purposes.

b) Objectives: The baseline (core) networks are designed.

c) Benefits: This implementation activity is addressing gaps identified in sections 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6 and 1.4.7. Climate predictions and projections will be increasingly skilful, the global observing system will be better able to meet climate information needs and to deliver timely and authoritative information on the status of the climate system at multiple temporal and spatial scales, the evolution of global observing systems will be better linked to individual implementation plans, and all observational requirements for the GFCS will be properly addressed as observing systems evolve. This will contribute to addressing needs expressed in all Exemplars for climate observations on appropriate temporal and spatial scales and by adhering to GFCS Principles 2 and 7.

d) Deliverables: The baseline (core) networks are incorporated in the global observing systems and implemented.

e) Prerequisites: (i) Entities that operate observing networks (such as NMHSs, research institutes, universities, and the private sector) will need to make their data available; (ii) Technological developments and national, regional, or global economic circumstances must enable these entities to sustain the delivery of these data over the long term, and (iii) Provision of adequate funding, human resources, and observing and IT technology to operate observing systems, to implement QA/QC procedures (including calibration and maintenance of the systems), to ensure reliability of data delivery, to ensure staff competencies, to ensure delivery using interoperable formats, and to distribute data and information worldwide in real or near-real time.

f) Timeframe and costs: 2 years for design plus 4 years to implement; $1.5M for the review process and design.

Project 2.3: Set-up Trust Fund to support operation of regional baseline networks in LDCs and SIDS

a) Description: In order to sustain, fill gaps, and generally expand the comprehensive atmospheric, oceanic and terrestrial and surface- and space-based networks, including air quality and cryospheric networks, support to operation of baseline networks in LDCs and SIDS should be provided by the international community.

b) Objectives: To set-up a Trust Fund to support operation of baseline networks in LDCs and SIDS.

c) Benefits: This implementation activity is addressing gaps identified in sections 1.4.1, 1.4.2, 1.4.5, 1.4.6, and 1.4.7. It will, especially support sustainability of critical observing stations in LDCs and SIDSs that are essential for the GFCS and aligned with GFCS Principle 1. The project will contribute to addressing needs expressed in all Exemplars for climate observations on appropriate temporal and spatial scales.
d) **Deliverables:** Trust Fund to support operation of baseline networks in LDCs and SIDS is established and contributions by the international community provided.

e) **Prerequisites:** Provision of adequate funding, human resources, and observing and IT technology to operate observing systems, to implement QA/QC procedures (including calibration and maintenance of the systems), to ensure reliability of data delivery, to ensure staff competencies, to ensure delivery using interoperable formats, and to distribute data and information worldwide in real or near-real time.

f) **Timeframe and costs:** Initial support for 2 years of about $0.5 M; $3M would be needed in the next 10 years.

**Project 2.4: Improve ground-based and space-based networks for measurement of precipitation**

a) **Description:** Measurement of precipitation will be improved by filling gaps and enhancing surface- and space-based monitoring networks in order to respond to users needs for more accurate and representative precipitation data. Agreed standards for observing practices will be applied to ensure that data are suitable for climate purposes.

b) **Objectives:** Reliable, spatially-representative precipitation data from atmospheric, oceanic, and terrestrial and surface- and space-based networks in near-real time.

c) **Benefits:** This implementation activity is addressing gaps identified in sections 1.4.1, 1.4.2, 1.4.3, 1.4.5 and 1.4.7. The Water Exemplar points out that “water security in a variable and changing climate continues to be a key concern at national, regional, and global scales” and that “addressing this concern has emphasized the critical importance of ongoing climate data for the assessment of fluctuations and trends in risks arising from exposure and vulnerability to natural hazards.” The project adheres, in particular, to GFCS Principles 4 and 7.

d) **Deliverables:** Error-characterized, quality-controlled, spatially representative precipitation data derived from the integration of data from surface and space-based observing systems and made available in near-real time over the GTS and other data distribution mechanisms.

e) **Prerequisites:** (i) Entities that operate observing networks (such as NMHSs, research institutes, universities, and the private sector) and space-based precipitation monitoring systems will need to make their data available; (ii) Technological developments and national, regional, or global economic circumstances must enable these entities to sustain the delivery of these data over the long term; and (iii) Provision of adequate funding, human resources, and observing and IT technology to operate observing systems, to implement QA/QC procedures (including calibration and maintenance of the systems), to ensure reliability of data delivery, to ensure staff competencies, to ensure delivery using interoperable formats, and to distribute data and information worldwide in real or near-real time.

f) **Timeframe and costs:** 4 years, $40M.

**Project 2.5: Develop guidelines for creation of Discovery Metadata (ISO19115) for registering climate observations and products in WIS and develop the WMO Data Model to enable the representation and exchange of additional climate observations**

a) **Description:** This project is in two parallel parts. Part one concerns discovery metadata and part two concerns data format. Observations and climate products are only useful if
the potential user communities know that they exist and can assess whether they are applied to the problem they are trying to solve. Guidance must be developed and training provided for GFCS contributors and users on how climate observations and products are described in Discovery Metadata records, so that the benefits from investment in observations and products can be achieved. Once accessed, the data must be usable so that they can be exchanged and processed unambiguously. WMO achieves this within its own community by using standard data representations; however, this approach becomes increasingly complex when collecting and exchanging information from widely different communities. Increasing requirements for more frequent and more detailed reporting of climate information mean that these data standards must be enhanced using a flexible approach that adapts easily to representing new information, but does not prevent those not yet able to make use of the additional information from using other information within the same report.

b) Objectives: To provide guidance and training on how to describe climate observations and products in WIS Discovery Metadata records for the potential user communities and to enhance the usability of climate observations by developing an abstract data model that allows seamless transition between data formats of different communities.

c) Benefits: Allows the benefits from investment in observations and products to be realized and reduces the cost of data processing. Also, the Health Exemplar, for example, points out that access to climate and health surveillance data is not always easy and openly available. This project promotes the improved coordination and trust that enables the data sharing the Health Exemplar advocates. The project is responsive, in particular, to GFCS Principle 2.

d) Deliverables: (i) Enhanced abstract data model providing improved usability and interoperability of data, and (ii) Training and guidance materials for user communities on how to describe climate observations and products in WIS Discovery Metadata records.

e) Prerequisites: Provision of adequate funding, human resources, and observing and IT technology.

f) Timeframe and Costs: Two years, $0.7M.

Project 2.6: Development of an integrated global greenhouse gas information system, including enhancing regional scale chemical measurements

a) Description: Ground- and space-based observations, carbon-cycle modelling, fossil fuel use data, and land-use data will be combined through meta-analysis and modelling to provide an extensive distribution system of information on changing sources and sinks of greenhouse gases, and their consequences, at policy-relevant temporal and spatial scales.

b) Objectives: Effective and cost-efficient adaptation requires an understanding of the anticipated rates and ultimate extent of climate change. The objective is to improve climate projections through enhanced information and understanding of greenhouse gas sources, sinks, transport, and impacts through enhanced research with increased, coordinated observations and improved analysis. Improved climate system projections will in turn respond, for example, to the call from the UN World Food Summit for improved early warning and forecasting systems for food insecurity and vulnerability, highlighted in the Agriculture and Food Security Exemplar.

c) Benefits: Such improved integrated greenhouse gas information will enhance climate projections and directly contribute to humankind’s climate change adaptation capacity,
its cost-effectiveness, its overall effectiveness, and, ultimately, more informed decision-making at all levels. This implementation activity addresses gaps identified in sections 1.4.1, 1.4.4, and 1.4.5 and is especially responsive to GFCS Principles 2 and 7.

d) Deliverables: An integrated global greenhouse gas information system that supports timely, regionally-specific information related to the state of greenhouse gas-driven warming, the rate of increase, and projections for future decades, during which adaptation measures will take place and upon which the success of adaptation measures will depend. In a 2-y horizon the project will: (i) evaluate the status of current levels of information relative to societies' current and anticipated needs; (ii) develop a prioritized list of deliverables; and (iii) develop a work plan and timeline for delivering globally coordinated, regional-scale information of sufficient certainty in order to enhance observation networks and high resolution global-scale modelling.

e) Prerequisites: (i) Coordination among WMO, GCOS, GEO-Carbon and regional projects such as ICOS in Europe, Carbon North America (CarboNA), and other similar efforts and existing networks around the world, along with their associated programmes, commissions and committees; (ii) technological developments to enable these entities to sustain the delivery of information products and services over the long term; and (iii) provision of adequate funding and human resources.

f) Timeframe and costs for initial 2 years: 5-6 meetings to scope out the project and deliver the above and salary for a consultant to prepare the plan, for a total of $0.35M.

Project 2.7: Establish best practices for air quality observations and monitoring in urban environments

a) Description: According to the World Bank (2008), to combat climate change, targeted research is needed at the city level to enable policy makers to understand the magnitude of the impacts and the alternatives to improve resilience of cities. In this project, case studies will be developed for understanding air pollution, health, and climate connections in large urban complexes in Africa, Asia, and Latin America. This will lead to the improvement and harmonization of air quality measurements and related modelling and to an international network of institutional partnerships to support air-quality related services.

b) Objectives: To establish guidelines and networks of quality assured air quality measurement sites in order to provide accurate knowledge of pollution levels in cities to support decision making. The Health Exemplar cites “air quality, pollens and allergens, ultra-violet radiation, and their impacts on human health, especially in cities,” as a particular concern.

c) Benefits: The improved coverage and reliability of air quality observation systems will allow for better and more knowledgeable decision making, for instance, in order to take appropriate precautionary/mitigation measures to address pollution problems related to health. This will result in better management of chronic disease burden associated with poor air quality. The project will also assist in the mitigation of short lived climate pollutants (SLCPs), such as ozone and black carbon, and thus both improve air quality and mitigate climate change. This implementation activity is addressing gaps identified in sections 1.4.1, 1.4.4, and 1.4.5 and is responsive to GFCS Principles 4 and 7.

d) Deliverables: Starting with a few cities in different regions, harmonized measurements, information and data systems, and delivery will be developed. Environmental and air
quality products and their dissemination will be improved. Guidelines will be developed based on this experience for the use of other institutes and authorities in the regions.

e) Prerequisites: (i) Collaboration at the national level among institutes dealing with air quality, such as NMHSs and Environmental Agencies and Municipal Governments, and at the international level among WMO, WHO, UNEP; and (ii) provision of adequate funding and human resources.

f) Timeframe and costs for initial 2 years: 2 meetings in each Asia, Africa, and Latin America, salary for a consultant to prepare the Guidelines, total $0.35M.

Project 3: Large scale data recovery, digitization, and homogenisation of climate records

a) Description: The project will provide support to global and regional Data Rescue, Digitisation, and Homogenisation (DARE&D&H) initiatives and develop new ones as required. The target initiatives are those using modern techniques, procedures, and tools to safeguard climate records at risk of damage or loss and to recover and digitise them. The project will promote the use of these techniques in developing and least developed countries, including through training workshops for NMHSs and other organizations working in climate data collection. The ultimate goals of the project are to enable access and use of high-quality long-term climate data with daily time resolution, to reconstitute and assess the changing behaviour of climate extremes affecting water, agriculture, and health, and to provide adequate databases on climate hazards to support DRR.

b) Objectives: (i) Enhance the capacity of NMHSs and other climate data communities to accelerate the recovery, digitisation, and homogenisation of climate records and to use modern data archiving and management tools; and (ii) Set up an internationally coordinated initiative for Climate Assessment and Data sets (ICA&D) for the development and provision of high-quality climate assessments and data sets based on the output of enhanced DARE activities worldwide. This responds, among other things, to the call in the DRR Exemplar for “strengthening data recovery and digitization to support disaster loss accounting and cost-benefit analysis.”

c) Benefits: Climate data rescue and the development of high-quality climate data sets are important areas of work described under 1.4.7 (Climate Monitoring Activities). This project will feed climate data sets into the CSIS with the required quantity, quality, and coverage to support the provision of climate services, in particular at regional and local scales. It is especially aligned with GFCS Principles 1 and 7.

d) Deliverables: Provision of long term high resolution high quality climate data sets and related products for climate assessment and sector applications.

e) Prerequisites: An effective engagement of NMHSs and supporting organizations at global and regional levels to carry out DARE in a sustained manner, including through international and regional collaborations; willingness of advanced NMHSs and other climate institutions to provide the know-how and technological tools to accelerate DARE worldwide and to encourage use of modern climate data management tools and systems.

f) Time frame: 4 years, 1M/Yr.
Project 4: Fully implement HYCOS in key shared international river basins to provide information for sustainable water resources development and management.

a) Description: The WHYCOS initiative, focussed on improved data collection, storage, dissemination and sharing and the development of water resources management products, provides an opportunity to implement integrated hydrometeorological and climate-related networks with the specific aim of sustainable water resources management in a changing climate. The programme is implemented through various components (HYCOSs) at the regional and/or basin scale, 3 to 4 of which are the focus of this project.

b) Objectives: WHYCOS is a global WMO programme, developed in response to the scarcity or absence of accurate data and information on freshwater resources mainly caused by the deterioration of observing networks and insufficient data management capabilities. WHYCOS's ultimate objective is to promote and facilitate the collection, analysis, exchange, dissemination and use of water-related information, using modern information technologies and capacity building and is especially aligned with GFCS Principles 1, 2, and 7.

c) Benefits: The HYCOS components are targeted at shared river systems and address the gaps in hydrological observations. Additional emphasis will be placed on improved integration of climate observation systems with hydrological observation systems. Managing access to and use of water in a variable and changing climate will benefit all sectors of society. The project contributes to addressing needs expressed in the Water Exemplar.

d) Deliverables: (i) Strengthened hydrological observation networks; (ii) Capacity development of NMHSs; (iii) Data sharing in international shared river basins; (iv) Integrated hydrological and climate observation systems; and (v) Hydrological data and products in support of integrated water resources management.

e) Prerequisites: (i) Agreement from, and cooperation between, the NMHSs to share the data and information collected; (ii) The adoption of agreed and common standards for the observation systems, data management systems, and products being developed; and (iii) Long-term commitment from the NMHSs to maintain the systems and production of products and services into the future.

f) Timeframe and costs: Individual HYCOS Projects usually consist of an initial preparatory phase of 1 year, followed by an implementation phase of between 3 and 4 years. The proposed budget of $15M would provide sufficient resources for between 3 and 4 individual HYCOS components. At this stage, it is proposed to support the second stage of the Pacific HYCOS project with resources of $4M over a 4-year period, and the third stage of the Southern Africa Development Community (SADC) HYCOS with a similar level of resources, $4M over a 4-year period. The remaining $7M would be used to fund preparatory phase studies in 3-4 internationally shared river basins at most risk as determined through the User Interface Platform project proposed under the Water Exemplar and where feasible commence at least one additional project in Africa.

Project 5: Monitor coastal regions in support of adaptation and understanding of vulnerabilities

a) Description: The activity will contribute to addressing weaknesses in observational coverage of climatically-important Essential Ocean Variables (EOV) and Essential Climate Variables (ECVs) required for coastal region monitoring, thus responding to the
requirements of the Framework for Ocean Observations in this regard (see section 1.4.6). This will allow better understanding and prediction of changes in the coastal environment (e.g., sea level rise, coastal erosion) and natural disasters (e.g., storm surges, extreme waves, tsunamis) in order to benefit coastal communities and better protect peoples’ lives and property.

b) Objectives: The objective in this period will be to increase the percentage completion of the initial global ocean observing system, as defined within the JCOMM Observations Programme Area Implementation Goals, from 62 to 80 percent. It addresses the identification of needs for strengthening the capacity for observations and monitoring to inform risk assessments in the DRR Exemplar.

c) Benefits: Benefits will be improved understanding of vulnerabilities, and prediction of changes and harmful event and disasters in coastal regions to help decision makers to adapt to such changes, and reduce related risks. GFCS Principles 4, and 7, in particular, are advanced through this project.

d) Deliverables: Deliverables will include prioritized national and regional plans for achieving enhanced coastal regions monitoring, and in particular the collection, and exchange of the required EOVs and ECVs.

e) Prerequisites: The understanding and prediction of changes, harmful events, and disasters is possible through appropriate monitoring of the costal regions. This requires appropriate atmospheric, ocean, and climate models and computing infrastructure, together with the routine observation of ocean and atmospheric variables analysed and assimilated in those models (see the observations needed for DRR described in section 2.4.4). As this activity only covers the observations part, prerequisites for this activity include: (i) Commitment of IOC and WMO Members/Member States to undertake the necessary ocean observation programmes as reflected in the JCOMM Observations Programme Area Implementation Goals; (ii) Open data policy and international exchange of the required data in real-time; and (iii) Parallel development (or improvement) of the required ocean, atmospheric, and climate models.

f) Timeframe and costs: The project is expected to start with an initial phase of two years, costing about $8M annually. The goal in this period will be to increase the percentage of completion of the initial global ocean observing system, as defined within the JCOMM Observations Programme Area Implementation Goals from, 62 percent to 80 percent. Future efforts will be to complete of the observing system.

Project 6: Establish a coordination mechanism for collection, management, and exchange of climate and related food security data

a) Description: This project aims to engage the climate community and the agriculture and food security sector in coordinated efforts to address needs for climate and related food security data, consistent with the High Level recommendation to the Committee on World Food Security and Nutrition to “facilitate a dialogue on improved global data collection efforts for climate change and food security.” As indicated in the Exemplar on Food Security, effective delivery of climate services critically depends on the two communities working together and learning from each other.

b) Objectives: Achieve enhanced, better coordinated collection and international exchange of climate and food security data and derived products, maximizing all possible synergies through the adoption of agreed data and metadata standards and improved data analysis and exchange capacities.
c) Benefits: This implementation activity addresses a need identified in sections 1.4, 1.4.4 (Table 1), 1.4.7, and 2.4.1. It is responsive to GFCS Principles 1, 4, 6, and 8.

d) Deliverables: High quality observations of the climate system, related socio-economic data and derived products are collected and exchanged, enabling the agriculture/food security sector to plan for and adapt to climatic variations, climatic extremes, and changes in climate.

e) Prerequisites: Sustained high-level engagement and commitment by the climate and agriculture and food security communities to addressing the challenges associated with improving coordination between the sectors; Provision of adequate resources and expertise to develop and authority to implement an effective coordination mechanism.

f) Timeframe and costs: 2 years; 0.1M.

Project 7: Establish a coordination mechanism for architecture for climate monitoring from space

a) Description: A sustained, coordinated Architecture for climate monitoring from space is an essential building block of the GFCS Observations and Monitoring Pillar, supporting all four priority sectors and all ECVs observable from space. A broad range of international partners contribute to the Architecture, and their coordination has started in 2011 through an ad-hoc team involving satellite mission operators and user representatives including WMO, GCOS, and WCRP. A standing coordination mechanism needs to be agreed and established over the next 2 years to bring the coordination of space-based observing systems, processing activities, and user services in support of climate monitoring to the same level as currently in place for weather forecasting.

b) Objectives: Coordination mechanism internationally agreed and established.

c) Benefits: This implementation activity is addressing gaps identified in section 1.4.1, 1.4.3 and 1.4.5. This will contribute to addressing needs expressed in all Exemplars for climate observations on appropriate temporal and spatial scales. The project is especially responsive to GFCS Principles 2 and 7.

d) Deliverables: (i) Agreed procedures for analyzing and addressing gaps in space-based climate monitoring; (ii) Establishment of initial inventory of ECV-relevant observing systems, datasets, and user expert groups; (iii) Identification of gaps and opportunities based on the ECV inventory; and (iv) Prioritized action plan to implement the Architecture.

e) Prerequisites: (i) Entities that operate observing networks (in this case, space agencies operating satellites and ground-based processing systems) will need to make their data available (this is a prerequisite for a system to be considered as part of the Architecture); and (ii) Technological developments and national, regional, or global economic circumstances must enable these entities to sustain the delivery of these data over the long term. It can be expected that international coordination will mitigate the risks associated with implementing and sustaining the Architecture.

f) Timeframe and costs: 2 years; 0.5M/year.

2.5 Implementation Approach (including operational and organizational aspects)

The implementation approach is composed of several phases and includes projects that will satisfy the necessary conditions described in section 2.1 and adhere to the criteria for selecting observation and monitoring projects identified in section 2.3. For many, if not most, types of
observations needed for the GFCS, networks and coordinating mechanisms have already been established. Thus, the implementation approach will be to work with existing entities wherever possible and to build upon activities that are already underway. Where adequate coordinating mechanisms do not exist, the User Interface Platform suggests that the organizational entities most involved should be identified and brought together to exchange views on what is needed and on how progress can be made. This is the intent of Project 1.1 with respect to observations.

In general, projects that can address significant gaps will be undertaken first. Several of the projects listed in Table 2 (e.g., Project 1.1) are discrete activities that will be concluded within the initial 2-year time period of the GFCS. Others, in particular gap-filling projects, will be launched during this period but are expected to continue well beyond the initial period. The emphasis on the early implementation activities in Table 2 does not preclude implementation of the larger set of actions and activities shown in Table 3b from advancing. These actions will be implemented by the various GFCS partner organizations as time and resources permit.

Many of the projects identified for early action are relevant at more than one scale. For example, while the project to improve the GSN and GUAN networks principally addresses globally-coordinated networks, data from individual stations also make substantive contributions at regional and local levels. Implementation of HYCOS projects is undertaken regionally, at river basin scale, but there will be interest at the local level in river stage and discharge measurements, and air pollution measurements, while primarily of local concern, also contribute to regional scale analyses of pollutant loadings.

2.6 Monitoring and Evaluating the Implementation of Activities (including monitoring success)

A review mechanism is an important tool to manage the operation and the development of observing systems and to rectify deviations from plans. The observing systems under this Pillar are operated, managed, and evaluated by a number of UN, intergovernmental, or international bodies, programmes, and coordinating mechanisms. For example, both GCOS and WIGOS have well-established mechanisms to monitor the implementation of their ongoing activities. Because of the possible interdependence of activities of different entities and/or pillars, however, it is foreseen that an overarching GFCS monitoring and evaluation mechanism will be required to monitor the performance of the observing systems in their entirety and introduce corrective measures into stakeholders’ activities when necessary. Such a system does not exist, and it may be difficult to agree upon one, but, nonetheless, is still important. A useful first step, therefore, will be to engage key partners and stakeholders in discussions aimed at clarifying the need for, scope, and focus of such an overarching system for the Observations and Monitoring Pillar, drawing on experience with established GCOS, WIGOS, and other review and adjustment mechanisms.

At a more micro level, it will also be necessary to monitor and evaluate progress with implementation of each project that falls under the Observations and Monitoring Pillar in order to:

- Ensure that implementation milestones and targets are being met;
- Identify needs for, and initiate, remedial actions as and when necessary to ensure that project implementation remains on track; and
- Assess the extent to which completed projects contribute to the overall goals of the Pillar by, for example, filling gaps in temporal and spatial observational coverage of climate
system components or supplying observations of additional ECVs needed to support the provision of climate services.

Project monitoring and assessment by the responsible project managers will assume particularly critical importance during the first two years of GFCS implementation.

2.7 Risk Management in the Implementation of Activities

A Risk Management Plan (RMP) that includes risk mitigation will be developed for each project and/or group of related projects in the Observations and Monitoring Pillar during the initial stage of project implementation. The RMP of the Pillar should be linked to the RMP of the overall GFCS. A reasonable amount of time will need to be allocated to identify specific risks and develop risk mitigation strategies. The following general risk areas have, however, been identified:

- The requirement for the firm commitment of all stakeholders to implementing projects under this Pillar within the agreed time frame, including the provision of required human and financial resources;
- The requirement for appropriate leadership for the implementation of the Framework, including clarity regarding authority and responsibilities of entities and individuals for the implementation of projects;
- The risk posed by inadequate coordination of interdependent projects;
- The requirement for an effective interface between users of services (agriculture, water resources, health, and DRR sectors) and entities operating observing systems, especially in integrating socio-economic data with physical variables;
- Lack of transparency in the management of the implementation of the project or activity; and
- The potential for inadequate implementation if sufficient human or financial resources are not available.

To minimize potential risks, Risk Management Plans must be agreed and monitored by the partners of each project.
3  ENABLING MECHANISMS

3.1 Synergies with Existing Activities

Many stakeholders in the Observations and Monitoring Pillar have developed initiatives and programmes for observing the environment that, at the very least, include practices for collecting, distributing, and providing data to users. This Pillar should take maximum advantage of such initiatives and programmes, even if their practices differ, thus building synergies to overcome financial, technological, and human limitations. Close collaboration among programmes that address the physical domains of the Earth, namely GCOS as the overarching coordination mechanism for climate, GOOS (for oceans), GTOS (for land), and WIGOS (for atmosphere) is ongoing and must be continued. UN agencies have been active for decades in capacity building efforts. However, most agree more needs to be done. Building on the existing programmes of these UN organizations is an area for increased cooperation. Mechanisms like the WMO Voluntary Cooperation Programme (VCP) that address implementation, operations, and maintenance of observing systems should be leveraged and built upon.

3.2 Building National, Regional and Global Partnerships

3.2.1 Improving coordination for observations for climate services

The effective functioning of the observing system for climate services will depend greatly on the degree to which appropriate coordination mechanisms are put in place at national and regional levels. At the national level, the responsibility for implementation and operation of observing systems is typically distributed across many national departments and agencies, rather than being focused solely in a single agency such as an NMHS. While NMHSs usually play a central role in providing basic atmospheric observations, environmental agencies, agricultural agencies, research agencies, space agencies, and (where countries are not landlocked) national ocean services also provide important climate-relevant data and are engaged in the production of climate services. The requirements for biological, socio-economic and other non-physical data will, moreover, draw upon the capacities of even more agencies and institutions.

The establishment of national coordination mechanisms can lead to improved awareness of the importance of climate observations and related socio-economic and other data and to ensuring that the data needed for climate services are available. Where climate data are concerned, the designation of National Climate Observing Coordinators and the establishment of National Climate Observing Committees have long been advocated by the GCOS Steering Committee and supported by recommendations of the WMO Congress and the Conference of the Parties to the UNFCCC. To date, however, only twenty-three countries have established national coordinators, and most of these are in developed countries. The incorporation of requirements for biological, socio-economic, and environmental data will require further broadening of such initiatives. Promoting the establishment or improvement of both national and regional coordination mechanisms for observations for climate services will be an important activity of the Observations and Monitoring Pillar of the GFCS.

3.2.2 Promoting observing system improvements through partnerships

Just as strengthened coordination at national and regional levels will be important in fully implementing the Observations and Monitoring Pillar of the GFCS, so too will be the establishment of new partnerships and the enhancement of relevant existing ones. Partnerships may be among UN agencies, for example, the partnership among ICSU, UNEP, UNESCO/IOC, and WMO that has created the GCOS. This partnership may be enhanced in the future by adding additional members. In particular, with the evolving needs of the GFCS in mind, it will be
important to develop close working partnerships with UN agencies and others who can bring socio-economic data and expertise to assist in the development and delivery of truly effective climate services that respond to user needs. This is one reason why this Annex has proposed establishing a formal mechanism for consultation with users as one of its initial priority implementation activities. Partnerships may also be between or among regional climate centres and UN agencies, including those involved in the key sectors; among NMHSs within a given region; among NMHSs and co-sponsored programmes; among development banks and/or international cooperation agencies and regional climate centres; etc. It is useful to mention several in this Annex, but many more could be cited.

One of the most relevant examples of a partnership that will eventually lead to the improvement of climate observations and climate services is the Climate for Development in Africa Programme (ClimDev Africa). This Programme was conceived as an integrated programme with the objective of improving climate observations, climate services, and climate policy in Africa in support of mainstreaming climate concerns into development planning. Its principal partners are the African Union Commission (AUC), the UN Economic Commission for Africa (UNECA), and the African Development Bank (AfDB), but these African institutions have been joined by GCOS, UNEP and WMO, regional climate centres in Africa, and others.

If the goal of the ClimDev Africa partners is realized and donors, both internal and external to Africa, provide the needed funds to implement demand-led projects to improve climate observations and services in Africa, the Programme could have a substantial impact on Africa’s ability to adapt to climate variability and change and to effectively address its development needs. The ClimDev Africa Programme, as it further develops, will be an important contribution to the GFCS in Africa. As with the GFCS itself, the active and continued involvement of partners will be required, as well as support by both national and international organizations.

A second example of a partnership that has been conceived to address needs for improved climate observations and climate services is that between the GCOS and the Centro Internacional de Investigaciones para el Fenómeno El Niño (CIIFEN). With the support of Spain and Switzerland and the participation of several international cooperation agencies, GCOS and CIIFEN organized a workshop for South American countries on Improving the Climate Observing System in South America to Enable Better Climate Services and Adaptation Strategies. The workshop, which convened both producers and users of climate information, had the following specific objectives: (1) To discuss and agree on the regional priorities for integrated projects with climate information providers, sectoral users, and technical cooperation agencies; (2) To identify possible pilot initiatives to demonstrate the benefits of an integrated approach and, thus, make it easier for national governments to use national resources to sustain improvements; and (3) To determine observational requirements for improving sector-specific climate services and climate change adaptation strategies in support of ongoing and emerging sustainable development initiatives.

### 3.3 Communications Strategy

A specific communications strategy for the Observation and Monitoring Pillar should nest within the overarching communications strategy for the GFCS. Elements of the specific strategy for the Pillar should, however, include:

- Reaching the users of climate data and information, predominantly through the User Interface Platform, through direct contact with relevant focal points, through newsletters,
and through analysis and technical reports on the status of the system, its gaps, and its evolution;

- Reaching partners through the established coordination mechanisms for operation and development of observing systems (such as UN agency coordination, GCOS, and WIGOS);
- Reaching the general public through press releases and the media, including Internet and social networks;
- Reaching professionals involved in the operation of the observing systems through workshops and technical and scientific conferences;
- Including consideration of the need for capacity building and outreach; and
- Building feedback loops into the strategy to enable continuous improvement of observing system performance.

As a particular issue, the reluctance of some countries to exchange or provide easy access to their observational and climate-related data requires that an effective communications strategy for the Pillar must place strong emphasis on explaining the benefits of the GFCS and highlighting the need for open exchange of data to support its successful implementation.
4 RESOURCE MOBILIZATION

4.1 National level (e.g., governments, the private sector, foundations, bilateral and multilateral funding mechanisms, international agencies, etc.)
Implementation of the actions identified in this Annex will depend heavily on the availability of financial, technological, and human resources. The organizations and other entities listed in the “stakeholder” column of Tables 3a and 3b in section 5 are typically those that will have a principal role in resource mobilization. Of necessity, resource mobilization will be pursued at global, regional, and national scales at the same time. Inevitably, national efforts to mobilize resources will be of highest importance, even in many developing countries. While the national governments of the least developed countries will have difficulty funding more than a small part of their countries’ observing needs, even these countries are not without recourse. At COP 17, for example, the Global Environment Facility confirmed that both the Least Developing Countries Fund and the Special Climate Change Fund could be used to address observing system needs. It is also foreseen that the Green Climate Fund, which is being established through UNFCCC processes, should eventually be available to fund adaptation needs of developing countries, including needs for improved climate observations. There is almost certainly additional scope for working through the UNFCCC and its subsidiary bodies (the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI)) to augment funding for improving observations in support of the GFCS and for other climate-related needs. The COP has, on various occasions, urged Parties to support observing system improvements. Furthermore, the SBSTA has shown considerable interest in the GFCS and has requested updates on progress in implementing it.

4.2 Regional level (e.g., regional development banks, regional organizations, etc.)
At the regional scale, regional development banks can play an important role. In Africa, for example, the African Development Bank has become a principal partner (along with the African Union Commission and the UN Economic Commission for Africa) of the Climate for Development in Africa Programme (ClimDev Africa). Beginning in 2012 it will be possible for NMHSs, regional climate organizations, and others to submit proposals for inclusion in the annual ClimDev Africa Work Programme. Proposals that address observing requirements in support of the GFCS will be given high priority. Regional organizations, such as the African Centre of Meteorological Applications for Development (ACMAD), the Caribbean Community Climate Change Centre (CCCCC), and CIIFEN all work to facilitate resource mobilization for their members.

4.3 Global level
At the global scale, international organizations have both general and specific responsibilities to facilitate the funding needs of their members and can be supportive. For example, the GCOS Programme, through its reporting link to the UNFCCC, works to highlight the funding needs mainly (but not exclusively) of developing countries for observing system improvements. It can also, to a limited extent, seek funds for application in developing countries through its GCOS Cooperation Mechanism.
5 COSTED SUMMARY OF ACTIVITIES/PROJECTS

Table 3a below presents a synthesis of proposed initiatives to address observational gaps and needs in the major components of the climate system. Table 3b, which follows, provides additional detail on the individual initiatives that have been synthesized in Table 3a. As noted earlier, these projects were selected from a larger number of proposed projects addressing needs for observing system improvements because they were deemed to be especially relevant to the GFCS. They were developed in consultation with key partners engaged with the existing mechanisms and programmes relating to the observational systems discussed in earlier sections of this Annex.
<table>
<thead>
<tr>
<th>ACTIVITY AREAS</th>
<th>DELIVERABLES</th>
<th>TIMELINES</th>
<th>STAKEHOLDERS</th>
<th>COSTS/YR (USD)</th>
<th>POTENTIAL RISKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> ROLLING REVIEW OF REQUIREMENTS &amp; ONGOING CONSULTATIONS WITH USERS</td>
<td>Well-defined user requirements for observations - all climate system components</td>
<td>Ongoing</td>
<td>All climate system partners and user groups in key sectors</td>
<td>TBD</td>
<td>Poor coordination; lack of funding; inadequate user participation</td>
</tr>
<tr>
<td><strong>2.</strong> ATMOSPHERIC OBSERVATIONS</td>
<td>Physical and chemical atmospheric observations and databases that meet GFCS users’ requirements</td>
<td>Various - final target date of 2020</td>
<td>WMO, GCOS, GAW, CEOS, CGMS, NMHSs, JCOMM, others</td>
<td>200 – 660M</td>
<td>Inadequate resources; Research requirements</td>
</tr>
<tr>
<td><strong>3.</strong> OCEAN OBSERVATIONS</td>
<td>Oceanic observations and databases that meet GFCS users’ requirements</td>
<td>Various – final target of 10 years</td>
<td>UNESCO/IOC, JCOMM, GOOS, GCOS, Space Agencies, National Ocean Agencies, NMHSs, other partners</td>
<td>5 – 40M</td>
<td>Mobilization; Lack of national/regional coordination</td>
</tr>
<tr>
<td><strong>4.</strong> TERRESTRIAL OBSERVATIONS</td>
<td>Hydrological and other terrestrial observations and databases that meet GFCS users’ requirements</td>
<td>Various - final target date of 2015</td>
<td>UNESCO, GCOS, GEO, FAO, WMO, Space Agencies, other partners</td>
<td>100 - 300M</td>
<td>Inadequate resources; Data policies</td>
</tr>
<tr>
<td><strong>5.</strong> CRYOSPHERIC OBSERVATIONS</td>
<td>Cryospheric observations, databases and products that meet GFCS users’ requirements</td>
<td>2015</td>
<td>WMO, NMHSs, all national and international institutes / agencies / groupings with cryosphere responsibilities</td>
<td>40 - 130M</td>
<td>Inadequate resources; Data policies; Continuity of satellite records</td>
</tr>
<tr>
<td><strong>6.</strong> CLIMATE SYSTEM MONITORING</td>
<td>Enhanced data rescue; operational reanalysis; extreme weather/climate databases; improved climate products</td>
<td>2020</td>
<td>WMO, NMHSs, GCOS, IOC, national/regional/international agencies</td>
<td>10 – 30M</td>
<td>Inadequate resources; NMHSs’ operational priorities</td>
</tr>
</tbody>
</table>
### 1. ROLLING REVIEW OF REQUIREMENTS

<table>
<thead>
<tr>
<th>No.</th>
<th>Activity</th>
<th>Deliverables</th>
<th>Indicators</th>
<th>Assessment measures</th>
<th>Time-lines</th>
<th>Stakeholders</th>
<th>Linkages with other activities</th>
<th>Costs/yr USD</th>
<th>Potential Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rolling consultations with users - Establish a formal mechanism.</td>
<td>(1) A plan to assist users and service providers developed; (2) A set of user requirements across all domains for the GFCS</td>
<td>Satisfaction of users with climate services</td>
<td>User Interface Platform</td>
<td>Biennial</td>
<td>All partners</td>
<td>Link with all WMO, co-sponsored and non-WMO programmes</td>
<td>TBD</td>
<td>Coordination, funding, communities’ interest</td>
</tr>
<tr>
<td>2</td>
<td>Set up a “GFCS Observational Requirements Task Team”.</td>
<td>(1) Up-to-date WMO Database; (2) Up-to-date SoGs; (3) Relevant EGOS-IP and updated GCOS-IP; (4) Plan for cost-effective evoln. of existing obs. Stations; (5) Guidance to Members for the establishment of Regional and National observational requirements</td>
<td>Completeness of WMO Database and SoGs regarding GFCS requirements</td>
<td>GFCS Task Team, and community review</td>
<td>Biennial</td>
<td>WMO Members and partners</td>
<td>CBS ET-EGOS, GCOS, WIGOS, GCW, TCs, CEOS, CGMS, GEOSS</td>
<td>155 K</td>
<td>Coordination, communities’ interest</td>
</tr>
<tr>
<td>3</td>
<td>Identify and implement priority GFCS-relevant actions from the EGOS-IP and the GCOS-IP.</td>
<td>(1) GFCS Compliant observing systems</td>
<td>Adequacy of observing systems</td>
<td>GFCS Community review</td>
<td>Ongoing</td>
<td>WMO Members and partners</td>
<td>CBS ET-EGOS, GCOS, GCW, TCs, CEOS, CGMS, GEOSS</td>
<td>TBD</td>
<td>Coordination</td>
</tr>
<tr>
<td>4</td>
<td>Comprehensive networks: Sustain, fill gaps and generally expand the comprehensive atmospheric in situ networks, including air quality networks.</td>
<td>Provision of required surface-based data adequate for GFCS, including data from rehabilitated silent stations and station in remote areas</td>
<td>Availability and quality of data</td>
<td>World Data Centres</td>
<td>2015</td>
<td>WMO, its Members and Partners</td>
<td>All atmospheric networks</td>
<td>140 – 440 M</td>
<td>Research needed for optimal and cost-effective design of networks and data policies</td>
</tr>
</tbody>
</table>

Table 3b. Actions and Activities Related to Observations and Monitoring
## 2. ATMOSPHERE

<table>
<thead>
<tr>
<th>No.</th>
<th>Activity</th>
<th>Deliverables</th>
<th>Indicators</th>
<th>Assessment measures</th>
<th>Time-lines</th>
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<th>Linkages with other activities</th>
<th>Costs/yr USD</th>
<th>Potential Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a</td>
<td>Rehabilitation of silent stations and key stations in data poor areas, with a special focus on GSN and GUAN stations (to include measuring instruments and related technology, consumables, and training).</td>
<td>Provision of data of required quality</td>
<td>Satisfactory monitoring reports of GSN and GUAN data</td>
<td>WMO and GCOS Monitoring</td>
<td>Ongoing</td>
<td>Respective WMO Members</td>
<td>WIGOS, GCOS, ClimDev Africa</td>
<td>5 M</td>
<td>Inadequate funding</td>
</tr>
<tr>
<td>4b</td>
<td>Baseline networks: fully implement the climate baseline networks and systems and operate them in accordance with CIMO practices and the GCMPs.</td>
<td>Provision of surface and upper-air data for global assessments and responses</td>
<td>Availability and quality of data</td>
<td>Reports from global data centres</td>
<td>2015</td>
<td>WMO, its Members and Partners</td>
<td>WIGOS, WCRP</td>
<td>40 - 130 M</td>
<td>Inadequate funding</td>
</tr>
<tr>
<td>5</td>
<td>Develop Standardization Database.</td>
<td>WIGOS Standardization Database</td>
<td>WIGOS Standardization Database operational</td>
<td>Easy availability of existing standards</td>
<td>2015</td>
<td>WMO, its Partners</td>
<td>All observing systems</td>
<td>1 M</td>
<td>Inadequate resources</td>
</tr>
<tr>
<td>6</td>
<td>Develop Operational Database.</td>
<td>WIGOS Operational Database</td>
<td>WIGOS Operational Database operational</td>
<td>Availability of metadata to users</td>
<td>2015</td>
<td>WMO, its Partners</td>
<td>All observing systems</td>
<td>1 M</td>
<td>Inadequate resources</td>
</tr>
<tr>
<td>7</td>
<td>Develop Architecture for Climate Monitoring from Space.</td>
<td>Strategy and Action Plan for Architecture for Climate Monitoring from Space</td>
<td>Endorsement of Architecture for Climate Monitoring from Space by all stakeholders</td>
<td>Architecture for climate monitoring in place</td>
<td>2015</td>
<td>WMO, its Partners, including CEOS, CGMS,</td>
<td>All observing systems</td>
<td>0.5 M</td>
<td></td>
</tr>
</tbody>
</table>
## 2. ATMOSPHERE (Cont’d.)

<table>
<thead>
<tr>
<th>No.</th>
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<th>Costs/yr USD</th>
<th>Potential Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Develop data management standards, principles and practices.</td>
<td>WIS data management standards, principles and practices; Build universal Database Management System capability based on existing initiatives; WIGOS Portal</td>
<td>WIS data management standards, principles and practices are applied through all WIGOS data management activities, incl. metadata; WIGOS Portal operational</td>
<td>Implementation started</td>
<td>2015</td>
<td>WMO, its Partners</td>
<td>All observing systems</td>
<td>0.5 M</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Conduct workshops to assess the role of observations in adaptation to climate change.</td>
<td>Final report and strategy</td>
<td>Publication of report</td>
<td>--</td>
<td>early 2013</td>
<td>GCOS Sponsors, FAO, WHO, others</td>
<td>UNEP and IOC activities in adaptation</td>
<td>0.3M</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>Submit all national precipitation data, including hourly totals and radar-derived products where available, to global data centres.</td>
<td>Availability of precipitation datasets</td>
<td>Percentage of nations providing all precipitation data to global data centres. Percentage of stations for which hourly data available</td>
<td>Reports from global data centres</td>
<td>2013</td>
<td>WMO, its Members and Partners</td>
<td>Precipitation networks</td>
<td>1-10 M</td>
<td>Inadequate funding, data policies</td>
</tr>
</tbody>
</table>
## 2. ATMOSPHERE (Cont’d.)

