# FUTURE SEAMLESS GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM

**1. Introduction**

The World Meteorological Congress, at its seventeenth session (Cg-17), noted the rapidly evolving transformations in the practice of operational numerical weather prediction, particularly the integrated or seamless modeling approach, and recognized:

1. That all WMO constituent bodies and numerous subsidiary expert level groups provide a complex framework for coordination and collaboration in which a large number of decision-makers and experts from virtually all Members and partner organizations address matters related to the Global Data-processing and Forecasting System (GDPFS),
2. That emerging requirements from the services-oriented programmes, such as aeronautical, marine, agriculture, health, and public weather services, as well as requirements from a wide range of hydro-meteorological-related emergencies, or from implementing disaster mitigation strategies, require an enhanced integrated, holistic and seamless GDPFS in order to be relevant to users’ decision-making,
3. That an enhanced integrated, holistic and seamless Data-processing and Forecasting System could have the potential to lead to important benefits for Members and their National Meteorological and Hydrological Services (NMHS) and the Organization as a whole,
4. That the integration of the technical support to meet the on-going and emerging requirements from different sectors of society in a single system (in a multi-dimensional/ multi-disciplinary approach) would be more cost-effective and relevant to decision-makers and users.

Cg-17 therefore decided, through Resolution 11 (Cg-17), to initiate a process for the gradual establishment of a future enhanced integrated and seamless GDPFS, in light of the conclusions of the first World Weather Open Science Conference (WWOSC-2014, Montreal, Canada, August 2014), and requested the Executive Council to formulate Terms of Reference for this process, and a description of the set of products the system should produce, for consideration by the eighteen session of the World Meteorological Congress (Cg-18) in 2019. A meeting of representatives of Technical Commissions (TCs) was held 10-12 February 2016 to begin to address the Resolution 11. Subsequent CBS Management Group (MG) meeting (15-19 Feb 2016) decided on the establishment of a CBS Lead Steering Group on Seamless GDPFS.

This paper, based on the above TCs experts meeting, responds to Cg-17 request by describing: (1) why we are doing this; (2) the scope; (3) the vision; (4) general considerations on GDPFS core aspects, needs and characteristics, linkages with observations and data exchange, services, role of regional bodies, international organizations, research, and capacity development, the priorities, (5) the benefits, (6) opportunities, success factors and challenges, and (7) the mechanism for implementation and timelines. A second longer and more detailed "living" paper, called the GDPFS White Paper, is available on the CBS WMO website at <http://www.wmo.int/pages/prog/www/DPFS/Future%20GDPFS/Future-GDPFS.html> .

**2. Scope**

The WMO Strategic Plan 2016-2019 will largely determine the scope of the evolution of the GDPFS. It will be driven by the need to support the role of NMHSs in their response to global societal needs facing the world population at large, focusing not only on those sectors for which they traditionally have had a leading role to play, mainly in reducing the socio-economic impacts of weather and climate related disasters in their respective countries, but more broadly on contributing to an expanding number of sustainable development issues related to weather, climate, water and related environmental factors, such as contributions to a carbon-free economy. This expansion or broadening of the scope of the GDPFS will be made possible by a number of factors, a key one being the seamless and integrated modeling approach, which allows the delivery of new environmental services in support of sustainable development across all timescales and disciplines (agriculture, hydrology etc.). Standardization and interoperability of data and products will also be important factors in enabling this broadening of the scope of the GDPFS.

The GDPFS, whilst maintaining its traditional role for standards, validation, verification and overall quality management for data processing and forecast services, will enhance its linkages with other WMO constituent bodies and programmes, with emphasis on regional bodies (TCP regional bodies, RAs) and technical programmes. It will also contribute to the capacity development of its client and user base, and will strengthen its interactions with research, through participation in the design and operational testing or validation of novel products emerging from RDP's and FDP's.

**3. The Vision**

The proposed vision for the Future GDPFS is:

* The GDPFS will be an effective and adaptable monitoring and prediction system enabling Members and partners to make better-informed decisions;
* The GDPFS will facilitate the provision of impact-based forecasts and risk-based warnings through partnership and collaboration;
* The GDPFS will do so through the sharing of weather, water, climate and related environmental data, products and services in a cost effective, timely and agile way, with the effect of benefitting all WMO Members, while also reducing the gaps between developed and developing Members.