<table>
<thead>
<tr>
<th>No.</th>
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<th>Potential Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Develop, improve, and sustain ground-based and space-based networks for measurement of precipitation and provision of products.</td>
<td>Availability of long-term homogeneous surface-based and satellite-based global precipitation products</td>
<td>Improved measurement methods and analysis techniques developed; inventory and guidance on precipitation products available; implementation of Global Precipitation Mission and follow-on</td>
<td>Reports from global data centres; IPWG</td>
<td>2018</td>
<td>WMO, its Members and partners, CGMS</td>
<td>Ground-based and space-based systems to estimate precipitation</td>
<td>20-60 M</td>
<td>Inadequate funding, data policies</td>
</tr>
<tr>
<td>13</td>
<td>Develop Core Metadata Standard, with emphasis on climate, and technical guidance.</td>
<td>WIGOS Core Metadata Standard applicable to climate; technical guidance</td>
<td>WIGOS Core Metadata Standard developed; technical guidance available</td>
<td>Initial core standard implemented</td>
<td>2015</td>
<td>WMO, its Partners</td>
<td>All observing systems</td>
<td>0.5 M</td>
<td>Inadequate resources</td>
</tr>
<tr>
<td>14</td>
<td>Develop QMS procedures.</td>
<td>Approved QMS procedures by WMO</td>
<td>Satisfactory quality of data</td>
<td>Monitoring of data quality</td>
<td>2015</td>
<td>WMO, its Partners</td>
<td>All observing systems</td>
<td>0.5 M</td>
<td>Inadequate resources</td>
</tr>
<tr>
<td>15</td>
<td>Develop Vision for integrated observing system &amp; its implementation plan, incl. technical guidance.</td>
<td>Vision for WIGOS and its implementation plan, incl. technical guidance</td>
<td>Vision for WIGOS and its implementation plan, incl. technical guidance available</td>
<td>Implementation initiated</td>
<td>2015</td>
<td>WMO, its Partners</td>
<td>All observing systems</td>
<td>0.5 M</td>
<td>Inadequate resources for implementation</td>
</tr>
<tr>
<td>16</td>
<td>Implement a global system for traceability of measurements to SI.</td>
<td>Measurements traceable to SI</td>
<td>Quality of data</td>
<td>Reports from global data centres</td>
<td>2020</td>
<td>WMO, its Partners, ISO, BIPM</td>
<td>All observing systems</td>
<td>5 -10 M</td>
<td>Inadequate resources</td>
</tr>
<tr>
<td>No.</td>
<td>Activity</td>
<td>Deliverables</td>
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<td>Assessment measures</td>
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<td>Linkages with other activities</td>
<td>Costs/yr USD</td>
<td>Potential Risks</td>
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<tr>
<td>17</td>
<td>Marine Climate Data System.</td>
<td>Develop the Marine Climate Data System (MCDS) under the JCOMM Expert Team on Marine Climatology (ETMC) so that it properly addresses the GFCS requirements for ocean and marine meteorological data</td>
<td>MCDS implemented</td>
<td>JCOMM review</td>
<td>10 years</td>
<td>WMO/IOC</td>
<td>CCI</td>
<td>30 K</td>
<td>Low</td>
</tr>
<tr>
<td>18</td>
<td>Address needs to monitor coastal regions and support adaptation and understanding of vulnerabilities.</td>
<td>Prioritized national and regional plans</td>
<td>Publications by regions and nations of their plans</td>
<td>To be established by technical advisory bodies</td>
<td>Continuing</td>
<td>Coastal countries OOPC</td>
<td></td>
<td>1-10 M annually</td>
<td>Mobilization; lack of national/ regional coordination</td>
</tr>
<tr>
<td>19</td>
<td>Improve number and quality of climate-relevant marine surface obs. from voluntary observing ships.</td>
<td>Improved number of observations</td>
<td>Increased quantity and quality of VOS reports</td>
<td>Availability of data</td>
<td>Continuing</td>
<td>NMHSs and climate services with shipping cos.</td>
<td></td>
<td>1-10 M annually</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Ensure coordination of contributions to CEOS Virtual Constellations for each ocean surface ECV relative to in situ ocean observing systems.</td>
<td>Annually updated charts on adequacy of commitments to space-based ocean observing system from CEOS</td>
<td>Updated charts</td>
<td>Continuing</td>
<td>Space agencies, JCOMM, GCOS, GOOS</td>
<td>WIGOS</td>
<td>1-10 M annually</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Implement the GLOSS Core Network.</td>
<td>Additional and/or improved tide gauges for about 300 tide gauge stations</td>
<td>Tide gauges in place and operating</td>
<td>Availability of sea level data</td>
<td>End of 2014</td>
<td>National ocean agencies, coordinated thru GLOSS of JCOMM</td>
<td></td>
<td>1-10 M annually</td>
<td></td>
</tr>
</tbody>
</table>
## 4. LAND

<table>
<thead>
<tr>
<th>No.</th>
<th>Activity</th>
<th>Deliverables</th>
<th>Indicators</th>
<th>Assessment measures</th>
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<th>Stakeholders</th>
<th>Linkages with other activities</th>
<th>Costs/yr USD</th>
<th>Potential Risks</th>
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</table>
| 22  | Establish prototype GTN-GW and a Global Groundwater Monitoring System (GGMS) as a web-portal for all GTN-GW datasets; deliver readily available data and products to the information system. | Prototype of GGMS operational  
To be completed by IGRAC | Reports to WMO CHy on the completeness of the GTN-GW record held in the GGMS, including the number of records in, and nations submitting data to, the GGMS; web-based delivery of products to the community. | Availability of data from GGMS | 2014 | IGRAC, in cooperation with GTN-H | UNESCO-IHP | 1-10M | Inadequate resources, data policies |
| 23  | Achieve national recognition of the need to exchange hydrological data of all networks encompassed by GTN-H, in particular the GCOS/GTOS baseline networks and hydrological networks, and facilitate the development of integrated hydrological products to demonstrate the value of these coordinated and sustained global hydrological networks for climate services. | Documented data sharing agreements from NMHSs for the sharing of selected station data in an institutionalized manner;  
Documentation of functional, integrated data products for a variety of purposes and in particular for climate services on national and regional scales | Number of datasets available in global data centres; Number of available demonstration products; Documentation of integrated data products and demand for these products | Direct contact with NMHSs and including river basin organizations; Requests for data products from a variety of user communities | 2015 | GTN-H Coordinator, WMO, GCOS, GTOS, in consultation with GTN-H Partners | GEO/IGWCO-COP | 1-2 M | Inadequate resources, data policies |
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<tr>
<th>No.</th>
<th>Activity</th>
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<tr>
<td>24</td>
<td>Development of a subset of current LTER and FLUXNET sites into a global terrestrial reference network of monitoring sites with sustained funding and co-located measurements of meteorological ECVs.</td>
<td>FLUXNET sites operational</td>
<td>Plan for the development and application of standardized protocols for the measurements of fluxes and state variables.</td>
<td>Availability of FLUXNET data</td>
<td>2014</td>
<td>National FLUXNET organizations US National Ecological Observatory Network (NEON) and the European Integrated Carbon Observation System (ICOS), in association with CEOS WGCV, CGMS-GSICS, and GTOS</td>
<td>Suggest that there must be linkages to WMO, NMHSs, research foundations and universities, etc</td>
<td>30-100M</td>
<td>Inadequate resources, data policies</td>
</tr>
<tr>
<td>25</td>
<td>Assess national needs for river gauges in support of impact assessments and adaptation, and consider the adequacy of those networks.</td>
<td>National reports on the adequacy of national hydrological networks</td>
<td>National needs identified; options for implementation explored</td>
<td>Assessment undertaken on the basis of sector-specific hydrological information requirements</td>
<td>2014</td>
<td>National Hydrological Services, in collaboration with WMO CHy and TOPC.</td>
<td>Water Resources Assessment activities of WMO</td>
<td>10-30M</td>
<td>Inadequate resources, data policies</td>
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<td>Assessment measures</td>
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<td>26</td>
<td>Generate annual products documenting global land-cover characteristics and dynamics at resolutions between 250 m and 1 km, according to internationally-agreed standards and accompanied by statistical descriptions of their accuracy.</td>
<td>Generated Products</td>
<td>Dataset availability</td>
<td>Availability of products</td>
<td>2012</td>
<td>Parties’ national services, research institutes and space agencies in collaboration with GLCN and GOFC-GOLD research partners and the GEO Forest Carbon Tracking task team.</td>
<td></td>
<td>1-10M</td>
<td>Inadequate resources</td>
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<tr>
<td>27</td>
<td>Implement agreed HYCOS initiatives in ten priority basins/regions of water scarcity to provide information for sustainable water resources development and management.</td>
<td>Information and products to support adaptation to climate variability and change.</td>
<td>River Basin and regional water resources development and management needs met.</td>
<td>Communities and sectors with access to water resources which mete identified needs.</td>
<td>2014</td>
<td>National Meteorological and Hydrological Services, in collaboration with WMO CHy.</td>
<td>Information collected will support climate modelling and verification analyses.</td>
<td>10-15M</td>
<td>Inadequate resources, data policies</td>
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## 5. CRYOSPHERE

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</tr>
</thead>
</table>
| 28  | Implement Global Cryosphere Watch, which will include among others:  
• Inventory of existing networks  
• Further development & completion of a network of sites/ reference sites/ supersites. | GCW implemented and operational | Availability of Cryo data through GCW Portal and WIS | Integrated data & products available for GFCS through GCW Portal and WIS | 2015 | WMO and Members, all national and international institutes / agencies / groupings with cryosphere responsibilities | All Domains | 2-10M | Lack of resources, data policies |
<p>| 29  | Strengthen and maintain existing snow-cover and snowfall observing sites; ensure that sites exchange snow data internationally; establish global monitoring of those data through WIS; and recover historical data. | Data &amp; products available through GCW Portal | Data submission to national archives, World Data Services and international bodies such as GPCC | GCW Portal and WIS | 2015 | NMHSs and research agencies, in cooperation with WMO GCW and WCRP and with advice from TOPC, AOPC, and the GTN-H. | Atmospheric &amp; Terrestrial Domains | 1-10M | Lack of resources, data policies |
| 30  | Maintain current glacier observing sites and add additional sites and infrastructure in data-sparse regions, including South America, Africa, the Himalayas, and New Zealand; attribute quality levels to long-term mass balance measurements; complete satellite-based glacier inventories in key areas. | Data &amp; products available through GCW Portal | Completeness of database held at NSIDC from WGMS and GLIMS | GCW Portal and WIS | 2015 | Parties’ national services and agencies, with international coordination through GTN-G partners, WGMS, GLIMS, NSIDC and GCW. | Atmospheric &amp; Terrestrial Domains | 10-30M | Lack of resources, data policies |</p>
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<tbody>
<tr>
<td>31</td>
<td>Ensure continuity of <em>in situ</em> ice sheet measurements and fill critical measurement gaps.</td>
<td>Data &amp; products available through GCW Portal</td>
<td>Integrated assessment of ice sheet change supported by verifying observations.</td>
<td>GCW Portal and WIS</td>
<td>2015</td>
<td>Parties, working with IACS, IASC, SCAR, GCW, and WCRP CliC</td>
<td>Atmospheric &amp; Terrestrial Domains</td>
<td>10-30M</td>
<td>Lack of research funding</td>
</tr>
<tr>
<td>32</td>
<td>Ensure continuity of the existing GTN-P borehole and active layer networks, upgrade existing sites, build “reference sites”, initiate operational permafrost temperature network at met. stations.</td>
<td>Data &amp; products available through GCW Portal</td>
<td>Number of sustained sites; completeness of database.</td>
<td>GCW Portal and WIS</td>
<td>2015</td>
<td>Parties’ national services/research institutions and International Permafrost Association. IPA/GTN-P and WMO GCW</td>
<td>Atmospheric &amp; Terrestrial Domains</td>
<td>10-30M</td>
<td>Lack of resources</td>
</tr>
<tr>
<td>33</td>
<td>Reprocess historical satellite data for consistent records of sea ice and snow properties. Facilitate intercomparisons of similar products.</td>
<td>Climate data records for sea ice extent, concentration, thickness, and motion, and snow cover extent and snow water equivalent.</td>
<td>Number of CDRs from different satellite systems</td>
<td>GCW and World Data System</td>
<td>2015</td>
<td>Satellite agencies, WMO Members, Intl. Scientific bodies, e.g. WCRP, GCOS, IASC, SCAR</td>
<td>Atmospheric, terrestrial and oceanic domains</td>
<td>5-10M</td>
<td>Continuity of satellite records</td>
</tr>
</tbody>
</table>
## 6. CLIMATE SYSTEM MONITORING

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>34</td>
<td>Large scale data recovery and digitization, with the integration of data from community observation networks.</td>
<td>- Establishment of initiatives and mechanisms for accelerating data recovery and digitization - Universal Climate Database Management System capability built, based on existing initiatives</td>
<td>Percent of climate records recovered and digitized (baseline: 2012)</td>
<td>Climate data flow into national, regional, and global data centres</td>
<td>2020</td>
<td>CCI, GCOS, CBS, CHy, CAgm, RAs, All Members ACMAD, RCCs, CLIMDEV, UNFCCC, UNEP, MEDARE, ACRE</td>
<td>Climate Data Management Systems (CDMSs), WIS DCPCs, CSIS, Nairobi Work Programme</td>
<td>400K year</td>
<td>Availability of funds</td>
</tr>
<tr>
<td>35</td>
<td>Establish a sustained capacity for global climate reanalysis and ensure coordination and collaboration among reanalysis centres.</td>
<td>Reanalysis on an operational basis</td>
<td>Reanalysis centres endowed with long-term and coordinated programmes</td>
<td>Cyclical flow of products of improving quality and widening range</td>
<td>2014; expansion into coupled reanalysis by 2016</td>
<td>National and international agencies</td>
<td></td>
<td>10-30M (Mainly developed countries)</td>
<td>Availability of funds</td>
</tr>
<tr>
<td>36</td>
<td>Provision and dissemination of new climate data sets and products, including <em>in situ</em> and space based.</td>
<td>- Yearly updates of World Weather Records - New products, including for monitoring from space</td>
<td>Countries implementing/ using these products</td>
<td>Data received by WMO, WDCs, RCCs and NMHSs</td>
<td>2016</td>
<td>CCI, GCOS, CBS, all Members, key priority sectors</td>
<td>CSIS, UIP, Climate Data Management Systems (CDMSs)</td>
<td>80K</td>
<td>Members Commitments</td>
</tr>
<tr>
<td>37</td>
<td>Ensuring better monitoring of the occurrence of climate extremes and their socio-economic impacts data bases on climate hazards in support of climate early warnings.</td>
<td>Establishment of regional and national data bases on extreme weather and climate events</td>
<td>Number of RCCs and NMHS data bases on extreme weather and climate events</td>
<td>Reports from Countries, RCCs, and NMHSs</td>
<td>2020</td>
<td>CCI, CBS, RAs, all WMO members</td>
<td>CSIS, UIP, Nairobi Work Programme</td>
<td>140K</td>
<td>Lack of funds, organizational structures, and operational priorities at NMHSs</td>
</tr>
</tbody>
</table>
Table 4. Status of Implementation of Networks and Identified Gaps

<table>
<thead>
<tr>
<th>ATMOSPHERE</th>
<th>Variable</th>
<th>Contributing Network(s)</th>
<th>Status</th>
<th>Contributing Satellite Data</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>GCOS Surface Network (subset of full WWW/GOS surface synoptic network).</td>
<td>At least 95 % of stations are active, but only about 80% transmit CLIMAT reports.</td>
<td></td>
<td>Operationally supported</td>
<td></td>
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<tr>
<td></td>
<td>Full WWW/GOS surface synoptic network.</td>
<td>Need data from entire network to be available for climate purposes; data receipt from many countries is inadequate.</td>
<td></td>
<td>Sea-surface temperature (IR, microwave) has strong influence on analysis of air temperature over the ocean.</td>
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<td></td>
<td>Additional national networks (see also Oceanic section, Sea-surface Temperature ECV).</td>
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<tr>
<td></td>
<td>GCOS Surface Network (subset of full WWW/GOS surface synoptic network).</td>
<td>At least 95 % of stations are active, but only about 80% transmit CLIMAT reports.</td>
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<tr>
<td></td>
<td>Full WWW/GOS surface synoptic network.</td>
<td>Some inconsistencies in pressure reduction methods to mean sea level.</td>
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<td></td>
<td>Buoys and ships (see Ocean Surface section).</td>
<td>50% of 1250 drifters with barometers. Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed. Global reference mooring network 34% complete. Over 400 VOSClim class VOS ships (i.e. 20%) providing climate quality data. Ice buoys with relatively good coverage in the Arctic in ice-covered regions (72 units), except in the Eurasian sector; retreating ice becoming a challenge for maintaining ice buoy network; ice buoys episodically deployed around Antarctica.</td>
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<td>Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed. Global reference mooring network 34% complete. Over 400 VOSClim class VOS ships (i.e. 20%) providing climate quality data. Ice buoys with relatively good coverage in the Arctic in ice-covered regions (72 units), except in the Eurasian sector; retreating ice becoming a challenge for maintaining ice buoy network; ice buoys episodically deployed around Antarctica.</td>
<td>Passive microwave for wind speed. Polarimetric microwave radiometry for wind vectors</td>
<td></td>
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<tr>
<td>Precipitation</td>
<td>GCOS Surface Network (subset of full WWW/GOS surface synoptic network). Full WWW/GOS surface synoptic network. Additional national meteorological and hydrological gauge networks; island networks. Surface-based radar networks. Buoys.</td>
<td>At least 95 % of stations are active, but only about 80% transmit CLIMAT reports. Quality of data and quantity of reports are variable. Most countries operate national high-resolution precipitation networks, but data are often not available internationally, or available only with time delay. Radar data not globally exchanged; spatial and temporal sampling limitations. Over 200 meteorological buoys worldwide, plus the Global tropical moored buoy network (completed in Pacific &amp; Atlantic; Indian 50% completed)</td>
<td>Passive microwave, VIS/IR on GEO. Precipitation radar.</td>
<td>High priority for climate applications</td>
<td>Uncertain continuity of precipitation radar, Temporal and spatial sampling limitations.</td>
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<tr>
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<tr>
<td>Water Vapour</td>
<td>GCOS Surface Network (subset of full WWW/GOS surface synoptic network); Full WWW/GOS surface synoptic network. Ships and moored buoys.</td>
<td>Water vapour is only partly included in CLIMAT reports, and not monitored. Over 200 meteorological buoys worldwide, plus the Global tropical moored buoy network (completed in Pacific &amp; Atlantic; Indian 50% completed). Over 400 VOS Clim class VOS ships (i.e. 20%) providing climate quality data; however, limited number of VOS making humidity measurements.</td>
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<tr>
<td>Surface Radiation Budget</td>
<td>BSRN.</td>
<td>High-quality data, but coverage should be extended and continuity secured. Quality and coverage of routine radiation data is inadequate for climate purposes.</td>
<td>GEWEX Surface Radiation Budget project</td>
<td>Solar from satellites For longwave, satellite data are used to estimate cloud parameters and near-surface thermodynamics fields are typically taken from NWP models</td>
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<tr>
<td></td>
<td>WWW/GOS surface synoptic network.</td>
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<td></td>
<td>Additional national networks.</td>
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<tr>
<td>Upper-Air Temperature</td>
<td>WWW/GOS radiosonde network (including GCOS Upper-Air Network -- GUAN).</td>
<td>About 90% of GUAN stations are reporting regularly, Totally, about 71% of stations are reporting regularly. Aircraft observations are valuable but limited to specific routes and levels except near airports. 6000 profiles per year, mainly in the North Atlantic.</td>
<td>Microwave sounders GNSS radio occultation Infrared sounders</td>
<td>Need to ensure continuity of MSU-like radiance bands Continuity for GNSS RO constellation needs to be secured</td>
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<td></td>
<td>Commercial aircraft. ASAP ships</td>
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<tr>
<td><strong>Upper-Air Wind Speed and Direction</strong></td>
<td>WWW/GOS radiosondes network (incl. GCOS Upper-Air Network). Radar (profilers). Commercial aircraft. ASAP ships</td>
<td>About 90% of GUAN stations are reporting regularly. Totally, about 71% of stations are reporting regularly. Radar data are not globally distributed. Aircraft observations are valuable but limited to specific routes and levels except near airports. 6000 profiles per year, mainly in the North Atlantic.</td>
<td>Visible and infrared (atmospheric motion vectors) from geostationary and polar orbit satellites. Lidar</td>
<td>Continuity of some polar winds at risk. Awaiting ADM/Aeolus demonstration; no continuity planned.</td>
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<tr>
<td><strong>Upper-Air Water Vapour</strong></td>
<td>Reference network of high-quality and high-altitude radiosondes (GRUAN). WWW/GOS radiosondes network (incl. GCOS Upper-Air Network). Ground-based GNSS receiver network. Commercial aircraft, e.g., CONTRAIL and IAGOS NDACC with Raman and DIAL LIDARs, as well as microwave instruments ASAP ships</td>
<td>International cooperation continues to work towards establishing the reference network as accurate reference radiosondes measuring upper-tropospheric and lower-stratospheric humidity are needed. Accuracy of water vapour measurements is improving, but is still inadequate for climate purposes in the upper troposphere and lower stratosphere. Wider international exchange of data is needed. Aircraft data are potentially useful.</td>
<td>Microwave imagers and sounders; Infrared sounders GNSS radio occultation; Infrared and micro-wave limb sounders Solar occultation NIR images over land</td>
<td>Continuity assured for operational microwave and IR sounders; Continuity uncertain for microwave imagery Continuity uncertain for research satellites and GNSS constellation.</td>
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<tr>
<td>Cloud Properties</td>
<td>Surface observations (GSN, WWW/GOS, VOS).</td>
<td>Surface observations of cloud cover provide an historical but uncertain record, and continuity is a concern; Reprocessing of cloud data is needed.</td>
<td>Visible, infrared and microwave radiances from geostationary and polar orbiting satellites; Cloud radar and lidar (research).</td>
<td>Cloud top temperature, microphysical properties and coverage are all operational.</td>
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<tr>
<td>Earth Radiation</td>
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<td>Broadband short- and longwave and total solar irradiance</td>
<td>Continuity and good calibration of measurements is of critical importance</td>
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<tr>
<td>Budget</td>
<td></td>
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<td>GERB geostationary measurements provide high time resolution broadband data.</td>
<td>NPP/JPSS will provide a CERES-like record starting in 2010.</td>
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<td>GERB useful for process studies, but no follow-on instrument.</td>
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<tr>
<td>Ozone</td>
<td>WMO GAW GCOS Global Baseline Profile Ozone Network (GAW ozonesonde network, including NASA SHADOZ and NDACC).</td>
<td>Mature operational balloon sonde network.</td>
<td>UV nadir and limb sounders</td>
<td>Operational continuity for column ozone; No future operational or research high vertical resolution profiling currently planned after 2015.</td>
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<td></td>
<td>WMO GAW GCOS Global Baseline Total Ozone Network (GAW column ozone network (filter, Dobson and Brewer stations) and profile ozone network (ozonesondes)).</td>
<td>Mature operational ground-based total column network. Operational; Operational data management.</td>
<td>IR nadir sounders IR and MW limb sounders</td>
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<td>NDACC</td>
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<tr>
<td>Carbon Dioxide</td>
<td>WMO GAW Global Atmospheric CO₂ Monitoring Network (major contribution to the GCOS comprehensive network for CO₂) consisting of: WMO GAW** continuous surface monitoring network. WMO GAW surface flask sampling network. Airborne sampling (CONTRAIL, CARIBIC). WMO GAW TCCON network (ground-based FTIR)</td>
<td>Operational; Operational data management.</td>
<td>SWIR and high-resolution IR</td>
<td>Continuity in IR operational instruments but products are immature and limited; A dedicated research satellite mission to provide better global products has been launched in 2009 (GOSAT), but continuity of such SWIR measurements need to be assured.</td>
<td></td>
</tr>
<tr>
<td>Methane and other long-lived greenhouse gases</td>
<td>WMO GAW Global Atmospheric CH₄ Monitoring Network ((major contribution to the GCOS comprehensive network for CH₄), consisting of: GAW continuous surface monitoring network. GAW surface flask sampling network. AGAGE, SOGE and University of California at Irvine, USA. Airborne sampling (CONTRAIL, CARIBIC, IAGOS). WMO GAW TCCON network (ground-based FTIR) NDACC</td>
<td>Operational; Operational data management.</td>
<td>IR nadir sounders SWIR nadir sounders</td>
<td>Satellite measurements on CH₄ are maturing and are part of operational satellites. Continuity of the observational needs is to be assigned. MLS, HIRDLS performs N₂O measurements in the stratosphere as well as of the other GHGs. Future research satellites might continue this, but there is uncertain continuity of profiling limb sounders.</td>
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</tbody>
</table>

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33 GAW includes networks operated by NOAA ESRL, CSIRO and many other WMO Members.
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Precursors (supporting the Aerosol and Ozone)</td>
<td>WMO GAW observing network for CO (continuous and flasks measurements)</td>
<td>Operational; Operational data management</td>
<td>UV/VIS/NIR/SWIR sounders</td>
<td>Precursors are measured by research satellites and operational satellites in future.</td>
</tr>
<tr>
<td></td>
<td>WMO GAW network for reactive nitrogen</td>
<td>Currently in the stage of establishment, several stations world-wide.</td>
<td></td>
<td>Information on high spatial and temporal resolution is limited</td>
</tr>
<tr>
<td></td>
<td>EMEP (GAW contributing network)</td>
<td>Operational European network for monitoring of primary pollutants, Sparse, research-oriented, Operational at national level, limited quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research programmes using MAXDOAS, SAOZ, FT/IR and other techniques (for NO₂)</td>
<td>Operational at national level, limited quality</td>
<td></td>
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<td></td>
<td>In situ network from environmental agencies</td>
<td>Limited operational aircraft vertical profiling initiated.</td>
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<td></td>
<td>Aircraft (IAGOS)</td>
<td>Operational (column and vertical profiles). Operational data management.</td>
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<tr>
<td></td>
<td>NDACC</td>
<td></td>
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<tr>
<td>Aerosol Properties</td>
<td>BSRN;</td>
<td>Operational.</td>
<td>Solar occultation VIS/IR imagers</td>
<td>Planned operational continuity for column products;</td>
</tr>
<tr>
<td></td>
<td>WMO GAW and contributing networks (AERONET); backscatter lidar networks (GALION and contributing networks)</td>
<td>Operational; Global coordination in progress.</td>
<td>Lidar profiling UV nadir Polarimetry Multi-angular viewing</td>
<td>No operational missions planned for aerosol type and aerosol size</td>
</tr>
<tr>
<td></td>
<td>NDACC (aerosol lidar).</td>
<td>Operational.</td>
<td></td>
<td>Research missions for profiling tropospheric aerosols;</td>
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<td></td>
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<td>No plans for continuity of stratospheric profiling.</td>
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</tbody>
</table>

³⁴ Including N₂O, CFCs, HCFCs, HFCs, SF₆ and PFCs.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Contributing Network(s)</th>
<th>Status</th>
<th>Contributing Satellite Data</th>
<th>Status</th>
</tr>
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</table>
| Sea surface heat flux    | Global tropical moored buoy network (~120) implemented through JCOMM/DBCP  
Sea-ice buoys implemented through JCOMM/DBCP  
Sustained and repeated ship-based hydrography network  
Critical current & transport monitoring                                                                                                                                                                                                                                                                  | Global tropical moored buoy network completed in Pacific & Atlantic; Indian 50% completed.  
Global reference mooring network 34% complete.  
Relatively good coverage in the Arctic in ice-covered regions (72 units), except in the Eurasian sector; retreating ice becoming a challenge for maintaining ice buoy network; ice buoys episodically deployed around Antarctica.  
Repeat hydrography and carbon inventory (10 year survey) 62% completed.  
CLIVAR, OceanSITES (over 100 sites), and IOCCP providing data for the critical current & transport monitoring.                                                                                                                                  | VIS/IR radiometry  
MW radiometry  
Scatterometry                                                                                                                                                                                                                                                                                                                                                                         | Operationally supported  
Continuity uncertain for microwave imagery  
Operationally supported |
| Significant wave height  | Meteorological moored buoys  
VOS fleet (25% of VOSclim class ships in the VOS fleet) implemented through JCOMM/SOT                                                                                                                                                                                                                                                                             | Over 200 moored buoys worldwide, mainly in USA, Canada, Europe  
Over 400 VOSclim class VOS ships (i.e. 20%) providing climate quality data with additional QC flag and metadata.                                                                                                                                                                                                                                                                                                                                                                   | Radar altimetry  
Synthetic aperture radar                                                                                                                                                                                                                                                                                                                                                                       | Continuity assured, subject to data sharing  
Continuity assured, subject to data sharing and timely processing |
| Sea State                |                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Radar altimetry                                                                                                                                                                                                                                                                                                                                                                           | Continuity assured, subject to data sharing |
| Sea surface height anomaly | GLOSS Core Sea-level Network, plus regional/national networks                                                                                                                                                                                                                                                                                    | 85% active stations; 71% fast delivery; 48% with GPS/DORIS; will increase with tsunami warning upgrades in Pacific, Caribbean.                                                                                                                                                                                                                                                                                                                                                     | High-precision satellite altimetry  
Radar altimetry                                                                                                                                                                                                                                                                                                                                                                                   | Continuity to be confirmed  
Continuity assured, subject to data sharing |
| Sea Level                |                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | High-precision satellite altimetry  
Radar altimetry                                                                                                                                                                                                                                                                                                                                                                                   | Continuity to be confirmed  
Continuity assured, subject to data sharing |
<table>
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<tr>
<th>Variable</th>
<th>Contributing Network(s)</th>
<th>Status</th>
<th>Contributing Satellite Data</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td><strong>Sea Surface Temperature (SST)</strong></td>
<td>Global surface drifting buoy array on 5°×5° resolution (1250) implemented through JCOMM/DBCP</td>
<td>Drifter network achieved required global density.</td>
<td>VIR/IR radiometry</td>
<td>Operationally supported</td>
</tr>
<tr>
<td></td>
<td>Global tropical moored buoy network (~120) implemented through JCOMM/DBCP</td>
<td></td>
<td>MW radiometry</td>
<td>Continuity uncertain for</td>
</tr>
<tr>
<td></td>
<td>VOS fleet (25% of VOSclim class ships in the VOS fleet) implemented through JCOMM/SOT</td>
<td></td>
<td></td>
<td>microwave imagery</td>
</tr>
<tr>
<td></td>
<td>Carbon VOS</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Global reference mooring network (30-40)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed.</td>
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<tr>
<td></td>
<td></td>
<td>Over 400 VOSclim class VOS ships (i.e. 20%) providing climate quality data with additional QC flag and metadata.</td>
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<td></td>
<td></td>
<td>See <a href="http://cdiac.esd.ornl.gov/oceans/VOS_Program/">http://cdiac.esd.ornl.gov/oceans/VOS_Program/</a> for status of Carbon VOS.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Global reference mooring network 34% complete.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sea Surface Salinity</strong></td>
<td>Global tropical moored buoy network (~120) implemented through JCOMM/DBCP</td>
<td>Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed.</td>
<td>Low-frequency MW radiometry (active or passive)</td>
<td>Demonstration phase</td>
</tr>
<tr>
<td></td>
<td>VOS fleet (25% of VOSclim class ships in the VOS fleet) implemented through JCOMM/SOT</td>
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<tr>
<td></td>
<td>Carbon VOS</td>
<td></td>
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<tr>
<td></td>
<td>Global reference mooring network (30-40)</td>
<td>Over 400 VOSclim class VOS ships (i.e. 20%) providing climate quality data with additional QC flag and metadata.</td>
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<tr>
<td></td>
<td></td>
<td>See <a href="http://cdiac.esd.ornl.gov/oceans/VOS_Program/">http://cdiac.esd.ornl.gov/oceans/VOS_Program/</a> for status of Carbon VOS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Global reference mooring network 34% complete.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ocean surface currents vector</strong></td>
<td>Global surface drifting buoy array on 5°×5° resolution (1250) for monthly means</td>
<td>Drifter network achieved required global density.</td>
<td>Contribution from</td>
<td>Continuity assured, subject to</td>
</tr>
<tr>
<td></td>
<td>Global tropical moored buoy network (~120)</td>
<td></td>
<td>radar altimetry</td>
<td>data sharing</td>
</tr>
<tr>
<td></td>
<td>Global reference mooring network (30-40)</td>
<td>Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Sustained and repeated ship-based hydrography network</td>
<td>Global reference mooring network 34% complete.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Repeat hydrography and carbon inventory (10 year survey) 62% completed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCEAN (Cont’d.)</td>
<td>Variable</td>
<td>Contributing Network(s)</td>
<td>Status</td>
<td>Contributing Satellite Data</td>
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<tr>
<td>Sea surface mass flux</td>
<td>Global reference mooring network (30-40) Sustained and repeated ship-based hydrography network Critical current &amp; transport monitoring</td>
<td>Global reference mooring network 34% complete. Repeat hydrography and carbon inventory (10 year survey) 62% completed. CLIVAR, OceanSiTEs (over 100 sites), and IOCCP providing data for the critical current &amp; transport monitoring.</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Argo profiling float network 41 repeat XBT line network implemented through JCOMM/SOOPIP Global tropical moored buoy network (~120) implemented through JCOMM/DBCP Global reference mooring network (30-40) Sustained and repeated ship-based hydrography network Critical current &amp; transport monitoring</td>
<td>Argo array maintained at the targeted global density but some issues to be addressed in marginal seas, polar areas; Active work on float enhancements based on OceanObs’09 recommendations. 80% of XBT lines occupied. Continuing work on XBT fall-rate equation bias – more metadata needed.</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
<td>Ocean temperature</td>
<td></td>
<td>Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed. Global reference mooring network 34% complete. Repeat hydrography inventory (10 year survey) 62% completed CLIVAR, OceanSiTEs (over 100 sites), and IOCCP providing data for the critical current &amp; transport monitoring</td>
<td></td>
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<tr>
<td>Variable</td>
<td>Contributing Network(s)</td>
<td>Status</td>
<td>Contributing Satellite Data</td>
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</tr>
<tr>
<td><strong>Ocean salinity</strong></td>
<td>Argo profiling float network</td>
<td>Argo array maintained at the targeted global density but some issues to be addressed in marginal seas, polar areas; Active work on float enhancements based on OceanObs'09 recommendations. Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed.</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Global tropical moored buoy network (~120) implemented through JCOMM/DBCP</td>
<td></td>
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<tr>
<td></td>
<td>Global reference mooring network (30-40)</td>
<td>Global reference mooring network 34% complete. Repeat hydrography inventory (10 year survey) 62% completed.</td>
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<td></td>
<td>Sustained and repeated ship-based hydrography network</td>
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<tr>
<td><strong>Ocean currents</strong></td>
<td>Argo profiling float network</td>
<td>Argo array maintained at the targeted global density but some issues to be addressed in marginal seas, polar areas; Active work on float enhancements based on OceanObs'09 recommendations. Global tropical moored buoy network completed in Pacific &amp; Atlantic; Indian 50% completed.</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Global tropical moored buoy network (~120) implemented through JCOMM/DBCP</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Global reference mooring network (30-40)</td>
<td>Global reference mooring network 34% complete. Repeat hydrography inventory (10 year survey) 62% completed.</td>
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<tr>
<td></td>
<td>Sustained and repeated ship-based hydrography network</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Ocean Colour</strong></td>
<td></td>
<td></td>
<td>Narrow-band VIS/NIR imagery</td>
<td>Continuity assured, challenges in data integration</td>
</tr>
<tr>
<td><strong>Ocean dissolved oxygen concentration</strong></td>
<td>Sustained and repeated ship-based hydrography network</td>
<td>Repeat hydrography inventory (10 year survey) 62% completed.</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
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</table>
| **Partial pressure oceanic CO2 (pCO2)** | Carbon VOS  
Sustained and repeated ship-based hydrography network  
Repeat hydrography and carbon inventory (10 year survey) 62% completed; 5.2M measurements of pCO2 from global oceans during 1957–2010 in LDEO database.  
CLIVAR, OceanSITEs (over 100 sites), and IOCCP providing data for the critical current & transport monitoring. | N.A. | |
| **Ocean Chlorophyll concentration** | Sustained and repeated ship-based hydrography network | Repeat hydrography inventory (10 year survey) 62% completed. | Narrow-band VIS/NIR imagery | Continuity assured, challenges in data integration |
| **Sea ice thickness** | Sea-ice buoys implemented through JCOMM/DBCP | Limited number of ice-buoys with Ice Mass Balance (IMB) capability in the Arctic in ice-covered regions; retreating ice becoming a challenge for maintaining ice buoy network; ice buoys episodically deployed around Antarctica. | Lidar altimetry and interferometric Synthetic Aperture Radar | No continuity assured |
| **Sea ice temperature** | Sea-ice buoys implemented through JCOMM/DBCP | Relatively good coverage in the Arctic in ice-covered regions, except in the Eurasian sector; retreating ice becoming a challenge for maintaining ice buoy network; ice buoys episodically deployed around Antarctica. | IR imagery  
MW imagery | Operationally supported  
Continuity uncertain |
| **Sea ice cover** | | | VIS/IR imagery  
Passive MW imagery  
Synthetic Aperture Radar | Operationally supported  
Operationally supported  
Continuity assured, subject to data sharing and timely processing |
<p>| <strong>Sea ice elevation</strong> | | | Lidar altimetry and interferometric Synthetic Aperture Radar | No continuity assured |</p>
<table>
<thead>
<tr>
<th>LAND</th>
<th>Variable</th>
<th>Contribution Network(s)</th>
<th>Status</th>
<th>Contributing Satellite Data</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>River Discharge</td>
<td>GCOS/GTOS Baseline GTN-R based on TOPC priority list</td>
<td>Stations selected and partly agreed by host countries, non-contributing stations approached.</td>
<td>Research concerning laser/radar altimetry for river levels and flow rates.</td>
<td>Operational laser altimeters not scheduled; EO-based network only research.</td>
</tr>
<tr>
<td></td>
<td>Lakes</td>
<td>GCOS/GTOS Baseline Lake Network based on TOPC priority list. To include freeze-up/break-up.</td>
<td>Stations selected, approached by HYDROLARE; GTN-L needs to be established.</td>
<td>Altimetry, high-resolution optical and radar imagery and reprocessing of archived data.</td>
<td>Operational laser altimeters not scheduled. Question mark over high-resolution systems continuity. EO-based network only research.</td>
</tr>
<tr>
<td></td>
<td>Ground Water (Levels, Use)</td>
<td>None, but framework for GGMN exists; many national archives of ground-water level exist.</td>
<td>Collection of aggregated data for GGMN has started; GTN-GW needs to be established.</td>
<td>Gravity missions</td>
<td>Gravity measurements operat’l, continuity needs to be secured</td>
</tr>
<tr>
<td></td>
<td>Water Use (Area of Irrigated Land)</td>
<td>No network, but a single geo-referenced database exists.</td>
<td></td>
<td>Any high-/medium-resolution optical/radar systems.</td>
<td>Lack of high-resolution optical continuity.</td>
</tr>
<tr>
<td></td>
<td>Snow Cover (incl. depth and snow water equivalent)</td>
<td>WWW/GOS surface synoptic network (depth). National Networks (depth and snow water equivalent).</td>
<td>Synoptic and national networks have significant gaps and are ALL contracting. Northern and Southern Hemisphere monitored operationally for extent and duration.</td>
<td>Moderate to high resolution optical for extent/duration. Passive microwave for snow water equivalent. Geostationary satellites</td>
<td>Moderate to high resolution optical and microwave sensor system follow-on is programmed.</td>
</tr>
<tr>
<td>Variable</td>
<td>Contributing Network(s)</td>
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<tr>
<td>Land Cover</td>
<td>FAO Global Land Cover Network; GOFC-GOLD.</td>
<td>First generation products available.</td>
<td>Any high-/medium-resolution optical/ radar systems.</td>
<td>Moderate resolution good; High-resolution optical system continuity required.</td>
<td></td>
</tr>
<tr>
<td>FAPAR</td>
<td>CEOS WGCV; FLUXNET; GTOS Net Primary Productivity.</td>
<td>Still no designated baseline network exists.</td>
<td>Optical, multi-spectral and multi-angular.</td>
<td>Moderate spatial resolution multi-spectral good; Continuation of multi-angular measurements required.</td>
<td></td>
</tr>
<tr>
<td>Albedo</td>
<td>CEOS WGCV; MODLAND; Atmospheric Radiation Measurement sites.</td>
<td>No designated reference network.</td>
<td>Multi-angular sensors. Geostationary Polar orbiters. GCMPs applied to measurements.</td>
<td>Use of operational meteorological satellites (SCOPE-CM Pilot Project) and moderate-resolution optical polar orbiters; Continuation of multi-angular missions required</td>
<td></td>
</tr>
<tr>
<td>Permafrost</td>
<td>GTN-P coordinates National Monitoring Networks.</td>
<td>Major geographical gaps. National data centres need to be established.</td>
<td>Derived near-surface temperature and moisture (e.g., from ERS/Radarsat, MODIS, AMSR-E).</td>
<td>No direct operational sensors to detect permafrost; no products.</td>
<td></td>
</tr>
<tr>
<td>Ice Sheets</td>
<td>Programme for Arctic Regional Climate Assessment; International Trans-Antarctic Scientific Expedition.</td>
<td>Large uncertainty in mass balances and dynamics. Ocean ice interaction major weakness.</td>
<td>Gravity mission, Synthetic Aperture Radar and laser altimetry.</td>
<td>Satellite altimetry research missions will help; Lack of laser altimetry mission continuity</td>
<td></td>
</tr>
<tr>
<td>Glaciers and Ice Caps</td>
<td>GTN-G coordinates national monitoring networks.</td>
<td>Major geographic gaps still need to be closed; especially concerning glacier mass balance measurements inadequate.</td>
<td>Visible and infrared high-resolution; Stereo optical imagery; Synthetic Aperture Radar Satellite altimetry.</td>
<td>Lack of high-resolution optical satellite continuity. Satellite altimetry research missions will help; Lack of laser altimetry mission continuity</td>
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<tr>
<td>LAND (Cont’d.)</td>
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<tr>
<td>LAI</td>
<td>CEOS WGCV; FLUXNET; GTOS.</td>
<td>Still no designated baseline network exists.</td>
<td>Optical, multi-spectral and multi-angular.</td>
<td>Moderate spatial resolution multi-spectral good; Continuation of multi-angular measurements required.</td>
<td></td>
</tr>
<tr>
<td>Above ground Biomass</td>
<td>FAO’s FRA; FLUXNET; No global data centre for non-forest biomass.</td>
<td>No designated baseline network exists; FRA data not currently applicable for high-resolution spatial analysis.</td>
<td>Low-frequency radar, optical and laser altimetry.</td>
<td>Laser/radar missions currently planned; need to be implemented</td>
<td></td>
</tr>
<tr>
<td>Soil Carbon</td>
<td>National soil carbon surveys</td>
<td>No designated global network or data centre exists; major geographical gaps; FAO-IIASA world soil map.</td>
<td>Not directly applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Disturbance</td>
<td>GOFC Regional Networks, GFMC</td>
<td>Some geographical gaps exist.</td>
<td>Optical and thermal.</td>
<td>Geostationary and moderate to high-resolution optical systems continuity required.</td>
<td></td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>FLUXNET; GTN-SM needs to be established WWW/GOS surface synoptic network</td>
<td>No designated baseline network exists.</td>
<td>Active and passive microwave missions</td>
<td>Continuity after the research missions required</td>
<td></td>
</tr>
</tbody>
</table>
## 6 APPENDIX 1 ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACMAD</td>
<td>African Centre for Meteorological Applications for Development</td>
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<tr>
<td>ACRE</td>
<td>Atmospheric Circulation Reconstructions over the Earth</td>
</tr>
<tr>
<td>ADM-AEOLUS</td>
<td>Atmospheric Dynamics Mission (ESA)</td>
</tr>
<tr>
<td>AERONET</td>
<td>Aerosol Robotic Network</td>
</tr>
<tr>
<td>AIDB</td>
<td>African Development Bank</td>
</tr>
<tr>
<td>AGAGE</td>
<td>Advanced Global Atmospheric Gases Experiment</td>
</tr>
<tr>
<td>AMSR-E</td>
<td>Advanced Microwave Scanning Radiometer for EOS</td>
</tr>
<tr>
<td>AntION</td>
<td>Integrated Antarctic Observing Network</td>
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<tr>
<td>AOPC</td>
<td>Atmospheric Observation Panel for Climate</td>
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<tr>
<td>AquaFed</td>
<td>International Federation of Private Water Operators</td>
</tr>
<tr>
<td>ARGO</td>
<td>Global Array of Profiling Floats that Measure Ocean Temperature and Salinity</td>
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<tr>
<td>ASAP</td>
<td>Automated Shipboard Aerological Programme</td>
</tr>
<tr>
<td>ASECNA</td>
<td>L’Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar</td>
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<tr>
<td>AU</td>
<td>African Union</td>
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<tr>
<td>AUC</td>
<td>African Union Commission</td>
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<tr>
<td>BAPMON</td>
<td>Background Air Pollution Monitoring Programme</td>
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<tr>
<td>BIPM</td>
<td>Bureau International des Poids et Mesures</td>
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<td>Biochemical Oxygen Demand</td>
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<td>CARIBIC</td>
<td>Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container</td>
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<td>Climate Data Record</td>
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<td>CIMO</td>
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</tr>
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<td>Coordination Group for Meteorological Satellites</td>
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<td>Climate for Development in Africa Programme</td>
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<td>CLIVAR</td>
<td>Climate Variability and Predictability (study, programme or project</td>
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<td>Conference of the Parties (UNFCCC)</td>
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<td>Data Rescue and Digitization</td>
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<td>Data Buoy Cooperation Panel</td>
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<td>DCPC</td>
<td>Data Collection or Production Centre</td>
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<td>Acronym</td>
<td>Full Form</td>
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<td>DIAL</td>
<td>Differential Absorption Lidar</td>
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<td>Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe</td>
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<td>Fraction of Absorbed Photosynthetically Active Radiation</td>
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<td>Global Network for Monitoring Fluxes CO₂, Water Vapour, and Energy between Terrestrial Ecosystems and the Atmosphere</td>
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<td>Fourier Transform Infra-Red Spectrometer</td>
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<td>Global Space-based Inter-Calibration System</td>
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<td>Description</td>
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<td>GCOS Surface Network</td>
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<td>Global Terrestrial Network - Lake Level/Area</td>
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<td>Global Terrestrial Network - Rivers</td>
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<td>High Level Panel of Experts on Food Security and Nutrition</td>
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<td>International Data Centre on the Hydrology of Lakes and Reservoirs</td>
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<td>International Association of Cryospheric Sciences</td>
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<td>IAGOS</td>
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<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<td>ICOADS</td>
<td>International Comprehensive Ocean Atmosphere Data Set</td>
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<td>ICOS</td>
<td>Integrated Carbon Observation System (European)</td>
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<td>International Council for Science</td>
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<td>Integrated Global Water Cycle Observations</td>
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<td>International Maritime Organization</td>
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<td>Intergovernmental Oceanographic Commission</td>
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<td>Infra-Red</td>
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<td>International Organization for Standardization</td>
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<td>Indian Space Research Organisation</td>
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<td>International Standards Organization</td>
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<td>International Surface Pressure Data Bank</td>
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<td>Information Technology</td>
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<td>Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology</td>
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<td>JCOMM Ship Observations Team</td>
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<td>Leaf Area Index</td>
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<td>Light Detection and Ranging</td>
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<td>Global Ocean Surface Water Partial Pressure of CO₂ Database</td>
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<td>Monitoring of Atmospheric Composition and Climate</td>
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<td>MAX-DOAS</td>
<td>Multi axis Differential Optical Absorption Spectroscopy</td>
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<td>Marine Climate Data System</td>
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<td>Mediterranean Climate Data Rescue Initiative</td>
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<td>Multi-Hazard Early Warning Systems</td>
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<td>Microwave Landing Systems (ICAO)</td>
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<td>Moderate Resolution Imaging Spectroradiometer</td>
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<td>Microwave</td>
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<td>National Aeronautics and Space Administration (USA)</td>
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<td>Network for the Detection of Atmospheric Composition Change</td>
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<td>Quality Control</td>
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<td>Regional Association (WMO)</td>
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<td>Regional Basic Climatological Network</td>
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<td>RCC</td>
<td>Regional Climate Centre</td>
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<td>RRR</td>
<td>Rolling Review of Requirements</td>
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<td>Système d’Analyse par Observations Zénithales</td>
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<td>Subsidiary Body for Implementation (UNFCCC/COP)</td>
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<td>Scientific Committee on Antarctic Research (ICSU)</td>
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<td>SCOPE-CM</td>
<td>Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring</td>
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<td>Southern Hemisphere Additional Ozonesondes</td>
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<td>System for Observation of Halogenated Greenhouse Gases in Europe</td>
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<td>User Interface Platform</td>
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<td>United Nations Environment Programme</td>
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<td>UNEP Global Ministerial Outlook Forum</td>
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<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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</table>
UNESCO IHP = International Hydrological Programme (UNESCO)
UNFCCC = United Nations Framework Convention on Climate Change
UNSGAB = UN Secretary-General's Advisory Board on Water and Sanitation
UNISDR = UN International Strategy for Disaster Reduction
USD = United States Dollars
USGS = United States Geological Survey
UV = Ultra Violet
VIS = Visible
VOS = Voluntary Observing Ship Programme
VOSCLIM = Voluntary Observing Ship Climate
VCP = Voluntary Cooperation Programme
WCP = World Climate Programme
WCRP = World Climate Research Programme
WCRP - CLIC = Climate and Cryosphere Project (WCRP)
WCSP = World Climate Services Programme
WDC = World Data Centre
WGCV = Working Group on Calibration and Validation
WGMS = World Glacier Monitoring Service
WHO = World Health Organization
WHYCOS = World Hydrological Cycle Observing System
WIGOS = WMO Integrated Global Observation System
WIAG = WHYCOS International Advisory Group
WIS = WMO Information System
WMO = World Meteorological Organization
WWRs = World Weather Records
WWW = World Weather Watch (WMO)
XBT = Expendable Bathythermograph
APPENDIX 2 REFERENCES


WMO, August 2007, IGOS Cryosphere Theme Report (WMO/TD No. 1045), Geneva.

WMO, 2005, Implementation Plan for Evolution of Space and Surface-Based Sub-systems of the GOS (WMO/TD-No. 1267), Geneva.


ANNEX

TO

THE IMPLEMENTATION PLAN
FOR THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

RESEARCH, MODELLING, AND PREDICTION COMPONENT

Version: 31 August 2012
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**RESEARCH, MODELLING, AND PREDICTION COMPONENT**

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EXECUTIVE SUMMARY

Climate observations, research, modelling, as well as experimental and practical prediction activities over the past few decades have greatly improved our understanding of the Earth climate change and variability and established a scientific foundation for development of the Global Framework for Climate Services (GFCS). However, practical implementation of GFCS will require further expansion and strengthening of the research on climate, development of multiple applications of climate knowledge, and targeting them on meeting the rapidly growing needs for science-based climate information in a wide range of socio-economic sectors for the globe and all regions of the world. GFCS requires systematic conversion of existing climate knowledge into practical solutions, and this in turn requires a change in how climate research is presently conducted. New professional networks of research communities in various socio-economic sectors should be created to unite climate research and the diverse service supplier and user communities.

The GFCS research, modelling, and prediction (RMP) pillar of GFCS will:

- Proactively target the research towards developing and improving practical applications and information products so that the identified requirements of climate information users, especially in the four near-term GFCS priority areas, could be satisfied at the current science and technology readiness level;
- Enhance significantly, including with help of the GFCS User Interface Platform (UIP), the interaction and cooperation of the corresponding research communities with climate information users and operators;
- Enhance the science readiness level for production of improved climate projections, predictions, and user-tailored climate information products; and
- Continue to improve the understanding of the Earth’s climate in the aspects that determine the impacts of its variability and change on people, ecosystems, and infrastructure.

The GFCS RMP activities will be coordinated or integrated with activities in other components of the Framework to ensure science support for the development of GFCS and to build the capacity of timely and effective delivery of valuable science-based climate information to the communities of users and decision makers. The activities will include:

- Developing research and user-interaction strategies in the GFCS priority areas, diversifying and expanding research with a major focus on the development of practical applications and strengthening validation and verification of resulting products in partnership with user communities;
- Systematically shortening the transition time from research to operations, expanding the scope of research products available to climate services users, in partnership with the GFCS Climate Services Information System (CSIS) and UIP, and developing means for effective science support of climate risk management and effective adaptation to climate change and variability; and
- Enhancing research on observations, design and development of observing networks, development of fundamental climate data records and their summaries and analysis of climate quality datasets; modeling and prediction/projection capabilities, and building the required infrastructure and capacity, both in developed and developing regions.
To provide sound science support to the GFCS development, it is imperative to involve key stakeholders in support and leading of corresponding activities and to ensure continuation of the effective coordination of practically oriented climate and climate prediction research. The World Climate Research Programme (WCRP) has expressed a commitment to strongly contribute to the GFCS development. Leading professional organizations in the sectors of human health, food and agriculture, water resource management, disaster risk, such as WHO, FAO, UNESCO, and UNEP, and some others, will direct and support research in main climate services application areas. Strategic partnerships among communities of climate scientists, practitioners, and users of climate information will be fostered to guide the development and use of specialized climate products in support of GFCS priorities.

This Annex to the GFCS Implementation Plan has been developed based on the High Level Team Report recommendations, considerations, and, especially, Principles governing the GFCS, and taking into account the existing and emerging climate information needs identified by UIP and CSIS components of GFCS. It has been prepared in close consultation with the Earth system science community that will play a critically important role in conducting research required to address these needs. To benefit from climate services, the users and decision makers need to know the limits of current scientific understanding of climate, how to take into account the inherent uncertainty of provided information, and how to effectively and accurately communicate their identified needs to scientists. The research communities must assess the current and future ability of climate science to satisfy the identified requirements and accommodate corresponding needs in their observations, research, development, and communication priorities. This Annex is intended also for the national and international research funding agencies and environmental agencies conducting applied research with climate dimension. The research priorities suggested in this document are essential for the development and implementation of GFCS, and it is hoped that they could be supported in the future proposal solicitations by research funding agencies and corresponding research and development plans of operational agencies. Without targeted investments in research, modeling and prediction activities, the progress in fulfilling decision makers’ needs for science-based climate information will be limited, at best.

Targeting climate research on delivery of climate information for decision-making support will involve *inter alia* experimental and theoretical work aimed at improving datasets and guidance material quality, extending the lead time and/or range for sub-seasonal to seasonal climate predictions, exploring the potential for practical decadal predictions and further improving longer-term projections, further substantiating climate models, developing techniques for observations and data assimilation, attribution and prediction of extreme events and assessment of their statistics, assessments of climate impacts on human health and its protection, food security, disaster risk reduction, and water management. The main direction of research under the GFCS will be expanding its practical dimension that makes its outcomes so valuable for informed decision-making dependent on the efficient use of climate information. The overall approach to the GFCS RMP pillar implementation will be to facilitate the transformation of the multitude of existing independent research activities into a more coherent, better supported, and more focused research process culminating in systematic generation, assessment, and improvement of valuable and timely climate-dependent information products that are in such great demand by decision makers and users both in the governmental and private sectors. The ultimate success of the GFCS RMP activities can be therefore gauged based on improvements in timely delivery and usefulness of the science-based products and services offered through the GFCS to different socio-economic sectors and regions.
1 INTRODUCTION

The High Level Taskforce (HLT) identified research, modelling, and prediction as one of the GFCS pillars and stated “... the research element encompasses the work of expert institutions to improve our understanding of climate and to develop core prediction tools, applications, and products that are essential for the ongoing development and continuous improvement of climate services.”

1.1 Objective, scope, and functions

The objectives of the RMP pillar of GFCS are to:

- Proactively target the research towards developing and improving practical applications and information products so that the identified requirements of climate information users, especially in the four near-term GFCS priority areas, could be satisfied at the current science and technology readiness level;
- Enhance significantly, including with help of the UIP, the two-way interaction and cooperation of the corresponding research communities with climate information users and operators;
- Enhance the science readiness level for production of improved climate projections, predictions, and user-tailored climate information products; and
- Continue to improve the understanding of the Earth’s climate in the aspects that determine the impacts of its variability and change on people, ecosystems, and infrastructure.

The scope of the GFCS RMP can be defined as:

- Encompassing a combination of fundamental and applied climate research;
- Embracing atmospheric sciences, oceanography, hydrology, cryospheric sciences, terrestrial and marine biogeochemistry, research on the socio-economic and human systems, and research on climate – dependent applications in key areas of human activities;
- Considering the Earth as a System, i.e. focusing on the significant interactions of all its components including human and natural subsystems;
- Including information on the past climate, largely based on paleoclimate research and observations, and prognostic information on the future climate up the end of this century and even beyond it, based on exploitation of our understanding of predictable processes and phenomena;
- Covering a wide spectrum of time- and space- scales, temporal and spatial resolutions, and regions of the world;
- Combining deterministic and statistical information including research on and evaluation of climate information uncertainty and value;
- Including all types and methods of research such as observations, field and model experiments, process studies, pilot prediction, assessment, production and validation of relevant datasets, etc.;
- Including policy relevant, but not policy prescriptive information; and
- Facilitating both cutting edge research and initial research capacity development at the global, regional, and national levels.
GFCS implementation requires resources and expertise to develop scientifically-based information, the technologies and solutions to help decision makers to address the challenges in adaptation, mitigation and risk management activities associated with the climate variability and change. The main function of the RMP is to facilitate improvements in relevant scientific knowledge and science-based climate information for their subsequent transition to operations and use in close coordination with service providers and users.

1.2 Requirement for the Research, Modelling, and Prediction pillar

All climate knowledge, services and ability to use them are science-based. The HLT emphasized the need for active engagement in GFCS development of climate scientists from academic institutions, hydrometeorological services, and many other organizations that conduct research to understand how the Earth’s climate system functions, design observing systems, develop climate models for projecting and predicting future climate conditions, and are engaged in applied research with respect of climate impacts on various aspects of human activities. At present these communities operate largely independently. As a rule, they do not have a requirement or an incentive to contribute the results of their research to an integrated system similar to the one that exists in meteorological services, where observations, data transmission and processing, modeling, and prediction regularly generate and deliver products, and where a failure to deliver in one part is immediately noticed both by the end customer and the other parts of the integrated system. Such a system has an inherent ability to detect flaws and improve operation of all its parts. Meteorological research strongly benefits from regular feedback resulting from the use of its results in providing meteorological services. GFCS needs targeted research and has the potential to link research, development, application, and feedback processes in the climate arena into an integrated system that would have the ability to encourage accelerated development in all its linked components, similarly to how the meteorological services system operates.

The WMO Executive Council Research Task Team (ECRTT) has made very important recommendations concerning the strategic way forward in environmental research, modeling and prediction. In the Report “Challenges and opportunities in research on climate, weather, water and environment” (WMO/TD-No. 1496, 2009) the Team recommended to develop “a unified approach to multidisciplinary weather, climate, water and environmental prediction research, step up high-performance computing investments to accommodate the increasing complexity and detail of models, and to accelerate the development, validation, and use of prediction models.” Implementation of this recommendation should lead to improvement of basic climate information products needed to generate user-tailored climate services. The Task Team also highlighted a need to further develop predictive capabilities through a mix of research and operations, involving all Earth System science disciplines and addressing corresponding needs on regional scales. The approach is illustrated in figure A showing how research and service delivery communities could work together towards operational implementation of research outcomes across weather and climate time scales.

The World Climate Conference-3 stated in 2009 that “major new and strengthened research efforts are needed to increase the time-range and skill of climate prediction through new research and modelling initiatives; and to improve the observational basis for climate prediction and services, and the availability and quality control of climate data”. To achieve these objectives, it called for major strengthening of the essential elements of GFCS such as the Global Climate Observing System (GCOS) and World Climate Research Programme (WCRP). GCOS and WCRP are indeed central for observations of and research on climate. However, in order to foster expanded and systematic delivery of tailored climate information to the end users and enable feedback on the products that helps and creates incentives to further improve them,
there is a need for a dedicated GFCS research pillar. RMP will unite communities conducting climate research, providing corresponding services, professionals from the health, water, energy, disaster risk management and many other sectors, and the users of climate information products; and add value to their individual work and the common outcome of it through an agreed and supported plan of implementation activities.

Figure A: Time scale dependence of various aspects of weather, climate, water and environmental prediction (EC RTT Report, 2009)

1.3 Inter-linkages with other pillars

Representation of GFCS as a composition of five pillars helps to design and organize the implementation of the whole system. The pillars are not distinct entities and are supposed to be strongly interacting with each other. The RMP pillar is not an exception, and to be useful and successful, it will have tight linkages with all other GFCS pillars.

Scientific research is a fundamental and generic means of capacity development (CD). In turn, education and training, as an essential part of traditional CD, help to support the resource base for scientific research. The links between the RMP pillar and the CD pillar will be therefore two-fold. The deliverables of the RMP pillar, including the significant increase in the availability and rigor of climate datasets and climate predictions and projections on global and regional scales and an advance in the usefulness and availability of practical applications in the domains of human health, food security, water management and disaster risk reduction, will help to enable wide, systematic, and successful CD programmes, especially for developing countries. Vice versa, arrangements and resources available through the CD pillar will be used by RMP pillar to facilitate CD in the domains of climate and applied research, especially in developing countries. Dedicated CD components of every significant RMP activities will be proposed, wherever feasible. For example, the WCRP Coordinated Regional Downscaling Experiment (CORDEX) project develops the capacity to downscale global climate predictions and projections to the regional and sub-regional scales for assessing regional impacts of climate change and for extended use of downscaled climate information in practical applications (Giorgi et al, 2009). The first focus area of the project is Africa. CORDEX is using both dynamic and statistical means of downscaling climate projections from the global to regional and sub-regional level and makes this information openly accessible to all scientists around the world. Activities like CORDEX offer a very promising platform for educational and CD activities in regions. Several
CD CORDEX-based CD activities have already been organized by WCRP and many more will follow under the GFCS umbrella.

The availability of relevant climate observations is essential for climate research and the Observation and Monitoring (OBS) pillar of GFCS has a large bearing on research. Until now, research funding remains the dominant source of support for climate monitoring, especially for ocean observations, atmospheric chemistry, some cryospheric, and even some meteorological observations. Research on observing techniques, their development and deployment are vital for closing gaps in the observational coverage and expanding the range of observed climate variables. Thus, the linkages between the RMP and OBS pillars are very strong. There will be many joint GFCS initiatives to be implemented by the RMP and OBS pillars.

The HLT report emphasizes that decision making at all levels is highly dependent on availability of sound climate information. Currently, the demand for such useful information based on reliable observations and solid science greatly exceeds the supply. One of the key deliverables of the RMP pillar will be accelerated improvement in availability to customers of science-based climate products, which will be achieved through the more active use of the CSIS channels. The growing demand for supply of such products according to identified user requirements should selectively facilitate research that has the potential to generate more user-oriented and user-friendly information to support decision making in applied sectors, and stimulate institutional support for timely provision of observations, model simulations, analysis and synthesis of the resulting climate information that will form the science basis of enhanced or completely new types of climate services.

The UIP will guide the research towards developing practical applications of climate science and generating required information products. At present the dialog between the climate research community, climate service providers, and climate information users is only starting. The development of UIP will establish a continuous interaction of providers and users of climate data on various regional scales, from global to regional, national, and local. The role of research communities in this interaction is to inform both the supply and demand sides of what is possible or may become possible if some targeted research and development is conducted, and what are the limits of use of information products resulting from insufficient knowledge or inherent product uncertainty. In this dialog the climate science will receive substantiated requests for product improvements and expansion of their scope and extremely valuable feedback on product and techniques qualities and shortcomings. The existence of such interaction will signify a cardinal change in the practice of defining user requirements for climate science and operations. It will facilitate translation of available climate products into sector-specific and region-specific products tailored for end users and inform users about the latest developments in fundamental climate science and its ability to deliver new information in their areas of interest. Involvement of representatives of all GFCS pillars in creating such an interaction mechanism is imperative.

1.4 Relevant existing activities, and identification of gaps

International research coordination helps to achieve greater progress in understanding and predicting climate variability and change and to address complex scientific challenges that cannot be tackled by individual nations. The leading programme in this area is the World Climate Research Programme (WCRP), the research branch of the World Climate Programme. The WCRP Strategic Framework 2005-2015 “Coordinated Observation and Prediction of the Earth System” (WCRP, 2005) targets climate research on the development of multiple practical applications of direct benefit and value for society. In 2007, GCOS, WCRP, and International Geosphere – Biosphere Programme (IGBP) conducted a Workshop “Future Climate Change Research and Observations: GCOS, WCRP and IGBP Learning from the IPCC Fourth
Assessment Report” (GCOS, WCRP, IGBP, 2008). The workshop identified gaps in knowledge and salient science issues and corresponding research needs for adaptation to and assessment of risks posed by climate change, treatment of uncertainty and providing relevant climate information on regional scales. The WCRP Implementation Plan 2010-2015 (WCRP, 2009) includes a series of research activities to address the identified gaps in knowledge. The activities proposed in the Plan are of extreme relevance to GFCS.

WCRP has expressed a commitment to support the development of the research pillar of GFCS and is updating its research priorities, structure and modus operandi to address this challenge. A series of consultations were held in 2008-2011 to define how climate research can help support and develop climate services. The WCRP Joint Scientific Committee at its 31st session (Antalya, Turkey, 15-19 February 2010) held a Joint Session with the fifteenth session of the WMO Commission for Climatology Technical Conference “Changing Climate and Demands for Climate Services for Sustainable Development” (Sivakumar et al., 2010). The WCRP Open Science Conference (OSC, Denver, USA, 24-28 October 2011) was devoted to the Theme “Climate Science in Service to Society” (Asrar et al., 2012) and had successful sessions on the private sector interest in climate services. Based on a series of consultations, the Joint Scientific Committee for WCRP in October 2011 identified six Grand Challenges in climate research, which are defined as specific barriers (i.e. gaps) to progress in understanding and predicting climate variability and change but are tractable through targeted research efforts with the likelihood of significant progress over 5-10 years. These grand challenges relate to understanding, attributing, modeling, and skillfully predicting or projecting:

- Regional climate;
- Regional sea-level rise (which also includes assessment of the change and variability of the global mean sea level);
- Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon);
- Interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity;
- Past and future changes in water availability (with connections to water security and hydrological cycle); and
- Extreme hydrometeorological events.

These challenges are very relevant for the RMP pillar, and activities aimed at addressing them are included in the initial and subsequent pillar initiatives.

The foci of the existing climate and health activities are early warnings for various diseases; response systems to health emergencies; and assessments of the health impacts of air quality problems, climate change, and climate variability. Even the Health Exemplar states that the list of relevant existing activities is very long and only most notable examples are given in that document. The list of current climate and health initiatives in the Health Exemplar includes:

- The Meningitis Environmental Risk Information Technologies (MERIT);
- The IRI Training Program on Climate Information for Public Health;
- The WMO Climate and Health Working Groups;
- A specific example of the Madagascar Climate and Health Working Group;
- Regional Health Policy for Climate Change;
- Health Alert systems for Extreme Weather events in the UK.

Most of these initiatives have a strong research dimension. The research-related gaps identified by the WMO Commission for Climatology Expert Team on Climate and Health include:
• Inadequate understanding of user needs for information and services;
• Lack of awareness of users of the available and potential services; and
• Inadequate communication between NMHSs and users.

Many existing activities in the water resource management sector have a strong research and climate component. These components also have a very wide scope. For example, the UNESCO’s International Hydrological Programme (IHP) work in the water sector is built on three tracks:

• Hydrological science for policy relevant advice;
• Education and capacity building responding to the growing needs of sustainable development; and
• Water resources assessment and management to achieve environmental sustainability.

A brief analysis of the most relevant existing activities in the water management, food security and disaster risk reduction sectors is given in Section 2.2. In this section we attempt to identify most notable gaps in corresponding research activities and their organization. For example, the Water Exemplar states that even in advanced countries there are significant constraints on funding support for research in water and climate applications, especially for modelling and prediction. Insufficient support to this area of research activity can be partially explained by the inability of this sector to broadly demonstrate its potential future value to coordinated water management due to a combination of insufficient accuracy of current climate predictions for a useful range of time scales and restricted ability to generate accurate water resource guidance even the climate information was perfect. In addition, interfacing between research and users in the water resources sector is generally underdeveloped. The Food Security Exemplar lists several collaborative activities between meteorological and agriculture communities that have a research objective or perspective. However, a very significant divide may also be detected between practitioners of this sector and research communities. The Disaster Risk Reduction Exemplar states that even in the detailed Exemplar document it was impossible to provide an exhaustive list of all stakeholders and partners active on regional and national scales that are dealing with natural disaster risks, prevention, recovery, and impact assessment. The requirements for associated research and means of directing and supporting it await consolidation, and the climate-oriented component of the disaster risk research still needs to be better defined at a variety of space scales.

The analysis of the existing research and development activities in the climate services domain indicates two kinds of GFCS-relevant gaps. First of all, there are gaps in knowledge or understanding of certain aspects of climate that reduce our ability to generate plausible climate information. The second very serious challenge for the RMP pillar is the communication gap between the research communities, including climate scientists per se and research communities active in the GFCS initial priority sectors (water, food and agriculture, disaster reduction, and human health), and, as well, between scientific and various operational communities involved in provision of climate information to users. At present, liaisons between these communities are weak, and there are no solid institutional arrangements for their effective cooperation. Such arrangements and links will have to be created in the course of the RMP pillar design and implementation. Many of the potential key partners and stakeholders are indicated in the four GFCS Exemplars, and building common ground for their joint future work will be the objective of some of the proposed initial RMP activities.

The research activities and programmes that are indicated above in this section represent only the tiny above-surface part of the whole GFCS-relevant activity iceberg. There are many other
international research programmes and agencies that conduct research work of significance to
the RMP pillar. Their non-exhaustive list includes:

- WHO research programmes for the climate and health sector, such as the Special
  Programme for Research and Training in Tropical Diseases (TDR) co-sponsored by the
  United Nations Children's Fund (UNICEF), the United Nations Development Programme
  (UNDP), and the World Bank;
- UNESCO research programmes, especially the International Hydrological Programme
  (IHP) for the water sector;
- Research components of the multiple FAO programmes;
- IOC constituent bodies and co-sponsored programmes;
- WMO NMHSs, World Weather Research Programme (WWRP), Hydrology and Water
  Resources Programme (HWRP), Global Atmosphere Watch (GAW); research
  communities affiliated with the World Weather Watch (WWW) and its Global Data
  Processing and Forecasting System, other constituent bodies and co-sponsored
  programmes such as WMO Technical Commissions and Programmes;
- Activities and programmes of other UN agencies and programmes, especially PROVIA of
  UNEP that helps to coordinate research on climate change vulnerability, impacts and
  adaptation as well as communicate the growing knowledge base in this area to policy
  makers and other stakeholders;
- ICSU constituent and interdisciplinary bodies and co-sponsored programmes including
  the IGBP, IHDP and major ICSU – related research initiatives such as the “Future Earth:
  Research for global sustainability” and Integrated Research on Disaster Risk Programme
  (IRDR); and
- Observing and services-oriented programmes: WIGOS, GCOS, GOOS, GTOS, etc.

Last but not least, a wealth of relevant climate information comes from periodic scientific
assessments of the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC), which
impartially reviews latest achievements of climate science and provides policy-relevant but not
policy-prescriptive information on climate. Planning of the GFCS research activities, presented in
this Annex, takes IPCC activities and their expected outcomes into detailed account.
2 IMPLEMENTATION OF THE PILLAR

At present, a significant volume of research is taking place on observing systems, data assimilation, climate models improvement, evaluation and uncertainty analysis of models and their results, understanding predictable elements of global and regional climate at a range of time scales, and development of information products necessary for climate services. Implementation of GFCS will mean a big change in this domain of climate research. It will add incentives, focus, resources, and a strong emphasis on the practical outcome of this research work. RMP will speed up the integration of presently independent research activities towards satisfying the needs of climate information users. As indicated above, this will require efficient planning, monitoring and coordination of the RMP activities and active involvement of users in targeting and assessing the activities.

Implementation of the RMP pillar will go far beyond simple expansion of already existing climate research. It will not only significantly affect the ongoing research but also include completely new implementation activities specifically dedicated to the accelerated development of GFCS.

2.1 The necessary and sufficient conditions for a successful implementation of the pillar

The RMP pillar implementation will be a success if the united community of climate scientists and users of climate information, working in cooperation and constant dialogue, develops an ability to provide considerably improved and much more useful information on important aspects of the past and present state of the climate system, achieves considerably better skill in capturing the predictable climate signal on an increased range of space and time scales, and enables, on that basis, delivery of climate information products that in turn enable adequate decision making. However, due to the extreme complexity of the Earth System and its limited predictability, climate predictions and projections, as most other predictions, will always be subject to significant uncertainty. The same can be said about diagnostic products that will never be able to describe the past and present climate with absolute accuracy, extremely high resolution, and in sufficient detail. The RMP pillar research will therefore successfully contribute to the development of GFCS if it provides a scientific underpinning for continuous improvement of useful climate products for past, current and future climate with substantive quantitative estimates of their uncertainty. It will also add value by providing appropriate guidance on how to make the information ‘actionable’, i.e. how to make specific optimized decisions taking into account the uncertainty in available information. With time, the skill of climate predictions will improve, but the need to consider a range of future likelihoods will always be a challenge for decision making. Also, the core value of climate research is that it not only develops observations and prediction tools, but also provides a framework for identifying and answering questions, which are not yet obvious for decision makers.

The necessary conditions for successful contribution of RMP pillar to the GFCS development are multiple and include:

- Active engagement of the climate science and corresponding applied science communities in:
  - Coordinated and targeted research on and development of all GFCS elements,
  - Understanding of the Earth’s climate and its impacts on people, ecosystems, and infrastructure,
  - Identifying predictable elements of climate,
  - Attributing causes of individual events, and
Developing technologies of climate observation, prediction, projection and data interpretation, etc.;

- Commitment of research groups and climate service providers to work together with users to define the necessary information products for practical applications in various socio-economic sectors;
- Involvement of funding agencies, university science, and availability of support from leading agencies at global, regional, national, and, where relevant, local level;
- Efficient planning of RMP activities particularly at the initial stage of GFCS implementation, involvement of initial GFCS priority sectors stakeholders in this process, and early identification of relevant partners, their potential contributions, and interests;
- Adequate funding, human resources, and computing/data transmission and information technology support;
- Resourceful and targeted CD and related education in core and applied climate research;
- Availability and sustainability of adequate observations for the Earth System including variables that result in representation in predictive models, their initial conditions, and forcing functions of known predictable processes and phenomena; and
- Creating an environment in which all communities involved in the RMP activities could work together on product design, development and delivery, in unison with the CSIS and UIP, and produce helpful guidance on how to efficiently use the imperfect observations, data, predictions and fundamental scientific understanding for informed decision making and social development.

All of these conditions are not easy to fulfill. For example, the active engagement of the climate science community in improving the practical aspects of climate services and in transitioning research into operations contradicts the very nature of academic research, which is always moving on to new questions and, in principle, lacks the incentive and interest to see innovations implemented into operations. The remedy here may be to try to offer opportunities for achieving research success in working across disciplines and together with operational services thus tracing the research outcomes up to where they are practically used. Turning the climate research into a more user-oriented and responsive domain of work that has more abilities to verify the practical outcomes of the research and more incentives to improve the used techniques and models may itself require innovative approaches. For example, the National Oceanic and Atmospheric Administration (NOAA) Climate Test Bed (CTB) is one model worth considering, at least in terms of improving availability of research-based climate information to a variety of users.

The sufficient condition for RMP successful contribution of the buildup of GFCS could be defined as fulfilling, at least at some minimal level, of all necessary conditions outlined above, and creating a framework or a platform whereby guided scientific developments resulting in improvements of needed climate information products could be effectively picked up by climate-reliant decision making. If such synergistic arrangements are in place, they will create, with time, more and more support to core and applied climate research. Any identified possibility for creating such “positive climate science - services feedback” should not be missed, and the initial line of the RMP action will therefore be creating a platform for dialogue of communities involved in climate science and services including communities interested in the development of practical applications of climate knowledge in a number of socio-economic sectors.

Computing power remains a serious limiting factor for the progress in development of climate models and corresponding data processing. It has set the limits on pace for improvement of climate/weather models horizontal, vertical and time resolution and in some cases inhibits the development and use of comprehensive parameterization packages for still unresolved physical, biological or chemical processes, such, for example, as clouds in the atmosphere, aerosols,
their interactions. It also prohibits the use of extended prediction ensembles thus reducing the reliability and comprehensiveness of the prediction statistics; and adversely affects the way in situ and satellite observations are processed and/or assimilated in models. Continuous access to more powerful computing resources, means of observation, broad bandwidth for data transmission, fast data processing and massive storage possibilities are technical requirements for the success of RMP pillar and GFCS in general. Efficient sharing of resources and the use of distributed information technology solutions should therefore be maximized, for example through partnership arrangements.

2.2 Engagement in working mechanisms of partners

Under the RMP pillar the needs of climate services will be promoted in research agendas of main stakeholders, encouraging improvement of climate information, including predictions and projections, for the time and space scales of concern to decision makers, and developing practical applications in partnerships with corresponding users. The bulk of the research contributing to the setup of GFCS will be conducted in nations at research divisions of NMHSs, universities, and academies of sciences, research laboratories or various national agencies, etc. Representatives of research and application communities will also be engaged in activities shaping the GFCS UIP and CSIS. Within the GFCS communities, providers of tailored climate information to the end users will be a major category of customers for the climate research community. Their assessment of climate information quality will help to further develop climate data and predictions. The RMP pillar will also help to communicate to the broader audience the views of the research community on the important issues of climate impacts on society and the role of science in addressing them. Coordination of such a system is difficult unless the pillar has a well-defined structure that is capable to maintain links between its interacting parts. To design such a structure, the first step would be to identify the main international stakeholders coordinating research and development in the four initial priority sectors for GFCS implementation and engage, with their help, main programmes conducting relevant research.

The UN Food and Agricultural Organization (FAO) and UN World Food Programme are the main stakeholders managing support to and coordination of the agriculture and food security. The sector should build the capacity of delivering climate services to the agriculture and food security based on the main existing activities, such as, e.g., the FAO Global Information and Early Warning System on food and agriculture (GIEWS), Famine Early Warning Systems Network (FEWS NET) of USAID, etc. The WMO Commission for Agricultural Meteorology reviews the main meteorological information requirements of agricultural, livestock, forestry, and fisheries communities, which contain a useful subset of climate information needs. Because not all of them can be effectively met at present, this helps to shape the corresponding research agenda. To supplement and implement it, the capabilities of and communities associated with the Consultative Group on International Agricultural Research (CGIAR), particularly their climate-related programmes, e.g. the Research Programme on Climate Change, Agriculture and Food Security (CCAFS) should guide identification of additional research priorities for climate services for food security and agriculture. The outcomes of the Earth System Science Partnership project “Global Environmental Change and Food Systems”, which was completed in 2011 (Ingram et al., 2010), and current CCAFS project efforts should be an integral part of such planning. There is a vast network of researchers involved in food and agriculture sector, and significant resources are invested in this research through partnerships that are already in place.

There are many international agencies and organizations coordinating water management, hydrological activities, and associated research. The Earth System Science Partnership Global Water System Project (GWSP) spearheads international research on global sustainability and water. The WCRP Global Energy and Water Experiment (GEWEX) project is the main international research programme focusing on the observations, understanding, modeling and
synthesis of the complex relationship between the Earth’s energy and water cycles. For the success of the GFCS it is essential to identify opportunities for specific and high impact contributions from flagship water research programmes such as the International Hydrological Programme of UNESCO. The United Nations World Water Development Report, released every three years in conjunction with the World Water Forum, provides the most authoritative assessment of the fresh water resource status for the world and related requirements. The WMO Commission for Hydrology and the Hydrology and Water Resources Programme are a valuable source of expertise and could assist in establishing the essential connection between international hydrological research and water related climate information services to be provided to decision makers through GFCS. Three main initiatives in corresponding observations are the World Hydrological Cycle Observing System (WHYCOS), Integrated Global Water Cycle Observations (IGWCO) Community of Practice of the Group on Earth Observations, and several Global Terrestrial Networks: for Hydrology (GTN-H), River Discharge (GTN-R), Lake level/area (GTN-L), Glaciers (GTN-G), and Permafrost (GTN-P).

Significant momentum for the World Health Organization (WHO) strategy and actions to enhance the capacity for assessing and monitoring health vulnerability, risks, and impacts due to climate variability and change was given by the 2008 World Heath Assembly, which identified the need to address significant gaps in knowledge and corresponding research on climate and health. Through the UIP needs for health and climate research can be mainstreamed and required research directions initiated and strengthened. WHO is requested to support more applied research on the linkages between climate and policies addressing climate change and health outcomes (D. Campbell-Lendrum et al., 2009). WHO is thus mandated to continue close cooperation with appropriate UN organizations, other agencies and funding bodies, and Member States, to develop capacity to assess the risks from climate change for human health and to implement effective response measures, by promoting further research and pilot projects in this area, including work on five priority areas: interactions of climate change with other health-related determinants and trends; direct and indirect climate impacts on human health; effectiveness of various strategies to contend with climate-related health impacts; health implications of climate mitigation and adaptation strategies; and means to enhance public health systems. In addition to the WHO-led global research agenda (WHO, 2009), other existing climate and health research agendas include the Earth System Science Partnership scientific strategy for Global Environmental Change Human Health (GECHH, 2007), the US-Interagency Report Outlining the Research Needs on the Human Health Effects of Climate Change (Portier et al., 2010), and the Special Programme for Research and Training in Tropical Diseases that has a special agenda for climate change and tropical and neglected diseases.

As indicated in the second biennial (UNISDR, 2011) Global Assessment Report on Disaster Risk Reduction, which is a key resource for understanding and analyzing global disaster risks, the national and regional paths of development are strongly sensitive to climate risks. The Hyogo Framework for Action 2005-2015 defines the strategy for building up the resilience of nations and the communities in accordance with the UN International Strategy for Disaster Reduction. ICSU and the International Social Science Council sponsor the Integrated Research on Disaster Risk Programme (IRDR). Natural disaster risk reduction has been endorsed as a current priority for WMO by the Sixteenth World Meteorological Congress and is addressed by the WMO DRR Programme. WCRP is developing the scientific basis for attributing and predicting climate extremes in near real time for risk management and mitigation purposes. The main customers of climate information on natural disasters are civil protection agencies and industries involved in developing projects with environmental risks and those offering insurance and re-insurance against such risks. Various communication and experience/practice sharing platforms are emerging in the disaster risk management areas, for example CAPRA (http://www.ecapra.org) and “Understanding Risk (http://www.understandingrisk.org).
Under the leadership of the programmes and agencies indicated above it will be possible to develop a RMP agenda of applied research in initial GFCS priority areas. To enable practical applications of climate information, such applied research should rely on availability of supporting climate information. At present, there are two major pathways of getting access to climate information including predictions. Firstly, under the WMO World Weather Watch, the Global Data-processing and Forecasting Systems (GDPFS) generates and makes available to Members a variety of real time and non-real time climate information products. They include climate-related global and regional diagnostics, such i.e. 10-day or 30-day means, summaries, anomalies, etc. Global Producing Centres (GPC) of long-range forecasts generate predictions for ranges between one month and up to two years. Some climate information products are available from other sources, including the WCP Climate Information and Prediction Services (CLIPS) project, which is being transitioned into GFCS. This work includes development of the concepts for National Climate Centres (NCC) and National Climate Services (NCS) and the establishment of Regional Climate Centres (RCC) around the world, along with standardized processes for the generation and dissemination of RCC products. The CSIS will facilitate coordinated access to such quasi-operational climate information. Secondly, WCRP and partners also produce experimental climate products through their global and regional prediction and projection activities such as the Coupled Model Intercomparison Project-5 (CMIP5), Coordinated Regional Downscaling Experiment (CORDEX), Climate System Historical Forecast Project (CHFP), and Climate Chemistry Model Validation-2 (CCMVal-2). At the time scale of numerical weather prediction (NWP), THORPEX, a World Weather Research Programme experiment, has enabled reliable access to the THORPEX Interactive Grand Global Ensemble (TIGGE) of 1-day to 2-week high-impact weather forecasts. TIGGE has become a hallmark in research on ensemble forecasting and predictability. The Common Metadata for Climate Modelling Digital Repositories (METAFOR) initiated the development of a Common Information Model standard for data and model outputs. Similar efforts are being extended to the analysis and re-analyses of historical and modern observational records by the major centres around the world. Specific attention is being paid to the issues of availability and ease of access to data through existing information networks. For example, the Earth Systems Grid promotes open and distributed access to data and information that benefits from a set of common standards, formats, and consistent description of the methodologies used to generate the data and includes error characteristics of the available information.

The two major sources of climate information, coordinated by the World Weather Watch, and WCP, on one side, and by various research programmes, on the other side, operate largely independently. Exchange of experience by communities involved in them, comparing operational and experimental products, further developing them in partnership with users, and interpreting them from the perspective of practical applications could bring a step-change in the usefulness of the climate information products and speed up their further development.

The emerging Future Earth Initiative under ICSU, which will likely substitute the Earth System Science Partnership and include several currently existing research programmes, should become a key WCRP partner in contributing to the GFCS development. Regional panels and subprojects of the core WCRP projects, such as CLIVAR, GEWEX, SPARC, and CliC, will be able to offer their expertise for addressing regional issues of importance for various domains of applications.

The development of capacity in research on climate and in climate-related applications should build on already existing strong links with and commitments by professional capacity building organizations such as START, IAI, APN, and many other aid organizations in the domain of climate change and adaptation to it, such as the Climate Change Adaptation and Development Initiative (CCDARE) of UNDP and UNEP.
2.3 Criteria for identification of projects/activities at global, regional and national levels

GFCS development will be based on continuation, strengthening, and some refocusing of existing relevant research activities, and, importantly, on a series of dedicated new research and development projects specifically addressing the main science requirements of GFCS. GFCS activities should adhere to the eight fundamental GFCS governance Principles. The approach to identifying the corresponding research activities to be continued or initiated under the umbrella of GFCS is to review decision makers’ main requirements in these areas, consolidate and translate them into guidance on the needs for essential research products supporting these requirements, seek opportunities to enable generation and provision of such products or to improve the existing products through research, and define implementation activities with active and early user engagement. This process requires involvement not only of scientists, but also users and climate information service providers. On the top level of the RMP pillar a similar approach has already been used in preparing this Annex. The RMP activities proposed in this Annex should be capable to

- Build partnerships of scientific research communities and application development communities/users or engage potential stakeholders into the RMP implementation;
- Come up with important required outcomes during the initial stage of GFCS implementation; or
- Create a solid basis for GFCS development on middle- and longer-terms.

For sector-specific and regional activities, the necessary development projects and programmes and demonstration projects still need to be identified. The main criterion for proposing any RMP activity will therefore be very its role and value for implementation of the RMP objectives and for addressing identified research needs of the pillar.

A very significant fraction of such scientific activities will be resourced by research funding agencies, which are independent of main GFCS stakeholders. Promoting the identified GFCS needs to the research funders and active two-way communication with them are therefore vital tasks in initiating research of high relevance for GFCS. Criteria of project selection that are in force in the agencies will apply for identifying successful proposals and teams. Allowing timely (fast) and open access to appropriate data, which is important for experimental product generation and delivery, would be a very important criterion that funding agencies should be requested to use enforce wherever feasible. Other important selection criteria would be:

- Anticipated value and impact of the successful proposal in addressing RMP needs at corresponding level;
- Likelihood of achieving the proposed objectives; and
- Cost effectiveness.

An example of such funding possibilities is the "Seasonal-to-decadal climate predictions towards climate services" call opened by the Seventh Framework Programme of the European Commission. The activities will contribute to the development of European climate services based on seasonal-to-decadal forecast systems. Many similar research projects can be considered as affiliated with or contributing to the GFCS implementation.

2.4 Implementation activities (including resource requirements and communication strategies) at global, regional, and national levels
The major foci for research activities under the RMP pillar will be developing new or improving existing climate products based on sound science and close interaction with the user community; creating a platform, opportunities and incentives for scientific groups to make a step from just investigating scientific problems to creating pilot products, technologies, methods and models for identified/envisioned climate services, making these products available and tested in the domain of climate services, experimentally and routinely; and the development of applied research in climate-dependent sectors of human activities that creates possibilities for effective use of climate information in services. The work on the buildup of the GFCS RMP pillar will have several stages that correspond to overall phases of GFCS development. At the initial phase, considerable efforts should be dedicated not only to the research and development activities per se but also to more detailed planning for the next phases, establishing links and partnerships with potential partners, working towards their commitments to cooperate and commit an effort to the GFCS development.

Thus, major types of efforts that will be undertaken under the RMP pillar, fall in three categories, as follows:

- Detailed planning of activities, building relevant partnerships, working towards commitment to support the identified research activities, and creating linkages that facilitate broader access to research outcomes and target the research towards delivering to GFCS;
- Creating and improving practical applications in the GFCS priority areas; and
- Developing and improving climate information products of major significance for climate services in multiple sectors.

2.4.1 Detailed RMP planning, building partnerships, linkages and commitments

Although a great deal of relevant research information and some capacity exists in priority domains of GFCS implementation, it is highly dispersed across disciplines, individuals and institutions. GFCS-relevant research strategies are developed sufficiently well only in the core climate science sector that is supposed to generate climate information suitable for use in multiple practical applications and in the health and climate sector. Commitments of leading organizations and programmes to support the GFCS research activities have been secured in these two research domains. However, even for these domains, it is necessary to elaborate the scope of RMP activities in more detail and establish planning, monitoring, and coordination mechanisms. For other sectors and for the RMP as a whole, significant planning, consolidation and mobilization activities are therefore required.

2.4.2 Planning of RMP research activities in GFCS near-term priority areas

The most needed GFCS activities in the human health and climate arena include building national capacity of both climate and health partners to conduct local research and development of climate data products for the sector. These two streams of research should be coordinated, better developed together, strengthen each other, e.g. through a forum to accelerate the application research to operations, and support in the translation of climate science to operations through a number of tasks such as, for example, developing standard research terminology to be used by collaborating climate and health sectors. The GFCS should also enable climate service providers, such as NMHSs, to be key partners in health research forums and partnerships and better support climate and health research that builds evidence for health-policy making. These developments should start with simple measures aimed at improved communication and support for how to interpret climate information and its uncertainty. Further developments should include establishment of verification and quality assurance standards and mechanisms and evaluation on the effectiveness of climate services in the sector.
A virtual forum on climate and health could help to bring together the existing body of relevant research methods, tools, data sets and research results, to periodically review the state-of-the-art and major gaps in responding to the requests of decision-makers, and highlight opportunities for research funding and training opportunities. It would also facilitate collaboration between researchers working in this field, including between developing and developed country researchers.

The activities in the climate and health research should have a broad agenda with clearly identified goals, systematic analysis of capacity and approaches to develop it, and involve a set of specific case studies on the benefits of the health sector working with climate services. Engagement of social sciences can help monitoring of readiness, perceptions, and utility of end-users in this area of activity. Dialogue with resource managers and economists may provide a useful cost-benefit analysis of activities and required evidence of efficiency for policy making. The resultant GFCS climate and health research strategy will also set targets and priorities to support research at regional and national levels.

For the water, food and agriculture, and disaster reduction sectors, the motivation for establishing planning and coordination of research activities is similar to the ones of the health sector but these sectors involve a large number of still loosely associated activities and initiatives and the volume of necessary preparatory work that needs to be conducted in them is even greater than in the health and climate sector.

**Activities**

Initiative groups will be formed to identify stakeholders and partners of the GFCS-relevant research, scope and plan the activities in more detail, seek commitments, establish management and monitoring mechanisms, and search for resources. Research funding and other relevant agencies will be briefed on the requirements and plans of the RMP pillar and will be involved in planning of corresponding activities. Implementation strategies and more detailed research plans will be firstly developed for the four initial priority sectors of GFCS and, at the later stage, for other sectors. Their promotion and discussion mechanisms such as dedicated virtual forums will be put in place. These activities should start at the earliest phase of the GFCS implementation.