Most or even all of this information will be made accessible as a public good product to all WMO Members, and their partners. And most of this information will be made available either in raw format, or directly as impact information. It will be disseminated and presented in whatever medium or format the users have chosen, and use point to point or, increasingly, cloud to point communication broadband technologies. It will be quality controlled, it will be validated and will have metadata information with appropriate publications in the peer-review literature and in the case of forecast information, it will be verified. Imbedded in the design of the system will be two-way feedback and real time communication capacities between the provider and the receiver of the data. This, off course, will require strong collaboration with WIGOS and WIS, the other two components of the World Weather Watch (WWW) Programme.

The system will also have evolved through partnership agreements that allow it to absorb or carry information produced either by the private sector and academia, or by other closely related organizations to the traditional NMHSs. And by using alternate and less expensive technologies, such as cloud computing, crowdsourcing, smartphones, open source software, big data storage, etc., as well as potential partnerships with private sector or other non traditional information providers, gaps between WMO Members in terms of ease and cost of access and positive user impacts will have decreased significantly.

**4. General considerations on core aspects and important linkages**

**4.1 The Successes of the past.**

WMO and its Members have since their creation successfully met a number of major technology jumps: for example, the switch from data plotting and map drawing by hand, and more or less subjective synoptic analyses to a NWP-based system using supercomputers and automation technologies; this was followed later by global modeling, highly efficient and accurate numerical methods and sophisticated data analysis systems and, further followed by global operational usage in data assimilation of space-based observing systems in real time, then by ensemble methods that allowed a probabilistic estimate of the accuracy of the forecast, increasing automation of forecast production with a redefinition of the role of the forecaster, and finally, recently, culminated with the so-called seamless and integrated modeling approach and impact-based forecasting and risk-based warnings which expands the potential applications and usefulness of earth system modeling systems.

It is thus with a high level of confidence that we should approach the next technology transitions: correctly managed, our responses will, as in the past, result in further improvements of the excellence, relevance and impacts of our products, and thus will contribute, overall, to further improvements in the security and socioeconomic progress of all our members, and reduce the gaps that separate some of the WMO Members today.

**4.2 Why are we doing this? Evolution, instead of revolution**

There are a number of reasons for re-examining the GDPFS. On one hand, we are witnessing rapid advances in information and computing technologies (including such objects as smartphones, cloud computing and data storage and retrieval, big data and deep data analytics concepts, fast broadband links, extremely powerful computing technology (capacity doubling every 18 months), novel and easily accessible visualization and display techniques, etc.). On the other hand, we are seeing steadily increasing demands from users for highly-localized weather forecast data provided at a high temporal resolution (at least hourly for the first 12-24 hrs.), spanning a much broader level of dimensions than traditional weather products, and focusing on risk warnings and impact forecasts. In other words, both the "system” and the "services" aspects will need to evolve.

Moreover, with the successful introduction of the seamless or integrated approach in earth system modeling, and the possibility through coupled modeling techniques to touch many non-traditional weather related applications, there will also be a need to re-examine if, how and how much the GDPFS needs to evolve in order to interact or liaise with non-traditional providers of data and services (such as climate services, hydrological services, atmospheric air quality services, space-weather services, maritime or polar services, and new socio-economic services).

Simultaneously, while adapting to these changes, the GDPFS will need to maintain its role as a global system which enables NMHSs to fulfill their national obligations, keep on enhancing WMO's role in disaster risk reduction and mitigation, increasing its linkages with the Climate Services Information System (CSIS) of the GFCS, and ultimately contributing to the reduction of service capability gaps between developed and developing countries.