**2.4.2.1 Bridging climate research and services and building communication and cooperation between involved communities**

The main objective of this part of the RMP pillar will be to make sure that both research communities and practitioners in climate services, who translate science achievements into information products, would add value to their work by cooperating, communicating and exchanging products and information. Technological limitations and considerations sometimes prevent producers of operational climate products from using the latest scientific achievements in their data processing and prediction techniques. On the other side, some research groups may have difficulties in targeting their products towards use in climate services and verification, or may experience problems in receiving sufficient feedback on their products. Creating a platform that would offer user access to experimental research products would be highly mutually beneficial for the users and product originators. For the latter it would create a demand and stimulate product development, sophistication, user-tailoring, and quality improvement. In the result one can anticipate an accelerated implementation of research advances into climate service provision. Opening the experimental climate products to the community of users will stimulate communication towards making the products more valuable.
One area that has a very significant potential for establishing bridges between climate science groups and the variety of users of climate information is regional climate prediction, projection, and downscaling. Because climate anomalies prominently manifest themselves on the regional scale, the availability to users of regionally downscaled climate information including experimental predictions and projections should be enhanced as a matter of urgency, along with proper documentation of the data and methods used, known uncertainties in them, and other relevant guidance on these data quality and/or their known limitations. Making such predictions or projections accessible to regional communities will create a foundation for verifying them and better calibrating the models. Accelerated provision of such science-based information should also be an integral part of GFCS institutional and human capacity development and may be highly instrumental in enabling assessment of climate change impacts and corresponding decision support, including for adaptation to climate change. Making experimental climate information systematically available to users requires a novel commitment of research groups and modelling centres to provide their contributions in a regular manner to GFCS CSIS and participate in product-related communications through UIP and CSIS.

Establishing the first elements of systematic science product delivery to climate services in the early stages of GFCS will provide the service-focused imperatives for observations, modelling and prediction. For example, routine production of predictions with longer ranges and lead times will require more reliable ocean and land-surface observations. Increasing number of available diagnostic and prognostic climate products will lead to the need to assess their comparative usefulness for practical applications. This will create conditions for more versatile and comprehensive verification of climate products. In turn, this will help to identify existing gaps and deficiencies in various components of the climate service system. Incentives for closing the gaps and improving the system will become stronger and would justify allocation of resources for system improvement. The emerging market of climate products for industries and communities and existence of platforms for tailoring existing products towards more specific user needs will help to speed up turning research advances into more operational products and services.

Activity

An activity is proposed to develop arrangements for making experimental climate information available to registered users through CSIS and involve various research groups, active both in the core climate science and in the other GFCS priority sectors, in UIP. An approach to making the climate information accessible may be a portal that directs the user to operational or quasi-operational information in the WMO GDPFS and experimental climate information produced by WCRP-affiliated projects like CMIP, CORDEX, and CHFP. Recommendations on optimal repeat cycles and lead times for experimental prognostic runs of climate models for different time scales should be prepared based on the actual or anticipated prediction skill, technical capabilities, and other relevant considerations.

2.4.3 Research in GFCS sectors

There is an urgent and largely unmet need for actionable science-based climate information for planning adaptation to climate change and climate-related risk management, and for supporting various aspects of sustainable development, including mitigation of climate change. To address this need, one of the key objectives of the GFCS research component will be to accelerate the development of science-based climate information that enables practical applications in the four near-term GFCS priority areas called for in the HLT report. The four GFCS priority areas in the near-term are agriculture and food security, water resource management, disaster risk reduction, and human health. The requirements for actionable climate information in support of these sectors determine priorities for the RMP initial efforts.
Research in support of climate services in the main socio-economic sectors will be conducted in accordance with dedicated and detailed plans introduced in the previous section of this Annex. To enable applied research in the four areas of the GFCS near-term priorities, arrangements will be sought for sustained and effective communication between providers of climate information and representatives of services and experts developing and using resulting information for specific applications and providing services to the targeted sectors. Involvement of scientists representing “core” climate knowledge in the above dialog will help to inform its participants about the latest developments in climate science and existing opportunities to develop certain products – or about possible limitations of their use – where science or technology is not yet ready to deliver. One way of achieving this will be effective liaison of the WCRP Working Group on Regional Climate with the GFCS UIP working bodies. Direct liaison of scientists affiliated with the RMP pillar and the users of climate information is recommended also on the regional, national and local levels.

2.4.3.1 GCFS research on health and climate

The health and climate sector has already developed a coherent programme of initial research activities. It is based on the analysis of the environmental determinants of human health and measures to address the associated problems.

Environmental determinants of human health include direct effects of climate conditions on health through, e.g. thermal stress (both due to heat and cold conditions), exposure to UV radiation, etc., and a number of other factors. Nutrition, water availability, natural disasters strongly affect the health sector, for example through:

- Reduced healthcare and drug access due to destruction of health infrastructure in floods and storms, reduced household income due to of impacts of extreme events and livelihood stress, migration and displacement following extreme events as well as reduced long term habitability, depletion of pharmaceuticals stock during extreme events, reduced availability of appropriate health staff for preventative health care because of the reallocation to health crisis response;
- Weakening of the support networks following economic and agricultural livelihood losses;
- Increases in health risks due to loss of shelter and livelihoods following extreme events; and
- Risk of increased mental health concerns via experience of extreme events, family and livelihood loss.

Adequate measures to address these issues should be initiated through the appropriate sector activities. Indirect environmental factors affecting health that are additional to existing in the food, water and disaster risk domains include:

- Temperature effects on food-borne diseases;
- Temperature, rainfall, humidity, dust effects on vector borne diseases (malaria, dengue, leishmaniasis, filariasis, schistosomiasis, trypanosomiasis, rift valley fever, kaftan, chickungunya, plague, etc.);
- Temperature, humidity, wind and dust effects on disease transmission (i.e. meningitis);
- Temperature and rainfall effects on air pollution and aeroallergen levels;
- Risk of eye infections and respiratory diseases related to high atmospheric aerosol/dust concentrations;
- Temperature and precipitation effects on water-borne diseases;
- Effect of floods and droughts on food and waterborne diseases (e.g. leptospirosis);
• Risk of dermatological and eye infections (via reduced hygiene practices) related to water scarcity/reduced access;
• Water quality impacts due to increased fertilization;
• Risk of micronutrient deficiencies via loss in dietary diversity;
• Risk of malnutrition via drought and flooding, and effects of pests, diseases, biodiversity loss, and economic disruption;
• Risk of protein malnutrition via loss of livestock and availability of marine/riverine protein sources;
• Risk of diarrhea and respiratory infections (via reduced hygiene practices) related to water scarcity/reduced access;
• Emergence or spread of pathogens via climate change driven biodiversity loss and changes in ecosystem habitats (changing expanse of ecological niches);
• Impact of UV radiation on skin cancer; and
• Biodiversity loss reducing availability of traditional medicine species.

Many necessary research tasks to address the above issues require multidisciplinary guidance and oversight (e.g. in reviewing and periodically revising the global research agenda, or producing “best-practice” guidance for economic assessments on climate change and health), or to carry out technical projects (such as global assessments of the current and future burden of disease attributable to climate change). In order to ensure coherence, these processes should have access to relevant climate expertise.

Activities

An inventory and assessment of climate information, products, and services currently available to (and used by) the health sector, which can be optimized and improved, will be conducted. Based on this inventory and as well on the analysis of the gaps in current research agendas, an assessment will be made of what is optimally required for climate related risk management and adaptation to climate change in the health sector. In doing this, the positive experience of several initiatives in the climate and health sector that can serve as building blocks for future developments will be used. This includes, for example, the well-known Meningitis Environmental Risk Information Technologies (MERIT) initiative, which has gained valuable experience in setting research strategies based on effective dialog between health researchers, practitioners, and their environmental counterparts. Existing practices and arrangements such as the Malaria Outlook Forum (MALOF) will also be used and strengthened as much as possible. The national level Health Early Warning Systems (EWS) and climate-sensitivity models will be evaluated to identify best and standard practices, cost-effectiveness and recommended evaluation criteria. A systematic analysis will be conducted of current health actor capacity/readiness to make climate informed decisions and inventory of common approaches used, including case studies on benefits of health and climate service collaboration. Research will also be conducted to evaluate the cost-effectiveness and cost-benefit of climate informed health operations. Most of these activities will contribute to the development of the strategic implementation plan of research on climate services for the human health, and they will start at the initial stage of the GFCS implementation.

2.4.3.2 GCFS Research on food security and agriculture

The food dimension of life support is extremely complex and diverse. Agriculture requires data on processes and phenomena affecting plant growth (zone and season), health, and processes that affect them, such as erosion, soil and water quality, pests, conditions of harvest collection and storage, and ultimately processing and dissemination of food products that affect human health and security. Livestock is highly dependent on grazing conditions. Forestry is most
vulnerable to fires and pests. Fisheries and aquaculture critically depend on a range of oceanographic, biogeochemical, and ecological conditions in the coastal zone, and, as an example, they may be interested in knowing how coastal upwelling systems will be affected by the climate change. All sectors of food production and distribution are vulnerable to storms and have well defined real-time weather prediction requirements. In terms of climate information, very significant value resides in combined long-term predictions of temperature and precipitation anomalies, and particularly of their extremes. Corresponding requirements for climate information differ for regions, sub-regions, and nations.

Activities

At the initial phase of the GFCS implementation a detailed research agenda will be developed to guide global and national efforts in agricultural and food security research. Research activities will be aimed at improving the understanding of the impacts of climate on agriculture and food systems, developing capacity to assess the risks from climate change for agriculture and to implement effective response measures, promoting research in sustainable agriculture and a secure food supply in a changing climate, formulating climate information requirements to support climate and agriculture research in favour of agriculture-policy making, planning and operations, and building the economic and political case for the application of climate services to protect agriculture from climate related risks.

2.4.3 GCFS research on water resources and their management

The water sector is a nexus of challenges and opportunities associated with livelihood of people, ecosystems and economic development. It is affected strongly by climate variability and change on one hand, and influences the evolution of Earth’s climate on the other hand. Water is essential for food, energy, transport, and many other aspects of life support. The needs for water resources related information and services vary with regions and are different for short- and longer-time scales, from days to seasons and decades. However, there are mainly three types of data/information that can benefit significantly every water-related application: (1) levels and capacity of fresh water reservoirs; (2) water availability and access; and (3) risks associated with quantity and quality of fresh water. They depend on environmental factors such as precipitation, snow/ice melt, evaporation, etc., and on human factors such as water withdrawals, consumption, and reuse. Water availability anomalies including droughts and floods depend on dominant modes of atmospheric and oceanic circulation, land-surface and soil moisture conditions and their seasonal and longer-term variability. Seasonal prediction of these anomalies on a regional scale, particularly prediction of anomalies associated with monsoon systems, still presents a bold challenge to climate, weather and hydrological sciences.

Activities

A strategy for coordination and integration of meteorological and hydrological research, including coupling climate-hydrological models for weather and climate prediction that is essential to the success of GFCS in this sector, will be developed. Because the improvement of the quality of observations and models for predicting the onset, distribution and quantity of precipitation depends on the progress in our ability to represent in models all components of the hydrological cycle and related atmospheric and land surface processes, research will engage in the development of a new generation of nested high-resolution hydrological models with inclusion of aspects of water quality and biogeochemistry, and human intervention, along with data assimilation systems and reanalysis capabilities. Another focus of the research will be measurement and modelling of clouds and precipitation at a spectrum of time- and space-scales. Climate science will work on enabling assessments of climate change impacts on all
elements of the hydrological cycle, on global and regional level, including its extremes, involving floods and droughts. As in the case of the food security and agriculture sector, a detailed research agenda will be developed at the initial phase of the GFCS implementation to guide global and national efforts in the hydrological and water resource research. Partnership with the “Future Earth” initiative in this research area will be especially instrumental.

2.4.3.4 GCFS research on climate services for disaster risk reduction

The need for climate services arises to a large extent because of the societal risks related to extreme hydrometeorological events. Poverty, underdevelopment, lack of resources and inadequate infrastructure, as well as long- and short-term decision-making failures turn exposure to hazards into vulnerability. The risk is growing partly because the societal infrastructure is becoming more exposed to weather related risks as the global economy expands and population grows, and partly because of the climate change. Provision of information and warnings for high impact weather, air quality–related and health-hazards are high priority objectives for the emerging multi-hazard early warning systems. The climate dimension of disaster risk reduction has two major sets of requirements. The first one is understanding (i.e. knowledge development) of the causes and enabling prediction of individual extreme climate events, such as long-term anomalies of temperature and precipitation, leading to droughts, floods, and storminess, especially with respect to tropical cyclones (typhoons, hurricanes) and extratropical storms. The second set of requirements is associated with information support for decision making, i.e. use of available knowledge, for example, of the climate defined as weather statistics. The probability distribution of weather events in a changing climate is non-stationary implying that the return periods of extreme events related to floods, avalanches, mud slides, drought, heat waves, wind exposure damage, weather related diseases, etc. are undergoing significant changes in many regions of the world. Due to the non-stationary character of current climate records, past climate information may be no longer representative for the future. The geographical distribution of environmental risks is uneven and there are areas of particularly high exposure to hazards, for example, low-lying deltas, and areas impacted by tropical cyclones and floods. It is essential therefore to ensure that climate information requirements for decision-making purposes are identified in an interactive manner between the research community and users.

Activities

In the area of disaster risk reduction, the climate science community will engage interested industries into a wide discussion on climate variability and change aspects of hazard risk estimation and safety reinforcement in sectors with identified vulnerability. Industry-specific engineering design criteria related to activities safety and insurability sectors will be reviewed. New civil engineering standards will be proposed that take into account climate predictions and their inherent uncertainties. Internationally accepted guidance on climate information for construction and operation safety codes and related basis for insurance coverage will be a very important outcome of this initiative. The expertise of insurance and reinsurance industry will be invited and used to promote the timely adoption and implementation of new practices. This may include development of financial risk transfer products for climate risks (such as weather index insurance) for agriculture, water resource management, and natural disaster risk reduction sectors. In addition, availability of environmental information useful for identifying hazards induced by climate variability and change and preparation of related advisories and warnings should be reinforced in this process. The use of climate predictions in the disaster risk assessment practices and in support of safety precautions will be promoted.
2.4.3.5 GCFS research in other sectors

Climate information products enabled during the initial stage of GFCS development to meet the needs of initial priority areas will be also instrumental for provision of climate information services in other key areas, for example, the energy sector, protection of ecosystems and the environment, ocean and coastal zone management, transport and tourism, life support and environmental protection in megacities, international environmental policy, etc. The list of future applications of climate service that is given below is by no means comprehensive and only illustrates the multiple sectors of application of climate knowledge awaiting that are in need of adequate information support.

Energy sector

The primary environmental, economic, and governance concerns in the sector of energy generation, supply, transmission, and consumption are similar to the ones in the agriculture and water sectors, which is reflected in an increasingly popular term “water-energy-agriculture nexus”. Intensive applied research in this sector is underway and it is highly dependent on contribution of the climate science. Research is also developing on alternative sources of energy and its transmission, which requires new types of data, e.g. on the wind regime, duration of sunshine, frequency of snow storms, icing, etc. Energy production and transport are at present strongly dependent on fossil fuel sources and are expanding strongly in developing countries.

Activities

Research activities will be aimed at provision of data on the emissions from energy sources and the impact of these industries on global climate. Research to support the development of growth of and reliance on the renewable energy (e.g. solar, wind, bio-energy, etc.) production, globally and in the regions, will be promoted.

Transport

Greenhouse gas emissions from transport are an essential contributor to the climate warming and a source of air and water pollution. Requirements for climate information and services for transport depend very strongly on the sector and are normally aimed at efficiency and safety. For example, changing ocean routes and the need to ensure optimal ice-bearing capacity of ships or their storm-worthiness are typical information requirements related to marine transport. For ports and harbours there is a well-defined set of climate information requirements. The main safety concern for terrestrial pipelines in cold regions is the carrying capacity of permafrost-affected soils. Aviation and airport operations also have well established requirements, especially for local climate information.

Activities

A large body of applied research will have to be stimulated in the transport sector to ensure the safety and increase economic efficiency of operations. Climate aspects of the research agendas of expert communities working in the transport industry should be enhanced and liaisons established to ensure that latest achievements in climate research are picked up in the development of practical applications.
**Other major sectors of environmental management including tourism, megacities, coastal zone management, etc.**

Environmental management is a fast and extremely important developing area of activity. It requires support by “traditional” climate data products with constantly increasing volume of ecological and biogeochemical climate-dependent information. The main scientific development needed in this area is accurate coverage by observations and representation in predictive models of interactions between climate variability and climate change, air and water quality, land cover and land use changes, vegetation, and all other aspects of terrestrial ecosystems, atmosphere and ocean biogeochemistry. There is very significant regional specificity of the required information. Just as an example, climate aspects of dust storms changed frequency and intensity are important for North Africa, Middle East, and West Asia. Climate change and its impact on aerosols and air quality is a very significant concern in other part of the world, especially South-East Asia. Such list of examples can be continued.

Requirements for climate information for tourism are very diverse and require a systematic study. There are significant distinctions between information requirements of terrestrial tourism, e.g. for alpine resorts, which are sensitive to availability of snow and vulnerable to mountain hazards such as avalanches, and marine resorts sensitive to sea level, storms, and changes in sunshine, to name just a few essential factors. Ecological and aesthetical aspects of the environment and its protection are of primary significance with a greater emphasis on ecosystem services and valuation of natural resources as a national wealth index. An essential aspect of climate services for tourism is its environmental impact, which should be minimized if it is negative.

Urbanization is one of the key features of the modern society. It has huge implications for all aspects of human life and largest environmental footprint. Their climate aspects need to be investigated. Continuing urbanization and migration of population to coastal zone create an urgent demand for specialized environmental services, such as sea-level predictions, predictions of the storm threats, especially from tropical cyclones and the associated extreme winds, precipitation, and storm surges. Salt water intrusion in coastal aquifers is a significant issue and exhibits dependence on the sea level.

**Activities**

Research will be conducted on adequate representation of aerosols and ozone in climate models and further improvement of modelling of the biogeochemical and hydrological cycles. Methods to estimate essential chemical components of water such as carbon, (reactive) nitrogen, phosphorus, sediments, and other constituencies will be developed. Efforts will be made to establish or strengthen a climate–oriented research agenda in support of tourism, urban development and management, and integrated coastal zone management. Involvement of the “Future Earth” initiative in this research with respect of the coastal zones will be instrumental.

**2.4.4 Research in support of the development and improvement of core climate information products of significance for climate services in multiple sectors**

In preparing this Annex, core climate information requirements were identified for each of the four priority areas of near-term GFCS development. Several of them were common. Consolidating these requirements results in a list of more universally required information products, the availability of which would enable many climate-reliant practical applications. Developing, improving, and evaluating these core information products in partnership with the community of users can help to shape the agenda of climate research.
The consolidated list of universally required climate information products includes:

- Reliable and comprehensive information on past and current climate conditions including, inter alia, series and statistical distributions of relevant hydrometeorological and oceanographic variables, such as temperature, precipitation, wind, visibility, wind waves, storm surges, with special attention to the long-term evolution of their long-return period values (“extremes”);

- Prognostic information:
  - Evolution of regional and sub-regional air temperature, precipitation, wind, water balance components, state of the land surface on the time scales from sub-seasonal to seasonal and up to one or two years;
  - Predictions of individual extreme events with anomalies of temperature and precipitation including droughts, floods, heat waves, cold spells, monsoon onset and phases, with lead times and ranges beyond the ones of the numerical weather prediction;
  - Further improved prediction of El Niño and La Niña and other dominant modes of climate variability;
  - Tropical cyclone (typhoon, hurricane) and tornadoes seasonal predictions and assessments of potential future changes in their frequency, intensity, and paths;
  - Long-term predictions of climate change short- and long-term forcers, air pollution, atmospheric chemicals, and UV radiation anomalies;
  - Water balance for lakes, reservoirs, and river basins including its cryospheric components; water reserves and availability for various uses; lake and reservoir levels; groundwater;
  - Oceanographic predictions including sea-ice prediction in polar regions and marginal seas;
  - Global and regional sea level variability and change, including extremes and their statistics; and
  - Variables describing the coastal zone state: inundation risks, impact of climate change on the coastal environment, etc.

High impact anomalies of regional climate often manifest themselves on sub-seasonal, seasonal, interannual, and decadal time scales. Despite the ongoing research, at present it is not sufficiently clear whether if it is possible to develop practically useful predictions at all these timescales and for all regions of the world or how to extract useful information from ensemble products, in which each element may have very limited skill. However, the research to address these requirements for practical utilization under the GFCS is required. Research activities to generate the above information products broadly fall into three categories, as follows:

- Research on climate predictability and improving skill of prognostic information;
- Research on observations, their processing and climate record generation; and
- Research on adding value to climate information for its use in services.

Motivations for and planned activities in these categories are presented below.
2.4.4.1 Research on climate predictability and improving prognostic skill: sub-seasonal to seasonal time scales

Research on improving predictive skill at the traditional interface between weather and climate is a high priority not only for meteorological services but also for GFCS and is best approached by effective cooperation between the weather and climate research communities. Predictions covering the timescale from weeks to a season are essential to support various socio-economic decisions and risk management strategies related to almost all GFCS sectors. Factors and processes determining potential predictability at these time scales need to be actively studied so that they can be captured in observations and represented in models. Such factors include Madden-Julian Oscillations, stratospheric processes with longer time scale than tropospheric processes, sudden stratospheric warming and cooling events, solar radiation effects, slowly varying initial conditions at the surface such as SST, sea-ice, snow height and cover, soil moisture anomalies, and, possibly, vegetation. Predictability of climate at sub-seasonal time scales is driven by a complex interaction between atmospheric predictability on weather timescales and the state and phase of dominant modes of the atmospheric and ocean largerscale variability, such as North Atlantic Oscillation, Southern Annular Mode, Indian Ocean Dipole, El Niño and La Niña. A focus of research on modes of organized convection and the interactions between tropical and extra-tropical latitudes, as part of the Year Of Tropical Convection (YOTC) project, has recently shown promising results and may help to identify additional predictability factors for mid-latitude regions. Unprecedented changes in the Polar Regions, especially the Arctic, which is undergoing fast socio-economic transformations and accelerated warming, require attention and special approach.

Predictions on sub-seasonal to seasonal timescales are strongly dependent on the availability of accurate initial conditions for all components of the Earth System, including those that have a longer memory than the atmosphere. Hence progress in prediction on the sub-seasonal and seasonal time scales can be expected due to more comprehensive observations, which will not only serve as the main means of initializing climate models but also are the foundation for better understanding and improved representation in models of the key phenomena and processes. It has also been concluded in the WCRP experiments on seasonal climate predictions that, even on this relatively short climate scale, it is important to ensure that models used for seasonal prediction have adequate long-term climate forcing (in the case of seasonal predictions - prescribed atmospheric composition).

Activities

Several RMP activities will address predictability and predictive skill on the sub-seasonal to seasonal time scale.

In the near-term perspective, the initial focus will be on improving predictions on the sub-seasonal time scale. This will be pursued by the weather and climate modelling communities through the joint WWRP – WCRP sub-seasonal to seasonal (S2S) initiative, to be developed in cooperation with the WMO system for long-range forecasts and building on the experience of the THORPEX Interactive Grand Global Ensemble (TIGGE) database for medium range forecasts (up to 15 days) and the Climate-system Historical Forecast Project (CHFP) for seasonal forecasts. Research on and modelling of multi-scale convection processes, ocean – atmosphere and ocean – atmosphere interactions, dominant tropical modes of atmospheric variability and assessment of the research needs to identify and capture predictability of monsoon phases will be included. Procedures for specification of initial conditions for sub-seasonal predictions will be reviewed. The project is envisaged to have a 5-year lifespan with the intention to demonstrate the initial benefits within the next two years. Polar prediction at weather and climate interface will
be pursued by the WWRP as a contribution to the Global Integrated Polar Prediction System (GIPPS). Existing professional working groups, such as the Societal and Economic Research Applications (SERA) Working Group of WWRP, are planning to analyze socio-economic benefits of this research and make recommendations to maximize it. Further recommendations will be made on using the research outcomes in practically important application areas, for example, in studying seasonal predictability of tropical cyclone activity.

The strategy to improve the skill of multi-time-scale numerical prediction system is associated with using ensembles of “coupled” models (atmosphere, ocean, land surface and cryosphere), implicit inclusion (parameterization) and explicit resolution of all significant processes determining interactions between various components of the climate system, and creating a so-called seamless suite of forecasts that optimizes longer range products based on information already available for shorter time scales. This may require a range of models tailored to specific prediction and projection needs with optimal sharing of model code and infrastructure in a manner that allows and promotes flexible configuration of the modelling system for the problem of interest. In addition to optimizing the model runs, significant benefit with this approach may reside in the exhaustive use of information available for all time scales, in preparation of a forecast. Dedicated research efforts will be made to start implementing at least initial elements of such a comprehensive prediction approach and assessing their cost benefit ratios in terms of improving prediction skill versus resource requirement and development complexity. Coordination of climate model development will continue through intercomparisons, process-based model evaluation, and development of guidance on the use of (multi-model) ensemble prediction schemes. The current skill of modelling and prediction of precipitation and its anomalies will be assessed.

Teleconnections and interactions between tropical and extratropical latitudes and between the troposphere and stratosphere will be investigated, including the means of representation of their predictable elements in models. Seasonal predictability of polar and subpolar regions also will also be investigated, especially with respect of the rapid changes taking place in these regions and the emerging needs for services. Similarly, the ability of predictive models to adequately simulate fluxes of energy, mass, and momentum between the atmosphere and underlying ocean or land surface will be systematically reviewed, which is a prerequisite for exploiting predictability associated with long-term climate variability and the interaction of the atmosphere with the underlying upper layer of the ocean, the ocean thermocline, and the upper layer of soil.

The research under RMP will target the improvement of both deterministic and statistical predictions of significant events and corresponding variables such as heat waves, cold spells, monsoon phases, precipitation and air temperature anomalies, tropical cyclone season characteristics, sea-ice conditions, etc.

2.4.4.2 Research on climate predictability and improving prognostic skill: decadal to centennial time scales

Decadal - centennial time scale is extremely important for adaptation to climate change and variability. Yet it is the scale where feasibility and reliability of climate predictions and projections is very difficult to estimate. Massive efforts are therefore required from the climate research community to address the corresponding scientific and technological challenges in support of major governance decisions at global, regional, national, and local levels.

The quality of the future climate projections on decadal – centennial time scale is dependent on the quality of long-term data for radiative forcing, which is influenced by concentration of greenhouse gases in the atmosphere, including carbon dioxide, methane, ozone, nitrous oxide,
halocarbons, reactive nitrogen, particulate matter including black carbon and mineral dust, as well as accuracy of treatment in models of feedback processes related to clouds and atmospheric water vapour and land surface processes. The evolution of the concentration and distribution of radiative forcing agents is therefore a crucial factor in future climate projections. Their specification results from the assumptions with respect to future emissions of anthropogenic greenhouse gases, first of all carbon dioxide, particles, and ozone-depleting substances.

The 17th Conference of Parties of the UNFCCC set up a process that envisions a legal agreement on climate change by 2015. Climate research advances would contribute to this process by providing relevant guidance on mitigation policies including informative metrics, such as cumulative carbon, which is responsible for practically irreversible elevated temperatures for hundreds of years or a millennium, and consideration of short-lived climate forcing agents, reduction of which would result in “trimming the peak” of warming on shorter time scales. For adequate support to adaptation to and mitigation of climate change, better understanding of the past and future climate evolution and forcing factors that determine it, and enabling more comprehensive climate projections and restorations, research and more regular atmospheric chemistry observations should continue to develop. This is the domain of the WMO GAW Programme and of some research projects such as the IGBP International Global Atmospheric Chemistry and the WCRP SPARC project. For enabling corresponding services, more sustained operational delivery of GAW products and support to its infrastructure will be needed.

Very significant risks for coastal zones are associated with uncertainties in assessments of the future sea level, both its global mean and its regional variations. Recent observations indicate a likelihood of accelerated sea-level rise in comparison with estimates made by IPCC in its AR4 in 2007. Significant remaining uncertainties are related to still insufficient knowledge of all mechanisms involved in ice sheet response to a warming climate and big potential range of forcing factors. The progress in sea-level research is very fast but the remaining issues are, nevertheless, challenging. There is also a clear need to translate conclusions of sea-level assessments into effective guidance for coastal zone protection and management.

Activities

For the decadal - centennial time scale, the climate research community will continue to work on experimental decadal predictions and centennial projections of climate change and changes in climate variability. The focus will be on identifying phenomena that offer some degree of predictability, enhancing the observing and data assimilation systems that would capture the predictability signal in forecast initial conditions, developing prediction systems able to realistically represent processes associated with all forms of climate predictability, and process the output of these systems to provide probabilistic forecasts with skill sufficient for planning and decision making purposes. Research on decadal prediction of Atlantic multi-decadal variability and Pacific decadal variability shows more perspective results for the Atlantic sector, which may be instrumental for subsequent prediction of climate variations over Europe, Africa and parts of the Americas. This will be the emphasis of special experimental research efforts. Some coherent changes in the global atmosphere follow major volcanic eruptions. If such an eruption occurs, there may be a need to consider its impact on climate prediction on decadal and climate projection on centennial timescales.

Systematic research will continue on the radiative forcing agents of climate and scenarios of future emissions of anthropogenic greenhouse gases, particles, and ozone-deleting substances. Past and present emissions and fluxes of radiative forcing agents will be validated against observed fluxes and concentrations of these gases. Such validation will be an essential contribution to the development of an integrated global greenhouse gas information system.
Climate reanalysis and projections using model systems that have been compared with observations of greenhouse gases and their fluxes and demonstrated a skill in describing the cycling of radiative forcing agents will be used to provide best possible information for climate change mitigation measures.

A major deliverable of climate research will be its contribution to the forthcoming IPCC AR5. This assessment will include four reports, namely on the Physical Science Basis; Impacts, Adaptation and Vulnerability; Mitigation of Climate Change; and a Synthesis Report. After the publication of AR5, which will start in 2013, the RMP activities under GFCS and some other components of the GFCS Implementation Plan will need to be reviewed and adjusted based on the new findings. Potential directions and themes of future research will include the role of the long- and short-living climate forcers in climate change, changes in frequency of occurrence of extreme events in temperature, precipitation, tropical and extratropical storms in changing climate, variations in tropical cyclone activity on decadal time scale, processes responsible for greenhouse gas exchange with terrestrial ecosystems, interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity using a range of scientific approaches including a hierarchy of models, etc.

A comprehensive programme of research on all factors contributing to the sea-level mean and regional change, with a view of significantly reducing the remaining uncertainties and developing informative recommendations for coastal zone management, will be developed. It will rely on related activities in other sectors and the outcomes of the IPCC AR5. Among the many specific future products, WCRP with partners, such as the Global Cryosphere Watch (GCW), will aim to produce an assessment of the state of the cryosphere in the 21st century with estimates of cryospheric contributions to future water resources and an assessment of regional variations in sea-level rise with guidance on expected sea-level extremes.

2.4.4.3 Most difficult issues of predictive climate science

There are several very difficult problems in climate science, for which the progress in developing skilful predicting techniques has been considerably slower than is desirable. They include prediction of monsoon phases and associated precipitation, blocking events, attribution of trends and variations in tropical cyclone activity, and, to some extent, reduction of some systematic errors in climate models. Achievement of progress in these areas of climate research cannot be timed precisely or even guaranteed. Further advances in computing power will enable coordinated development of climate models of increased sophistication and related experimentation with focus on model dynamics, boundary layer processes, clouds, convection, precipitation (including the use of “superparameterization” for more explicit treatment of some sub-grid scale processes), gravity waves, aerosols, land surface processes, and their interactions across scales. Any its positive outcome in addressing these “stubborn” problems of climate science will be communicated for implementation in more operational services and decision making purposes.

2.4.4.4 Treatment of uncertainty and improving decision-making in climate related risks

The range of potential skilful deterministic prediction of weather and its elements is assumed to be up to two weeks due to inherent non-linearity of the system. Prediction of climate and its anomalies is nevertheless possible, to a certain degree, because it is a prediction of weather statistics, which evolves at longer time scales due to atmosphere interactions with slower components of the climate system, such as the ocean, the role of the annual cycle, natural variations of climate, and forced climate change. The use of multi-model ensembles helps in assessing the climate prediction uncertainty, in particular, by relating it to the spread of
trajectories of individual climate predictions. This approach can be very efficiently used for weather prediction and shorter-term climate predictions, but longer-term climate projections cannot be often validated against observations. Their credibility thus needs to be assessed through multiple lines of evidence, such as the agreement across models and methods, the performance of models in representing observed climates and key processes, understanding of the effects of systematic model biases and understanding of the processes that underlie the projected responses. The complexity of all these approaches results in the large gap that presently exists between users’ needs for actionable and valuable information and the climate services capability to serve those needs.

To be useful for climate information services, climate research has therefore an obligation to provide effective guidance on climate information and prediction uncertainty and enable users to exploit climate information with its inherent uncertainty more easily and more effectively, minimizing possibilities of misinterpretation or misuse of complex climate information. Ultimately, users are primarily interested in the value of using the forecast information, which is distinctly different from its quality or uncertainty. Value pertains to the benefits resulting from the use of climate information and is therefore related to the ability of users to make informed decisions and manage climate risks. Approaches to inform decisions on climate – dependent matters may be specific in the Framework’s priority areas.

Activity

This activity will focus on improving the ability of users to incorporate uncertain climate information into their decision-making processes in order to prepare for and manage climate-related risks. The activity will engage both the users and the providers of climate information in developing techniques to extract useful and actionable information for their decisions and to more effectively exploit the emerging prediction capabilities in climate science. For example, it will review knowledge in this area and develop guidance on characterizing the probability density function for predicted climate conditions and optimizing the climate information, products, and services for users with identified requirements. Complementary ways of estimating the uncertainty for multi-model ensemble runs will be considered. Interdisciplinary case studies will demonstrate how existing climate information can improve decision making for each of the Framework’s priority sectors. A multi-disciplinary research project aimed at improving decision-making processes in climate related risks will be developed for approval by the Framework.

2.4.4.5 Research-based climate observations and dataset development

Most of proposed activities in this area are described in the OBS Annex. Sustaining, developing, and optimizing the climate observing system is an important GFCS requirement. The RMP Annex describes only activities with a strong research component.

In the area of observations, (re-)processing, and (re-)analysis of historical observations, there is an urgent need for the research and development of observing techniques capable to help closing the gaps in observations in the polar and mountainous (i.e. cold climate) regions, enhance the observations in the deep oceans and the upper part of atmosphere, and start to more actively observe the atmosphere, ocean, and land chemical and biological variables. Scientific research can help to make the case for sustainable investments in observations by adding value to products emerging from them. There is also a need to ensure that modern observing systems include observation of variables that are important for initialization, calibration, and validation of predictive climate models. This includes particularly ocean observations, including sea-ice cover. The Global Ocean Data Assimilation Experiment (GODAE) project has developed the foundations of ocean data assimilation for climate change
detection and experimental climate prediction. Ocean observations should now be regularly assimilated in models to produce consistent datasets representing state of the ocean up to a certain significant depth.

As mentioned above, significant advances are required in the understanding of past and current evolution and hence observations of the atmosphere and ocean chemistry, to include spatial and temporal distributions of long-lived greenhouse gases, reactive species, aerosols and corresponding estimates of radiative forcing. For example, many important chemistry-related observations are developed and carried out mainly in the research domain and often in academic institutions. This research concerns the chemical composition and physical properties of aerosol, carbon fluxes between the earth’s surface and the atmosphere, and feedback mechanisms between biogeochemical cycles of nitrogen and carbon. The vitality of the WMO GAW Programme, which to a significant degree is driven by academia and is research oriented, is instrumental for the global exploration and mapping of greenhouse gases and aerosols in the radiative forcing context. Systematic and resourceful translation of such observations, made in research mode, into a more operational mode, is required.

Activities

Research will continue on satellite climate observations including their algorithms and calibration (Trenberth et al., 2011). The quasi-operational sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) will be created. Retrieval algorithms for additional Essential Climate Variables will be developed and Fundamental Climate Data Records (FCDRs) and Thematic CDRs will be created. Possibilities for successful cross-calibrations for old and new satellite sensors, which require major scientific input, will be reviewed. Independent observations and analysis of observations made by other means and systems will be used to increase the reliability of conclusions on various aspects of detection of climate variability and change. An international assessment of research priorities required for filling the existing gaps in climate monitoring continuity, accuracy, and efficiency, both from space and in situ, and building an operational global climate observing system will be conducted. This assessment will result in recommendations for transition from research to operational capability and identification of the overlaps needed to prevent critical gaps in the climate-relevant observations administered by many national and international agencies.

Research-intensive coordinated climate data reprocessing will continue in participating agencies and centres. The scope and period of coverage of meteorological reanalyses will be extended, and new types of reanalyses (e.g. for atmospheric chemistry, cryosphere, etc.) particularly involving coupling between different components of the climate system will be initiated. Metadata standards and indication of the dataset “maturity” will be further developed. Development of standards for presentation and documentation of model- and observation- generated climate data following the Climate and Forecast metadata convention will continue. Data reprocessing and reanalysis, as well as paleoclimate observations and research will strongly benefit from the strengthened climate data rescue activities proposed in the OBS Annex.

The RMP pillar would also strongly benefit from continuously making relevant data more accessible. A single repository for all gridded and processed observational datasets that is analogous to the CMIP archive of model data, provides users with easy access to data/information in a standard format, and facilitates their comparisons and accurate citation, will be promoted. Metadata standards and conventions, such as Climate and Forecast (CF), and indication of the dataset “maturity” will be further developed. Similarly, WCRP will continue wide communication on all aspects of reanalysis activities to create a knowledge base for all users of reanalyses and facilitate further development and greater use of reanalysis products beyond the current highly specialized group of users (http://reanalysis.org). This work will be coordinated

with CSIS and rely on the capabilities, functionalities, and the data standards provided by the WMO Information System (WIS).

Based on the outcomes of the predictability studies, requirements for advances in ocean observations, especially in the Polar Regions, will be widely promoted. Research will intensify on data assimilation for ocean temperature, salinity, and dynamic topography in all oceans including deeper layers than currently accessible to the Argo programme. New satellite sensors will be used for this purpose. This will enable issue of novel ocean data syntheses and production of a range of oceanographic predictions including sea-ice prediction in Polar Regions and marginal seas with sea-ice cover.

As indicated in the OBS Annex, an integrated global greenhouse gas (GHG) information system, including enhancing regional scale chemical measurements, will be developed. It will provide timely, regionally specific information related to the state of greenhouse gas-driven warming, the rate of GHG increase, and projections for future decades, during which adaptation measures will take place and upon which the success of adaptation measures will depend. Required coordination among WMO, GCOS, GEO-Carbon and regional projects such as ICOS in Europe, Carbon North America (CarboNA), and other similar efforts and existing networks around the world will be ensured.

2.5 Initial implementation activities/projects

In addition to the RMP activities listed in the Table A below, the pillar will take part and will contribute to a number of initial GFCS activities outlined in the other Annexes to the GFCS Implementation Plan.

At the near-term of GFCS implementation, the RMP efforts will be aimed at creating conditions for overall implementation of the pillar, which involves more detailed planning of the pillar activities and creating commitments from research organizations to contribute to the establishment the scientific foundation of the climate services. Such planning will be developed and commitments will be sought on global, regional and national level. Partnerships will be established between the scientific groups and climate services practitioners, who in that case will act as climate science users. Development of successful research in the four domains of GFCS initial priorities also requires some spin-up and this will be achieved by creating research strategies with respect to human health, water management, and food and agriculture while the existing well-defined research strategies in the domain of disaster reduction will be complemented by intensified research on extreme events. Climate and application research capacity development activities will be included in the strategies and plans to be developed.

An effort will be made to make scientific experimental climate information, especially predictions and projections, more regularly accessible to the community of users of climate information. This will lead to some commitments of research groups to make their information publicly available and will help to generate impartial feedback on the experimental products from interested users.

An attempt will be made to capitalize on existing results, plans, and momentum in the predictive research on time scales from weeks to up to a season. This is the scale, which is already preconditioned for obtaining additional skill in predictions due to research under the auspices of both WWRP and WCRP. First experiments and activities will also be conducted under the Polar Prediction Project focusing on the same time scales.

The WCRP CMIP5 and CORDEX projects will produce unprecedented volume of global and regional predictive information on decadal and centennial time scales that will be highly relevant
for research on adaptation to climate change. Research activities aimed at maximizing the benefits of using this information in climate risk management, creating generic adaptive capacity at national and household level, and for overall support to adaptation to climate change can be started at the earliest stages of GFCS implementation. Development of an integrated global greenhouse gas information system will help to substantiate information on the radiative forcing of climate and will lead to multiple advantages in climate projection and estimating the emissions.

Extending the time period covered by reanalyzes, expanding their scope and sophisticating the data assimilation schemes used to generate the datasets will be very important in terms of creating datasets useful for scientific research, verification of predictions, understanding of processes, and developing practical applications of such data. This work should take advantage of the ongoing reprocessing of satellite data records with the use of improved retrieval algorithms and data quality control at all stages of processing.

After the completion of the IPCC AR5 and assessing the available knowledge about the causes and consequences of sea-level rise and still remaining gaps in our understanding and capacity to model and project all factors determining the future sea-level standing, WCRP will engage in formulation of a comprehensive research programme in support of practically addressing risks associated with sea level, globally and regionally.

Finally, the RMP pillar will lead a GFCS-level activity on improving the ability of users to incorporate uncertain climate information into their decision-making processes in order to prepare for and manage climate-related risks.