**4.3 Overall needs and/or desired characteristics driving the evolution of the GDPFS.**

* The need for a clear vision for the future of the GDPFS that would contribute significantly to the long term positioning of the WMO as a world leader in facilitating the provision of both data and forecast products encompassing not only traditional weather related products, but also increasingly a widening spectrum of environmentally related information, in the spirit of the integrated and seamless approach;
* The need to devise a system that would be flexible and easily adaptable to the many technical and expanding service needs and requirements emerging in the user and producer communities, without necessitating a complete rebuild of the system, now, or in the future (for example, standardization on model /system output formats “or” transformation scripts to achieve transformation of standardized formats);
* The need to expand collaborations with many other partners, not necessarily in the traditional family of NMHSs, and adjust the GDPFS to facilitate this openness; for example, the earth system modeling community, including atmosphere, oceans, land, cryosphere, chemistry interactions, etc.;
* The need for a clear focus on high impact products, whilst respecting the professionalism of some users, particularly in the marine, hydrological and agro-meteorological sectors, who are well trained and aware of the impact which certain environmental conditions create and as well, the need to have all Members of WMO benefit from state of the art data and products specific to their particular needs;
* The need for a system where two-way feedback between producers and users is not only facilitated but also recognized as a key to success. This could be achieved through the creation of a Client-Provider Interface;
* The need to enable NMHSs and other institutions to share and leverage each other’s data resources and to identify other sources of data e.g. crowd sourcing, future mobile phone systems as meteorological observation platforms, road/rail/marine vehicles as data sources through similar systems as AMDAR on aircrafts, Nano- technology, etc.;
* The urgent need to transit the GDPFS towards a system capable of producing impact-based forecasting and risk based-warning (IBF & RBW).

**4.4 Observations and data**

The GDPFS, GOS and GTS are the three World Weather Watch (WWW) components. Noting the emerging sophisticated requirements, GOS and GTS have evolved into WIGOS and WIS, respectively, and as such, the evolution of the GDPFS is closely linked to these developments in the observational and information systems. If indeed one wishes to proceed with a global implementation of the seamless and integrated data-processing and forecasting system, focusing on IBF and RBW, it is necessary that access to enhanced or non-traditional observations and data sets, such as preparedness, local transportation, building and power infrastructure status, and disaster management rules be provided either through WIGOS and WIS, or coordinated with all necessary partners.

**4.5 Systems and Services**

At a meeting of experts held at WMO in February 2016 to discuss the future evolution of the GDPFS, representatives from the 6 major services areas of WMO (weather, climate, hydrology, oceanography and marine meteorology, agricultural meteorology and aeronautical meteorology) presented their views and countless examples of the new types of information and services they expect to provide in the future. It was clear that, in relation to concerning observations and data, particularly for water, climate and agriculture, changes would be needed also for the system components. Their TCs detailed requirements are in the full draft of the GDPFS White Paper posted on the WMO website at http://www.wmo.int/pages/prog/www/DPFS/Future%20GDPFS/Future-GDPFS.html. The proposed evolution, if it is to meet successfully the future needs of the users will need to consider many aspects, both technical and organizational. On the one hand, we are witnessing rapid advances in information and computing technologies (including such objects as smartphones, cloud computing and data storage and retrieval, big data and deep data analytics concepts, fast broadband links, extremely powerful computing technology (capacity doubling every 18 months), novel visualization and display techniques, etc.). On the other hand, we are seeing steadily increasing demands from users for highly-localized weather forecast data provided at a high temporal resolution (at least hourly for the first 12-24 hrs.), spanning a much broader level of dimensions than traditional weather products, and focusing on risk warnings and impact forecasts. These background technical issues will be common to all services. In the discussions, it was also apparent that organizational changes would probably be necessary, particularly for climate and agro-meteorological services.

**4.6 Regional bodies**

As much of the new information will become highly localized, and tailored specifically for specific user communities, RAs and other regional bodies, such as TCP regional bodies and RA working groups, will need to become more closely involved, depending on the specific focus and scope of the new services. They represent classes of both providers and users of observational, data and forecasting information. As well, RAs provide a governance mechanism to plan and coordinate activities as well as providing a mechanism to enable supra-national discussions and decision-making. Those bodies vary immensely in their capacities and political influence, and specific products needs, this being driven by both socioeconomic, administrative and political factors, and the specific regional characteristics that weather, climate, hydrological and other environmental impacts display in the specific regional areas which they cover. As the GDPFS evolves towards the provision of an expanding set of products, and focuses increasingly on forecasting impacts, close coordination with regional bodies will become more and more essential. Forecasting impacts at an increasing space and time resolution requires access to whole new sets of observations and data (including exposure and vulnerability), as well as an expanding suite of numerical models, ensemble products, etc., coupled with a diverse suite of dissemination and presentation technologies: these will vary greatly between Regions.