The Table A below lists the planned initial implementation activities of the RMP pillar. The costs are given for the initial two-year period only.
Table A

Planned initial implementation activities of the RMP pillar

<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Deliverables</th>
<th>Indicators</th>
<th>Assessment measures (sources verification)</th>
<th>Timelines</th>
<th>Partners and Stakeholders</th>
<th>Linkages with other activities</th>
<th>Cost, M US$ for 2 years</th>
<th>Potential Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Harmonization and strengthening coordination of the ongoing and planned research activities of main organizations, agencies, and programmes of direct relevance to GFCS with a focus on mid- and longer-term perspectives</td>
<td>More detailed plan of research activities in support of GFCS in the mid- and longer-term perspectives</td>
<td>Agreed and published planned document containing activities, responsibilities, management arrangements, resources, etc. for all component activities and the pillar</td>
<td>Input and expressed commitments of main stakeholders</td>
<td>2013-2014 with later update</td>
<td>WCRP, WMO, ICSU, UNESCO and its IOC, other UN Partners, ICSU, etc.</td>
<td>Regional partners</td>
<td>0.20</td>
<td>Complexity, balance of interests</td>
</tr>
<tr>
<td>2</td>
<td>Briefings of main research funding agencies on GFCS and the RMP implementation plan (see Activity 1)</td>
<td>Involvement and commitment of research funding agencies in the GFCS RMP activities</td>
<td>Funding level for GFCS relevant projects. Funders adopting the RMP project identification criteria. Funders monitoring performance and data policy adherence according to GFCS requirements</td>
<td>Communication with funding agencies</td>
<td>2014</td>
<td>WCRP, WMO, ICSU</td>
<td>IGFA, Belmont Forum</td>
<td>0.10</td>
<td>Mismatch of objectives, conflict with earlier commitments</td>
</tr>
<tr>
<td>3</td>
<td>Developing partnership of communities producing experimental and regular climate information, including predictions, and making research products regularly available to climate service users for assessment</td>
<td>Availability to users of experimental climate products. Feedback of users on research community products.</td>
<td>Number of openly available and accessible climate predictions at a spectrum of time scales and for diverse applications</td>
<td>Monitoring of available product and of user feedback on them</td>
<td>2014 with subsequent continuation</td>
<td>WCRP constituencies, WWW, CBS, CSIS</td>
<td>WCP, leading modeling centres</td>
<td>0.40</td>
<td>Insufficient pace of development, slow increase in commitments</td>
</tr>
<tr>
<td></td>
<td>Develop GFCS climate and health research strategy and set targets and priorities to support health and climate research at regional and national levels</td>
<td>Strategy as a document</td>
<td>Translation of strategic recommendations into regional and national research and development plans. Proposals on research capacity development.</td>
<td>Inquiry with countries</td>
<td>2012-2014</td>
<td>WHO, GECHH, others</td>
<td>WCP, CSIS, WCRP, WGRC, PROVIA</td>
<td>0.20</td>
<td>Complexity, dependence on local level of development, which may be insufficient</td>
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<tr>
<td>4-1</td>
<td>Develop virtual forum on climate and health research</td>
<td>Web-portal</td>
<td>Active posts and exchange of views on the portal</td>
<td>Website monitoring</td>
<td>2012-2014</td>
<td>WHO, GECHH, others</td>
<td></td>
<td>0.05</td>
<td>Negligible</td>
</tr>
<tr>
<td>4-2</td>
<td>Develop GFCS climate, water management and hydrological cycle research strategy and set targets and priorities to support research at regional and national levels</td>
<td>Strategy as a document</td>
<td>Translation of strategic recommendations into regional and national research and development plans. Proposals on research capacity development.</td>
<td>Inquiry with countries</td>
<td>2012-2014</td>
<td>GEWEX, WMO CHy, IHP of UNESCO</td>
<td>Satellite agencies, regional stakeholders</td>
<td>0.20</td>
<td>Organizational complexity, insufficient knowledge of partner communities</td>
</tr>
<tr>
<td>5</td>
<td>Develop GFCS climate, food and agriculture research strategy and set targets and priorities to support research at regional and national levels</td>
<td>Strategy as a document</td>
<td>Translation of strategic recommendations into regional and national research and development plans. Proposals on research capacity development.</td>
<td>Inquiry with countries</td>
<td>2012-2014</td>
<td>FAO, CGIAR, WCRP, PROVIA</td>
<td>Regional stakeholders</td>
<td>0.20</td>
<td>Complexity, insufficient knowledge of partner communities, divide between communities</td>
</tr>
<tr>
<td>6-1</td>
<td>Develop virtual forum on climate and food research</td>
<td>Web-portal</td>
<td>Active posts and exchange of views on the portal</td>
<td>Website monitoring</td>
<td>2012-2014</td>
<td>FAO,</td>
<td></td>
<td>0.05</td>
<td>Negligible</td>
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<tr>
<td>6-2</td>
<td>Mechanisms to coordinate research on attribution and prediction of climate extremes and transition of its outcomes into climate services</td>
<td>Improved attribution and skillful prediction of individual extreme events and their statistics, guidance to users</td>
<td>Publications on attribution of extreme events, increased percentage of predicted events, enhanced guidance on extreme events that is useful to decision making, Proposals on research capacity development.</td>
<td>Verification scores for meteorological variables associated with the extreme events, insurance loss data</td>
<td>2014 with subsequent continuation</td>
<td>Research groups affiliated with WCRP, especially CLIVAR and GEWEX, WCP, NMHS</td>
<td>IRDR, PROVIA, regional stakeholders</td>
<td>0.20</td>
<td>Multi-disciplinary challenges, resources required to resolve tails of distributions</td>
</tr>
<tr>
<td>No.</td>
<td>Development project on improving skill of global and regional climate predictions for time scales from weeks to seasons</td>
<td>Improved skill and enhanced availability of predictions</td>
<td>Number of centres producing predictions, regular availability of experimental and forecasts positive evolution of standard verification scores of predictions by leading centres</td>
<td>2012-2017 with initial activities before 2014</td>
<td>WWRP/WCRP Sub-seasonal to Seasonal (S2S) Initiative</td>
<td>CSIS</td>
<td>Complexity of research field, technical complexity of experiments</td>
<td>0.30</td>
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<tr>
<td>9</td>
<td>Global Integrated Polar Prediction System for time scales up to a season and beyond</td>
<td>Experiments aimed at improved skill and enhanced availability of predictions</td>
<td>Number of centres producing predictions, regular availability of experimental and forecasts positive evolution of standard verification scores of predictions by leading centres</td>
<td>2012-2022 with initial activities before 2014</td>
<td>WWRP Polar Prediction Project in close collaboration with WCRP Polar Climate Predictability Initiative</td>
<td>Other WWRP constituencies, WCRP, CBS, IASC, EC-PORS</td>
<td>Significant number of unknowns</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Coordinated research on global and regional climate predictions and projections on time scales from decades to centuries for climate risk management and adaptation to climate change</td>
<td>Databases of predictions and projections, regional and national studies</td>
<td>Volume of downloaded data, publications on data use and interpretation information from centres responsible for data holdings</td>
<td>2013 with subsequent continuation</td>
<td>WCRP CMIP and CORDEX, WGRC</td>
<td>WCRP projects, PROVIA, regional and national partners</td>
<td>Complexity of experiments, unknown existence of predictability, resources</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Coordinated reprocessing of fundamental climate data records</td>
<td>Substantiated fundamental climate data records</td>
<td>Number of fundamental climate data records generated references to datasets, publications</td>
<td>2014 with subsequent continuation</td>
<td>WCRP affiliated research centres, WCRP WDAC</td>
<td>GEWEX, OBS</td>
<td>Technical challenges, resources required</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Coordination and extension of reanalysis activities</td>
<td>Expanded scope and increased accuracy of reanalyses</td>
<td>Number of years and variables covered, use of coupled models and data assimilation techniques in producing reanalysis, publications based on the data use documentation from responsible centres</td>
<td>2014 with subsequent continuation</td>
<td>Responsible centres</td>
<td>WCRP WDAC</td>
<td>Technical challenges, resources required</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Design of an integrated global greenhouse gas information system (joint with OBS pillar)</td>
<td>Provision of timely, regionally specific information related to the state of GHG, the rate of GHG increase, and projections for future decades</td>
<td>Increased availability of enhanced GHG observations and data</td>
<td>Preparation for implementation in 2015-2020</td>
<td>GAW, GCOS, GEO-Carbon and regional projects such as ICOS in Europe, Carbon North America (CarboNA), and other similar efforts and existing networks around the world</td>
<td>IGAC, WCRP</td>
<td>0.20</td>
<td>Difficulties of transition between research and operations</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Development of an interagency programme on regional sea-level rise and its future extremes</td>
<td>Interagency research programme to address uncertainties in assessment of future sea-level</td>
<td>Agreed planned document</td>
<td>Publications, regional assessments</td>
<td>2014 with subsequent continuation</td>
<td>WCRP, JCOMM, IOC</td>
<td>Partners involved in geodetic research, hydrological community, etc.</td>
<td>0.20</td>
<td>Complexity of the inter-disciplinary coordination</td>
</tr>
<tr>
<td>15</td>
<td>Improving decision-making processes in climate related risks</td>
<td>Case studies to demonstrate how existing climate information can improve decision making in GFCS priority sectors. A proposal for a corresponding research project</td>
<td>Reports on techniques to extract useful and actionable information for decision making and to more effectively exploit the emerging prediction capabilities</td>
<td>User feedback through UIP, report assessment</td>
<td>2014 with subsequent continuation</td>
<td>WCRP to form a consortium with inclusion of NMHSs, sector lead agencies, local decision makers, users of climate information, etc.</td>
<td>Groups involved in experimental prediction, PROVIA, etc.</td>
<td>1.00</td>
<td>Multi-disciplinary challenges, complexity of the issue</td>
</tr>
</tbody>
</table>
2.6 Implementation approach (including operational and organizational aspects)

The main pathways to achieving benefits of GFCS in climate science-reliant sectors will be:

- Detailed planning of the core climate and applied research activities;
- Building communities of researchers, practitioners and users of climate information and facilitating communication within such communities;
- Seeking commitment to support RMP activities by operational agencies and research funders;
- Efforts to make regularly updated experimental climate diagnostic and prognostic information through GFCS and facilitating informative and useful feedback on the information products by its users;
- Focusing climate research on sustained improvement of climate information identified as feasible and most needed for GFCS implementation; and
- Supporting applied climate research for developing practical applications through pilot and demonstration projects that bring together all five elements of the GFCS with a primary focus on integration and delivery of climate information to users and decision makers.

GFCS development will require strengthening the links, coordination, and cooperation between the research and operations communities. Organization of and support to such interaction requires establishment of the pillar management structure on a variety of regional levels. This structure will be proposed after the top GFCS governance decisions are made and in the course of execution of RMP planning activities indicated in section 2.5.

The initial RMP activities outlined in section 2.5 will be conducted under the leadership of representatives of key stakeholders, such as WCRP, WMO, WHO, FAO, UNESCO and its IOC and IHP, ICSU, and others. Completion of the detailed RMP implementation plan will result in a proposed management structure of the pillar at the global, regional and national level. As an example, the WMO Regional Associations will be able to assist the development of climate services at the regional level. The IOC regional alliances will also be expected to support implementation of the GFCS in various parts of the world oceans, develop their capacity to make required ocean observations, and guide the preparations of a range of oceanographic products for their respective zones of interest. Regional subprojects of WCRP have the necessary expertise to address many of the identified research requirements and scientists affiliated with them will be asked to participate in RMP activities. Regional programmes, activities and offices of FAO, WHO, ICSU may be approached in search for suitable partners. Early participation of research funding agencies in the pillar activities planning, establishing partnership relations with them, and their involvement in the pillar management, will be essential for timely issue of calls for research proposals.

2.7 Monitoring and evaluation of the implementation

Mechanisms for review and monitoring of the RMP activities will be proposed in the detailed RMO implementation plan and corresponding arrangements will be imbedded into the overall management structure of the RMP. The indicators of performance, progress, and assessment measures for the RMP activities will be developed individually for each of the main activities. The RMP pillar Secretariat will have to accept the task to assess the RMP performance at the global level. Performance indicators for individual research and development projects supported
by research funding agencies and agencies leading applied research will need to be established for every project and should be reported to the global and regional level. The enhancements in commitment for delivery of climate science information to CSIS will be evaluated in cooperation with WIS and CSIS. User feedback will be the cornerstone of the open-ended GFCS UIP, the main vehicle directing the applied climate research, and one of the tasks for climate scientists participating in the UIP working constituencies will be to report progress and or lack thereof, and identify corresponding stumbling blocks. Close cooperation between the GFCS management and contributing partners and participating programmes and organizations will ensure timely reaction on any feedback regarding performance of the corresponding projects and activities.

2.8 Risk management in implementation of activities

The risk management principles and arrangements for other GFCS pillars that are associated with institutional complexity, management, resources, etc., also apply for the RMP, and their description is not repeated in this Annex. Description of anticipated risk management practices and considerations will be a standard requirement in soliciting proposals in response to all calls for funding activities under the RMP. Risk management practices of funding agencies will apply, as a rule, to all RMP funded research activities. Specific considerations on risk management will be requested from the initial planning activities of the pillar as indicated in the last column of Table A.

A key element of risk management for the RMP pillar will be a sufficiently robust evaluation process and documentation for any new product and service to be provided by GFCS. Its use will help to avoid potential misunderstanding or misinterpretation of such product or service by non-expert users. Participation of multiple research groups in provision of climate information and predictions will help to ensure a possibility of intercomparing, validating, and calibrating the products. Early identification of slow progress or failure to deliver will also be facilitated by considerably increased and active user involvement in the RMP research activities.
3 ENABLING MECHANISMS

3.1 Synergies with existing activities and building national, regional and global partnerships

Multiple synergies of the RMP activities can be identified that may help them to be efficient and add value to the joint work. The RMP activities, where possible, will be built on consolidation, targeting and strengthening of already existing climate research and research in socio-economic sectors, with active participation on user communities. For example, the existing WWW practices of providing access to the long-range forecasting under can be extended for used for arranging access of the users to experimental climate information. The existing working mechanisms under the WCP can serve as building blocks for effective startup of research on climatological applications in the four initial GFCS priority areas. There are very significant dependencies of human health and wellbeing on factors related to food, water and safety. They were used in constructing the list of core climate products in section 2.4.3 of this Annex. Synergies of RMP with the OBS pillar, which is to a large extent constructed on research outcomes, have been already emphasized in this Annex. Global observing programmes will strongly benefit from the RMP activities and vice versa. Synergies between the weather and climate research are multiple and will materialize in practical implementation of “seamless” prediction systems.

To a significant degree, the synergies between applied and fundamental climate research, observations, modeling and prediction can be extended from the global to regional and national level. Each of the agencies, programmes and many large-scale projects have regional and national counterparts and focal points. Their work also benefits from a variety of synergies at the regional scale. At the same time, liaisons between various disciplinary activities on the regional level are usually weaker than the liaisons within disciplines on global and regional level. For example, activities of the WMO Regional Associations have considerably stronger links with global WMO Programmes than links with corresponding IOC regional bodies or with activities coordinated by the ICSU regional offices. Establishing links between various organizations and programmes to work on the GFCS implementation on regional level may result in considerable mutual benefit for them. Active participation of national organizations and groups in the RMP activities will entrain their expertise and capabilities in the GFCS buildup and will have the potential of bringing additional resources and incentives for expanding the scope of activities and improving their products.

3.2 Communication Strategy

The importance of communication for the GFCS and RMP implementation cannot be overstated. The GFCS will be developed through an intensive two-way communication of the new opportunities to the user and the corresponding feedback and requirements to the provider. This means that the GFCS and RMP communication strategy should both serve internal connections within the pillar and its external relations. Proper documentation of activities and their output, use of the open source approach - whenever possible, frequent reporting of project progress or lack thereof, and constant liaison with the “receiving” end should be tirelessly promoted. For the efficient internal communication in the pillar it will be important to start its implementation by building liaisons and communication channels and arrangements between the providers and users of interim products - because it is their interaction that determines the eventual ability of the overall system to succeed. Communication to the “outside” helps to break
the vicious circle whereby the usefulness of climate services is not known to the potential users and funders, and the resultant lack of interest, support, and funding slows down the required progress in socially relevant research. This means that the GFCS and RMP should proactively report success of its activities and their value for the society.

Advances in the RMP activities will be reported and promoted both individually by participants and through a special section on the Website of GFCS and those of partners and participating programmes/organizations. Available experimental climate products will be widely announced to the user communities identified in this Annex. New IT technologies will be used to promote RMP activities including controlled distribution of information through social networks.

In addition to the GFCS efforts, WCRP is developing a communications strategy for the Programme. GFCS issues of relevance to WCRP will be picked up in the implementation of that strategy. The WCRP outreach and communications strategy target audiences include scientists, media and general public, sponsors and funding agencies, decision makers, students and early career scientists, affiliates of scientific climate assessments, and global and regional environmental conventions. The efficiency of the strategy and measures implementing it will be evaluated at regular intervals. Involvement of experts engaged in the GFCS capacity building activities in assessing the GFCS communication strategy may results in useful proposals to increase its efficiency.
4 RESOURCE MOBILIZATION

Investments into climate services create stronger resilience and improve the *investment climate* because "the benefits of strong, early action on climate change outweigh the costs" (Stern, 2005). Climate research and applied research are the vehicles that are capable to significantly increase return on investments into GFCS. On this understanding, the World Climate Conference-3 called for major strengthening of the essential elements of GFCS including the World Climate Research Programme, underpinned by adequate computing resources and increased interaction with other global climate relevant research initiatives.

Despite GFCS is expected to convert climate knowledge into action, and hence a strong focus of RMP research activities will the development of practical applications of climate science, the RMP pillar will need an optimal combination of investments in fundamental and applied climate research to provide both the required basic and specialized climate information to different economic sectors and geographic regions that are vulnerable to climate variability and change. Without adequate funding for fundamental research, progress of climate research will slow down and very soon the science will become incapable of addressing the rapidly emerging and complex needs for climate information. In addition, fundamental research will be needed to address the still existing multiple unresolved issues in climate science. Without demonstrating the practical benefits of climate information to society, research loses its credibility and support base. In turn, the society becomes more vulnerable to environmental risks. This vicious circle, which is typical for almost any emerging activity including climate services, can be avoided with help of an effective communication strategy and proactive involvement of multiple stakeholders.

Successful initial development of GFCS and the resultant provision of more effective and efficient services to customers will help to promote activities and the need to allocate some limited share of funding for the design of the system and its coordination. However, the usual problem of shortage of initial funding is acute. Early and effective promotion of GFCS and RMP to make sure that the governments and funding agencies assign resources for the initial GFCS development is therefore very important. Cost efficiency of the RMP research and early assessments of the long-term and short-term returns on investment into the GFCS and RMP should thus be a part of the initial planning activities. In addition to efforts to find external resources, at the beginning of the GFCE implementation there will be a need to strive to do more with less and attempt to demonstrate the value of RMP and GFCS to potential funders as early as possible. The sources of modest initial own funding should be participating agencies, such as NMHSs, national and international research funding agencies, satellite agencies, academies of sciences and universities willing to invest in own research to practically-oriented climate science. NMHSs and governmental agencies may be willing to invest into the costs of the regional observing systems and national infrastructure for climate predictions. It is extremely important to ensure fruitful cooperation with national and international research funding agencies so that they would issue calls of research opportunity of direct relevance to GFCS. It should be noted that the science support to the development of climate services is high on the agenda of many research-funding agencies and there are therefore many well-supported research opportunities of extreme relevance to GFCS. To make them efficiently cooperating and adding value requires adequate resource support to their coordination that can be provided under the RMP pillar of GFCS. Specialized agencies may be willing to invest seed funding into forming communities of climate scientists and practitioners in the areas of their interest. Their proposals on development of user tailored products may attract interest of corresponding governmental agencies or industries. Such creative and flexible partnerships will be key to the
success of the RMP pillar and the GFCS as a whole. Prioritization of RMP activities will be always required.

Briefings for international and national research funding agencies and other stakeholders supporting climate research and experimental prediction should be organized at the initial stage of GFCS development and at the later stages. An assessment of scale and ways of return on investment into GFCS by different stakeholders would be instrumental in advocacy for funding. Sharing of the lessons learned, both positive and negative, should be an integral part of such a dialog with the funding and sponsoring organizations.
5 COSTED SUMMARY OF ACTIVITIES / PROJECTS

The total cost of coordination and pillar management development activities is estimated as US$ 4.2 Million. Their summary is shown in Table B.

Table B

<table>
<thead>
<tr>
<th>Activity Areas</th>
<th>Deliverables</th>
<th>Time-lines</th>
<th>Partners</th>
<th>Cost, M US$ for 2 years</th>
<th>Main Potential Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengthening coordination of the ongoing and planned research activities, developing applied research strategies in GFCS priority areas and virtual forums supporting them, engaging sponsors</td>
<td>Management arrangements for pillar, strategies for main research directions, web presence, identification of partners and stakeholders. Plan of research activities in support of GFCS in the mid- and longer-term perspectives.</td>
<td>2013-2014 with later update</td>
<td>WCRP, WHO, ICSU, UNESCO and its IOC, IHP, FAO, etc.</td>
<td>1.00</td>
<td>Complexity, balance of interests, insufficient knowledge of partner communities</td>
</tr>
<tr>
<td>Bridging communities producing experimental and regular climate information, including predictions, and making research products available to climate service users</td>
<td>Wide availability of experimental climate products to users. Feedback of users on research community products.</td>
<td>2014 with subsequent continuation</td>
<td>WCRP, WWW, CBS, CSIS, WIS</td>
<td>0.40</td>
<td>Slow increase in commitments</td>
</tr>
<tr>
<td>Research in support of the provision of core climate products including sub-seasonal to seasonal predictions, decadal centennial predictions, and regional and thematic climate information</td>
<td>Studies on attribution and prediction of extreme events. Improved skill of predictions and projections on sub-seasonal to seasonal scale and regional information including polar regions. Interagency research programme to address uncertainties in assessment of future sea level.</td>
<td>2014 with subsequent continuation</td>
<td>WCRP, WWRP</td>
<td>1.20</td>
<td>Multi-disciplinary challenges, resources required to resolve tails of distributions</td>
</tr>
<tr>
<td>Research on improvement of climate observations, change detection, and fundamental climate data records and their summaries</td>
<td>Coordinated reprocessing of fundamental climate data records. Expanded scope and increased accuracy of reanalyzes. Integrated global greenhouse gas information system.</td>
<td>2014 with subsequent continuation</td>
<td>WCRP, OBS</td>
<td>0.60</td>
<td>Technical challenges, large resources requirements</td>
</tr>
<tr>
<td>Improving decision-making processes in climate related risk</td>
<td>Case studies to demonstrate how existing climate information can improve decision making in GFCS priority sectors. A proposal for a corresponding research project</td>
<td>2014 with subsequent continuation</td>
<td>WCRP, applied research communities, service provides and users</td>
<td>1.0</td>
<td>Multi-disciplinary challenges, complexity of the issue</td>
</tr>
</tbody>
</table>
6 APPENDICES

References used


Lemos, Maria et al., 2012: Building adaptive capacity to climate change in less developed countries. - WCRP OSC position papers (in prep.)


Portier, C.J. et al., 2010: A Human Health Perspective on Climate Change. Environmental Health Perspectives and the National Institute of Environmental Health Sciences. www.niehs.nih.gov/climatereport


Sivakumar et al., 2010. Changing Climate and Demands for Climate Services for Sustainable Development

Stern, N., 2005: The Economics of Climate Change.

Trenberth et al., 2012: Challenges of a sustained climate observing system. - WCRP OSC position papers (in prep.)


### Acronyms used

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APN</td>
<td>Asia-Pacific Network for Global Change Research</td>
</tr>
<tr>
<td>CarboNA</td>
<td>Carbon North America</td>
</tr>
<tr>
<td>CAS</td>
<td>WMO Commission for Atmospheric Sciences</td>
</tr>
<tr>
<td>CBS</td>
<td>WMO Commission for Basic Systems</td>
</tr>
<tr>
<td>CCAFS</td>
<td>Research Program on Climate Change, Agriculture and Food Security</td>
</tr>
<tr>
<td>CCI</td>
<td>WMO Commission for Climatology</td>
</tr>
<tr>
<td>CCMVal</td>
<td>Chemistry-Climate Model Validation</td>
</tr>
<tr>
<td>CD</td>
<td>Capacity Development</td>
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<tr>
<td>CDR</td>
<td>Climate Data Record</td>
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<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
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<tr>
<td>CHFP</td>
<td>Climate-system Historical Forecast Project</td>
</tr>
<tr>
<td>CHy</td>
<td>WMO Commission for Hydrology</td>
</tr>
<tr>
<td>CLIPS</td>
<td>WCP Climate Information and Prediction Services (CLIPS)</td>
</tr>
<tr>
<td>CIIC</td>
<td>Climate and Cryosphere Project</td>
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<td>CLIVAR</td>
<td>Climate Variability and Predictability Project</td>
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<td>CMIP</td>
<td>Coupled Model Intercomparison Project</td>
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<td>CORDEX</td>
<td>WCRP Coordinated Regional Downscaling Experiment</td>
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<td>CSIS</td>
<td>Climate Services Information System</td>
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<tr>
<td>CTB</td>
<td>Climate Test Bed</td>
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<tr>
<td>DRR</td>
<td>Disaster Risk Research</td>
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<tr>
<td>EC</td>
<td>Executive Council</td>
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<tr>
<td>ECMWF</td>
<td>European Centre for Medium-Range Weather Forecasts</td>
</tr>
<tr>
<td>ECPORS</td>
<td>WMO EC Team of Experts on Polar Observations, Research and Services</td>
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<tr>
<td>ECRTT</td>
<td>WMO Executive Council Research Task Team</td>
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<td>ESSP</td>
<td>Earth System Science Partnership</td>
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<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>FCDR</td>
<td>Fundamental Climate Data Record</td>
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<td>FEWS NET</td>
<td>Famine Early Warning Systems Network of USAID</td>
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<td>GAW</td>
<td>Global Atmosphere Watch</td>
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<td>GIEWS</td>
<td>FAO Global Information and Early Warning System on food and agriculture</td>
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<td>GCOS</td>
<td>Global Climate Observing System</td>
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<td>GCW</td>
<td>Global Cryosphere Watch</td>
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<td>GDPFS</td>
<td>Global Data-processing and Forecasting System</td>
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<td>GECHH</td>
<td>Global Environmental Change and Human Health</td>
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<td>GEO</td>
<td>Group on Earth Observations</td>
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<td>GEWEX</td>
<td>Global Energy and Water Cycle Experiment</td>
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<td>Global Framework for Climate Services</td>
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<td>GHG</td>
<td>Greenhouse gas</td>
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<td>GODAE</td>
<td>Global Ocean Data Assimilation Experiment</td>
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<td>Global Ocean Observing System</td>
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<td>Global Producing Centres</td>
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<td>GTN</td>
<td>Global Terrestrial Network</td>
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<td>GTN-G</td>
<td>Global Terrestrial Network for Glaciers</td>
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<td>GTN-H</td>
<td>Global Terrestrial Network for Hydrology</td>
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<td>GTN-L</td>
<td>Global Terrestrial Network for Lake Level/Area</td>
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<td>GTN-P</td>
<td>Global Terrestrial Network for Permafrost</td>
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<td>GTN-R</td>
<td>Global Terrestrial Network for River Discharge</td>
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<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>GTOS</td>
<td>Global Terrestrial Observing System</td>
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<td>GWSP</td>
<td>Global Water System Project</td>
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<tr>
<td>HLT</td>
<td>High Level Taskforce</td>
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<td>IAI</td>
<td>InterAmerican Institute for Global Change Research</td>
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<td>IASC</td>
<td>International Arctic Science Committee</td>
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<tr>
<td>ICOS</td>
<td>Integrated Carbon Observation System</td>
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<tr>
<td>ICUS</td>
<td>International Council for Science</td>
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<tr>
<td>IGAC</td>
<td>International Global Atmospheric Chemistry</td>
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<td>IGBP</td>
<td>International Geosphere–Biosphere Programme</td>
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<td>IGFA</td>
<td>International Group of Funding Agencies for Global Change Research</td>
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<td>IHP</td>
<td>International Hydrological Programme of UNESCO</td>
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<td>IOC</td>
<td>Intergovernmental Oceanographic Commission of UNESCO</td>
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<td>IRD</td>
<td>Integrated Research on Disaster Risk</td>
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<td>IRI</td>
<td>International Research Institute for Climate and Society</td>
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<td>JCOMM</td>
<td>Joint WMO/IOC Technical Commission for Oceanography ad Marine Meteorology</td>
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<td>MALOF</td>
<td>Malaria Outlook Forum (MAOFL)</td>
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<td>MERIT</td>
<td>Meningitis Environmental Risk Information Technologies</td>
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<td>METAFORE</td>
<td>Common Metadata for Climate Modelling Digital Repositories</td>
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<td>NCAR</td>
<td>(US) National Center for Atmospheric Research</td>
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<tr>
<td>NCC</td>
<td>National Climate Centre</td>
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<tr>
<td>NCS</td>
<td>National Climate Services</td>
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<tr>
<td>NGO</td>
<td>Non-governmental organization</td>
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<tr>
<td>NMHS</td>
<td>National Meteorological and Hydrological Service</td>
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<td>NOAA</td>
<td>(US) National Oceanic and Atmospheric Administration</td>
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<tr>
<td>OBS</td>
<td>Observations and Monitoring</td>
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<tr>
<td>PROVIA</td>
<td>Programme of Research on Climate Change Vulnerability, Impacts and Adaptation</td>
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<td>RCOF</td>
<td>Regional Climate Outlook Forum</td>
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<td>RCC</td>
<td>Regional Climate Centre</td>
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<td>RMP</td>
<td>Research, Modelling, and Prediction</td>
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<td>S2S</td>
<td>Subseasonal to Seasonal Initiative</td>
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<td>Global Change System for Analysis, Research, and Training</td>
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<td>The Observing System Research and Predictability Experiment</td>
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<td>THORPEX Interactive Grand Global Ensemble</td>
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<td>UIP</td>
<td>User Interface Platform</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Children's Fund</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
</tr>
<tr>
<td>UV</td>
<td>Ultra-violet</td>
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<tr>
<td>WCP</td>
<td>World Climate Programme</td>
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<tr>
<td>WCRP</td>
<td>World Climate Research Programme</td>
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<tr>
<td>WCSP</td>
<td>World Climate Services Programme</td>
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<tr>
<td>WGRG</td>
<td>WCRP Working Group on Regional Climate</td>
</tr>
<tr>
<td>WIGOS</td>
<td>WMO Integrated Global Observing System</td>
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<tr>
<td>WIS</td>
<td>WMO Information System</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>WMO</td>
<td>World Meteorological Organization</td>
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<tr>
<td>WWRP</td>
<td>WMO World Weather Research Programme</td>
</tr>
<tr>
<td>WWW</td>
<td>World Weather Watch</td>
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<tr>
<td>YOTC</td>
<td>Year of Tropical Convection</td>
</tr>
</tbody>
</table>
ANNEX

TO

THE IMPLEMENTATION PLAN OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

CAPACITY DEVELOPMENT COMPONENT

Version: 31 August 2012
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EXECUTIVE SUMMARY

The Global Framework for Climate Services (GFCS) aims to develop the capacity of countries to apply and generate climate information and products relevant to their particular concerns, thus all aspects of GFCS include capacity development. The World Climate Conference-3 recognized that many countries lacked policies and institutions or human resources with the right skills or practices to enable them to take advantage of new or existing climate data and products or create national user interface groups to establish national dialogue on these issues. The Capacity Development component of the GFCS Implementation Plan can be seen as a foundation that links and supports the four other pillars.

The Capacity Development component of the GFCS Implementation Plan thus tackles two separate but related activity areas: (i) the particular capacity development requirements identified in the other four pillars; and (ii) more broadly the basic requirements (national policies/legislation, institutions, infrastructure and personnel) to enable any GFCS related activities to occur. In the context of both activity areas capacity development actions under the Framework will facilitate and strengthen, not duplicate existing activities. The Capacity Development component of the GFCS Implementation Plan complements the wider capacity development plans being implemented by the GFCS partners and other agencies.

By necessity the GFCS Implementation Plan, to date, has been built top down using generalized capacities and assumptions to provide a first guess estimate of what is required, what can be implemented in a sustainable manner and how much it could cost. The implementation of specific projects at national or regional or sub-regional level will require that these generalized assumptions, capacities and costs are tested for the specific circumstances and projects, thus leading to a gap analysis or refinement for each project. This analysis will also need to determine the presence or absence of the underlying foundations for sustainable GFCS projects and what to do if the foundations do not exist. Key questions to be asked are:

- Does national legislation or regulation exist authorizing the collection, communication (nationally and internationally), archival and production of climate information (including data) and products?
- Are there institutions appointed to collect, communicate, create and archive climate information and products at a national level?
- Do the authorized institutions have the infrastructural facilities, procedures and sufficient personnel to carry out their tasks in a sustainable manner? and
- Do the personnel have the appropriate skills and qualifications to undertake the required tasks as well as the specific GFCS capacity development requirements?

The results of the analysis will determine the financial, human and institutional resources required to implement the GFCS related project on a sustainable basis and the collaboration and coordination mechanisms between various players such as the UN agencies and programmes, government institutions, NGOs and the private sector.

A number of activities relevant to the priority areas of GFCS are already being implemented in different parts of the globe by different institutions, organizations and other entities. These activities (essentially capacity development activities) can be grouped into four main areas linked to the pillars: capacity for climate information users (UIP), developing capacity for the
generation of climate information (CSIS), infrastructural capacity (elements of CSIS, OBS and M, and Research and P), and international collaboration and partnership in relevant capacity development activities.

Some projects that could be fast tracked in the implementation of the GFCS are identified in this Capacity Development component to GFCS Implementation Plan. These projects address the needs of the countries, especially Developing and Least Developed Countries (LDCs) and Small Island Developing States (SIDSs), and could be used as pilot projects to further refine the underlying assumptions used in the top down approach. The criteria for identifying these projects will be determined by the needs of the GFCS priority sectors (Disaster Risk Reduction, Health, Water resources, food and agriculture) in those countries. An estimated cost of approximately 300 million USD is required to implement GFCS capacity development activities in its initial phase (2013-2017) with a possibility for an additional similar amount in its last phase (2018-2023).

A number of UN Agencies and programmes are currently implementing Capacity Development activities that have relevance to the objectives of the GFCS’s pillars. Partnerships will: be key in the implementation of the GFCS; help to ensure that GFCS specific activities complement and build upon other activities, not replicate them; and, also enhance ownership in GFCS. Mechanisms for agencies to work together and exchange relevant information on their activities will need to be refined or developed where they don’t exist.

For the successful and sustainable implementation of the GFCS at all levels the beneficiary countries, with guidance from the GFCS Secretariat and other bodies, will need to target potential national, regional and global stakeholders who will be a possible source of financial, technical and guiding support. These include Governments, organizations, non-governmental organizations and the private sector. There are also Foundations, Bilateral and Multilateral funding mechanisms, international agencies and regional entities/banks that provide funds in the countries. In most cases funding from such bodies comes through governments or regional organizations. Countries will be able to use the GFCS as part of their rationale for applying for funding from an identified donor because successful implementation of the GFCS at the national level will benefit the national economies.
1 INTRODUCTION

1.1 Objective, scope and functions

Capacity development for GFCS refers to investment in people, practices, policies and institutions to stimulate and systematically develop capacities in the Pillars of the GFCS namely: User-Interface Platform; Climate Services Information System; Climate observations and monitoring; and, Research, Modelling and Prediction. Capacity development actions under the Framework will facilitate and strengthen, not duplicate existing activities. They will also address needs from both the demand side and the supply side of climate services. These capacity development needs fall under the following four areas;

- **Human resource capacity** – equipping individuals with the knowledge, skills and training to enable them to generate, communicate and use decision-relevant climate information;
- **Infrastructural capacity** – enabling access to the resources that are needed to implement infrastructure to generate, archive, quality control, communicate, exchange and use climate data and decision-relevant information and products, including on the supply side instruments for observing networks, data management systems, computer hardware and software, internet access, communication tools, manuals and scientific literature, with similar things on the demand side but potentially much more diverse;
- **Procedural capacity** – defining, implementing and advancing best practices for generating and using climate information;
- **Institutional capacity** – on the supply side elaborating management structures such as defining the position and terms of reference of NHMSs for climate services, processes, policies and procedures that enable effective climate services, not only within organizations but also in managing relationships between the different organizations and sectors (public, private and community, including international collaboration) with similar requirements on the demand side but once again more diverse.

The outcome of capacity development actions within the above four areas are to support the other pillars so that GFCS, through its Pillars, is successfully implemented in initially addressing the four priority sectors of Agriculture, Water resources, Health and Disaster Risk Management and providing a solid basis for tackling other key thematic areas such as transport, energy, tourism etc.

1.1.1 Goal of the Capacity Development Pillar

The main objective of the Capacity Development Pillar is to facilitate the provision of improved climate services to those people who need it. In the first phase of GFCS this means that, for the four priority sectors: the level of interactions between providers of climate services and users will be further developed; national policies and practices on climate data management will be strengthened; the number, type and quality of climate observations improved; and, new climate monitoring products and capacities for provision of seasonal climate outlooks enhanced.

Under the GFCS, countries with limited capacity need assistance to enable them to provide more products and information including climate prediction products and climate projections. Sometimes these products and information will come from new local capacity and sometimes from regional or global capacity but through the national climate service provider. Figure 1 illustrates the link between the typical climate service products currently envisaged and the four
generic national climate service classifications used in this Implementation Plan. Figure 2 indicates the estimated maturity of national climate services providers in each category as of October 2010. The target for the first phase of GFCS is to increase the number of countries having access to Essential Climate Services by moving the peak from Basic to Essential. The report of the High-Level Taskforce (HLT), formed after World Climate Conference-3 (WCC-3), broadly estimated that this would globally require the recruitment or retraining of an additional 1000 staff at the cost of the order of USD 60 million.

Figure 1. Types of climate products and services by category of national climate service provider:
1.2 Requirement for the Capacity Development Pillar

The main providers of climate services in many of the Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Land Locked Developing Countries (LLDCs) lack the necessary mandate to interact with users and the capacity, to generate and provide the full range of climate services needed by users in an efficient, accurate and timely manner. These countries, which are most vulnerable and least capable, often have: inadequate observation networks for climate information; lack expertise in generating climate products and outlooks; and, insufficient facilities for easy dissemination of information to the various user communities in required format and capacities to undertake targeted research to improve the quality of the products. Users of climate services will also require capacity development for them to best use the existing data, products and information and be involved in the process of developing products and services.
Whilst the substance of these issues are addressed by the other pillars and key sectors’ exemplars for the GFCS, the Capacity Development processes and activities outlined here will facilitate their inter-linkage and strength them with the necessary expertise, infrastructure and institutional frameworks so that the GFCS objectives and goals can be achieved. It is important to note that, the capacities and capabilities to facilitate implementation are fundamentally dependent on finances, which are required, at all levels, to support staff, operations, equipment and sustainability.

The HLT report indicated that there are gaps and challenges in the provision and use of climate services. However, most of the institutions/agencies providing climate services around the world are currently providing, at a minimum, raw data and some analysis of climate data and other information, but generally with limited or no capability to generate the climate outlooks or forecasts and assist users with their interpretation and use which are amongst the key outputs for a minimum GFCS implementation.

1.3 Inter-linkages with other Pillars

The Capacity Development interacts with all pillars (WMO, 2011c, d, e, f, and g) because they need to develop their capacities to fulfil the GFCS objectives. Beginning to address the capacity development requirements of the pillars’ at an early stage is very important for a successful implementation of the GFCS. The key aspects of capacity development identified in the implementation plan for each of the pillars are summarized below.

User Interface Platform (UIP):

- To provide support in developing capacity of both the providers and users in ensuring that the information and products and messaging/communications are pertinent, applicable, actionable, timely, understandable for easy utilization;
- To address the role of the users in identifying and developing improved applications of climate information;
- To identify societal observations which would help understand the linkages between the climate system and socio-economic factors.

Research, Modelling and Prediction (RM&P):

- To support improvement of the total observation networks of both the physical and chemical components of the earth system. Research on observing techniques, their development and deployment are vital for closing gaps in the observational coverage and expanding the range of observed climate variables;
- Education and training, as an essential part of traditional capacity building, will help to support the resource base for RM&P;
- To develop capacity of relevant human resources and provision of tools and software;
- To support research which would help understand the linkages between the climate system and socio-economic factors.
Observation and Monitoring (O&M):

- To support capacity development for provision of quality observation networks based on user requirements, so as to underpin development of user-targeted products for priority sectors in a country;
- To support capacity development on climate data observations and monitoring and procedural and practices;
- To provide improved mechanisms for and cooperation in data and product exchange and for the essential communications and transmissions of information and products;
- To support capacity development in remediying gaps and deficiencies in existing observational networks and systems, acquiring new types of observations, and processing and integrating the information;
- To address societal observations which would help understand the linkages between the climate system and socio-economic factors.

Climate Services Information System (CSIS):

- The development and sustained operation of formalized and interoperable structures and mechanisms at global, regional and national levels;
- A comprehensive catalogue has to be created at different hierarchical levels viz. Nations, Regional Associations and Global, of available and upcoming climate services;
- Enhancing the capacity of the national and regional elements of the CSIS, and also to enhance the effective use of global and regional inputs in national level CSIS operations.

1.4 Relevant existing activities, and identification of gaps

Activities which are relevant to capacity development in the key areas of climate services are being implemented in different parts of the globe by different institutions and organizations. The HLT Report provided detailed information on those activities which are being implemented at different level to address generation, provision and user advocacy of climate services. These activities are grouped into four main areas that include developing capacity for the generation of climate information, capacity for Climate Information Users, Infrastructural capacity, and International Collaboration in relevant capacity development activities. These activities are implemented at global, regional and national levels, depending on the mandate and capability of the implementing entity. The activities cover the following main areas:

- Human capacity in generation and use of climate information;
- Infrastructural capacity of climate information and products for providers and users;
- Institutional capacity of climate information and products for providers and users;
- Procedural capacities of climate information and products for providers and users.

A detailed description of current capacity development activities in the generation of climate services is provided in Appendix I.

There has been significant effort to develop capacities of institutions to facilitate improvement in the provision of climate services and their uptake by users, however there still exists major
opportunities which the GFCS through its pillars will have to address especially in early phases of its implementation. These opportunities could include, among others: support to many NMHSs in developing countries to provide basic climate services; assist users of climate information with knowledge in using the information, data and products; address the lack of infrastructure for generation and dissemination of climate information and products; and improve coordination within UN System in the provision of climate services. The following are some of the gaps in capacity development which the GFCS through its pillars will have to address:

- High priority in the establishment and funding of Regional Climate Centres during the early implementation of the GFCS, as these will help address some of the needs of developing countries that are not yet capable of producing information and climate products themselves, while efforts are launched to build those national capabilities. WMO has initiated a process for establishment of RCCs in most regions, but many incipient RCCs will require financial support and even help with expertise to become operational designated centres with the least delay;
- Capacity development for climate information providers at national scale, especially in developing countries, needs to be enhanced because some of these countries still lack the necessary capacity to provide even the basic required climate information and products. Under the GFCS, it will be necessary to take stock of the status of national capacities to set a baseline, and then to identify which countries need to be supported so that they can improve their responsibilities to provide the required national climate services in a carefully staged approach (one step at a time);
- Lack of capacities and capabilities for the UIP to function at all levels. The capacities of many elements covered by the Framework’s Pillars are currently inadequate and need improvement;
- Some users of climate information are still not confident with the climate information provided and therefore need, through all possible available arrangements, to be engaged by the providers on the quality, usefulness, and packaging of the information. Through such interaction users will be able to appreciate the climate information and products provided;
- Some users lack climate knowledge, and need help to better apply the information in effective decisions and therefore the need for awareness, outreach, interdisciplinary training, and interface mechanisms such as COFs, and interdisciplinary working groups and conferences, etc.;
- Necessary infrastructure for the generation and the dissemination of climate information and products (hardware, software, manuals, literature, Internet access, communications tools, etc.) are still lacking in some countries. The relevant activities of the GFCS working with global and regional entities will have to address these issues as they are the means of producing quality information and products, and then getting these to those who need it;
- Observation networks for most of the basic parameters are still poor especially in the tropics and in many remote areas of the world (e.g. mountainous areas, high latitudes and over, and in, the oceans). As a result some generated products are not very accurate. Through the GFCS CD activities this problem in the O&M pillar will be given high attention;
- Use of current and emerging technologies such as the internet and other forms of media is still a problem in some countries. CD activities related to CSIS and RMP could facilitate the wider use of some of these technologies. The GFCS will provide an opportunity for UN Agencies and other development partners to support countries in the
provision of technologies that countries may require to enhance their capacities in provision of climate services;

- Coordination of UN Agencies, international institutions and programmes, NGOs and other players in both provision and use of climate information activities need to be strengthened. The GFCS Technical Committees will have to establish mechanisms whereby such coordination could be realized and achieved;

- Preparedness activities such as establishing early-warning systems to shift from crisis management to risk management for long term planning strategies to cope with climate extremes and climate change are urgently needed to improve the effectiveness of response and recovery;

- Significant efforts are still required to strengthen disaster risk reduction worldwide and meet the goals of the Hyogo Framework. The main areas for improvement are provided in the DRR exemplar;

- Procedural capacities for production and provision of climate services need to be developed for all levels including global, regional and national centres.

Detailed information on gaps/opportunities is provided in Appendix II.

A number of UN Agencies and programmes, through various activities including those of WMO technical commissions/groups, constituent bodies, co-sponsored programmes such as those of the World Climate Research Programme (WCRP) are currently implementing Capacity Development activities either through collaboration or individually that are relevant to the objectives of the GFCS and its pillars. Coordination and collaboration between agencies/institutions in implementing these activities save duplication and minimize expenses. Some of these activities are elaborated in Appendix III to this document.
2 IMPLEMENTATION OF THE CAPACITY DEVELOPMENT ACTIVITIES

2.1 The conditions for Capacity Development to contribute to a successful Implementation of the GFCS

In order for the GFCS to be implemented successfully and sustainably at the national or regional level it is important to identify the available capacity and then undertake an analysis against the user requirements as shown in Figure 2 above to identify any gaps. Selection of a small group of countries to participate in Phase 1 will allow sampling and analysis methods to be tested. In some cases the identified gap may be so great that it may be necessary to rescale the proposal to fit the anticipated sustainable resources.

The results of the gap analysis will identify the financial, human and institutional resources to implement the required capacity development activities and the collaboration and coordination mechanisms that are needed between various players including UN institutions, government institutions, Non-governmental organizations (NGOs) and the private sector. Therefore the necessary and sufficient conditions for a successful implementation of the GFCS are the following:

- Active National, Regional and Global User-Interface-Platforms are established;
- National Governments provide high priority in allocating resources to support all areas (human resources, infrastructural, procedural and institutional) of capacity development of national institutions such as NMHSs and others that are responsible for the provision and application/utilization of climate services;
- Strong national, regional and global collaboration and coordination mechanisms are established to support core GFCS Pillars’ capacity development activities especially for the priority sectors.

Figure 3 below outlines one variation of the general capacity development process which is composed of eight steps. Each step could equate to a capacity development action for a country, a group of countries or GFCS as a whole. In addition to specifying each action, it would also be necessary to identify who is responsible for undertaking the action, by when and who is responsible for overseeing the cycle. It is important to note that activities under steps 1 to 3, in most case, some work has already been done and therefore there is already some information from which baseline and gap analysis information could be drawn from, even though the available information could be incomplete or imperfect. Implementation of step 4 in the circle is the main issue that this Annex addresses so that the latter steps in the circle can work. Experience shows that whilst this is the overall flow, at a high level, there is often need for cycling back and forth between succeeding steps as more information becomes available.
2.2 **Engagement in the working mechanisms of potential partners at global, regional and national levels**

The Capacity Development activities under the Framework will systematically develop the capacity of the national climate services and climate services stakeholders, such as the four priority sectors, to enable all countries to manage climate risk effectively through the use of climate services. These activities will typically strengthen existing capabilities in the areas of climate services governance, management, human resources development, leadership, partnership creation, science communication, service delivery, resource mobilization and infrastructure.

It will be necessary for the GFCS to establish mechanisms that facilitate partnerships to implement capacity development activities through co-sponsorship and joint implementation as guided by the partners’ frameworks and systems. This spirit would include implementation of relevant GFCS activities for the supply and demand sides such as workshops/seminars, training and projects.