**4.7 International organizations**

Linkages with a number of other international organizations, particularly but not exclusively humanitarian agencies, some in the UN system (e.g. UNEP, UNESCO, IAEA, and WHO), some outside (like GEO, and ICSU), are also required to ensure the GDPFS of the future can respond to their needs. It is to be expected that as socio-economic related information is made available through the GDPFS, this number could increase substantially.

**4.8 Research**

The value chain in meteorology is rapidly being diversified. From mainly providing weather forecasts to the general public, the NMHSs progressively develop and apply downstream models/post-processing of NWP forecasts or reanalysis for a range of applications in specific societal sectors. Marine forecasts, GCM climate projections and environmental predictions are also included. Many of these have been rendered possible by adopting the seamless and integrated modeling approach, a key result of international R&D collaborations, often under the leadership of WMO.

Examples of specific applications include road traffic, aviation (civil and military), shipping, energy production and consumption (wind, solar, hydro, fossil), air quality, integrated global greenhouse gas information system, biogeochemical fluxes (ecosystem including freshwater impact), estimation of emissions of trace chemical species, agriculture, tourism, high impact weather (wind, precipitation, temperature), avalanches and mud slides, coastal erosion, storm surges, offshore weather including waves, icing on infrastructure, emergency preparedness (search and rescue), oil spill, drifting infrastructure; volcanic ash dispersion, dispersion and deposition of radioactivity, large explosions and fires, forest fires, sand and dust storms. The list can be made even longer.

The important point here is to note the foundational role of research in making this evolution possible. WMO, largely through the CAS (GAW, WWRP, GURME), CCl, JCOMM and other research programs, some of which are co-sponsored, such as the WCRP, GCOS, and others, has played a key role in making it an operational reality. It should also be noted that most of the research initiated, coordinated or facilitated through partnerships by WMO are services and policy driven, as is most of the research conducted within the NMHSs. Research activities also provides an important ‘sentinel’ role in that it facilitates an over the horizon S&T watch, which allows better strategic planning for future operational programs and the GDPFS.

**4.9 Capacity development, including education and training**

The evolution of the GDPFS will require a strong focus on capacity development, including education, training and support to countries facing difficulties in assessing and using the new types of products that will either request specifically, or be made available to them. There will be a challenge in interpreting the value (accuracy, relevance and impact on decision-making processes) of specific products, as well as disseminating and presenting them to users. A key issue here will be for WMO to ensure that progress made in a subset of countries in providing a more diverse, probabilistic based and impact focused set of products is actually useful to those countries who presently lack the capacity to make best use of underlying techniques. These, countries are often those which need them most. Moreover, as products become more closely tied to regional and local features and issues, this capacity development will need to be fine-tuned to regional, national and local needs. Therefore, education and training will follow approaches described in the WMO Capacity Development Strategy available at: <http://www.wmo.int/pages/prog/dra/CDS.html>.

**5. Benefits**

The benefits of the future GDPFS can be articulated along three axes: contribution to the UN and WMO agendas, the quality, diversity and relevance of GDPFS information and the furthering of existing and new partnerships. Fundamentally, the new WMO GDPFS will expand tremendously the quality, relevance and impact of data and forecast information related to the UN Sustainable Development Agenda, and particularly the three Global Societal Needs identified in the WMO 2016-2019 Strategic Plan. At the same time, because of the fundamental nature of the evolution of the GDPFS, it will bring in new partners, including private sector operators and academia. Although it is too early at this time to define more precisely this evolution, in the end, it should yield direct benefits to decision makers or ordinary individual clients and users in optimizing either their business practices, risk mitigation of threatening environmental high impact events, or longer range adaptation and sustainable strategies.

**6. Opportunities, Success factors and Challenges**

**6.1 The context**

The weather, water, climate and earth system observations and predictions are, first and foremost, science-based and highly technological (largely IT-related). This information has global reach and relevance, and is key to countless decision-making processes, be it on: 1) global policy-making issues (UNFCC, UNCD, Ozone, COP21, transport of atmospheric pollutants and toxics and associated morbidity, nuclear weapons controls, etc.), 2) global weather, water and climate related disaster risk reduction, and 3) important and steadily growing socio-economic impacts, often stemming from unsustainable growth practices.

Recently, significant scientific progresses in both observational technology (particularly, but not exclusively, space-based observing systems), as well as novel climate and weather data assimilation and modeling practices, have led us to the possibility of vastly expanding the diversity of its environmental information potential. At the same time, it is fair to say that both the information technology and dissemination related processes are evolving at an accelerating pace (the transition of the traditional paper-based written media to a largely IT-based dissemination process (tablet, smart-phone, etc.) provides a good example of this acceleration. Given that there is a global market for the types of products NMHSs as well as regional and global centers, largely publicly funded, are on the verge of making available, it is reasonable to expect an increasing interest from the private sector with potential partnerships with the academia to take a share of the market (in fact, this has already started).

**6.2 Important issues needing consideration**

Throughout this document, and in many of the discussions with the group of experts, it is possible to identify a number of important issues that need some consideration if the proposed evolution of the GDPFS is to be a success:

**6.2.1 Access to data and observations**

One important consequence of moving towards a seamless and integrated modeling approach is access to new, and sometimes non-traditional observations, and at much higher spatial and temporal resolutions than has been customary. This follows from the fact that forecast products will expand to new disciplinary or thematic domains, which so far have not been part of the traditional inputs and outputs of production centers of NMHS's.

There are also other dimensions to consider: standards and formats, interoperability of the information, information storage, telecom bandwidth and downstream computing and post-processing (this may lead the GDPFS to establish globally distributed storage farms such as what CERN has done to manage the information generated by the LHC and make available the basic information along with the approved piece of code to generate the post-processed information on cloud computing platforms. This will require discussions on availability and data exchange protocols between WMO Members and other international, regional and national organizations.

Similarly, the concept of "risk-based warnings" and "impact-based forecasting" requires access and sharing of novel types of data (infrastructure, emergency decision-making policies, population distribution, transportation networks, etc.), not easily amenable to present guidelines on formats, metadata, validation, etc. Moreover, some countries could be reluctant to make this data available for all kinds of reasons. Again, there will be a need for extensive discussions between WMO Members and the other organizations controlling access to these data.

**6.2.2 Future information products: optimal production, dissemination and usage, and feedback**

Many of the future warning and forecast data and information, such as those related to air quality, hydrological, marine, aviation, agro-meteorological information, and more generally speaking socio-economic applications are often of use for organizations outside traditional NMHS's. These organizations have their own internal decision-making processes, data and forecast related protocols, partners and user bases. A good example was provided for hydrological forecasting. And similar issues exist for other services. Again, WMO will need to establish the necessary partnerships, in order expand the current GDPFS to include these new products. In fact, concerning so-called "big data" related issues and applications; WMO has already started such a process through its Executive Council Task Team on Data Policies and Emerging Issues (EC-TT DPEI).

Another key aspect, which requires further consideration, is user information and feedback. The creation by WMO of some form of Client-Provider Interface geographically or thematically structured is perhaps worth some further consideration.

**6.2.3 Transition towards a new global, regional and national production infrastructure**

Much of the information also depends on very high-resolution observational and modeling grids, often at the kilometer size and less. A relatively small number of countries actually have the capacity (human and technical) to operate at these resolutions. And at this time, at least, it does not seem feasible to generate these products at a small number of central locations (e.g., global NWP centers) for global distribution. In order to help prevent the widening of a gap between the countries, which possess the capacity, and those that do not, some transitory and eventually permanent solutions will have to be found, perhaps involving private sector or academia-led initiatives, or use of new computing technologies, such as cloud-computing.