The success of the GFCS CD activities will require the involvement of many partners. There are a number of UN agencies, international institutions, Non-governmental organizations (NGOs) and others who have activities relevant to capacity development that can contribute to the implementation of the GFCS. The following list below (Table 1) provides just a few of the potential partners, as addressed in other GFCS Implementation Plan Annexes and exemplars, that have already indicated interest in collaborating in this respect and that will be potential partners in the implementation of the GFCS:
Table 1: An example of a few potential partners with interest in the implementation of the GFCS

<table>
<thead>
<tr>
<th>Organization/Institution</th>
<th>Engagement on CD activities contributing to the GFCS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human Resources</td>
</tr>
<tr>
<td>Global Climate Observing System (GCOS)</td>
<td>CD for Providers and users</td>
</tr>
<tr>
<td>International Fund for Agricultural Development (IFAD)</td>
<td>CD for users on the use to the agriculture sector</td>
</tr>
<tr>
<td>International Federation of Red Cross and Red Crescent Societies (IFRC)</td>
<td>CD for users in risk reduction and management</td>
</tr>
<tr>
<td>International Strategy for Disaster Reduction (ISDR)</td>
<td>CD for users on risk reduction and management</td>
</tr>
<tr>
<td>International Research Institute (IRI)</td>
<td>CD for users and providers</td>
</tr>
<tr>
<td>United Nations Educational, Scientific and Cultural Organization (UNESCO)</td>
<td>CD for Providers and users</td>
</tr>
<tr>
<td>United Nations Development Programme (UNDP)</td>
<td>CD for Users</td>
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<tr>
<td>United Nations Environmental Programme (UNEP)</td>
<td>CD for Users</td>
</tr>
<tr>
<td>Food and Agriculture Organization (FAO)</td>
<td>CD for Users</td>
</tr>
<tr>
<td>Organizational Entities</td>
<td>CD for (Users)</td>
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<tr>
<td>-------------------------------------------------------------</td>
<td>---------------------------------------</td>
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<tr>
<td>World Food Programme (WFP)</td>
<td>CD for Users</td>
</tr>
<tr>
<td>World Climate Research Programme (WCRP)</td>
<td>CD for Providers and users</td>
</tr>
<tr>
<td>World Health Organization (WHO)</td>
<td>CD for providers and users</td>
</tr>
<tr>
<td>World Meteorological Organization (WMO)</td>
<td>CD for Providers and Users of climate information</td>
</tr>
<tr>
<td>Global Producing Centres (GPCs) for Long-range Forecasts and Regional Climate Centres (RCCs)</td>
<td>CD for providers</td>
</tr>
<tr>
<td>African Development Bank (AfDB)</td>
<td>CD for both providers and users</td>
</tr>
</tbody>
</table>
World Bank (WB)  | CD for both providers and users | Supports infrastructural development in developing countries | Supports development of institutional frameworks and practices | Develops Standards and practices through developing training

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

The HLT report identified some potential projects that could be fast tracked in the implementation plan. The criteria for identifying these projects will need to address the HLT report priority areas. The main selection criteria proposed are role, relevance to the priority sectors and value of an activity for implementation of the GFCS at all levels, anticipated likelihood of its successful completion, demonstrated value and impact for the intended use, and cost effectiveness.

The following are some of the criteria to be used in prioritizing the identification of the projects and their associated activities:

- Does the project involve a developing or least developed country, a small island developing state, or a land locked country?
- Does the project build upon CD activities that already exists with some refocusing by expanding the area, locating in a new place, making it operational, or broadening its scope?
- Is the project achievable within the time frame and proposed budget? The project should have a high probability of success, and be able to deliver within the time-frame;
- Does the project speak to the Feedback, Dialogue, Monitoring and Evaluation or Literacy outcomes of the GFCS pillars?
- A project that builds upon, not duplicating, the partnerships in place between existing organizations and groups;
- Does the project take an approach that involves capacity development of climate information providers and users throughout?
- Does the activity contribute to the stated necessary and sufficient conditions for capacity development (Section 2.1)?
- Does the project result in contributing to the GFCS objectives that would have not been possible by individual entities?
- Does the project fills gaps and develops capabilities so that services are improved in quality, quantity and can reach all those in need?
- Does the project have a demonstrated value and impact for the intended use?
- Does the project have a sustainable impact to those who need it?
- Is it a cost effective project for the invested resources?

2.4 **Implementation of activities at global, regional and national levels**

The implementation of the GFCS activities will follow the eight HLT governing principles (WMO, 2011a). In addition, the activities that will be implemented especially during the first six years of the implementation of the GFCS will address the four priority sectors of agriculture, water resources, health and disaster risk reduction. Although capacity development is a long-term activity it will be necessary for the GFCS to fast track implementation of some activities to raise
the capability of all relevant institutions to at least a level of capability of providing basic to essential climate services (see Fig.1). In regions where there are many countries functioning at only basic climate services levels, the establishment of a regional climate institution could improve, through NMHSs and other relevant institutions, the capabilities of those countries considerably, while the national entities undergo other improvements. It is therefore important to address the GFCS Implementation Plan in accordance to the activities of the four components specified in section 1.1 above at national, regional and global levels.

2.4.1 Implementation activities at national level

The need for capacity development in provision of climate services at national level, especially in developing and least developed countries is very high. It is important to note that these countries are the source of almost all observational data and products for use within country and exchanging internationally. A detailed list of activities to be implemented at national level is given in Appendices IV and V. These include those activities that are meant to build capacity to interface with users of climate services (Appendix IV) and activities to develop capacity of national climate services (Appendix V) respectively.

2.4.2 Implementation activities at regional level

The HLT indicated that no single country could by itself develop all the required capabilities to provide advanced national climate services. They recommended efforts be made to establish regional climate centres. The Taskforce recognized the difficulties regional centers normally face; difficulties in reaching agreement on which country or institution in which to locate the centre; and, difficulties, especially in developing countries, in getting sustainable sources of funding to support their operations. The HLT therefore recommended that an effective network of regional centres be established by the end of 2021.

This target will require strengthening existing centres through their own voluntary effort as well as with assistance from governments and partners (Appendix VI). It will also be necessary to create new centers in new areas particularly in regions where there are clusters of highly vulnerable countries with low climate services capacity (Appendix VII). The roles and activities of these regional climate centres will vary according to the specific interests and needs of the region. Minimally, a regional climate centre would carry out operational activities that would, among others, include: capacity development of climate experts and users within the region through workshops and other forums, generation of regional and sub-regional climate information and products (particularly for climate system monitoring and Long-Range Forecasting (LRF) and outlooks), interpreting and assessing relevant seasonal analysis, prediction and climate change scenario products from global centres, and establishing historical reference climatology for the region and/or sub-regions, and preparing regional climate watch. The following are the typical capacity development activities that would be required for the regional centers to assist the national centres:

- Implement broadband high-speed internet access in support of climate research, modelling and prediction;
- Improve human technical capacities on expertise to generate appropriate climate information and products that are needed by users through strengthening research and operational capacities;
- Provide modern equipment with new technologies to support the operational activities of the centers;
- Organize workshops/training to enhance interaction with regional and national users.
2.4.3 Activities to build capacity at global level

There will be a need to implement certain climate services activities at global level that will have impact at regional and national level (Appendices VIII and IX). One example is the implementation of the Global Producing Centers (GPCs) of Long-Range Forecasts which produce global-scale climate products that are downscaled at regional and national levels (Appendix VIII). These GPCs are, however, implemented by developed countries that have a high level of technological and economic capacity, and may not require infrastructural, human resources and institutional capacity development through the implementation of GFCS but they may need capacity especially on issues like user interaction. Another example is the implementation of Global Climate Observing System (Appendix IX). A large number of improvements in observing systems at global scale are needed which translate to the needs at regional and national scales. The actions, for example, that are identified in the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC, are all in some way relevant to the GFCS especially in the implementation of its activities in the priority sectors of agriculture, health, water resources, and disaster risk reduction. The following are some of the activities for implementation at a global scale:

2.4.3.1 Activities to improve mechanisms for data exchange between centres, countries and users

The mechanisms and policy for the exchange of climate services data and products (meteorological, climatological, hydrological, environmental and societal) between providers of information, users and countries will be a key component of GFCS. For example, the WMO Information System (WIS) is a single coordinated global infrastructure responsible for the telecommunications and data management functions for WMO Members. WIS provides an integrated approach suitable for routine collection and automated dissemination of observed data and products, as well as data discovery, access and retrieval services for all weather, climate, water and related data produced by centres and WMO Member countries. WIS is capable of storing and exchanging large data volumes, such as those from new ground and satellite based systems, for handling finer resolution data and products from numerical weather prediction models and climate models, and in their applications.

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

Consistent with the above it will be necessary for the GFCS to have activities that will be promoting developing capacity in line with the implementation of WIS at regional and national level. These activities will include the following:

- Acquire new and replacement of the aging Automatic Message Switching Systems at national climate centres;
- Develop a policy for countries to support the establishment of appropriate networking for easy exchange of relevant data and products;
- Rehabilitate/modernize national centres telecommunication networks for data collection and transmission facilities along the WMO WIS/GTS guidelines;
- Implement broadband high-speed internet access;
Upgrade/modernize media systems at the climate centres for information dissemination. However, it must be noted that options for exchange of data used by other partners, other than the WMO WIS, should be examined and taken on board as appropriate during the implementation of the GFCS.

2.5 Initial Implementation activities/projects

The initial implementation activities and projects are elaborated in Appendices X and XI. These activities will be responding to some of the CD activities that are raised in the Annexes of O&M, UIP, and RMP and CSIS Pillars and the exemplars prepared for the four GFCS priority sectors. These would include the information given below, with the bracket information identifying the associated GFCS pillar(s):

- Organizing application pilot projects to enhance use of climate information and products (UIP pillar);
- Improvement of product generation and use, through collaboration with users and other stakeholders including use of the extensive national level planning and consultation that has been achieved under such activities as the National Adaptation Programme of Action (NAPA) in Least Developed Countries (LDC) (CSIS / UIP / RM&P pillars);
- Strengthening of the Observing Network in developing and least developed countries and Small Island Developing Countries (O&M pillar, UIP);
- Improvement of Meteorological Telecommunications and communication systems (O&M/RM&P / CSIS pillars);
- Improvement of the level of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services for the priority sectors) including procedural issues (RM&P, CSIS pillars);
- Improved institutional capacity of national and regional centres to provide relevant, reliable and timely climate and weather services (CSIS pillar);
- Strengthening research and operational capacities of the global, regional and national climate centres such as the GPCs, WMO RCCs and NMHSs to function as efficient network of coordination, development and dissemination centres (CSIS and RM&P pillars).

2.6 Implementation approach (including operational and organizational aspects)

The implementation approach is based upon the eight HLT principles and builds upon activities already underway by providers and users to improve the access to climate services of those countries that do not have capacity to produce climate services which their communities need. The first priority should be to building capacities of national institutions that are (or will be) providing climate services at national level. The second level of priority should be for regional institutions as these can help to solve problems associated with countries that do not have the financial and human resources to provide the needed services. The GFCS Implementation Plan proposes that the approach in implementing each activity will be influenced by whether it is dealt with at the global, regional or national level. Therefore the implementation approach should be undertaken to create efficiencies, delineate responsibilities, and maximize value at each level, for example:

- The development of international standards and products will be best developed through coordination at the global level;
• Regional access to information, development and delivery of products for regions, some aspects of training and capacity development and some aspects of establishment of relationships between producers and users will be best undertaken at the regional level;
• Development and delivery of products for the national and local scale, establishment of relationships between providers and users, training and capacity development will best be taken at the national level.

In developing capacities of national climate services the GFCS will need to implement activities given Appendices X and XI which, in most cases, address GFCS CD activities. The GFCS working with relevant UN Agencies, programmes, institutions, and other stakeholders will have to follow an approach with these steps:

• Develop, between 2012–mid-2013, an action plan on how the GFCS is to be implemented to address the priority sectors in the countries that need basic climate services; and identify areas for initial implementation;
• Between mid-2013-2017, initial implementation of the activities as planned;
• Between 2018-2022 Assess progress and expand implementation to new sectors and areas as necessary.

For example in implementing activity number 2 on training of personnel from climate services, it will be necessary for the GFCS to collaborate in planning and implementing the activity with all relevant stakeholders including the WMO and its co-sponsored programmes, academia and research institutions and other relevant programmes from other UN agencies. This will help in identification of the required activities to meet the demand of the countries and stakeholders that need support to establish or improve their climate services through enhanced capacity of human resources. Through this planning which involves all relevant partners, a strategy will be developed that will guide the implementation process of that particular activity. It is important to note that there may be need to organize a meeting for these people to come together during the planning or initial stage and follow up meetings during the implementation stage of the activity as necessary.

This strategic approach could be followed for the implementation of all the other proposed activities described in Appendix XI.

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

The implementation of activities will need to be continuously monitored both at the implementation plan and project level to ensure that the process is moving in the right direction and to solve problems that may occur in the process. Whilst the overall governance will be a decision of the governing body it will be necessary to develop a GFCS Monitoring and Evaluation (M&E) Plan template based on specific indicators. The template will facilitate the monitoring and iterative reporting on progress of GFCS initiatives. The template’s primary focus will be on monitoring progress towards addressing deficiencies in the ability of climate services providers to fulfil the requirements of the users. More importantly, the M&E plan should assist monitor and evaluate how the overall objectives of the Framework are being met, that is, how the use of quality climate information fares within the priority sectors of the GFCs. It will be necessary to monitor and evaluate the progress of the Framework itself from a results-based perspective. For this to succeed it will be important and necessary to:
• Develop methodology/modalities to assist providers of climate services incorporate Monitoring and Evaluation into CD investments and participate in data gathering which will be reported/published periodically and used for continuous improvement;
• Make relevant Monitoring and Evaluation data for climate services providers available for access by stakeholders including partners and investors;
• Develop modalities for evaluation reports, monitoring reports, and any other periodic reviews of progress and implementation of the GFCS and ensure findings and lessons learned are made available to its relevant Technical Management Committees and the Interagency Board for continuous update, improvement and implementation.

The monitoring and evaluation (M&E) of the GFCS activities could perhaps/ideally be undertaken by relevant stakeholders at the regional level with WMO Regional Associations (RAs) ideally being the leads. The M & E should then be part of the routine RAs' and other relevant stakeholders' M&E of their Strategic Operating Plans (SOP). Establishment of real and quantifiable baselines and monitoring of deliverable execution are significant to the success of the M&E process. Tools and methods used to establish baselines need to be determined. Surveys at global levels, the tool used often to establish baselines for global initiatives, are often superficial. Regional (and national) surveys are more reliable, thus the recommendation to focus the M & E at the regional level.

2.8 Risk management in GFCS Capacity Development

The risks associated with the GFCS can be summarized as follows:

• Poor or incomplete definition or too wide a scope of the needs from the GFCS pillars;
• Inefficiencies or ineffectiveness of the processes and procedures for identifying and resourcing GFCS “approved” Capacity Development activities;
• Misusing or moving the funds to other areas;
• Implementation difficulties of the Capacity Development activities;
• Problems related to long term sustainability of the Capacity Development activities;
• Interests of stakeholders not converging into the stated objectives;
• Involving not the right people in the particular activities that is being advanced and thus the cooperation and coordination expected are not achieved;
• Poor coordination of interdependent projects;
• Partners do not cooperate in defining the full requirement of the required information; and
• Duplicating activities that are already being implemented by other stakeholders.

For a pillar like UIP most of the above risks can be addressed through clear, decisive leadership from the highest level of governments and other institutions, as risk stems from inherent defensiveness within bureaucracies at departmental/institutional or sectional level. Much also depends on how the interaction between the private and public sectors is established, which will vary between countries. Mobilizing and sustaining financial resources at global, regional, and national levels will also be important factor.

At an individual project level in the implementation of such a complex multi-national and multi-institutional structure there will always be risks involved which will somehow affect the implementation of the GFCS. Active project management should be able to identify and control such risks. In such cases the multi-partner and multi-national aspects of GFCS related projects suggest that the following risks need to be addressed:
- Falling short of funds before completion of the activities;
- Stakeholders not being wholly supportive to the activities;
- Poor leadership in implementing the various activities;
- Lack of transparency in the management of the implementation of the activity;
- The potential for inadequate implementation if human resources are not available.

To manage these risks it will be necessary to spend time at the early planning stage of implementation, to identify likely risks and their risk mitigation strategies that will need to be taken in order to rectify the situation.
3 ENABLING MECHANISMS

3.1 Synergy with existing activities.

There are many activities on capacity development that are currently being implemented at global, regional and national levels which are similar to the GFCS’s planned capacity development activities. The UN system through its different programmes is already carrying out many relevant capacity development activities such as those on developing human resource, infrastructure development, procedural issues and user capacity. FAO, WFP, IFAD, WHO, UNDP, World Bank, International Strategy for Disaster Reduction (ISDR), WMO through its various programmes, UNESCO with its Intergovernmental Oceanographic Commission (IOC), co-sponsored entities such as Global Ocean Observing Systems (GOOS), GCOS, WCRP and many others all have some capacity development activities which are similar to the GFCS’s capacity development activities in those areas given above (see also Table 1). Similarly there are some regional and sub-regional entities that are either implementing or supporting these activities. It will therefore be important for GFCS, during its implementation stage, to partner with such entities that are implementing activities with objectives similar to its capacity development pillar and provide a mechanism for these agencies to exchange relevant information on their activities. This would reduce risk in duplicating activities thus saving resources that can be used in other areas of implementing the GFCS.

3.2 Building national, regional and global partnership

In order for the GFCS to successfully implement its activities for all its pillars it will be necessary to have strong partnership with various entities and stakeholders at national, regional and global levels. This would require Infusion of highly-skilled human scientific talent via training and capacity building, especially through young scientists and, importantly, in the developing regions of the world. Developed countries must work with developing countries in transferring capacity, technology, education and computing facilities.

3.2.1 Building National Partnership

At national level, during the implementation of the GFCS, strong partnerships are needed with the national climate services providers which in many countries, especially the Developing and Least Developed Countries are the NMHSs. Partnership with these institutions is important because these are the institutions providing climate information and products to various users at the national level and work with entities such as Red Cross, NGOs and others that use the information to address issues at grass root communities. The capacities range from human resources, infrastructure user interaction and others. In addition to the partnership with national provider institutions the GFCS will need to partner with other national stakeholders including research institutions, universities, private sector, government departments and others that address issues relevant to climate variability and change. Partnership with NMHSs will also be important in facilitating establishment of national framework for climate services which aim at linking together national providers and users of climate information. The working mechanisms of partnership and collaborations would conform to either existing national level arrangements or forge new relationships through the respective NMHSs.

Country assessments are needed to accurately determine the scope of required capacities and help formulate appropriate capacity development responses, as well as to better prioritize investments. Therefore under the GFCS strong partnerships will be necessary, between NMHSs and other national climate services providers through facilitating the following:
• Assist Member Countries to in identifying capacities needed to meet national priority-driven service requirements;
• Assist countries to engage grass root agencies in using climate information and products;
• Assist countries in identifying deficiencies through role and operation of national climate services providers guidance material and country assessments. Expected role of national climate services providers in national and international contexts will be used to inform the process;
• Categorize climate services providers according to the level of services and use the categories to guide assistance given to achieve GFCS’ addressing its priority areas. The categories will also be linked to the human, institutional, infrastructural and procedural capacities needed to provide the corresponding levels of service.

3.2.2 Building regional and sub-regional partnership

There are already a number of regional and sub-regional entities at regional level that are providing capacity development activities on climate services. These activities include modelling and climate prediction, packaging of information and supporting national climate services providers in the region. These institutions include such as those of ICPAC in Nairobi (Kenya), Centro Internacional para la Investigacion del Fenomeno de El Nino (CIIFEN) in Guayaquil (Ecuador), the African Centre for Meteorological Applications and Development (ACMAD) in Niamey (Niger), Beijing Climate Centre in Beijing (China), Tokyo Climate Centre in Tokyo (Japan) and others. There are also regional entities that provide resources to build capacities of regional institution working on climate issues. These include regional banks, Regional Economic Communities and others. Therefore the GFCS will have to partner with these regional institutions so that it can benefit from the experience they have gained so far.

3.2.3 Building global partnership

Partnership of the GFCS on capacity development with relevant global entities is necessary for its short and long term sustainability. At global level there are global centres that produce climate products which are received at regional level and are then downscaled at regional and sub-regional levels. There are also the UN agencies and programmes which have good capacity development programmes which range from human resources through infrastructural tools and software. Details of some of these activities are elaborated in the other GFCS Annexes and Exemplars. The GFCS will have to partner with these entities to ensure that the products provided meet the demands/needs of the users.

3.3 Review Mechanisms

It must be noted that the evaluation of Capacity Development activities promotes institutional arrangements, leadership, knowledge and accountability. This step defines the process of monitoring and evaluation of the overall CD actions, not only at the end of an implementation phase but throughout the process at defined intervals.

In the proposed structure of the Framework an Interagency Board on Climate Services, open to membership of all countries, will be established that will make use of the quadrennial intergovernmental World Meteorological Congress to act as a channel of accountability, and for all formal intergovernmental decisions. Plenary sessions of the Board, involving all interested governments, would meet periodically, probably biennially, and would make decisions following the processes of the WMO Congress.
Under the Board there will be the Technical Management Committees, responsible for the activities under each of the five pillars which would oversee the Framework’s implementation activities. Mindful of the need to avoid duplication by making use of existing committees and mechanisms of the UN system, the HLT recommended that leadership and membership of the five committees may have an overlap membership with existing entities in the UN System. Specifically, the HLT recommended that the Technical Management Committee for the CD (and also that for UIP) would benefit from a federated approach for leadership meaning that a programme like the United Nations Development Programme (UNDP) would be valuable to lead the CD activities.

Considering the multi-agency nature of the Technical Management Committee, it will be important to establish a review mechanism of the GFCS CD implementation. This mechanism will include participation of technical committees formed by representatives of relevant entities from the UN Agencies. For example WMO would include participation of experts from any of the following areas such as WMO Education and Training, Commission for Climatology (CCl) and Commission for Basic Systems (CBS) in conjunction with NMHSs. Similar representations to the team would be made from other UN Agencies and stakeholders. The report from the technical committees would be presented to the Technical Management Committee which will review it and, as appropriate, take action or submit it to the Board for its consideration as appropriate.

3.4 Communication Strategy

The Framework being a multi-agency, multi-institutional and an intergovernmental body will need to establish a system of communication, both at global, regional and national levels, which will be responsible for issuing reports regularly on the activities of the Framework to all involved institutions and the general public. Therefore an overall Communications Strategy for the GFCS will need to be developed that will have a list of objectives and will identify ways of achieving them, involving a wide variety of communications methods and media.

Among the objectives of such an overall Communication Strategy will be to:

- Create and increase awareness of the need for, and benefits of, climate services in helping all of society adapt to climate variability and change;
- Engage support for the Framework from all stakeholders, including the user community, the service developers and providers, governments and donors by promoting the significant benefits the Framework will bring and how it will achieve them, and through dialogue, foster a sense of ownership among stakeholders to ensure the long-term viability and success of the Framework;
- Strengthen brand recognition of the Framework so that communications are spread outwards from the Framework by different stakeholders and actors in a dynamic and interactive fashion which gains its own momentum;
- Improve climate literacy in the user community through a range of public education initiatives and on-line training programmes. The Framework, through the UIP, will address the need for advocacy of climate services to the global, regional, and national level communities and the opportunities for sector-oriented training and related capacity development initiatives.

Information on the GFCS would be passed to all interested parties through various forms of media and a mailing list available within the responsible secretariat. The media, in all its forms (the printed media, the electronic media, internet and telephone) can be used for this purpose depending on who needs the information, effectiveness of the method and at what time. In this
case the private sector, through its heavy involvement in all major forms of media content, is a critical intermediary in the consumption of climate services. Beyond this arrangement many other intermediaries could assist the flow of climate information to individual users at different level including communities. Many non-governmental organizations working in disaster and humanitarian relief are consumers of climate services and act as intermediaries passing on advices and warnings to local communities who are the end users. Local and provincial governments, with planning and disaster management response responsibilities are consumers of climate services and can also act as intermediaries, passing on climate information to end users.

Reports on the Framework’s pillars’ activities presented at various meetings, conferences and workshops/seminars will also help to communicate messages on the activities of the relevant pillars if not the Framework as a whole.

These efforts will help the GFCS pillars in:

- Contributing information that will strengthen the central, positive message about the value of climate services;
- Providing information on links with other activities and reporting on early success stories;
- Provision of information that shows its relevance to the activities of the GFCS;
- Using its direct contacts with the user communities and with intermediaries to promote GFCS in appropriate ways.
4 RESOURCE MOBILIZATION

4.1 Resource mobilization at national level

Resource mobilization at national level will target Governments and the private sector. There are Foundations, bilateral and multilateral funding mechanisms, international agencies that provide funding in the countries but in most cases funding from these bodies comes through the government. It is important to note that funding at national level depends very much on how the government prioritizes the sector. If meteorology is among the high priority sectors in the country then it will be among the sectors to get government funding and also funding from bilateral and multilateral funding mechanisms, and international agencies as the priority for funding from these bodies is usually vetted by the government. It is noteworthy that in a number of countries, governments have experienced the catastrophic climate related disasters that impact their nations and have realized the need to adapt to these impacts and mitigate them. Therefore some governments have realized the need to invest in the meteorological sector and giving it high priority within their national budgets and provide support to the sector in getting funding from external entities. Funding from private sector and Foundations is not yet a common thing especially in developing countries where priorities could be on other social issues not climate services. Therefore the GFCS, during its early part of implementation, need to work with climate services stakeholders to sensitize governments, through showing the economic value of the climate services, and thus the need to invest on them. To enhance the level of in-country and external support to climate services stakeholders it is imperative to advocate strongly the importance and value of climate services in support of the national development process. In this respect, GFCS will assist the climate services providers in their efforts to demonstrate the social and economic value and benefits of weather, climate and water products and services by:

- Undertaking feasibility studies with a socio-economic benefit assessment component;
- Standardizing methodologies for the evaluation and demonstration of the socio-economic benefits;
- Undertaking case studies, collecting “best practices” for wider use;
- Supporting strong advocacy programmes at the national and regional levels; and
- Undertaking community consultation and information workshops in order to ensure full participation of communities in the planning process at the start of the implementation phase.

It is hoped that this exercise will help governments and attract private sector and Foundations to increase the level of funding to the relevant climate services providers.

National ownership of any process is the foundation for the enabling environment needed to ensure sustainable development of that process at national level. The Engagement Strategy proposed in the WMO CDS will seek to create closer cooperation and partnerships between government ministries and departments that are responsible for institutions such as the NMHSs and those sections of government responsible for setting national priorities to secure political buy-in and good will in favour of climate services providers within countries. Expected results are that countries will recognize the national and international significance of investing in climate services providers as part of their national development priorities, and in essence, demonstrate ownership and commitment needed for sustainable development of these institutions under GFCS at national level. To realize this, the GFCS will have to:
• Prepare and support climate services providers as they engage with their governments to secure national ownership and buy-in based on requirements, benefits and deficiencies;
• It should also be noted that socio-economic benefit (SEB) analysis should not just be performed to convince senior decision-makers of value, rather it should be performed regularly to help climate service providers understand and prioritize societal needs for their business and investment planning;
• Assist climate services providers define and establish modalities for partners and stakeholder engagement at country and at regional levels. Coordination amongst partners will avoid duplication and foster the sharing of resources. This coordination will be needed to develop, mobilize and harmonize investments for the capacity development of national climate services institutions such as NMHSs of various countries;
• Take into account, the contribution of climate services activities to the achievement of the United Nations Millennium Development Goals, and national development plans and action plans of least developed countries and small island developing States;
• Take opportunity of the significant in-country financing opportunities that could exist through the national budgeting processes, overseas missions and embassies, the United Nations “One UN” country funds, the Global Environment Facility and other mechanisms. Resource mobilization will need a focus on assisting national climate services providers and other relevant institutions to avail of these in-country financing opportunities through training seminars and direct support; and
• Find an alignment between the stated priorities of the donors and the priorities identified within regional strategies and national plans.

4.2 Resource mobilization at regional level

As already pointed out above, the GFCS will have to work with countries and regional stakeholders in order to find resources needed to strengthen the capacities of regional climate centres and to launch new potential ones for providing climate services within the region or sub-region. The GFCS should work with Regional Economic Communities (RECs) where they exist. This is important because in some cases funding to support the centres has to come through the respective RECs or other regional administrative blocks, for example African Union (AU). Therefore the RECs need to understand the importance of climate services for the social economical development of the region. The GFCS in working with the respective RECs and other stakeholders should be able to solicit funding from regional funding bodies such as the regional development banks (for example in Africa, the African Development Bank and in Asia the Asia Development Bank etc) and funds channelled through UN agencies such as UNDP, UNEP, ISDR, WMO and others which are specifically earmarked to support activities within that respective region.

4.3 Resource mobilization at global level

At global level the GFCS will have to work with the UN agencies and programmes to get funding from them to support its activities that are relevant to their areas of responsibility. It will also work with them to solicit funding from their Members, for example WMO through its Voluntary Cooperation Programme (VCP) activity can help to get funds that can support developing capacity of a number of countries that need support through the GFCS CD Pillar.

The GFCS should engage bilateral and multilateral funding mechanisms such as those of the World Bank, European Union (EU), all countries (e.g. supporting capacity development), disaster relief agencies and international agencies for funds to support its activities. Most of
these bodies and countries through their multilateral activities are very much aware of the need to address climate related issues especially in developing and Least Developed Countries and SIDSs and understand the need to support capacity development of these countries in addressing climate related issues.

At global and regional level the GFCS will have to support mobilization of resources, among others ways, through:

- Identify development needs at the regional and national levels in association with regional associations, Permanent Representatives and Regional Offices;
- Sensitize development partners and national governments to the value of climate services and the economic benefits that building greater capacity of relevant institutions can bring to a variety of users;
- Develop a comprehensive understanding of the needs and operations of funding agencies and development partners, including their project cycles and priorities and transmit this information to UN Agencies and programmes, Regional Offices and Permanent Representatives;
- Facilitate development of and source financial support for high-impact hydrometeorological infrastructure and service development projects by engaging with existing and potential development partners for establishment of multi-annual framework agreements and partnerships agreements for joint regional and national interventions;
- Engage and establish mutually beneficial relations with the private sector and establish private-public partnerships as appropriate.
5 COSTED SUMMARY OF ACTIVITIES/PROJECTS
The successful implementation of GFCS will be a flagship activity and should assist all countries improve the security and safety of their citizens, minimize the risk of property and economic loss as a result of climate change and variability. Global collaboration, coordination and goodwill are necessary for this to occur, in no other area more than capacity development. The summary of proposed activities and projects including estimated costs is given in the Table 2 below. The cost estimates for the activities in Table 2 are for the implementation periods of 2012-2013 and that of 2014 to 2017. The cost for the activities between the period 2018 to 2023 will be determined at an appropriate time during the initial implementation period and its estimates, as per the HTF Report budget for capacity development activities, will be within the range of those considered for the period 2014 to 2017.
**Table 2: Costed Summary of activities and projects**

<table>
<thead>
<tr>
<th>Activity Number</th>
<th>Activity</th>
<th>2012-2013 (Cost US$ x M)</th>
<th>2014-2017 (Cost US$ x M)</th>
<th>2018-2023 (Cost US$ x M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial planning for implementation of the GFCS. An action plan for the CD activities will be developed through the involvement of all relevant stakeholders and pillars.</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Training of national climate centres’ technical personnel. This will involve the training of technical staff such as meteorologists and other support technical staff in areas such as climate modeling and down scaling of climate information thus enhancing provision of climate information and products for key sectors to facilitate activities such as national planning in areas like climate variability and change adaptation.</td>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Development of capacities of national climate centers’ infrastructure including computing facilities. National climate centres from developing, LDCs and SIDSs will need to be equipped with modern technological computing facilities that will enable them to cope with the needs raised from users on climate services.</td>
<td>2</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Establish mechanisms to enhance interface of climate services providers with users of the priority sectors through pilot projects and other activities such as Regional Climate Outlook Forums (RCOFs), MALOF and others as defined in the other GFCS Annexes and Exemplars.</td>
<td>2</td>
<td>30</td>
<td></td>
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<tr>
<td>5</td>
<td>Establishing the four new planned WMO Regional Climate Centres through provision of new technological equipment, human resources, supporting development of relevant research through</td>
<td>2</td>
<td>35</td>
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<td>6</td>
<td>Strengthen existing regional climate centres and establishing new ones, as need arises, to meet the user needs. Available regional climate centres need to be strengthened and new ones to be developed according to the regional demands. Activities will include provision of new technological equipment, improving relevant research through exchange programmes, and new services.</td>
<td>1</td>
<td>30.</td>
<td></td>
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<tr>
<td>7</td>
<td>Enhancement of the capacity of global observing network. There is an urgent need to maintain and upgrade the global coverage of modern observing systems, especially by closing the gaps in observations in the tropics, polar and mountainous regions, increasing the density of observations in poorly sampled regions, and enhancing the observations in the deep oceans and the upper part of the atmosphere. Intensification of surface observation systems such as radars will be required in addressing water resources related issues. Ensure standards for instrumentation and observational techniques as developed by international experts to meet international requirements.</td>
<td>2</td>
<td>75</td>
<td></td>
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<tr>
<td>8</td>
<td>Enhance capacity of global climate centres through improving relevant research through exchange programmes, advanced technological systems and provision of new services.</td>
<td>1</td>
<td>20</td>
<td></td>
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<tr>
<td>9</td>
<td>Improve mechanisms for data management and strengthening data recovery and digitization (data rescue) to support activities such as disaster loss accounting and cost-benefit analysis under the DRR and exchange at global, regional and national levels through provision of new technological facilities.</td>
<td></td>
<td>20</td>
<td></td>
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<tr>
<td>10</td>
<td>Strengthen regional and national telecommunication networks especially in Developing Countries, LDCs</td>
<td>2</td>
<td>20</td>
<td></td>
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<tr>
<td></td>
<td>Support Institutional framework and policy capacity development of NMHSs and other national climate services providers and users. In the case of users, the framework’s principles include the involvement of all the stakeholders. The Framework can support risk governance and implement its inclusivity principle by ensuring that its priority implementation activities provide benefits at the local level.</td>
<td>1</td>
<td>3</td>
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<tr>
<td>11</td>
<td>ESTIMATED TOTAL</td>
<td>16</td>
<td>298</td>
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APPENDICES

APPENDIX I: EXISTING CAPACITY DEVELOPMENT ACTIVITIES IN THE GENERATION OF CLIMATE INFORMATION AND PRODUCTS.

1. A tiered approach

The HLT Report provided detailed information on those activities which are being implemented at national, regional and global levels to address generation, provision and user advocacy of climate services. These activities are grouped into four main areas that include developing; capacity for the generation of climate information; capacity for Climate Information Users; Infrastructural capacity; and, International Collaboration in relevant capacity development activities.

With respect to global and regional capacity development for provision of climate services, the United Nations (UN) Agencies and other partners have realized that it is not possible in the short term to build the capacity of each provider institution to the level of being able to support advanced climate services. Therefore with this understanding, WMO and partners are creating networks of global and regional operational centres to assist the World Meteorological Organization Members and their institutions including NMHSs to meet the climate–related needs of social and economic systems in their countries. This worldwide three-level structure includes, inter alia, National Meteorological and Hydrological Services acting on a national scale, WMO Regional Climate Centres (RCCs) providing sub-regional, continent-wide climate information and services as well as WMO Global Producing Centres (GPCs) of Long Range Forecasts (LRFs) that deliver global-scale information and services. The WMO initiative of establishing RCCs is the responsibility of its CCI and CBS and relevant programmes, and its constituent body, the Executive Council (EC), whereas at present, GPCs are designated through CBS and EC. These centres are being established in collaboration with the respective regional member countries, regional economic groups in some cases, and the WMO Regional Associations. GPCs and RCCs are established and operated as Centres of Excellence, and the criteria for their designation are within the WMO Technical Regulations.

The above initiatives ensure that all the global and regional entities that have been (or will be) developed and operated as designated entities of WMO, will abide by the relevant WMO and other partners standards, regulations and data policies. It is important to note that it is recognized and respected within the three level structure that services on a national and local scale (which is probably the most relevant to climate services) and most direct user-liaison should be provided by national institutions except where all parties agree otherwise.

Issues and concerns related to providing global and regional climate services vary by location and circumstances. In most cases global and regional centres operating in developed countries experience relatively fewer and less serious financial, human resources and infrastructural problems than those operating in developing countries. Centres operating in developing countries not only face a lack of sustainable financial resources to support the infrastructure and operations, but they also often lack qualified new recruits and insufficient funds for training of personnel and insufficient Internet and communications functionality.

The current infrastructural capabilities of national climate services providers can be gauged from the following classification: basic, essential, full and advanced capacities (see Fig. 1). For example, the NMHSs classified at present in basic and essential categories (i.e. minimum to
average provision of climate services) are in many cases from developing and least developed
countries (notably, several developing countries function at a strong level in climate services,
and are technically advanced). In some countries with basic to essential only capability, some
effort is currently made to improve their infrastructure of observation network, and product
generation and communication facilities, and in training for seasonal prediction, data rescue for
example in order to help them improve their capacities in provision of climate services. These
efforts are in most cases not coordinated or systematic, and there is inadequate funding to
address all gaps.

2. **Human capacity in the generation of climate information**

There are a number of UN Agencies such as WMO, UNEP and UNDP and other international
organizations and institutions that have and still continue to build human capacities of climate
information providers. The World Meteorological Organization, as a UN specialized agency in
weather, water and climate, has played a leading role in coordinating the development of
weather and climate scientist skills through promoting access to training programmes by
providing fellowships, relevant technologies, manuals, guidance documents, technical papers
and workshops and by development of the appropriate competencies for climate work that will
affect education and recruitment of new staff for a range of climate activities that will be
increasingly developed under GFCS. There are currently 23 World Meteorological Organization
Regional Training Centres and a network of cooperating universities and advanced training
institutions that contribute to the education and training effort in meteorology and hydrology as
well as to establishing and developing specialized centres of excellence in various regions,
especially, Developing and Least Developed Countries. The main focus of training activities in
Regional Training Centres (RTCs) has been and currently still is, however, on training of
weather forecasters and meteorological technicians for weather services, rather than on training
climatologists and meteorologists for climate services.

While most of the focus has been and currently still is on training of weather forecasters and
meteorological technicians rather than climatologists per se, there has been progress made in
many parts of the world through World Meteorological Organization Climate Information and
Prediction Services (CLIPS) training workshops (WMO, 2011h) which have helped to create
some national capacity to develop and deliver climate information including seasonal outlooks.
Furthermore considerable effort has been made by CCl in conducting training for meteorological
personnel in climate activities for Data Rescue (DARE), in data management and the use of
Climate Database Management Systems (CDMS), as well as in development of climate indices
for climate change detection.

Since the late 1990s there has been progress made in many parts of the world in climate
training, through the World Meteorological Organization Climate Information and Prediction
Services (CLIPS) Project. CLIPS training workshops have helped to create national capacity in
developing countries to operationally produce and deliver climate information including seasonal
outlooks. CLIPS and other training programmes targeting the development of seasonal climate
forecasting expertise have been held around the world, with support from centres such as the
IGAD Climate Prediction and Application Centre (ICPAC) in Nairobi, Southern African
Development Community (SADC) Climate Services Centre (CSC) in Botswana, Australian
Bureau of Meteorology, the China Meteorological Administration, the United States-based
International Research Institute (IRI) for Climate and Society, the Korea Meteorological
Administration, the United Kingdom Met Office, Météo-France, Tokyo Climate Centre, the
Climate Prediction Centre (CPC) of the United States National Oceanic and Atmospheric
Administration (NOAA) and Ministry of Earth Sciences in India. Many of these programmes
have been hosted by WMO Regional Climate Centres and other centres dealing with regional climate issues and have undertaken fairly regular capacity development activities linked to the Regional Climate Outlook Forums (RCOFs).

WMO hosts other climate-relevant training activities, including the Global Atmospheric Watch Training and Educational Centre (GAWTEC) training initiative of the GAW programme, which develops capacity in the specialized field of atmospheric composition monitoring, calibration standards and data quality control. As well, WMO Members such as USA (COMET) and the UK provide comprehensive training in basic climatology and in climate statistics through online activities and workshops.

A number of academic institutions including universities and research centres in many parts of the world have continued to contribute in the training of experts in various aspects of climate and climate services, and in a number of Universities, climate has now become part of their curriculum, in addition to the more typical meteorology and geography degree programmes. For example in Africa, the University of Nairobi (Kenya) has been offering a Science Master’s degree in Climate Change. The contribution made by such institutions in developing capacities, especially human resources and research, in the area of climate services cannot be underestimated.

To accomplish its mission, the World Climate Research Programme (WCRP) in collaboration with other partners engages the international Earth/climate system science community and forges strategic partnership to ensure a vibrant workforce who will guide the Programme and support its goal and objectives. Therefore the WCRP long-term success depends on the continued engagement of the international science community, especially those from developing nations, through strategic partnerships with WCRP sponsors, the International Council for Science (ICSU), the Intergovernmental Oceanographic Commission (IOC) and WMO and sister organizations such as the Global Change System for Analysis, Research and Training (START), Asia-Pacific Network for Global Change Research (APN), International American Institute (IAI), and others. Through its activities and under the strategy for education training and capacity development WCRP is striving to respond to the current emerging needs from climate services providers and users through building climate research capacities and communicating science to the public worldwide and especially in developing regions. In this regard WCRP’s significant contributions, through its various co-sponsored training activities, have been:

- To facilitate and coordinate climate research, modelling, analysis and prediction to provide the required science-based climate information to decision makers;
- To assist the research community and institutions of higher learning in education, training and development of next generation of climate scientists;
- To provide greater opportunities for the early career scientists, especially those from developing regions, to become more active in global, regional and national climate research and application;
- To empower young generation of climate scientists to be more active and gain experience in analysis and interpretation of climate information to serve the needs of decision makers and experts who are pursuing climate adaptation and risk management planning;
- To establish an effective dialogue with decision makers, politicians and those responsible for socio-economic development by finding a common language in using the latest knowledge based information.
The World Climate Research Programme, the Global Climate Observing System, the World Meteorological Organization and the Nairobi-based IGAD Climate Prediction and Applications Centre (ICPAC) joined together to implement a project to demonstrate key elements of an effective climate risk management strategy for the Greater Horn of Africa region (WCRP, 2011). This activity provided opportunity for providers and users to interact and build capacity of participants from IGAD countries. The organizers were greatly assisted by volunteers from the UK Met Office and the UNDP Africa Adaptation Programme.

There have been numerous programmes to train scientists in generating downscaled climate change scenarios. For example, the Abdus Salam International Centre for Theoretical Physics in Italy hosts regular workshops and online training opportunities for scientists from developing countries. Another active player has been the United Kingdom Met Office, which frequently holds workshops for its downscaling model that include discussions concerning data requirements for impact assessments. Also, in the cooperation programme conducted by the Conference of Directors of Iberoamerican NMHS, several workshops for generating regional climatic change scenarios have been carried out for the particular region.

Although there has been much effort in the aspect of capacity development of human resources through training to support providers to develop and deliver climate services, lack of resources and coordination have continued to be a major problems. Unfortunately, not enough experts from developing countries have been trained through these efforts, as many of these depend on financial support provided from developed countries. In addition, lack of resources and sustained commitment also prevents keeping skills of personnel that have had training up to date with new advances. A vision of continuous learning and improvement is needed in an ongoing operational GFCS.

3. **Infrastructural capacity of climate information and products for providers**

Some efforts have been going on in various countries to address institutional and infrastructural capacities for climate services, for example WMO through its Voluntary Cooperation Programme (VCP) and other funded projects such as those supported through bilateral arrangements from the WB and other regional banks, has made considerable effort to upgrade and provide new observations network, computing, communications and data management facilities, and training of personnel. Furthermore through these efforts there have been projects that have made systems such as the Climate Data Management Systems (CDMS), software, Internet access, communications mechanisms and others to be made available in some of the Developing and Least Developed Countries (LDCs) and SIDSs.

In terms of institutional infrastructure, some efforts have been made to support the strengthening of various NMHSs and other relevant institutions in developing countries to help them achieve capacities to provide the required information, products and services. Also, efforts have been made to strengthen and establish global and regional climate centres to enable them play their roles effectively, with a view to developing information and products that will enable some provision of climate services in all countries. However, despite of these efforts not nearly enough attention has been paid to the needs in developing countries for the observing system infrastructure needed to provide the density of climate observations needed for a full range of climate services at national scales for a broad spectrum of user needs.

Furthermore some effort has been going on by environmental space agencies to improve climate observations made from the space satellites. This information has been very useful in the climate modelling aspects. Some effort has also been made to improve and provide data
and products receiving facilities, from these systems, in developing and Least Developed Countries

Unfortunately these processes sometimes have been implemented in a piecemeal and not a staged and well coordinated way, which is something that may need to be addressed by the GFCS through its pillars during its implementation stage. There have also been some efforts through programmes such as the World Weather Watch (WWW) and the Global Climate Observation System (GCOS) to repair, upgrade, and establish observation networks and installation of new sites.

In addition there have been problems for developing countries of lacking the necessary infrastructure to support high speed internet and communication links which are needed to support activities on exchange of data, information and products.

4. Institutional capacity of climate information and products for providers

The roles that various institutions should play in a national climate services matrix need to be defined so as to identify how authoritative information on climate services can be provided. Although in many countries the NMHSs are the institutions responsible for provision of climate services, this may not be the case for all countries. In some cases, other institutions are given this mandate. In a number of countries, currently effort is being made to define which institution is responsible for provision of the various climate services or how the provision should be structured so that the optimal benefit of all national efforts can be attained. This will require relevant national legislative and policy frameworks to be developed and be clearly defined. Though in some countries the NMHSs will play a key or a leadership role, in some countries improvements in their management structures and procedures and in their staff complements may need to be implemented first. Under the GFCS, through its Pillars especially the Capacity Development Pillar, this effort will be necessary in supporting countries to clearly defining the responsible structures with their terms of references for providing climate services in the countries. In line with this effort the optimal approach would be for countries to establish some national coordination mechanisms, where possible led by the NMHS, such as the proposed national framework for climate services if they decide to do so.

5. Procedural capacities of climate information and products for providers

In order to define and enable best practices relevant to various GFCS operations, agencies such as the WMO through its Technical Commissions including the Commission for Climatology (CCl), Commission for Basic Systems (CBS) and the Commission for Hydrology (CHy) has published Guides to Climatological, Observations and Hydrological Practices respectively which define standards for observations, data processing, basic statistical analyses along with presentation and interpretation of climatological information. In addition, the Commission for Atmospheric Sciences (CAS) has, through the GAW Programme, provided relevant guidance on the procedure applicable to atmospheric composition observations and data processing. While CBS has provided standards that have been specified and to a large degree implemented for producing seasonal forecast products from global models, no such standards yet exist for regional or national seasonal-scale forecasts based on statistical models or for model-based on downscaled forecasts. There is a range of software products that have been developed to assist countries in making downscaled and tailored forecast products for a range of timescales, and WMO RCCs also assist countries in their domains with downscaling. Downscaling techniques are supported by the research efforts of the WCRP and other partners. These efforts provide capacities to NMHSs and other relevant institutions for better provision of climate services.
APPENDIX II: EXISTING ACTIVITIES FOR USERS OF CLIMATE SERVICES, INTERNATIONAL COLLABORATION AND IDENTIFICATION OF GAPS ON BOTH PROVIDERS AND USERS

1. Human capacity for users of climate information.

Effort has been made in developing human capacity of users of climate information and products both at regional and national levels. Through the Regional Climate Outlook Forums (RCOFs) that are held in various regions of the globe, often through the coordination of WMO RCCs and other regional climate centres, users from various sectors are invited to participate in these forums as part of understanding the interpretation of the products and how to apply them. This process is translated to the national level where in some countries National Climate Outlook Forums (NCOFs) are held between providers and users to interact on the interpretation of further downscaled versions of the regional forecasts to national and sub-national scales. The participation of users in these processes from various sectors helps to build their capacities in the application of the information, and to understand the processes and problems involved in developing climate products and information.

Even though RCOFs are very much valued by both providers and users as a means of interaction and engagement, the forums are, in most cases, only held either once or twice in a region in a year due to limited financial resources. While this may limit the face-to-face interaction between providers and users of climate services, some COFs are successfully continuing the liaison using electronic means at other times of the year. Whether through face-to-face forums or interactions supported more remotely, COFs at regional and national scale have proven to be invaluable sources of feedback from users to providers of the information and products.

Developing human capacity on application of climate information and products across disciplines to engage in such partnerships and to create competency in using climate information is also required. There have been numerous United Nations-supported human capacity development initiatives, for example START, the United Nations Educational, Scientific and Cultural Organization (UNESCO), and IAI for Global Change Research provide examples of initiatives that develop human capacity in the developing world for scientists, policy makers, technical experts and local communities to enhance resiliency to climate change. Their joint efforts in education, research and assessment, training, curriculum development and communication contribute to better-informed decision making about issues of global environmental change and development. Some specific capacity development programmes of some agencies being implemented globally include the following:

- UNESCO works on education and outreach on climate change and variability and natural disaster preparedness, targeting the general public, educational systems and youth in Small Island Developing States and Africa. Regular interactions between climate information providers and users are enabled through these Climate Change Fora. Its Natural Sciences sector implements major international science programmes while promoting national and regional science and technology polices and development. These programmes include the Intergovernmental Oceanographic Commission, the International Hydrological Programme, the Man and the Biosphere Programme, the International Geoscience Programme, and the Abdus Salam International Centre for Theoretical Physics, each of which has capacity development programmes;
A number of capacity development programmes specifically for promoting dialogue between climate services provider and user communities are beginning to be developed such as those from WHO (WHO, 2011). Other examples include the Summer Institute on Climate and Health run by the International Research Institute on Climate and Society, the Center for International Earth Science Information Network and the Mailman School of Public Health bring climate scientists and health specialists together to impart a mutual understanding of the role climate plays in driving the infectious disease burden and public health outcomes as well as how to assimilate climate information to improve the decision making process in public health;

In recent years, the Public Weather Services Programme of WMO helped establish and strengthen “Climate and Health Working Groups” in a number of countries in Africa. These involve service providers and users and promote interdisciplinary assessment of socio-economic benefits of meteorological and hydrological services. In particular, the working groups address the specific needs of the health sector, as a user community for climate and weather information. The Climate and Health Working Groups work to develop national capacity and key outcomes are elaborated in Box 5 of the UIP Annex;

The UNDP–Global Environment Fund (GEF) unit (UNDP-GEF, 2011) supports developing countries to make low-emission, climate-resilient environmentally sustainable development not only possible, but also economically attractive. To achieve this, capacities are developed to put in place the right mix of regulatory and financial incentives, remove institutional and policy barriers, and create enabling environments that attract and drive private sector investment into green development. In doing this, UNDP/GEF assists partner countries to access, combine and sequence resources from a wide range of funds, and financial instruments and mechanisms. Over the past 18 years, UNDP has helped developing countries access more than $3.3 billion in project financing from the GEF Trust Fund and associated Least Developed Countries Fund and Special Climate Change Fund through GEF-4, as well as leveraging an additional $9.2 billion in co-financing. The GEF operates as a partnership between three implementing agencies — UNDP, UNEP and the World Bank — and seven executing agencies (Asian, African, and Inter-American Development Banks, the European Bank for Reconstruction and Development, FAO, IFAD and United Nations Industrial Development Organization (UNIDO), to integrate global environmental benefits into county-led development. UNDP-supported programmes and projects with GEF financing are normally developed and executed by national governments, although international agencies and Non-governmental Organizations (NGOs) are used on occasion. A wide range of public and private sector agencies and institutions, including local communities, are involved in project implementation. These programmes and projects are mainstreamed into overall UNDP operations and are primarily managed by UNDP’s network of over 140 country offices;

UNDP supports developing countries and countries in transition with Climate Risk Management. For example, The Central Asian Multi-country Programme on Climate Risk Management (CA–CRM) is a four year programme to assist five Central Asian countries to adjust their national development processes to address risks posed by current climate variability and future climate change (one is Turkmenistan: http://www.undptkm.org/index.php?option=com_content&task=view&id=1067&Itemid=43);

UNDP supports development of national communications for UNFCCC (see example at: http://ncsp.undp.org/document/enabling-activities-preparation-ghanas-second-national-communications-unfccc);

The Food and Agriculture Organization works to raise levels of nutrition while improving agricultural productivity. National Forums and Farmer Field Schools are a good means
of educating the agricultural users to the decision support tools and products available. Multi-agency meetings are used to engage stakeholders to assess their needs, prepare agro-advisories, and, re-evaluate the results of the products and services provided to the user communities. The WMO Agricultural Meteorology Programme has also conducted a very effective Roving Seminar Training series for over a decade on many operational agricultural meteorology applications. Through Farmer Field Schools, climate service information can reach the farming community. Non-Governmental Organizations have been instrumental in setting up telecentres in remote areas of Least Developed Countries;

- The WMO, WB, UNDP, UNISDR and bilateral funders such as the European Commission are collaborating on disaster risk reduction national and regional capacity development projects in South East Europe, the Caribbean, and Southern Asia. The projects involve regional and national institutional and operational mapping; user-driven assessment of gaps, needs, prioritization and requirements; strengthening of disaster risk reduction policies, institutional roles, partnerships and capacity development; and strengthening of regional specialized meteorological centres, regional climate centres and national meteorological and hydrological services to improve meteorological, hydrological and climate services;

- The WB has a number of relevant activities on capacity building in partnership with other entities/governments which addressing various aspects that are related to impacts of climate variability and change and the associated adaptation and mitigation measures.

2. Developing infrastructural and procedural capacities for users of climate information

There are efforts being carried out on building infrastructural and procedural capacities for users of climate services. These efforts, among others, include the following:

- The Intergovernmental Panel on Climate Change (IPCC) Assessment Reports that constitute the most obvious example of best practices for translating climate data into decision-relevant information through involving extensive collaboration between climate and sectoral scientists;

- There exist a number of United Nations-driven efforts to promote the engagement of producers and users through getting together beyond the scientific community and on regional, national and local levels. These efforts include those of the Food and Agricultural Organization and the World Meteorological Organization through their projects and meetings/workshops/seminars;

- There are effective examples taken from United Nations agencies such as UNDP, WHO and UNEP as well as from a number of countries and academia and research institutions to translate climate information into impact assessments and policy guidance including the insight gained from the annual production of the Greenhouse Bulletin by GAW;

- There are national examples from countries such as Kenya, Mali and others that illustrate application of climate information at seasonal scale into policy guidance;

- A few institutions from user communities have recognized the need to invest in raising awareness and translating climate information. One such example is the Red Cross/Red Crescent Climate Centre which interacts with groups including the National Meteorological Services through the World Meteorological Organization and the International Research Institute (IRI) for Climate and Society and other scientific research groups to develop information products tailored to the movement’s specific
needs. The Red Cross/Red Crescent Climate Centre provides an example of how to build communities that represent users of climate information and that are able to engage with the scientific community;

- In a number of countries (including Developing and Least Developed Countries) effort is being made to make arrangements with mobile phone providers to facilitate the provision of their climate information and products through mobile phones.

3. **International collaboration to build capacity**

In the past interaction on climate issues between centres and experts in developed and developing countries around the world has generally been weak or sporadic. However, since the late 1990s there has been significant improvement where experts from developed countries have partnered to work with scientists from developing countries. Experts from developed countries have participated and contributed in developing the RCOF products which in most cases to date have been developed for tropical countries (there is reasonable skill at seasonal scale in tropical regions, and considerable need for climate products due to high vulnerability).

Students from developing countries pursuing studies in climate variability and change and other related areas have been admitted to study in North American and European institutions in countries like Norway, Great Britain, USA, Canada, France and others. Institutions such as the United Kingdom Meteorological Office, Japan Meteorological Agency (JMA), and IRI in USA have helped to build capacity of experts from developing countries especially from Africa, Asia, and South America by working with them. For example some very useful prediction tools and software that are being used by developing countries have been developed by government agencies and in institutions in academia from developed countries.

Support on infrastructural capacity development to developing countries has been given by developed countries and from multilateral funding mechanisms and international agencies. However some climate services provider institutions in these countries still lack the capacity to meet the needs of their clients because of a number of factors that may include: lack of available people to be trained; the support provided is inadequate; and countries are slow in implementing some of the support they receive.

In some cases South–South cooperation has played a major role in building capacities of personnel, infrastructure and institutions between countries. For example countries from Africa have got support from countries in Asia and similarly countries within Africa have supported one another. Through the GFCS these interactions will need to be maintained and enhanced. Another example is the cooperation programme between Iberoamerican NMHSs (including Spain and Portugal) through which several training activities have been conducted between Services and also the development of a common Database Management System of Hydrometeorological data that was given to WMO to be used for interested NMHSs.

4. **Identified gaps in developing capacities of providers and users of climate information**

Despite the fact that there has been significant effort to develop capacities of institutions to facilitate improvement in the provision of climate services and their uptake by users, there still exist major gaps which the GFCS through its pillars especially the CD Pillar will have to address in its early part of the implementation. From a preliminary analysis carried out by HLT on the national capacities to provide climate services, it was found that about 70 countries (of the World Meteorological Organization’s 189 Members) do not have the necessary capabilities for essential climate services at present and recommended that a high profile programme of fast-track projects be established to develop the capacities of these countries over the two four-year
periods 2014–2017 and 2018–2021 after a two year planning and fast tracking phase (2012–2013). The results of the analysis showed that six countries have extremely limited national climate services capacity and that a further 64 countries, 36 small and 28 large, are in need of strengthening but nonetheless have a viable meteorological service already, with basic weather forecasting and climate services capabilities and a staff with relevant skills in forecasting, analysis and statistics. The proposed capacity development training will be coordinated in stages, starting with the needs for basic, essential and then full suite of services. This training schedule will elevate centres to increased functionality over a period of time. In addition, the HLT estimated that an additional 2500 staff around the world would need to be trained/recruited to produce the climate information and products required by users in a fully operational and effective GFCS. Hiring new staff would be needed to manage the increased workloads, and to bring on board new competencies that may not typically be found in small institutions. This programme is focused on developing personnel and service delivery capabilities of the NMHSs and other national climate services providers.
APPENDIX III: PROGRAMMES, CO-SPONSORED PROGRAMMES AND CONSTITUENT BODIES

1. WMO Executive Council Working Group on Capacity Development

The WMO Executive Council Working Group on Capacity Development is mandated with a responsibility for a continued mechanism to review on a regular basis issues related to capacity development of WMO Members in respect of the eight Expected Results of the WMO Strategic Plan (2012-2015) (WMO, 2012), in particular Expected Result 6: Enhanced capabilities of NMHSs, in particular in developing and least developed countries, to fulfil their mandates. The Working Group recognized the need for better coordination of the WMO priorities: Disaster Risk Reduction (DRR), GFCS, Aeronautical Meteorology and WMO Information System (WIS)/WMO Integrated Global Observing System (WIGOS) to be included in the WMO Capacity Development Strategy (CDS) which the group is currently developing. The Working Group has agreed that in order to capture capacity issues holistically, the WMO CDS needs to focus on the following four areas of capacity: Human Capacity, Infrastructural Capacity, Procedural Capacity and Institutional Capacity in national, regional and global contexts for all its programmes including the GFCS which will specifically be addressing issues related to climate services. The WMO CDS is expected, among others, to:

- Facilitate the transformation of NMHSs by developing upon existing capacities in national systems while ensuring strengthened capacities are an integral part of WMO’s Global and regional priorities, Technical Commissions as well as WMO cosponsored programmes where applicable, and embedded in National Development Plans;
- Integrate and harmonize capacity development activities within WMO priority areas (GFCS, WIGOS/WIS, Quality Management System (QMS) in Aeronautical Meteorology and DRR), as well as capacity development activities of external organizations and partners of WMO with agendas to strengthen NMHSs of countries;
- Better mobilize and channel financial resources to leverage funds while reducing duplication;
- Enable coalition building of partners and stakeholders at national, regional and international levels and will involve identification and engagement for strategic partnerships and synergies and the sequencing of joint activities in a programmatic approach aligned to the WMO Strategic priority areas to ensure sustainability. Particular emphasis on internal national partnerships to secure ownership and commitment by national governments;
- Harmonize the monitoring and evaluation of activities at all levels of programming and optimize resulting knowledge and lessons learned by wide dissemination to inform decision making and programme improvement.

It may be important to note that there are many times a disjoint between training intervention and the career path of scientists that have benefited from these interventions. The human capacity develop is not about ad hoc interventions but a lifetime, structured intervention where the employers, universities and research institutions should work as a team on a common plan for the individual.

2. WMO Technical Commissions

WMO has eight Technical Commissions (see WMO-No. 15 (edition 2011), 2011b) with the purpose to study and make recommendations to Congress and the Executive Council on subjects within its terms of reference and in particularly on matters directly referred to a
Commission by Congress and the Executive Council. For example the role of CCI is to stimulate, lead, implement, assess and coordinate international technical activities within WMO under the World Climate Programme and the Global Framework for Climate Services to obtain and apply climate information and knowledge in support of sustainable socio-economic development and environmental protection (WMO, 2010). It achieves its mandate through a network of experts who are serving the four panels on: climate data management, climate monitoring and assessment, climate products and services and their delivery mechanisms, climate information for adaptation and risk management. The expert teams associated with these four panels are addressing issues that concern the generation, provision and user involvement activities on climate services. A number of activities under the World Climate Programme which CCI implements are involved with capacity development on climate services. These include the CLIPS Project, GPCs, RCCs, RCOFs, Climate Data Management Systems (CDMS) and the preparation of the Guide to Climatological Practices and others. Furthermore CCI established an Expert Team on Strategy for Capacity Building for Climate Services (ET-SCBCS). A tremendous network of climate experts is developed through the activities of these teams.

The GFCS will benefit from the activities of CBS and more specifically from WIGOS of the World Weather Watch, which is an all-encompassing approach to the improvement and evolution of WMO global observing systems. WIGOS will foster the orderly evolution of the present WMO global observing systems (mainly Global Observing Systems (GOS), GAW observing component (guided by the Commission for Atmospheric Science CAS), World Hydrological Cycle Observation System (WHYCOS) (guided by CHy), and the cross-cutting Global Cryosphere Watch (GCW)) into an integrated, comprehensive and coordinated system. It will satisfy, in a cost-effective and sustainable manner, the evolving observing requirements of WMO Members, while enhancing coordination of the WMO observing system with systems co-sponsored by international partners which includes GOOS, Global Terrestrial Observing System (GTOS) and the Global Climate Observing System (GCOS) (all coordinated by GCOS, not CBS) and the Global Earth Observation System of Systems (GEOSS) (which is not part of WMO or guided by any of our constituent bodies). WIGOS together with WIS will provide data and distribute these to feed into the production under CSIS of climate information and products and support improved service delivery within the GFCS (WMO, 2011c). CBS, in collaboration with other relevant entities in GFCS will support the improvement of the observing networks of WMO and partnering agencies, and the necessary communications facilities.

There are a growing number of joint initiatives between CAS and the climate research community in general and WCRP in particular. These include new initiatives on sub-seasonal to seasonal prediction research as well as prediction on both weather and climate timescales. The sub-seasonal to seasonal timescale provides a unique opportunity to capitalize on the expertise of the weather and climate research communities, and to bring them together to improve predictions on a timescale of particular relevance to the GFCS. From the end-user perspective, the sub-seasonal to seasonal time range is a very important one, as many management decisions in agriculture and food security, water, disaster risk reduction and health fall into this range. Improved weather-to-climate forecasts promise to be of significant social and economic value.

The GAW programme also has significant relevance to climate studies and services. It is important to realizing that it is primarily the changing atmospheric composition, especially atmospheric Greenhouse gas concentrations, that is the driving force to the changing climate. Therefore the information obtained from GAW is not only a new climate service in its own right but a necessary component in prediction services relevant to the GFCS.
In all WMO Technical Commissions there are significant activities that address capacity development of human resources, infrastructural, procedural and institutional nature which contribute to the implementation of the GFCS. Therefore the GFCS, during its implementation, will need to work with these Commissions in order to benefit from their various relevant activities.

3. **UN Agencies regional activities**

The WMO has divided the globe into six regional associations which are Regional Association I (Africa), Regional Association II (Asia), Regional Association III (South America), Regional Association IV (Northern America, Central America and the Caribbean), Regional Association V (South-West Pacific) and Regional Association VI (Europe). The WMO Regional Associations have the mandate, among other issues, to develop plans and strategies for capacity development in the Region for Member States within the areas of responsibilities, and have assumed a key role in the identification, establishment and operations of WMO RCCs. Other UN Agencies such UNEP and UNDP have regional activities that have relevance to climate services. The structure of those regional activities may not be as those of the WMO Region Associations but could be addressing activities relevant to GFCS. Therefore the GFCS will have to collaborate with these regional associations and those of other UN Agencies in developing their strategies for capacity development in all the areas that will support production and provision of climate services.

Scientific research is an effective means of capacity development through both mentorship and formal training. The deliverables of Research, Modelling and Prediction pillar (RMP), and especially the significant increase in the availability of numerical climate predictions on global and regional scales will enable wide, systematic, and successful capacity development programmes for developing countries. For example, the WCRP Coordinated Regional Climate Downscaling Experiment (CORDEX) is a project committed to develop the capacity for regional climate predictions through the exploitation of dynamical and statistical means of downscaling. The first focus area of CORDEX is Africa. In turn, education and training, as an essential part of traditional capacity development, will help to support the resource base for the RMP pillar of the GFCS. This work should be conducted in coordination with the CGI Expert Team on Capacity Development Strategy for Climate Services.

4. **Co-sponsored and other programmes**

Implementation of the GFCS will require full engagement in the programmes and working mechanisms of partners at global, regional, and national levels. In most of these programmes the issues of capacity development are addressed. For the observation and monitoring pillar at the global level these include a number of UN agencies, such as UNEP, UNDP, UNESCO and its IOC, UN Water, ISDR, FAO, IFAD, WFP, UNFCCC, WMO and WHO, and also other systems that these organizations co-sponsor, such as GCOS,GOOS, GTOS, and WCRP activity. They also include initiatives fostering integration of different observing systems, such as WIGOS. Equally important at national and regional scales are the contributions that the NMHSs, national and regional space agencies (for example EUMETSAT), and national environmental agencies make in the aspects of observations.

The observations and monitoring and research, modelling and prediction components of the GFCS is expected to make significant contribution to its capacity development pillar. The representatives of climate research communities will be engaged in activities shaping the GFCS pillars in their various aspects. WCRP future plans and priorities are for promoting and
supporting development of a vibrant international research network. In order to develop and maintain an effective capacity development thrust, WCRP plans to strengthen those efforts that have proven to be effective, based on the feedback from the participants and/or independent evaluation, as well as forge strategic partnership and alliances with the capacity development organizations with proven successful track records and established networks in developing regions of the world. These partnerships would include international scientific and technical unions, societies and other organizations towards the achieving of its education, training and capacity development objectives. The following are some of the areas identified by WCRP to promote greater involvement of developing-country scientists, early career professionals and students in climate science activities to be sponsored by WCRP.

i) **Engaging regional experts in climate research, modeling and analysis through:** (1) promoting regional analysis of global simulations within the seasonal to inter-annual prediction project and the coupled model inter-comparison project CMIP5, through the regional panels; (2) analysis of regional modeling outputs within Coordinated Regional Climate Downscaling Experiment (CORDEX) with the initial focus on Africa but later extended to Asia, South America etc; (3) the monitoring of changes in extremes using the suite of climate indices that describe different aspects of temperature and precipitation extremes, including frequency, intensity and duration - developed by the Expert Team on Climate Change Detection and Indices (ETCCDI); and (4) support scientists working on climate change adaptation based on models and observations (and reanalysis products), and the facilitate interactions with interdisciplinary groups from water resources, agriculture, marine sciences, etc. to train a critical mass of local scientists who can appropriately offer local knowledge and expert opinion to interpret climate change information and uncertainties for decision makers;

ii) **Scientific Exchange**, to promote visiting of scientists to foster collaboration of institutions and centres in the developed world with scientists and institutions in the developing countries thus developing the capacity of scientists from developing countries to a level at which they can actively participate in the exciting scientific research and generate predictions with comparable skill at national or regional centres;

iii) **Train-the-Trainers**, to promote and support experts in selected areas of climate science from developed countries to spend several weeks in climate research institutions to provide training for targeted group of scientists based in developing nations. Such initiatives could be achieved through strategic partnership with WCRP sponsors (e.g. WMO, IOC and ICSU) and/or with international partner programmes/organizations such as START, IAI, APN, International Centre for Theoretical Physics (ICTP) and the World Ban;

iv) **Special Topics Conferences and Workshops**, to promote greater representation of scientists from the developing countries and young scientists in all WCRP planning and coordination meetings, workshops and conferences. Provide global and regional fora for exchange of ideas and knowledge amongst climate researchers and students;

v) **Summer Schools**, to explore the feasibility of summer schools for both specific WCRP disciplinary themes and interdisciplinary topics. This should be done in collaboration with institutions and projects that have a long experience in organizing such events, such as ICTP, National Centre for Atmospheric Research (NCAR), IRI and IAI. Such efforts should target mainly early career scientists worldwide, with greater emphasis on participation of young scientists from developing regions/nations;
vi) **Fellowships and Scholarships**, to work closely with its international partners towards the development of a longer-term education programme aiming at supporting the training and education of next generation of climate experts. Activities should be targeted at helping these young scholars to be able to better analyze and interpret climate information products for adaptation planning and risk management.

In addition to WCRP, the research component of GFCS will involve the following main categories of stakeholders:

- WMO constituent bodies and co-sponsored programmes, including all WMO Technical Commissions and Programmes;
- IOC constituent bodies and co-sponsored programmes;
- ICSU constituent and interdisciplinary bodies and co-sponsored programmes;
- Activities and programmes of other UN agencies and programmes;
- National Meteorological and National Hydrological Services;
- Research affiliates of the World Climate Services Programme;
- Research communities affiliated with World Weather Research Programme (WWRP) and World Weather Watch and practitioners, particularly associated with the Global Data Processing and Forecasting System;
- Observing programmes: WIGOS, GCOS, GOOS, GTOS, the observation component of WMO GAW and its contributing networks, etc.;
- Possible “Future Earth” Initiative, the successor to Earth System Science Partnership (ESSP);
- Players in the market of providing value added climate services;
- Research funding agencies;
- Universities and research institutions.

Using these already available opportunities of research activities of these various programmes and institutions will help to facilitate the development of capacity in research for the GFCS for experts in Developing and Least Developed Countries and SIDS.

5. **National Meteorological and Hydrological Services**

NMHSs are fundamental part of national infrastructure and play an important role in supporting vital functions of governments in defining development plans of countries on climate impacts adaptation activities. Their engagement with GFCS is essential in view of inadequate infrastructure and limited human resources in some NMHSs, especially in Developing and LDCs, are among the factors that limit their capacity to improve their services or to coordinate national efforts between partners relevant to climate services. The climate observations, research and climate data gathered by NMHSs are the foundation of their monitoring and climate prediction services. There is marked disparity in the observation networks and research activities, however, with developing and least developed countries having sparse networks, limited facilities to carry out research and disseminating climate information that do not adequately provide for the range of climate services that NMHSs can provide to users. The NMHSs also use telecommunications networks, which are vital for the timely exchange of climate data and products that enable them to fulfill their national mandates as climate services providers. Unfortunately the network including GTS and Internet connectivity used by some NMHSs for this purpose are inadequate and obsolete, and this hampers the efficient flow of observations and products. The GFCS will have to work with the NMHSs through WMO
Programmes and other mechanisms to facilitate development of their capacities in all these aspects.

6. **Global producing centres and regional climate centres**

The importance of global producing institutions and regional climate institutions in the implantation of the GFCS cannot be underestimated because these produce climate information which is usually downscaled at national level. Some of these centres provide key services and other GPCs provide important global meteorological monitoring datasets which are very useful in supporting work on climate services. In some cases they also provide direct services to some end users with global/regional interests. For example the WMO RCCs are likely to support the NMHSs and other national institutions in providing services thus enhancing capacities of national institutions through training personnel and provision of tools and software that are needed for climate services. This is especially true when a regional climate centre is resourced and staffed by all Members within the region.

7. **Non-governmental organizations, universities and research institutions and the private sector**

Non-governmental stakeholders representing climate service user and provider communities in all four priority areas of the GFCS such as the International Federation of Red Cross and Red Crescent Societies, International Council for Science, International Union for the Conservation of Nature (IUCN), World Wildlife Fund (WWF), and international research institutions and the academia groups must be fully engaged in its implementation dialogue. Where there is a strong relevance of their work to that of the Framework, international non-governmental organizations and research entities at all levels should be encouraged to join in the dialogues promoted by the CD pillar and other GFCS pillars. The implementation plan must include criteria for their participation and a process for encouraging the participation of those that meet these criteria.

In some countries other agencies and institutions such as universities, research institutions, departments of environment and agriculture may have roles in climate services nationally. Universities such as University of Nairobi, in Kenya and North Carolina University of North Carolina in the USA have contributed significantly in training climate services providers in Africa and other developing countries. In the interest of developing strong national climate service capability it will be beneficial, in the implementation of the GFCS, to enhance this interaction through increased exchange of scientists and increased number of admission and support of students from the developing world.

Developing capacity in climate services should look to strengthen existing capabilities, particularly in the area of partnerships. Furthermore capacity development activities should be driven by user requirements and should inform decision and policy making processes directed at national goals for sustainable development. They should also support the specific service requirements of sectors and users. The private sector is one of the main users of climate services and is also involved in activities relevant to all pillars of the GFCS. Considerable capacity development is required to establish and manage these complex relationships in such a way that users have the ultimate benefit. It will be necessary for the Capacity Development component of the GFCS Implementation Plan to include results of dialogue from the private sector that may also be a major source of resources to support its implementation.
APPENDIX IV: ACTIVITIES TO BUILD CAPACITY TO INTERFACE WITH USERS

The Framework’s User Interface Platform will be the mechanism through which potential users of climate services will be able to express their requirements and to provide feedback about the services they receive as well as make any changes in their requirements. It is also the platform through which the providers will get feedback from users. Users of the Framework’s services will expect that their statements of requirements and views on service quality, relevance and reliability, are fed back to those responsible for managing each of the Framework’s components (observations and monitoring, research and modelling and information systems). For example, the GFCS near-term priority actions for human health will include the activities of the health research community focused on their research agendas and building national capacity of both climate and health partners to conduct local research, and activities of the climate research community aimed at development of more appropriate climate data products for the sector.

The HLT proposed a number of pilot projects targeting the users in the priority areas of agriculture, water, disaster risk reduction and health for the period 2014-2017, broadening to other sectors on a needs basis in 2018-2021. Specifically some of the capacity development projects in the user interface platform would include the following projects:

- Implement pilot application projects at regional and national levels to demonstrate the economic benefits of climate services. This can be done through organizing workshops at regional and national climate institutions involving producers and users of climate information and products on their social economic benefits of these services;
- Conduct capacity development workshops involving all stakeholders of climate information on the best practices for effective use of climate information and products;
- Identify the optimal methods for obtaining feedback from priority sectors user communities;
- Build a dialogue between climate service users and those responsible for the observations and monitoring, research modelling and prediction and Climate Services Information System components of the Framework with the aim of developing metrics for the performance of the Framework as affected by the contributions of the components and also for communications, for getting feedback for continual product evaluation and improvements;
- Develop monitoring and evaluation measures for the Framework that are agreed between users and providers;
- Improve climate literacy in the user community through a range of public education initiatives (outreach and awareness) and on-line training programmes. Interdisciplinary training can be effective too – providers also need to understand the perspectives and issues of the users with respect to climate and other pressures they face;
- Support Regional and National Climate Outlook Forum (RCOF and NCOF) activities as part of facilitating interaction between providers and users to learn from each other;
- Support implementation of user-driven outlook forums with a sector focus such as the MALOF (Malaria Outlook Forum);
- Support development and application of sector-specific climate indices, involving climate and sector experts;
- Support the provider-user efforts to improve the outputs of COFs to better meet user requirements, including the necessary integration of sector information to create more decision-relevant products for decision-makers.
APPENDIX V: ACTIVITIES TO DEVELOP CAPACITY OF CLIMATE SERVICES AT NATIONAL LEVEL

The activities to be implemented at national level to address the existing weaknesses include the following:

- Establishing new/reviving silent climate related observation networks through new installations, upgrades and replacements;
- Rehabilitate/modernize national meteorological telecommunication networks for data collection and transmission facilities at NMHSs along WMO WIS/GTS guidelines.
- Implement broadband high-speed internet access at all relevant centres that provide climate services centres;
- Upgrading or installation of necessary infrastructure that will support production of information and products. This will include equipment and tools (including hardware, software), internet and any other new technological development in infrastructural aspects;
- The importance of global producing institutions and regional climate institutions in the implementation of the GFCS cannot be underestimated because these produce climate information which is usually downscaled at national level. Some of these centres provide key services for example a centre like National Centres for Environmental Prediction (NCEP) and other GPCs provide important global meteorological monitoring datasets long-range forecasts which are very useful in supporting work on climate services. In some cases they also provide direct services to some end users with global/regional interests. For example the WMO RCCs are likely to support the NMHSs, and other national institutions in providing services as appropriate, thus enhancing capacities of national institutions through training personnel and provision of tools and software that are needed for climate services;
- Providers will have to be given better tools to produce better and more consistent products – they will need training in any of these advances in climate science, as well as training in access to and use of products from GPCs and RCCs;
- Strengthen institutions through promoting legal frameworks and establish new ones where necessary for provision of better climate services;
- Improve management, planning, operational and maintenance practices in the national climate centres to ensure efficient use of resources and quality services to customers;
- Improve funding base of the NMHSs through strengthening status of the organizations and financial management;
- Provide training on issues that need to improve interaction between providers and users.
APPENDIX VI: ACTIVITIES TO ESTABLISH NEW REGIONAL CLIMATE CENTRES

One of the main activities to be implemented within the early part of the GFCS, on regional level, will be the establishment of new centres in the Regions or sub-regions that do not have one already established and which need the services of such a centre. It should be recognized that establishing a centre in a region with many developing and least developed countries will require the mobilization of the resources needed to launch the centre, and perhaps to operate it for a period of time while the region explores its options for financing. New regional centres/institutions will likely need to be established in areas such as Central and North Africa, parts of Asia, South America, Central America and the Caribbean and other areas, if so desired by the countries in these regions. The process for establishing such centres is enshrined in the respective UN bodies’ regulations such as the WMO Technical Regulations, which works under the authority of the WMO CCI and CBS. The experience gained through designation of the already successfully established WMO RCCs is of great benefit to establishing the new ones. This could also mean using the successfully established institutions to train experts that will help set up the new regional centres.
APPENDIX VII: ACTIVITIES TO STRENGTHEN EXISTING REGIONAL CLIMATE CENTRES

There are regional climate centres which are basically already operational, for example, two RCCs were officially designated by WMO in June 2009 under the current regulations established jointly by CBS and CC (RCC Beijing (China) and RCC Tokyo (Japan)), both in RA II (Asia). A demonstration phase has been underway for an RCC-Network for Europe (RA VI) for several years, and is now completed. The process of formal designation has been initiated through CC and CBS. Four additional centres have begun demonstration phases, namely the North Eurasian Climate Centre (RA II), Mashad Climate Centre of the Islamic Republic of Iran (RAI), the RCC-Africa hosted by the African Centre of Meteorological Applications for Development (ACMAD) in Niamey, Niger and the Intergovernmental Authority on Development (IGAD)-RCC hosted by IGAD Climate Prediction and Application Centre (ICPAC), in Nairobi, Kenya.

WMO RA III has agreed to implement three RCCs or RCC-networks, one of which will be operated by the Centro Internacional para la Investigación del Fenómeno de El Niño (CIIFEN) in Guayaquil, Ecuador. The others will be RCC-Networks involving countries in southern and eastern South America. Regional Association IV has agreed to initiate a demonstration phase of an RCC for the Caribbean to be hosted by the Caribbean Institute for Meteorology and Hydrology (CIMH).

It should be noted that although the process of establishing RCCs as noted above has been launched with the support of their governments and some partners, it is likely that resource mobilization, including through the GFCS, will yet be needed to support some of these for rapid completion, particularly those in less well developed parts of the world.

There are a number of other well-established centres that play key roles in supporting the climate needs of National Meteorological and Hydrological Services and that take some part in engaging user communities. These include: Southern African Development Community Climate Services Centre (SADC CSC) in Gaborone, Botswana; the Agro-meteorology and Hydrology Regional Centre (AGRYMET) in Niamey, Niger; the Asia-Pacific Economic Cooperation Climate Centre (APECCC) in Busan, Republic of Korea and the ECO Regional Centre for Risk Management of Natural Disasters (ECO-RCRM) in west Asia that supports ECO member countries including Iran, Afghanistan, Turkmenistan, Tajikistan, Kyrgyzstan, Kazakhstan, Azerbaijan, Turkey, Pakistan, Uzbekistan. Headquarter of this centre is located in the Islamic Republic of Iran (Mashad Climate Centre).

Some of these centres may eventually be proposed for RCC status. Additionally, there has been a need identified for RCCs to serve central Africa and northern Africa, and further proposals may yet be made in different regions, and to serve multiple regions (e.g. in the Arctic and Antarctic and the Mediterranean). Most of these potential initiatives will likely need considerable financial and technical support in developing and sustaining the RCC capacity. Currently for the African region the African Development Bank (AfDB), through the ClimDev programme, has provided some financial support to kick start some activities in the proposed RCCs.

As can be noted from above some of the centres are already operationally performing some roles of regional climate centres through the support of their governments and some partners. However, these centres need reliable sustainable financing support so that they become fully fledged operational regional climate centres. This will need reliable sources of financial support and the availability of people to be trained as part of human resource development, infrastructural, procedural and institutional as may be necessary.
APPENDIX VIII: ACTIVITIES TO BUILD CAPACITY OF GLOBAL OBSERVATION NETWORKS

It is clear that some climate services can be provided with the existing set of climate observations that are available globally. From a service perspective, the broad-scale global and regional products from the advanced centres may meet the need for climate products of some countries. However, in downscaling these broad scale products to meet national needs there is a requirement, inter alia, for local data to validate climate analyses and to assist in the interpolation of predictive products. Unfortunately, developing countries have poor and inefficient meteorological observing network – poor inputs to the global and regional models and analyses means greater uncertainty and less reliability on the downscaled products in that region. In addition to this, if a country has poor data (inadequate coverage in space and time, poor data quality, insufficient parameters observed, lack of digitization of the observations, etc), it is very difficult to provide data-based analyses and climate diagnostics and predictions of any kind to meet national user’s needs in a variety of sectors. Therefore developing national observation capacity for climate purposes in developing nations should be a high priority from the early to the latter part of the implementation of the GFCS – this includes:

- Implementation of the WIGOS at global, regional and national scales as broadly as possible;
- Collection and processing of the climate data observed through partnering agencies;
- Implementing as many climate observing stations as possible at national scales;
- Ensuring that all stations (including those in the Global Climate Observing System surface and upper-air networks) are fully functional.

Emphasis in initial activities is therefore placed on filling gaps and sustaining the comprehensive existing climate networks. Naturally, it will not be possible to do everything in the first few years of the GFCS, and therefore an early focus will be on:

- Rehabilitation and rejuvenation of silent stations and key stations in data poor areas, with a special focus on Global Surface Network (GSN) and GCOS Upper-Air Network (GUAN) stations;
- Fully implementing coordinated space-based observations in support of climate services;
- Expanding databases which will include making use of all of the relevant data that exist, and hence a concerted effort in capacity development in rescuing and archiving historical data.

There are still significant gaps related to GAW observations in some regions of the tropics and high latitudes that, if improved could result in a better understanding of process of relevance to radiative forcing in the atmosphere. Due to the complex chemical and physical interaction between atmospheric components the suite of measurements at some GAW stations could be extended to build further understanding. Due to the complex nature of the measurements and analyzing the data, capacity building remains a central priority.
APPENDIX IX: ACTIVITIES TO ENHANCE CAPACITY OF GLOBAL CLIMATE CENTRES

There are a number of activities performed by global centres that will need to be improved to meet the required standard of the products produced from the GFCS. The global centres including the WMO GPCs and Global Climate Data and Monitoring Centres working with various research communities for the early part of the implementation of the GFCS need to work towards improving at all levels (global, regional and national) provision of skilful global and regional climate predictions for time scale from weeks to seasons. This will be necessary for the GFCS to demonstrate its effectiveness in provision of climate information and products, initially, to the priority sectors and thereafter to other sectors too.

The activities that will need to be implemented include, among others, the following:

• Improvement of forecasts and predictions to meet the needs of users at different scale;
• Improve human technical capacities and expertise to generate appropriate climate information and products that can be used by NMHSs and other national entities to meet user needs and demands;
• Enhance capacity for interacting with users from different level.
APPENDIX X: CD PROJECTS/STRATEGIC GOALS, KEY STRATEGIC INTERVENTIONS, EXPECTED RESULTS FOR THE GFSC IMPLEMENTATION PLAN

These projects will address high priority areas such as:

- Strengthening observation network, telecommunication/communication infrastructure and data management systems (O&M Pillar);
- Launch of regional climate centres such as the WMO RCCs which would include development of training curriculum and establishing a training schedule to get category 1 countries to category 2, and category 2 to category 3, etc, in a phased approach (CSIS, RM&P, CD);
- Development of climate tool kit, and the manual for climate services that will provide consistency and harmonization of climate services activities (CD Pillar);
- Development of new methods and tools for decision-support products needed by users (UIP Pillar);
- Development and application of sector-specific climate indices (CD and UIP Pillars);
- Promotion of best practices in Climate Risk Management (CD Pillar and RM&P Pillar).
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<tr>
<th>Projects/Strategic goals</th>
<th>Strategic direction/development</th>
<th>Expected Results</th>
<th>Areas addressed of the capacity development Pillar</th>
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<tbody>
<tr>
<td>1. Strengthening of the Observing Network in developing and least developed countries</td>
<td>1.1 Revive/establish rainfall and climate stations at national level to increase the network available for monitoring climate and have more data for applications and research.</td>
<td>1.1.1 Increased rainfall and climate data base for different parameters such as rainfall and temperature</td>
<td>Infrastructural</td>
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<td>1.2 Expand surface observing network in countries especially those with sparse networks including over the Indian Oceans and inland lakes.</td>
<td>1.2.1 Increased surface observational data from land and water bodies 1.2.2 Improved forecasts and warnings</td>
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<td>1.3 Increase the number of the AMDAR aircraft reports.</td>
<td>1.3.1 Improved availability of upper air data 1.3.2 Improved aeronautical forecasts</td>
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<td>1.4 Establish/Rehabilitate Automatic Weather Observing Stations (AWOSs) and Automatic Weather Stations (AWSs) in data sparse areas, within the manned stations, along the coast, over large lakes, and upgrade the existing stations.</td>
<td>1.4.1 Increased availability of real-time data 1.4.2 Improved quality of forecasts and warnings</td>
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<td>1.5 Revive silent stations and upgrade outdated upper-air stations at various NMHSs.</td>
<td>1.5.1 Improved availability of upper-air data which is needed for research and modelling</td>
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<td>1.6 Acquire and network weather radars in countries for monitoring real-time weather for and public safety and for the safety and efficiency of air transport, marine navigation among other weather dependent activities.</td>
<td>1.6.1 Availability of radar data and information for now casting and short range forecasting and warning services 1.6.2 Improved monitoring and forecasting for severe weather events</td>
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<td>1.7</td>
<td>Train staff at regional and national centres in management, operation and maintenance and calibration of observing instruments.</td>
<td>1.7.1 Availability of well trained staff at national and regional centres in instrument maintenance and calibration 1.7.2 Improved quality data from well maintained and calibrated instruments</td>
<td>1.8 Allocate adequate staff to the regional instrument calibration centres and avail necessary calibration instruments. 1.8.1 Enhanced capability for calibration of instruments at regional instruments calibration centres</td>
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<td>2.1</td>
<td>Acquire new and replace the aging Automatic Message Switching Systems at NMHSs.</td>
<td>2.1.1 Improved efficiency of data exchange between national centres and other centre through Global Telecommunication System (GTS)</td>
<td>Infrastructural</td>
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<td>2.2</td>
<td>Countries develop a policy to support the establishment of appropriate Networking for exchange of meteorological data and products.</td>
<td>2.2.1 Improved access and use of large volumes of data and products from global centres through internet by national and regional centers</td>
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<td>2.3</td>
<td>Support national climate centres to rehabilitate/modernize National Meteorological Telecommunications Networks for data collection and transmission facilities at NMHSs along WMO WIS/GTS guidelines.</td>
<td>2.3.1 Increased quantity and timeliness of data collection and exchange between NMHSs and other related centres</td>
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<td>2.4</td>
<td>Support relevant national and regional centres to implement broadband high-speed Internet access in support of NWP and Climate Modelling and prediction Services.</td>
<td>2.4.1 Enhanced accessibility of data and products</td>
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<td>2.5</td>
<td>Upgrade/modernize NMHSs media systems for information dissemination.</td>
<td>2.5.1 Improved quality of Public Weather Services (PWS) products and timeliness of disseminated data to end users</td>
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<td>3.1</td>
<td>National and regional centres develop new innovative products, through initiating pilot projects at regional and some national centres, replicating to others later on.</td>
<td>3.1.3 Improved availability of well packaged policy relevant and sector specific products</td>
<td>Human resources, infrastructural, and procedural</td>
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2. Improvement of Meteorological Telecommunications and communication systems for rapid data collection, exchange and dissemination of data and information
| Policy-relevant climate information and operational warning services for the priority sectors including procedural issues | 3.2 Support training on new product development and packaging techniques involving regional centres in collaboration with national climate centres, research communities such as the WRCP activities and development Partners. | 3.3 Support acquisition of relevant hardware and software for data analysis and generation of tailored products at regional and national climate centres. | 3.4 Support upgrading of Data base management and monitoring systems including Data Rescue. | 3.4.1 Enhanced quantity and quality of data at regional and centres | 3.5 Support Upgrading and Modernization of real time Data Processing and Forecasting, post-processing and service production systems at national and regional centres. | 3.5.1 Improved quality and timeliness of predictions and products issued by national and regional centers | 3.6 Strengthen the capacity of national and regional centres for Numerical Weather Prediction (NWP) and climate modelling including assessment of high resolution climate scenarios. | 3.6.1 Improved accuracy and quality of NWP, Climate modelling products | 4. Improvement of products generation and use through collaboration with various users and other stakeholders | 4.1 Implement pilot applications projects at regional and national level to demonstrate economic benefits of climate services. | 4.1.1 Increased awareness of the economic benefits of climate services by stakeholders | Human resources and user interface | 4.2 Conduct capacity building workshops involving global, regional and national centres, stakeholders and Users of climate information and products on best practices for generation and of effective use of climate products and information. | 4.2.1 Improved capacity for generation of relevant user friendly tailor made products | 4.2.2 Availability of more sector tailored made products |
| 5. Improved institutional capacity of national and regional centres to provide relevant, reliable and timely climate and weather services |
|---|---|---|
| 5.1 Develop policy and institutional framework for the climate services providers sector/institution at regional and national level. | 5.1.1 Availability of policy framework for meteorology sector | Institutional and human resources |
| 5.2 Improve funding base of the national institution and centres through strengthened status of the organizations and financial management. | 5.2.1 Improved efficiency and accountability of national centres |  |
| 5.3 Improve human resources capacity in the national/regional climate centres to ensure improved quality services. | 5.3.1 Smooth access of national and regional institutions |  |
| 5.4 Facilitate development of Memorandums of Understanding (MOUs) to facilitate smooth operation of climate services between countries and institutions. |  |

<p>| 6. Strengthening capacity of the global, regional and national climate centres such as the GPCs, WMO RCCs and NMHSs to function as efficient network of coordination, development and dissemination centres |
|---|---|---|
| 6.1 Develop coordination and management mechanisms to ensure efficient regional coordination and cooperation between climate services institutions and stakeholders. | 6.1.1 Improved coordination and cooperation between climate services provider institutions and stakeholders | Institutional and infrastructural |
| 6.2 Support Implementation of relevant regional events and networking. | 6.2.1 Increased awareness and use of services by stakeholders |  |
| 6.3 Improve funding base for the regional and national climate centres to ensure efficient functioning of the institutions. | 6.3.1 Improved efficiency of functioning and quality of service delivery of institutions |  |</p>
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<tr>
<td><strong>6.4</strong> Upgrade human resources and infrastructure of regional and national centres to ensure availability of requisite services.</td>
<td></td>
</tr>
<tr>
<td><strong>6.5</strong> Upgrade hardware and software infrastructure at regional and national climate services for CSIS operational duties.</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX XI: ELABORATION ON THE ABOVE CD ACTIVITIES THAT COULD BE IMPLEMENTED THROUGH PROJECTS DURING THE IMPLEMENTATION OF THE GFCS.