**6.2.4 Training and capacity building**

The increasing complexity of many of the products will in turn increasingly require an increase in the capacity of the users (NMHSs or others) to make optimal usage of their information content. This will represent a challenge for most countries, and necessitate a strategic re-think of WMO's and its Members approach to training and capacity-building initiatives.

**6.2.5 Organizational impacts**

Finally, as this expansion of the scope of the GDPFS happens, and numerous agreements and partnerships with new international, regional and national organizations are struck, there could be pressures from countries and partners to revisit the current membership structures. For example, it could be that some countries will wish to be represented by different types of managers or administrators along with the current Directors or CEOs of NMHSs.

**6.3 Policy considerations**

From the preceding Sections, it becomes clear that whilst the evolution of the GDPFS proper remains an internal management and operational issue, it will also require EC and Congress to consider a number of policy issues, which will guide, clarify and facilitate this evolution.

**6.3.1 Open data policies**

In order to fulfill WMO's vision, and a successful evolution of the GDPFS, free and open access to all necessary data, particularly observations, is critical. We are already witnessing initiatives, some led by the private sector, where new observations are either not shared openly, or if so, at reduced spatial and temporal resolutions, or against cost. At the same time, while most observations paid for by the public purse have open access, particularly to the private sector and academia, some are not. There are also related issues linked with formats, validation and quality control. Eventually, some policy decisions will be required to clarify these issues and propose some solutions.

**6.3.2 Role of the private sector and the academia**

This issue is closely linked with open data policies. However, there is also increasing evidence that some major corporations are moving towards establishing their own internal data processing and forecasting capacities, including global analyses and predictions. Given the potential value of applications derived from such capacities, mostly targeting specific socioeconomic sectors, they will in a sense potentially duplicate or compete with public good products, made available through the future GDPFS. At some point, some policy decisions might be needed to as to how the GDPFS should take these developments into account.

**6.3.3 Training and capacity building**

We have already alluded to the linkages of this aspect to the evolution of the GDPFS. In the discussions leading to this paper, there was often mention of the high priority that should be given to this issue. As the products become even more complex, both in their content, as well as in their formats (ensemble products, impact based, etc.), and target many new and different non traditional sectors, training and capacity building will become essential to the success of the GDPFS evolution, unless one accepts the possibility of increasing gaps between members. Discussions between Members and eventually policy decisions will probably be needed.

**6.3.4 GDPFS information quality assessment**

One of the key benefits obtained by WMO Members from using GDPFS products should be assurance on their quality, accuracy and reliability. Concerning weather prediction activities, for which the WMO is the UN lead agency, and which is its core business (e.g. GDPFS, etc.), there is no official external scientific assessment (produced say by an international team of experts, similar to IPCC Assessment Reports) of quality, accuracy and reliability of these products.

It may be worth it for WMO to consider putting together a core team of experts, under the leadership of RES/WWRP and WDS/DPFS to produce scientific assessments and reports on quality, accuracy and reliability of GDPFS products. This may include reporting on Predictability of various weather parameters by the seamless GDPFS. This would reaffirm WMO global leadership in these matters, but would also contribute very positively to the future evolution of the GDPFS, help its users in their decision-making activities, and facilitate the discussions with potential new partners.

**7. Road map for implementation and timelines**

**7.1 Phases**

Theplanning and implementation of the GDPFS evolution process should proceed in phases defined by the CBS led Steering Group on Seamless GDPFS and vetted by EC in order to assure oversight, review and direction. Most likely, there will be two main phases which may take a few years to complete: a) The implementation phase will focus on developing and implementing a framework for seamless GDPFS (including Management of project, initiation of pilot projects to prove the concept, identification of procedures etc.); b) Operational implementation

The process foreseen was one where planning and implementation of an integrated and seamless WMO GDPFS would culminate with the adoption by Eighteenth Congress (CG-18) in 2019.