<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Deliverables</th>
<th>Indicators</th>
<th>Assessment measures</th>
<th>Timeline</th>
<th>Partners and stakeholders</th>
<th>Linkages with other activities</th>
<th>Cost US$ x M</th>
<th>Potential risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial planning for implementation of the Pillar. Development of an action plan for the pillar’s activities through involvement of all stakeholders</td>
<td>A plan action for implementation of the pillar</td>
<td>Number of trained expert providers and technicians from developing and LDC and SIDS</td>
<td>2012-2013</td>
<td>UN Agencies, International institutions, NHMSs</td>
<td>Linked to activities of all other pillars</td>
<td>WMO, WCRP, development partners, Universities, GPCs, RCCs, International institutions and agencies (e.g. COMET)</td>
<td>2</td>
<td>Not meeting the deadline</td>
</tr>
<tr>
<td>2</td>
<td>Training of national climate centres Personnel</td>
<td>Trained experts in climate modelling, prediction, downscaling, and products interpretation and packaging and other technical personnel to maintain equipment</td>
<td>Number of trained expert providers and technicians from developing and LDC and SIDS</td>
<td>Mainly for priority sectors 2014-2017 continue for other sectors in 2018-2023</td>
<td>WMO, WCRP, development partners, Universities, GPCs, RCCs, International institutions and agencies (e.g. COMET)</td>
<td>Links with RMP and CSIS activities</td>
<td>For the first phase 20</td>
<td>45</td>
<td>Lack of resources and people to train</td>
</tr>
<tr>
<td>3</td>
<td>Development of capacities of national climate centres’ Infrastructure</td>
<td>Improved, efficiency, and quality of products</td>
<td>Increased quantity and quality of products</td>
<td>2014-2017</td>
<td>WMO, WCRP, International institutions, development partners</td>
<td>Links with RMP and CSIS and OBS</td>
<td>45</td>
<td>Lack of funding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Establish mechanisms to interface with users through pilot projects and other existing mechanisms such as RCOFs, NCOFs, User COFs and interdisciplinary workshops on sector-specific climate indices</td>
<td>A number of ways in which providers are interfacing with users to provide information and get feedback</td>
<td>Identified communities of users that are using information and products from providers</td>
<td>2014-2017</td>
<td>UN Agencies such as FAO, ISDR, WHO, UNESCO, UNDP, WMO, WFP, international and regional institutions and development partners, Private sector, NGOs</td>
<td>Links with UIP and CSIS activities</td>
<td>For the first phase</td>
<td>30</td>
<td>Lack of funding</td>
</tr>
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<tr>
<td>4</td>
<td>During the early stage of the GFCS establishment there is a need as a priority for supporting the establishment of four new WMO Regional Climate Centres</td>
<td>Basic climate services received by countries that couldn’t provide such information</td>
<td>Number of established new regional climate centres that have capacity of provide basic to essential climate services.</td>
<td>2014-2017</td>
<td>WMO, Regional banks, Development partners, Regional Economic Communities, and Governments,</td>
<td>Activities of CSIS and RMP and UIP</td>
<td>35</td>
<td>Inadequate staff resources to manage user relationships, generate services, and monitor user uptake and use Regional Centres are not close enough to users to understand user needs</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Strengthen existing regional climate centres. There will be need to strengthen</td>
<td>Improved climate services to the levels of essential category 2 to</td>
<td>An increased number of centres that are able to provide enhanced</td>
<td>Initially between 2014-2017</td>
<td>UN Agencies, Development Banks, Regional Economic Communities, Governments,</td>
<td>For the first phase</td>
<td>30</td>
<td>Lack of funding</td>
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<tr>
<td>7</td>
<td>Enhancement of capacity of global observing network especially in developing and LDCs and SIDCs which have observation networks</td>
<td>Increased observations of climate data that can be used to produce improved climate services both at national and regional levels.</td>
<td>7.1 Number of new stations that have been established and those that have been rejuvenated</td>
<td>2014-2017</td>
<td>FAO, UNESCO, WMO, Space Agencies</td>
<td>75</td>
<td>Lack of funding</td>
<td></td>
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<tr>
<td>8</td>
<td>Enhance capacity of global climate centres in addressing user needs and interface processes and level of absorption of the products from these centres</td>
<td>Climate information and products with improved skill, procedural capacity and level of interaction with users</td>
<td>8.1 Number of centres with improved climate prediction skill</td>
<td>2014-2017</td>
<td>WMO, WCRP, Universities, international climate research institutions, GPCs</td>
<td>20</td>
<td>Regional Centres are not close enough to users to understand user needs</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>Improve mechanisms for data management</td>
<td>Data and products exchanged in a timely, Amount of information received at the centre or</td>
<td></td>
<td>2014-2017</td>
<td>WMO, NMHSs, other relevant UN Agencies</td>
<td>20</td>
<td>Lack of resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and exchange in developing countries and LDCs and SIDCs through provision of new technological facilities</td>
<td>easily, and efficient manner</td>
<td>disseminated by the centre and also amount of information exchanged between providers and users</td>
<td></td>
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<tr>
<td>10</td>
<td>Strengthen regional telecommunication networks especially at developing countries and LDCs</td>
<td>National and international Data collected or transmitted at national level</td>
<td>Amount of data collected at the national climate centre and the amount of data disseminated for regional and international exchange</td>
<td>2014-2017</td>
<td>WMO, NMHSs, other UN Agencies</td>
<td>20</td>
<td>Lack of resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Support Institutional framework and policy capacity development of national climate services providers</td>
<td>Defined policy for national climate service providers and legal framework to support them</td>
<td>Number of national legalized institutions with mandate for provision of climate services supporting the framework defined</td>
<td>2014-2017</td>
<td>WMO and NMHSs</td>
<td>3</td>
<td>Lack of resources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES:

UNDP–GEF 2011: Adapting to Climate Change, UNDP–GEF Initiatives Financed by the Least Developed Countries Fund, Special Climate Change Fund and Strategic Priority on adaptation.


WHO, 2011: Improving Climate Services for the Health Sector, A background Report for the Inter-Agency Consultation Meeting on the Global Framework for Climate Services User Interface Platform (UIP) and Implementation Plan, November 2011, Geneva, Switzerland.

WMO, 2010: Commission for Climatology Session XV Resolution 7 Capacity Building for Climate Services


WMO, 2011b: Basic Documents No.1. WMO Publication No. 15.


WMO, 2011e: Final report on Consultation Workshop on NMHS Capacity Development Requirements for GFCS, 10-12 October, 2011, Geneva Switzerland


WMO, 2012: WMO Capacity Development Strategy
DEFINITIONS OF KEY WORDS:

**Climate Service**: The provision of one or more climate products or advice in such a way as to assist decision-making by individuals or organizations.

**Climate services providers**: Institutions and entities that are providing climate services. At national level these institutions include the NMHSs.

**National Climate Services (NCS)**: Those services that, through a collaborative network of entities that create and provide authoritative, credible, usable and dependable science-based climate information, products and advice that is of value to government institutions, socio-economic sectors and the broader community.

**National climate centre**: The national climate centre is the national provider of climate data and operational climate products that enable a national climate service to serve its users’ needs. In most countries NHMSs are national climate centres.

**Capacity development**: The process of strengthening the abilities or capacities of individuals, organizations and societies to solve problems and meet their objectives on a sustainable basis which:

- Is an on-going continuous improvement process with feedback mechanisms rather than a short-term intervention;
- Aims to augment capacity in a manner conducive to sustained growth;
- Includes the activities, approaches, strategies, and methodologies which help organizations, groups and individuals improve their performance, and generate development benefits;
- Is an endogenous process driven by national mechanisms and facilitated by complementing external agencies; and
- Should be evaluated based on growth as a whole and over time.

**Capacity Building**: The process that tends to support the initial stages of building or creating capacities, based on an assumption that there are no existing capacities to start from. The approach can be relevant to crisis or immediate post-conflict situations but it is considered to be less comprehensive than capacity development.

**Human resources capacity**: As defined in section 1.1 above

**Infrastructural capacity**: As defined in section 1.1 above

**Procedural capacity**: As defined in section 1.1 above

**Institutional capacity**: As defined in section 1.1 above
<table>
<thead>
<tr>
<th>ACRONYMS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACMAD</td>
<td>African Centre for Meteorological Applications and Development</td>
</tr>
<tr>
<td>AfDB</td>
<td>African Development Bank</td>
</tr>
<tr>
<td>AGRHYMET</td>
<td>Agro-meteorology and Hydrology Regional Centre</td>
</tr>
<tr>
<td>APECCC</td>
<td>Asia-Pacific Economic Cooperation Climate Centre</td>
</tr>
<tr>
<td>APN</td>
<td>Asian-Pacific Network</td>
</tr>
<tr>
<td>AU</td>
<td>African Union</td>
</tr>
<tr>
<td>AWOSs</td>
<td>Automatic Weather Observing Stations</td>
</tr>
<tr>
<td>AWSs</td>
<td>Automatic Weather Stations</td>
</tr>
<tr>
<td>CAS</td>
<td>Commission for Atmospheric Sciences</td>
</tr>
<tr>
<td>CBS</td>
<td>Commission for Basic Systems</td>
</tr>
<tr>
<td>CD</td>
<td>Capacity Development</td>
</tr>
<tr>
<td>CDMS</td>
<td>Climate Data Management System</td>
</tr>
<tr>
<td>CDS</td>
<td>Capacity Development Strategy</td>
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<tr>
<td>CCI</td>
<td>Commission for Climatology</td>
</tr>
<tr>
<td>CIIFEN</td>
<td>Centro Internacional para la Investigación del Fenómeno de El Niño</td>
</tr>
<tr>
<td>CIMH</td>
<td>Caribbean Institute for Meteorology and Hydrology</td>
</tr>
<tr>
<td>CHy</td>
<td>Commission for Hydrology</td>
</tr>
<tr>
<td>ClimDev (Africa)</td>
<td>Climate Development for Africa Programme</td>
</tr>
<tr>
<td>CLIPS</td>
<td>Climate Information and Prediction Services</td>
</tr>
<tr>
<td>COFs</td>
<td>Climate Outlook Forums</td>
</tr>
<tr>
<td>COMET</td>
<td>Cooperation Programme for Operational Meteorology Education and Training</td>
</tr>
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<td>CORDEX</td>
<td>Coordinated Regional Climate Downscaling Experiment</td>
</tr>
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<td>CSIS</td>
<td>Climate Services Information Systems</td>
</tr>
<tr>
<td>CPC</td>
<td>Climate Prediction Centre</td>
</tr>
<tr>
<td>DARE &amp;D</td>
<td>Data Rescue and Digitization</td>
</tr>
<tr>
<td>DCPC</td>
<td>Data Collection or Production Centre</td>
</tr>
<tr>
<td>DRR</td>
<td>Disaster Risk Reduction</td>
</tr>
<tr>
<td>ESSP</td>
<td>Earth System Science Partnership</td>
</tr>
<tr>
<td>EC</td>
<td>Executive Council</td>
</tr>
<tr>
<td>ETCCDI</td>
<td>Expert Team on Climate Change Detection and Indices</td>
</tr>
<tr>
<td>ET-SCBCS</td>
<td>Expert Team on Strategy for Capacity Building for Climate Services</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<td>EUMETSAT</td>
<td>European Organization for the Exploitation of Meteorological Satellites</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<tr>
<td>GAW</td>
<td>Global Atmospheric Watch</td>
</tr>
<tr>
<td>GWATEC</td>
<td>GAW Training and Education Centre</td>
</tr>
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<td>GCW</td>
<td>Global Cryosphere Watch</td>
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<td>GCOS</td>
<td>Global Climate Observing System</td>
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<td>GDFPS</td>
<td>Global Data Processing and Forecasting System</td>
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<td>GEF</td>
<td>Global Environment Fund</td>
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<td>GEOSS</td>
<td>Global Earth Observation System of Systems</td>
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<td>GFCS</td>
<td>Global Framework for Climate Services</td>
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<tr>
<td>GOS</td>
<td>Global Observing Systems</td>
</tr>
<tr>
<td>GOOS</td>
<td>Global Ocean Observing Systems</td>
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<tr>
<td>GPC</td>
<td>Global Prediction Centres</td>
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<td>GSN</td>
<td>Global Surface Network</td>
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<td>GTOS</td>
<td>Global Terrestrial Observing System</td>
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<td>GTS</td>
<td>Global Telecommunications System</td>
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<td>GUAN</td>
<td>GCOS Upper-Air Network</td>
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<td>HLT</td>
<td>High-Level Taskforce</td>
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<tr>
<td>ICPAC</td>
<td>IGAD Climate Prediction and Applications Centre</td>
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<td>ICTP</td>
<td>International Centre for Theoretical Physics</td>
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<td>International Council for Science</td>
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<td>International Fund for Agricultural Development</td>
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<td>IFRC</td>
<td>International Federation of Red Cross and Red Crescent Societies</td>
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<td>IGAD</td>
<td>Inter-Governmental Authority in Development</td>
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<td>IOC</td>
<td>Intergovernmental Oceanographic Commission (of UNESCO)</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<tr>
<td>IRI</td>
<td>International Research Institute (for Climate and Society)</td>
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<td>ISDR</td>
<td>International Strategy for Disaster Reduction</td>
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<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
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<td>JMA</td>
<td>Japan Meteorological Agency</td>
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<td>JCOMM</td>
<td>Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology</td>
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<td>LDCs</td>
<td>Least Developed Countries</td>
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<td>LRF</td>
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<td>MALOF</td>
<td>Malaria Outlook Forum</td>
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<td>MEDARE</td>
<td>Mediterranean Data Rescue Initiative</td>
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<tr>
<td>M&amp;E</td>
<td>Monitoring and Evaluation</td>
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<tr>
<td>MOU</td>
<td>Memorandum of Understanding</td>
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<td>NAPA</td>
<td>National Adaptation Programme for Action</td>
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<td>NCAR</td>
<td>National Centre for Atmospheric Research</td>
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<td>National Centres for Climate Prediction</td>
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<td>NGOs</td>
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<td>NMHSs</td>
<td>National Meteorological and Hydrological Services</td>
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<td>NWP</td>
<td>Numerical Weather Prediction</td>
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<td>O&amp;M</td>
<td>Observation and Monitoring Pillar</td>
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<td>OMS</td>
<td>Quality Management System</td>
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<td>Global Change System for Analysis, Research and Training</td>
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<td>User Interface Platform</td>
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<td>United Nations Educational, Scientific and Cultural Organization</td>
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<td>United Nations Environmental Programme</td>
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<td>United Nations Industrial Development Organization</td>
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</table>
AGENDA ITEM 4: GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

GFCS COMMUNICATION STRATEGY

SUMMARY

ACTION REQUIRED:

Note the contents of the draft communication strategy.

CONTENT OF DOCUMENT:

The Table of Contents is available only electronically as a Document Map in MS Word (Go to “View” -> “Document Map”).

CONGRESS

EXTRAORDINARY SESSION

Geneva, 29 to 31 October 2012
Communication Strategy for the
Global Framework for Climate Services (GFCS)
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III. General overview .......................................................................................................... 4
IV. Target Audiences ......................................................................................................... 5
V. The GFCS messages ...................................................................................................... 6
VI. Communications tools ................................................................................................. 7
VII. Identifying and managing risks .................................................................................. 8
VIII. Monitoring and evaluating performance .................................................................... 9
I. INTRODUCTION

The Global Framework for Climate Services (GFCS) is a mechanism for coordinating, facilitating, developing and supporting operational climate services. It bridges the gap between climate service users and providers and ensures that past and future investments in physical infrastructure and human and organizational capacity are exploited to the full. The Framework facilitates the assimilation of climate knowledge into decision making to achieve societal benefits.

The success of the GFCS will depend on the full engagement of national governments and of United Nations and other international organizations. Sustainable government-to-government partnerships will be particularly crucial for meeting the Framework’s goals. United Nations and other international organizations will support the Framework through programmes, projects and activities that deliver and apply practical technical outputs. Within each country, partnerships among the users and producers of climate information and services are also essential.

Communications must be fully integrated into the activities of the GFCS in order to be effective and sustainable. All participating governments and organizations should therefore be encouraged to actively promote the message that climate services and the GFCS offer added value and important societal benefits. They should be invited to collaborate at both the international and national levels on continuously promoting and communicating the advantages, benefits and successes of climate services and the Framework.

The communications strategy described in this document addresses the first phase of GFCS implementation, which concludes in 2015. To be effective, the strategy will need to involve the entire GFCS partnership. The WMO Secretariat will be proactive in facilitating the engagement of the partnership in the communications activities described below.

II. GOALS OF THE COMMUNICATION STRATEGY

In support of the Framework’s objectives and two-year milestones, the GFCS partnership will initially pursue three core goals in its communications work:

1. Raise the awareness of partners, users and other target audiences about the need for, and usefulness and benefits of, climate services and the Framework.

2. Promote sustainable partnerships and foster a sense of ownership of the GFCS by governments, United Nations bodies, and other organizations, while identifying and engaging non-traditional partners, including think-tanks, philanthropic organizations and user communities, to successfully deliver the Framework in the longer term.

3. Encourage Members to support the Framework by funding climate infrastructure, programmes, projects and services at the national, regional and global levels, and attract government support for the administrative expenses of the Framework.

III. GENERAL OVERVIEW

The GFCS communications strategy seeks to clearly convey to all stakeholders the need for, and benefits of, climate services and the Framework. The best way to convince stakeholders that they can benefit from climate services will be to provide specific and concrete examples of existing and successful services and how they have helped particular users. Success stories, case studies, lessons learned and pilot projects can all contribute to this effort.

Traditional as well as electronic and social media will be used to advocate the benefits of climate information and the usefulness of the Framework to potential beneficiaries. Key messages and information materials will be formulated in consultation with representatives of user organizations and GFCS partners in order to deliver user driven messages rather than provider driven ones.
A clear and distinctive brand will be created for the GFCS. The UN system “delivering as one” will form a core part of this branding. All GFCS materials should have the same ‘look and feel’ and contribute to delivering consistent messages about the Framework.

The communication departments of all UN and other partners will be invited to contribute to this communications strategy. All GFCS partners will be encouraged to approach their media contacts. Efforts will be made to document on-the-ground activities in order to provide a human face to an otherwise abstract activity.

GFCS will use conferences, seminars and workshops as platforms to engage with partners and users. Communications activities will build on the momentum of major international events, such as UNFCCC COPs, that are strategically important for the development and use of climate services that will contribute to sustainable development and adaptation. Governing body sessions of partner agencies can also be used to sensitize user audiences about the Framework and stimulate buy-in from relevant sectors and organizations. A schedule of the major governing body sessions and internationally significant events will be developed.

Individual experts can be engaged through targeted user consultation meetings, the drafting and reviewing of the GFCS Implementation Plan documents and other outreach material as well as through interagency projects. Communicating the successful implementation of collaborative projects and their respective accomplishments will lead to a greater appreciation of the Framework and what it can offer to countries and organizations.

Making the case that climate services will increase the predictability of and preparedness for climate hazards and associated health and food security problems will aid in persuading funding agencies to engage. Concrete cost-benefit analyses and demonstration projects that clearly show the added value of empowered climate service providers will further attract contributions to the Framework.

The added value of the Framework and its Secretariat and Intergovernmental Board needs to be demonstrated in order to obtain sustained financial support. The success of the GFCS will depend on its success at the national and regional levels and will be measured accordingly. Communicating the quality and scope of activities that are being facilitated through the GFCS is imperative in order to recognize the contributors and demonstrate the growing interest.

IV. TARGET AUDIENCES

The GFCS communications activities will seek to reach out to and influence the following audiences:

- **National Governments** are central to the implementation of the GFCS, and a first priority is to engage them.
- **The United Nations system** is also a core part of the GFCS partnership and, among other contributions, will take a lead in defining the perspective and needs of the users of climate services.
- **The end users of climate services**, including communities, civil society and decision-makers in sectors such as agriculture, water resources, disaster risk reduction and public health, will drive the development of climate services.
- **The private sector** should be engaged primarily, but not exclusively, as users of climate services in the GFCS priority sectors, predominantly through their “umbrella” organizations.
- **Development assistance and other funding agencies** will be invited to provide financial support for capacity building. Their visible commitment to the GFCS would encourage governments to provide further support to the Framework.
Research communities, academic institutions and “think tanks” should be engaged, in particular to contribute to the research and modelling pillar by advancing climate science and developing new tools.

Media engagement is critical for reaching all other audiences.

V. THE GFCS MESSAGES

The messages delivered to these target audiences need to articulate how science-based climate information can inform decisions about climate variability and climate change. These messages need to demonstrate the economic and societal benefits of such information. They should reflect the current political discourse on adaptation and major development goals.

Messaging should aim to translate scientific and technical information into formats readily understood in the language and culture of the recipients. In all communications, the appropriate media should be used to take account of the needs, preferences and cultures of various user groups. Both traditional channels (such as the print media) and new ones (such as social networks) can be used to deliver messages.

Messaging should focus not on pessimistic scenarios of climate change but rather on stories that illustrate the positive and practical impact of climate services for subsistence farmers, coastal communities, town planners, structural engineers and other specific audiences. Progress in the accuracy and usefulness of weather forecasts has already generated large socio-economic dividends – and rewards from progress in the development and application of climate predictions will be potentially even greater.

Ten key messages for GFCS include:

1. The GFCS is a collaborative effort of the United Nations for supporting climate-smart decision-making for sustainable development.

2. The GFCS promotes the use of climate-smart decision-making to improve the lives and livelihoods of the most vulnerable people to climate variability and climate change.

3. The GFCS enables users of climate services to play an active role in their design, delivery and implementation, leading to better-informed decisions on the ground.

4. The GFCS encourages countries to form cohesive platforms enabling the active exchange of views and opinions, needs and requests for tailored climate services.

5. The GFCS advocates for cross- and interdisciplinary collaboration among government agencies, private companies and research institutions to foster dialogue and the delivery of effective and efficient climate services.

6. The GFCS promotes collaborative problem solving efforts at the regional and global levels by learning from others, hence reducing costs and duplication.

7. The GFCS advocates for the free and open exchange of climate and other data relevant for the development and delivery of climate services, while respecting national policies.

8. The GFCS ensures the long-term success of major infrastructure investments for climate observation, storage and delivery facilities through cooperation with partners and the commitment of the national governments to the Framework.

9. The GFCS opens up avenues for the operational production, delivery and use of climate services from innovative research and private industry initiatives.

10. The GFCS interacts robustly with the international donor community in order to provide the basic capacities for the national production, delivery and application of climate services.
VI. COMMUNICATIONS TOOLS

The GFCS communications strategy will be implemented using some or all of the following tools:

- **Branding** – Strengthening brand recognition of the Framework will promote the sense of community amongst the GFCS partners and ensure a strong and coherent GFCS identity.

- **Website** ([http://www.wmo.int/gfcs/](http://www.wmo.int/gfcs/)) – The site serves as a platform for disseminating a broad range of information. It will include video and photo essays to illustrate the practical benefits of climate services.

- **Social media** – WMO and other partners will promote the GFCS through their Facebook and Twitter activities until the Framework achieves its own identity and capacity to take the lead on this. Social media is more interactive and proactive than the web and can reach new audiences. It is also a useful tool for gaining feedback from user groups, especially at the local community level. Social media tools are being successfully used by some UN organizations for fund-raising. Google Groups can also be used to facilitate the exchange of ideas and opinions ([http://www.wmo.int/gfcs/group](http://www.wmo.int/gfcs/group)).

- **Newsletter** – A quarterly newsletter highlighting the progress being made will be placed on the webpage and emailed to key lists.

- **Outreach materials** – Available in print and electronic formats, materials can include fact sheets, brochures, Q&As and FAQs, standard powerpoint presentations, videos, photos, and animations.

- **Book on best practices and lessons learned** – The full-color book Climate Exchange has been prepared in time for the User Dialogue and Extraordinary Congress. This exercise could be repeated in the future.

- **Technical documents** – For example, a document describing the key steps for implementing Frameworks for Climate Service at the National Level.

- **Educational materials** – The GFCS partners, together with a leading international organization on education, could produce a guidance document on how to mainstream climate knowledge into school curricula.

- **United Nations resources** – The United Nations Information Centres are located in many countries around the world and can support outreach at the national level. Other resources are the various United Nations themed Days and Years, which GFCS can build upon or contribute to.

- **National communications campaigns** – GFCS partner agencies could use GFCS materials provided by the UN and others to promote the Framework.

- **Media outlets** – GFCS could foster partnerships with media associations, especially in developing countries. Television and radio weather presenters reach out to large audiences in most countries, and GFCS could foster training and awareness activities to transform them from weather presenters into climate broadcasters and educators.

- **Opinion articles** – GFCS partners can contribute newspaper articles, opinion pages, letters to editors and blogs to increase awareness of climate services and the role of the Framework.

- **Conference presentations** – The governing body sessions of UN partners, UNFCCC COPs, professional and sectoral associations, and many other venues offer promising opportunities for presenting GFCS.

- **Official documents** – Stakeholders can be encouraged to write and review the Implementation Plan and other documents produced as part of the GFCS process.
• Technical collaboration – GFCS can encourage inter-agency projects at the technical level that demonstrate the benefits of climate service to the user community as well as pilot projects demonstrating the process for implementing Frameworks for Climate Services at the national level.

• Non-governmental organizations – GFCS partners can reach out to business associations and Chambers of Commerce at international, regional and national levels, as well as large international and national companies that could benefit from climate services.

VII. IDENTIFYING AND MANAGING RISKS

A first assessment of the potential risks facing GFCS and this communications plan, their likelihood and impact, and how they might be mitigated, is presented below:

<table>
<thead>
<tr>
<th>Risk</th>
<th>Likelihood</th>
<th>Impact</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncoordinated overlap with other initiatives</td>
<td>High</td>
<td>Would destroy the message of non-duplication and will scare donors off</td>
<td>Be aware and pro-actively engage with those initiatives without imposing on them.</td>
</tr>
<tr>
<td>Similar messages from sources other than GFCS community (e.g. Climate Service Partnership, Academic Institutions)</td>
<td>Medium</td>
<td>Loss of credibility. Loss of authoritative voice</td>
<td>Find a common and clear definition of climate services. Strong branding that will clearly identify the origin of the message.</td>
</tr>
<tr>
<td>Conflicting messages from within GFCS Community</td>
<td>High</td>
<td>Create confusion towards partners and donors</td>
<td>High interaction with communication departments/teams in GFCS Partners.</td>
</tr>
<tr>
<td>Sense of a too WMO-centric approach – damage relationship with partners</td>
<td>High</td>
<td>Will scare partners off</td>
<td>Seek the active engagement of partners in the review of documents and implementation of activities. Search for opportunities of clarifying dialogues.</td>
</tr>
<tr>
<td>Members fear interference with their national sovereignty</td>
<td>High</td>
<td>Lack of engagement</td>
<td>Produce goals and objectives that will not interfere with national mandates. Communicate these clearly through all channels.</td>
</tr>
<tr>
<td>Countries do not want to implement Frameworks for Climate Service at the National level</td>
<td>Medium</td>
<td>Will counteract with the goals set in the implementation plan</td>
<td>Clearly communicate the benefits of such a framework at the national level to countries.</td>
</tr>
<tr>
<td>Donors will not feel enticed to pledge</td>
<td>Medium</td>
<td>Will lead to loss of credibility of the initiative</td>
<td>Provide donors with cases that show socio-economic benefits to the framework. This includes cost-benefit analyses.</td>
</tr>
</tbody>
</table>
Raise expectations beyond the achievable | Medium | Will lead to the termination of the initiative | Have realistic goals and objectives and communicate them through all channels.

VIII. MONITORING AND EVALUATING PERFORMANCE

The communications strategy will evolve as the Framework is implemented. In particular, it will be adapted in response to developments and decisions arising from the Extraordinary Session of the World Meteorological Congress.

The goals, target audiences, messages and tools will be reviewed on an ongoing basis and will be revised based on early successes and challenges. In general, an overall revision of the strategy should be made every six months. All activities are being monitored through the World Meteorological Congress and its subsidiary bodies. Meetings of the Monthly Project Oversight Board made up of Senior WMO managers who are also monitoring and evaluating this strategy and its implementation.

The following outputs and results could be included in the periodic evaluations of the communications strategy:

- Web and social media statistics, analytics and trends (quarterly);
- Uptake of printed and distributed publications (yearly);
- Uptake of messages (half yearly);
- Feedback received (continuous);
- Quantity and quality of communications departments contributing to GFCS communications activities (half yearly);
- Media coverage (monthly);
- Quantity and impact of national and international outreach events organized by GFCS partners (half yearly);
- Number of countries implementing Frameworks for Climate Service at the National level (yearly).
AGENDA ITEM 4: GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

AGENDA ITEM 4.2: ESTABLISHMENT OF THE INTERGOVERNMENTAL BOARD ON CLIMATE SERVICES

GFCS BUDGET

SUMMARY

DECISIONS/ACTIONS REQUIRED:

To consider requirements and decide on the level and source of financial resources for institutional support of the Intergovernmental Board on Climate Services, secretariat support (GFCS Office) and for implementation activities and projects.

REFERENCES

Background material - Appendix C

Pro-forma trust fund Letter of Agreement – Appendix D

CONTENT OF DOCUMENT:
The Table of Contents is available only electronically as a Document Map in MS Word (Go to “View” -> “Document Map”).
APPENDIX A:
DRAFT TEXT SUPPORTING THE DECISIONS –
FOR INCLUSION IN THE GENERAL SUMMARY

4. GLOBAL FRAMEWORK FOR CLIMATE SERVICES (AGENDA ITEM 4)

4.2 Establishment of the Intergovernmental Board on Climate Services (agenda item 4.2)

4.2.x.1 The Congress considered the financial requirements for the institutional support of the Intergovernmental Board, the secretariat and for the implementation activities and ...

[Comment: to be completed following the discussion]

4.2.x.2 The Congress adopted Resolution 3 (Cg-Ext.(2012)).
APPENDIX B:

DRAFT RESOLUTION 3 (Cg-Ext.(2012))–FINANCING THE INTERGOVERNMENTAL BOARD ON CLIMATE SERVICES, SECRETARIAT AND GFCS IMPLEMENTATION PLAN

THE CONGRESS,

Noting:

(1) Resolution 1 (Cg-Ext.(2012)) – Implementation Plan for the Global Framework for Climate Services,

(2) Resolution 2 (Cg-Ext.(2012)) – Establishment of the Intergovernmental Board on Climate Services,

Having considered:

(1) The financial requirements for institutional and secretariat support to the Intergovernmental Board;

(2) The financial requirements for the GFCS implementation projects and activities;

Decides:

(1) To set the initial base budget for the institutional and secretariat support to the Board as CHF XXXXX;

(2) To set the initial base budget for the implementation activities at CHF XXXXX;

Urges Members:

(1) To make voluntary contributions to the GFCS trust fund for the resources needed for institutional and secretariat support of the Board;

(2) Report to the GFCS Secretariat all commitments and support to the GFCS supported through bilateral and multilateral mechanisms in a transparent and timely fashion for their inclusion in GFCS Office reports to the Intergovernmental Board;

Calls on:

(1) United Nations system entities to contribute resources to projects, programmes and activities and to provide in-kind support to the GFCS Office;

(2) Multilateral funding agencies to include the GFCS activities, programmes and projects in their funding plans and priorities;

Requests the Secretary General to bring this resolution to the attention of all concerned
APPENDIX C:

BACKGROUND INFORMATION – NOT TO BE INCLUDED IN THE GENERAL SUMMARY

1. Congress considered the various sources of funding and the terms of the GFCS Trust Fund. It recognized that implementation of the GFCS will require resources. Funds would be required to support: (a) the institutional structure of the GFCS including the Board and its sessions, a Secretariat, the substructure and activities of the Board; as well as (b) the project activities that will deliver outcomes around the priority areas. The costs of the institutional arrangements had been estimated with an upper and lower range. Funds for the governance (funding the Board and substructures) and Secretariat (core functions) and WMO-led programme and projects should be administered by WMO through the regular budget and the GFCS Trust Fund.

2. With regard to project activities contributing to the Framework, Congress noted that distributed project management by the partner organizations would likely be a common approach. The Board would in effect recognize a project as a GFCS activity or act as a clearing house and that activity would generate outcomes delivering on GFCS priority work areas, but the Board would not necessarily have oversight on all GFCS projects and activities at all geographical scales i.e. national, regional and global.

3. Congress agreed that it would approve the GFCS main principles, Implementation Plan and budget allocation from the WMO regular resources (assessed and voluntary contributions of the Members), and that any matter having additional financial and operational implication on all Member States and Territories should be reported to Congress.

4. Congress noted that partner organizations should be invited to institutionalize their GFCS-related activities, as well as those under their leadership, as identified by the Board, within their organizations with subsequent resource commitment, with the Board to provide some form of coordination. The Board would likely play an active catalytic role in mobilizing resources and its compendium, which would be used to identify gaps and priorities and which could give legitimacy to new projects and programmes consistent with the Implementation Plan under the Framework.

Financial requirements for institutional support of the Intergovernmental Board on Climate Services

5. Congress considered the financial requirements for institutional support of the Intergovernmental Board on Climate Services (Table 1), the functioning of its subsidiary bodies (Table 2) and the options for hosting sessions of the Board and its substructures (Tables 3 and 4).
<table>
<thead>
<tr>
<th>Table 1: Intergovernmental Board on Climate Services – Institutional Support costs (CHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUANTITY</strong></td>
</tr>
<tr>
<td>CICG Services</td>
</tr>
<tr>
<td>Conf. Services pre-session</td>
</tr>
<tr>
<td>Conf. Services in-session</td>
</tr>
<tr>
<td>Interpreters</td>
</tr>
<tr>
<td>Translation 6 L*</td>
</tr>
<tr>
<td><strong>SUB-TOTAL SERVICES</strong></td>
</tr>
<tr>
<td>48 LDC travel**</td>
</tr>
<tr>
<td>48 LDC per-diem***</td>
</tr>
<tr>
<td><strong>SUB-TOTAL LDC</strong></td>
</tr>
<tr>
<td>Other 100 travel****</td>
</tr>
<tr>
<td>Other 100 per diem</td>
</tr>
<tr>
<td><strong>SUB-TOTAL +100</strong></td>
</tr>
<tr>
<td><strong>TOTAL incl. LDC</strong></td>
</tr>
<tr>
<td><strong>TOTAL incl. 150</strong></td>
</tr>
</tbody>
</table>

* Average cost of translation: EC 400,000 CHF; CBS & CCl – 150,000 CHF
** Average economic most direct route
*** DSA Geneva Feb – 2012 – USD 413
**** All developing and economies in transition, in addition to LDCs

<table>
<thead>
<tr>
<th>Table 2: Subsidiary bodies cost per year (CHF, English only)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUANTITY</strong></td>
</tr>
<tr>
<td>Management Committee</td>
</tr>
<tr>
<td>Technical Committee*</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
</tr>
</tbody>
</table>

* Limited financial support for meetings

<table>
<thead>
<tr>
<th>Table 3: Total cost per year with one 5 day session (CHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIN</strong></td>
</tr>
<tr>
<td>Board plenary</td>
</tr>
<tr>
<td>Board substructure</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
</tr>
<tr>
<td>Trust Fund support cost 7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4: Total 4 years – with 2 sessions (CHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIN</strong></td>
</tr>
<tr>
<td>Board plenary</td>
</tr>
<tr>
<td>Board substructure</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
</tr>
<tr>
<td>Trust Fund support cost 7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Financial requirements for Secretariat support

6. The financial requirements for supporting the functioning of the Secretariat are indicated in Table 5.
Table 5: GFCS Office costs per year (CHF)

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>COST*</th>
<th>SUB-TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director **</td>
<td>1</td>
<td>309,350</td>
</tr>
<tr>
<td>Senior Pro. Officers ***</td>
<td>3</td>
<td>256,150</td>
</tr>
<tr>
<td>Administrative Assistant**</td>
<td>1</td>
<td>157,450</td>
</tr>
<tr>
<td>General support staff</td>
<td>1</td>
<td>143,600</td>
</tr>
<tr>
<td>Missions travel</td>
<td>20</td>
<td>5,000</td>
</tr>
<tr>
<td>Office support****</td>
<td>1</td>
<td>10,000</td>
</tr>
<tr>
<td>Office space at WMO</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

TOTAL 1,488,850

* WMO standard cost as of July 2012
** WMO Regular Budget 2012-2015
*** Professional staff could be required or seconded from Governments or UN organizations
**** Computers, communication, IT support, consumables, other direct costs

Financial requirements for the implementation projects and activities

7. As suggested by the High-Level Taskforce, the bulk of implementation resources would come from the routine contribution of services and the participation of experts supported by governments and stakeholder organizations as part of their ongoing mandates and programmes. The task of implementing the Framework in the developing world would require support from development agencies, multilateral funding agencies including development banks, bilateral funding mechanisms and by the country programmes of the United Nations system.

8. Sixteenth Congress had agreed with the estimation of the High-Level Taskforce that in broad terms the costs associated with initiating and designing projects might require consultants and meeting expenses of US$ 250,000 to 400,000 per year, which could amount to US$ 2 M in 2013, rising to US$ 3 M in 2014. In addition, the costs of the initial high priority projects would amount to US$10-15 M over the first two years of the Framework.

9. The overall cost of implementation of priority activities is given in Table 6.

Table 6: Cost of Implementation of priority activities

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Building capacity of the User Interface Platform</td>
<td>1</td>
<td>21 to 34</td>
<td>21 to 34</td>
</tr>
<tr>
<td>Building national climate service capacity</td>
<td>1 to 2</td>
<td>53 to 64</td>
<td>50 to 60</td>
</tr>
<tr>
<td>Building climate centre capacity</td>
<td>1 to 2</td>
<td>76 to 90</td>
<td>80 to 94</td>
</tr>
<tr>
<td>Building observations capacity</td>
<td>1 to 2</td>
<td>80 to 100</td>
<td>28 to 40</td>
</tr>
<tr>
<td>Building research capacity</td>
<td>3</td>
<td>7 to 13</td>
<td>18 to 27</td>
</tr>
<tr>
<td>Implement a management capability</td>
<td>2 to 4</td>
<td>13 to 17</td>
<td>13 to 16</td>
</tr>
<tr>
<td>** TOTAL**</td>
<td><strong>8 to 13</strong></td>
<td><strong>229 to 284</strong></td>
<td><strong>189 to 237</strong></td>
</tr>
</tbody>
</table>

Terms of reference of the GFCS trust fund

10. A GFCS trust fund was established in 2011 and various countries have contributed to it. The GFCS trust fund is managed according to WMO Financial Rules and Regulations, which are used according to a contractual agreement between the WMO and Donor. Funds deposited into the trust fund can be earmarked for specific activities or be left to the discretion of the governance and management of the GFCS Secretariat. Contributions made to the trust fund thus far are indicated in Table 7.
Table 7: Contributions to the GFCS trust fund

<table>
<thead>
<tr>
<th>Country</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>1,000,000 CAD</td>
</tr>
<tr>
<td>China</td>
<td>100,000 CHF</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>5,000 CHF</td>
</tr>
<tr>
<td>India</td>
<td>125,000 USD</td>
</tr>
<tr>
<td>Norway</td>
<td>10,000,000 USD</td>
</tr>
<tr>
<td>Switzerland</td>
<td>500,000 CHF</td>
</tr>
</tbody>
</table>

11. A letter of agreement stipulating the amount of the contribution to the trust fund, the objectives and scope of the contribution, the activities to be supported and reporting requirements is signed between WMO and the donor contributing to the trust fund. This ensures effective monitoring of resources contributed to the trust fund. Reports are prepared on an annual basis and included in the WMO financial statements. Specific reporting requirements for particular donors are specified in the individual agreements with such donors.
APPENDIX D:

PRO-FORMA TRUST FUND LETTER OF AGREEMENT

Agreement on Contribution to the GFCS
Between

THE DONOR
and

WORLD METEOROLOGICAL ORGANIZATION (WMO)

This Agreement is drawn between the following Parties of this Agreement:

The Donor, represented by (Donor representative) with address at …

and

The World Meteorological Organization (subsequently referred to as WMO) having its headquarters located at 7 bis, avenue de la Paix, Case postale No. 2300, CH-1211 Geneva 2, Switzerland, represented by its Secretary-General.

PREAMBLE

…

AGREEMENT

The Donor has agreed to contribute (amount) to finance the costs to be incurred to implement the following activities:

1. …;
2. …;
3. … etc.

SCOPE OF ACTIVITIES AND EXPENSES

Activities to be implemented (time frame)

1. Activity 1

Purpose and description of activity.
2. **Activity 2**

Purpose and description of activity.

3. **Activity 3, etc.**

### PERIOD OF APPLICATION OF THE AGREEMENT

This Agreement enters into force on the signature by both Parties and shall be effective up to the (date).

### PAYMENT OF THE CONTRIBUTION

For the implementation of the activities specified in this Agreement, the **Donor** will pay an amount of (amount) to the GFCS Trust Fund, administrated according to WMO’s Financial Rules and Regulations. The payments will be made in accordance with the following schedule:

- XXX (payment periods); and
- XXX.

The payment is made under the condition that … (conditions if applicable).

#### WMO Bank Account details:

- **Account Holder:** World Meteorological Organization (WMO)
- **Bank:** UBS SA, Geneva
- **Bank Address:** Rue du Rhône 8
  Case Postale 2600
  CH-1211 Geneva 2
- **SWIFT:** UBSWCHZH80A
- **CHF Account No:** 240-C0191516.0
- **CHF IBAN:** CH56 0024 0240 C0191516 0

### DESIGNATION OF IMPLEMENTING OFFICE

WMO designates the GFCS Office (or GFCS Secretariat), as implementing office to be responsible for the coordination and implementation of the activities specified in this Agreement. The **Donor** designates (xxx) as focal point for the coordination of activities under this Agreement. WMO and the **Donor** will jointly formulate, review and monitor the activities.

### PROGRAMME SUPPORT COSTS

The programme support costs will be charged in accordance with the approved WMO policy, namely, 7 per cent of the direct costs incurred for the activities.

### ADMINISTRATION OF THE CONTRIBUTION AND THE IMPLEMENTATION CONTROL

The contribution will be administered in accordance with the WMO Rules and Regulations. The responsibility for monitoring compliance with the Agreement rests within WMO, including reporting requirements.
REPORTING REQUIREMENTS

Reports are prepared on an annual basis and included in the WMO financial statements.

TREATMENT OF INTERESTS

The interests generated from the contribution will be credited to the trust fund.

SETTLEMENT OF DISPUTES

Any dispute between WMO and the Donor arising out of the interpretation or execution of this Agreement shall be settled by mutual agreement. If WMO and the Donor are unable to reach agreement on any question in dispute or on a mode of settlement other than arbitration, either party shall have the right to request arbitration in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL), as at present in force. The Parties agree to be bound by any arbitration award rendered in accordance with the above, as the final adjudication of any such dispute.

TERMINATION OF THE AGREEMENT

Both Parties reserve the right of terminating this Agreement after prior consultation, with written advance notice of six months. Upon termination, WMO and the Donor will agree on the use of any balance from the contribution, after deduction of unliquidated obligations and expenses necessary for winding-up activities supported by the Parties.

Signed in three originals,

For the Donor

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at......................... on...........................

For the World Meteorological Organization

at......................... on...........................

(French Jarraud)
Secretary-General