**7.2 Terms of Reference (ToRs) for the Steering Group for the Seamless GDPFS**

The CBS Management Group (February 2016) recommended the establishment of a Steering Group for the Seamless GDPFS. It proposed that the Steering Group be chaired by the president of CBS and will be comprised of representatives of technical commissions and regional associations. The following Terms of Reference is proposed:

(1) Develop and document various phases for the implementation of seamless GDPFS;

(2) Provide guidance and monitor the development of the process for the gradual establishment of a future enhanced integrated and seamless WMO Data-processing and Forecasting System;

(3) Manage the integration of new components in the GDPFS, including addressing synergies with and requirements of all WMO Programs and Regions, through active consultations with technical commissions and regional associations;

(4) Develop, following the advise of the subsidiary bodies of the technical commissions and regional associations, a description of the set of products the system should produce;

(5) Complete the detailed White Paper along with the Implementation Plan for consideration by EC-69.

**7.3 Priorities and pilot projects**

The Steering Group for the Seamless GDPFS should also propose “pilot projects designed to test the concept of seamless GDPFS so that problem areas are identified earlier and addressed, therefore helping to fine tune the implementation plan.. Some examples of potential pilot projects follow:

(a) Identifying 1 or 2 geographical areas, where a system capable of producing impact-based forecasting and risk based-warning (IBF & RBW) could be tested to demonstrate the feasibility and benefits of the integrated and seamless approach; this would require good links with the PWS programme, and its Expert Team on Impact (ET-IMPACT). In addition, it is important to ensure that the project is aligned with existing ones (e.g. SWFDP, CIFDP, FFGS) where appropriate;

(b) Select a few examples from the GFCS list of potential applications to test the seamless approach;

(c) Develop and test a coupled weather-climate-water forecasting system over a major basin (CHAMMP)

(d) Develop and test a prototype Integrated Global (or regional) Greenhouse Gas Information System (IG3IS); (e) Develop and test an operational TIGGE or TIGGE LAM, where appropriate.

In conclusion, it is believed that the proposed evolution of the GDPFS along the ideas expressed here will generate important benefits for Members, their National Meteorological, Climate and Hydrological Services and for the WMO as a whole. It would also be an important element in the efforts towards a crosscutting approach on topics of interest within WMO.

**7.4 Cost/Governance**

The move to seamless GDPFS will require resources. A Project Office, including a Project Manager and a small team, will be necessary. It is suggested that WMO, through its DRA/Resource Mobilization Office, may raise extra-budgetary funding to support it. A Task Team of Experts may be necessary under the OPAG of DPFS to work on the details of implementation plan and guidelines.

**List of acronyms**

WMO World Meteorological Organization

FDP Forecast demonstration project

RDP Research Demonstration Project

TCP Tropical Cyclone Programme

RA Regional Association

NWP Numerical Weather Prediction

CSIS Climate Services Information System

GFCS Global Framework for Climate Services

UIP User Interface Platform

AMDAR Aircraft Meteorological Data Relay

EC Executive Council

CG World Meteorological Congress

IBF Impact-Based Forecasting

RBW Risk-Based Warning

WIGOS WMO Integrated Global Observing System

WIS WMO Information System

CAS Commission for Atmospheric Sciences

CAgM Commission for Agricultural Meteorology

CCl Commission for Climatology

JCOMM Joint WMO-UNESCO/IOC Commission for Oceanography and Marine Meteorology

UN United Nations

UNEP UN Environmental Programme

UNESCO UN Educational, Scientific and Cultural Organization

IAEA International Atomic Energy Agency

IOC Intergovernmental Oceanographic Commission

WHO World Health Organization

GEO Group on Earth Observations

ICSU International Council for Science

GCM Global Climate Model

GAW Global Atmosphere Watch

WWRP World Weather Research Programme

GURME GAW Urban Research Meteorology and Environment

WCRP World Climate Research Programme

GCOS Global Climate Observing System

UNFCC UN Framework Convention on Climate Change

UNCCD UN Convention to Combat Desertification

COP Conference of the Parties

CERN Conseil Européen pour la Recherche Nucléaire (European Organization for Nuclear Research)

LHC Large Hadron Collider

CHAMMP Coupled Hydrology-Atmosphere Modeling and Prediction

TIGGE THORPEX Interactive Grand Global Ensemble

LAM Limited Area Model